

PROCEEDINGS OF SPIE

Quantum Technologies 2020

Eleni Diamanti
Sara Ducci
Nicolas Treps
Shannon Whitlock
Editors

6–10 April 2020
Online Only, France

Sponsored by
SPIE

Cosponsored by
City of Strasbourg (France)
Eurometropole (France)
CNRS (France)
Région Grand Est (France)
iCube (France)
Université de Strasbourg (France)

Cooperating Organisations
Photonics 21 (Germany)
EOS—European Optical Society (Germany)
Photonics Public Private Partnership (Belgium)
Photonics France (France)

Published by
SPIE

Volume 11347

Proceedings of SPIE 0277-786X, V. 11347

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

Quantum Technologies 2020, edited by Eleni Diamanti, Sara Ducci, Nicolas Treps, Shannon Whitlock,
Proc. of SPIE Vol. 11347, 1134701 · © 2020 SPIE · CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2571395

The papers 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. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers 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 these proceedings:

Author(s), "Title of Paper," in *Quantum Technologies 2020*, edited by Eleni Diamanti, Sara Ducci, Nicolas Treps, Shannon Whitlock, Proceedings of SPIE Vol. 11347 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510634664

ISBN: 9781510634671 (electronic)

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 © 2020, 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 \$21.00 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/20/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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. A unique citation identifier (CID) number is assigned to each article at the time of 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 and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five 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.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

QUANTUM SENSING, IMAGING, AND METROLOGY I

11347 0I	Quantum illumination with simple detection [11347-18]
11347 0J	Sensing electromagnetic fields with the AC-Stark effect in two-photon spectroscopy of cold trapped HD⁺ [11347-19]

NEW DEVICES FOR QUANTUM TECHNOLOGIES

11347 13	Signal-to-noise ratio in correlation plenoptic imaging [11347-41]
11347 14	GaN laser diodes for quantum sensors and optical atomic clocks [11347-42]

POSTER SESSION

11347 17	Shot noise-based quantum random number generator [11347-44]
11347 19	FPGA based time-to-digital converters [11347-47]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five 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.

Ai, Xiao, 19
Clark, C. C., 14
Constantin, F. L., 0J
Dahnoun, Naim, 19
D'Angelo, Milena, 13
Garuccio, Augusto, 13
Jeffers, John, 0I
Leszczyński, M., 14
Lu, Yang, 19
Macarthur, J., 14
Massaro, Gianlorenzo, 13
McKnight, L., 14
Najda, S. P., 14
Niemczuk, Jakub, 17
Nock, Richard W., 19
Pascasio, Saverio, 13
Pepe, Francesco V., 13
Perlin, P., 14
Prade, L., 14
Pritchard, Jonathan, 0I
Rarity, John G., 19
Roga, Wojciech, 0I
Scala, Giovanni, 13
Slight, T. J., 14
Stanczyk, S., 14
Yang, Hao, 0I

Conference Committee

Symposium Chairs

Francis Berghmans, Vrije Universiteit Brussel (Belgium)
Thierry Georges, Oxxius SA (France)
Paul Montgomery, Université de Strasbourg (France)
Lluis Torner, ICFO Barcelona (Spain)

Conference Chairs

Eleni Diamanti, Sorbonne Université, CNRS (France)
Sara Ducci, Université Paris 7 (France)
Nicolas Treps, Laboratoire Kastler Brossel (France)
Shannon Whitlock, Université de Strasbourg (France)

Conference Programme Committee

Kai Bongs, The University of Birmingham (United Kingdom)
Philippe Bouyer, Laboratoire Photonique, Numérique et Nanosciences (France)
Félix Bussièrès, id Quantique SA (Switzerland)
Thomas Gerrits, National Institute of Standards and Technology (United States)
Hugues de Riedmatten, ICFO - Institut de Ciències Fotòniques (Spain)
Chiara Macchiavello, Università degli studi di Pavia (Italy)
Tracy E. Northup, Universität Innsbruck (Austria)
Fabio Sciarrino, Sapienza – Università di Roma (Italy)
Paolo Villorosi, Università degli Studi di Padova (Italy)
Frank Wilhelm-Mauch, Universität des Saarlandes (Germany)

Session Chairs

- 1 Quantum Cryptography and Communication I
Sara Ducci, Laboratoire Materiaux Et Phénomènes Quantiques (France)
- 2 Quantum Simulation and Computing I
Jens S. Eisert, Freie Universität Berlin (Germany)
- 3 Quantum Simulation and Computing II
Stefanie Barz, Universität Stuttgart (Germany)
- 4 Quantum Cryptography and Communication II
Nicolas Treps, Laboratoire Kastler Brossel (France)

- 5 Quantum Sensing, Imaging, and Metrology I
Philippe Bouyer, Laboratoire Photonique, Numérique et Nanosciences (France)
- 6 Quantum Sensing, Imaging, and Metrology II
Tanja E. Mehlstäubler, Physikalisch-Technische Bundesanstalt (Germany)
- 7 Novel Quantum Platforms and Hybrid Devices
Roberto Osellame, CNR-Istituto di Fotonica e Nanotecnologie (Italy)
- 8 Single- and Two-photon Emitters
Costanza Toninelli, Istituto Nazionale di Ottica (Italy)
- 9 Integrated Quantum Devices
Rinaldo Trotta, Johannes Kepler Universität Linz (Austria)
- 10 New Devices for Quantum Technologies
Shannon Whitlock, Institut de Science et d'Ingénierie Supramoléculaires (France)