## PROCEEDINGS OF SPIE

# **Optics Education and Outreach VII**

G. Groot Gregory Anne-Sophie Poulin-Girard Editors

22 August 2022 San Diego, California, United States

Sponsored and Published by SPIE

Volume 12213

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 *Optics Education and Outreach VII*, edited by G. Groot Gregory, Anne-Sophie Poulin-Girard, Proc. of SPIE 12213, Seven-digit Article CID Number (DD/MM/YYYY); (DOI IIRI)

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510654105

ISBN: 9781510654112 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) SPIE.org

sric.uig

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

#### **LEARNING ONLINE**

12213 02	A case study into technical eLearning: upskilling Excelitas' workforce with SPIE partnership [12213-1]
12213 03	Problem-based learning in advanced photonics manufacturing: adapting to online delivery during a global pandemic [12213-6]
12213 04	Online learning games and simulations for photonic integrated circuit (PIC) sensor design and operation [12213-3]
12213 05	Learning in a pandemic: a model for virtual outreach [12213-5]
12213 06	VR-based implementation of interactive laboratory experiments in optics and photonics education [12213-4]
	PROMOTING OPTICS
12213 07	Optics, arts, and sound: celebrating 100 years of Kaluza's 5th dimension in a geographically distributed interactive hybrid exhibition [12213-9]
12213 08	Quantum education and pathways: an open-source modifiable presentation to high school and college students [12213-38]
	TOOLS FOR EDUCATION
12213 09	Lambertian surfaces with over- and under-filled field of view [12213-12]
12213 0A	Re-sequencing optics instruction to first build conceptual understanding in introductory courses [12213-13]
12213 OB	Free space fiber optics experiments for photonics engineers and technician training [12213-14]

### FILLING THE SKILLS GAP

	TIELING THE SKIELS GAI
12213 0C	Addressing the critical shortage of optics technicians [12213-16]
12213 0D	Optics manufacturing technician apprenticeships [12213-17]
12213 OE	Upskilling photonics technicians to meet challenges of the quantum 2.0 revolution [12213-19]
12213 OF	Leading owls toward the light: advances in optics and precision manufacturing educational pathways at Keene State College [12213-20]
	POSTER SESSION
12213 0G	Successfully implementing inquiry-based labs: a case study for a college waves and modern physics course [12213-23]
12213 OH	The practical optics workshop: educating the optical engineers of tomorrow [12213-24]
12213 OI	Nonlinear photonics in undergraduate curriculum: hands-on training to meet the demands of a qualified workforce [12213-30]
12213 OJ	Learning and thoughts of how industrial internship can inspire new generation talents [12213-33]
12213 OK	Computer generated hologram (CGH) education kit for hands-on learning of optical metrology for complex optics and systems [12213-36]
12213 OL	New teaching method to simplify Boolean logic functions using 3D cubes [12213-37]
12213 OM	Leveraging TikTok and other new media for optics educational outreach [12213-40]
12213 ON	From Mars to humans: interactive Raman spectroscopy-based outreach activities [12213-41]
12213 00	Dynamic curricular concepts for research orientated programs in optics and photonics [12213-29]