PROCEEDINGS OF SPIE

Advanced Wavefront Control: Methods, Devices, and Applications VIII

David C. Dayton Troy A. Rhoadarmer Darryl J. Sanchez Editors

2 and 5 August 2010 San Diego, California, United States

Sponsored and Published by SPIE

Volume 7816

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 Advanced Wavefront Control: Methods, Devices, and Applications VIII, edited by David C. Dayton, Troy A. Rhoadarmer, Darryl J. Sanchez, Proceedings of SPIE Vol. 7816 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X ISBN 9780819483126

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 © 2010, 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 0277-786X/10/\$18.00.

Printed in the United States of America.

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



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 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

∨ii	Conference Committee				
SESSION 1	ADVANCED WAVEFRONT SENSING				
7816 02	Estimation of optical turbulence characteristics from Shack Hartmann wavefront sensor measurements (Invited Paper) [7816-01] T. J. Brennan, D. C. Mann, The Optical Sciences Co. (United States)				
7816 04	Shack-Hartmann wavefront sensing performance evaluation for active correction of the Large Synoptic Survey Telescope (LSST) [7816-03] K. L. Baker, L. G. Seppala, Lawrence Livermore National Lab. (United States)				
7816 05	The aggregate behavior of branch points: altitude and strength of atmospheric turbulence layers [7816-04] D. W. Oesch, Science Applications International Corp. (United States); D. J. Sanchez, C. M. Tewksbury-Christle, P. R. Kelly, Air Force Research Lab. (United States)				
7816 06	The aggregate behavior of branch points: a proposal for an atmospheric turbulence layer sensor [7816-05] D. J. Sanchez, Air Force Research Lab. (United States); D. W. Oesch, Science Applications International Corp. (United States); C. M. Tewksbury-Christle, P. R. Kelly, Air Force Research Lab. (United States)				
SESSION 2	ADVANCED WAVEFRONT CONTROL				
7816 07	Fitting error in deep turbulence for a flat subaperture segmented deformable mirror [7816-06] D. J. Sanchez, Air Force Research Lab. (United States); D. W. Oesch, Science Applications International Corp. (United States); P. R. Kelly, Air Force Research Lab. (United States)				
7816 08	Experimental analysis of diffraction effects from a segmented MEMS deformable mirror for a closed loop adaptive optics system [7816-07] K. Shtyrkova, Air Force Research Lab. (United States); L. Arguello, Being-LTS (United States); D. Oesch, Science Applications International Corp. (United States); D. J. Sanchez, P. Kelly, C. Tewksbury-Christle, J. Smith, Air Force Research Lab. (United States)				
7816 09	Impact of spatial resolution on thermal blooming phase compensation instability [7816-08] M. F. Spencer, S. J. Cusumano, J. D. Schmidt, S. T. Fiorino, Air Force Institute of Technology (United States)				
SESSION 3	ALGORITHMS				
7816 OB	New phasor reconstruction methods for speckle imaging [7816-10] G. C. Dente, GCD Associates (United States); M. L. Tilton, Boeing-LTS (United States)				

7816 OC Adaptive jitter control for tracker line of sight stabilization [7816-21]

S. Gibson, T.-C. Tsao, Univ. of California, Los Angeles (United States); D. Herrick, Air Force Research Lab. (United States); C. Beairsto, R. Grimes, T. Harper, J. Radtke, B. Roybal, J. Spray, S. Squires, D. Tellez, M. Thurston, U.S. Army White Sands Missile Range (United States)

SESSION 4 ADVANCED ADAPTIVE OPTICS TECHNOLOGIES

- 7816 0D Evaluation of polymer membrane deformable mirrors for high peak power laser machining applications (Invited Paper) [7816-11]
 - J. D. Mansell, B. G. Henderson, G. Robertson, Active Optical Systems, LLC (United States)
- 7816 0E A method of generating atmospheric turbulence with a liquid crystal spatial light modulator [7816-12]

C. C. Wilcox, F. Santiago, T. Martinez, J. R. Andrews, S. R. Restaino, U.S. Naval Research Lab. (United States); M. Corley, Naval Postgraduate School (United States); S. W. Teare, New Mexico Tech (United States); B. N. Agrawal, Naval Postgraduate School (United States)

- 7816 0F Speed enhancements for a 489-actuator, piston-tip-tilt segment, MEMS DM system [7816-13] M. A. Helmbrecht, M. Besse, C. J. Kempf, M. He, Iris AO, Inc. (United States)
- 7816 0G High efficiency quasi-ternary design for nonmechanical beam-steering utilizing polarization gratings [7816-14]

J. Kim, M. N. Miskiewicz, North Carolina State Univ. (United States); S. Serati, Boulder Nonlinear Systems, Inc. (United States); M. J. Escuti, North Carolina State Univ. (United States)

7816 0H An experimental study showing the effects on a standard PI controller using a segmented MEMS DM acting as a mod(λ) device [7816-15]

J. C. Smith, Air Force Research Lab. (United States); J. Brown, Science Applications International Corp. (United States); D. J. Sanchez, Air Force Research Lab. (United States); D. W. Oesch, Science Applications International Corp. (United States); P. Kelly, K. Shtyrkova, C. M. Tewksbury-Christle, Air Force Research Lab. (United States)

SESSION 5 ATMOSPHERIC PHOTO-CHEMISTRY FOR WAVEFRONT SENSING

Na layer variability and implications for LGS adaptive optics: determination, analysis and impact on AO correction [7816-16]

K. J. Jones, WBAO (United States)

7816 0J SWIR air glow mapping of the night sky [7816-17]

M. M. Myers, Air Force Research Lab. (United States); D. C. Dayton, Applied Technology Associates (United States); J. D. Gonglewski, G. Fertig, Air Force Research Lab. (United States); J. Allen, Applied Technology Associates (United States); R. Nolasco, Air Force Research Lab. (United States); D. Burns, I. Mons, Textron Defense Systems Kauai (United States)

7816 OK

SWIR sky glow imaging for detection of turbulence in the upper atmosphere [7816-18]

D. Dayton, R. Nolasco, J. Allen, Applied Technology Associates (United States); M. Myers,

J. Gonglewski, G. Fertig, Air Force Research Lab. (United States); D. Burns, I. Mons, Textron

Defense Systems Kauai (United States)

POSTER SESSION

7816 OL Fabrication and simulation of large-scale MEMS deformable mirror for wave front active control [7816-19]

P.-Y. Lin, H.-T. Hsieh, G.-D. J. Su, National Taiwan Univ. (Taiwan)

Author Index

Conference Committee

Program Track Chairs

Stephen M. Hammel, Space and Naval Warfare Systems Center, San Diego (United States)

Alexander M. J. van Eijk, TNO Defense, Security and Safety (Netherlands)

Conference Chairs

David C. Dayton, Applied Technology Associates (United States)

Troy A. Rhoadarmer, Science Applications International Corporation (United States)

Darryl J. Sanchez, Air Force Research Laboratory (United States)

Program Committee

Kevin L. Baker, Lawrence Livermore National Laboratory (United States)

Jeffrey D. Barchers, Nutronics, Inc. (United States)

Thomas G. Bifano, Boston University (United States)

Philip J. Bos, Kent State University (United States)

Tanya Cherazova, Lomonosov Moscow State University (Russian Federation)

Lewis F. DeSandre, Office of Naval Research (United Kingdom)

Robert J. Grasso, Northrop Grumman Electronic Systems (United States)

Alexis V. Kudryashov, Moscow State Open University (Russian Federation)

Gordon D. Love, Durham University (United Kingdom)

Justin D. Mansell, MZA Associates Corporation (United States)

Dan K. Marker, Air Force Research Laboratory (United States)

Aaron J. Masino, MZA Associates Corporation (United States)

Kent L. Miller, Air Force Office of Scientific Research (United States)

Denis W. Oesch, Science Applications International Corporation (United States)

Jim F. Riker, Air Force Research Laboratory (United States)

James R. Rotgé, Boeing LTS, Inc. (United States)

Jason D. Schmidt, Air Force Institute of Technology (United States)

Don D. Seeley, High Energy Laser Joint Technology Office (United States)

Vladimir Yu. Venediktov, Research Institute for Laser Physics (Russian Federation)

Session Chairs

- Advanced Wavefront SensingDarryl J. Sanchez, Air Force Research Laboratory (United States)
- Advanced Wavefront Control
 David C. Dayton, Applied Technology Associates (United States)
- 3 Algorithms Richard A. Carreras, Air Force Research Laboratory (United States)
- Advanced Adaptive Optics Technologies
 Troy A. Rhoadarmer, Science Applications International Corporation (United States)
 Michael M. Meyers, Air Force Research Laboratory (United States)
- Atmospheric Photo-Chemistry for Wavefront Sensing
 Denis W. Oesch, Science Applications International Corporation (United States)