## PROCEEDINGS OF SPIE

# Developments in X-Ray Tomography XV

#### Bert Müller Ge Wang Editors

19–22 August 2024 San Diego, California, United States

Sponsored by SPIE

Cosponsored by Carl Zeiss Microscopy, LLC (United States)

Published by SPIE

Volume 13152

Proceedings of SPIE 0277-786X, V. 13152

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 *Developments in X-Ray Tomography XV*, edited by Bert Müller, Ge Wang, Proc. of SPIE 13152, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510679641 ISBN: 9781510679658 (electronic)

Published by **SPIE** P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) SPIE.org Copyright © 2024 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

- ix Conference Committee
- xi Introduction

#### X-RAY, GAMMA-RAY, AND PARTICLE TECHNOLOGIES PLENARY

13152 02 On the cusp of x-ray tomographic mapping of the human brain and its 10<sup>11</sup> cells (Plenary Paper) [13152-501]

#### APPLICATIONS I: MICRO- AND NANO-TOMOGRAPHY IN BIOMEDICINE

- 13152 03 High-resolution dynamic synchrotron-based x-ray microtomography of the human middle ear (Invited Paper, Best Oral Presentation Award, Merit Award) [13152-1]
- 13152 04 Evaluation of the noise-exposed cochlea using synchrotron radiation-based microtomography [13152-2]
- 13152 05 Development of a H&E multi-agent-staining method for laboratory-microCT applied to endocrine glands of MENX rats [13152-3]

#### INSTRUMENTATION I: PHASE TOMOGRAPHY AND NON-CYLINDRICAL OBJECTS

- 13152 07 An innovative integration of high-resolution synchrotron x-ray laminography fluorescence imaging [13152-5]
- 13152 08 Multi-resolution gratings for edge illumination x-ray phase contrast imaging: a simulation study [13152-6]
- 13152 09 A new user facility with flexible multi-scale, multi-contrast micro-CT capabilities [13152-7]
- 13152 0A X-ray micro-computed tomography with amplitude modulated beams (beam tracking, edge illumination): opportunities, challenges, and outlook (Invited Paper) [13152-8]

#### ALGORITHMS I: ARTIFACT CORRECTION AND DENOISING

- 13152 OC Interior photon-counting CT data denoising via multi-agent reinforcement learning [13152-10]
- 13152 0D Impact of network architecture and training strategy for photon counting CT data correction [13152-65]

13152 OE X-ray reconstruction using synthetic prior image restoration, with application to noise and artefact removal [13152-12]

#### INSTRUMENTATION II: MULTISCALE TOMOGRAPHY

- 13152 OF New high-numerical-aperture macroscope for low radiation dose tomography at the BMIT beamlines of the Canadian Light Source (Invited Paper) [13152-80]
- 13152 OG Development of micro/nano-tomography system at SPring-8 BL47XU (Invited Paper) [13152-14]

#### APPLICATIONS II: NON-DESTRUCTIVE CHARACTERIZATION OF DEDICATED OBJECTS

13152 0J Advanced soft tissue visualization in conjunction with bone structures using contrastenhanced micro-CT [13152-17]

#### INSTRUMENTATION III: ADVANCED LABORATORY-BASED CT SYSTEMS

- 13152 0M Non-destructive imaging of internal structures of a mosquito with sub-micrometer resolution (Merit Award) [13152-20]
- 13152 0N Horizontal extension of the field-of-view in cone-beam tomography at a laboratory instrument [13152-21]
- 13152 00 Sub-second dynamic x-ray micro-CT and fast phase-sensitive multi-contrast micro-CT with a laboratory source [13152-22]

#### **APPLICATIONS III: IMAGING MULTICOMPONENT OBJECTS**

- 13152 OP In-situ synchrotron CT measurements on the interface between shape memory alloy wire and polymer matrix in hybrid composites under tensile loading (Invited Paper) [13152-23]
- 13152 0Q Multi-modal printed circuit board netlist extraction with x-ray and optical imaging [13152-24]
- 13152 08 Mineralized tissue of shark vertebral centra studied with microCT under in situ load (Invited Paper) [13152-26]

#### ALGORITHMS II: DEEP RECONSTRUCTION AND IMAGE ANALYSIS

- 13152 0T Self-supervised deep image restoration for x-ray computed laminographic tomography [13152-27]
- 13152 0U Deep-learning models enable high-resolution reconstruction of large-volume x-ray microscopy datasets [13152-28]

13152 0V Adapting neural networks for rapid segmentation of mineralized tissues in mouse jaws (Invited Paper) [13152-29]

#### ALGORITHMS III: TOMOGRAPHIC RECONSTRUCTION

- 13152 0W X-ray simulations with gVXR as a useful tool for education, data analysis, set-up of CT scans, and scanner development (Invited Paper, Merit Award) [13152-30]
- 13152 0X Extending the field-of-view of speckle-based microtomography with the UMPA model (Merit Award) [13152-31]
- 13152 0Y Deep image prior for sparse-view reconstruction in static, rectangular multi-source x-ray CT systems for cargo scanning [13152-32]
- 13152 07 Machine learning for the reconstruction and analysis of synchrotron-radiation tomography data [13152-33]

#### ALGORITHMS IV: SOPHISTICATED X-RAY TOMOGRAPHY

- 13152 10 Intensity-based stitching microtomography using synchrotron radiation at DESY (Invited Paper) [13152-34]
- 13152 11 Comparison of large-volume imaging approaches using computed tomography [13152-35]
- 13152 12 Fast and efficient tetrahedral volume mesh reconstruction with CAD-ASTRA [13152-36]
- 13152 13 High-throughput x-ray microtomography at FaXToR: a survey towards high-performance image reconstruction (Invited Paper) [13152-37]

#### INSTRUMENTATION IV: ADVANCED TOMOGRAPHIC TECHNIQUES

- 13152 14 Detection of cardiac-induced motion in murine cerebrospinal fluid space captured in vivo with synchrotron radiation-based microtomography [13152-38]
- 13152 15 Recent developments in quantitative phase-contrast microtomography using Talbot array illuminators [13152-39]
- 1315216 Hierarchical phase-contrast tomography: a non-destructive multiscale imaging approach for whole human organs [13152-40]
- 13152 17 Full-field micro and nano tomography at APS-U (Invited Paper) [13152-41]

#### INSTRUMENTATION V: MULTIMODAL IMAGING AND ADVANCED DETECTOR TECHNOLOGY

- 13152 18 Oxygenation imaging of deep targets at high resolution with an x-ray luminescence micro-CT system [13152-43]
- 13152 1AFull-field multimodal imaging technology of x-ray transmission, fluorescence, and<br/>scattering tomography (PI-CT) with polychromatic source (Invited Paper, Merit Award)<br/>[13152-45]

#### APPLICATIONS IV: ADVANCED TOMOGRAPHIC IMAGING

- 13152 1B Cell nuclei segmentation in mm-scale x-ray holographic nanotomography images of mouse brain tissue (Invited Paper) [13152-46]
- 13152 1C Hierarchical and operando tomography with x-rays and beyond [13152-81]
- 13152 1D X-ray microtomography of fossil types in natural history collections [13152-47]
- 13152 1E Recent advancements in microtomography [13152-48]

### TRIBUTE TO ULRICH BONSE: FOUNDER OF CONFERENCE SERIES: DEVELOPMENTS IN X-RAY TOMOGRAPHY

- 13152 1F Tribute to Ulrich Bonse: his doctoral thesis on x-ray imaging of strain fields around dislocations in germanium single crystals (Invited Paper) [13152-49]
- 13152 1G Ulrich Bonse's impact on development of x-ray tomography [13152-50]
- 13152 1H Bonse-Hart x-ray interferometer and tomography [13152-82]
- 13152 11 Tribute to Ulrich Bonse: full-field imaging using first to third generation of synchrotron radiation sources [13152-51]
- 13152 1J Ulrich Bonse's lasting influence through x-ray interference [13152-52]

#### POSTER SESSION

13152 1L	A 3D-printed table for hybrid x-ray CT and optical imaging of a live mouse [13152-54]
13152 1N	Feasibility test of simultaneous neutron and x-ray tomography for HANARO thermal neutron beam line (Best Poster Award) [13152-56]
13152 1P	Dynamic flat field correction in edge illumination imaging [13152-58]

- 13152 1R Hierarchical three-dimensional imaging using x-ray micro-/nano-tomography at BL20XU of SPring-8 [13152-60]
- 13152 15 Development of fully automatic high-energy x-ray tomography system at SPring-8 BL28B2 [13152-61]
- 13152 11 Parallel usage of x-ray diffraction contrast tomography and micro-computed tomography for multi-modal characterization at the HEMS P07 beamline [13152-62]
- 13152 10 Improvements of a laboratory phase-contrast nano-computed tomography system [13152-63]
- 13152 1V A study on position and energy correction of multi-pixel events in pixelated semiconductor detector for XFCT imaging [13152-64]
- 13152 1W Exploring physics-informed machine learning for system matrix formulation in x-ray imaging forward models [13152-66]
- 13152 1Y X-ray image reconstruction for continuous acquisition with accelerated rotation [13152-68]
- 13152 17 Multi-modal image registration and machine learning for the generation of 3D virtual histology of bone implants [13152-70]
- 13152 20 A tomography slice through the entire human brain with less than three micrometer voxels (Best Poster Award) [13152-71]
- 13152 21 Contrast-enhanced micro-CT for visualization of cell distribution in hydrated human cornea (Best Poster Award) [13152-72]
- 13152 23 Suitability of synchrotron-radiation phase-contrast tomography for imaging of inner ear of harbor porpoise [13152-74]
- 13152 24 Compton camera for 3D SPECT imaging [13152-75]
- 13152 25 Challenges and opportunities in non-destructive characterization of stacked IC packaging: insights from SAM and 3D x-ray analysis [13152-76]
- 13152 28 Motivating automated multimodal failure analysis for heterogeneously integrated devices [13152-79]
- 13152 29 Three-dimensional hard x-ray micro-tomographic imaging of the human palatal anatomy and gracilis muscle [13152-83]