

PROCEEDINGS OF SPIE

Advances in Laboratory-based X-Ray Sources, Optics, and Applications IV

Ali M. Khounsary
Carolyn A. MacDonald
Editors

10 August 2015
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 9590

Proceedings of SPIE 0277-786X, V. 9590

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

Advances in Laboratory-based X-Ray Sources, Optics, and Applications IV,
edited by Ali M. Khounsary, Carolyn A. MacDonald, Proc. of SPIE Vol. 9590,
959001 · © 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2217997

Proc. of SPIE Vol. 9590 959001-1

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.

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 *Advances in Laboratory-based X-Ray Sources, Optics, and Applications IV*, edited by Ali M. Khounsary, Carolyn A. MacDonald, Proceedings of SPIE Vol. 9590 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781628417562

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 © 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. 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

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article 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 six-digit article numbering system structured as follows:

- 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.

Contents

- v *Authors*
- vii *Conference Committee*
- ix *Introduction*

SESSION 1 NOVEL X-RAY SOURCES I

- 9590 02 **Hard x-rays from a tabletop all-laser-driven synchrotron light source (Invited Paper)** [9590-1]
- 9590 05 **A novel technique to produce x-rays for XRF, medical, and scientific purposes (Invited Paper)** [9590-4]

SESSION 2 NOVEL X-RAY SOURCES II

- 9590 06 **From incoherent to coherent x-rays with ICS sources (Invited Paper)** [9590-5]
- 9590 09 **Liquid jet target x-ray tube with field emission cathode** [9590-8]

SESSION 3 OPTICS AND APPLICATIONS

- 9590 0B **Beam conditioning multilayer optics for laboratory x-ray sources** [9590-10]
- 9590 0D **The best of both worlds: automated CMP polishing of channel-cut monochromators** [9590-12]
- 9590 0E **Possibility for new PolyCO imaging: stroboscopic imaging based on vibrating capillary optics** [9590-13]

SESSION 4 APPLICATIONS AND TECHNIQUES

- 9590 0F **A triboelectric closed loop band system for the generation of x-rays** [9590-14]
- 9590 0G **THERMAL analysis of high-power x-ray target: scaling effects** [9590-15]
- 9590 0H **X-ray tube thermal management** [9590-16]

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.

Bondarenko, Taras, 09
Botyachkova, Alexandra, 09
Camara, Carlos G., 05, 0F
Cortes, P., Jr., 0F
Cuadra, D., 0F
Dabagov, S. B., 0E
Della Ventura, G., 0E
Erdmann, Mark, 0D
Fong, J., 0F
Frolov, Sergey, 09
Frontera, Mark, 0G
Ganlieli, Z., 0F
Geisler, Andreas, 09
Graves, William S., 06
Hampai, D., 0E
Hansen, S., 0F
Heid, Oliver, 09
Ivanov, Vladislav, 09
Jiang, Licai, 0B
Karpinskiy, Gennadiy, 09
Kasman, Elina, 0D
Kim, Bonglea, 0B
Khounsary, Ali M., 0H
Kotowski, Andy, 05, 0F
Liedl, A., 0E
Lucas, B., 0F
Mehta, N., 0F
Moncton, David E., 06
Nadella, Naresh, 0H
Nanni, Emilio A., 06
Platonov, Yuriy, 0B
Polese, C., 0E
Polikhov, Stepan, 09
Putterman, Seth J., 05
Raber, Thomas R., 0G
Robinson, Vance S., 0G
Stoupin, Stanislav, 0D
Umstadter, Donald P., 02
Van Cleve, E., 0F
Verman, Boris, 0B
Wong, E. W., 0F
Zhang, Xi, 0G

Conference Committee

Program Track Chairs

Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute of Technology (United States)

Ralph B. James, Brookhaven National Laboratory (United States)

Conference Chairs

Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute of Technology (United States)

Carolyn A. MacDonald, University at Albany (United States)

Conference Program Committee

Mark A. Anastasio, Washington University in St. Louis (United States)

Sandra G. Biedron, Colorado State University (United States)

Jovan G. Brankov, Illinois Institute of Technology (United States)

Björn Hansson, Excillum AB (Sweden)

Hans M. Hertz, KTH Royal Institute of Technology (Sweden)

George A. Kyrala, Los Alamos National Laboratory (United States)

Derrick C. Mancini, Illinois Institute of Technology (United States)

Ladislav Pina, Czech Technical University in Prague (Czech Republic)

J. Scott Price, GE Global Research (United States)

Gert E. van Dorssen, PANalytical B.V. (Netherlands)

Session Chairs

- 1 Novel X-Ray Sources I

Ali M. Khounsary, X-ray Optics, Inc. (United States) and Illinois Institute of Technology (United States)

- 2 Novel X-Ray Sources II

George A. Kyrala, Los Alamos National Laboratory (United States)

- 3 Optics and Applications

Björn Hansson, Excillum AB (Sweden)

Carlos Camara, Tribogenics (United States)

- 4 Applications and Techniques

Ladislav Pina, Czech Technical University in Prague (Czech Republic)

Introduction

Since the discovery of X-rays and for most of their 110 year history, there has been an increasing demand for more powerful X-ray sources. Substantial investment and research has led the development of worldwide synchrotron facilities to satisfy research needs. However, industrial and medical applications typically cannot rely on remote sources. Despite the relative lack of investment, there has been steady progress in the development of a variety of laboratory-based sources and optics for medical, industrial, and related applications.

The presentations at this conference provided a broad review of the recent advances in source and optics developments, as well as a number of applications. We hope that the conference fosters closer collaboration between the developers and users of laboratory-based X-ray systems.

The first part of the conference concentrated on source development, including laser-based, triboelectric, inverse Compton, field emission, nanometer focus, liquid jet sources, and also the thermal management of anodes. This was followed by a discussion of optics, including electroform mirrors, channel cut monochromators and multilayer optics and applications including CT microscopy, and phase, monochromatic and stroboscopic imaging.

Ali M. Khounsary
Carolyn A. MacDonald

