PROCEEDINGS OF SPIE

Optics in Atmospheric Propagation and Adaptive Systems XI

Anton Kohnle
Karin Stein
John D. Gonglewski
Editors

16–18 September 2008
Cardiff, Wales, United Kingdom

Sponsored by
SPIE *Europe*

Cooperating Organisations
EARSC—European Association of Remote Sensing Companies
EOS—European Optical Society
Technium OpTIC (United Kingdom)
NASA—National Aeronautics and Space Administration (United States)
WOF—Welsh Opto-electronics Forum (United Kingdom)

Published by
SPIE

Volume 7108

Proceedings of SPIE, 0277-786X, v. 7108

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

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 *Optics in Atmospheric Propagation and Adaptive Systems XI*, edited by Anton Kohnle, Karin Stein, John D. Gonglewski, Proceedings of SPIE Vol. 7108 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X
ISBN 9780819473394

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 © 2008, 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/08/$18.00.

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, 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

vii *Conference Committee*

SESSION 1 CHARACTERISATION OF THE PROPAGATION ENVIRONMENT

7108 03 **Measurement of optical refraction, transmission, and turbulence effects in False Bay, South Africa: June 2007** [7108-02]
A. N. de Jong, P. B. W. Schwering, P. J. Fritz, TNO Defence, Security and Safety (Netherlands)

7108 04 **Measurements and modeling of the vertical radiance profile of sea and sky backgrounds using infrared sensors** [7108-03]
A. D. van Rheenen, E. Brendhagen, L. T. Heen, Norwegian Defence Research Establishment (Norway)

7108 05 **Statistical model for atmospheric limb radiance structure: application to airborne infrared surveillance systems** [7108-04]
C. Quang, ONERA (France); F. Dalaudier, Service d'Aéronomie, CNRS (France); A. Roblin, V. Rialland, P. Chervet, ONERA (France)

7108 06 **Millimeter wave propagation through dust** [7108-05]
D. Nüßler, H. Essen, N. von Wahl, R. Zimmermann, S. Rötzel, FGAN-Research Institute for High Frequency Physics and Radar Techniques (Germany); I. Willms, Univ. Duisburg-Essen (Germany)

SESSION 2 PROPAGATION AND IMAGING THROUGH OPTICAL TURBULENCE I

7108 08 **Influence of the source spectrum on the accuracy of optical measurements of turbulence** [7108-07]
V. P. Lukin, Tomsk State Univ. (Russian Federation)

7108 09 **Optical turbulence profiling at Mount John University Observatory** [7108-08]
J. L. Mohr, Univ. of Canterbury (New Zealand); R. A. Johnston, Aranz Scanning Ltd. (New Zealand); C. C. Worley, P. L. Cottrell, Univ. of Canterbury (New Zealand)

7108 0A **The effect of the strong turbulence regime on the laser beam propagation and focusing** [7108-09]
F. V. Shugaev, E. N. Terentiev, L. S. Shtemenko, O. I. Dokukina, T. A. Petrova, M. V. Lomonosov Moscow State Univ. (Russian Federation)

SESSION 3 PROPAGATION AND IMAGING THROUGH OPTICAL TURBULENCE II

7108 0B **Wavefront sensing of supersonic aero-optical effects on side-mounted windows** [7108-11]
R. Deron, F. Mendez, J. Montri, ONERA (France)

7108 0C **Numerical study of the wavefront distortion in an aerodynamical flow field** [7108-27]
B. Sorrente, P. d'Espiney, R. Deron, ONERA (France)

7108 0D **Turbulence modeling by realization of density fluctuations** [7108-12]
O. Padé, Rafael (Israel)

SESSION 4 MITIGATION OF ATMOSPHERIC EFFECTS AND SYSTEMS I

7108 0E **High power laser diodes as LADAR illuminators: atmospheric considerations** [7108-26]
D. Dayton, Applied Technology Associates (United States); J. Gonglewski, C. StArnauld, Air Force Research Lab. (United States)

7108 0F **Integrated approach to airborne laser communication** [7108-13]
J. A. Louthain, J. D. Schmidt, Air Force Institute of Technology (United States)

7108 0H **Laser guide stars and models of atmospheric turbulence (Invited Paper)** [7108-15]
L. A. Bol'basova, V. P. Lukin, Tomsk State Univ. (Russian Federation)

7108 0I **Adaptive optics compensation over a 3 km near horizontal path** [7108-17]
R. Mackey, C. Dainty, National Univ. of Ireland, Galway (Ireland)

7108 0K **Tests of the adaptive optical system with a modified correlation sensor at the big solar vacuum telescope** [7108-19]
V. P. Lukin, Institute of Atmospheric Optics (Russian Federation) and Tomsk State Univ. (Russian Federation); V. M. Grigor'ev, Institute of Solar-Terrestrial Physics (Russian Federation); L. V. Antoshkin, N. N. Botygina, O. N. Emaleev, P. A. Konyaev, Institute of Atmospheric Optics (Russian Federation); P. G. Kovadlo, V. I. Skomorovskii, Institute of Solar-Terrestrial Physics (Russian Federation)

SESSION 5 MITIGATION OF ATMOSPHERIC EFFECTS AND SYSTEMS II

7108 0L **Quantitative performance evaluation of a blurring restoration algorithm based on principal component analysis** [7108-20]
M. Greco, C. Huebner, G. Marchi, FGAN-FOM (Germany)

7108 0M **Blind deconvolution algorithms for the restoration of atmospherically degraded imagery: a comparative analysis** [7108-21]
C. S. Huebner, M. Greco, FGAN-FOM (Germany)

7108 0N **A comparison of multi-frame blind deconvolution and speckle imaging energy spectrum signal-to-noise ratios** [7108-22]
C. L. Matson, Air Force Research Lab. (United States)

7108 0O **Inner- and outer-scales of turbulent wavefront phase defined through the lens of multi-scale Lévy fractional Brownian motion processes** [7108-23]
D. G. Pérez, Pontificia Univ. Católica de Valparaíso (Chile); L. Zunino, Ctr. de Investigaciones Ópticas (Argentina) and Univ. Nacional de La Plata (Argentina)

POSTER SESSION

7108 0Q **Adaptive optics system prototype for the automatic control of geometrical fluctuations in a laser beam in air** [7108-25]
S. Grasso, Univ. degli Studi di Roma Tre (Italy); F. Acernese, R. Romano, F. Barone, Univ. degli Studi di Salerno (Italy) and Sezione di Napoli, Compl. Univ. di Monte S. Angelo, INFN (Italy)

Author Index

Conference Committee

Symposium Chairs

Guido D'Urso, Università degli Studi di Napoli Federico II (Italy)
Steven P. Neeck, NASA Headquarters (United States)

Conference Chairs

Anton Kohnle, FGAN-FOM Research Institute for Optronics and Pattern Recognition (Germany)
Karin Stein, FGAN-FOM Research Institute for Optronics and Pattern Recognition (Germany)
John D. Gonglewski, Air Force Research Laboratory (United States)

Program Committee

David C. Dayton, Applied Technology Associates (United States)
Denis Dion, Jr., Defense Research and Development Canada-Valcartier (Canada)
Stephen M. Hammel, Space and Naval Warfare Systems Center, San Diego (United States)
Vladimir V. Lukin, Institute of Atmospheric Optics (Russian Federation)
Charles L. Matson, Air Force Research Laboratory (United States)
Sergio R. Restaino, Naval Research Laboratory (United States)
Jennifer C. Ricklin, DARPA/STO (United States)
Jim F. Riker, Air Force Research Laboratory (United States)
Marc J. F. Séchaud, ONERA (France)
Mikhail A. Vorontsov, Army Research Laboratory (United States)

Session Chairs

1 Characterisation of the Propagation Environment
Karin Stein, Forschungsgesellschaft für Angewandte Naturwissenschaften e.V. (Germany)

2 Propagation and Imaging Through Optical Turbulence I
Marc J. F. Séchaud, ONERA (France)

3 Propagation and Imaging Through Optical Turbulence II
David C. Dayton, Applied Technology Associates (United States)

4 Mitigation of Atmospheric Effects and Systems I
John D. Gonglewski, Air Force Research Laboratory (United States)

5 Mitigation of Atmospheric Effects and Systems II
Vladimir P. Lukin, Institute of Atmospheric Optics (Russian Federation)