

Photons Plus Ultrasound: Imaging and Sensing 2015

Alexander A. Oraevsky

Lihong V. Wang

Editors

8–10 February 2015

San Francisco, California, United States

Sponsored by

SPIE

Cosponsored by

Seno Medical Instruments, Inc. (United States)

Published by

SPIE

Volume 9323

Proceedings of SPIE, 1605-7422, V. 9323

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Photons Plus Ultrasound: Imaging and Sensing 2015, edited by Alexander A. Oraevsky, Lihong V. Wang
Proc. of SPIE Vol. 9323, 932301 · © 2015 SPIE · CCC code: 1605-7422/15/\$18
doi: 10.1117/12.2192869

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 *Photons Plus Ultrasound: Imaging and Sensing 2015*, edited by Alexander A. Oraevsky, Lihong V. Wang, Proceedings of SPIE Vol. 9323 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 1605-7422

ISBN: 9781628414134

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 © 2015, 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 1605-7422/15/\$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. Papers are published as they are submitted and meet publication criteria. A unique 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.

Contents

xi	Authors
xv	Conference Committee
xvii	Introduction

SESSION 1 CLINICAL APPLICATIONS

- 9323 02 **Monitoring cerebral venous blood oxygenation in neonates with a medical-grade optoacoustic system** [9323-1]
- 9323 03 **Wavelength optimization for *in vivo* multispectral photoacoustic/ultrasound tomography of hemoglobin oxygenation in ovarian cancer: clinical studies** [9323-2]
- 9323 04 ***In vivo* melanoma depth detection by a handheld photoacoustic microscope** [9323-3]
- 9323 05 **Flow imaging using an integrated photoacoustic/ultrasound probe** [9323-4]
- 9323 07 **Clinical study of *ex vivo* photoacoustic imaging in endoscopic mucosal resection tissues** [9323-14]
- 9323 08 **Optoacoustic monitoring of real-time lesion formation during radiofrequency catheter ablation** [9323-6]

SESSION 2 PRECLINICAL RESEARCH

- 9323 0A **Photoacoustic imaging of single circulating melanoma cells *in vivo*** [9323-9]
- 9323 0B **Optimizing the optical wavelength for the photoacoustic imaging of inflammatory arthritis** [9323-10]
- 9323 0C **Quantifying bone thickness, light transmission, and contrast interrelationships in transcranial photoacoustic imaging** [9323-11]

SESSION 3 ANIMAL MODELS

- 9323 0G ***In vivo* deep brain imaging of rats using oral-cavity illuminated photoacoustic computed tomography** [9323-15]
- 9323 0I **Isotropic-resolution linear-array-based photoacoustic computed tomography through inverse Radon transform** [9323-17]
- 9323 0J **Evaluation of multispectral optoacoustic tomography (MSOT) performance in phantoms and *in vivo*** [9323-18]

9323 0M **Label-free structural photoacoustic tomography of intact mouse brain [9323-21]**

SESSION 4 DUAL MODALITY SYSTEMS

9323 0N **Three-dimensional laser optoacoustic and laser ultrasound imaging system for biomedical research [9323-22]**

9323 0R **Investigation of a dual modal method for bone pathologies using quantitative ultrasound and photoacoustics [9323-26]**

9323 0S **Real-time sono-photoacoustic imaging of gold nanoemulsions [9323-27]**

9323 0T **Cyclic magnetomotive photoacoustic/ultrasound imaging [9323-28]**

SESSION 5 ENDOSCOPIC AND OTHER HIRES IMAGING

9323 0Y **Catheter-based photoacoustic endoscope for use in the instrument channel of a clinical video endoscope [9323-33]**

9323 0Z **Large-field-of-view laser-scanning OR-PAM using a fibre optic sensor [9323-34]**

9323 10 **Amplitude-masked photoacoustic wavefront shaping: theory and application in flowmetry [9323-35]**

9323 11 **Characteristics of optimized fibre-optic ultrasound receivers for minimally invasive photoacoustic detection [9323-36]**

9323 12 **Orthogonal Fabry-Pérot sensor array system for minimal-artifact photoacoustic tomography [9323-37]**

SESSION 6 SIGNAL PROCESSING AND IMAGE RECONSTRUCTION

9323 13 **Photoacoustic computed tomography without accurate ultrasonic transducer responses [9323-38]**

9323 14 **Image reconstruction of multi-channel photoacoustic and laser-ultrasound data using reverse time migration [9323-39]**

9323 15 **Accelerated iterative image reconstruction in three-dimensional optoacoustic tomography [9323-40]**

9323 17 **Multispectral photoacoustic decomposition with localized regularization for detecting targeted contrast agent [9323-42]**

9323 19 **Photoacoustic reconstruction using beamformed RF data: a synthetic aperture imaging approach [9323-44]**

SESSION 7 NEW IMAGING METHODS AND SYSTEMS

- 9323 1C **Frequency response and directivity of highly sensitive optical microresonator detectors for photoacoustic imaging** [9323-48]
- 9323 1D **Bone assessment via thermal photoacoustic measurements** [9323-49]
- 9323 1E **Imaging and sensing based on dual-pulse nonlinear photoacoustic contrast: a preliminary study on fatty liver** [9323-50]
- 9323 1H **Lifetime-weighted photoacoustic imaging** [9323-53]
- 9323 1L **Broadband ultrasonic sensor array via optical frequency domain reflectometry** [9323-57]
- 9323 1M **Optoacoustic imaging in five dimensions** [9323-58]
- 9323 1N **Three-dimensional multispectral hand-held optoacoustic imaging with microsecond-level delayed laser pulses** [9323-59]
- 9323 1O **A real-time ultrasonic field mapping system using a Fabry P erot single pixel camera for 3D photoacoustic imaging** [9323-60]
- 9323 1P **Forward and adjoint radiance Monte Carlo models for quantitative photoacoustic imaging** [9323-123]

SESSION 8 QUANTITATIVE TOMOGRAPHY

- 9323 1Q **High-frequency photoacoustic imaging of erythrocyte aggregation and oxygen saturation: probing hemodynamic relations under pulsatile blood flow** [9323-61]
- 9323 1R **Continuous blood oxygen saturation detection with single-wavelength photoacoustics** [9323-62]
- 9323 1S **Evaluation of Gleason scores by photoacoustic spectral analysis** [9323-63]
- 9323 1T **Quantitative photoacoustic assessment of ex-vivo lymph nodes of colorectal cancer patients** [9323-64]
- 9323 1U **Cardiac function and perfusion dynamics measured on a beat-by-beat basis in the live mouse using ultra-fast 4D optoacoustic imaging (Best Paper Award)** [9323-65]
- 9323 1V **Effect of wavelength selection on the accuracy of blood oxygen saturation estimates obtained from photoacoustic images** [9323-66]
- 9323 1X **Influence of the light propagation models on a linearized photoacoustic image reconstruction of the light absorption coefficient** [9323-68]

SESSION 9 IMAGE GUIDED AND MONITORING PROCEDURES

- 9323 1Y **Universal temperature-dependent normalized optoacoustic response of blood** [9323-69]
- 9323 1Z **Probing the in vivo changes in oxygen saturation with photoacoustic imaging as a non-invasive means of assessing treatment progression** [9323-70]
- 9323 20 **Tissue oxygen monitoring by photoacoustic lifetime imaging (PALI) and its application to image-guided photodynamic therapy (PDT)** [9323-71]
- 9323 21 **Real-time needle guidance with photoacoustic and laser-generated ultrasound probes** [9323-72]
- 9323 22 **A new approach to depict bone surfaces in finger imaging using photoacoustic tomography** [9323-73]

SESSION 10 MICROSCOPY

- 9323 24 **DMD-based spatially Fourier-encoded photoacoustic microscopy** [9323-75]
- 9323 26 **Retrieving small features in reflection-mode raster-scan optoacoustic mesoscopy (RSOM) using multi-frequency reconstruction** [9323-77]
- 9323 27 **Photo-imprint super-resolution photoacoustic microscopy** [9323-78]

SESSION 11 MOLECULAR IMAGING AND NANO PROBES

- 9323 2C **Triggered vaporization of gold nanodroplets for enhanced photothermal therapy** [9323-83]
- 9323 2H **Validating tyrosinase homologue MelA as a photoacoustic reporter gene for imaging *Escherichia coli*** [9323-88]
- 9323 2J ***In vitro* characterization of a lifetime-based activatable photoacoustic probe** [9323-90]

POSTER SESSION: SUNDAY

- 9323 2K **Development of photoacoustic imaging technology overlaid on ultrasound imaging and its clinical application** [9323-91]
- 9323 2L **Integrating sphere-based photoacoustic setup for simultaneous absorption coefficient and Grüneisen parameter measurements of biomedical liquids** [9323-92]
- 9323 2M **Optical absorbance measurements and photoacoustic evaluation of freeze-thawed polyvinyl-alcohol vessel phantoms** [9323-93]
- 9323 2N **Hybrid ultrahigh resolution optical coherence/photoacoustic microscopy** [9323-95]
- 9323 2O **High frame rate photoacoustic computed tomography using coded excitation** [9323-96]

- 9323 2Q **Fast calibration of speed-of-sound using temperature prior in whole-body small animal optoacoustic imaging** [9323-98]
- 9323 2R **Technique development for photoacoustic imaging guided interventions** [9323-99]
- 9323 2S **Texture generation in compressional photoacoustic elastography** [9323-100]
- 9323 2T **Early detection of melanoma with the combined use of acoustic microscopy, infrared reflectance and Raman spectroscopy** [9323-101]
- 9323 2V **Blanket illumination vs scanned-mosaicking imaging schemes for wide-area photoacoustic tomography** [9323-103]
- 9323 2W **Tissue type characterization using photoacoustic power spectrum, a feasibility study** [9323-104]
- 9323 2X **Hybrid optoacoustic and ultrasound imaging in three dimensions and real time by optical excitation of a passive element** [9323-105]
- 9323 2Y **Needle visualization using photoacoustic effect** [9323-106]
- 9323 2Z **A micromachined silicon parallel acoustic delay line (PADL) array for real-time photoacoustic tomography (PAT)** [9323-107]
- 9323 30 **Photoacoustic imaging with rotational compounding for improved signal detection** [9323-108]
- 9323 32 **Label-free optical-resolution photoacoustic endomicroscopy *in vivo* (Best Poster Award)** [9323-110]
- 9323 33 **Quantitative assessment of photoacoustic tomography systems integrating clinical ultrasound transducers using novel tissue-simulating phantoms** [9323-111]
- 9323 34 **Three-dimensional photoacoustic and ultrasonic endoscopic imaging of two rabbit esophagi** [9323-112]
- 9323 38 **Photoacoustic microscopy of complex regional pain syndrome type I (CRPS-1) after stellate ganglion blocks *in vivo*** [9323-127]

POSTER SESSION: MONDAY

- 9323 39 **Realistic photoacoustic image simulations of collections of solid spheres using linear array transducer** [9323-117]
- 9323 3A **Synergistic image reconstruction for hybrid ultrasound and photoacoustic computed tomography** [9323-118]
- 9323 3B **Image reconstruction in transcranial photoacoustic computed tomography of the brain** [9323-119]

- 9323 3C **Photoacoustic imaging of small organic molecule-based photoacoustic probe in subcutaneous tumor using P(VDF-TrFE) acoustic sensor** [9323-120]
- 9323 3G **Experimental validation of a theoretical model of dual wavelength photoacoustic (PA) excitation in fluorophores** [9323-125]
- 9323 3H **Optical-resolution photoacoustic microscopy of the metabolic rate of oxygen in a mouse renal tumor model** [9323-128]
- 9323 3I **Speed of sound and acoustic attenuation of compounds affected during photoacoustic monitoring of thermal therapies measured in the temperature range from 5°C to 60°C** [9323-129]
- 9323 3J **Real-time interleaved photoacoustic/ultrasound (PAUS) imaging for interventional procedure guidance** [9323-131]
- 9323 3K **Noninvasive photoacoustic microscopy of methemoglobin *in vivo*** [9323-132]
- 9323 3L **Effect of rotating partial illumination on image reconstruction for photoacoustic breast tomography** [9323-133]
- 9323 3N **Noninvasive, photoacoustic detection and characterization of intra- and extracranial hematomas and cerebral hypoxia** [9323-135]
- 9323 3O **Multi-depth photoacoustic microscopy with a focus tunable lens** [9323-136]
- 9323 3S **Assessing carotid atherosclerosis by fiber-optic multispectral photoacoustic tomography** [9323-140]
- 9323 3T **Multimodal non-contact photoacoustic and OCT imaging with galvanometer scanning** [9323-141]
- 9323 3U **Photoacoustic projection imaging using a 64-channel fiber optic detector array** [9323-142]
- 9323 3V **A tunable MOPA for optical resolution photoacoustic microscopy** [9323-143]
- 9323 3W **Dual modality of non-contact photoacoustic tomography and fluorescence imaging using double cladding fiber** [9323-144]
- 9323 3X **Comparative experiments of photoacoustic system using laser light source and LED array light source** [9323-145]
- 9323 3Z **Attempts to increase penetration of photoacoustic system using LED array light source** [9323-147]
- 9323 40 **A compact and cost-efficient photoacoustic microscopy system with a pulsed laser diode excitation** [9323-148]
- 9323 42 **First-harmonic sensitivity functions for a linearised diffusion model of ultrasound-modulated optical tomography** [9323-150]

- 9323 45 **Photoacoustic perfusion measurements: a comparison with Power Doppler in phantoms** [9323-153]
- 9323 46 **The influence of cellular uptake on gold nanorods photostability and photoacoustic conversion efficiency** [9323-154]
- 9323 47 **Detecting inflammation and fibrosis in bowel wall with photoacoustic imaging in a Crohn's disease animal model** [9323-155]
- 9323 48 **Image registration for limited-view photoacoustic imaging using two linear array transducers** [9323-156]

POSTER SESSION: TUESDAY

- 9323 49 **Advanced laser systems for photoacoustic imaging** [9323-157]
- 9323 4A **Evaluating peripheral arterial volume distensibility by photoacoustic microscopy** [9323-158]
- 9323 4B **Phantom studies with gold nanorods as contrast agents for photoacoustic imaging: novel and old approaches** [9323-159]
- 9323 4C **Pattern of distribution and kinetics of accumulation of gold nanorods in mouse spleen** [9323-160]
- 9323 4E **A theoretical model for photoacoustic spectral analysis** [9323-164]
- 9323 4F **Photoacoustic physio-chemical analysis and its implementation in deep tissue with a catheter setup** [9323-165]
- 9323 4I **Characterization of bone microstructure using photoacoustic spectrum analysis** [9323-169]
- 9323 4N **A self-monitored theranostic platform based on nanoparticle hyperthermia therapy and alternating magnetic field induced thermoacoustic imaging** [9323-174]
- 9323 4Q **Photoacoustic tomography of the human finger: towards the assessment of inflammatory joint diseases** [9323-177]
- 9323 4U **High repetition nanosecond Ti:sapphire laser for photoacoustic microscopy** [9323-181]

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.

Abolmaesumi, Purang, 48
Agano, Toshitaka, 3X, 3Z
Agbor, Adaeze, 3N
Ai, Min, 48
Allen, T. J., 0Z
Anastasio, Mark A., 0N, 13, 15, 3A, 3B, 3L
Anis, Fatima, 0N, 15
Apostolidis, Georgios K., 2T
Arabul, M. Ü., 2M, 45
Arbeit, Jeffrey M., 3H
Armanetti, Paolo, 4B, 4C
Arnal, Bastien, 0S, 0T, 3J
Arridge, Simon R., 1O, 1P, 42
Asano, Tomohiko, 2K
Ashkenazi, Shai, 20, 2J
Asokan, Vasantha, 3N
Avigo, Cinzia, 4B, 4C
Ayaori, Makoto, 2K
Azuma, Masataka, 2O
Bae, Sung Chul, 4U
Barber, Quinn, 2H, 2V
Bauer-Marschallinger, Johannes, 3T, 3U
Bay, Erwin, 08, 1N
Beard, Paul C., 0Z, 11, 12, 1C, 1O, 1V, 21
Berer, Thomas, 3T, 3U
Bernelot Moens, H. J., 4Q
Betcke, Marta, 1O
Biswas, S. K., 22, 4Q
Boctor, Emad M., 0C, 17, 19, 2W, 2Y
Bohndiek, Sarah E., 0J
Bok, Tae-Hoon, 1Q
Bouchal, Klaus-Dieter, 3U
Brewer, Molly, 03
Bruning, Rebecca, 3S
Buchsbaum, Andreas, 3T
Burgholzer, Peter, 3U
Campbell, Robert, 2H
Cavigli, Lucia, 46, 4B, 4C
Cecchini, Marco, 4B
Centi, Sonia, 46
Chan, Gary, 49
Chang, Cheng-Chung, 2Z
Chen, Ruimin, 0Y, 32, 34
Chen, Ying, 17
Cheng, Alexis, 2Y
Cheng, Ji-Xin, 3S
Cheng, Qian, 2R, 4A, 4F
Chitnis, Parag V., 1T
Cho, Young Y., 2Z
Choi, Seul Ki, 4U
Choti, Michael A., 2W, 2Y
Chung, Euiheon, 3O
Cini, Alberto, 46
Cirocco, Maria, 07
Colchester, Richard J., 21
Conjusteau, Andre, 0N
Cornelius, Lynn A., 04
Cox, Ben, 12, 1O, 1P, 1V
DaCosta, Ralph, 07
Danielli, Amos, 32
Daoudi, Khalid, 05
Davis, Mandy A., 1S
de Angelis, Marella, 46
Deán-Ben, Xosé Luís, 08, 1M, 1N, 1U, 2Q, 2X
Deng, Cheri X., 1D, 4I
Desjardins, Adrien E., 21
Di Lascio, Nicole, 4B, 4C
Dillman, Jonathan R., 47
Dori, I., 2T
Doumas, Argyrios, 2T
Drexler, W., 2N, 2S
Du, Sidan, 1D, 4I
Ellwood, Robert, 12
Eom, Jonghyun, 3W
Eom, Tae Joong, 3O
Ermilov, Sergey A., 0N, 15, 1Y, 3I, 3L
Esenaliev, Rinat O., 02, 3N
Eyal, Avishay, 0R, 1L
Fabiilli, Mario, 1E
Faita, Francesco, 4B, 4C
Favazza, Christopher, 34
Fehm, Thomas Felix, 1M, 2X
Felbermayer, Karoline, 3U
Feleppa, Ernest J., 1T
Feng, Ting, 1D, 2R, 4I
Feng, Xiaohua, 1R, 4N
Fonseca, Rafael A., 02
Forbrich, Alex, 1H, 30, 3V
Ford, Steven J., 1U
Foster, F. Stuart, 07
Fowlkes, J. Brian, 4E
Francis, Sheeja, 0B
Gabai, Haniel, 1L
Gannot, Israel, 0R
Gao, Fei, 1R, 4N
Gao, Liang, 24
Gao, Xiaohu, 0T
Garcia-Uribe, Alejandro, 0M

Garra, Brian S., 33
 Gateau, Jérôme, 26
 Georgoulas, Panagiotis, 2T
 Giovannelli, Ilaria, 46
 Girish, Gandikota, 0B
 Glatz, T., 2S
 Goergen, Craig J., 3S
 Goldstein, Seth D., 2W
 Gottschalk, Sven, 1M
 Grigoriadou, Ifigeneia, 2T
 Grivas, Ioannis, 2T
 Gross, Daniel, 49
 Grün, Hubert, 3U
 Guggenheim, James A., 1C
 Guo, Xiaoyu, 17, 19, 2Y
 Hackel, Benjamin J., 2J
 Hanaoka, Takamitsu, 3X, 3Z
 Harrison, Tyler, 2V
 Heinmiller, A., 30
 Heller, Donald F., 49
 Hemphill, Ashton S., 10
 Heres, H. M., 2M, 45
 Hermann, B., 2N
 Higgins, Peter D. R., 47
 Hirasawa, Takeshi, 1X, 2K, 3C
 Hirota, Kazuhiro, 2K
 Hirson, D., 30
 Hochreiner, Armin, 3T
 Hochuli, Roman, 1P, 1V
 Hondebrink, Erwin, 2L
 Horiguchi, Akio, 2K
 Hsiao, Yi-Sing, 1D
 Hu, Jack, 0B, 47
 Hu, Song, 38, 3H
 Hui, Jie, 3S
 Huynh, Nam, 1O
 Hysi, Eno, 1Q, 1Z, 39
 Iakovlev, Vladimir V., 07
 Ikewaki, Katsunori, 2K
 Irisawa, Kaku, 2K
 Ishihara, Miya, 1X, 2K, 3C
 Jia, Congxian, 33
 Jo, Janggun, 0B
 Johnson, Jami L., 14
 Johnson, Laura A., 47
 Johnson, Sadie M., 2J
 Jose, J., 30
 Joseph, James, 0J
 Kamiya, Mako, 3C
 Kang, Hyun Jae, 17, 19, 2Y
 Kang, Jin U., 2W
 Karagiannis, Georgios T., 2T
 Karmakar, Subhajit, 39
 Kasamatsu, Tadashi, 2K
 Kazantzides, Peter, 0C
 Kim, Ju Wan, 3W
 Kim, Min Ju, 4U
 Kitagawa, Kazuo, 3X, 3Z
 Klosner, Marc, 49
 Kolios, Michael C., 1Q, 1Z, 39
 Komatsu, Tomohiro, 2K
 Kondo, Kengo, 2O
 Kozloff, Kenneth M., 1D, 4I
 Kumavor, Patrick D., 03, 40
 Kuniyil Ajith Singh, Mithun, 05
 Kunju, Lakshmi P., 1S
 Kushibiki, Toshihiro, 1X
 Kusmic, Claudia, 4B, 4C
 Laufer, Jan, 3G
 Lediju Bell, Muyinatu A., 0C
 Lee, Byeong Ha, 3W
 Lee, Kiri, 3O
 Leiss-Holzinger, Elisabeth, 3T
 Leung, Terence S., 42
 Lewis, John D., 2H
 Li, Chiye, 0Y, 24, 27, 32
 Li, Guo, 0A, 0I, 0M
 Li, Hai, 03
 Li, Jing, 1C
 Li, Junwei, 0T
 Li, Ke, 0C
 Li, Lei, 0I, 0M, 3H
 Li, Pai-Chi, 2C
 Li, Rui, 3S
 Li, Shyh-Dar, 1Z
 Li, Yan, 2H
 Liang, Jinyang, 10, 24, 3H
 Liao, Chien-Sheng, 3S
 Lim, Liang, 07
 Lin, Jian-die D., 4F
 Lin, Li, 0G
 Liopo, Anton, 1Y
 Liu, M., 2N, 2S
 Liu, Shu-Wei, 2C
 Liu, Wei-Wen, 2C
 Liu, Xiaojun, 4E
 Lombardo, Michael, 0S
 Lopata, R. G.P., 2M, 45
 Lou, Yang, 3L
 Lu, Zhi Hong, 3H
 Machi, Junji, 1T
 Mahmud, Mohammad Sultan, 3V
 Mamou, Jonathan, 1T
 Mandal, Subhamoy, 2Q
 Manohar, S., 22, 4Q
 Marcon, Norman, 07
 Märk, Julia, 3G
 Marquardt, April, 0B
 Maslov, Konstantin I., 04, 32, 38, 3H
 Matteini, Paolo, 46
 Matthews, Thomas P., 3A
 Maurer, B., 2N
 May, Jonathan P., 1Z
 Meng, Zhou-xian, 4F
 Menichetti, Luca, 4B, 4C
 Merkulov, Aleksey, 03
 Meucci, Sandro, 4B
 Meyer, D., 2N
 Mitsuhashi, Kenji, 3B
 Morgan, Fiona J E, 0J

Morgounova, Ekaterina, 20, 2J
Morisono, Koji, 3X, 3Z
Mosse, Charles A., 21
Nadvoretzkiy, Vyacheslav, 3L
Nakatsuka, Hitoshi, 3X, 3Z
Namita, Takeshi, 2O
Nandy, Sreyankar, 40
Nasonova, Elena, 2Q
Needles, A., 30
Nguyen, Thu-Mai, 0T, 3J
Nikitichev, Daniil I., 21
Ntziachristos, Vasilis, 26
O'Donnell, Matthew, 0S, 0T, 3J
Okawa, Shinpei, 1X, 3C
Omar, Murad, 26
Oravsky, Alexander A., 0N, 15, 1Y, 3I, 3L
Oruganti, Tanmayi, 0N, 3I
Ostrowski, Anastasia K., 0C
Pang, Genny A., 08
Papakonstantinou, Ioannis, 21
Paproski, Robert J., 2H
Park, Seong Jun, 3W
Park, Soongho, 3W
Pelivanov, Ivan M., 0S, 0T, 3J
Peng, Qiwen, 1R
Perez, Camilo, 0S
Perosky, Joseph, 1D
Petersen, Wilma, 2L
Petrov, Andrey, 02, 3N
Petrov, Irene Y., 02, 3N
Petrov, Yuriy, 02, 3N
Petrova, Elena V., 1Y, 3I
Pfefer, Joshua, 33
Phillips, Evan, 3S
Pini, Roberto, 46, 4B, 4C
Pomper, Martin, 17
Poulatsidou, Kyriaki-Nefeli, 2T
Powell, Samuel, 1P, 42
Pozzo, Danilo, 0S
Prough, Donald S., 02, 3N
Rao, Bin, 32
Ratto, Fulvio, 46, 4B, 4C
Razansky, Daniel, 08, 1M, 1N, 1U, 2Q, 2X
Richardson, C. Joan, 02
Robertson, Claudia S., 3N
Rohling, Robert, 48
Rossi, Francesca, 46
Rutten, M. C.M., 2M, 45
Saegusa-Beercroft, Emi, 1T
Saha, Ratan K., 39
Salcudean, Tim, 48
Salehi, Hassan S., 03, 40
Sampathkumar, Ashwin, 1T, 49
Sanders, Melinda, 03
Sato, Naoto, 3X, 3Z
Scherzer, O., 2S
Schmid, J. W., 2S
Schmitner, N., 2N
Schmitt, Franz-Josef, 3G
Shao, Peng, 1H, 3V
Shao, Qi, 20, 2J
Sheng, Qiwei, 13
Shi, Wei, 1H, 3V
Shigeta, Yusuke, 3X, 3Z
Shiina, Tsuyoshi, 2O
Shragge, Jeffrey, 14
Shu, Weihang, 48
Shung, K. Kirk, 0Y, 32, 34
Siddiqui, Javed, 1S
Soetikno, Brian, 3H
Sohn, Rebecca E., 3H
Soliman, Dominik, 26
Stea, Francesco, 4B, 4C
Steenbergen, Wiendelt, 05, 22, 2L, 4Q
Steinberg, Idan, 0R, 1L
Streutker, Catherine J., 07
Sturek, Michael, 3S
Su, Richard, 0N, 15
Tang, Min, 3K
Tang, Shuo, 48
Tao, Chao, 4E
Tatini, Francesca, 46
Tavakoli, Behnoosh, 17, 2W
Tay, Jian Wei, 10
Tchang, B. C.Y., 45
Theiss, Christoph, 3G
Tian, Chao, 1D, 1E
Tomaszewski, Michal, 0J
Tomlins, Scott A., 1S
Tsingotjidou, Anastasia, 2T
Tsuda, Hitoshi, 2K
Tsujiita, Kazuhiro, 2K
Undzys, Elijus, 1Z
Urano, Yasuteru, 3C
van de Vosse, F. N., 2M, 45
van den Berg, Pim J., 05
van Es, P., 22, 4Q
van Wijk, Kasper, 14
Veres, Istvan A., 3U
Villanueva, Yolanda, 2L
Vogt, William C., 33
Wang, Cheng, 4A
Wang, Kun, 0N, 13, 15, 3A, 3L
Wang, Lidai, 0A, 0I, 27
Wang, Lihong V., 04, 0A, 0G, 0I, 0M, 0Y, 10, 13, 24, 27, 2Z, 32, 34, 38, 3A, 3B, 3H, 3K
Wang, Pu, 3S
Wang, Tianheng, 40
Wang, Xueding, 0B, 1D, 1E, 1S, 2R, 47, 4A, 4E, 4F, 4I
Wear, Keith A., 33
Wei, Chen-Wei, 0S, 0T, 3J
Wei, John T., 1S
Wei, Xinbin, 4A
Weninger, W. J., 2N
Wesarg, Stefan, 2T
West, Simeon, 21
Westermann, Stephan, 02
Widlak, T., 2S
Wilson, Brian C., 07

Wilson, Michael, 2J
Wirtzfeld, Lauren, 1Z
Wong, Terence T. W., 0G
Wu, Chunbai, 49
Wynne, Karon E., 02
Xia, Jinjun, 3J
Xia, Jun, 0G, 0I, 0M, 13
Xie, Zhixing, 1E
Xing, Wenxin, 04, 38
Xu, Guan, 0B, 1S, 2R, 47, 4A, 4E, 4F, 4I
Xu, Song, 0A
Yamakawa, Makoto, 2O
Yang, Joon-Mo, 0Y, 32, 34
Yang, Timothy K., 4U
Yao, Junjie, 0A, 27, 32, 34
Yeh, Cheng-Hung, 32, 3H
Yi, Xiaobin, 38
Yuan, Jie, 0B, 1D, 2R, 4I
Zabihian, B., 2S
Zemp, Roger J., 1H, 2H, 2V, 3V
Zhang, Chi, 27
Zhang, Edward Z., 0Z, 11, 12, 1C, 1O, 21
Zhang, Haichong K., 19, 2O
Zhang, Haonan, 2R
Zhang, Ruiying, 0A, 0G, 3K
Zheng, Yuanjin, 1R, 4N
Zhou, Qifa, 0Y, 32, 34
Zhou, Yong, 04, 38, 3K
Zhu, Liren, 13
Zhu, Quing, 03, 40
Zou, Jun, 0A, 2Z

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)

Conference Chairs

Alexander A. Oraevsky, TomoWave Laboratories, Inc. (United States)

Lihong V. Wang, Washington University in St. Louis (United States)

Conference Program Committee

Mark A. Anastasio, Washington University in St. Louis (United States)

Paul C. Beard, University College London (United Kingdom)

A. Claude Boccara, Institut Langevin (France)

Stanislav Y. Emelianov, The University of Texas at Austin
(United States)

Rinat O. Esenaliev, The University of Texas Medical Branch
(United States)

Martin Frenz, Universität Bern (Switzerland)

Pai-Chi Li, National Taiwan University (Taiwan)

Andreas Mandelis, University of Toronto (Canada)

Vasilis Ntziachristos, Helmholtz Zentrum München GmbH (Germany)

Matthew O'Donnell, University of Washington (United States)

Günther Paltauf, Karl-Franzens-Universität Graz (Austria)

Wiendelt Steenbergen, Universiteit Twente (Netherlands)

William M. Whelan, University of Prince Edward Island (Canada)

Vladimir P. Zharov, University of Arkansas for Medical Sciences
(United States)

Qifa Zhou, The University of Southern California (United States)

Quing Zhu, University of Connecticut (United States)

Session Chairs

1 Clinical Applications

Alexander A. Oraevsky, TomoWave Laboratories, Inc. (United States)

Lihong V. Wang, Washington University in St. Louis (United States)

2 Preclinical Research

Matthew O'Donnell, University of Washington (United States)

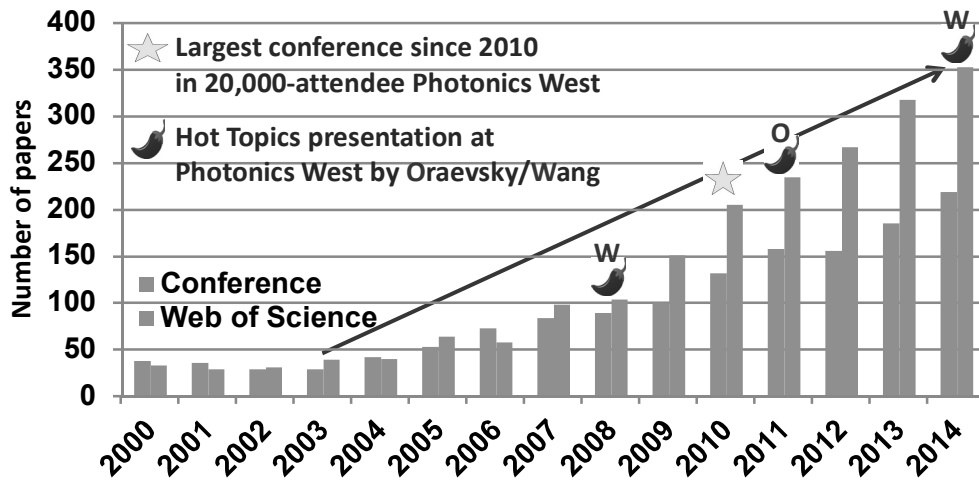
- 3 Animal Models
Stanislav Y. Emelianov, The University of Texas at Austin
(United States)
Alexander A. Oraevsky, TomoWave Laboratories, Inc. (United States)
- 4 Dual Modality Systems
Wiendelt Steenbergen, Universiteit Twente (Netherlands)
Quing Zhu, University of Connecticut (United States)
- 5 Endoscopic and other HiRes Imaging
Vladimir P. Zharov, University of Arkansas for Medical Sciences
(United States)
Qifa Zhou, The University of Southern California (United States)
- 6 Signal Processing and Image Reconstruction
Mark A. Anastasio, Washington University in St. Louis (United States)
Andreas Mandelis, University of Toronto (Canada)
- 7 New Imaging Methods and Systems
A. Claude Boccara, Institut Langevin (France)
Rinat O. Esenaliev, The University of Texas Medical Branch
(United States)
- 8 Quantitative Tomography
Paul C. Beard, University College London (United Kingdom)
- 9 Image Guided and Monitoring Procedures
Wiendelt Steenbergen, Universiteit Twente (Netherlands)
- 10 Microscopy
Lihong V. Wang, Washington University in St. Louis (United States)
Matthew O'Donnell, University of Washington (United States)
- 11 Molecular Imaging and Nano Probes
Stanislav Y. Emelianov, The University of Texas at Austin
(United States)
Pai-Chi Li, National Taiwan University (Taiwan)

Introduction

This volume of *Proceedings of SPIE* summarizes research and development conducted by our growing community in the past year. The field of photoacoustic/optoacoustic tomography continues to experience growth as shown in the following chart. The journal papers were from the Web of Science, and the number of conference papers reflects the actual number of presentations in the conference on Photons plus Ultrasound. This chart shows the number of research papers published per year by our community has doubled every three years recently.

Since 2010, our conference has become the largest in Photonics West. Our technology has been highlighted by the two of us three times at the BiOS Hot Topics plenary sessions. However, the number of conference papers dropped this year in comparison to 2014 despite the continued growth in the number of journal papers.

One possible reason is that our technology positively has influenced other fields of science and engineering and a number of new biomedical applications have emerged. Therefore, a large number of papers on optoacoustics/photoacoustics that could have been traditionally submitted to the conference on "Photons plus Ultrasound: Imaging and Sensing" were presented at other conferences of Photonics West and other optical and ultrasonic symposia worldwide. Of course, we are delighted to see that our technology has contributed to the growth of other related technologies. Another possible reason is that travel funds have lately become scarcer. Nevertheless, our conference remains as the largest in Photonics West. A total of 108 papers, including 55 oral papers and 54 posters, were presented over the course of three days.



The conference organizing committee selected the Best Paper Award and the Best Poster Award with \$2,500 for each, generously sponsored by Seno Medical Instruments (San Antonio, Texas).

The Best Paper Award went to:

Steven J. Ford, Xosé Luis Deán-Ben, Helmholtz Zentrum München GmbH (Germany); Daniel Razansky, Helmholtz Zentrum München GmbH (Germany) and Technische Univ. München (Germany). “Cardiac function and perfusion dynamics measured on a beat by beat basis in the live mouse using ultra-fast 4D optoacoustic imaging.”

The Best Poster Award went to:

Joon-Mo Yang, Chiye Li, Washington Univ. in St. Louis (United States); Ruimin Chen, The Univ. of Southern California (United States); Bin Rao, Junjie Yao, Amos Danielli, Konstantin I. Maslov, Washington Univ. in St. Louis (United States); Qifa Zhou, Koping Kirk Shung, The Univ. of Southern California (USA); Lihong V. Wang, Washington Univ. in St. Louis (United States). “Label-free optical-resolution photoacoustic endomicroscopy in vivo.”

We would like to congratulate the winners and thank all the contributors to this conference and the Organizing Committee for their hard work.

**Alexander A. Oraevsky
Lihong V. Wang**