

PROCEEDINGS OF SPIE

# ***Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII***

**Jonas Zmuidzinas  
Jian-Rong Gao**  
*Editors*

**18–22 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*  
SPIE

**Volume 13102**

Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 13102

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

Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII,  
edited by Jonas Zmuidzinas, Jian-Rong Gao, Proc. of SPIE Vol. 13102,  
1310201 · © 2024 SPIE · 0277-786X · doi: 10.1117/12.3048429

Proc. of SPIE Vol. 13102 1310201-1

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 *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII*, edited by Jonas Zmuidzinas, Jian-Rong Gao, Proc. of SPIE 13102, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510675278  
ISBN: 9781510675285 (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 © 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](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

xi Conference Committee

## Part One

---

### IMAGERS AND POLARIMETERS I

---

- 13102 02 **NEW-MUSIC: The Next-generation Extended-Wavelength Multiband Sub/millimeter Inductance Camera** [13102-1]
- 13102 03 **CCAT: design and performance of densely packed, high-frequency, dual-polarization kinetic inductance detectors for the Prime-Cam 850 GHz module** [13102-2]

---

### CMB INSTRUMENTS I

---

- 13102 04 **In-flight performance of SPIDER's 280 GHz receivers** [13102-6]
- 13102 05 **Commissioning the CMB polarization telescope GroundBIRD with the full set of detectors** [13102-7]

---

### NEW INSTRUMENTS AND CONCEPTS I

---

- 13102 06 **The key science drivers for the Atacama Large Aperture Submillimeter Telescope (AtLAST)** [13102-12]
- 13102 07 **Concept camera for the next-generation mm-wave cosmological surveys** [13102-15]

---

### CMB INSTRUMENTS II

---

- 13102 08 **MNTES: modeling nonlinearity of TES detectors for enhanced cosmic microwave background measurements with LiteBIRD** [13102-18]
- 13102 09 **MISTRAL: technical commissioning and first W-band photons from the Sardinia Radio Telescope** [13102-19]
- 13102 0A **Breadboard model assembly and characterization of a sapphire achromatic half-wave plate for LiteBIRD low-frequency telescope** [13102-21]

## DETECTORS

---

- 13102 0B **Transition edge sensor arrays for future FIR space missions** [13102-22]
- 13102 0C **The W-band LEKID array of the MISTRAL instrument** [13102-25]
- 13102 0D **Highly sensitive far-IR KIDs for PRIMA: optical characterization of a 25-micron array** [13102-27]

## OPTICS AND COMPONENTS I

---

- 13102 0E **Laser ablated subwavelength structure antireflection coating on an alumina lens** [13102-31]

## SPECTROMETERS I

---

- 13102 0F **Virtually Image Phased Array (VIPA): demonstration of the next generation direct detection spectrometer for velocity resolved spectroscopy in the far-infrared** [13102-33]
- 13102 0G **FINER: Far-Infrared Nebular Emission Receiver for the large millimeter telescope** [13102-34]

## COHERENT RECEIVER TECHNOLOGY

---

- 13102 0H **Possibilities and limitations of the offline scheme frequency transfer method** [13102-38]
- 13102 0I **4×2 hot electron bolometer mixer arrays for detection at 1.4, 1.9, and 4.7 THz for a balloon borne terahertz observatory** [13102-39]
- 13102 0J **Development status of wideband millimeter-wave receivers for LMT-FINER** [13102-160]
- 13102 0K **ALMA Band 8 version2 receiver upgrade project** [13102-41]
- 13102 0L **Development of an SIS mixer-based amplifier for large-scale multipixel heterodyne receivers** [13102-42]
- 13102 0M **ALMA2030 Band-4+5 receiver front-end wideband sensitivity upgrade: first year initial development and future plan** [13102-43]

---

## NEW INSTRUMENTS AND CONCEPTS II

---

- 13102 0N **BISOU: a balloon pathfinder for CMB spectral distortions studies** [13102-50]
- 13102 0O **CONCERTO: instrument model of Fourier transform spectroscopy, white-noise components** [13102-52]
- 13102 0P **Innovative octave band quad ridge feed horn and vacuum window for next-generation radio observatories** [13102-53]

---

## MULTIPLEXING AND READOUT I

---

- 13102 0Q **A first demonstration of active feedback control and multifrequency imaging techniques for kinetic inductance detectors** [13102-57]
- 13102 0R **The CRS: a scalable full-stack control system for microwave kinetic inductance detectors** [13102-58]

---

## DETECTORS III

---

- 13102 0S **Design of ultra-low-noise AIMn transition edge sensor for far-infrared applications** [13102-59]
- 13102 0T **Design and characterization of kinetic inductance detectors for the next-generation OLIMPO experiment** [13102-62]

---

## SPECTROMETERS II

---

- 13102 0U **CCAT: a status update on the EoR-Spec instrument module for Prime-Cam** [13102-65]
- 13102 0V **A 10.24-GHz-wide digital spectrometer array system for LMT-FINER: system design and laboratory performance verification** [13102-68]

---

## POSTER SESSION: DETECTORS I

---

- 13102 0W **The PolarKID project: polarization measurements with KIDs for the next generation of CMB telescopes** [13102-69]
- 13102 0X **The Simons Observatory: design, fabrication, and characterization of low-frequency detectors** [13102-71]
- 13102 0Y **Development of the low-frequency telescope focal plane detector arrays for LiteBIRD** [13102-72]

- 13102 0Z **Dual polarization kinetic inductance detectors for large imaging cameras at millimeter wave bands** [13102-73]
- 13102 10 **The characterisation of a PID feedback-controlled array of TES-bolometers in a far-infrared double-Fourier interferometry testbed** [13102-74]

---

**POSTER SESSION: MULTIPLEXING AND READOUT I**

---

- 13102 11 **Development of RFSOC-based direct sampling highly multiplexed microwave SQUID readout for CMB and submillimeter surveys** [13102-78]
- 13102 12 **On-board science data quality analysis using anomaly detection for ASTHROS** [13102-79]
- 13102 13 **CCAT: multirate DSP for sub-mm astronomy: polyphase synthesis filter bank on FPGA for enhanced MKID readout** [13102-80]
- 13102 14 **Development of LiteBIRD's cold readout sub-assembly** [13102-82]
- 13102 15 **Johnson-noise calibration of a TES bolometer array using FDM readout with baseband feedback** [13102-83]

---

**POSTER SESSION: CMD INSTRUMENTS I**

---

- 13102 16 **Technical feasibility of microwave absorbers for straylight mitigation in the LiteBIRD MHFT telescopes** [13102-88]
- 13102 17 **HoverCal + PoloCalC: precise on-flight metrology performance results over CLASS telescope** [13102-89]
- 13102 18 **Design and validation of a cold load for characterization of CMB-S4 detectors** [13102-94]
- 13102 19 **The Simons Observatory: calibration and characterization of the first small-aperture telescope** [13102-95]
- 13102 1A **Measuring the CMB spectral distortions with COSMO: the multimode antenna system** [13102-97]
- 13102 1B **The Simons Observatory: deployment and current configuration of the observatory control system for SAT-MF1 and data access software systems** [13102-98]
- 13102 1C **Replicating sky emission in labs for astronomers** [13102-187]

## Part Two

---

### POSTER SESSION: IMAGERS AND POLARIMETERS

---

- 13102 1D **ROGer: Remote Observing from Greenland** [13102-100]
- 13102 1E **Simulated radiation features of a C-band phased array feed located at the Sardinia Radio Telescope primary focus** [13102-101]

---

### POSTER SESSION: NEW INSTRUMENTS AND CONCEPTS

---

- 13102 1F **Concept design of the AMT front-end optics** [13102-103]
- 13102 1G **LuSEE-Night power requirements and power generation strategy** [13102-104]
- 13102 1H **Compact turnstile quad-ridge orthomode transducer with octave bandwidth for radio astronomy applications** [13102-105]
- 13102 1I **Free space experimental characterization of a multilayer Fabry-Pérot resonator for DALI** [13102-107]
- 13102 1J **Commissioning Kuntur: the LLAMA 690GHz receiver at JCMT** [13102-108]
- 13102 1K **Development of an ultra-sensitive 210-micron array of KIDs for far-IR astronomy** [13102-109]
- 13102 1L **A C-band dual-mode radio astronomy low-noise block downconverter designed for the 4-element radio interferometer of North-West University** [13102-188]

---

### POSTER SESSION: DETECTORS II

---

- 13102 1M **A cryogenic facility to characterize detector-particle interactions** [13102-112]
- 13102 1N **Spatial mapping of kilopixel kinetic inductance detector arrays for PRIMA** [13102-116]
- 13102 1O **CCAT: nonlinear effects in 280 GHz aluminum kinetic inductance detectors** [13102-117]
- 13102 1P **A review of the enduring performance and reliability of SCUBA-2 at the JCMT** [13102-119]
- 13102 1Q **SNSPD development within the SPID / IQSENS project** [13102-185]

---

**POSTER SESSION: OPTICS AND COMPONENTS I**

---

- 13102 1R **Holographic field-retrieval method of near-field measurements of wide field of view millimeter-wave telescopes using reference phase shifting** [13102-120]
- 13102 1S **Near-field reflection measurements of lightweight absorbers in the millimeter-wavelengths for space missions** [13102-124]
- 13102 1T **Design and characterization of a 60-cm reflective half-wave plate for the CLASS 90 GHz band telescope** [13102-125]
- 13102 1U **Design, fabrication, and applications of THz dielectric metamaterials** [13102-126]
- 13102 1V **A low-loss silicon optical diplexer for millimeter and submillimeter radio astronomy** [13102-127]
- 13102 1W **Reflectance measurements of mm-wave absorbers using frequency-domain continuous wave THz spectroscopy** [13102-170]

---

**POSTER SESSION: CMD INSTRUMENTS II**

---

- 13102 1X **Development status of the cryogenic holder mechanism for LiteBIRD LFT PMU** [13102-130]
- 13102 1Y **Vector beam mapping at millimeter wavelengths using a robot arm** [13102-134]
- 13102 1Z **Anti-reflection coating of laser-ablated sub-wavelength structure for millimeter-wave alumina filters** [13102-135]
- 13102 20 **Capacitive sensors for the polarization modulator unit of the mid- and high-frequency telescopes of LiteBIRD space mission** [13102-136]
- 13102 21 **Design and performance test of a modular readout electronic for the kinetic inductance detectors for the COSMO experiment based on commercial components** [13102-137]
- 13102 22 **CCAT: Prime-Cam optics overview and status update** [13102-138]
- 13102 23 **The Simons Observatory: studies of detector yield and readout noise from the first large-scale deployment of microwave multiplexing at the large aperture telescope** [13102-140]
- 13102 24 **Calibration of CMB Telescopes with PROTOCALC** [13102-141]
- 13102 25 **The European low-frequency survey on the Simons Array** [13102-191]



---

**POSTER SESSION: COHERENT RECEIVER**

---

- 13102 26 **A customizable, five-stage, intermediate frequency, low-noise amplifier and readout chain for the Astrophysics Stratospheric Telescope for High-spectral Resolution Observations at Submillimeter-wavelengths (ASTHROS)** [13102-142]
- 13102 27 **Cryogenic high-linearity and dynamic range C-band low-noise amplifier for uMUX TES and CMB readout systems** [13102-144]
- 13102 28 **Development of 230 GHz finline SIS mixers for next-generation large array receivers and HARP instrument upgrade** [13102-145]
- 13102 29 **Development of 86 GHz low-noise wideband receiver** [13102-147]
- 13102 2A **VLBI instrument for Millimetron Space Observatory** [13102-149]
- 13102 2B **Broadband tuneable travelling wave parametric multiplier based on high-gap superconducting thin film** [13102-150]
- 13102 2C **The ALMA2030 wideband sensitivity upgrade** [13102-186]

---

**POSTER SESSION: MULTIPLEXING AND READOUT II**

---

- 13102 2D **Study of a Microwave Kinetic Inductance Detector (MKID) readout system based on FPGAs and SoCs** [13102-84]
- 13102 2E **CCAT: detector noise limited performance of the RFSoc-based readout electronics for mm/sub-mm/far-IR KIDs** [13102-152]
- 13102 2F **CMB-S4 SiGe ASIC-based daughter board for low-temperature detectors front-end analog readout** [13102-154]

---

**POSTER SESSION: SPECTROMETERS I**

---

- 13102 2G **TIME: the Tomographic Ionized-carbon Mapping Experiment: an update on design, characterization, and data from the 2022 commissioning observations** [13102-156]
- 13102 2H **CCAT: characterizing the Fabry-Pérot interferometer mirrors and mount for the epoch of reionization spectrometer** [13102-162]
- 13102 2I **Superfluid-tight cryogenic receiver with continuous sub-kelvin cooling for EXCLAIM** [13102-163]
- 13102 2J **PULsar SKArab-based system for Radio astronomy (PULSKAR)** [13102-164]
- 13102 2K **Development and characterization of the flight model spectrometer onboard LuSEE-Night** [13102-165]

---

**POSTER SESSION: OPTICS AND COMPONENTS II**

---

- 13102 2L **Development of a wideband receiver for dual-band and dual-polarization observations in 230 and 345 GHz bands** [13102-166]
- 13102 2M **Multilayer antireflection coats using ePTFE membrane for mm-wavelength plastic optics** [13102-167]
- 13102 2N **3D printed alumina as a millimeter-wave optical element** [13102-168]
- 13102 2O **Thermal and mechanical study of a parametrised cryostat model for optical characterisation of upcoming CMB experiments** [13102-169]

---

**POSTER SESSION: CMB INSTRUMENTS III**

---

- 13102 2P **The Precursor Small Aperture Telescope (PreSAT) CMB polarimeter** [13102-172]
- 13102 2Q **The Simons Observatory: alarms and detector quality monitoring** [13102-173]
- 13102 2R **Systematic effects induced by half-wave plate differential optical load and TES nonlinearity for LiteBIRD** [13102-174]
- 13102 2S **The Simons Observatory: dark characterization of the large aperture telescope** [13102-176]
- 13102 2T **The map-making and data filtering pipeline for the MISTRAL receiver** [13102-177]
- 13102 2U **Design, mechanical, and thermal analysis for medium- and high-frequency telescopes of LiteBIRD** [13102-178]
- 13102 2V **LiteBIRD MHFT W-band RF breadboard modeling and characterisation** [13102-179]
- 13102 2W **Design optimization of anechoic SKYLOAD dedicated for LiteBIRD MHFT on-ground testing** [13102-183]
- 13102 2X **Multichroic pixels using double flare angle bowtie antenna coupled KIDs for CMB observation** [13102-184]

# Conference Committee

## *Symposium Chairs*

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

## *Symposium Co-chairs*

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

## *Conference Chairs*

**Jonas Zmuidzinis**, California Institute of Technology (United States)  
**Jian-Rong Gao**, SRON Netherlands Institute for Space Research  
(Netherlands) and Delft University of Technology (Netherlands)

## *Conference Program Committee*

**Jason E. Austermann**, National Institute of Standards and Technology  
(United States)  
**Jochem J. A. Baselmans**, SRON Netherlands Institute for Space  
Research (Netherlands)  
**Christopher E. Groppi**, Arizona State University (United States)  
**Masashi Hazumi**, High Energy Accelerator Research Organization,  
KEK (Japan)  
**Roger C. O'Brient**, Jet Propulsion Laboratory (United States)  
**Karl Schuster**, IRAM-Domaine Universitaire de Grenoble (France)  
**Giovanni Signorelli**, Istituto Nazionale di Fisica Nucleare (Italy)  
**Gordon J. Stacey**, Cornell University (United States)  
**Johannes G. Staguhn**, NASA Goddard Space Flight Center (United  
States) and Johns Hopkins University (United States)  
**Neil A. Trappe**, National University of Ireland, Maynooth (Ireland)  
**Carole E. Tucker**, Cardiff University (United Kingdom)  
**Yoshinori Uzawa**, National Astronomical Observatory of Japan  
(Japan)  
**Martina C. Wiedner**, Observatoire de Paris (France)

