

PROCEEDINGS OF SPIE

# ***7th International Conference on Image Formation in X-Ray Computed Tomography***

**Joseph Webster Stayman**  
*Editor*

**12–16 June 2022**

*Sponsored by*

Johns Hopkins University Department of Biomedical Engineering (United States)  
Canon Medical Systems Corporation (Japan)  
GE Healthcare (United States)  
Philips Healthcare (United States)  
Siemens Healthineers (United States)  
United Imaging Healthcare (China)

*Published by*  
SPIE

**Volume 12304**

Proceedings of SPIE 0277-786X, V. 12304

7th International Conference on Image Formation in X-Ray Computed Tomography,  
edited by Joseph Webster Stayman, Proc. of SPIE Vol. 12304, 1230401  
© 2022 SPIE · 0277-786X · doi: 10.1117/12.2662172

Proc. of SPIE Vol. 12304 1230401-1

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](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 *7th International Conference on Image Formation in X-Ray Computed Tomography*, edited by Joseph Webster Stayman, Proc. of SPIE 12304, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510656697  
ISBN: 9781510656703 (electronic)

Published by  
**SPIE**  
P.O. Box 10, Bellingham, Washington 98227-0010 USA  
Telephone +1 360 676 3290 (Pacific Time)  
[SPIE.org](http://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](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.

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.

**SPIE. DIGITAL LIBRARY**  
[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**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*

---

## NOVEL CT TECHNOLOGIES

---

- 12304 02 **Dark-field imaging on a clinical CT system: realization of Talbot-Lau interferometry in a gantry** [12304-26]
- 12304 03 **Dark-field imaging on a clinical CT system: performance and potential based on first results** [12304-82]
- 12304 04 **Non-invasive real-time thermometry via spectral CT physical density quantifications** [12304-89]

---

## DEEP LEARNING AND RECONSTRUCTION

---

- 12304 05 **Cone-beam reconstruction for a circular trajectory with transversely-truncated projections based on the virtual fan-beam method** [12304-38]
- 12304 06 **Iterative image reconstruction for CT with unmatched projection matrices using the generalized minimal residual algorithm** [12304-43]
- 12304 07 **Deep learning-based detector row upsampling for clinical spiral CT** [12304-101]
- 12304 08 **DL-Recon: combining 3D deep learning image synthesis and model uncertainty with physics-based image reconstruction** [12304-5]
- 12304 09 **Learned cone-beam CT reconstruction using neural ordinary differential equations** [12304-29]

---

## CT ACQUISITION

---

- 12304 0A **LaBr<sub>3</sub>:Ce and silicon photomultipliers: towards the optimal scintillating photon-counting detector** [12304-45]
- 12304 0B **Preliminary investigations of a novel dynamic CT collimator** [12304-116]
- 12304 0C **X-ray CT data completeness condition for sets of arbitrary projections** [12304-23]
- 12304 0D **CT imaging with truncated data over limited-angular ranges** [12304-77]

12304 OE **Extension of the cone-beam CT field-of-view using two short scans with displaced centers of rotation** [12304-6]

---

#### SPECTRAL CT

---

12304 OF **Consistency-based auto-calibration of the spectral model in dual-energy CT.** [12304-47]

12304 OG **Co-clinical photon counting CT research for multi-contrast imaging** [12304-11]

12304 OH **Reproducibility in dual energy CT: the impact of a projection domain material decomposition method** [12304-46]

12304 OI **Dual-source photon-counting CT: consistency in spectral results at different acquisition modes and heart rates** [12304-70]

---

#### ARTIFACTS AND SPARSE CT

---

12304 OJ **Deep scatter estimation for coarse anti-scatter grids as used in photon-counting CT** [12304-53]

12304 OK **Cross-domain metal segmentation for CBCT metal artifact reduction** [12304-4]

12304 OL **Sparsier2Sparse: weakly-supervised learning for streak artifact reduction with unpaired sparse-view CT data** [12304-20]

12304 OM **Dual domain closed-loop learning for sparse-view CT reconstruction** [12304-60]

12304 ON **Hybrid reconstruction using shearlets and deep learning for sparse x-ray computed tomography** [12304-7]

---

#### MODELING AND ASSESSMENT

---

12304 OO **Trade-offs between redundancy and increased rank for tomographic system matrices** [12304-90]

12304 OP **Stationary x-ray tomography for hemorrhagic stroke imaging: sampling and resolution properties** [12304-73]

12304 OQ **Angular normalized glandular dose coefficient in breast CT: clinical data study** [12304-67]

12304 OR **Estimating the accuracy and precision of quantitative imaging biomarkers as endpoints for clinical trials using standard-of-care CT** [12304-59]

---

## DEEP LEARNING ASSESSMENT

---

- 12304 OS **Reconstructing invariances of CT image denoising networks using invertible neural networks** [12304-113]
- 12304 OT **Local linearity analysis of deep learning CT denoising algorithms** [12304-3]
- 12304 OU **Evaluation of deep learning-based CT reconstruction with a signal-Laplacian model observer** [12304-93]

---

## SPECTRAL AND POLYENERGETIC CT RECONSTRUCTION

---

- 12304 OV **Tunable neural networks for multi-material image formation from spectral CT measurements** [12304-104]
- 12304 OW **Self-supervised nonlocal spectral similarity induced material decomposition network for dual-energy CT** [12304-64]
- 12304 OX **Likelihood-based bilateral filtration in material decomposition for photon counting CT** [12304-94]
- 12304 OY **Experimental evaluation of polychromatic reconstruction for quantitative CBCT** [12304-34]
- 12304 OZ **Dual-energy cone-beam CT with three-material decomposition for bone marrow edema imaging** [12304-8]

---

## INTERVENTIONAL IMAGING

---

- 12304 10 **Real-time liver tumor localization via a single x-ray projection using deep graph network-assisted biomechanical modeling** [12304-78]
- 12304 11 **3D reconstruction of stents and guidewires in an anthropomorphic phantom from three x-ray projections** [12304-15]

---

## CARDIAC CT AND MOTION COMPENSATION

---

- 12304 12 **Context-aware, reference-free local motion metric for CBCT deformable motion compensation** [12304-72]
- 12304 13 **Simulation of random deformable motion in soft-tissue cone-beam CT with learned models** [12304-71]
- 12304 14 **A five-dimensional cardiac CT model for generating virtual CT projections for user-defined bolus dynamics and ECG profiles** [12304-10]

12304 15 **A virtual imaging trial framework to study cardiac CT blooming artifacts** [12304-16]

---

**MONDAY POSTER SESSION**

---

12304 16 **First results on Compton camera system used for x-ray fluorescence computed tomography** [12304-95]

12304 17 **Iterative grating interferometry-based phase-contrast CT reconstruction with a data-driven denoising prior** [12304-25]

12304 18 **A scatter correction method of CBCT via CycleGAN and forward projection algorithm** [12304-107]

12304 19 **Design and optimization of 3D VSHARP® scatter correction for industrial CBCT using the Linear Boltzmann Transport Equation** [12304-109]

12304 1A **Motion correction image reconstruction using NeuralCT improves with spatially aware object segmentation** [12304-12]

12304 1B **Photon-counting x-ray CT perfusion imaging in animal models of cancer** [12304-13]

12304 1C **Undersampled dynamic tomography with separated spatial and temporal regularization** [12304-123]

12304 1D **Full-spectrum-knowledge-aware unsupervised network for photon-counting CT imaging** [12304-62]

12304 1E **Soil matrix study using a hybrid a-Se/CMOS pixel detector for CT scanning** [12304-40]

12304 1F **The reason of why dynamic dual-energy CT is better than multi-energy CT in reducing statistical noise** [12304-84]

12304 1G **Cone-beam x-ray luminescence computed tomography reconstruction based on Huber Markov Random Field regularization** [12304-55]

12304 1H **Dual-domain network with transfer learning for reducing bowtie-filter induced artifacts in half-fan cone-beam CT** [12304-79]

12304 1I **Organ-specific vs. patient risk-specific tube current modulation in thorax CT scans covering the female breast** [12304-54]

12304 1J **An analytical Prj2CR covariance estimation method for iterative CT reconstruction algorithms** [12304-106]

12304 1K **Material decomposition from photon-counting CT using a convolutional neural network and energy-integrating CT training labels** [12304-14]

12304 1L **Using tissue-energy response to generate virtual monoenergetic images from conventional CT for computer-aided diagnosis of lesions** [12304-50]

- 12304 1M **Detruncation of clinical CT scans using a discrete algebraic reconstruction technique prior** [12304-74]
- 12304 1N **Deep-learning-based respiratory surrogate signal extraction** [12304-100]
- 12304 1O **Deep learning enabled wide-coverage high-resolution cardiac CT** [12304-102]
- 12304 1P **Preliminary study on image reconstruction for limited-angular-range dual-energy CT using two-orthogonal, overlapping arcs** [12304-98]
- 12304 1Q **Fully automated deep-learning-based resolution recovery** [12304-117]
- 12304 1R **Dual-energy head cone-beam CT using a dual-layer flat-panel detector: physics-based material decomposition** [12304-120]
- 12304 1S **Combining deep learning and adaptive sparse modeling for low-dose CT reconstruction** [12304-114]
- 12304 1T **X-ray dissectography enables stereotography** [12304-118]
- 12304 1U **Mixed coronary plaque characterization with the first clinical dual-source photon-counting CT scanner: a phantom study** [12304-87]

---

**TUESDAY POSTER SESSION**

- 12304 1V **Photon starvation artifact reduction by shift-variant processing** [12304-9]
- 12304 1W **Data-driven metal artifact correction in computed tomography using conditional generative adversarial networks** [12304-51]
- 12304 1X **CT-value conservation-based spatial transformer network for cardiac motion correction** [12304-21]
- 12304 1Y **Exploiting voxel-sparsity for bone imaging with sparse-view cone-beam computed tomography** [12304-76]
- 12304 1Z **Estimation of contrast agent concentration from pulsed-mode projections to time contrast-enhanced CT scans** [12304-111]
- 12304 20 **Time separation technique using prior knowledge for dynamic liver perfusion imaging** [12304-32]
- 12304 21 **A hybrid neural network combining explicit priors for low-dose CT reconstruction** [12304-97]
- 12304 22 **High resolution cerebral perfusion deconvolution via mixture of Gaussian model based on noise properties** [12304-63]

- 12304 23 **Simulating arbitrary dose levels and independent noise image pairs from a single CT scan** [12304-18]
- 12304 24 **Dark-field imaging on a clinical CT system: sample data processing and reconstruction** [12304-27]
- 12304 25 **S<sup>2</sup>MS: self-supervised learning driven multi-spectral CT image enhancement** [12304-85]
- 12304 26 **Virtual non-metal network for metal artifact reduction in the sinogram domain** [12304-80]
- 12304 27 **Residual W-shape network (ResWnet) for dual-energy cone-beam CT imaging** [12304-41]
- 12304 28 **Dark-field imaging on a clinical CT system: modelling of interferometer vibrations** [12304-66]
- 12304 29 **Fully utilizing contrast enhancement on lung tissue as a novel basis material for lung nodule characterization by multi-energy CT** [12304-49]
- 12304 2A **Image reconstruction in phase-contrast CT with shortened scans** [12304-22]
- 12304 2B **Self-trained deep convolutional neural network for noise reduction in CT** [12304-69]
- 12304 2C **2D-3D motion registration of rigid objects within a soft tissue structure** [12304-115]
- 12304 2D **Gas bubble motion artifact reduction through simultaneous motion estimation and image reconstruction** [12304-17]
- 12304 2E **Comparing one-step and two-step scatter correction and density reconstruction in x-ray CT** [12304-108]
- 12304 2F **Material decomposition from unregistered dual kV data using the cOSSCIR algorithm** [12304-91]
- 12304 2G **PixelPrint: three-dimensional printing of patient-specific soft tissue and bone phantoms for CT** [12304-86]
- 12304 2H **Practical workflow for arbitrary non-circular orbits for CT with clinical robotic C-arms** [12304-112]
- 12304 2I **Motion correction via locally linear embedding for helical photon-counting CT** [12304-68]

---

**WEDNESDAY POSTER SESSION**

- 12304 2J **An attempt of directly filtering the sparse-view CT images by BM3D** [12304-19]
- 12304 2K **Assessment of perceptual quality measures for multi-exposure radiography and tomography** [12304-31]



- 12304 2L **Geometric calibration of seven degree of freedom robotic sample holder for x-ray CT**  
[12304-39]
- 12304 2M **Comparison of energy bin compression strategies for photon counting detectors** [12304-42]
- 12304 2N **A visible edge aware directional total variation model for limited-angle reconstruction**  
[12304-125]
- 12304 2O **Dual-task learning for low-dose CT simulation and denoising** [12304-61]
- 12304 2P **Statistical iteration reconstruction based on Gaussian mixture model for photon-counting CT**  
[12304-65]
- 12304 2Q **Deep learning ring artifact correction in photon-counting spectral CT with perceptual loss**  
[12304-99]
- 12304 2R **Photon counting detector-based multi-energy cone beam CT platform for preclinical small animal radiation research** [12304-92]
- 12304 2S **Design of novel loss functions for deep learning in x-ray CT** [12304-35]
- 12304 2T **Effect of attenuation model on iodine quantification in contrast-enhanced breast CT** [12304-33]
- 12304 2U **Motion compensated weighted filtered backprojection considering rebinning process**  
[12304-52]
- 12304 2V **On the use of voxel-driven backprojection and iterative reconstruction for small ROI CT imaging** [12304-88]
- 12304 2W **A decomposition method for directional Total Variation with application to needle reconstruction in interventional imaging** [12304-105]
- 12304 2X **New reconstruction methodology for chest tomosynthesis based on deep learning** [12304-58]
- 12304 2Y **Iterative intraoperative digital tomosynthesis image reconstruction using a prior as initial image**  
[12304-57]
- 12304 2Z **Learning CT scatter estimation without labeled data: a feasibility study** [12304-56]
- 12304 30 **Implementations of statistical reconstruction algorithm for CT scanners with flying focal spot**  
[12304-83]
- 12304 31 **Multiple linear detector off-line calibration** [12304-28]
- 12304 32 **Iodine-enhanced liver vessel segmentation in photon counting detector-based computed tomography using deep learning** [12304-48]
- 12304 33 **Optimization of empirical beam hardening correction algorithm** [12304-110]

- 12304 34 **Deep learning-based prior toward normalized metal artifact reduction in computed tomography** [12304-24]
- 12304 35 **On use of augmentation for the DNN-based CT image denoising** [12304-75]
- 12304 36 **Joint multi-channel total generalized variation minimization and tensor decomposition for spectral CT reconstruction** [12304-81]

# Conference Committee

## *Conference Chair*

**Joseph Webster Stayman**, Johns Hopkins University (United States)

## *Organizing Committee*

**Grace J. Gang**, *Chair*, Johns Hopkins University (United States)  
**Junyuan Li**, Johns Hopkins University (United States)  
**Yiqun Q. Ma**, Johns Hopkins University (United States)  
**Alejandro Sisniega**, Johns Hopkins University (United States)  
**Matthew Tivnan**, Johns Hopkins University (United States)  
**Wenying Wang**, Johns Hopkins University (United States)  
**Yijie Yuan**, Johns Hopkins University (United States)  
**Wojciech Zbijewski**, Johns Hopkins University (United States)

## *Program Committee*

**Adam Wang**, Stanford University (United States)  
**Bruno De Man**, GE Research (United States)  
**Cristian Badea**, Duke University (United States)  
**Cyril Riddell**, GE Healthcare (France)  
**Emil Sidky**, University of Chicago (United States)  
**Frédéric Noo**, University of Utah (United States)  
**Ge Wang**, Rensselaer Polytechnic Institute (United States)  
**Guang-Hong Chen**, University of Wisconsin-Madison (United States)  
**Hengyong Yu**, University of Massachusetts Lowell (United States)  
**Hiroyuki Kudo**, University of Tsukuba (Japan)  
**Ioannis Sechopoulos**, Radboud University (Netherlands)  
**Jeff Fessler**, University of Michigan (United States)  
**Jeff Siewerdsen**, Johns Hopkins University (United States)  
**Jerome Liang**, Stony Brook University (United States)  
**Jing Wang**, University of Texas Southwestern (United States)  
**Jingyan Xu**, Johns Hopkins University (United States)  
**Johan Nuyts**, KU Leuven (Belgium)  
**John Boone**, University of California, Davis (United States)  
**Jongduk Baek**, Yonsei University (South Korea)  
**Karl Stierstorfer**, Siemens Healthineers (Germany)  
**Katsuyuki Taguchi**, Johns Hopkins University (United States)  
**Ke Li**, University of Wisconsin-Madison (United States)  
**Ken Sauer**, University of Notre Dame (United States)  
**Kirsten Boedeker**, Canon Medical Systems (United States)  
**Lifeng Yu**, Mayo Clinic (United States)  
**Marc Kachelrieß**, German Cancer Research Center (Germany)

**Mats Danielsson**, KTH Royal Institute of Technology (Sweden)  
**Michael McNitt-Gray**, University of California, Los Angeles (United States)  
**Peter Noël**, University of Pennsylvania (United States)  
**Rongping Zeng**, U.S. Food and Drug Administration (United States)  
**Scott Hsieh**, Mayo Clinic (United States)  
**Srinivasan Vedantham**, University of Arizona (United States)  
**Stanislav Zabic**, Philips (United States)  
**Stefan Sawall**, German Cancer Research Center (Germany)  
**Thomas Koehler**, Philips Research Hamburg (Germany)  
**Thomas Koenig**, Ziehm Imaging (Germany)  
**Joseph Webster Stayman**, Johns Hopkins University (United States)  
**Wenli Wang**, Avant Tomography Consulting LLC (United States)  
**Xiaochuan Pan**, University of Chicago (United States)  
**Xun Jia**, University of Texas Southwestern (United States)  
**Yuxiang Xing**, Tsinghua University (China)  
**Zhicong Yu**, Accuray (United States)  
**Zhou Yu**, Canon Medical Research (United States)  
**Zhye Yin**, GE Research (United States)

#### *Session Chairs*

- 1 Novel CT Technologies  
**Bruno De Man**, GE Research (United States)  
**Ke Li**, University of Wisconsin-Madison (United States)
- 2 Reconstruction and Deep Learning  
**Marc Kachelrieß**, German Cancer Research Center (Germany)  
**Koen Michielsen**, Radboud University (Netherlands)
- 3 CT Acquisition  
**Adam Wang**, Stanford University (United States)  
**Rolf Clackdoyle**, Université Grenoble Alpes (France)
- 4 Spectral CT  
**Kevin Brown**, Philips (United States)  
**Cristian Badea**, Duke University (United States)
- 5 Artifacts and Sparse CT  
**Xiaochuan Pan**, University of Chicago (United States)  
**Jerome Liang**, Stony Brook University (United States)
- 6 Modeling and Assessment  
**Grace J. Gang**, Johns Hopkins University (United States)  
**Kirsten Boedeker**, Canon Medical Systems (United States)

- 7 Deep Learning Assessment  
**Saiprasad Ravishankar**, Michigan State University (United States)  
**Rongping Zeng**, U.S. Food and Drug Administration (United States)
- 8 Spectral and Polyenergetic CT Reconstruction  
**Emil Sidky**, University of Chicago (United States)  
**Johan Sunnegårdh**, Siemens Healthineers (Germany)
- 9 Interventional Imaging  
**Cyril Riddell**, GE Healthcare (France)
- 10 Cardiac CT and Motion Compensation  
**Katsuyuki Taguchi**, Johns Hopkins University (United States)  
**Simon Rit**, CREATIS, Université de Lyon (France)

