# PROCEEDINGS OF SPIE

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

Jonas Zmuidzinas Jian-Rong Gao Editors

14–22 December 2020 Online Only, United States

Sponsored and Published by SPIE

**Volume 11453** 

Part One of Two Parts

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 *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X*, edited by Jonas Zmuidzinas, Jian-Rong Gao, Proceedings of SPIE Vol. 11453 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510636934

ISBN: 9781510636941 (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 SPIF org

Copyright © 2020, 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 \$21.00 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/20/\$21.00.

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:** 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

## Part One

	CAMERAS AND POLARIMETERS I
11453 02	The ToITEC camera: an overview of the instrument and in-lab testing results [11453-1]
11453 03	Pre-deployment verification and predicted mapping speed of MUSCAT [11453-2]
11453 04	Characterization, deployment, and in-flight performance of the BLAST-TNG cryogenic receiver [11453-3]
	OPTICS I
11453 06	Planar silicon metamaterial lenslet arrays for millimeter-wavelength imaging [11453-6]
11453 07	Design and experimental investigation of a planar metamaterial silicon-based lenslet [11453-7]
	CAMERAS AND POLARIMETERS II
11453 09	MUSCAT focal plane verification [11453-193]
	DETECTOR ARRAYS II
	DETECTOR ARRATS II
11453 OH	Optical design of the Experiment for Cryogenic Large-Aperture Intensity Mapping (EXCLAIM) [11453-184]
11453 OJ	Optical and electrical transient response of ultra-low-noise far-infrared transition edge sensors for the SAFARI instrument on SPICA [11453-19]
	SPECTROMETERS II
11453 OK	Development of a cryogenic far-infrared post-dispersed polarizing Fourier transform spectrometer: a demonstrator for the SPICA SAFARI instrument [11453-20]
11453 OM	μ-spec spectrometers for the EXCLAIM instrument [11453-22]
11453 ON	Large format imaging spectrograph for the Large Submillimeter Telescope (LST) [11453-24]

	COHERENT DETECTION: RECEIVERS
11453 OP	Wideband technology development to increase the RF and instantaneous bandwidth of ALMA receivers [11453-26]
11453 0Q	An SIS-mixer-based amplifier for multi-pixel heterodyne receivers [11453-27]
	COHERENT DETECTION: SYSTEMS
11453 OT	The Tenerife Microwave Spectrometer (TMS) experiment: studying the absolute spectrum of the sky emission in the 10-20GHz range [11453-30]
	READOUT AND MULTIPLEXING
11453 0X	Performance and characterization of the SPT-3G digital frequency multiplexed readout system using an improved noise and crosstalk model [11453-34]
	FUTURE CMB INSTRUMENTS
11453 10	Concept design of low frequency telescope for CMB B-mode polarization satellite LiteBIRD [11453-37]
	CMB INSTRUMENTS I
11453 14	Receiver development for BICEP Array, a next-generation CMB polarimeter at the South Pole [11453-41]
11453 15	The Simons Observatory: the Large Aperture Telescope Receiver (LATR) integration and validation results [11453-183]
11453 16	Broadband polarimeter receivers at 30 and 40 GHz for cosmic microwave background measurement [11453-44]
	CMB INSTRUMENTS II
11453 17	Assembly development for the Simons Observatory focal plane readout module [11453-46]

	OPTICS II
11453 1A	Demonstration of anti-reflective structures over a large area for CMB polarization experiments [11453-49]
	DETECTOR ARRAYS III
11453 1E	Antenna-coupled thermal kinetic inductance detectors for ground-based millimeter-wave cosmology [11453-54]
	POSTER SESSION: DETECTOR ARRAYS I
11453 1F	CCAT-prime: Designs and status of the first light 280 GHz MKID array and mod-cam receiver [11453-58]
11453 1Q	Design and characterization of the MUSCAT detectors [11453-190]
	POSTER SESSION: READOUT AND MULTIPLEXING
11453 1T	On the development of a reconfigurable readout for superconducting arrays [11453-63]
11453 1Z	Readout for kinetic-inductance-detector-based submillimeter radio astronomy [11453-191]
-	POSTER SESSION: DETECTOR ARRAYS II
11453 20	Detector and readout characterization for POLARBEAR-2b [11453-148]
11453 25	Comparing complex impedance and bias step measurements of Simons Observatory transition edge sensors [11453-185]
	POSTER SESSION: CMB INSTRUMENTS
11453 27	Polarization calibration of the BICEP3 CMB polarimeter at the South Pole [11453-149]
11453 28	Detection chain and electronic readout of the QUBIC instrument [11453-155]
11453 29	Data acquisition and management system for the CMB polarization experiment: Simons Array [11453-156]

11453 2A	The design of the Ali CMB Polarization Telescope receiver [11453-159]
11453 2C	Development of an optical detector testbed for the Simons Observatory [11453-166]
11453 2D	Observing low elevation sky and the CMB Cold Spot with BICEP3 at the South Pole [11453-169]
11453 2E	Analysis of Temperature-to-Polarization Leakage in BICEP3 and Keck CMB Data from 2016 to 2018 [11453-171]
11453 2F	Design and pre-flight performance of SPIDER 280 GHz receivers [11453-173]

#### **Part Two**

### POSTER SESSION: CMB INSTRUMENTS (CON'T.) 11453 2G Calibration of QUBIC: The Q and U bolometric interferometer for cosmology [11453-174] 11453 2H Simulation of the cosmic ray effects for the LiteBIRD satellite observing the CMB B-mode **polarization** [11453-186] POSTER SESSION: MM/SUBMM/FAR-IR INSTRUMENTATION 11453 2K Optical design study for the 860 GHz first-light camera module of CCAT-p [11453-64] POSTER SESSION: NEW DEVELOPMENTS 11453 20 On the benefits of the Eastern Pamirs for sub-mm astronomy [11453-59] 11453 2P Millimeter-wave polarization angle calibration using UAV-based sources [11453-65] 11453 2T Simulating the radiation loss of superconducting submillimeter wave filters and transmission lines using Sonnet EM [11453-82] 11453 2V PRIISM: Synthesis imaging tool based on the sparse modeling for radio astronomy [11453-89] 11453 2X Characterization of low-loss hydrogenated amorphous silicon films for superconducting resonators [11453-94] 11453 2Z The new era of Seoul National University Radio Astronomy Observatory (SRAO) [11453-97] 11453 30 Simulations of athermal phonon propagation in a cryogenic semiconducting bolometer [11453-98]

Superconducting lumped element bandpass filter for multi-color submillimeter imaging 11453 33 [11453-192] POSTER SESSION: SPECTROMETERS 11453 34 Upgrading the field-imaging far-infrared line spectrometer for the Stratospheric Observatory for Infrared Astronomy (SOFIA) with KIDs: enabling large sample (extragalactic) surveys [11453-101] 11453 38 Design of a novel cryogenic stiffness-compensated reactionless scan mechanism for the Fourier transform spectrometer of SPICA SAFARI instrument [11453-114] 11453 3A Q-band receiver system design for the Canadian DVA-2 radio telescope [11453-117] TiEMPO: Open-source time-dependent end-to-end model for simulating ground-based 11453 3C submillimeter astronomical observations [11453-123] 11453 3F A millimeter-wave on-chip superconducting filter bank spectrometer for atmospheric science [11453-133] 11453 3J Modelling technique for few-moded far-infrared grating spectrometers [11453-187] POSTER SESSION: COHERENT DETECTION: MM/SUBMM/THZ Upgrade of an ALMA Band 10 prototype receiver for ASTE radio telescope [11453-125] 11453 3Q 11453 3R SIS mixers study on Heterodyne Array Receiver Program (HARP) at JCMT [11453-128] 11453 3S Development of receiver optics for ALMA bands 1 and 2, and possible synergies with ngVLA [11453-132] 11453 3T Commissioning of Nāmakanui on the JCMT [11453-134] 11453 3U CHARM: a room-temperature 345GHz receiver for the Large Millimeter Telescope [11453-138] 11453 3V A distributed Raspberry-Pi control system for wSMA frontend [11453-140] ASTE BAND10 commissioning and science verification [11453-143] 11453 3X 11453 3Y Design of all-in-one 2SB mixer for ALMA band 10 [11453-144] 11453 3Z Development of the new multi-beam receiver and telescope control system for NASCO [11453-146]

#### POSTER SESSION: COHERENT DETECTION: RADIO

11453 40	The potential for a K-band receiver on the Large Millimeter Telescope [11453-103]
11453 43	3D printed pyramidal horn antenna for K band frequency applications [11453-120]
11453 45	Phase-locked oscillator operated in a fiber-coupled repeater station [11453-126]
11453 48	Preliminary design of 18-45 GHz radio astronomy receiver [11453-135]
11453 49	Development of the multi-band simultaneous observation system of the Nobeyama 45-m Telescope in HINOTORI (Hybrid Installation project in NObeyama, Triple-band ORlented) [11453-139]
	POSTER SESSION: OPTICS
11453 4A	The optical design and performance of ToITEC: a millimeter-wave imaging polarimeter [11453-5]
11453 4B	Design of the frequency independent optic axis of the Pancharatnam base achromatic half-wave plate for CMB polarization experiment [11453-147]
11453 4C	Anti-reflection structures for large-aperture cryogenic lenses and vacuum window in 100-GHz band [11453-153]
11453 4E	Breadboard model of the polarization modulator unit based on a continuously rotating half-wave plate for the low-frequency telescope of the LiteBIRD space mission [11453-162]
11453 4F	Development of a wideband waveguide diplexer for simultaneous observation at 210-375 GHz [11453-165]
11453 4H	Optical design of the 1.85-m mm-submm telescope in 210–375 GHz band [11453-172]
11453 4I	Demonstration of five-layer phase-flat achromatic half-wave plate with anti-reflective structures and superconducting magnetic bearing for CMB polarization experiments [11453-175]
11453 4J	Metal mesh IR filter for wSMA [11453-176]
11453 4K	Mechanical strength and millimeter-wave transmission spectrum of stacked sapphire plates bonded by sodium silicate solution [11453-179]
11453 40	Modeling sidelobe response for ground-based mm-wavelength telescopes with the geometrical theory of diffraction [11453-189]