PROGRESS IN BIOMEDICAL OPTICS AND IMAGING
Vol. 17 No. 22

Optical Elastography and Tissue Biomechanics III

Kirill V. Larin
David D. Sampson
Editors

13–15 February 2016
San Francisco, California, United States

Sponsored by
SPIE

Cosponsored by
Thorlabs, Inc.

Published by
SPIE

Volume 9710

Proceedings of SPIE, 1605-7422, V. 9710

Optical Elastography and Tissue Biomechanics III, edited by Kirill V. Larin, David D. Sampson, Proc. of SPIE
Vol. 9710, 971001 · © 2016 SPIE · CCC code: 1605-7422/16/$18 · doi: 10.1117/12.2239750

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 SPIEDigitalLibrary.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 *Optical Elastography and Tissue Biomechanics III*, edited by Kirill V. Larin, David D. Sampson, Proceedings of SPIE Vol. 9710 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 1605-7422
ISSN: 2410-9045 (electronic)
ISBN: 9781628419443

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

Printed in the United States of America.

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

SPIEDigitalLibrary.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

NOVEL METHODS III

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.

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 Chair

Steven L. Jacques, Oregon Health and Science University (United States)

Conference Chairs

Kirill V. Larin, University of Houston (United States)
David D. Sampson, The University of Western Australia (Australia)

Conference Program Committee

Jeffrey C. Bamber, The Royal Marsden NHS Foundation Trust (United Kingdom)
Claude Boccara, Institut Langevin (France)
Stephen A. Boppart, University of Illinois at Urbana-Champaign (United States)
Brett E. Bouma, Wellman Center for Photomedicine, Massachusetts General Hospital (United States)
Zhongping Chen, Beckman Laser Institute and Medical Clinic (United States)
Donald D. Duncan, Portland State University (United States)
Kishan Dholakia, University of St. Andrews (United Kingdom)
Daniel S. Elson, Imperial College London (United Kingdom)
Mathias Fink, Institut Langevin (France)
Brendan F. Kennedy, The University of Western Australia (Australia)
Sean J. Kirkpatrick, Michigan Technological University (United States)
Seemantini K. Nadkarni, Harvard School of Medicine (United States)
Kentaro Nakamura, Tokyo Institute of Technology (Japan)
Amy L. Oldenburg, The University of North Carolina at Chapel Hill (United States)
Francesco S. Pavone, European Laboratory for Non-linear Spectroscopy (Italy)
Andrew E. Pelling, University of Ottawa (Canada)
Gabriel Popescu, University of Illinois at Urbana-Champaign (United States)

Giuliano Scarcelli, University of Maryland (United States)
Gijs van Soest, Erasmus MC (Netherlands)
Victor X. D. Yang, Ryerson University (Canada)
Seok Hyun A. Yun, Wellman Center for Photomedicine, Massachusetts General Hospital (United States)
Ruikang K. Wang, University of Washington (United States)
Qifa Zhou, The University of Southern California (United States)

Session Chairs

1 Novel Methods I
Stephen A. Boppart, University of Illinois at Urbana-Champaign (United States)
Kishan Dholakia, University of St. Andrews (United Kingdom)

2 Cellular and Extracellular Mechanics
Seok Hyun A. Yun, Wellman Center for Photomedicine, Massachusetts General Hospital (United States)
Gabriel Popescu, University of Illinois at Urbana-Champaign (United States)

3 Novel Methods II
Amy L. Oldenburg, The University of North Carolina at Chapel Hill (United States)

4 Brillouin Elastography
Claude Boccara, Institut Langevin (France)
Ruikang K. Wang, University of Washington (United States)

5 Elastography Methods and Applications I
Qifa Zhou, The University of Southern California (United States)
Giuliano Scarcelli, University of Maryland (United States)

6 Elastography Methods and Applications II
Gijs van Soest, Erasmus MC (Netherlands)
Francesco S. Pavone, European Laboratory for Non-linear Spectroscopy (Italy)
Kentaro Nakamura, Tokyo Institute of Technology (Japan)

7 Keynote Session
David D. Sampson, The University of Western Australia (Australia)

8 Computation and Modeling in Elastography I
Brendan F. Kennedy, The University of Western Australia (Australia)
Mathias Fink, Institut Langevin (France)

9 Computation and Modeling in Elastography II
Jiang Zhu, Beckman Laser Institute and Medical Clinic (United States)

Introduction

Optical elastography is the use of optics to characterize cells and tissues based on their mechanical properties. In utilizing the high-resolution capability of optics, this rapidly emerging field builds on and complements the related fields of ultrasound and MR elastography, as well as existing biomechanics methods, such as atomic force microscopy, cell indentation, micropipette aspiration, and particle rheology.

Mechanical forces play an important role in biological behavior and development at all spatial scales, from cells and their constituents to tissues and organs, and influence health, structural integrity, and normal function. High-resolution optical methods could help further the understanding of such mechanical interactions and properties in the cell mechanics and clinical diagnosis of a wide range of diseases. An important part of this contribution is expected to be the accurate determination of cell and tissue biomechanical properties, such as Young's or shear modulus.

This third annual conference continued the vibrant intellectual ambience of the first two conferences and displayed a strongly multidisciplinary character, bringing together technology and applications experts in bioengineering, biophysics, cell biology, clinical sciences, medical imaging, optics and photonics, and tissue engineering. This year, 49 contributed papers were built around 2.5 days of invited and contributed talks and posters. Exceptional keynote and invited speakers headlined the program:

Keynote:
Dennis E. Discher, University of Pennsylvania (United States), "Cells might not see where they are but they certainly feel the mechanics of their microenvironment!"

Invited:
Zhongping Chen, Beckman Laser Institute and Medical Clinic (United States), "Acoustic radiation force optical coherence elastography"

Brendan F. Kennedy, The University of Western Australia (Australia), "Compression optical coherence elastography for improved diagnosis of disease"

Seemantini K. Nadkarni, Harvard School of Medicine (United States), "Laser speckle rheology"

Assad A. Oberai, Rensselaer Polytechnic Institute (United States), "Inverse problems in biomechanical imaging"

This year's keynote speaker, Dennis E. Discher, provided insight on biomechanics at the cellular level. He provided a comprehensive overview of the role of mechanical forces during everyday cellular activity. Special acknowledgement goes to Thorlabs, Inc., whose sponsorship supported this keynote session. Highlights of this year's contributed program include the progress and impact made in Brillouin microscopy, and in both the shear wave and compression-based optical coherence elastography approaches. Applications in the anterior eye continued to grow, with some important progress in breast cancer and interesting new approaches to imaging skin and scar mechanical properties.

Optical Elastography and Tissue Biomechanics has confirmed its important place in supporting this emerging area – we look forward with excitement and anticipation to see what the next twelve months will bring. In the meantime, please enjoy reading the papers submitted for this volume.

Kirill V. Larin
David D. Sampson