PROCEEDINGS OF SPIE

Ground-based and Airborne Instrumentation for Astronomy VIII

Christopher J. Evans Julia J. Bryant Kentaro Motohara Editors

14–22 December 2020 Online Only, United States

Sponsored and Published by SPIE

Volume 11447

Part One of Three Parts

Proceedings of SPIE 0277-786X, V. 11447

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

Ground-based and Airborne Instrumentation for Astronomy VIII, edited by Christopher J. Evans, Julia J. Bryant, Kentaro Motohara, Proc. of SPIE Vol. 11447, 1144701 · © 2020 SPIE · CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2591716

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 *Ground-based and Airborne Instrumentation for Astronomy VIII*, edited by Christopher J. Evans, Julia J. Bryant, Kentaro Motohara, Proceedings of SPIE Vol. 11447 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510636811

ISBN: 9781510636828 (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.ora

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

	MAJOR OBSERVATORIES I
11447 02	Instrumentation at the Subaru Selescope [11447-1]
11447 06	Current status of the facility instruments at the Large Binocular Telescope Observatory [11447-5]
	MAJOR OBSERVATORIES II
11447 09	Development status of the SOXS spectrograph for the ESO-NTT telescope [11447-8]
11447 OA	Status update of LLAMAS: a wide field-of-view visible passband IFU for the 6.5m Magellan telescopes [11447-9]
	MULTI-MESSENGER INSTRUMENTATION
11447 OH	Calibration and performance of the readout system based on switched capacitor arrays for the Large-Sized Telescope of the Cherenkov Telescope Array [11447-16]
11447 OJ	MeerTRAP in the era of multi-messenger astrophysics [11447-18]
	NOVEL IMAGERS
11447 OL	Rubin commissioning camera: integration, functional testing, and lab performance [11447-20]
11447 ON	ULTIMATE-Subaru: conceptual design of WFI, a near-infrared wide field imager [11447-22]
11447 00	Towards ASTEP+, a two-color photometric telescope at Dome C, Antarctica [11447-23]
11447 OP	Understanding the Universe for less money: TANGO first robotic ground observatories under extreme conditions [11447-413]

MAJOR OBSERVATORIES IV 11447 OT The Planet as Exoplanet Analog Spectrograph (PEAS): design and first-light [11447-153] **SOLAR INSTRUMETATION** 11447 OY Sunrise Chromospheric Infrared SpectroPolarimeter (SCIP) for sunrise III: system design and **capability** [11447-159] 11447 OZ IBIS2.0: The new Interferometric Bldimensional Spectrometer [11447-400] MOS I 11447 10 Installation of the Dark Energy Spectroscopic Instrument at the Mayall 4-meter telescope [11447-160] 11447 11 Performance of the Dark Energy Spectroscopic Instrument (DESI) fiber system [11447-161] 11447 14 Integration and early testing of WEAVE: the next-generation spectroscopy facility for the William Herschel Telescope [11447-164] MOS II 11447 15 Hector: a new multi-object integral field spectrograph instrument for the Anglo-Australian **Telescope** [11447-234] VIRUS2: a next generation replicated integral field spectrograph with wide field and broad 11447 16 wavelength coverage [11447-235] 11447 17 Crescent MOONS: an update on the ongoing construction of the new VLT's multi-object **spectrograph** [11447-236] 11447 18 SDSS-V local volume mapper instrument: overview and status [11447-237] MOS III 11447 1A Gemini Infrared Multi-Object Spectrograph: preliminary design overview [11447-239] 11447 1B Gemini IRMOS: preliminary optical design of a multi-object adaptive optics-fed infrared integral-field spectrograph [11447-240] 11447 1D The Keck-FOBOS spectroscopic facility: conceptual design [11447-242]

11447 1E	The Magellan Infrared Multiobject Spectrograph project [11447-243]
	HIGH-RESOLUTION SPECTROGRAPHS I
11447 lF	On-sky commissioning of MAROON-X: a new precision radial velocity spectrograph for Gemini North [11447-244]
	HIGH-RESOLUTION SPECTROGRAPHS II
11447 1L	A microresonator-based etalon for visible light precision radial velocity measurements [11447-327]
11447 IN	Characterization of a multi-etalon array for ultra-high resolution spectroscopy [11447-328]
	HIGH SPATIAL RESOLUTION INSTRUMENTS
11447 1P	The Keck Planet Imager and Characterizer: a dedicated single-mode fiber injection unit for high resolution exoplanet spectroscopy [11447-330]
11447 1R	MAVIS conceptual design [11447-332]
11447 18	GPI 2.0: upgrading the Gemini Planet Imager [11447-333]
	ELT INSTRUMENTATION I
11447 1U	A status report on the instruments for ESO's Extremely Large Telescope [11447-335]
11447 1W	HARMONI: first light spectroscopy for the ELT: instrument final design and quantitative performance predictions [11447-337]
11447 IY	The Infrared Imaging Spectrograph (IRIS) for TMT: instrument overview [11447-339]
	ELT INSTRUMENTATION II
11447 1Z	Performance and limitations of using ELT and MCAO for 50 µas astrometry [11447-387]

ELT INSTRUMENTATION III

	ELT INSTRUMENTATION III
11447 25	MOSAIC: the high multiplex and multi-IFU spectrograph for the ELT [11447-393]
11447 26	ELT-HIRES, the high resolution spectrograph for the ELT: the Phase A study and the path to construction [11447-394]
11447 28	The MANIFEST pre-concept design [11447-396]
	POSTER SESSION: ELT INSTRUMENTATION
11447 2D	The MICADO first light imager for the ELT: relay optics opto-mechanical design [11447-340]
11447 2H	HARMONI: first light spectroscopy for the ELT: final design and assembly plan of the spectrographs [11447-343]
11447 2J	Conceptual design of the Giant Magellan Telescope Commissioning Camera [11447-346]
11447 2L	HARMONI: first light spectroscopy for the ELT: novel techniques for the calibration of non-common path aberrations [11447-349]
11447 2N	HARMONI: first light spectroscopy for the ELT: simulating the alignment of a three-mirror anastigmat [11447-352]
11447 20	The design of the cryostat for ELT/METIS [11447-353]
11447 2Q	Optical interface study of MANIFEST to GMACS and GCLEF instruments [11447-357]
11447 2R	The warm calibration unit of METIS: laboratory tests and proof-of-concept [11447-358]
11447 2T	Warm calibration unit of the mid-infrared E-ELT instrument METIS: overview and current status of the project [11447-361]
11447 2U	An N-band test bench for the METIS coronagraphic masks [11447-362]
11447 2W	A mass optimized support and access structure for ESO's Mid-infrared E-ELT Imager and Spectrograph (METIS) [11447-359]
11447 2Z	The InfraRed Imaging Spectrograph (IRIS) for TMT: photometric characterization of anisoplanatic PSFs and testing of PSF-Reconstruction via AIROPA [11447-373]
11447 32	HARMONI science path optics: predicting and analysing the expected as-built performance with and end-to-end optical model [11447-370]
11447 34	Preliminary design and performance verification of the MICADO Standalone Relay Optics [11447-401]

11447.05	MACRY Instrument Control Hamburgus and according [11,447,274]
11447 35	MAORY Instrument Control Hardware: general overview [11447-374]
11447 37	The Michigan infrared test thermal ELT N-band (MITTEN) cryostat [11447-379]
11447 39	CO ₂ -based refrigeration system for the NFIRAOS optics enclosure [11447-381]
	POSTER SESSION: HIGH-RESOLUTION SPECTROGRAPHS
11447 3C	The CARMENES M-dwarf planet survey [11447-262]
11447 3D	Characteristics and performances of an interferometric Doppler imager installed at the 188 cm telescope of Okayama Observatory [11447-249]
11447 3G	ESPRESSO Fiber-Link upgrade. I: Project overview and performances [11447-267]
11447 3H	Environmental stability achieved for the Manfred Hirth Planet Spectrograph [11447-257]
11447 3K	MARVEL, a four-telescope array for high-precision radial-velocity monitoring [11447-41]
Part Two	
11447 30	A high-resolution echelle spectrograph for precision Doppler observations with small telescopes [11447-316]
11447 3Q	Fiber-coupling of Fourier transform spectrographs [11447-274]
11447 3R	Gemini High-Resolution Optical SpecTrograph (GHOST) outer enclosure design and construction [11447-275]
11447 3W	NIRPS: integration and validation of thermal performance of the cryogenic near infra-red spectrograph subsystem [11447-309]
11447 40	Ghosts of NEID's past [11447-276]
11447 41	The NEID port adapter at WIYN: tip-tilt control and vibration analysis [11447-277]
11447 42	Keck Planet Finder: design updates [11447-278]
11447 43	Integration of the Gemini High-Resolution Optical SpecTrograph (GHOST) bench spectrograph [11447-286]
11447 44	Stationary Fourier transform spectrometry [11447-250]
11447 46	Towards precision radial velocity science with SALT's High-Resolution Spectrograph [11447-287]

11447	Bifrost: an ultra-low-cost cross-dispersed optical echelle spectrograph [11447-404]
11447	Using a passively stabilized Fabry-Perot etalon for determining instrumental artifacts in a spectrograph [11447-288]
11447	IRANTI: a compact flexible configuration infrared échelle spectrograph integrating emerging technologies for precise radial velocity measurements [11447-261]
11447	Verification observations of the Manfred Hirt Planet Spectrograph [11447-299]
11447	The NEID spectrometer: fibre injection system design [11447-318]
	POSTER SESSION: HIGH-SPATIAL RESOLUTION INSTRUMENTS
11447	The optical alignment of the coronagraphic masks of SHARK-NIR: paving the way for exoplanets detection and characterization [11447-264]
11447	Combination of apodized pupil and phase mask coronagraph for SCExAO at Subaru Telescope [11447-254]
11447	Enhanced high-dispersion coronagraphy with KPIC phase II: design, assembly and status of sub-modules [11447-313]
11447	Liger for next-generation Keck AO: filter wheel and pupil design [11447-280]
11447	4Z End-to-end simulation of the SCALES integral field spectrograph [11447-294]
11447	SHARK-NIR: challenges and solutions of a high contrast imager alignment [11447-296]
11447	The segmented pupil experiment for exoplanet detection. 4. A versatile image-based wavefront sensor for active optics [11447-297]
11447	Laboratory demonstration of focal plane wavefront sensing using phase diversity: a way to tackle the problem of NCPA in SHARK-NIR [11447-301]
11447	An atmospheric dispersion corrector design with milliarcsecond-level precision from 1 to 4 microns for high dispersion coronagraphy [11447-302]
11447	Optical design of a broadband atmospheric dispersion corrector for MAVIS [11447-263]
11447	The MAVIS Image Simulator: predicting the astrometric performance of MAVIS [11447-265]
11447	Liger for next-generation Keck adaptive optics: opto-mechanical dewar for imaging camera and slicer [11447-311]
11447	DiskFM: A forward modeling tool for disk analysis with coronagraphic instruments [11447-251]

11447 5A	Gemini Planet Imager observational calibrations XV: instrument calibrations after six years on sky [11447-258]
11447 5B	Calibration of the instrumental polarization effects of SCExAO-CHARIS' spectropolarimetric mode [11447-402]
11447 5D	GPI 2.0: Upgrades to the IFS including new spectral modes [11447-410]
	POSTER SESSION: MAJOR OBSERVATORIES
11447 5E	WALOP-South: A wide-field one-shot linear optical polarimeter for PASIPHAE survey [11447-24]
11447 5F	SOXS: effects on optical performances due to gravity flexures, temperature variations, and subsystems alignment $[11447\text{-}70]$
11447 5H	The University of Tokyo Atacama Observatory 6.5m telescope: On-sky performance of the near-infrared instrument SWIMS on the Subaru telescope [11447-33]
11447 51	Conceptual design of a high-resolution ultra-stable spectrograph for GTC [11447-74]
11447 5J	Cerberus: A three-headed instrument for the OARPAF telescope [11447-88]
11447 5K	MuSCAT3: a 4-color simultaneous camera for the 2m Faulkes Telescope North [11447-29]
11447 5L	Progress on the UV-VIS arm of SOXS [11447-36]
11447 5M	Curved detector-based optical design for the VLT/BlueMUSE instrument [11447-77]
11447 5N	The development status of the NIR Arm of the new SoXS instrument at the ESO/NTT telescope [11447-90]
11447 50	The current status of the imaging and spectrograph (IMSP) for 4m telescope [11447-30]
11447 5P	Gemini infrared multi-object spectrograph: calibration system [11447-78]
11447 5R	Final design and performance of the Fully Automatic Spectrograph for Transient (FAST) [11447-106]
11447 5T	Performances of an integral field unit for FOCAS on the Subaru telescope [11447-35]
11447 5U	Further development and testing of TCal: a mobile spectrophotometric calibration unit for astronomical imaging systems [11447-108]
11447 5V	Final design and development status of the acquisition and guiding system for SOXS [11447-80]
11447 5W	A simple concept for atmospheric dispersion correctors on-sky commissioning tests [11447-102]

11447 5X	The University of Tokyo Atacama Observatory 6.5m telescope: On-sky performance evaluations of the mid-infrared instrument MIMIZUKU on the Subaru telescope [11447-38]
11447 5Z	Multi-wavelength SimultaneouS High throughput Imager and polarimeter (MuSaSHI): development and its performance [11447-42]
11447 60	Stellar astrophysics in the near-UV with VLT-CUBES [11447-104]
11447 63	Multifocal station for the Wendelstein 2m Fraunhofer Telescope [11447-43]
11447 64	Update on the preliminary design of SCALES: the Santa Cruz Array of Lenslets for Exoplanet Spectroscopy [11447-110]
11447 65	Optical aspects of Near-Infrared Imager Spectrometer and Polarimeter instrument (NISP) [11447-46]
11447 66	Design and development of the SOXS calibration unit [11447-45]
11447 67	Design requirements for the Wide-field Infrared Transient Explorer (WINTER) [11447-113]
11447 68	A dual-beam spectrograph design for transient follow-up with SALT [11447-47]
11447 69	Development of the ROSIE integral field unit on the Magellan IMACS spectrograph [11447-116]
11447 6A	Flexure updates to MOSFIRE on the Keck I telescope [11447-114]
11447 6C	Development status of the UV-VIS detector system of SOXS for the ESO-NTT telescope [11447-52]
11447 6E	Stray light analysis and reduction for IFU spectrograph LLAMAS [11447-118]
11447 6H	Ground support facilities of the WSO-UV space mission [11447-119]
11447 61	The University of Tokyo Atacama Observatory 6.5m telescope: update of the Near-Infrared Echelle Spectrograph NICE as a first light instrument [11447-54]
11447 6K	On-sky examination of optical diffusers installed in MuSCAT [11447-58]
11447 6L	TSPEC4: near-IR spectroscopy for the SOAR telescope [11447-120]
11447 6N	New technologies for the Tenerife Microwave Spectrometer and current status [11447-63]
11447 6P	The AIV strategy of the common path of Son Of X-Shooter [11447-60]
11447 6Q	Preliminary mechanical design of the Gemini Infrared Multi-Object Spectrograph (GIRMOS) Cryostat [11447-123]

11447 6R A novel method for on-sky measurements of atmospheric dispersion [11447-64]

Part Three

11447 6U	Mechanical aspects of near infrared imager spectrometer and polarimeter [11447-62]
11447 6Z	GATOS: A fast multi-channel imager and spectrograph for the Gran Telescopio Canarias
11447 71	SCALA upgrade: development of a light source for sub-percent calibration uncertainties [11447-72]
11447 74	SCORPIO: Final design and performance estimates for time-domain astronomy [11447-144]
11447 76	Conceptual design of the BRONCO spectrograph [11447-86]
11447 78	Electronics design and development of near-infrared imager, spectrometer, and polarimeter [11447-89]
11447 7A	FORS-Up: Making the most versatile instrument in Paranal ready for 15 more years of operations [11447-97]
11447 7C	Operational modes and efficiency of SOXS [11447-99]
11447 7D	The Exoplanet Transmission Spectroscopy Imager (ETSI) [11447-100]
11447 7E	Ongoing and future instrument upgrades at Gemini [11447-101]
11447 7F	Developing Modular Adaptive Transition Edge Sensor SQUID Electronics (MATESSE) [11447-141]
11447 7G	Panoramic SETI: overall focal plane electronics and timing and network protocols [11447-149]
	POSTER SESSION: MULTI-OBJECT SPECTROGRAPHS
11447 7R	Final assembly, metrology, and testing of the WEAVE fibre positioner [11447-165]
11447 7V	Prime Focus Spectrograph (PFS): the prime focus instrument [11447-175]
11447 7W	MOONS-ESO spectrograph: status of the cryogenic opto-mechanical system for movable optics [11447-168]
11447 7Y	Starbugs field-allocation simulations for FOBOS [11447-169]

11447 81	A robotic Focal Plane System (FPS) for the Sloan Digital Sky Survey V [11447-173]
11447 83	DMD based flat field calibration system for MOONS [11447-185]
11447 84	Prime Focus Spectrograph (PFS): the metrology camera system [11447-174]
11447 85	The DESI sky continuum monitor system [11447-187]
11447 86	Testing the 10 spectrograph units for DESI: approach and results [11447-179]
11447 87	4MOST low resolution spectrograph MAIT [11447-188]
11447 8B	Mauna Kea Spectrographic Explorer (MSE): new preliminary design for the multi-object high resolution spectrograph [11447-191]
11447 8D	MOONS, the next ESO VLT's multi-object spectrograph: the field corrector and the rotating front end [11447-184]
11447 8G	The Hector Instrument: performance of the Hector fibre integral field units [11447-189]
11447 8K	Performance of the Dark Energy Spectroscopic Instrument (DESI) focal plane [11447-193]
11447 8N	The SDSS-V local volume mapper fiber cable system [11447-204]
11447 80	SDSS-V focal plane robot positioning metrology [11447-215]
11447 8P	Test results of the SDSS-V fiber micro-positioners [11447-217]
11447 8Q	The 4MOST secondary guider imaging system [11447-210]
11447 8T	Testing fiber tapers for use in the SDSS-V focal plane system [11447-206]
11447 8U	The Hector Instrument: optical design of the new higher-resolution spectrograph [11447-219]
11447 8W	Mechanical design of the VIRUS2 instrument [11447-221]
11447 8Y	The prototype telescope and spectrograph system for the AMASE project [11447-225]
11447 8Z	VIRUS2: Interfaces to the 2.7 m Harlan J Smith Telescope [11447-226]
11447 90	Design of a theta/phi fiber positioner robot for the Sloan Digital Sky Survey V [11447-227]
1144701	Panding losses in multi-made fibers with law numerical aparture [11447-220]

11447 94	Performance of Kitt Peak's Mayall 4-meter telescope during DESI commissioning [11447-399]
11447 95	Maunakea Spectroscopic Explorer Low Moderate Resolution Spectrograph: paths toward the Preliminary Design Phase [11447-407]
	POSTER SESSION: NOVEL IMAGERS
11447 96	Microbolometer arrays for ground-based infrared imaging [11447-27]
11447 98	Detection and calculation of meteor trajectories by MOFID All Sky cameras network [11447-105]
11447 9A	Fabrication and characterization of filters for the Large Synoptic Survey Telescope [11447-39]
11447 9B	The PICTURE-C MKID camera [11447-79]
11447 9E	EMPOL: an EMCCD based optical imaging polarimeter [11447-44]
11447 9F	Opto-mechanical design of the Wide-Field Infrared Transient Explorer (WINTER) fly's eye camera [11447-115]
11447 91	Performance of the BSTI instrument on the NUTTelA-TAO telescope for high time-resolution, simultaneous three-channel imaging of prompt gamma-ray burst optical emission [11447-50]
11447 9K	The wide-field infrared transient explorer (WINTER) [11447-55]
11447 9M	Development of flat fielding method in MIR for accurate photometry with TAO/MIMIZUKU [11447-59]
11447 9U	(KFISP) Kottamia Faint Imaging Spectro-Polarimeter: opto-mechanical design and performance analysis [11447-75]
11447 9W	(KFISP) Kottamia Faint Imaging Spectro-Polarimeter: software, motion control, performance and results [11447-76]
11447 9Y	A coronagraph using a digital micromirror device as an adaptive occultation mask: design and observational result [11447-284]
11447 9Z	Using the OWL@OUKA telescope to follow-up the TESS planet candidates: first results [11447-93]
11447 A0	MAVIS: science case, imager, and spectrograph [11447-285]
11447 A1	New narrow-band filter system for the IRSF 1.4m telescope [11447-405]
11447 A2	A heterogeneous telescope array optimized for low surface-brightness imaging [11447-409]

POSTER SESSION: SOLAR

Sunrise Chromospheric Infrared spectroPolarimeter (SCIP) for SUNRISE III: polarization modulation unit [11447-166]
Development of new tunable filter for solar observation in Hida observatory [11447-176]
Observing the integrated and spatially resolved Sun with ultra-high spectral resolution [11447-156]
Sunrise Chromospheric Infrared spectroPolarimeter (SCIP) for SUNRISE III: opto-mechanical analysis and design [11447-195]
Design of an integral field unit for a solar telescope [11447-203]
CYRA: the cryogenic infrared spectrograph for the Goode Solar Telescope in Big Bear [11447-213]
Sunrise Chromospheric Infrared spectroPolarimeter (SCIP) for SUNRISE III: optical design and performance [11447-205]
The SUNRISE UV Spectropolarimeter and imager for SUNRISE III [11447-220]
Polarimeter for the HELLRIDE instrument at Vacuum Tower Telescope [11447-231]