PROCEEDINGS OF SPIE

X-Ray, Optical, and Infrared Detectors for Astronomy XI

Andrew D. Holland Kyriaki Minoglou Editors

16–20 June 2024 Yokohama, Japan

Sponsored by SPIE

Cosponsored by
NAOJ—National Astronomical Observatory of Japan (Japan)
NICT—National Institute of Information and Communications Technology (Japan)
JNTO—Japan National Tourism Organization (Japan)
City of Yokohama (Japan)

Cooperating Organization Optronics Co., Ltd. (Japan)

Published by SPIF

Volume 13103

Proceedings of SPIE 0277-786X, V. 13103

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 X-Ray, Optical, and Infrared Detectors for Astronomy XI, edited by Andrew D. Holland, Kyriaki Minoglou, Proc. of SPIE 13103, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510675292

ISBN: 9781510675308 (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

INFRARED DETECTORS I

13103 02 Teledyne Digital Imaging's recent contributions to astronomy and planetary science (Invited Paper) [13103-1] 13103 03 SIRIS: a new, fast, high dynamic, and very low noise SWIR camera [13103-3] 13103 04 A 64-pixel mid-intrared single-photon imager based on superconducting nanowire detectors [13103-5] 13103 05 In situ cryogenic electro-optical and radiation hardness characterization of a T2SL MWIR sensor for space imaging [13103-6] 13103 06 Advancing large format MCT/Si infrared detectors for astrophysics research [13103-7] 13103 07 Leonardo UK infrared sensors for scientific applications [13103-9] X-RAY IMAGING 13103 08 Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] 13103 09 X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector subsystem [13103-24]		INFRARED DETECTORS I
13103 04 A 64-pixel mid-infrared single-photon imager based on superconducting nanowire detectors [13103-5] 13103 05 In situ cryogenic electro-optical and radiation hardness characterization of a T2SL MWIR sensor for space imaging [13103-6] 13103 06 Advancing large format MCT/Si infrared detectors for astrophysics research [13103-7] 13103 07 Leonardo UK infrared sensors for scientific applications [13103-9] X-RAY IMAGING 13103 08 Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] 13103 09 X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 02	
defectors [13103-5] In situ cryogenic electro-optical and radiation hardness characterization of a T2SL MWIR sensor for space imaging [13103-6] 13103 06 Advancing large format MCT/Si infrared detectors for astrophysics research [13103-7] 13103 07 Leonardo UK infrared sensors for scientific applications [13103-9] X-RAY IMAGING 13103 08 Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] 13103 09 X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 03	SIRIS: a new, fast, high dynamic, and very low noise SWIR camera [13103-3]
sensor for space imaging [13103-6] 13103 06 Advancing large format MCT/Si infrared detectors for astrophysics research [13103-7] 13103 07 Leonardo UK infrared sensors for scientific applications [13103-9] X-RAY IMAGING 13103 08 Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] 13103 09 X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 04	
X-RAY IMAGING Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 05	
X-RAY IMAGING 13103 08 Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] 13103 09 X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 06	Advancing large format MCT/Si infrared detectors for astrophysics research [13103-7]
Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 07	Leonardo UK infrared sensors for scientific applications [13103-9]
Evaluation of a CMOS sensor for solar flare soft x-ray imaging spectroscopy onboard the sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] The MICADO first light imager for the ELT: overview of the near infrared mosaic detector		
sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] The MICADO first light imager for the ELT: overview of the near infrared mosaic detector		X-RAY IMAGING
[13103-18] 13103 0A CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector		
INFRARED DETECTORS II 13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 08	
13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector		sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS)
13103 0B High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 09	sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18]
 (Invited Paper) [13103-21] 13103 0C Cassiopée, towards technological development for XAO on ELT: the e-APD infrared detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector 	13103 09	sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18]
detector [13103-22] 13103 0D The MICADO first light imager for the ELT: overview of the near infrared mosaic detector	13103 09	sounding rocket experiment FOXSI-4 (Excellent Early Career Presentation) [13103-17] X-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19]
	13103 09 13103 0A	x-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency
	13103 09 13103 0A 13103 0B	x-ray optimised CMOS image sensors for the auroral x-ray imaging spectrometer (AXIS) [13103-18] CMOS image sensors for x-ray interferometry [13103-19] INFRARED DETECTORS II High-performance infrared detector developments at the European Space Agency (Invited Paper) [13103-21] Cassiopée, towards technological development for XAO on ELT: the e-APD infrared

CCDS AND SINGLE PHOTON DETECTORS I

13103 0E	SMILE soft x-ray imager (SXI) CCD370 proton irradiation results [13103-26]
13103 OF	Astronomical spectroscopy with Skipper CCDs: first results from a Skipper CCD focal plane prototype at SIFS [13103-28]
13103 0G	Effects of proton irradiation on the performance of skipper CCDs [13103-29]
13103 OH	Studying amplifier glow in p-channel silicon MOSFETs using Skipper-CCDs [13103-30]
13103 01	Assessment and removal of thin tearing resembling structures in deep-depletion CCDs [13103-27]
	X-RAY I
13103 OJ	X-ray speed reading with the MCRC: prototype success and next generation upgrades [13103-32]
13103 OK	Soft x-ray resolution and scientific performance of CCD sensors for future x-ray missions [13103-33]
13103 OL	High-speed x-ray imaging spectroscopy by CCD-CMOS hybrid sensor [13103-34]
13103 0M	Status of x-ray hybrid CMOS detector development efforts at PSU [13103-35]
13103 ON	SSAXI-Rocket delta-doped CMOS sensors (Excellent Early Career Presentation) [13103-36]
	CMOS IMAGE SENSORS
13103 00	Innovations in imaging technology at Teledyne e2v to support future visible, NIR, UV, and x-ray applications (Invited Paper) [13103-37]
	CMOSI
13103 OP	MCP-TimePix3 at OARPAF: a pathfinder for an imaging detector with high time resolution for astronomy [13103-38]
13103 0Q	Superlattice-doped PMOS imaging arrays for broadband visible applications [13103-39]
13103 OR	Beyond CCDs: characterization of sCMOS detectors for optical astronomy [13103-40]
13103 OS	Characterizing radiation-tolerant single photon resolving CMOS detectors [13103-41]

	CMOS II
13103 OT	Transfer gate effects on the dark current in pinned photodiode image sensors [13103-42]
13103 OU	Characterization and validation of next generation image sensors for space applications [13103-45]
	CAMERA
13103 OV	WFST primary mosaic CCD camera and its first light [13103-46]
13103 OW	LSST Camera focal plane optimization [13103-47]
	INFRARED DETECTORS
	INFRARED DETECTORS
13103 0X	JWST FGS tracking performance during the DART observations [13103-49]
13103 OY	Multiple nondestructive readout strategy to improve the signal-to-noise ratio of faint exposures with infrared arrays [13103-134]
13103 OZ	Very low-flux short-wave infrared FPAs developments at LETI for astronomy applications [13103-52]
	CCDS AND SINGLE PHOTON DETECTORS II
13103 10	Sub-electron noise multi-amplifier sensing CCDs for spectroscopy [13103-53]
13103 11	Readout optimization of multi-amplifier sensing charge-coupled devices for single-quantum measurement [13103-54]
13103 12	Demonstrating sub-electron noise performance in single electron sensitive readout (SiSeRO) devices [13103-57]
	TEST AND MODELING
13103 13	Design consideration for full well capacity and charge transfer efficiency of a CCD-in-CMOS imager pixel: TCAD study [13103-58]
13103 14	Imager of MPPC-based optical photon counter from Yamagata [13103-59]
13103 15	Performance of the image persistence model for Euclid infrared detectors [13103-63]

X-RAY II 13103 16 Characterization of x-ray detectors in the MIT x-ray polarimetry beamline [13103-64] 13103 17 Directions for advancement of MIT-LL CCDs for x-ray astrophysics applications [13103-65] 13103 18 HypeX: high yield polarimetry experiment in x-rays [13103-68] **MONDAY POSTER SESSION** 13103 19 Study of new types of detectors in the SWIR: extension of the operating band beyond 1.7µm [13103-69] 13103 1A Firmware design of a science CMOS camera and its performance test [13103-70] 13103 1B Non-ionising radiation effects in a soft x-ray CMOS image sensor [13103-71] 13103 1C Limiting atmospheric emission lines with on-detector subarrays [13103-72] 13103 1D The XOC x-ray beamline: probing colder, quieter, and softer [13103-77] 13103 1E Performance test of commercial InGaAs detectors in low temperature [13103-79] 13103 1F A holistic understanding of the JWST-MIRI detector PSF using physical optics propagation [13103-80] 13103 1G Performance report of a substrate-removed InGaAs sensor for the JASMINE mission [13103-82] 13103 1H Continued developments in x-ray speed reading; fast, low noise readout for nextgeneration wide-field imagers [13103-83] 13103 11 Assessing the suitability of CIS220 for low-light astronomy [13103-85] 13103 1J ESA's packaging solution for Leonardo's IBEX detector: design, manufacture, and test **activities** [13103-86] 13103 1K Development of large format visible CMOS sensor for short-time scale astronomy [13103-88] 13103 1L Trigger performance evaluation and anti-coincidence demonstration of an event-driven

SOI pixel detector for x-ray astronomy [13103-89]

13103 1M	Characterizing the noises of InGaAs cameras for astronomical observations	[13103-92]

13103 1N **EMCCD gain estimation: a comparison of techniques** [13103-93]

TUESDAY POSTER SESSION

	TOUSDAT TO STER SESSION
13103 10	Novel ceramic concept for CCD sensor packages and focal plane assemblies [13103-74]
13103 1P	Cherenkov photon background for low-noise silicon detectors in space [13103-97]
13103 1Q	PUNCH flight detector characterization [13103-98]
13103 1R	Fast resets of sub-windows on infrared detectors as a strategy for persistence mitigation [13103-99]
13103 15	Development of large area cross strip readout technologies for microchannel plate UV detectors [13103-101]
13103 1T	Advanced electronics development for temperature control in X-IFU's ADR system [13103-103]
13103 1U	METIS first light imager and spectrograph for the ELT: overview of the near and mid-infrared detector subsystems [13103-105]
13103 1V	ANDES, the high-resolution spectrograph for the ELT: RIZ and UBV spectrographs' preliminary design of the detector unit [13103-107]
13103 1W	Toward a universal characterization methodology for conversion gain measurement of CMOS APS: application to Euclid and SVOM [13103-110]
13103 1X	COMODOR: ESA's new modular CMOS controller for science payload validation activities [13103-111]
13103 1Y	Detector characterization of the Little Ultraviolet Camera (LUVCamera) [13103-115]
13103 1Z	Origins and analysis of nonlinear crosstalk in the Rubin Observatory LSST Camera [13103-116]
13103 20	Glow reduction of ultra-low noise LmAPDs: towards photon counting infrared arrays [13103-118]
13103 21	Electro-optical characterization of LSST camera CCDs using the LSST beam simulator [13103-119]
13103 22	High-speed array controller: design of a 64-channel detector controller [13103-122]

13103 23	Preliminary characterization of a MCP photon counting detector prototype based on a custom-developed readout ASIC [13103-124]
13103 24	Characterization of the dark signal of the Solar Orbiter/Metis detectors [13103-126]
13103 25	Characterization of a longwave HgCdTe GeoSnap detector [13103-128]
13103 26	Direct measurement of pseudothermal light violating Siegert relation [13103-130]
13103 27	The PRIME camera: results and performance after continuous observations [13103-131]

Conference Committee

Symposium Chairs

Sarah Kendrew, European Space Agency (United States)Satoshi Miyazaki, National Astronomical Observatory of Japan (Japan)

Symposium Co-chairs

Desirée Della Monica Ferreira, DTU Space (Denmark) **Anna Moore**, The Australian National University (Australia)

Conference Chairs

Andrew D. Holland, Centre for Electronic Imaging (United Kingdom)
Kyriaki Minoglou, European Space Research and Technology Centre (Netherlands)

Conference Program Committee

Alessandra Ciapponi, European Space Research and Technology Centre (Netherlands)

Chiaki Crews, The Open University (United Kingdom)

Meghan L. Dorn, Teledyne Imaging Sensors (United States)

Elizabeth M. George, European Southern Observatory (Germany)

Michael E. Hoenk, Jet Propulsion Laboratory (United States)

Douglas Jordan, Teledyne e2v UK Ltd. (United Kingdom)

Ralf Kohley, European Space Astronomy Centre (Spain)

Gregory Mosby Jr., NASA Goddard Space Flight Center (United States)

Roger M. Smith, California Institute of Technology (United States)

Takeshi Go Tsuru, Kyoto University (Japan)

Kyriaki Minoglou, European Space Agency (Netherlands)