

PROCEEDINGS OF SPIE

***Optics and Photonics for  
Counterterrorism, Crime Fighting,  
and Defence XI; and Optical  
Materials and Biomaterials in  
Security and Defence Systems  
Technology XII***

**Douglas Burgess  
Gari Owen  
Harbinder Rana  
Roberto Zamboni  
François Kajzar  
Attila A. Szep**  
*Editors*

**21–23 September 2015  
Toulouse, France**

*Sponsored by*  
SPIE

*Cooperating Organisations*  
European Optical Society • Optitec (France) • Route des Lasers (France)

*Published by*  
SPIE

**Volume 9652**

Proceedings of SPIE 0277-786X, V. 9652

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

Optics and Photonics for Counterterrorism, Crime Fighting, and Defence XI; and Optical Materials and Biomaterials in Security and Defence Systems Technology XII, D. Burgess, G. Owen, H. Rana, R. Zamboni, F. Kajzar, A. A. Szep, Eds., Proc. of SPIE Vol. 9652, 965201 · © 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2228212

Proc. of SPIE Vol. 9652 965201-1

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 [SPIDigitalLibrary.org](http://SPIDigitalLibrary.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 *Optics and Photonics for Counterterrorism, Crime Fighting, and Defence XI; and Optical Materials and Biomaterials in Security and Defence Systems Technology XII*, edited by Douglas Burgess, Gari Owen, Harbinder Rana, Roberto Zamboni, François Kajzar, Attila A. Szep, Proceedings of SPIE Vol. 9652 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)  
ISBN: 9781628418620

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](http://SPIE.org)

Copyright © 2015, 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/15/\$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**  
[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. Papers are published as they are submitted and meet publication criteria. A unique 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.

# Contents

- vii *Authors*
- ix *Conference Committees*
- xiii *Introduction to Part A: Optics and Photonics for Counterterrorism, Crime Fighting, and Defence*
- xvii *Notes from Open Discussion on Detection, Imaging, and Characterisation of Objects through Barriers: Can we do this?*

## **PART A      Optics and Photonics for Counterterrorism, Crime Fighting, and Defence**

---

### **DETECTION AND IDENTIFICATION OF THINGS DANGEROUS, HIDDEN AND SUSPICIOUS I**

---

- 9652 02    **Detection of munitions grade G-series nerve agents using Raman excitation at 1064 nm [9652-1]**
- 9652 04    **Multispectral analysis of biological agents to implement a quick tool for stand-off biological detection (Best Student Paper Award) [9652-3]**
- 9652 05    **Tests of various colorants for application of a Fourier transform infrared imaging system to deciphering obliterated writings [9652-4]**

---

### **DETECTION AND IDENTIFICATION OF THINGS DANGEROUS, HIDDEN AND SUSPICIOUS II**

---

- 9652 06    **Laser desorption of explosives as a way to create an effective non-contact sampling device [9652-5]**
- 9652 07    **Liquid explosive detection using near infrared LED [9652-6]**
- 9652 08    **CRIM-TRACK: sensor system for detection of criminal chemical substances [9652-7]**
- 9652 09    **Magnetic induction imaging with optical atomic magnetometers: towards applications to screening and surveillance [9652-8]**

---

### **DETECTION, IMAGING AND CHARACTERISATION OF OBJECTS THROUGH BARRIERS: CAN WE DO THIS?**

---

- 9652 0B    **Principal limitation of standard THz time-domain spectroscopy method of the detection and identification of substance and way of its overcoming [9652-10]**

---

**SUSPICIOUS ACTIVITY: PEOPLE, THEIR ACTIONS, AND OBJECTS ASSOCIATED WITH THEM I**

---

- 9652 0C **Embedded security system for multi-modal surveillance in a railway carriage** [9652-11]
- 9652 0D **Automatic inference of geometric camera parameters and inter-camera topology in uncalibrated disjoint surveillance cameras** [9652-12]
- 9652 0E **Incremental concept learning with few training examples and hierarchical classification** [9652-13]
- 9652 0F **Posture estimation for improved photogrammetric localization of pedestrians in monocular infrared imagery** [9652-14]
- 9652 0G **Detecting abandoned objects using interacting multiple models** [9652-15]

---

**SUSPICIOUS ACTIVITY: PEOPLE, THEIR ACTIONS, AND OBJECTS ASSOCIATED WITH THEM II**

---

- 9652 0H **Multi-feature-based robust face detection and coarse alignment method via multiple kernel learning** [9652-24]
- 9652 0I **Video content analysis on body-worn cameras for retrospective investigation** [9652-16]
- 9652 0K **Versatile illumination platform and fast optical switch to give standard observation camera gated active imaging capacity** [9652-18]
- 9652 0L **Towards a real-time wide area motion imagery system** [9652-19]
- 9652 0M **Sensor for real-time determining the polarization state distribution in the object images** [9652-20]

---

**SPECIAL SESSION: BIOMETRICS RESEARCH+DEVELOPMENT AT THE NATIONAL INSTITUTE OF TECHNOLOGY-DURGAPUR, INDIA**

---

- 9652 0O **SIFT fusion of kernel eigenfaces for face recognition** [9652-22]
- 9652 0P **FRIT characterized hierarchical kernel memory arrangement for multiband palmprint recognition** [9652-23]

**PART B** ***Optical Materials and Biomaterials in Security and Defence Systems Technology***

---

**BIOTRONICS**

---

- 9652 0T **Different strategies for the detection of bioagents using electrochemical and photoelectrochemical genosensors** [9652-33]

---

#### OPTICS AND ELECTRO-OPTICS

---

- 9652 0U **Bio-inspired materials for electrochemical devices (Keynote Paper)** [9652-34]
- 9652 0V **Absorption spectrum analysis based on singular value decomposition for photoisomerization and photodegradation in organic dyes (Keynote Paper)** [9652-35]
- 9652 0W **Hybrid organic-inorganic composites for applications in Vis-NIR photodiodes (Invited Paper)** [9652-36]
- 9652 0X **Fabrication and characterization of an inkjet-printed DNA biopolymer-based UV photodetector (Invited Paper)** [9652-37]

---

#### NONLINEAR OPTICS I

---

- 9652 0Z **Ultrafast conformational changes in biomolecules studied by time-resolved circular dichroism (Invited Paper)** [9652-49]
- 9652 10 **Influence of various solvents on the nonlinear optical properties of metallophthalocyanines (MPcs) (Invited Paper)** [9652-40]

---

#### POSTER SESSION

---

- 9652 16 **Optical properties of polymethacrylate with styrylquinoline side chains** [9652-45]
- 9652 17 **Proposal of all-optical sensor based on nonlinear MMI coupler for multi-purpose usage** [9652-46]



## 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.

Aga, Roberto S., Jr., 0X  
Akmalov, Artem E., 06  
Ambellouis, Sébastien, 0C  
Arens, Michael, 0G  
Aubry, Marie, 0K  
Audigier, Romaric, 0C  
Azzopardi, George, 0E  
Baan, Jan, 0D, 0I  
Bartsch, Carrie M., 0X  
Becker, Stefan, 0G  
Benhadda, Hamid, 0C  
Bettazi, Francesca, 0T  
Bouma, Henri, 0D, 0E, 0I  
Breckon, Toby P., 0F  
Burghouts, Gertjan J., 0E, 0I  
Buus, Ole T., 08  
Capman, François, 0C  
Carestia, M., 04  
Cenciarelli, O., 04  
Changenet-Barret, P., 0Z  
Chida, Toshifumi, 0V  
Chistyakov, Alexander A., 06  
Deans, Cameron, 09  
den Hollander, Richard J. M., 0D, 0I  
Derkowska-Zielinska, Beata, 10, 16  
Dossi, Eleftheria, 08  
Eendebak, Pieter T., 0D, 0E, 0I  
Figà, V., 16  
Firmino, A., 0U  
Foulkes, S. B., 0L  
Fujihara, Takashi, 0V  
Gabriele, J., 04  
Gaudio, P., 04  
Gelfusa, M., 04  
Grasser, R., 0K  
Gupta, Phalguni, 0O, 0P  
Hache, F., 0Z  
He, Jun, 0H  
Heckman, Emily M., 0X  
Hoffland, Soren, 02  
Hübner, Wolfgang, 0G  
Hussain, Sarah, 09  
Ito, Shiori, 07  
Itozaki, Hideo, 07  
Jakobsen, Mogens H., 08  
Jayme, C. C., 0U  
Jimenez, D. E. Q., 0U  
Joudrier, Stéphanie, 0C  
Kajzar, François, 0U  
Kakauridze, George, 0M  
Kanicki, J., 0U  
Kawabe, Yutaka, 0V  
Kawamoto, Masuki, 0V  
Kieritz, Hilke, 0G  
Kilosanidze, Barbara, 0M  
Kisku, Dakshina Ranjan, 0O, 0P  
Kotkovskii, Gennadii E., 06  
Krupka, O., 16  
Kundegorski, Mikolaj E., 0F  
Kurkhuli, Georgi, 0M  
Kvernadze, Teimuraz, 0M  
Lamarque, Thierry, 0C  
Larsen, Jan, 08  
Lässig, Lina, 08  
Lombardi, J. P., III, 0X  
Ludovici, G. M., 04  
Lungaroni, M., 04  
Luszczynska, Beata, 0W  
Malizia, A., 04  
Marmugi, Luca, 09  
MatJafri, M. Z., 17  
Mindroi, M., 0U  
Miyato, Yuji, 07  
Münch, David, 0G  
Munk, Jens K., 08  
Murari, A., 04  
Nogueira, A. F., 0U  
Palchetti, Ilaria, 0T  
Pardoe, Ian, 02  
Pawlicka, A., 0U  
Peyronneaudi, Benjamin, 0K  
Pizzoferrato, R., 04  
Rau, Ileana, 0U  
Renzoni, Ferruccio, 09  
Roy, Eric, 02  
Sabadini, R. C., 0U  
Sandström, Lars, 08  
Sassa, Takafumi, 0V  
Sato-Akaba, Hideo, 07  
Schutte, Klamer, 0E  
Sentanin, F., 0U  
Silva, M. M., 0U  
Sing, Jamuna Kanta, 0O, 0P  
Smokal, V., 16  
Sodoyer, David, 0C  
Sugawara, Shigeru, 05  
Sun, Bo, 0H  
Szymanski, Marek Z., 0W

Tada, Kazuhiro, 0V  
Tajaldini, M., 17  
Tatlow, Sol, 08  
ter Haar, Frank B., 0I  
Tihan, G. T., 0U  
Tistarelli, Massimo, 0O  
Trofimov, Vyacheslav A., 0B  
Tsutsumi, Naoto, 0V  
van den Broek, Sebastiaan P., 0I  
van Rest, Jeroen H. C., 0D, 0I  
Varentsova, Svetlana A., 0B  
Voccia, Diego, 0T  
Wijn, Remco, 0I  
Wilcox, Phillip G., 02  
Wu, Xuewen, 0H  
Yon, Kevin, 0K  
Yoshikawa, Toshio, 0V  
Young, R. I., 0L  
Yu, Lejun, 0H  
Zagursky, Dmitry Yu., 0B  
Zakharova, Irina G., 0B  
Zgarian, R. G., 0U  
Zhang, Di, 0H  
Zouaoui, Rhalem, 0C

# Conference Committees

## *Symposium Chair*

**David H. Titterton**, UK Defence Academy (United Kingdom)

## *Symposium Co-chair*

**Reinhard Ebert**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

## **Part A Optics and Photonics for Counterterrorism, Crime Fighting, and Defence**

### *Conference Chairs*

**Douglas Burgess**, Burgess Consulting (United Kingdom)

**Gari Owen**, Annwyn Solutions (United Kingdom)

**Harbinder Rana**, Defence Science and Technology Laboratory (United Kingdom)

### *Conference Programme Committee*

**Benedicte Bascle**, Thales Optronique S.A.S. (France)

**Richard R. Botten**, Ministry of Defence (United Kingdom)

**Henri Bouma**, TNO (Netherlands)

**Felicity Carlisle**, University of Strathclyde (United Kingdom)

**Deeph Chana**, Imperial College London (United Kingdom)

**David J. Clarke**, Placing Value Company, Ltd. (Thailand)

**Giovanni Cocca**, SELEX ES S.p.A. (Italy)

**Howard J. Cummins**, Her Majesty's Government Communications Centre (United Kingdom)

**Brian E. Foulger**, Ministry of Defence (United Kingdom)

**Gillian F. Marshall**, QinetiQ Ltd. (United Kingdom)

**Niamh Nic Daeid**, University of Dundee (United Kingdom)

**Salman Rosenwaks**, Ben-Gurion University of the Negev (Israel)

**Andrew M. Scott**, QinetiQ Ltd. (United Kingdom)

**Neil C. Shand**, Defence Science and Technology Laboratory (United Kingdom)

**Robert J. Stokes**, Cobalt Light Systems Ltd. (United Kingdom)

**Miranda van Iersel**, TNO Defence, Security and Safety (Netherlands)

**Mauro G. Varasi**, Finmeccanica (Italy)

**Yitzhak Yitzhaky**, Ben-Gurion University of the Negev (Israel)

**Peter W. Yuen**, Cranfield University (United Kingdom)

### *Session Chairs*

- 1 Detection and Identification of Things Dangerous, Hidden and Suspicious I  
**Douglas Burgess**, Burgess Consulting (United Kingdom)
- 2 Detection and Identification of Things Dangerous, Hidden and Suspicious II  
**Douglas Burgess**, Burgess Consulting (United Kingdom)
- 3 Detection, Imaging and Characterisation of Objects through Barriers: Can we do this?  
**Gari Owen**, Annwyn Solutions (United Kingdom)
- 4 Suspicious Activity: People, their Actions, and Objects Associated with them I  
**Harbinder Rana**, Defence Science and Technology Laboratory (United Kingdom)
- 5 Suspicious Activity: People, their Actions, and Objects Associated with them II  
**Harbinder Rana**, Defence Science and Technology Laboratory (United Kingdom)
- 6 Special Session: Biometrics Research+Development at the National Institute of Technology-Durgapur, India  
**Harbinder Rana**, Defence Science and Technology Laboratory (United Kingdom)

## **Part B Optical Materials and Biomaterials in Security and Defence Systems Technology**

### *Conference Chairs*

**Roberto Zamboni**, Istituto per la Sintesi Organica e la Fotoreattività (Italy)  
**François Kajzar**, University Politehnica of Bucharest (Romania)  
**Attila A. Szep**, Air Force Research Laboratory (United States)

### *Conference Programme Committee*

**Chantal Andraud**, Ecole Normale Supérieure de Lyon (France)  
**André-Jean Attias**, Université Pierre et Marie Curie (France)  
**Carrie M. Bartsch**, Air Force Research Laboratory (United States)  
**Werner J. Blau**, Trinity College Dublin (Ireland)  
**Fabrice Charra**, Commissariat à l'Énergie Atomique (France)  
**Larry R. Dalton**, University of Washington (United States)

**Beata Derkowska-Zielinska**, Nicolaus Copernicus University (Poland)  
**Manfred Eich**, Technische Universität Hamburg-Harburg (Germany)  
**Patrick Feneyrou**, Thales Research & Technology (France)  
**Barrett Flake**, European Office of Aerospace Research and Development (United Kingdom)  
**Marina Saphiannikova Grenzer**, Leibniz-Institut für Polymerforschung Dresden e.V. (Germany)  
**James G. Grote**, Air Force Research Laboratory (United States)  
**Emily M. Heckman**, Air Force Research Laboratory (United States)  
**Charles Y. C. Lee**, Air Force Office of Scientific Research (United States)  
**Antoni C. Mitus**, Wrocław University of Technology (Poland)  
**Jaroslav Mysliwiec**, Wrocław University of Technology (Poland)  
**Robert L. Nelson**, Air Force Research Laboratory (United States)  
**Fahima Ouchen**, Air Force Research Laboratory (United States)  
**Ullrich Pietsch**, Universität Siegen (Germany)  
**Ileana Rau**, University Politehnica of Bucharest (Romania)  
**Niyazi Serdar Sariciffci**, Johannes Kepler University Linz (Austria)  
**Renato Seeber**, Università degli Studi di Modena e Reggio Emilia (Italy)  
**Kenneth D. Singer**, Case Western Reserve University (United States)

*Session Chairs*

- 5 Biotronics  
**Beata Luszczynska**, Lodz University of Technology (Poland)
- 6 Optics and Electro-Optics  
**Attila A. Szep**, Air Force Research Laboratory (United States)
- 7 Nonlinear Optics I  
**François Kajzar**, University Politehnica of Bucharest (Romania)
- 8 Nonlinear Optics II  
**André P. Persoons**, KU Leuven (Belgium)



## Introduction to Part A: Optics and Photonics for Counterterrorism, Crime Fighting, and Defense

Welcome to the proceedings of the 2015 conference on Optics and Photonics for Counterterrorism, Crime Fighting and Defence.

The conference was arranged around two themes: The first of these was the detection and identification of dangerous, hidden, and suspicious materials, weapons, and contraband; the second was the identification in CCTV and thermal imagery of suspicious activity; people, their actions, and objects associated with them. The conference included an open discussion on the difficulties of detecting, imaging, and characterising concealed objects and materials.

The first session on short-range detection and identification of chemical and biological warfare agents highlighted the breadth of technology maturity in this field. The first speaker from the United States [9652-01] described a Raman-based instrument for chemical warfare agent detection that was commercially available. The second speaker, from Italy [9652-03], described experiments using a range of UV wavelengths to identify biological agents from their fluorescence. The session ended with a speaker from the Japanese Police Science Research Institute [9652-04] describing experiments to read writing obliterated by overprinted ink.

Continuing the short range detection theme, the second session began with a speaker from the Russian Federation [9652-05] describing how resonant and non-resonant laser desorption could be used to identify explosives residues without the need to wipe a suspicious surface. A professor from Japan [9652-06] provided an update on his work on building and commercialising an instrument for detecting explosives hidden inside bottles of liquid, a continuing problem at airports. The next speaker, from Denmark [9652-07], described an EU-funded project to develop a sensor for identifying dangerous chemicals from the way their vapour changed the colour of an array of dye spots. The session was closed with a United Kingdom research paper [9652-08] describing the detection and identification of metals using a magnetic induction imaging technique with extra sensitivity provided by an optical atomic magnetometer readout. In answers to questions, the speaker agreed that it might be possible to detect a metal object within a metal box.

As a memorial to Professor Colin Lewis who began the open discussions of this conference, we dedicated this year's open discussion to his memory. The discussion's title was "Detecting, imaging and characterisation of objects through barriers: Can we do this?" Sadly, Dr Stepan Lucyszyn (who was to lead the

discussion was unable to be present, so after a paper on THz time domain spectroscopy for explosives detection from the Russian Federation [9652-10], the conference chairs managed the discussion. Notes of this discussion are presented in the next section of these proceedings.

The second day of the conference had the theme, "Suspicious Activity: People, their Actions, and Objects associated with them." It began with a presentation from France [9652-11] that described how a combination of audio and CCTV could quickly detect dangerous behaviour in a railway station or carriage. The second presentation from the Netherlands [9652-12] described how imagery of people moving in the scene could be used to auto-calibrate the field of view of one camera and to coordinate between camera images. The same speaker [9652-13] then went on to describe algorithm learning techniques for the detection and tracking of people when there were only a few training examples. A United Kingdom speaker [9652-14] explained how the estimation of a person's range from a thermal image was affected by their posture, but that this error could be corrected if their movements were taken into account. The final presentation in the section came from Germany [9652-15]. The speaker showed how he could track people moving in CCTV imagery and then identify when objects became suspicious by no longer being associated with anyone.

Session five continued where the previous session had left off, with a paper from China [9652-24] on forehead identification as a way of determining the orientation of a face caught on CCTV. The Netherlands speaker then returned [9652-16] to describe how imagery from body-worn cameras could be correlated with results from static CCTV imagery to help in retrospective investigations. A German speaker [9652-17] explained how tamper detection in software and hardware had not been brought together. He explained how relatively simple components – a camera, a door opening sensor, software for detecting people, and skin – could be brought together to help an operator determine who had interfered with a computer cabinet.

For longer range imaging, a French speaker [9652-18] described how a combination of a pulsing illuminating laser and a linked fast optical switch in the receiving optics could offer a bolt-on solution to difficult surveillance problems across a wide range of wavelengths. For airborne equipment where power size and weight were limited, a United Kingdom speaker [9652-19] described how he had managed to use just a laptop to extract track information in real time from imagers mounted in the nose cone of an aeroplane. The final presentation from Georgia [9652-20] described a sensor for the real time measurement of the polarisation state of an object; a parameter that can be used to distinguish man-made from natural objects.

Two presentations from India [9652-22, 9652-23] were not given because the author had failed in his attempt to obtain a visa for travel to the conference. The

subject of the papers was biometrics research at the Indian Institute of Technology; the first on face recognition, the second on palmprint recognition. Because of the importance of these topics the two papers are included in these proceedings.

If you came to the 2015 conference, or if you are reading this book or CD and wished you'd been there, or feel you can contribute to next year's event, then please note that we shall be meeting in Edinburgh, United Kingdom, towards the end of September 2016.

**Douglas Burgess**  
**Gari Owen**  
**Harbinder Rana**



## Notes from the Open Discussion on “Detection, Imaging and Characterisation of Objects through Barriers: Can we do this?”

For reasons of technical challenges and cost, the THz waveband is the last region of the electromagnetic spectrum to be evaluated and exploited. The aim of this session was to debate the claims put forward by people researching this frequency about its detection and resolution capabilities, particularly against obscured or hidden materials and objects. Here is an example of the type of claim encountered:

*...The researchers demonstrated that they could detect the signal from 67 feet away, the length of their laboratory space, but theoretically they could identify materials hundreds of feet or even miles away.*

If we consider the detection process as a chain, then maybe that helps identify where improvements need to be made:

Source of radiation (if active imaging) – atmosphere – barrier – target – barrier – atmosphere – detector – processing – decision making.

All of these components influence the process. Some are under the control of the system designer, some are not.

It is generally accepted that THz radiation is useful only for a few 10s of metres range. It was suggested that in general it may be more realistic to detect “components rather than systems” e.g., component chemicals of explosives; CO<sub>2</sub> from humans. The issue then becomes: What can be exploited? The key is to look for a signature. An example we had seen in the earlier presentation was the possibility of the detection of a copper object inside an aluminium box.

The barrier determines the possibility of exploitation. A barrier is frequently scenario dependent, e.g., a wet wall has different transmission properties from a dry wall. Wall penetration may be limited by clutter problems. Future building techniques using reflecting foils might limit the applicability of THz technologies. It was suggested that novel architectures should be developed from spectrometers that maximise the use of returned signals – some commercial THz instruments have not been designed for this application.

For active systems, the source of illuminating radiation is a parameter that can be controlled and varied, perhaps to suit the application or scenario.

Cost is a major issue in system acceptance by users and is usually grossly underestimated. There are economies of scale but often the number of products required is typically small.

The discussion ended without any actions on the participants, but with much food for thought that should lead to more presentations in future conferences.

