PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 8246

, "Front Matter: Volume 8246," Proc. SPIE 8246, Free-Space Laser
Communication Technologies XXIV, 824601 (21 March 2012); doi:
10.1117/12.930905

SPIE.

Event: SPIE LASE, 2012, San Francisco, California, United States

PROCEEDINGS OF SPIE

Free-Space Laser Communication Technologies XXIV

**Hamid Hemmati
Don M. Boroson**
Editors

**24–26 January 2012
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 8246

Proceedings of SPIE, 0277-786X, v. 8246

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 *Free-Space Laser Communication Technologies XXIV*, edited by Hamid Hemmati, Don M. Boroson, Proceedings of SPIE Vol. 8246 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X

ISBN 9780819488893

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 © 2012, 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/12/\$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 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 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. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii *Conference Committee*

SESSION 1 INVITED TALKS I

- 8246 04 **Achievable capacity using photon-counting array-based receivers with on-off-keyed and frequency-shift-keyed modulation formats (Invited Paper)** [8246-03]
B. S. Robinson, D. M. Boroson, MIT Lincoln Lab. (United States)
- 8246 05 **On approaching the ultimate limits of communication using a photon-counting detector (Invited Paper)** [8246-04]
B. I. Erkmen, B. E. Moision, S. J. Dolinar, K. M. Birnbaum, D. Divsalar, Jet Propulsion Lab. (United States)

SESSION 2 INVITED TALKS II

- 8246 07 **Current development status of Small Optical TrAnsponder (SOTA) for satellite-ground laser communications (Invited Paper)** [8246-06]
Y. Takayama, M. Toyoshima, Y. Koyama, H. Takenaka, M. Akioka, National Institute of Information and Communications Technology (Japan); K. Shiratama, NEC TOSHIBA Space Systems, Ltd. (Japan); I. Mase, O. Kawamoto, NEC Corp. (Japan)

SESSION 3 DETECTION, MODULATION, AND CODING

- 8246 09 **Limits on achievable dimensional and photon efficiencies with intensity-modulation and photon-counting due to non-ideal photon-counter behavior** [8246-08]
B. Moision, B. I. Erkmen, W. Farr, S. J. Dolinar, K. M. Birnbaum, Jet Propulsion Lab. (United States)
- 8246 0A **Development and evaluation of a digital signal processing for single polarization QPSK modulation format** [8246-09]
K. Endo, Y. Hashimoto, T. Tanaka, T. Takamichi, K. Fukuchi, NEC Corp. (Japan); M. Toyoshima, Y. Takayama, National Institute of Information and Communications Technology (Japan)
- 8246 0B **Design of encoders and decoders for code/pulse-position-swapping (C/CPPS) based on sonar codes** [8246-10]
A. J. Mendez, Mendez R&D Associates (United States)

SESSION 4 DEMONSTRATIONS

- 8246 0C **Overview and status of the Lunar Laser Communications Demonstration** [8246-11]
D. M. Boroson, B. S. Robinson, D. A. Burianek, D. V. Murphy, MIT Lincoln Lab. (United States); A. Biswas, Jet Propulsion Lab. (United States)

- 8246 0D **Laser communication terminals for the European Data Relay System** [8246-12]
K. Böhmer, M. Gregory, F. Heine, H. Kämpfner, R. Lange, Tesat-Spacecom GmbH & Co. KG (Germany); M. Lutzer, R. Meyer, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)
- 8246 0F **10-Gb/s lasercom system for spacecraft** [8246-14]
J. Kovalik, H. Hemmati, A. Biswas, Jet Propulsion Lab. (United States)
- 8246 0G **40-Gbit/s optical free-space transmission experiment using QPSK modulation format** [8246-15]
Y. Hashimoto, N. Kamiya, K. Endo, T. Tanaka, S. Nishimura, N. Hashimoto, M. Shimizu, Y. Suzuki, K. Shiratama, NEC Corp. (Japan); M. Toyoshima, Y. Takayama, National Institute of Information and Communications Technology (Japan); K. Fukuchi, NEC Corp. (Japan)
- 8246 0H **Long-range beam propagation for quantum communications** [8246-17]
I. Capraro, A. Tomaello, A. Dall'Arche, F. Gerlin, G. Vallone, P. Villoresi, Univ. of Padova (Italy)

SESSION 5 LASERS

- 8246 0I **All-semiconductor-based narrow linewidth high-power laser system for laser communication applications in space at 1060 nm** [8246-18]
S. Spießberger, Ferdinand-Braun-Institut (Germany); M. Schiemangk, Humboldt-Univ. zu Berlin (Germany); A. Sahm, F. Bugge, J. Fricke, H. Wenzel, A. Wicht, G. Erbert, G. Tränkle, Ferdinand-Braun-Institut (Germany)
- 8246 0J **1.5-micron MOPA deep-space downlink transmitter** [8246-19]
D. L. Sipes, Jr., J. D. Tafoya, D. S. Schulz, Optical Engines, Inc. (United States); B. G. Ward, C. G. Carlson, U.S. Air Force Academy (United States)
- 8246 0K **Short-wavelength (1010-1030nm) Yb-fiber-MOPA-based multi-aperture high-power uplink laser beacons for space communication** [8246-20]
D. Engin, W. Lu, F. Kimpel, S. Gupta, Fibertek, Inc. (United States)
- 8246 0L **Preliminary results of testing a space-grade laser transmitter for optical communications** [8246-21]
M. W. Wright, Jet Propulsion Lab. (United States); A. B. Piccirilli, A. R. Grant, LGS Innovations Inc. (United States)
- 8246 0M **Design of a 40-Watt 1.55µm uplink transmitter for Lunar Laser Communications** [8246-22]
D. O. Caplan, J. J. Carney, MIT Lincoln Lab. (United States); R. E. Lafon, NASA Goddard Space Flight Ctr. (United States); M. L. Stevens, MIT Lincoln Lab. (United States)

SESSION 6 ATMOSPHERIC PROPAGATION

- 8246 0N **Anisoplanatism over horizontal path: comparison of theoretical and experimental results** [8246-23]
J. P. Bos, A. V. Sergeyev, M. C. Roggemann, Michigan Technological Univ. (United States)
- 8246 0O **Mitigation of time-spatial influence in free-space optical networks utilizing route diversity** [8246-24]
J. Libich, S. Zvanovec, M. Mudroch, Czech Technical Univ. in Prague (Czech Republic)

- 8246 OP **Model-oriented availability analysis of optical GEO-ground links** [8246-25]
N. Perlot, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany);
J. Perdigues-Armengol, ESA-ESTEC (Netherlands)

SESSION 7 DETECTORS/OPTICS/RANGING

- 8246 OR **Superconducting nanowire arrays for multi-meter free-space optical communications receivers** [8246-27]
W. H. Farr, J. A. Stern, M. D. Shaw, Jet Propulsion Lab. (United States)
- 8246 OS **Optimum beam setting for near-field free-space optical communication system with bidirectional beacon tracking** [8246-28]
Y. Arimoto, National Institute of Information and Communications Technology (Japan)
- 8246 OT **Conical refraction multiplexing for free-space optical communications** [8246-29]
Y. V. Loiko, A. Turpin, Univ. Autònoma de Barcelona (Spain); T. K. Kalkandjiev, Univ. Autònoma de Barcelona (Spain) and Conerefringent Optics SL (Spain); J. Mompart, Univ. Autònoma de Barcelona (Spain)

SESSION 8 ANALYSIS AND TESTING

- 8246 OV **Throughput maximization of optical LEO-ground links** [8246-31]
N. Perlot, T. de Cola, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)
- 8246 OW **Evaluation of deep-space laser communication under different mission scenarios** [8246-32]
A. Biswas, S. Piazzolla, B. Moision, D. Lisman, Jet Propulsion Lab. (United States)
- 8246 OX **Progress on the development of a simulation environment for optical communications** [8246-33]
J. Shields, M. Srinivasan, M. W. Regehr, Jet Propulsion Lab. (United States)
- 8246 OY **Radiation hardening techniques for rare-earth-based optical fibers and amplifiers** [8246-34]
S. Girard, CEA, DAM, DIF (France); M. Vivona, ixFiber SAS (France), Lab. Hubert Curien, CNRS, Univ. Jean Monnet Saint-Etienne (France), and Univ. degli Studi di Palermo (Italy);
L. Mescia, Politecnico di Bari (Italy); A. Laurent, ixFiber SAS (France); Y. Ouerdane, Lab. Hubert Curien, CNRS, Univ. Jean Monnet Saint-Etienne (France); C. Marcandella, CEA, DAM, DIF (France); F. Prudeniano, Politecnico di Bari (Italy); A. Boukenter, Lab. Hubert Curien, CNRS, Univ. Jean Monnet Saint-Etienne (France); T. Robin, B. Cadier, E. Pinsard, ixFiber SAS (France); M. Cannas, R. Boscaino, Univ. degli Studi di Palermo (Italy)

Author Index

Conference Committee

Symposium Chairs

Friedhelm Dorsch, TRUMPF Werkzeugmaschinen GmbH + Co. KG
(Germany)

Alberto Piqué, U.S. Naval Research Laboratory (United States)

Symposium Cochairs

Bo Gu, IPG Photonics Corporation (China)

Andreas Tünnermann, Friedrich-Schiller-Universität Jena (Germany)

Conference Chairs

Hamid Hemmati, Jet Propulsion Laboratory (United States)

Don M. Boroson, MIT Lincoln Laboratory (United States)

Program Committee

Vincent W. Chan, Massachusetts Institute of Technology (United States)

Renny A. Fields, The Aerospace Corporation (United States)

G. Charmaine Gilbreath, U.S. Naval Research Laboratory (United States)

Michael A. Krainak, NASA Goddard Space Flight Center (United States)

Robert Lange, Tesat-Spacecom GmbH & Co. KG (Germany)

Zoran Sodnik, European Space Research and Technology Center
(Netherlands)

Morio Toyoshima, National Institute of Information and
Communications Technology (Japan)

Alan E. Willner, The University of Southern California (United States)

Shiro Yamakawa, Japan Aerospace Exploration Agency (Japan)

Session Chairs

- 1 Invited Talks I
Hamid Hemmati, Jet Propulsion Laboratory (United States)

- 2 Invited Talks II
Don M. Boroson, MIT Lincoln Laboratory (United States)

- 3 Detection, Modulation, and Coding
Knut Böhmer, Tesat-Spacecom GmbH & Co. KG (Germany)

- 4 Demonstrations
Hamid Hemmati, Jet Propulsion Laboratory (United States)
- 5 Lasers
Don M. Boroson, MIT Lincoln Laboratory (United States)
- 6 Atmospheric Propagation
Abhijit Biswas, Jet Propulsion Laboratory (United States)
- 7 Detectors/Optics/Ranging
Don M. Boroson, MIT Lincoln Laboratory (United States)
- 8 Analysis and Testing
Yoshihisa Takayama, National Institute of Information and Communications Technology (Japan)