

Optical Coherence Tomography and Coherence Techniques VI

Brett E. Bouma
Rainer A. Leitgeb
Editors

13–15 May 2013
Munich, Germany

Sponsored by
The Optical Society (United States)
SPIE

With Support From
Air Force Office of Scientific Research (United States)
ThorLabs (United Kingdom)

Student Award Sponsors
Toptica Photonics AG (Germany)
Zeiss (United States)

Published by
SPIE

Volume 8802

Proceedings of OSA Biomedical Optics-SPIE, 1605-7422, V. 8802

Optical Coherence Tomography and Coherence Techniques VI, edited by Brett E. Bouma, Rainer A. Leitgeb,
Proc. of OSA Biomedical Optics-SPIE Vol. 8802, 880201 · © OSA-2013 SPIE
CCC code: 1605-7422/13/\$18 · doi: 10.1117/12.2034120

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 *Optical Coherence Tomography and Coherence Techniques VI*, edited by Brett E. Bouma, Rainer A. Leitgeb, Proceedings of OSA Biomedical Optics-SPIE Vol. 8802 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 1605-7422

ISBN: 9780819496515

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

The Optical Society

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 © 2013, Society of Photo-Optical Instrumentation Engineers and The Optical Society.

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 1605-7422/13/\$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, 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

- ix *Conference Committee*
xi *Introduction*

SESSION 1 ADVANCEMENTS IN TECHNOLOGY AND APPLICATIONS

- 8802 02 **Advanced integrated spectrometer designs for miniaturized optical coherence tomography systems** [8802-11]
B. I. Akca, Univ. Twente (Netherlands); B. Považay, Medizinische Univ. Wien (Austria); L. Chang, Univ. Twente (Netherlands); A. Alex, Medizinische Univ. Wien (Austria); K. Wörhoff, R. M. de Ridder, Univ. Twente (Netherlands); W. Drexler, Medizinische Univ. Wien (Austria); M. Pollnau, Univ. Twente (Netherlands)
- 8802 03 **An advanced algorithm for dispersion encoded full range frequency domain optical coherence tomography** [8802-5]
F. Köttig, P. Cimalla, M. Gärtner, E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)
- 8802 04 **Bone regeneration assessment by optical coherence tomography and MicroCT synchrotron radiation** [8802-19]
M. L. Negruțiu, C. Sinescu, S. Canjau, Univ. of Medicine and Pharmacy Victor Babes Timișoara (Romania); A. Manescu, Univ. Politecnica delle Marche (Italy); F. I. Topală, B. Hoinoiu, M. Romînu, C. Mărcăuțeanu, Univ. of Medicine and Pharmacy Victor Babes Timișoara (Romania); V. Duma, Aurel Vlaicu Univ. of Arad (Romania); A. Bradu, A. G. Podoleanu, Univ. of Kent (United Kingdom)
- 8802 05 **Towards increase of diagnostic efficacy in gynecologic OCT** [8802-2]
M. Kirillin, Institute of Applied Physics (Russian Federation); O. Panteleeva, Institute of Applied Physics (Russian Federation) and Clinical Hospital of the Russian Railways (Russian Federation); D. Eliseeva, Institute of Applied Physics (Russian Federation) and Nizhny Novgorod State Medical Academy (Russian Federation); O. Kachalina, Nizhny Novgorod State Medical Academy (Russian Federation); E. Sergeeva, Institute of Applied Physics (Russian Federation); L. Dubasova, P. Agrba, Institute of Applied Physics (Russian Federation) and N.I. Lobachevsky State Univ. of Nizhni Novgorod (Russian Federation); G. Mikailova, Nizhny Novgorod State Medical Academy (Russian Federation); M. Prudnikov, Institute of Applied Physics (Russian Federation); N. Shakhova, Institute of Applied Physics (Russian Federation) and Nizhny Novgorod State Medical Academy (Russian Federation)
- 8802 06 **Evaluating the benefits of using balance detection in Fourier domain optical coherence tomography** [8802-7]
A. Bradu, A. Podoleanu, Univ. of Kent (United Kingdom)

SESSION 2 ELASTOGRAPHY

- 8802 07 **Preliminary study of digital image correlation based optical coherence elastography** [8802-27]
C. Sun, Ryerson Univ. (Canada) and Univ. of Toronto (Canada); B. Vuong, Ryerson Univ. (Canada); X.-Y. Wen, Univ. of Toronto (Canada); V. Yang, Ryerson Univ. (Canada), Univ. of Toronto (Canada), and Sunnybrook Health Science Ctr. (Canada)
- 8802 08 **Correlation-stability elastography in OCT: algorithm and in vivo demonstrations** [8802-20]
V. Y. Zaitsev, L. A. Matveev, Institute of Applied Physics (Russian Federation) and Nizhny Novgorod State Univ. (Russian Federation); A. L. Matveyev, G. V. Gelikonov, Institute of Applied Physics (Russian Federation) and Nizhny Novgorod State Medical Academy (Russian Federation); V. M. Gelikonov, Institute of Applied Physics (Russian Federation) and Nizhny Novgorod State Univ. (Russian Federation)

SESSION 3 OPTICAL COHERENCE MICROSCOPY AND DIGITAL HOLOGRAPHY

- 8802 09 **Mirau-based full-field time-domain optical coherence tomography using Ce³⁺:YAG crystal fiber light source** [8802-10]
C.-C. Tsai, Y.-T. Wang, T.-S. Ho, National Taiwan Univ. (Taiwan); M.-Y. Lin, J.-W. Tjiu, National Taiwan Univ. College of Medicine (Taiwan); K.-Y. Hsu, C.-K. Chang, S.-L. Huang, National Taiwan Univ. (Taiwan)
- 8802 0A **Dynamic imaging by full-field optical coherence microscopy with a sCMOS detector and Riesz transform-based demodulation** [8802-29]
S. E. Schausberger, B. Heise, D. Stifter, Johannes Kepler Univ. Linz (Austria)

SESSION 4 ADAPTIVE OPTICS AND RESOLUTION ENHANCEMENT

- 8802 0B **Real-time depth-resolved Shack-Hartmann measurements** [8802-12]
J. Wang, A. G. Podoleanu, Univ. of Kent (United Kingdom)
- 8802 0C **Control of focusing in high resolution eye imaging and microscopy using a deformable mirror** [8802-13]
C. Costa, J. Rogers, A. Bradu, A. Podoleanu, Univ. of Kent (United Kingdom)
- 8802 0D **Estimation of weighted multi-scatterer contributions for improvement of lateral resolution of optical coherence tomography images** [8802-22]
E. Bousi, C. Pitris, Univ. of Cyprus (Cyprus)

SESSION 5 ENDOSCOPIC AND INTRAVASCULAR OCT

- 8802 0E **High speed 3D endoscopic optical frequency domain imaging probe for lung cancer diagnosis** [8802-15]
J. Li, F. Feroldi, J. Mo, F. Helderma, M. de Groot, J. F. de Boer, Vrije Univ. Amsterdam (Netherlands)

8802 0F **Four-dimensional optical coherence tomography imaging of total liquid ventilated rats** [8802-8]
L. Kirsten, C. Schnabel, M. Gaertner, E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)

8802 0G **Optical coherence tomography assessment of vessel wall degradation in aneurysmatic thoracic aortas** [8802-17]
E. Real, A. Eguizabal, Univ. de Cantabria (Spain); A. Pontón, Univ. Hospital Marqués de Valdecilla (Spain) and Univ. de Cantabria (Spain); J. F. Val Bernal, M. Mayorga, J. M. Revuelta, Univ. Hospital Marqués de Valdecilla (Spain) and Univ. de Cantabria (Spain); J. M. López-Higuera, O. M. Conde, Univ. de Cantabria (Spain)

SESSION 6 OPTHALMIC OCT I

8802 0H **Angio-OCT as a noninvasive tool for three-dimensional vascular network visualization in retinal diseases (Invited Paper)** [8802-21]
D. Bukowska, D. Ruminski, Nicolaus Copernicus Univ. (Poland); B. L. Sikorski, Nicolaus Copernicus Univ. (Poland) and Collegium Medicum, Nicolaus Copernicus Univ. (Poland); I. Gorczynska, D. Borycki, M. Szkulmowski, M. Wojtkowski, Nicolaus Copernicus Univ. (Poland)

8802 0I **High-resolution optical coherence tomography in mouse models of genetic and induced retinal degeneration** [8802-26]
P. Cimalla, Universitätsklinikum Carl Gustav Carus Dresden (Germany); M. Carido, S. Pran Babu, T. Santos-Ferreira, DFG-Ctr. for Regenerative Therapies Dresden (Germany); M. Gaertner, S. Kordowich, D. Wittig, Universitätsklinikum Carl Gustav Carus Dresden (Germany); M. Ader, DFG-Ctr. for Regenerative Therapies Dresden (Germany); M. Karl, DFG-Ctr. for Regenerative Therapies Dresden (Germany) and Deutsches Zentrum für Neurodegenerative Erkrankungen e. V. (Germany); E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)

SESSION 7 OPTHALMIC OCT II

8802 0J **Segmentation of the macular choroid in OCT images acquired at 830nm and 1060nm** [8802-18]
S. Lee, M. F. Beg, M. V. Sarunic, Simon Fraser Univ. (Canada)

SESSION 8 BLOOD FLOW IMAGING AND SPECKLE

8802 0K **Velocity noise reduction by using enhanced joint spectral and time domain optical coherence tomography** [8802-23]
J. Walther, E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)

8802 0L **Speckle suppression in Fourier domain optical coherence tomography by fractional Fourier domain compounding** [8802-28]
N. Lippok, F. Vanholsbeeck, P. Nielsen, The Univ. of Auckland (New Zealand)

SESSION 9 SPECTROSCOPIC OCT AND CONTRASTING TECHNIQUES

- 8802 0M **Magnetomotive imaging of iron oxide nanoparticles as cellular contrast agents for optical coherence tomography** [8802-25]
P. Cimalla, T. Werner, M. Gaertner, C. Mueller, J. Walther, D. Wittig, Universitätsklinikum Carl Gustav Carus Dresden (Germany); M. Ader, DFG-Ctr. for Regenerative Therapies Dresden (Germany); M. Karl, DFG-Ctr. for Regenerative Therapies Dresden (Germany) and Deutsches Zentrum für Neurodegenerative Erkrankungen e. V. (Germany); E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)
- 8802 0N **Dispersion mapping at the micron scale using tri-band optical frequency domain imaging** [8802-30]
N. Lippok, S. Murdoch, K.-L. Wu, P. Nielsen, F. Vanholsbeeck, The Univ. of Auckland (New Zealand)

SESSION 10 HOT TOPICS AND POSTDEADLINE SESSION

- 8802 0O **Ultrahigh-speed intravascular optical coherence tomography imaging at 3200 frames per second** [8802-24]
T. Wang, Erasmus MC (Netherlands); W. Wieser, Ludwig-Maximilians-Univ. München (Germany); G. Springeling, R. Beurskens, C. T. Lancee, Erasmus MC (Netherlands); T. Pfeiffer, Ludwig-Maximilians-Univ. München (Germany); A. F. W. van der Steen, Erasmus MC (Netherlands) and Interuniv. Cardiology Institute of the Netherlands (Netherlands); R. Huber, Ludwig-Maximilians-Univ. München (Germany); G. van Soest, Erasmus MC (Netherlands)

POSTER SESSION

- 8802 0P **In-vivo imaging of keratoconic corneas using high-speed high-resolution swept-source OCT** [8802-14]
S. Marschall, A. Gawish, Y. Feng, L. Sorbara, P. Fieguth, K. Bizheva, Univ. of Waterloo (Canada)
- 8802 0Q **Single fiber perfusion phantom for optical coherence tomography** [8802-1]
P. Podlipná, St. Anne's Univ. Hospital Brno (Czech Republic); R. Kolář, Brno Univ. of Technology (Czech Republic)
- 8802 0R **Optical coherence tomography as a reference method for the detection of nanoparticles in thin-film polymer matrices** [8802-9]
L. Kirsten, M. Mehner, Universitätsklinikum Carl Gustav Carus Dresden (Germany); R. Grombe, T. Linsinger, H. Emons, European Commission, Joint Research Ctr., Institute for Reference Materials and Measurements (Belgium); E. Koch, Universitätsklinikum Carl Gustav Carus Dresden (Germany)

8802 OS

Texture based segmentation method to detect atherosclerotic plaque from optical tomography images [8802-6]

A. Prakash, Univ. of Manitoba (Canada); M. Hewko, M. Sowa, National Research Council Canada (Canada); S. Sherif, Univ. of Manitoba (Canada)

Author Index

Conference Committee

General Chairs

Irene Georgakoudi, Tufts University (United States)
Peter Andersen, Technical University of Denmark (Denmark)

Programme Chairs

Jürgen Popp, Friedrich-Schiller Universität Jena (Germany)
Andreas H. Hielscher, Columbia University (United States)

Conference Chairs

Brett E. Bouma, Harvard Medical School (United States)
Rainer A. Leitgeb, Medizinische Universität Wien (Austria)

Conference Program Committee

Jennifer K. Barton, The University of Arizona (United States)
Stephen A. Boppart, University of Illinois at Urbana-Champaign
(United States)
Adrien Desjardins, University College London (United Kingdom)
James G. Fujimoto, Massachusetts Institute of Technology
(United States)
Valentin M. Gelikonov, Institute of Applied Physics
(Russian Federation)
Robert A. Huber, Ludwig-Maximilians-Universität München (Germany)
Martin Leahy, National University of Ireland, Galway (Ireland)
Wang-Yuhl Oh, KAIST (Korea, Republic of)
Michael Pircher, Medizinische Universität Wien (Austria)
Adrian Gh. Podoleanu, University of Kent (United Kingdom)
Andrew M. Rollins, Case Western Reserve University (United States)
David D. Sampson, The University of Western Australia (Australia)
Gijs van Soest, Erasmus MC (Netherlands)
Maciej Wojtkowski, Nicolaus Copernicus University (Poland)
Yoshiaki Yasuno, University of Tsukuba (Japan)

Session Chairs

- 1 Advancements in Technology and Applications
Rainer A. Leitgeb, Medizinische Universität Wien (Austria)
- 2 Elastography
David D. Sampson, The University of Western Australia (Australia)

- 3 Optical Coherence Microscopy and Digital Holography
Maciej Wojtkowski, Nicolaus Copernicus University (Poland)
 - 4 Adaptive Optics and Resolution Enhancement
Adrian Gh. Podoleanu, University of Kent (United Kingdom)
 - 5 Endoscopic and Intravascular OCT
Rainer A. Leitgeb, Medizinische Universität Wien (Austria)
 - 6 Ophthalmic OCT I
Robert A. Huber, Ludwig-Maximilians-Universität München (Germany)
 - 7 Ophthalmic OCT II
Michael Pircher, Medizinische Universität Wien (Austria)
 - 8 Blood Flow Imaging and Speckle
Maciej Wojtkowski, Nicolaus Copernicus University (Poland)
 - 9 Spectroscopic OCT and Contrasting Techniques
Brett E. Bouma, Harvard Medical School (United States)
 - 10 Hot Topics and Postdeadline Session
Jürgen Popp, Friedrich-Schiller Universität Jena (Germany)
Andreas H. Hielscher, Columbia University (United States)
- Poster Session
Andreas H. Hielscher, Columbia University (United States)

Introduction

This volume is a collection of papers presented at the Optical Coherence Tomography and Coherence Techniques VI conference held May 13–15, 2013 at the European Conference on Biomedical Optics in Munich, Germany.

The present proceedings provide an excellent overview about current state-of-the-art OCT technology as well as advance in holography and Laser Speckle Imaging and gives new perspectives for applications in medicine, biology, and material sciences.

The conference was organized into the following 9 sessions: Advancements in Technology and Applications, Optical Coherence Microscopy and Digital Holography, Adaptive Optics and Resolution Enhancement, Endoscopic and Intravascular OCT, Ophthalmic OCT I&II, Blood Flow Imaging and Speckle, Spectroscopic OCT and Contrasting Techniques. Moreover, this year, a full session was dedicated to an emerging field in OCT, Elastography. As usual, OCT focused papers were predominant throughout the sessions. However, we were happy to see interesting contributions of the field of holography and from Laser Speckle Imaging.

All submissions were peer-reviewed and scored by the conference committee members, who were instrumental for keeping the high quality of presented papers. Authors were requested to submit a 3-page summary. The conference included six excellent invited presentations that were selected as the top six scored submissions:

Branislav Grajciar, Quantitative phase contrast optical coherence microscopy for imaging live cell dynamics, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, Austria

Danuta M. Bukowska, Angio-OCT as a noninvasive tool for three-dimensional vascular network visualization in retinal diseases, Nicolaus Copernicus University, Torun, Poland.

David G. Blauvelt, Three-dimensional in vivo blood flow mapping in tumors using optical frequency domain imaging, Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, MA, USA,

Martin Villiger, Characterization of coronary plaques with polarization sensitive optical frequency domain imaging, Wellman Center for Photomedicine, Harvard Medical School and Massachusetts General Hospital, Boston, MA, USA,

Amir Nahas, 3D static elastography and shear wave imaging using Full Field OCT, Langevin Institute, Paris, France,

Bernhard Baumann, Polarization sensitive optical coherence tomography for quantitative assessment of tissue properties in the rat eye in vivo, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, Austria;

The conference chairs would like to thank the members of the Technical Program Committee for their considerable effort in reviewing and scoring all submissions and for their help in organizing the conference. We appreciate the support from OSA, SPIE, and the conference staff. Finally we would like to thank all the conference attendees and manuscript authors for their contributions and participation that helped to make this conference a success.

Brett E. Bouma
Rainer A. Leitgeb