

PROCEEDINGS OF SPIE

Space Telescopes and Instrumentation 2018: Ultraviolet to Gamma Ray

Jan-Willem A. den Herder
Shouleh Nikzad
Kazuhiro Nakazawa
Editors

10–15 June 2018
Austin, Texas, United States

Sponsored by
SPIE

Cosponsored by
4D Technology (United States) • Andor Technology, Ltd. (United Kingdom) • Astronomical Consultants & Equipment, Inc. (United States) • Giant Magellan Telescope (Chile) • GPixel, Inc. (China) • Harris Corporation (United States) • Materion Corporation (United States) • Optimax Systems, Inc. (United States) • Princeton Infrared Technologies (United States) • Symétrie (France) • Teledyne Technologies, Inc. (United States) • Thirty Meter Telescope (United States)

Cooperating Organizations
European Space Organisation • National Radio Astronomy Observatory (United States) • Science & Technology Facilities Council (United Kingdom) • Canadian Astronomical Society (Canada) • Canadian Space Association ASC (Canada) • Royal Astronomical Society (United Kingdom) • Association of Universities for Research in Astronomy (United States) • American Astronomical Society (United States) • Australian Astronomical Observatory (Australia) • European Astronomical Society (Switzerland)

Published by
SPIE

Volume 10699
Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 10699

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 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 *Space Telescopes and Instrumentation 2018: Ultraviolet to Gamma Ray*, edited by Jan-Willem A. den Herder, Shouleh Nikzad, Kazuhiro Nakazawa, Proceedings of SPIE Vol. 10699 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510619517

ISBN: 9781510619524 (electronic)

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 © 2018, 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/18/\$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 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

xiii	<i>Authors</i>
xxv	<i>Conference Committee</i>

UV I

10699 02	Ultrathin protective coatings by atomic layer engineering for far ultraviolet aluminum mirrors [10699-1]
10699 04	New far-UV instrumentation enabled by recent advances in mirror coating processes [10699-3]
10699 05	HabEx ultraviolet spectrograph design and DRM [10699-4]

UV II

10699 06	POLLUX: a UV spectropolarimeter for the LUVUOIR space telescope project [10699-5]
10699 09	High-energy astrophysics with CETUS: a UV space telescope concept [10699-8]

UV III

10699 0C	The Colorado ultraviolet transit experiment (CUTE): final design and projected performance [10699-11]
10699 0D	Conceptual design of a wide-field near UV transient survey in a 6U CubeSat [10699-12]
10699 0F	Monitoring the high-energy radiation environment of exoplanets around low-mass stars with SPARCS (Star-Planet Activity Research CubeSat) [10699-14]

UV IV

10699 0H	The EUI flight instrument of Solar Orbiter: from optical alignment to end-to-end calibration [10699-15]
10699 0J	Stray and scattered light properties of the Juno ultraviolet spectrograph [10699-17]
10699 0K	The fourth flight of CHES: spectral resolution enhancements for high-resolution FUV spectroscopy [10699-19]

DECADAL STUDY OVERVIEWS: JOINT SESSION WITH CONFERENCES 10698 AND 10699

10699 0N **The Lynx X-ray Observatory: concept study overview and status** [10699-21]

OPTICS I

10699 0O **Astronomical x-ray optics using mono-crystalline silicon: high resolution, light weight, and low cost** [10699-22]

10699 0P **Fabrication of lightweight silicon x-ray mirrors for high-resolution x-ray optics** [10699-23]

10699 0S **Metrology for quality control and alignment of CAT grating spectrometers** [10699-26]

OPTICS II

10699 0U **Sub-arcsecond imaging with multi-image x-ray interferometer module (MIXIM) for very small satellite** [10699-29]

10699 0V **Small satellites with MEMS x-ray telescopes for x-ray astronomy and solar system exploration** [10699-30]

10699 0W **Microchannel plate x-ray optics on the Mercury imaging x-ray spectrometer** [10699-31]

OPTICS: ATHENA + LYNX

10699 0X **Development of the ATHENA mirror** [10699-32]

10699 0Z **Results of silicon pore optics mirror modules optical integration in the ATHENA telescope** [10699-34]

10699 10 **Integration of the ATHENA mirror modules: development status of the indirect and direct x-ray methods** [10699-35]

LYNX

10699 12 **The high definition x-ray imager (HDXI) instrument on the Lynx X-ray Surveyor** [10699-37]

10699 14 **An x-ray transmission grating spectrometer for Lynx** [10699-39]

10699 17 **Toward fast low-noise low-power digital CCDs for Lynx and other high-energy astrophysics missions** [10699-42]

TIMING AND PROGRAM

- 10699 19 **STROBE-X: a probe-class mission for x-ray spectroscopy and timing on timescales from microseconds to years** [10699-44]
- 10699 1B **Current progress of x-ray multilayer telescope optics based on thermally slumping glass for eXTP mission** [10699-46]
- 10699 1C **The Large Area Detector onboard the eXTP mission** [10699-47]

ATHENA I

- 10699 1E **ATHENA: system studies and optics accommodation** [10699-49]
- 10699 1F **Development of the Wide Field Imager instrument for ATHENA** [10699-50]
- 10699 1G **The ATHENA X-ray Integral Field Unit (X-IFU)** [10699-51]

ATHENA WFI

- 10699 1H **First tests of large prototype DEPFET detectors for ATHENA's wide field imager** [10699-52]
- 10699 1I **Evaluation of the ATHENA/WFI instrumental background** [10699-53]
- 10699 1J **The ATHENA WFI science products module** [10699-54]
- 10699 1K **ATHENA WFI optical blocking filters development status toward the end of the instrument phase-A** [10699-55]

ATHENA X-IFU

- 10699 1M **Development of TiAu TES x-ray calorimeters for the X-IFU on ATHENA space observatory** [10699-57]
- 10699 1Q **Estimates for the background of the ATHENA X-IFU instrument: the cosmic rays contribution** [10699-61]
- 10699 1R **ATHENA X-IFU thermal filters development status toward the end of the instrument phase-A** [10699-62]

OPERATIONAL

- 10699 1T **Two decades of Chandra high-resolution camera operations: lessons learned and future prospects** [10699-64]
- 10699 1U **The insight-HXMT mission and its recent progresses** [10699-65]
- 10699 1W **Effective area calibration of the nuclear spectroscopic telescope array (NuSTAR)** [10699-67]

APPROVED II

- 10699 1Y **ART-XC / SRG overview** [10699-69]
- 10699 1Z **How eROSITA was made** [10699-70]
- 10699 20 **SVOM: a French/Chinese cooperation for a GRB mission** [10699-71]
- 10699 21 **MXT instrument on-board the French-Chinese SVOM mission** [10699-72]
- 10699 22 **Concept of the X-ray Astronomy Recovery Mission** [10699-73]

APPROVED III

- 10699 23 **Soft x-ray imaging telescope (Xtend) onboard X-ray Astronomy Recovery Mission (XARM)** [10699-74]
- 10699 25 **Einstein Probe: a lobster-eye telescope for monitoring the x-ray sky** [10699-76]

PROPOSED I

- 10699 27 **The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)** [10699-78]

PROPOSED II

- 10699 28 **Super DIOS: future x-ray spectroscopic mission to search for dark baryons** [10699-79]
- 10699 29 **AXIS: a probe class next generation high angular resolution x-ray imaging satellite** [10699-80]

10699 2D **The FORCE mission: science aim and instrument parameter for broadband x-ray imaging spectroscopy with good angular resolution** [10699-84]

DETECTORS I

10699 2E **X-ray hybrid CMOS detectors: recent development and characterization progress** [10699-85]

DETECTORS II

10699 2I **Large x-rays high impedance μ -calorimeters matrices: status and prospects** [10699-89]

GAMMA-RAY I

10699 2J **The e-ASTROGAM gamma-ray space observatory for the multi-messenger astronomy of the 2030s** [10699-90]

10699 2K **The polarimetric performance of the Compton Spectrometer and Imager (COSI)** [10699-91]

GAMMA-RAY II

10699 2M **The advanced energetic pair telescope for gamma-ray polarimetry** [10699-93]

10699 2O **The continued development of a low energy Compton imager for GRB polarization studies** [10699-95]

10699 2P **CAMELOT: Cubesats Applied for MEasuring and LOcalising Transients mission overview** [10699-96]

10699 2R **SAGE: using CubeSats for gravitational wave detection** [10699-98]

POSTER SESSION

10699 2U **COS2025: a strategy to extend the lifetime of the FUV detector on the Cosmic Origins Spectrograph** [10699-100]

10699 2V **Opto-mechanical assembly and ground calibration of LUCI** [10699-101]

10699 2W **Optical alignment of the high-precision UV spectro-polarimeter (CLASP2)** [10699-102]

- 10699 2X **E-beam generated plasma etching for developing high-reflectance mirrors for far-ultraviolet astronomical instrument applications** [10699-103]
- 10699 2Y **Broadband EUV/FUV mirror coatings for a solar spectrograph mission** [10699-104]
- 10699 2Z **Design and performance of MgF₂+ Au coatings on aluminum mirrors: enabling far-ultraviolet solar occultation measurements for Europa-UVS** [10699-106]
- 10699 30 **Wave-front error measurements and alignment of CLASP2 telescope with a dual-band pass cold mirror coated primary mirror** [10699-107]
- 10699 31 **In-flight characterization and calibration of the Juno-Ultraviolet Spectrograph (Juno-UVS)** [10699-108]
- 10699 32 **CUTE data simulator and reduction pipeline** [10699-109]

Part Two

- 10699 33 **Reflectometry of surfaces of 1.7-m mirror of WSO-UV space telescope** [10699-110]
- 10699 34 **The solar orbiter Metis and EUI intensified CMOS-APS detectors: concept, main characteristics, and performance** [10699-111]
- 10699 35 **The new field camera unit imaging instrument onboard WSO-UV** [10699-112]
- 10699 36 **Rosetta-Alice II: an upgraded UV spectrograph for a Rosetta-type mission** [10699-113]
- 10699 38 **Instrument prototypes of miniature near-UV imaging spectro-polarimeters for observations of solar magnetism** [10699-115]
- 10699 39 **UV capabilities of the CETUS multi-object spectrometer (MOS) and NUV/FUV camera** [10699-116]
- 10699 3A **Planning operations in Jupiter's high-radiation environment: optimization strategies from Juno-UVS** [10699-117]
- 10699 3B **The science case for POLLUX: a high-resolution UV spectropolarimeter onboard LIVOIR** [10699-118]
- 10699 3D **Theoretical study of filter design for UV-bandpass filters for the CETUS probe mission study** [10699-120]
- 10699 3E **PIONS: a CubeSat imager to observe variable UV sources** [10699-121]
- 10699 3G **World Space Observatory ultraviolet mission: instrumentation and the core program** [10699-123]
- 10699 3H **Microchannel plate detectors for future NASA UV observatories** [10699-240]

- 10699 3I **Progress in the realization of the beam expander testing x-ray facility (BEaTriX) for testing ATHENA's SPO modules** [10699-124]
- 10699 3J **The Geant4 mass model of the ATHENA Silicon Pore Optics and its effect on soft proton scattering** [10699-125]
- 10699 3K **Performance and stability of mirror coatings for the ATHENA mission** [10699-126]
- 10699 3L **Silicon pore optics manufacturing plan and schedule for ATHENA** [10699-127]
- 10699 3P **Oxide-bonded molecular-beam epitaxial backside passivation process for large-format CCDs** [10699-203]
- 10699 3R **Development of a lightweight x-ray mirror using thin carbon-fiber-reinforced plastic (CFRP)** [10699-132]
- 10699 3S **The McXtrace AstroX toolbox: a general ray tracing software package for end to end simulation of x-ray optics for astronomical instrumentation** [10699-133]
- 10699 3T **AHEAD joint research activity on x-ray optics** [10699-134]
- 10699 3U **Optical design of the off-plane grating rocket experiment** [10699-135]
- 10699 3X **Evaluation of x-ray reflectors by optical diffraction patterns** [10699-138]
- 10699 3Y **The effect of nitrogen incorporation in boron carbide and iridium thin films** [10699-139]
- 10699 3Z **The finite element analysis modeling of micro pore optic plate** [10699-140]
- 10699 40 **Alignment and bonding of silicon mirrors for high-resolution astronomical x-ray optics** [10699-141]
- 10699 41 **Reflective coatings for the future x-ray mirror substrates** [10699-142]
- 10699 42 **Thermal oxide patterning method for compensating coating stress in silicon x-ray telescope mirrors** [10699-143]
- 10699 43 **X-ray telescope mirror mounting and deformation reduction using ThermoYield actuators and mirror geometry changes** [10699-144]
- 10699 48 **The wide field monitor onboard the eXTP mission** [10699-149]
- 10699 4A **Design of the charged particle diverter for the ATHENA mission** [10699-151]
- 10699 4B **A magnetic electron repeller to improve the ATHENA/WFI background level** [10699-152]
- 10699 4C **Structural modelling and mechanical tests supporting the design of the ATHENA X-IFU thermal filters and WFI optical blocking filter** [10699-153]

- 10699 4F **Energy response of ATHENA WFI prototype detectors** [10699-156]
- 10699 4G **Characterizing particle background of ATHENA WFI for the science products module: swift XRT full frame and XMM-PN small window mode observations** [10699-157]
- 10699 4H **Reducing the ATHENA WFI background with the science products module: lessons from Chandra ACIS** [10699-158]
- 10699 4I **Studies of operation modes for the ATHENA WFI detectors** [10699-159]
- 10699 4K **The performance of the ATHENA X-ray Integral Field Unit** [10699-161]
- 10699 4L **Simulating x-ray observations of galaxy clusters with the x-ray integral field unit onboard the ATHENA mission** [10699-162]
- 10699 4M **Energy scale calibration and drift correction of the X-IFU** [10699-163]
- 10699 4N **Reproducibility and monitoring of the instrumental particle background for the x-ray integral field unit** [10699-164]
- 10699 4O **Testing the X-IFU calibration requirements: an example for quantum efficiency and energy resolution** [10699-165]
- 10699 4P **Development of the WFEE subsystem for the X-IFU instrument of the ATHENA Space Observatory** [10699-166]
- 10699 4Q **Performance of a state-of-the-art DAC system for FDM readout** [10699-167]
- 10699 4R **Radio frequency shielding of thin aluminized plastic filters investigated for the ATHENA X-IFU detector** [10699-168]
- 10699 4S **ATHENA X-ray Integral Field Unit on-board event processor: analysis of performance of two triggering algorithms** [10699-169]
- 10699 4T **The cryogenic anticoincidence detector for ATHENA X-IFU: preliminary test of AC-S9 towards the demonstration model** [10699-170]
- 10699 4V **First results of the ATHENA/X-IFU digital readout electronics prototype** [10699-172]
- 10699 4W **Numerical simulation and validation of ATHENA/X-IFU/digital readout electronics** [10699-173]
- 10699 50 **Thermal modelling of the ATHENA X-IFU filters** [10699-177]
- 10699 51 **Initial jitter analysis of Lynx, a proposed future large astrophysics facility** [10699-178]
- 10699 52 **Analysis of the NGXO telescope x-ray Hartmann data** [10699-179]

- 10699 54 **Ultrafast laser micro-stressing for correction of thin fused silica optics for the Lynx X-Ray Telescope Mission** [10699-181]
- 10699 57 **Adjustable x-ray mirrors based on plastic electroactive polymer actuators for the Lynx mission** [10699-184]
- 10699 59 **Compensating film stress in silicon substrates for the Lynx x-ray telescope mission concept using ion implantation** [10699-186]
- 10699 5A **Performances of the gas pixel detector to a continuum and highly polarized x-ray beam** [10699-187]
- 10699 5B **Dependence on temperature of the response of a gas pixel detector to polarized radiation** [10699-188]
- 10699 5C **Calibration of the IXPE instrument** [10699-189]
- 10699 5D **Overview of the detector and its readout on board the imaging x-ray polarimetry explorer** [10699-190]
- 10699 5E **On-ground calibration of the ART-XC/SRG instrument** [10699-191]
- 10699 5F **eROSITA system functionality and operation** [10699-192]
- 10699 5G **eROSITA ground operations** [10699-193]
- 10699 5H **eROSITA mated with SRG** [10699-194]
- 10699 5J **Calibration of the spectral response of the SVOM/ECLAIRs detection plane** [10699-196]
- 10699 5K **Status of technological development on ECLAIRs camera onboard the SVOM space mission** [10699-197]
- 10699 5N **Background simulations of WXT aboard the Einstein Probe mission** [10699-200]
- 10699 5O **Developments of scientific CMOS as focal plane detector for Einstein Probe mission** [10699-201]
- 10699 5Q **Exploring fine subpixel spatial resolution of hybrid CMOS detectors** [10699-204]
- 10699 5R **The effects of charge diffusion on soft x-ray response for future high-resolution imagers** [10699-205]
- 10699 5S **BlackCAT CubeSat: a soft x-ray sky monitor, transient finder, and burst detector for high-energy and multimessenger astrophysics** [10699-206]
- 10699 5T **High impedance transition edge sensors with classical readout electronics: a new scheme toward large x-ray matrices** [10699-207]

- 10699 5U **The gamma-ray transient monitor for ISS-TAO: new directional capabilities** [10699-208]
- 10699 5V **Modeling and development of soft gamma-ray channeling** [10699-209]
- 10699 5W **SMILE-2+: the 2018 balloon flight and the instrument design of the electron-tracking Compton camera** [10699-210]
- 10699 5X **The Advanced Scintillator Compton Telescope (ASCOT) balloon payload** [10699-211]
- 10699 62 **Kanazawa-SAT³: micro-satellite mission for monitoring x-ray transients coincide with gravitational wave events** [10699-217]
- 10699 63 **Development of focal plane x-ray detector aboard a microsatellite for monitoring supermassive blackholes** [10699-218]
- 10699 64 **CAMELOT: design and performance verification of the detector concept and localization capability** [10699-219]
- 10699 65 **Simulating modulated x-ray calibration sources for future x-ray missions using GEANT4** [10699-220]
- 10699 69 **In-orbit calibration status of the Insight-HXMT** [10699-224]
- 10699 6B **The complicated evolution of the ACIS contamination layer over the mission life of the Chandra X-ray Observatory** [10699-226]
- 10699 6C **Automating the Swift scheduling pipeline** [10699-239]
- 10699 6D **Blazed transmission grating technology development for the Arcus x-ray spectrometer explorer** [10699-228]
- 10699 6F **Ray-tracing Arcus in phase A** [10699-230]
- 10699 6H **The Off-plane Grating Rocket Experiment (OGRE) system overview** [10699-232]
- 10699 6K **Grating design for the Water Recovery X-ray Rocket** [10699-235]
- 10699 6M **Optical instrument design of the High-Energy X-ray Probe (HEX-P)** [10699-237]