PROCEEDINGS OF SPIE

High-Power Lasers and Technologies for Optical Countermeasures

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

5–7 September 2022 Berlin, Germany

Sponsored by SPIE

Cooperating Organisations Cranfield University (United Kingdom) OpTecBB (Germany) International Society for Photogrammetry and Remote Sensing European Association of Remote Sensing Companies

Published by SPIE

Volume 12273

Proceedings of SPIE 0277-786X, V. 12273 SPIE is an international society advancing an interdisciplinary approach to the science and application of light. 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 *High-Power Lasers and Technologies for Optical Countermeasures*, edited by David H. Titterton, Robert J. Grasso, Harro Ackermann, Willy L. Bohn, Mark A. Richardson, Proc. of SPIE 12273, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510655492 ISBN: 9781510655508 (electronic)

Published by **SPIE** P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) SPIE.org Copyright © 2022 Society of Photo-Optical Instrumentation Engineers (SPIE).

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 fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center 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.

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.



Paper Numbering: A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE 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 Conference Committee

MODELLING AND SIMULATION

- 12273 04 Stability and noise in frequency combs: efficient and accurate computation using dynamical methods (Invited Paper) [12273-1]
- 12273 05 Simulation of caustics caused by high-energy laser reflection from melting metallic targets adapted by a machine learning approach [12273-2]
- 12273 06 Modelling the behaviour of UAVs structural materials under continuous laser irradiations (Invited Paper) [12273-3]

THREATS, THREAT DETECTION AND THREAT DISCRIMINATION

- 12273 07 Threat detection, identification, and optical counter measures for space-based applications [12273-5]
- 12273 08 Enhanced laser ranging for micro UAV localization [12273-6]
- 12273 09 Smart GPS spoofing to countermeasure autonomously approaching agile micro UAVs [12273-7]

LASERS AND SOURCES

High-energy laser experiments for vulnerability studies in the context of the European TALOS program (Invited Paper) [12273-8]
Reflection measurements in TNO's 30 kW laser facility [12273-10]
Large bandwidth lasers coherent beam combining in a 7-element YDFL array using a tailored SPGD algorithm [12273-20]

QUANTUM CASCADE LASERS

12273 0G Compact multi-watt QCL module (Invited Paper) [12273-12]

OPTICS AND OPTICAL SYSTEMS

12273 01	Compact, diode end-pumped, eye-safe laser rangefinder transmitter (Invited Paper) [12273-15]
	LASER EFFECTS
12273 OJ	The effectiveness of amplitude modulation on the laser dazzling of a mid-infrared imager (Invited Paper) [12273-16]
12273 OK	Laser damage experiments on fiber-reinforced plastic (Invited Paper) [12273-17]
12273 OL	Numerical investigation of thermal effects of high-energy laser irradiation on a germanium lens [12273-18]
12273 OM	Experimental investigation of high-power laser irradiation of missile materials in subsonic and supersonic flows [12273-21]