

PROCEEDINGS OF SPIE

# ***Technologies for Optical Countermeasures XII; and High-Power Lasers 2015: Technology and Systems***

**Harro Ackermann**  
**Willy L. Bohn**  
**David H. Titterton**  
**Robert J. Grasso**  
**Mark A. Richardson**  
*Editors*

**21, 23–24 September 2015**  
**Toulouse, France**

*Sponsored by*  
SPIE

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

*Published by*  
SPIE

**Volume 9650**

Proceedings of SPIE 0277-786X, V. 9650

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

Technologies for Optical Countermeasures XII; and High-Power Lasers 2015: Technology and Systems, edited by Harro Ackermann, Willy L. Bohn, David H. Titterton, Robert J. Grasso, Mark A. Richardson, Proc. of SPIE Vol. 9650, 965001 · © 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2217605

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 *Technologies for Optical Countermeasures XII; and High-Power Lasers 2015: Technology and Systems*, edited by Harro Ackermann, Willy L. Bohn, David H. Tiffterton, Robert J. Grasso, Mark A. Richardson, Proceedings of SPIE Vol. 9650 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781628418606

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

- v *Authors*
- vii *Conference Committee*
- ix *Introduction to Part B: Technologies for Optical Countermeasures*

## **Part A**     *High-Power Lasers 2015: Technology and Systems*

---

### **LASERS AND LASER ARCHITECTURES FOR POWER SCALING**

---

- 9650 02     **Recent advances in Er<sup>3+</sup>:YAG solid-state heat-capacity technology (Invited Paper)**  
[9650-1]
- 9650 03     **Considerations of a ship defense with a pulsed COIL** [9650-2]

---

### **ADVANCES IN FIBER LASERS**

---

- 9650 07     **High-power near-infrared supercontinuum source generated in an ytterbium-doped fiber amplifier** [9650-7]

---

### **NEW SINGLE FREQUENCY/NARROW BAND SOLID STATE LASERS**

---

- 9650 08     **High-average-power narrow-line-width sum frequency generation 589 nm laser** [9650-8]

---

### **SIMULATIONS AND EXPERIMENTS IN DIODE-PUMPED ALKALI LASERS**

---

- 9650 0A     **Supersonic diode pumped alkali lasers: Computational fluid dynamics modeling (Invited Paper)** [9650-10]
- 9650 0B     **Modeling of pulsed K DPAL taking into account the spatial variation of the pump and laser intensities in the transverse direction** [9650-11]
- 9650 0C     **CFD assisted simulation of temperature distribution and laser power in pulsed and CW pumped static gas DPALs** [9650-12]
- 9650 0D     **Low pressure cesium and potassium Diode Pumped Alkali Lasers: pros and cons (Invited Paper)** [9650-13]
- 9650 0E     **3D CFD modeling of subsonic and transonic flowing-gas DPALs with different pumping geometries (Best Student Paper)** [9650-14]

**Part B**      *Technologies for Optical Countermeasures*

---

**AIRCRAFT PROTECTION**

---

- 9650 0H      **Potential of preemptive DIRCM systems (Invited Paper) [9650-23]**
- 9650 0I      **Quantification of helicopter rotor downwash effects on electro-optical defensive aids suites [9650-24]**

---

**ATMOSPHERIC AND EXTERNAL PLATFORM EFFECTS UPON LASER PROPAGATION**

---

- 9650 0L      **Experimental and numerical analysis of atmospheric propagation of high energy laser [9650-27]**
- 9650 0M      **Helicopter engine exhaust rotor downwash effects on laser beams [9650-28]**

---

**PULSE MODULATION AND SIGNATURE EFFECTS**

---

- 9650 0N      **IRCM spectral signature measurements instrumentation featuring enhanced radiometric accuracy [9650-30]**

---

**POSTER SESSION**

---

- 9650 0O      **Different pulse pattern generation by frequency detuning in pulse modulated actively mode-locked ytterbium doped fiber laser [9650-29]**

# 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.

Auslender, Ilya, 0B  
Barmashenko, Boris D., 0A, 0B, 0C, 0E  
Bigotta, Stefano, 02  
Chen, He, 00  
Chen, Sheng-Ping, 07, 00  
Diener, Karsten, 02  
Duschek, Frank, 0L  
Eichhorn, Marc, 02  
Eisele, Christian, 0I  
Fan, Guobin, 08  
Fischbach, Thomas, 0L  
Geiss, Lothar, 02  
Grünewald, Karin M., 0L  
Hall, Thomas, 0L  
Handke, Jürgen, 0L  
Henriksson, Markus, 0I, 0M  
Hou, Jing, 07  
Ibach, Thierry, 02  
Jiang, Zong-Fu, 07, 00  
Jin, Ai-Jun, 07  
Klaffki, Kirsten, 0L  
Knize, Randall J., 0B, 0D  
Lantagne, Stéphane, 0N  
Lu, Yanhua, 08  
Möller, Sebastian, 0I  
Moreau, Louis, 0N  
Pargmann, Carsten, 0L  
Prel, Florent, 0N  
Ren, Huaijin, 08  
Rosenwaks, Salman, 0A, 0B, 0C, 0E  
Rotondaro, Matthew D., 0B, 0D  
Roy, Claude, 0N  
Sadot, Oren, 0A, 0E  
Schöner, Jörg, 02  
Seiffer, Dirk P., 0I, 0M  
Shaffer, Michael K., 0D  
Si, Lei, 07, 00  
Sjöqvist, Lars, 0I, 0M  
Steinvall, Ove, 0H  
Stöppler, Georg, 02  
Takehisa, K., 03  
Thieser, Jim, 0L  
Togna, Fabio, 0I  
Velluet, Marie-Thérèse, 0I  
von Salisch, Michael, 02  
Waichman, Karol, 0A, 0C  
Wan, Min, 08  
Willers, Cornelius J., 0N  
Xu, Xiafei, 08  
Yacoby, Eyal, 0A, 0E  
Zhang, Bin, 07, 00  
Zhang, Lei, 08  
Zhang, Wei, 08  
Zhdanov, Boris V., 0B, 0D



# Conference Committee

## *Symposium Chair*

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

## *Symposium Co-chair*

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

## **Part A: High-Power Lasers 2015: Technology and Systems**

### *Conference Chairs*

**Harro Ackermann**, High Energy Laser Joint Technology Office (United States)

**Willy L. Bohn**, BohnLaser Consult (Germany)

### *Session Chairs*

- 1 Lasers and Laser Architectures for Power Scaling  
**Willy L. Bohn**, BohnLaser Consult (Germany)
- 2 Advances in Fiber Lasers  
**Willy L. Bohn**, BohnLaser Consult (Germany)
- 3 New Single Frequency/Narrow Band Solid State Lasers  
**Willy L. Bohn**, BohnLaser Consult (Germany)
- 4 Simulations and Experiments in Diode-Pumped Alkali Lasers  
**Salman Rosenwaks**, Ben-Gurion University of the Negev (Israel)

## **Part B: Technologies for Optical Countermeasures**

### *Conference Chairs*

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

**Robert J. Grasso**, EOIR Technologies (United States)

### *Conference Programme Committee*

**Brian Butters**, Meon Technology Limited (United Kingdom)

**Marc Eichhorn**, Institut Franco-Allemand de Recherches de Saint-Louis (France)  
**Ian F. Elder**, SELEX Galileo Ltd. (United Kingdom)  
**David B. James**, Cranfield University (United Kingdom)  
**Helena Jelinkova**, Czech Technical University in Prague (Czech Republic)  
**Gerald C. Manke II**, Naval Surface Warfare Center Crane Division (United States)  
**Espen Lippert**, Norwegian Defence Research Establishment (Norway)  
**Eric D. Park**, Q-Peak, Inc. (United States)  
**Ric H. M. A. Schleijpen**, TNO Defence, Security and Safety (Netherlands)  
**Dirk Peter Seiffer**, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)  
**Ove Steinvall**, FOI-Swedish Defence Research Agency (Sweden)  
**Hans-Dieter Tholl**, Diehl BGT Defence GmbH & Co. KG (Germany)  
**Maria S. Willers**, Denel Dynamics (South Africa)  
**Cornelius J. Willers**, Council for Scientific and Industrial Research (South Africa)

*Session Chairs*

- 5 Keynote Session  
**Robert J. Grasso**, EOIR Technologies (United States)  
**David H. Titterton**, UK Defence Academy (United Kingdom)
- 6 Aircraft Protection  
**Stuart Duncan**, SELEX Galileo Ltd. (United Kingdom)
- 7 Lasers and Sources for Countermeasures  
**David H. Titterton**, UK Defence Academy (United Kingdom)
- 8 Atmospheric and External Platform Effects upon Laser Propagation  
**Mark A. Richardson**, Cranfield University (United Kingdom)  
**Hans-Dieter Tholl**, Diehl BGT Defence GmbH & Company KG (Germany)
- 9 Pulse Modulation and Signature Effects  
**Ove Steinvall**, FOI-Swedish Defence Research Agency (Sweden)  
**Leon Smith**, Cranfield University (United Kingdom)

## Introduction to Part B: Technologies for Optical Countermeasures

This was the twelfth time we have held this conference, conducted over two days, and offered a range of papers pertinent to Electro-Optical and Infrared Countermeasures. As in the past, we also held our panel discussion debating the topic of "IRCM – Back to the Future". This discussion is very popular and caused some very interesting discussion, especially when the topic of "where do we move from here and how do we get there given technology and cost constraints" was raised.

This year's conference had five sessions, which focused upon Aircraft Protection, Laser Technology, and Atmospheric, Platform, and Signature Effects. There were two exceptional papers in the keynote session, which addressed "Semiconductor Lasers for DIRCM" and "Advancement in High Power MIR Sources." In the following sessions there were invited presentations covering Pre-emptive DIRCM System Architectures, Helicopter Rotor Downwash Effects, and High Energy Laser Propagation Effects. Of particular interest was our session on, "Atmospheric and External Platform Effects upon Laser Propagation." Here we had two excellent papers dealing with "Experimental and Numerical Analysis of Propagation of High-Energy Beams," and "Helicopter Engine Exhaust Rotor Downwash Effects on Laser Beams." Both of these papers deal with what we get at the end of the propagation chain once rotor downwash effects, atmospheric propagation effects, and absorption and scattering take their toll on our otherwise perfect beam emanating from our system.

We wish to thank all of the presenters for delivering an outstanding conference; moreover, we also thank the Programme Committee for their continued support and willingness to chair the various sessions, which is also appreciated by SPIE. The chairmen encouraged the audience to consider topics for discussion at next year's conference and symposium, which will be held in Edinburgh, Scotland.

**David H. Titterton**  
**Robert J. Grasso**  
**Mark A. Richardson**

