

PROCEEDINGS OF SPIE

# ***Millimetre Wave and Terahertz Sensors and Technology II***

**Keith A. Krapels  
Neil A. Salmon**  
*Editors*

**1–3 September 2009  
Berlin, Germany**

*Sponsored by*  
SPIE Europe

*Cooperating Organisations*  
SPIE  
Electro-Magnetic Remote Sensing Defence Technology Centre  
(United Kingdom)  
OPTHER

*Published by*  
SPIE

**Volume 7485**

Proceedings of SPIE, 0277-786X, v. 7485

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 *Millimetre Wave and Terahertz Sensors and Technology II*, edited by Keith A. Krapels, Neil A. Salmon, Proceedings of SPIE Vol. 7485 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X  
ISBN 9780819477910

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 © 2009, 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/09/\$18.00.

Printed in the United States of America.

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

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a barcode or a signal waveform.

[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 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*
- ix *Joint research for tomorrow's security and defence (Plenary Paper) [7483-31]*  
*R. Krug, The Federal Ministry of Defence (Germany)*

---

## SESSION 1 SENSOR SYSTEMS I

---

- 7485 02 **Millimeter-wave radar systems for biometric applications** [7485-02]  
D. T. Petkie, E. Bryan, C. Benton, B. D. Rigling, Wright State Univ. (United States)
- 7485 04 **Handheld terahertz spectrometer for the detection of liquid explosives** [7485-04]  
N. Krumbholz, C. Jansen, M. Scheller, Technische Univ. Braunschweig (Germany);  
T. Müller-Wirts, S. Lübbecke, TEM Messtechnik GmbH (Germany); R. Holzwarth,  
R. Scheunemann, R. Wilk, Menlo Systems GmbH (Germany); B. Sartorius, H. Roehle, D. Stanze,  
Fraunhofer-Institut für Nachrichtentechnik Heinrich-Hertz-Institut (Germany); J. Beckmann,  
L. S. von Chrzanowski, U. Ewert, Bundesanstalt für Materialforschung und -prüfung  
(Germany); M. Koch, Univ. of Marburg (Germany)

---

## SESSION 2 SENSOR SYSTEMS II

---

- 7485 05 **Ultra wide band detection of on body concealed weapons using the out of plane polarized late time response (Invited Paper)** [7485-05]  
S. Harmer, D. Andrews, N. Bowring, N. Rezgui, M. Southgate, Manchester Metropolitan Univ.  
(United Kingdom)
- 7485 06 **An unobtrusive liquid sensor utilizing a micromilled RF spark gap transmitter and resonant cavity** [7485-06]  
H. Berry, C. Wilson, Louisiana Tech Univ. (United States)

---

## SESSION 3 SIGNATURES/MATERIALS MEASUREMENTS

---

- 7485 0B **Further analysis and evaluation of the results of the NATO common shield–DAT#7 experiment: defence against terrorism** [7485-11]  
S. Dill, M. Peichl, M. Jirousek, H. Süß, Deutsches Zentrum für Luft- und Raumfahrt e.V.  
(Germany)
- 7485 0C **Measurements of aerospace materials and their interpretation for non-destructive testing** [7485-12]  
N. A. Salmon, I. Mason, S. Price, J. Beale, QinetiQ Ltd. (United Kingdom)
- 7485 0D **Nondestructive terahertz imaging for aerospace applications** [7485-13]  
D. T. Petkie, I. V. Kemp, C. Benton, C. Boyer, L. Owens, J. A. Deibel, Wright State Univ. (United States); C. D. Stoik, M. J. Bohn, Air Force Institute of Technology (United States)

---

**SESSION 4      SYSTEMS MODELING/ANALYSIS/SIMULATION/TESTING**

---

- 7485 OE      **Analytical performance comparison of active and passive SMMW imaging for contraband detection (Invited Paper)** [7485-14]  
H. B. Wallace, MMW Concepts LLC (United States); M. J. Rosker, DARPA/MTO (United States)
- 7485 OF      **Studies of millimeter-wave phenomenology for helicopter brownout mitigation** [7485-15]  
C. A. Schuetz, Phase Sensitive Innovations, Inc. (United States); E. L. Stein, Jr., J. Samluk, D. Mackrides, J. P. Wilson, Univ. of Delaware (United States); R. D. Martin, T. E. Dillon, Phase Sensitive Innovations, Inc. (United States); D. W. Prather, Univ. of Delaware (United States)
- 7485 OG      **Optical configuration of an upconverted millimeter-wave distributed aperture imaging system** [7485-16]  
T. E. Dillon, C. A. Schuetz, R. D. Martin, Phase Sensitive Innovations, Inc. (United States); E. L. Stein, Jr., J. P. Samluk, D. G. Mackrides, Univ. of Delaware (United States); M. S. Mirotznik, The Catholic Univ. of America (United States); D. W. Prather, Univ. of Delaware (United States)
- 7485 OH      **Millimeter wave sensor requirements for maritime small craft identification** [7485-17]  
K. Krapels, R. G. Driggers, J. Garcia, Office of Naval Research Science and Technology Reserves (United States); E. Boettcher, DCS Corp. (United States); D. Prather, C. Schuetz, J. Samluk, L. Stein, Univ. of Delaware (United States); W. Kiser, A. Visnansky, J. Grata, Penn State Electro-Optic Ctr. (United States); D. Wikner, R. Harris, Army Research Lab (United States)

---

**SESSION 5      COMPONENTS I**

---

- 7485 OI      **Advanced Gunn diode as high power terahertz source for a millimetre wave high power multiplier (Invited Paper)** [7485-18]  
F. Amir, C. Mitchell, The Univ. of Manchester (United Kingdom); N. Farrington, e2v technologies (UK) Ltd. (United Kingdom); M. Missous, The Univ. of Manchester (United Kingdom)
- 7485 OJ      **Traceable terahertz power measurement by using optical methods** [7485-19]  
A. Steiger, B. Gutschwager, P. Meindl, C. Monte, R. Müller, L. Werner, J. Hollandt, Physikalisch-Technische Bundesanstalt (Germany)
- 7485 OK      **First operation of 8×8 glow discharge detector VLSI focal plane array toward mm wave and THz radiation video rate imaging** [7485-20]  
N. S. Kopeika, Ben-Gurion Univ. of the Negev (Israel); A. Abramovich, Ariel Univ. Ctr. of Samaria (Israel); H. Joseph, Ben-Gurion Univ. of the Negev (Israel); A. Akram, Ariel Univ. Ctr. of Samaria (Israel); O. Yadid-Pecht, A. Belenky, S. Lineykin, Ben-Gurion Univ. of the Negev (Israel)
- 7485 OL      **Millimeter-wave monolithic integrated circuits for imaging and remote sensing at 140, 200, and 300 GHz** [7485-21]  
I. Kalfass, A. Tessmann, A. Leuther, H. Massler, M. Schlechtweg, O. Ambacher, Fraunhofer-Institut für Angewandte Festkörperphysik (Germany)

---

**SESSION 6 COMPONENTS II**

---

- 7485 0M **Terahertz imaging with a quantum cascade laser and amorphous-silicon microbolometer array** [7485-22]  
F. Simoens, T. Durand, J. Meilhan, Commissariat à l'Energie Atomique (France); P. Gellie, W. Mainault, C. Sirtori, S. Barbieri, Lab. Matériaux et phénomènes, CNRS, Univ. Paris Diderot (France); H. Beere, D. Ritchie, Univ. of Cambridge (United Kingdom)
- 7485 0N **Compact tunable terahertz source: perspectives on planar configurations** [7485-23]  
A. Cutolo, A. Ferrara, A. Cusano, M. Pisco, Univ. degli Studi del Sannio (Italy); D. Mascolo, STMicroelectronics (Italy); A. Ricciardi, Univ. degli Studi di Napoli Parthenope (Italy)
- 7485 0O **Image reconstruction with sub-diffraction resolution in radio vision devices of millimeter and terahertz range using receiving arrays and image scanning** [7485-24]  
A. N. Vystavkin, A. V. Pestryakov, S. E. Bankov, V. M. Chebotarev, Institute of Radio-Engineering and Electronics (Russian Federation)

---

**POSTER SESSION**

---

- 7485 0P **Modelling of thermal emissivity of covered bulk explosive materials in the THz range** [7485-25]  
W. M. Ciurapinski, M. Szustakowski, N. Palka, M. Zyczkowski, R. Ryniec, M. Piszczek, P. Zagrajek, Military Univ. of Technology (Poland)

*Author Index*



# Conference Committee

## *Symposium Chairs*

**David H. Titterton**, Defence Science and Technology Laboratory  
(United Kingdom)

**Reinhard R. Ebert**, FGAN-FOM Research Institute for Optronics and  
Pattern Recognition (Germany)

## *Conference Chairs*

**Keith A. Krapels**, U.S. Army Night Vision & Electronic Sensors Directorate  
(United States)

**Neil A. Salmon**, QinetiQ Ltd. (United Kingdom)

## *Program Committee*

**Amir Abramovich**, Ariel University Center of Samaria (Israel)

**Nicholas J. Bowring**, Manchester Metropolitan University (United  
Kingdom)

**Markus Peichl**, Deutsches Zentrum für Luft- und Raumfahrt e.V.  
(Germany)

**Douglas T. Petkie**, Wright State University (United States)

**Christopher A. Schuetz**, Phase Sensitive Innovations, Inc. (United States)

## *Session Chairs*

- 1 Sensor Systems I  
**Keith A. Krapels**, U.S. Army Night Vision & Electronic Sensors Directorate  
(United States)  
**Amir Abramovich**, Ariel University Center of Samaria (Israel)
- 2 Sensor Systems II  
**Neil A. Salmon**, QinetiQ Ltd. (United Kingdom)  
**Markus Peichl**, Deutsches Zentrum für Luft- und Raumfahrt e.V.  
(Germany)
- 3 Signatures/Materials Measurements  
**Nicholas J. Bowring**, Manchester Metropolitan University (United  
Kingdom)  
**Christopher A. Schuetz**, Phase Sensitive Innovations, Inc. (United States)
- 4 Systems Modeling/Analysis/Simulation/Testing  
**Douglas T. Petkie**, Wright State University (United States)  
**Amir Abramovich**, Ariel University Center of Samaria (Israel)

- 5 Components I  
**Markus Peichl**, Deutsches Zentrum für Luft- und Raumfahrt e.V.  
(Germany)
- 6 Components II  
**Keith A. Krapels**, U.S. Army Night Vision & Electronic Sensors Directorate  
(United States)  
**Neil A. Salmon**, QinetiQ Ltd. (United Kingdom)