PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 6780

, "Front Matter: Volume 6780," Proc. SPIE 6780, Quantum Communications
Realized, 678001 (10 September 2007); doi: 10.1117/12.771232

SPIE.

Event: Optics East, 2007, Boston, MA, United States

PROCEEDINGS OF SPIE

Quantum Communications Realized

**Yasuhiko Arakawa
Masahide Sasaki
Hideyuki Sotobayashi**
Editors

**10–12 September 2007
Boston, Massachusetts, USA**

Sponsored and Published by
SPIE

Volume 6780

Proceedings of SPIE, 0277-786X, v. 6780

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 *Quantum Communications Realized*, edited by Yasuhiko Arakawa, Masahide Sasaki, Hideyuki Sotobayashi, Proceedings of SPIE Vol. 6780 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X

ISBN 9780819469403

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 © 2007, 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/07/\$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

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*

QUANTUM COMMUNICATION AND QUANTUM CRYPTOGRAPHY I

- 6780 04 **Gigahertz-clocked quantum key distribution in passive optical networks** [6780-03]
V. Fernandez, R. J. Collins, K. J. Gordon, Heriot-Watt Univ. (United Kingdom);
P. D. Townsend, Univ. College, Cork (Ireland); G. S. Buller, Heriot-Watt Univ. (United Kingdom)

QUANTUM INFORMATION PROCESSING WITH CONTINUOUS VARIABLES

- 6780 06 **Non-Gaussian control of continuous variables with photon counting and filtering (Invited Paper)** [6780-05]
M. Sasaki, National Institute of Information and Communications Technology (Japan);
K. Wakui, H. Takahashi, National Institute of Information and Communications Technology (Japan) and The Univ. of Tokyo (Japan); M. Takeoka, S. Suzuki, National Institute of Information and Communications Technology (Japan)

SINGLE-PHOTON, ENTANGLED-PHOTON SOURCES, AND QUANTUM REPEATER

- 6780 09 **A high-flux source of single-mode fiber-coupled nondegenerate polarization-entangled photons (Invited Paper)** [6780-08]
F. N. C. Wong, D. Venkatraman, Massachusetts Institute of Technology (USA)
- 6780 0A **Quantum networking with quantum dots coupled to micro-cavities (Invited Paper)** [6780-18]
E. Waks, D. Sridharan, IREAP, Univ. of Maryland, College Park (USA); J. Vuckovic, E.L. Ginzton Labs., Stanford Univ. (USA)

QUANTUM CRYPTOGRAPHY II

- 6780 0B **Long-distance quantum cryptography with entangled photons (Keynote Paper)** [6780-09]
A. Zeilinger, Institute for Quantum Optics and Quantum Information (Austria)
- 6780 0C **High-repetition rate quantum key distribution (Invited Paper)** [6780-10]
J. C. Bienfang, A. Restelli, D. Rogers, A. Mink, B. J. Hershman, A. Nakassis, X. Tang, L. Ma, H. Xu, D. H. Su, C. W. Clark, C. J. Williams, National Institute of Standards and Technology (USA)

ENTANGLEMENT MANIPULATION

- 6780 OE **Multiphoton entanglement engineering via projective measurements (Invited Paper)** [6780-12]
C. Schmid, N. Kiesel, W. Wieczorek, R. Pohlner, H. Weinfurter, Max-Planck-Institut für Quantenoptik (Germany) and Ludwig-Maximilians-Univ. (Germany)
- 6780 OF **New perspectives in generation and manipulation of hyperentangled states (Invited Paper)** [6780-13]
G. Vallone, E. Pomarico, F. De Martini, P. Mataloni, Univ. La Sapienza (Italy) and Consorzio Nazionale Interuniversitario per le Scienze Fisiche della Materia, Roma (Italy)
- 6780 OG **Entanglement swapping with high coherence photon pair sources (Invited Paper)** [6780-14]
M. Halder, H. Zbinden, Univ. of Geneva (Switzerland)

QUANTUM REPEATER AND MEMORY

- 6780 OK **Optimizing the storage and retrieval efficiency of a solid-state quantum memory through tailored state preparation (Invited Paper)** [6780-19]
M. D. Eisaman, National Institute of Standards and Technology (USA); S. Polyakov, National Institute of Standards and Technology (USA) and Joint Quantum Institute of National Institute of Standards and Technology and Univ. of Maryland (USA); M. Hohensee, Harvard Univ. (USA); J. Fan, National Institute of Standards and Technology (USA) and Joint Quantum Institute of National Institute of Standards and Technology and Univ. of Maryland (USA); P. Hemmer, Texas A&M Univ. (USA); A. Migdall, National Institute of Standards and Technology (USA) and Joint Quantum Institute of National Institute of Standards and Technology and Univ. of Maryland (USA)

QUANTUM METROLOGY

- 6780 OL **Frequency comparison between optical lattice clocks (Invited Paper)** [6780-20]
H. Katori, M. Takamoto, T. Akatsuka, R. Higashi, The Univ. of Tokyo (Japan) and CREST, Japan Science and Technology Agency (Japan)
- 6780 OO **Optical lattice clock with spin-polarized ^{87}Sr atoms** [6780-40]
X. Baillard, M. Fouché, R. Le Targat, P. Westergaard, A. Lecallier, J. Lodewyck, F. Chapelet, M. Abgrall, G. D. Rovera, P. Laurent, P. Rosenbusch, S. Bize, G. Santarelli, A. Clairon, P. Lemonde, LNE-SYRTE, Observatoire de Paris (France); G. Grosche, B. Lipphardt, H. Schnatz, Physikalisch-Technische Bundesanstalt (Germany)

SINGLE-PHOTON SOURCES AND DETECTORS

- 6780 OQ **An optical fiber-based source of polarization-entangled photon pairs** [6780-24]
J. Fan, M. D. Eisaman, A. Migdall, National Institute of Standards and Technology (USA) and Joint Quantum Institute, Univ. of Maryland (USA)

6780 OR **Tomographic characterization of fiber-generated polarization-entangled Bell states** [6780-25]
M. Medic, Northwestern Univ. (USA) and Ctr. for Photonic Communication and Computing, Northwestern Univ. (USA); K. F. Lee, J. Altepeter, B. Gokden, C. Liang, Ctr. for Photonic Communication and Computing, Northwestern Univ. (USA); S. W. Nam, National Institute of Standards and Technology (USA); P. Kumar, Northwestern Univ. (USA) and Ctr. for Photonic Communication and Computing, Northwestern Univ. (USA)

6780 OU **Low-noise PPLN-based single-photon detector** [6780-28]
H. Xu, L. Ma, O. Slattery, X. Tang, National Institute of Standards and Technology (USA)

QUANTUM CRYPTOGRAPHY III

6780 OZ **Quantum key distribution device with coherent states (Invited Paper)** [6780-33]
J. Lodewyck, LNE-SYRTE, Observatoire de Paris (France); M. Bloch, Georgia Tech, CNRS (France); R. García-Patrón, Univ. libre de Bruxelles (Belgium); S. Fossier, Thales Research and Technologies (France) and l'Institut d'Optique (France); E. Karpov, Univ. libre de Bruxelles (Belgium); E. Diamanti, l'Institut d'Optique (France); T. Debuisschert, Thales Research and Technologies (France); N. J. Cerf, Univ. libre de Bruxelles (Belgium); R. Tualle-Broui, l'Institut d'Optique (France); S. W. McLaughlin, GeorgiaTech, CNRS (France); P. Grangier, l'Institut d'Optique (France)

QUANTUM INFORMATION PROCESSING WITH CONTINUOUS VARIABLES II

6780 10 **Experimental generation of optical Schrödinger cats from photon number states (Invited Paper)** [6780-34]
A. Ourjoumtsev, Lab. Charles Fabry de l'Institut d'Optique, Univ. Paris-Sud, CNRS (France); H. Jeong, Univ. of Queensland (Australia); R. Tualle-Broui, P. Grangier, Lab. Charles Fabry de l'Institut d'Optique, Univ. Paris-Sud, CNRS

QUANTUM CRYPTOGRAPHY IV

6780 12 **Quantum key distribution system for metropolitan-area networks (Invited Paper)** [6780-36]
A. Tomita, ERATO-SORST, JST (Japan) and NEC Corp. (Japan)

6780 13 **Entangled free-space quantum key distribution (Invited Paper)** [6780-37]
G. Weihs, C. Erven, Univ. of Waterloo (Canada)

6780 14 **Custom hardware to eliminate bottlenecks in QKD throughput performance** [6780-38]
A. Mink, National Institute of Standards and Technology (USA)

6780 15 **Differential-phase-shift quantum key distribution (Invited Paper)** [6780-39]
K. Inoue, Osaka Univ. (Japan), NTT Corp. (Japan), and JST-CREST (Japan); H. Takesue, T. Honjo, NTT Corp. (Japan) and JST-CREST (Japan)

Author Index

Conference Committee

Symposium Chairs

Achyut Kumar Dutta, Banpil Photonics, Inc. (USA)
Werner Weiershausen, T-Systems Enterprise Services GmbH (Germany)

Conference Chairs

Yasuhiko Arakawa, The University of Tokyo (Japan)
Masahide Sasaki, National Institute of Information and
Communications Technology (Japan)
Hideyuki Sotobayashi, National Institute of Information and
Communications Technology (Japan)

Program Committee

Achyut Kumar Dutta, Banpil Photonics, Inc. (USA)
Chris A. Fuchs, Lucent Technologies, Bell Laboratories (USA)
Kyo Inoue, Osaka University (Japan), NTT Corporation (Japan), and
JST-CREST (Japan)
Prem Kumar, Northwestern University (USA)
Alex M. Kuzmich, Georgia Institute of Technology (USA)
Paolo Mataloni, Università degli Studi di Roma/La Sapienza (Italy) and
Consorzio Nazionale Interuniversitario per le Scienze Fisiche della
Materia, Roma (Italy)
Sae Woo Nam, National Institute of Standards and Technology (USA)
Alexander V. Sergienko, Boston University (USA)
Tatsuya Tomaru, Hitachi Ltd. (Japan)
Akihisa Tomita, NEC Corporation (Japan) and ERATO-SORST, JST
(Japan)
Alexei S. Trifonov, MagiQ Technologies, Inc. (USA)
Werner Weiershausen, T-Systems Enterprise Services GmbH (Germany)
Harald Weinfurter, Ludwig-Maximilians-Universität (Germany) and Max-
Planck-Institut für Quantenoptik (Germany)
Carl J. Williams, National Institute of Standards and Technology (USA)

Session Chairs

- 1 Quantum Communication and Quantum Cryptography I
Anton Zeilinger, Universität Wien (Austria) and Institute for Quantum
Optics and Quantum Information (Austria)

- 2 Quantum Information Processing with Continuous Variables
Alexei Ourjoumtsev, Laboratoire Charles Fabry de l'Institut d'Optique,
Université Paris-Sud, CNRS (France)
- 3 Single-Photon, Entangled-Photon Sources, and Quantum Repeater
Franco N. C. Wong, Massachusetts Institute of Technology (USA)
James D. Franson, University of Maryland, Baltimore County (USA)
- 4 Quantum Cryptography II
Prem Kumar, Northwestern University (USA)
- 5 Entanglement Manipulation
Alexander V. Sergienko, Boston University (USA)
- 6 Quantum Repeater and Memory
Hideo Mabuchi, California Institute of Technology (USA)
- 7 Quantum Metrology
Alex M. Kuzmich, Georgia Institute of Technology (USA)
- 8 Single-Photon Sources and Detectors
Alan L. Migdall, National Institute of Standards and Technology (USA),
and the Joint Quantum Institute, National Institute of Standards and
Technology and the University of Maryland (USA)
- 9 Quantum Information Processing and Measurement
Nicolas J. Cerf, Université Libre de Bruxelles (Belgium)
- 10 Quantum Cryptography III
Hugo Zbinden, Université de Genève (Switzerland)
- 11 Quantum Information Processing with Continuous Variables II
Paolo Mataloni, Università degli Studi di Roma/La Sapienza (Italy) and
Consorzio Nazionale Interuniversitario per le Scienze Fisiche della
Materia, Roma (Italy)
- 12 Quantum Cryptography IV
Alexei S. Trifonov, MagiQ Technologies, Inc. (USA)