

# PROCEEDINGS OF SPIE

## ***Real-time Photonic Measurements, Data Management, and Processing***

**Bahram Jalali**

**Ming Li**

**Keisuke Goda**

**Mohammad Hossein Asghari**

*Editors*

**9–11 October 2014**

**Beijing, China**

*Sponsored by*

SPIE

COS—Chinese Optical Society

*Cooperating Organizations*

Tsinghua University (China) • Peking University (China) • University of Science and Technology of China (China) • Zhejiang University (China) • Tianjin University (China) • Beijing Institute of Technology (China) • Beijing University of Posts and Telecommunications (China) • Nankai University (China) • Changchun University of Science and Technology (China) • University of Shanghai for Science and Technology (China) • Capital Normal University (China) • Huazhong University of Science and Technology (China) • Beijing Jiaotong University (China) • Shanghai Institute of Optics and Fine Mechanics (China) • Changchun Institute of Optics and Fine Mechanics (China) • Institute of Semiconductors (China) • Institute of Optics and Electronics (China) • Institute of Physics (China) • Shanghai Institute of Technical Physics (China) • China Instrument and Control Society (China) • Optoelectronics Technology Committee, COS (China) • SPIE National Committee in China (China) • Optical Society of Japan (Japan) • Optical Society of Korea (Korea, Republic of) • The Australian Optical Society (Australia) • Optics and Photonics Society of Singapore (Singapore) • European Optical Society

*Supporting Organizations*

CAST—China Association for Science and Technology (China)

NSFC—National Nature Science Foundation (China)

*Published by*

SPIE

**Volume 9279**

Proceedings of SPIE 0277-786X, V. 9279

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

Real-time Photonic Measurements, Data Management, and Processing, edited by Bahram Jalali, Ming Li, Keisuke Goda, Mohammad Hossein Asghari, Proc. of SPIE Vol. 9279, 927901 · © 2014 SPIE  
CCC code: 0277-786X/14/\$18 · doi: 10.1117/12.2181568

Proc. of SPIE Vol. 9279 927901-1

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 *Real-time Photonic Measurements, Data Management, and Processing*, edited by Bahram Jalali, Ming Li, Keisuke Goda, Mohammad Hossein Asghari, Proceedings of SPIE Vol. 9279 (SPIE, Bellingham, WA, 2014) Article CID Number.

ISSN: 0277-786X

ISBN: 9781628413526

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 © 2014, 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](http://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/14/\$18.00.

Printed in the United States of America.

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



[SPIDigitalLibrary.org](http://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 *Authors*
- ix *Symposium Committees*
- xi *Conference Committee*

---

## **SESSION 1 MICROWAVE PHOTONICS I**

---

- 9279 03 **Coherent optical frequency combs based wideband signal channelization and analog to digital conversion (Invited Paper) [9279-2]**

---

## **SESSION 2 MICROWAVE PHOTONICS II**

---

- 9279 05 **Recent progress in on-chip signaling with ultra-compact integrated photonic devices (Invited Paper) [9279-4]**
- 9279 07 **Theoretical analysis on the sampling criteria for time-interleaved photonic analog-to-digital converters (Invited Paper) [9279-6]**
- 9279 09 **160 GSa/s all-optical pulsed sampling with a single semiconductor optical amplifier (Invited Paper) [9279-8]**

---

## **SESSION 3 ALL-OPTICAL SIGNAL PROCESSING I**

---

- 9279 0A **Energy-efficient optical pulse multiplication and shaping based on triply-sampled spectral filter utilizing fiber Bragg grating (Invited Paper) [9279-9]**

---

## **SESSION 4 ALL-OPTICAL SIGNAL PROCESSING II**

---

- 9279 0F **Ultrafast optical signal generation and processing based on fiber long period gratings (Invited Paper) [9279-14]**

---

## **SESSION 5 BROADBAND SIGNAL PROCESSING AND DETECTION**

---

- 9279 0L **Optical upconversion of single sideband signal using low-cost radio-over-fiber system [9279-20]**
- 9279 0M **Simplified photonic approach for high-coding-efficiency, digitalized microwave frequency measurement using multiple optical filter arrays with different FSRs [9279-21]**

9279 0O **Recognition technology research based on 3D fingerprint** [9279-24]

9279 0P **3D palmprint data fast acquisition and recognition** [9279-25]

---

**SESSION 6 OPTICAL IMAGING I**

---

9279 0Q **Computational multi-dimensional imaging based on compound-eye optics (Invited Paper)** [9279-27]

9279 0R **Fast blur removal via optical computing (Invited Paper)** [9279-28]

9279 0S **Coherent Raman dual-comb spectroscopy and imaging (Invited Paper)** [9279-29]

---

**SESSION 7 OPTICAL IMAGING II**

---

9279 0U **Signal reduction in fluorescence imaging using radio frequency-multiplexed excitation by compressed sensing** [9279-31]

9279 0V **Estimation of vibration frequency of loudspeaker diaphragm by parallel phase-shifting digital holography** [9279-32]

9279 0W **Multiwavelength digital holography utilizing the space-bandwidth capacity-enhance** [9279-34]

9279 0X **Self-synchronized fast reflectance acquisition** [9279-35]

---

**POSTER SESSION**

---

9279 0Y **Theory research on performance of high-speed random bitstream ranging system based on single-photon counting** [9279-22]

9279 0Z **Timing design and image processing of CMOS sensor LUPA-4000 based on FPGA** [9279-26]

9279 10 **Synthetic transmit aperture technique in medical ultrasound imaging implemented on a GPU** [9279-33]

9279 11 **Accurate time-of-flight measurement of particle based on ECL-TTL timer** [9279-36]

9279 12 **Random laser scattering pulse signal analysis in laser particle counter with lognormal distribution** [9279-37]

9279 13 **The applications of optical computerized tomography (OCT) in cold and hot complex flow fields** [9279-38]

9279 14 **Microwave photonic down-conversion based on phase modulation and Brillouin-assisted notch-filtering** [9279-39]

- 9279 16 **Experimental demonstration of 2×80-Gbit/s OTDM multi-channel add-drop multiplexing in a single fiber** [9279-41]
- 9279 17 **Research of aluminium alloy aerospace structure aperture measurement based on 3D digital speckle correlation method** [9279-42]



## Authors

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

An, Dongsheng, 0X  
Arai, Yasuhiko, 0W  
Ashrafi, Reza, 0F  
Azaña, José, 0F  
Bai, Lu, 17  
Bernhardt, Birgitta, 0S  
Chan, Antony C. S., 0U  
Chen, Jianping, 07  
Chen, Li-zhu, 13  
Chen, Qian, 0Y  
Chen, Xiaodong, 10  
Chen, Xuxing, 0A  
Chen, Yun-Yun, 13  
Cheng, Yin, 11  
Dai, Huidong, 0Y  
Dai, Qionghai, 0R, 0X  
Dai, Yitang, 03  
Endo, Y., 0V  
Gao, Nan, 0P  
Gu, Fang, 13  
Gu, Yiyi, 0L  
Guelachvili, Guy, 0S  
Gui, Huaqiao, 11  
Han, Xiuyou, 0L  
Hänsch, Theodor W., 0S  
He, Weiji, 0Y  
Holzner, Simon, 0S  
Horisaki, Ryoichi, 0Q  
Hu, Jingjing, 0L  
Huang, Shuhua, 11  
Huang, Shujun, 0O, 0P  
Ideguchi, Takuro, 0S  
Ito, T., 0V  
Jia, Nan, 16  
Jiao, Zhihai, 10  
Kaku, Toru, 0W  
Kakue, T., 0V  
Kang, Zijian, 0L  
Lam, Edmund Y., 0U  
Li, Deping, 11  
Li, Heping, 09  
Li, Hongpu, 0A  
Li, Jianqiang, 03  
Li, Jie, 12  
Li, Ming, 0F  
Li, Peixuan, 0M  
Li, Tang-jun, 16  
Li, Ying, 10  
Liu, Jianguo, 11  
Liu, Xinkai, 0M, 14  
Liu, Yong, 09  
Lu, Bing, 0M  
Lu, Yihuai, 11  
Luo, Bin, 0M, 14  
Lv, Hongpeng, 12  
Nakamura, Tomoya, 0Q  
Pan, Wei, 0M, 14  
Picqué, Nathalie, 0S  
Shen, Shanshan, 0Y  
Shi, Nuannuan, 0L  
Shimobaba, T., 0V  
Su, Feiran, 07  
Sun, Jian, 16  
Sun, Weiping, 12  
Suo, Jinli, 0R, 0X  
Tahara, Tatsuki, 0W  
Tanida, Jun, 0Q  
Tian, Qianxiao, 0O  
Tsia, Kevin K., 0U  
Wang, Haoqian, 0X  
Wang, Heng, 09  
Wang, Hongbo, 17  
Wang, Jian, 05  
Wang, Jie, 11  
Wang, Mu-guang, 16  
Wang, Shouyu, 12  
Wang, Xiaoxu, 0P  
Wang, Yi, 10  
Wu, Guiling, 07  
Xin, Li, 0Z  
Xu, Kun, 03  
Xue, Liang, 12  
Yan, Keding, 12  
Yan, Lianshan, 0M, 14  
Yan, Zhengang, 12  
Yang, Rong, 17  
Yin, Feifei, 03  
Yu, Daoyin, 10  
Yue, Tao, 0R  
Zhang, Chuang, 10  
Zhang, Hui, 17  
Zhang, Shangjian, 09  
Zhang, Weili, 14  
Zhang, Xijing, 12  
Zhang, Yali, 09  
Zhang, Zonghua, 0O, 0P  
Zhao, Mingshan, 0L  
Zheng, Di, 14

Zhong, Kang-ping, 16  
Zhou, Jiangfan, 17  
Zhu, Wenwu, 0L  
Zou, Xihua, 0M, 14  
Zou, Xinhai, 09

# Symposium Committees

## *General Chairs*

**H. Philip Stahl**, NASA Marshall Space Flight Center (USA)  
**Bingkun Zhou**, Tsinghua University (China)

## *General Co-chairs*

**Arthur Chiou**, National Yang-Ming University (Taiwan, China)  
**Jianlin Cao**, China Ministry of Science and Technology (China)  
**Junhao Chu**, Shanghai Institute of Technical Physics (China)

## *Technical Program Chairs*

**Songlin Zhuang**, Shanghai University of Science and Technology  
(China)  
**Xingde Li**, Johns Hopkins University (United States)

## *Technical Program Co-chairs*

**Qiming Wang**, Institute of Semiconductors (China)  
**Xu Liu**, Zhejiang University (China)  
**Daoyin Yu**, Tianjin University (China)  
**Qihuang Gong**, Peking University (China)  
**Tianchu Li**, National Institute of Metrology (China)  
**Wei Huang**, Nanjing University of Posts and Telecommunications  
(China)

## *Local Organizing Committee Chair*

**Guangcan Guo**, University of Science and Technology of China  
(China)

*Local Organizing Committee Co-chairs*

**Guoqiang Ni**, Beijing Institute of Technology (China)  
**Shusen Xie**, Fujian Normal University (China)  
**Xiaomin Ren**, Beijing University of Posts and Telecommunications  
(China)  
**Ying Gu**, People's Liberation Army General Hospital (China)  
**Huilin Jiang**, Changchun University of Science and Technology  
(China)

*General Secretary*

**Qihuang Gong**, Peking University (China)

*Local Organizing Committee*

**Yan Li**, Chinese Optical Society/Peking University (China)  
**Zhiping Zhou**, Peking University (China)  
**Changhe Zhou**, Shanghai Institute of Optics and Fine Mechanics  
(China)  
**Qingming Luo**, Huazhong University of Science and Technology  
(China)  
**Chongxiu Yu**, Beijing University of Posts and Telecommunications  
(China)  
**Hongda Chen**, Institute of Semiconductors (China)  
**Yongtian Wang**, Beijing Institute of Technology (China)  
**Yiping Cui**, Southeast University (China)  
**Xuping Zhang**, Nanjing University (China)  
**Feijun Song**, Daheng Corporation (China)  
**Cunlin Zhang**, Capital Normal University (China)  
**Yanting Lu**, Nanjing University (China)  
**Yuejin Zhao**, Beijing Institute of Technology (China)  
**Chunqing Gao**, Beijing Institute of Technology (China)  
**Tiegen Liu**, Tianjin University (China)  
**Xiaocong Yuan**, Nankai University (China)  
**Weimin Chen**, Chongqing University (China)  
**Zhongwei Fan**, Academy of Optoelectronics (China)  
**Hanyi Zhang**, Tsinghua University (China)  
**Lan Wu**, Zhejiang University (China)  
**Yongsheng Zhang**, University of Science and Technology of China  
(China)  
**Hong Yang**, Peking University (China)  
**Xiaoying Li**, Tianjin University (China)  
**Wei Xiong**, Chinese Optical Society (China)

# Conference Committee

## *Conference Chairs*

**Bahram Jalali**, University of California, Los Angeles (United States)  
**Ming Li**, Institute of Semiconductors (China)  
**Keisuke Goda**, The University of Tokyo (Japan)  
**Mohammad Hossein Asghari**, University of California, Los Angeles  
(United States)

## *Conference Program Committee*

**Hongwei Chen**, Tsinghua University (China)  
**Xiangfei Chen**, Nanjing University (China)  
**Hao Chi**, Zhejiang University (China)  
**Yitang Dai**, Tsinghua University (China)  
**Christophe Dorrer**, University of Rochester (United States)  
**Chanju Kim**, Advanced Photonics Research Institute  
(Korea, Republic of)  
**Yasushi Kondo**, Shimadzu Corporation (Japan)  
**Hongpu Li**, Shizuoka University (Japan)  
**Yong Liu**, University of Electronic Science and Technology of China  
(China)  
**Asad M. Madni**, University of California, Los Angeles (United States)  
**Kayvan R. Niazi**, NantWorks, LLC (United States)  
**Tatsutoshi Shioda**, Saitama University (Japan)  
**Daniel R. Solli**, Georg-August-Universität Göttingen (Germany)  
**Yikai Su**, Shanghai Jiao Tong University (China)  
**Kevin K. Tsia**, The University of Hong Kong (Hong Kong, China)  
**Sergei K. Turitsyn**, Aston University (United Kingdom)  
**Chao Wang**, University of Kent (United Kingdom)  
**Jian Wang**, Huazhong University of Science and Technology (China)  
**Ming Wang**, Nanjing Normal University (China)  
**Xu Wang**, Heriot-Watt University (United Kingdom)  
**Kun Xu**, Beijing University of Posts and Telecommunications (China)  
**Lianshan Yan**, Southwest Jiaotong University (China)  
**Akio Yazaki**, Hitachi, Ltd. (Japan)  
**Changyuan Yu**, National University of Singapore (Singapore)  
**Xinliang Zhang**, Huazhong University of Science and Technology  
(China)  
**Xiaoping Zheng**, Tsinghua University (China)  
**Xihua Zou**, Southwest Jiaotong University (China)

*Session Chairs*

- 1 Microwave Photonics I  
**Xinliang Zhang**, Huazhong University of Science and Technology  
(China)
- 2 Microwave Photonics II  
**Xinliang Zhang**, Huazhong University of Science and Technology  
(China)
- 3 All-Optical Signal Processing I  
**Jian Wang**, Huazhong University of Science and Technology (China)
- 4 All-Optical Signal Processing II  
**Ming Li**, Institute of Semiconductors (China)
- 5 Broadband Signal Processing and Detection  
**Reza Ashrafi**, McGill University (Canada)
- 6 Optical Imaging I  
**Yasuyuki Ozeki**, The University of Tokyo (Japan)
- 7 Optical Imaging II  
**Yasuyuki Ozeki**, The University of Tokyo (Japan)