Front Matter: Volume 10880
Optical Elastography and Tissue Biomechanics VI

Kirill V. Larin
Giuliano Scarcelli
Editors

2–3 February 2019
San Francisco, California, United States

Sponsored by
SPIE

Cosponsored by
Thorlabs (United States)

Published by
SPIE

Volume 10880
## Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>v</td>
<td>Authors</td>
</tr>
<tr>
<td>vii</td>
<td>Conference Committee</td>
</tr>
<tr>
<td>xi</td>
<td>Introduction</td>
</tr>
</tbody>
</table>

### OPTICAL COHERENCE ELASTOGRAPHY I

| 10880 03 | Assessment of the biomechanical changes in cardiac tissue after myocardial infarction with optical coherence elastography [10880-2] |
| 10880 04 | Correlation of optical coherence elastography with clinical evaluation of systemic sclerosis [10880-3] |
| 10880 07 | Optimal frequency for vibrational optical coherence elastography (OCE) on tissue mechanical properties characterization [10880-6] |

### NOVEL METHODS I

| 10880 0G | Perspectives and advances in optical elastography (Invited Paper) [10880-15] |
| 10880 0H | Real-time and non-invasive quantitative phase imaging of pancreatic ductal adenocarcinoma cell mechanical properties [10880-16] |
| 10880 0K | Phase-sensitive OCT in monitoring of slow-rate strains in laser tissue reshaping [10880-19] |

### OPTICAL COHERENCE ELASTOGRAPHY II

| 10880 0P | Differentiation of murine colon pathology by optical and mechanical contrast using optical coherence tomography and elastography [10880-24] |

### BRILLOUIN ELASTOGRAPHY

<p>| 10880 16 | Sequentially-Shifted Excitation (SSE) Brillouin spectroscopy for recovering signal contaminated with strong scattering, absorption or fluorescence [10880-41] |</p>
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>10880 1D</td>
<td>A preliminary study on using reverberant shear wave fields in optical coherence elastography to examine mice brain ex vivo</td>
<td>10880-48</td>
</tr>
<tr>
<td>10880 1H</td>
<td>Evaluation of human corneal ulcer healing process using optical coherence tomography: an in vitro study</td>
<td>10880-52</td>
</tr>
<tr>
<td>10880 1I</td>
<td>Adaptive Doppler analysis for robust handheld optical coherence elastography</td>
<td>10880-53</td>
</tr>
<tr>
<td>10880 1J</td>
<td>OCE quantification of Poisson’s ratio through 2D speckle tracking</td>
<td>10880-54</td>
</tr>
<tr>
<td>10880 1K</td>
<td>Simultaneous reconstruction and displacement estimation for spectral-domain optical coherence elastography</td>
<td>10880-55</td>
</tr>
<tr>
<td>10880 1O</td>
<td>Assessing the effects of storage medium on the biomechanical properties of porcine lens with optical coherence elastography</td>
<td>10880-59</td>
</tr>
<tr>
<td>10880 1P</td>
<td>Quantifying lens elastic properties with optical coherence elastography as a function of intraocular pressure</td>
<td>10880-60</td>
</tr>
</tbody>
</table>
Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five 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.

Aglyamov, Salavat R., 0P, 1O, 1P
Assassi, Shervin, 04
Bagnaninchi, Pierre O., 0H, 1K
Baum, O. I., 0K
Canell, M., 0H
Das, Susobhan, 0P
Du, Yong, 0P
El Haj, A. J., 0H
El Haj, Alicia, 1K
Gamal, W., 0H
Garg, Harshita, 1J
Ge, Gary R., 0G, 1D
Gelikonov, G. V., 0K
Giannetto, Michael, 1D
Gilles, D., 0H
Huang, Zhihong, 07, 1H
Larin, Kirill V., 03, 04, 0P, 1O, 1P
Larina, Irina V., 03
Le, Triet, 0P
Leach, John, 03
Li, Chunhui, 07, 1H
Ling, Yuting, 1H
Liu, Chih-Hao, 03, 04, 0P
Liu, Xuan, 1I, 1J
Martin, James F., 03
Mason, Jonathan H., 1K
Matveev, L. A., 0K
Matveyev, A. L., 0K
Mestre, Humberto, 1D
Mohan, Chandra, 04, 0P
Nair, Achuth, 0P
Nedergaard, Maiken, 1D
Omelchenko, A. I., 0K
Parker, Kevin J., 0G, 1D
Purslow, Christine, 1H
Reinwald, Yvonne, 0H, 1K
Rippy, Justin, 03
Rodriguez, Jonathan, 1J
Rolland, Jannick P., 0G, 1D
Schiill, Alexander, 04
Serrels, A., 0H
Singh, Mamomohan, 03, 04, 0P, 1O, 1P
Smith, Christopher, 04
Sobol, E. N., 0K
Soomro, Sanam, 0P
Sovetsky, A. A., 0K
Theodore, Samuel, 04
Troyanova-Wood, Maria, 16
Wang, Chizhong, 1I
Wang, Jinjiang, 07
Wang, Ruikang, 07
Wang, Shang, 03
Wang, Yahui, 1I
Waters, Sarah, 1K
Wu, Chen, 1P
Yakovlev, Vladislav V., 16
Yang, Ying, 0H, 1H, 1K
Yuzhakov, A. V., 0K
Zaitsev, V. Y., 0K
Zaki, Farzana, 1I, 1J
Zhang, Duo, 07
Zhang, Hongqiu, 1O, 1P
Zhou, Kanheng, 07
Zvietcovich, Fernando, 0G, 1D
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 Medical School (United States)

Symposium Co-chairs:

Jennifer K. Barton, The University of Arizona (United States)
Wolfgang Drexler, Medical University of Vienna (Austria)

Program Track Chairs

E. Duco Jansen, Vanderbilt University (United States)
Jessica C. Ramella-Roman, Florida International University (United States)

Conference Chairs

Kirill V. Larin, University of Houston (United States)
Giuliano Scarcelli, University of Maryland, College Park (United States)

Conference Program Committee

Steven G. Adie, Cornell University (United States)
Jeffrey C. Bamber, Institute of Cancer Research (United Kingdom)
Albert Claude Boccara, Institut Langevin Ondes et Images (France)
Stephen A. Boppart, Beckman Institute for Advanced Science and Technology (United States)
Brett E. Bouma, Wellman Center for Photomedicine (United States)
Zhongping Chen, Beckman Laser Institute and Medical Clinic (United States)
Kishan Dholakia, University of St. Andrews (United Kingdom)
Christine P. Hendon, Columbia University (United States)
Davide Iannuzzi, Vrije Universiteit Amsterdam (Netherlands)
Brendan F. Kennedy, The University of Western Australia (Australia)
Sean J. Kirkpatrick, Michigan Technological University (United States)
Matthew O'Donnell, University of Washington (United States)
Amy L. Oldenburg, The University of North Carolina at Chapel Hill (United States)
Gabriel Popescu, University of Illinois at Urbana-Champaign (United States)
Jannick P. Rolland, University of Rochester (United States)
David D. Sampson, University of Surrey (United Kingdom)
Ian A. Sigal, University of Pittsburgh (United States)
Gijs van Soest, Erasmus MC (Netherlands)
Kandice Tanner, National Cancer Institute (United States)
Peter Török, Imperial College London (United Kingdom)
Ruikang K. Wang, University of Washington (United States)
Vladislav V. Yakovlev, Texas A&M University (United States)
Seok Hyun A. Yun, Harvard University (United States)
Vladimir Y. Zaitsev, Russian Academy of Science Nizhny Novgorod (Russian Federation)
Qifa Zhou, The University of Southern California (United States)

Session Chairs

1  Optical Coherence Elastography I
Qifa Zhou, The University of Southern California (United States)
Brett E. Bouma, Wellman Center for Photomedicine (United States)

2  Cell Biomechanics
Jannick P. Rolland, University of Rochester (United States)
Matthew O'Donnell, University of Washington (United States)

3  Keynote Session
Kirill V. Larin, University of Houston (United States)
Giuliano Scarcelli, University of Maryland, College Park (United States)

4  Computation and Modeling
Sean J. Kirkpatrick, Michigan Technological University (United States)
Seok-Hyun Yun, Wellman Center for Photomedicine (United States)
Peter Török, Imperial College London (United Kingdom)

5  Novel Methods I
Ruikang K. Wang, University of Washington (United States)
Kishan Dholakia, University of St. Andrews (United Kingdom)
Christine P. Hendon, Columbia University (United States)

6  Optical Coherence Elastography II
Davide Iannuzzi, Vrije Universiteit Amsterdam (Netherlands)
Vladimir Yu. Zaitsev, Russian Academy of Science Nizhny Novgorod (Russian Federation)
David D. Sampson, University of Surrey (United Kingdom)
7 Novel Methods II
Albert Claude Boccara, Institut Langevin Ondes et Images (France)
Stephen A. Boppart, Beckman Institute for Advanced Science and Technology (United States)

8 Biomechanics of the Eye
Steven G. Adie, Cornell University (United States)
Vladislav V. Yakovlev, Texas A&M University (United States)
Gijs van Soest, Erasmus MC (Netherlands)

9 Brillouin Elastography
Zhongping Chen, Beckman Laser Institute and Medical Clinic (United States)
Brendan F. Kennedy, The University of Western Australia (Australia)
Amy L. Oldenburg, The University of North Carolina at Chapel Hill (United States)
Introduction

This proceedings volume is from the Optical Elastography and Tissue Biomechanics VI conference held Saturday-Sunday, 2–3 February 2019, at SPIE BIOS, Photonics West, in San Francisco, California. Optical elastography can be broadly defined as the use of optics to probe and exploit the mechanical properties of cells and tissues including their ability to apply forces on the surrounding environment, as well as respond to forces of the surrounding microenvironment. The development of advanced optical techniques fits the larger context of tissue biomechanics studies where non-optical elastography techniques (ultrasound, magnetic resonance) have been established for many years as well as cell biomechanics research where the biological relevance of the mechanical metrics has triggered the development of many techniques such as atomic force microscopy, traction force microscopy, micropipette aspiration, particle rheology, and optical tweezers.

Many biological processes are strongly dependent on mechanical properties and forces at all scale, from sub-cellular organization to cellular function to tissue development to physiological and pathological behavior. As a result, a wide variety of contexts require different solutions to the evaluation of mechanical forces and mechanical properties of biological entities. In the past ten years, optical methods have emerged as important tools for these characterizations, both leading to clinically useful diagnostic and therapy-monitoring methods and helping illuminate the important mechanical interactions occurring at cell and tissue scale. In addition, the information provided by optical methods is recently being incorporated with computational modeling efforts to accurately predict cell and tissue behavior.

This sixth annual conference continued the growth of the first five conferences and displayed a strongly multidisciplinary character, bringing together optical technology experts, clinical scientists, cell biologists, biophysicists, and biomechanics computational modeling experts. The meeting demonstrated increased attendance year to year. Also, this year, over 60 contributed papers were built around 2 days of talks and posters. Here are the keynote and invited talks of the program:

Keynote Presentation:

C. Ross Ethier, Georgia Institute of Technology (United States), “How imaging is informing diagnosis and treatment of glaucoma.”

Invited Papers:

Assad A. Oberai, The Univ. of Southern California, (United States), “Linear and nonlinear optical coherence elastography in three dimensions.”

Kandice Tanner, National Cancer Institute (United States), “High-frequency active microrheology in 3D reveals mismatch between tumor cell cytoskeletal and extracellular matrix mechanics.”

Jannick P. Rolland, Univ. of Rochester (United States), “Perspectives and advances in optical elastography.”
Karol Karnowski, Institute of Physical Chemistry of the Polish Academy of Sciences (Poland), “Imaging of anterior segment pathologies: challenges and future opportunities.”


Darryl R. Overby, Imperial College London (United Kingdom), “Brillouin spectroscopy is insensitive to stiffness after correcting for the influence of water content in hydrogels.”

Peter T. C. So, Massachusetts Institute of Technology (United States), “The application of interferometric imaging in quantitative mechanobiology.”

Stefan Catheline, INSERM, Univ. of Lyon (France), “Passive elastography: from organ to cell.”

The highlight of this year’s meeting was the keynote lecture by Ross Ethier on the relevance of biomechanics in the diagnosis and treatment of glaucoma. Prof. Ethier is a biomechanicist and a glaucoma expert. After an overview on the biology of glaucoma, he reported his group’s recent results establishing how outflow tissue stiffness reflects tissue function in glaucoma and optical coherence tomography methods to assess outflow tissue functional status. Special acknowledgement goes to Thorlabs Inc., whose sponsorship supported the keynote presentation.

Overall, this sixth annual conference continued to serve as a catalyst for the growth of the emerging area of optical technology development for cell and tissue biomechanical research. Several sessions also pointed at interesting developments to be expected in the next year. We hope you will enjoy the papers submitted for this volume.

Kirill V. Larin
Giuliano Scarcelli