

Ophthalmic Technologies XXV

Fabrice Manns
Per G. Söderberg
Arthur Ho
Editors

7–8 February 2015
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 9307

Proceedings of SPIE, 1605-7422, V. 9307

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

Ophthalmic Technologies XXV, edited by Fabrice Manns, Per G. Söderberg, Arthur Ho, Proc. of SPIE
Vol. 9307, 930701 · © 2015 SPIE · CCC code: 1605-7422/15/\$18 · doi: 10.1117/12.2183904

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 *Ophthalmic Technologies XXV*, edited by Fabrice Manns, Per G. Söderberg, Arthur Ho, Proceedings of SPIE Vol. 9307 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 1605-7422

ISBN: 9781628413977

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.

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

- vii *Authors*
- ix *Conference Committee*
- xiii *Introduction*
- xv *15th Pascal Rol Award for Excellence in Ophthalmic Technologies*
- xvii *The Ophthalmic Technologies Foundation Award*

OPHTHALMIC IMAGING: IMAGE PROCESSING AND ANALYSIS

- 9307 03 **High-resolution retinal imaging: enhancement techniques [9307-2]**

OPHTHALMIC SURGERY: INTRAOPERATIVE IMAGING AND MONITORING

- 9307 06 **Novel microscope-integrated stereoscopic display for intrasurgical optical coherence tomography [9307-5]**
- 9307 07 **Automated real-time instrument tracking for microscope-integrated intraoperative OCT imaging of ophthalmic surgical maneuvers [9307-6]**
- 9307 08 **Image-guided modified deep anterior lamellar keratoplasty (DALK) corneal transplant using intraoperative optical coherence tomography [9307-7]**
- 9307 0A **Design and evaluation of an intraocular B-scan OCT-guided 36-gauge needle [9307-9]**
- 9307 0B **Power-controlled temperature guided retinal photocoagulation [9307-10]**

OPHTHALMIC IMAGING: SMALL ANIMAL MODELS

- 9307 0H **Multispectral scanning laser ophthalmoscopy combined with optical coherence tomography for simultaneous *in vivo* mouse retinal imaging [9307-16]**

OPHTHALMIC DIAGNOSTICS: POLARIZATION

- 9307 0N **Polarimetric imaging of retinal disease by polarization sensitive SLO [9307-22]**

VISION: ASSESSMENT, CORRECTION, RESTORATION

- 9307 0Q **The first prototype of chromatic pupillometer for objective perimetry in retinal degeneration patients** [9307-25]
- 9307 0R **Fast optical measurement of intraocular straylight** [9307-26]
- 9307 0S **Clinical trials of interference-based extended depth of focus intra ocular lens design** [9307-27]
- 9307 0T **Photovoltaic restoration of sight with high visual acuity in rats with retinal degeneration** [9307-28]

OPHTHALMIC IMAGING: ADAPTIVE OPTICS

- 9307 0Z **Concept for image-guided vitreo-retinal fs-laser surgery: adaptive optics and optical coherence tomography for laser beam shaping and positioning** [9307-34]
- 9307 10 **A computational approach to high-resolution imaging of the living human retina without hardware adaptive optics** [9307-35]

OCULAR TISSUE CHARACTERIZATION

- 9307 14 **Optical characterization of vitreous structure in health and disease** [9307-39]
- 9307 15 **Determining the optomechanical properties of accommodating gel for lens refilling surgery using finite element analysis and numerical ray-tracing** [9307-40]
- 9307 16 **Co-focused ultrasound and optical coherence elastography system for the study of age-related changes of biomechanical properties of crystalline lens in rabbit eyes** [9307-41]
- 9307 17 **Near infrared radiation damage mechanism in the lens** [9307-42]
- 9307 18 **Three-dimensional mapping of corneal elasticity using optical coherence elastography** [9307-43]
- 9307 19 **Quantitative assessment of corneal biomechanical properties using optical coherence elastography and a modified Rayleigh Lamb-frequency model** [9307-44]

OPHTHALMIC IMAGING: MODELS, PHANTOMS, TECHNOLOGY

- 9307 1C **Real-time calibration-free C-scan images of the eye fundus using Master Slave swept source optical coherence tomography** [9307-47]
- 9307 1D **Automatic optimization high-speed high-resolution OCT retinal imaging at 1 μ m** [9307-48]
- 9307 1F **Ultra-compact switchable SLO/OCT handheld probe design** [9307-50]

POSTER SESSION

- 9307 1G **Developing a flammability test system for sunglasses: results** [9307-51]
- 9307 1H **Deep stroma investigation by confocal microscopy** [9307-52]
- 9307 1J **Progress on the self-service kiosk for testing the UV protection on sunglasses: polynomial and neural network approximation for calculating light transmittance** [9307-54]
- 9307 1O **En-face imaging of the ellipsoid zone in the retina from optical coherence tomography B-scans** [9307-60]
- 9307 1P **High-power visible diode laser for the treatment of eye diseases by laser coagulation** [9307-61]
- 9307 1Q **Two-photon autofluorescence lifetime and SHG imaging of healthy and diseased human corneas** [9307-62]
- 9307 1S **Implementation of a capsular bag model to enable sufficient lens stabilization within a mechanical eye model** [9307-64]
- 9307 1T **Cornea-based imaging via its tactile spatial stimulation** [9307-65]
- 9307 1U ***In-vivo* human corneal nerve imaging using Fourier-domain OCT** [9307-66]
- 9307 1X **A novel platform for minimally invasive delivery of cellular therapy as a thin layer across the subretina for treatment of retinal degeneration (Translational Research Paper Award)** [9307-69]
- 9307 1Y **High precision laser sclerostomy** [9307-70]
- 9307 1Z **Characterization of rat model of acute anterior uveitis using optical coherence tomography angiography** [9307-71]

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.

Achiron, Asaf, 0Q
Adie, Steven G., 10
Aglyamov, Salavat R., 16, 19
Akula, James D., 03
Ardia, Roberta, 1H
Artal, Pablo, 0R
Baade, Alexander, 0B
Barnes, Fred, 1C
Batista, Ana, 1Q
Bayer, Natascha, 1S
Beckert, Erik, 1S
Beiderman, Yevgeny, 1T
Belkin, Michael, 0Q, 1T, 1X
ben Yaish, Shai, 0S
Birngruber, Reginald, 0B
Boinagrov, D., 0T
Bonora, Stefano, 1D
Boppart, Stephen A., 10
Bradu, Adrian, 1C
Breunig, Hans Georg, 1Q
Brinkmann, Ralf, 0B
Brockmann, Dorothee, 0Z
Burns, Marie E., 0H
Buzzonetti, Luca, 1H
Canovetti, Annalisa, 1H
Carney, P. Scott, 10
Carrasco-Zevallos, Oscar, 06
Carter, R. M., 1Y
Chibel, Ron, 0Q
Choi, Woo June, 1Z
Csaky, K., 1O
Cua, Michelle, 1D
Desouza, Philip, 06
Dhillon, B., 1Y
Doron, Ravid, 0S
Downing, M., 1O
Drauschke, Andreas, 1S
DuBose, Theodore, 1F
Dupps, William J., 08
Ehlers, Justis P., 07, 08
El-Haddad, Mohamed T., 07
Elsner, Ann E., 0N
Emelianov, Stanislav, 16
Eom, Tae Joong, 1U
Farsiu, Sina, 1F
Ferguson, R. Daniel, 03
Fulton, Anne B., 03
Galichanin, Konstantin, 17
Garway-Heath, David F., 1C
Gewohn, Timo, 0Z
Ginis, Harilaos, 0R
Goetz, G., 0T
Góra, W. S., 1Y
Goto, Hiroshi, 0N
Hagen, Clemens, 1P
Hahn, Paul, 06
Haj Yahia, Soad, 0Q
Han, Zhaolong, 16, 19
Hand, D. P., 1Y
Hansen, Anja, 0Z
Harlander, Maximilian, 1P
Harris, J., 0T
Heinrich, Arne, 1P
Ho, Arthur, 1S
Holmes, T., 1O
Horke, Konstanze, 0Z
Hwang, Ho Sik, 1U
Iffimia, Nicusor, 03
Iwasaki, Takuya, 0N
Izatt, Joseph A., 06, 1F
Jian, Yifan, 0H, 1D
Joos, Karen M., 0A
Kalish, Sapir E., 1X
Kamins, T., 0T
Kanapathipillai, Sangarapillai, 15
Kapinchev, Konstantin, 1C
Keane, Pearce, 1C
Keller, Brenton, 06
Ketterling, Jeffrey A., 14
Khoshnevis, Matin, 14
Knoop, Gesche, 0Z
Koinzer, Stefan, 0B
König, Karsten, 1Q
Kronschläger, Martin, 17
Krüger, Alexander, 0Z
Kuo, Anthony, 06
LaBarbera, Michael, 08
Lahav Yacouel, Karen, 0S
Larin, Kirill V., 16, 18, 19
Larkin, S., 1O
LaRocca, Francesco, 1F
Lee, Byeong Ha, 1U
Lee, Sieun, 1D
Lee, Sujin, 1D
Lei, X., 0T
Lenzetti, Ivo, 1H
Li, Jiasong, 16, 18, 19
Limon, Ofer, 0S

Liu, Chih-hao, 16, 19
 Liu, Xiyun, 1D
 Liu, Yuan-Zhi, 10
 Lorach, H., 0T
 Mackenzie, Paul J., 1D
 Magri, Renan, 1G
 Mahajna, Mohamad, 0Q
 Malandrini, Alex, 1H
 Mandel, Y., 0T
 Manns, Fabrice, 15, 16
 Mathieson, K., 0T
 Matthias, Ben, 0Z
 McIntosh, L., 1Y
 Meir, Amilia, 1X
 Mello, M. M., 1J
 Menabuoni, Luca, 1H
 Miao, Dongkai, 1D
 Miura, Masahiro, 0N
 Mohammad-Pour, Hooman, 15
 Morgado, António Miguel, 1Q
 Mujat, Mircea, 03
 Nagler, Arnon, 1X
 Nankivil, Derek, 1F
 Nussbaumer, Bernhard, 1P
 Palanker, D., 0T
 Patel, Ankit, 03
 Pepple, Kathryn L., 1Z
 Pini, Roberto, 1H
 Podoleanu, Adrian Gh., 1C
 Pugh, Edward N., 0H
 Rajendram, Ranjan, 1C
 Rank, Elisabet, 1S
 Raveh, Ido, 0S
 Ripken, Tammo, 0Z
 Rossi, Francesca, 1H
 Rotenstreich, Ygal, 0Q, 1T, 1X
 Sahin, Onurcan, 0R
 Sampathkumar, Ashwin, 14
 Sarunic, Marinko V., 0H, 1D
 Schlott, Kerstin, 0B
 Schulmeister, Karl, 17
 Schwarzer, Wadim, 0B
 Sebag, J., 14
 Seitz, Berthold, 1Q
 Shemonski, Nathan D., 10
 Shen, Jin Hui, 0A
 Shen, Liangbo, 06
 Shephard, J. D., 1Y
 Sher, A., 0T
 Sher, Ifat, 0Q, 1X
 Shin, Jun Geun, 1U
 Singh, Manmohan, 16, 18, 19
 Smith, R., 0T
 Söderberg, Per G., 17
 South, Fredrick A., 10
 Srivastava, Sunil K., 07, 08
 Talebizadeh, Nooshin, 17
 Tao, Yuankai K., 07, 08
 Tatini, Francesca, 1H
 Toth, Cynthia A., 06
 Traxler, Lukas, 1S
 Treves, Avraham J., 1X
 Twa, Michael D., 18, 19
 Tzameret, Adi, 1X
 Uchugonova, Aisada, 1Q
 Urich, A., 1Y
 Valente, Paola, 1H
 Vantipalli, Srilatha, 18, 19
 Ventura, Liliane, 1G, 1J
 Viehland, Christian, 06
 Wang, Ruikang K., 1Z
 Wang, Shang, 16, 18, 19
 Wang, Xinlei, 0H
 Waterman, Gar, 06
 Wilson, C. G., 1Y
 Wu, Chen, 16, 19
 Yu, Zhaohua, 17
 Zabic, Miroslav, 0Z
 Zalevsky, Zeev, 0S, 1T
 Zam, Azhar, 0H
 Zawadzki, Robert J., 0H, 1D
 Zhang, Pengfei, 0H
 Zhi, Zhongwei, 1Z
 Zlotnik, Alex, 0S

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

Brian Jet-Fei Wong, Beckman Laser Institute and Medical Clinic
(United States)

Conference Chairs

Fabrice Manns, University of Miami (United States)

Per G. Söderberg, Uppsala University (Sweden)

Arthur Ho, Brien Holden Vision Institute (Australia)

Conference Program Committee

Rafat R. Ansari, NASA Glenn Research Center (United States)

Michael Belkin, Tel Aviv University (Israel)

Kostadinka Bizheva, University of Waterloo (Canada)

David Borja, Alcon Laboratories, Inc. (United States)

Ralf Brinkmann, Universität zu Lübeck (Germany)

Wolfgang Drexler, Medizinische Universität Wien (Austria)

Daniel X. Hammer, U.S. Food and Drug Administration (United States)

Karen M. Joos, Vanderbilt University (United States)

Kirill V. Larin, University of Houston (United States)

Ezra Maguen, American Eye Institute (United States)

Donald T. Miller, Indiana University (United States)

Daniel V. Palanker, Stanford University (United States)

Jean-Marie Parel, Bascom Palmer Eye Institute (United States)

Roberto Pini, Istituto di Fisica Applicata Nello Carrara (Italy)

Luigi Rovati, Università degli Studi di Modena e Reggio Emilia (Italy)

Georg Schuele, OptiMedica Corporation (United States)

Jerry Sebag, VMR Institute (United States)

Peter Soliz, VisionQuest Biomedical, LLC (United States)

Valery V. Tuchin, N.G. Chernyshevsky Saratov State University
(Russian Federation)

Session Chairs

Ophthalmic Imaging: Image Processing and Analysis

Peter Soliz, VisionQuest Biomedical, LLC (United States)

Marco Ruggeri, Bascom Palmer Eye Institute (United States)

Ophthalmic Surgery: Intraoperative Imaging and Monitoring

Wolfgang Drexler, Medizinische Universität Wien (Austria)

Karen M. Joos, Vanderbilt University (United States)

Pascal Rol Lecture

Per G. Söderberg, Uppsala University (Sweden)

Ophthalmic Imaging: Small Animal Models

Daniel X. Hammer, U.S. Food and Drug Administration (United States)

Per G. Söderberg, Uppsala University (Sweden)

Ophthalmic Diagnostics: Polarization

Donald T. Miller, Indiana University (United States)

Ezra Maguen, American Eye Institute (United States)

Vision: Assessment, Correction, Restoration

David Borja, Alcon Laboratories, Inc. (United States)

Rafat R. Ansari, NASA Glenn Research Center (United States)

Retinal and Choroidal Angiography and Blood Flow

Georg Schuele, Abbott Medical Optics (United States)

Rafat R. Ansari, NASA Glenn Research Center (United States)

Ophthalmic Imaging: Adaptive Optics

Arthur Ho, Brien Holden Vision Institute (Australia)

Daniel X. Hammer, U.S. Food and Drug Administration (United States)

Ocular Tissue Characterization

Roberto Pini, Istituto di Fisica Applicata Nello Carrara (Italy)

Jean-Marie Parel, Bascom Palmer Eye Institute (United States)

Ophthalmic Imaging: Models, Phantoms, Technology

Jerry Sebag, VMR Institute (United States)

Fabrice Manns, University of Miami (United States)

Special XXVth Edition Session: Ophthalmic Technologies

Arthur Ho, Brien Holden Vision Institute (Australia)

Fabrice Manns, University of Miami (United States)

Per G. Söderberg, Uppsala University (Sweden)

Pascal Rol Award Presentation
Arthur Ho, Brien Holden Vision Institute (Australia)
Fabrice Manns, University of Miami (United States)

Introduction

The papers contained in this volume were presented at the 25th conference on Ophthalmic Technologies, held 7–8 February 2015 at the Moscone Center in San Francisco, California, as a part of the SPIE Photonics West BIOS Meeting.

A total of 49 papers and 24 posters were presented by scientists, clinicians, and engineers from academia, private clinics, and industry representing many countries and four continents. Topics included new technology for surgical guidance using optical coherence tomography, new devices and approaches for vision assessment, applications of polarization imaging, ophthalmic tissue characterization using elastography, retinal vasculature imaging, ophthalmic image processing, and advances in adaptive optics and retinal prostheses.

This year we celebrated the 25th edition of the Ophthalmic Technologies conference with a special "Silver Anniversary" session. Jean-Marie Parel, Karen Joos, Jerry Sebag, Wolfgang Drexler and Rafat Ansari presented brief personal accounts of the conference's impact, and their vision of where ophthalmic technologies are headed. We thank the five speakers very much for providing their insights.

The anniversary session ended with a special award given to Prof. Jean-Marie Parel in recognition of his contributions to the field of ophthalmic technologies and to the conference. Prof. Parel founded the conference and chaired the first six editions.

The conference concluded with the presentation of the 15th Pascal Rol Award to Francesco LaRocca and his colleagues from Duke University for their excellent paper on "*Ultracompact switchable SLO/OCT handheld probe design*" (9307-50). Established in memory of Dr. Pascal O. Rol, former chair and co-founder of the Ophthalmic Technologies conference, the award is in recognition of the best manuscript and presentation. The outstanding finalists, selected by the entire program committee among 71 abstract submissions, were Daniel Palanker (9307-28), Nathan Shemonski (9307-35) and Liangbo Shen (9307-05).

We are very grateful to the Brien Holden Vision Institute in Sydney, Australia, for sponsoring the 2015 Pascal Rol award, through the Pascal Rol Foundation.

Due to unforeseen circumstances, the Pascal Rol lecture on the topic of clinical applications and technological needs for femtosecond laser cataract surgery, to be given by Prof. Zoltan Nagy, had to be cancelled.

We thank the Program Committee members, session chairs, speakers, and participants, as well as the SPIE staff for their support and dedication in making this conference a success.

We extend an invitation for the Ophthalmic Technologies XXVI conference, which is scheduled for Saturday and Sunday, 13–14 February 2016 in San Francisco, California.

Fabrice Manns
Per G. Söderberg
Arthur Ho

**Fifteenth Pascal Rol Award for Excellence in Ophthalmic Technologies
Supported by the Brien Holden Vision Institute
through the Pascal Rol Foundation**

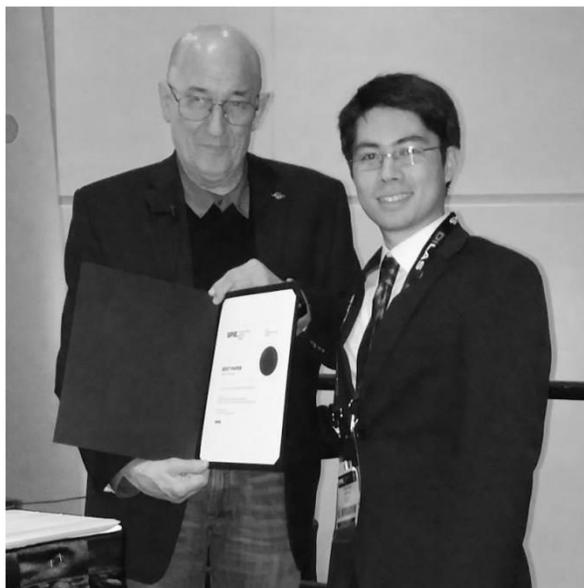


Presented on Sunday February 8, 2015 to

Francesco LaRocca

for his excellent paper on

" Ultracompact switchable SLO/OCT handheld probe design "



Jean-Marie Parel (left) presents the 2015 Pascal Rol Award to Francesco LaRocca (right).

Past awardees

2014	Marco Ruggeri	<i>Biometry of the ciliary muscle during dynamic accommodation assessed with OCT</i>
2013	Yossi Mandel	<i>In-vivo performance of photovoltaic subretinal prosthesis</i>
2012	Clemens Alt	<i>In vivo quantification of microglia dynamics with an SLO in a mouse model of focal laser injury</i>
2011	James Loudin	<i>Photovoltaic Retinal Prosthesis</i>
2010	Daniel Hammer	<i>Multimodal adaptive optics for depth enhanced high-resolution ophthalmic imaging</i>
2009	Kazuhiro Kurokawa	<i>1μm wavelength adaptive optics scanning laser ophthalmoscope</i>
2008	Boris Povazay	<i>Minimum distance mapping using volumetric OCT: A novel indicator for early glaucoma diagnosis</i>
2007	Yoshiaki Yasuno	<i>Clinical examinations of anterior eye segments by three-dimensional swept-source optical coherence tomography</i>
2006	Enrique Fernandez	<i>Adaptive optics using a liquid crystal spatial light modulator for ultrahigh-resolution optical coherence tomography</i>
2005	Karsten König	<i>Cornea surgery with nanojoule femtosecond laser pulses</i>
2004	Daniel Palanker	<i>Attracting retinal cells to electrodes for high-resolution stimulation</i>
2003	Igor Ermakov	<i>Non-invasive optical techniques for the measurement of macular pigments</i>
2002	Georg Schuele	<i>Non-invasive temperature measurements during laser irradiation of the retina with optoacoustic techniques</i>
2001	Matthew Smith	<i>Minimizing the influence of fundus pigmentation on retinal vessel oximetry measurements</i>

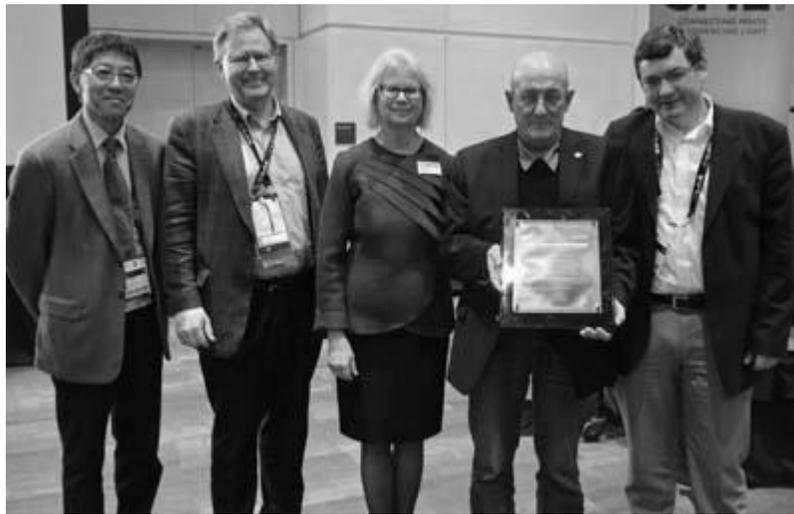
The Ophthalmic Technologies Foundation Award

Presented to

Jean-Marie Parel

Bascom Palmer Eye Institute,
University of Miami School of Medicine

Sunday February 8, 2015



Presentation of the award by Marilyn Gorsuch, Director Technical Programs, SPIE to Professor Jean-Marie Parel.
From left to right: Arthur Ho, Per Soderberg, Marilyn Gorsuch, Jean-Marie Parel, Fabrice Manns.

We hereby recognize Professor Parel as a founder of the Ophthalmic Technologies Conference.

Since 1991, through his tireless leadership, guidance, and contributions, Professor Parel has been the mainstay in the foundation and growth of this unique world-leading forum. The result of Professor Parel's invested energies are manifest in this successful annual gathering of engineers, scientists and clinicians in ophthalmology and vision research for the advancement of ophthalmic systems, improving eye care and eye research the world over. Furthermore, Professor Parel has fostered the careers of generations of scientists and engineers through his outstanding inventiveness, teaching and mentoring.

With this plaque, we express our sincere gratitude and appreciation for his dedication and seminal contribution to the Ophthalmic Technologies Conference.

Presented by:

Marilyn Gorsuch
Director, Technical Programs
On behalf of SPIE

