Front Matter: Volume 8150
The papers included 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. The papers published in these proceedings 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 this book:


ISSN 0277-786X
ISBN 9780819487605

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 © 2011, 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/11/$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

SPIEDigitalLibrary.org

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.
Contents

vii Conference Committee

ix Introduction

xi The little photometer that could: technical challenges and science results from the Kepler Mission (Plenary Paper) [8146 100]
J. M. Jenkins, NASA Ames Research Ctr. (United States); J. Dunnuck, Ball Aerospace & Technologies Corp. (United States)

xxiii Large Binocular Telescope Adaptive Optics System: new achievements and perspectives in adaptive optics (Plenary Paper) [8149 100]
S. Esposito, A. Riccardi, E. Pinna, A. Puglisi, F. Quirós-Pacheco, C. Arcidiacono, M. Xompero, R. Briguglio, G. Agapito, L. Busoni, L. Fini, J. Argomedo, A. Gherardi, INAF - Osservatorio Astrofisico di Arcetri (Italy); G. Brusa, D. Miller, J. C. Guerra, Large Binocular Telescope Observatory, The Univ. of Arizona (United States); P. Stefanini, P. Salinari, INAF - Osservatorio Astrofisico di Arcetri (Italy)

SESSION 1 CRYOGENIC TECHNOLOGIES

8150 02 Hemispherical reflectance and emittance properties of carbon nanotubes coatings at infrared wavelengths [8150-01]
M. A. Quijada, J. G. Hagopian, S. Getty, R. E. Kinzer, Jr., E. J. Wollack, NASA Goddard Space Flight Ctr. (United States)

8150 03 A novel approach to tribological measurements at harsh conditions [8150-02]
E. R. Weltevreden, E. van der Heide, TNO (Netherlands)

8150 04 A cryogenic half-wave plate polarimeter using a superconducting magnetic bearing [8150-03]
J. Klein, A. Aboobaker, Univ. of Minnesota (United States); P. Ade, Cardiff Univ. (United Kingdom); F. Aubin, McGill Univ. (Canada); C. Baccigalupi, Scuola Internazionale Superiore di Studi Avanzati (Italy); C. Bao, Univ. of Minnesota (United States); J. Borill, Lawrence Berkeley National Lab. (United States); D. Chapman, J. Didier, Columbia Univ. (United States); M. Dobbs, McGill Univ. (Canada); B. Gold, Univ. of Minnesota (United States); W. Grainger, Cardiff Univ. (United Kingdom); S. Hanany, Univ. of Minnesota (United States); J. Hubmayr, National Institute of Standards and Technology (United States); S. Hillbrand, Columbia Univ. (United States); J. Grain, Institut d’Astrophysique Spatiale, Univ. Paris-Sud (France); A. Jaffe, Imperial College London (United Kingdom); B. Johnson, Columbia Univ. (United States); T. Jones, Univ. of Minnesota (United States); T. Kiser, Lawrence Berkeley National Lab. (United States); A. Korotkov, Brown Univ. (United States); S. Leach, Scuola Internazionale Superiore di Studi Avanzati (Italy); A. Lee, Lawrence Berkeley National Lab. (United States); L. Levinson, Weizmann Institute of Science (Israel); M. Limon, Columbia Univ. (United States); K. MacDermid, McGill Univ. (Canada); T. Matsumura, High Energy Accelerator Research Organization, KEK (Japan); A. Miller, Columbia Univ. (United States);
A flux-pinning mechanism for segment assembly and alignment [8150-04]
J. A. Gersh-Range, Cornell Univ. (United States); W. R. Arnold, Jacobs ESTS Group (United States); M. A. Peck, Cornell Univ. (United States); H. P. Stahl, NASA Marshall Space Flight Ctr. (United States)

Space and airborne sensor testing in a cryogenic test environment at Arnold Engineering Development Center [8150-05]
H. Lowry, R. Nicholson, S. Steely, M. Fedde, J. Labello, K. Bynum, A. Wojcik, Aerospace Testing Alliance, Arnold Engineering Development Ctr. (United States); J. Claybrook, Arnold Engineering Development Ctr. (United States)

SESSION 2 JWST - TELESCOPE AND INSTRUMENTS' TECHNOLOGIES

James Webb Space Telescope system cryogenic optical test plans [8150-06]
L. D. Feinberg, NASA Goddard Space Flight Ctr. (United States); A. Barto, Ball Aerospace & Technologies Corp. (United States); M. Waldman, Sigma Space Corp. (United States); T. Whitman, ITT Corp. Geospatial Systems (United States)

Cryogenic performance of the JWST primary mirror segment engineering development unit [8150-07]
D. M. Chaney, Ball Aerospace & Technologies Corp. (United States); J. B. Hadaway, The Univ. of Alabama in Huntsville (United States); J. Lewis, B. Gallagher, B. Brown, Ball Aerospace & Technologies Corp. (United States)

Cryogenic thermal distortion performance characterization for the JWST ISIM structure [8150-08]
J. Johnston, NASA Goddard Space Flight Ctr. (United States); E. Cofie, SGT, Inc (United States); J. Hylan, R. Ohl, M. Nowak, D. McGuffey, J. Pontius, E. Johnson, NASA Goddard Space Flight Ctr. (United States)

Cryogenic thermal distortion model validation for the JWST ISIM structure [8150-09]
J. Johnston, NASA Goddard Space Flight Ctr. (United States); E. Cofie, SGT, Inc. (United States)
SESSION 3  JWST - INSTRUMENTS' TECHNOlogIES - NIRSPEC

8150 0B  Wavelength calibration of the JWST near-infrared spectrograph (NIRSpec) [8150-11]
S. M. Birkmann, T. Böker, P. Ferruit, G. Giardino, P. Jakobsen, G. De Marchi, M. Sirianni, M. B. J. te Plate, J.-C. Savignol, European Space Agency, ESTEC (Netherlands); X. Gnata, T. Wettemann, EADS Astrium GmbH (Germany); B. Dorner, Observatoire de Lyon (France) and Univ. de Lyon (France) and Ctr. de Recherche Astrophysique de Lyon, CNRS (France); G. Cresci, INAF - Osservatorio Astrofisico di Arcetri (Italy); F. Rosales-Ortega, CSIC - INTA (Spain); M. Stuhlinger, European Space Astronomy Ctr. (Spain); R. Cole, J. Tandy, C. Brockley-Blatt, Univ. College London (United Kingdom)

8150 0C  Calibrating the position of images and spectra in the NIRSpec instrument for the James Webb Space Telescope [8150-12]
G. De Marchi, M. B. J. te Plate, S. M. Birkmann, T. Böker, P. Ferruit, G. Giardino, P. Jakobsen, M. Sirianni, J.-C. Savignol, European Space Agency, ESTEC (Netherlands); X. Gnata, R. Bartho, M. Kosse, P. Mosner, EADS Astrium GmbH (Germany); B. Dorner, Observatoire de Lyon (France) and Ctr. de Recherche Astrophysique de Lyon, CNRS (France); G. Cresci, INAF - Osservatorio Astrofisico di Arcetri (Italy); F. Rosales-Ortega, CSIC - INTA (Spain); M. Stuhlinger, European Space Astronomy Ctr. (Spain); T. Gross, T. Leikert, Carl Zeiss Optronics GmbH (Germany)

SESSION 4  JWST - INSTRUMENT TECHNOLOGIES - NIRCAM I

8150 0D  JWST NIRCam flight mirror assemblies [8150-13]

8150 0E  NIRCam coronagraphic Lyot stop: design, fabrication, and testing [8150-14]
Y. Mao, T. B. Andersen, T. Kubo, M. Virgen, H. Chan, G. Feller, L. W. Huff, E. Smith, G. Vasudevan, S. Somerset, T. Jamieson, Lockheed Martin Space Systems Co. (United States); S. Horner, NASA Ames Research Ctr. (United States); J. Krist, C. A. Beichman, Jet Propulsion Lab. (United States); C. Barone, R. Schmidt, D. Levin, S. Seymour, Max Levy Autograph, Inc. (United States); D. Kelly, M. J. Rieke, Steward Observatory, The Univ. of Arizona (United States)

8150 0F  Flight build of the collimator and shortwave camera optics on NIRCam [8150-15]
E. T. Kvamme, M. Jacoby, T. Hix, Lockheed Martin Advanced Technology Ctr. (United States)

8150 0G  Design, build, and test of the NIRCam focal plane array housing [8150-16]
D. Little, M. Jacoby, E. Casco, Lockheed Martin Advanced Technology Ctr. (United States)

SESSION 5  JWST - INSTRUMENT TECHNOLOGIES - NIRCAM II

8150 0H  Tracking the surface figure error of the pick off mirror throughout build and environmental testing of the focus and alignment mechanism qualification unit of the near-infrared camera of JWST [8150-17]
Qualifying the flight design of the focus and alignment mechanism of the near-infrared camera on the James Webb Space Telescope [8150-18]
B. Witherspoon, Lockheed Martin Space Systems Co. (United States)

Redesign and test of cryogenic mechanism for improved stiffness [8150-19]
C. S. Clark, M. S. Jacoby, Lockheed Martin Space Systems Co. (United States)

Fret wear mediation of NIRCam filter wheel assembly [8150-20]
B. I. Privári, Lockheed Martin Space Systems Co. (United States)

Lessons learned during the development of components for NIRCam [8150-22]
A. Nordt, C. S. Clark, Lockheed Martin Advanced Technology Ctr. (United States)

POSTER SESSION

Testing and calibration of phase plates for JWST optical simulator [8150-23]
Q. Gong, NASA Goddard Space Flight Ctr. (United States); J. Chu, Orbital Sciences Corp. (United States); S. Tournois, SGT, Inc. (United States); W. Eichhorn, D. Kubalak, NASA Goddard Space Flight Ctr. (United States)

A Panchromatic Imaging Fourier Transform Spectrometer for the NASA Geostationary Coastal and Air Pollution Events Mission [8150-25]
Y.-H. Wu, R. Key, S. Sander, J.-F. Blavier, D. Rider, Jet Propulsion Lab. (United States)
Conference Committee

Program Track Chair

Oswald H. Siegmund, University of California, Berkeley (United States)

Conference Chairs

James B. Heaney, Stinger Ghaffarian Technologies, Inc. (United States)
E. Todd Kvamme, Lockheed Martin Space Systems Company (United States)

Program Committee

David M. Chaney, Ball Aerospace & Technologies Corporation (United States)
Steven A. Macenka, Jet Propulsion Laboratory (United States)
Raymond G. Ohl IV, NASA Goddard Space Flight Center (United States)
Leigh Ann Ryder, Lockheed Martin Space Systems Company (United States)
Theodore D. Swanson, NASA Goddard Space Flight Center (United States)

Session Chairs

1 Cryogenic Technologies
Theodore D. Swanson, NASA Goddard Space Flight Center (United States)

2 JWST - Telescope and Instruments' Technologies
James B. Heaney, Stinger Ghaffarian Technologies, Inc. (United States)

3 JWST - Instruments' Technologies - NIRSpec
Steven A. Macenka, Jet Propulsion Laboratory (United States)

4 JWST - Instrument Technologies - NIRCam I
David M. Chaney, Ball Aerospace & Technologies Corporation (United States)

5 JWST - Instrument Technologies - NIRCam II
E. Todd Kvamme, Lockheed Martin Space Systems Company (United States)
Introduction

This volume contains the Proceedings of our 14th Cryogenic Optical Systems and Instrumentation Conference that was held in San Diego, 21-25 August 2011. Previous books in this series include SPIE volumes 509 (1984), 619 (1986), 973 (1988), 1340 (1990), 1765 (1992), 2227 (1994), 2814 (1996), 3435 (1998), 4131 (2000), 4822 (2002), 5172 (2003), 5904 (2005), 6692 (2007), and 7439 (2009). Taken together with this most recent volume (8150), these yellow-covered Proceedings are a veritable library documenting more than a quarter century of technological advances related to the design, development, testing, and performance of optical components and instruments and the mechanisms and techniques used to cool and maintain them at cryogenic temperatures. The international community is well represented in their contents.

From the beginning, the needs of the aerospace community have had a formative influence on the evolution of this technology. Space satellite missions such as UARS, COBE, SIRTF (Spitzer), Cassini, WMAP, the evolving JWST and many others have contained instrumentation that was required to operate in some cases at temperatures near absolute zero. Their design, testing and performance evaluation challenged their cryogenic engineering and forced an advancement of the state-of-the-art. In our most recent conferences dating back to 2005, NASA’s JWST Mission, with its joint NASA/ESA instrumentation suite, has contributed significantly to the contents of volumes 5904, 6692, 7439 and this current volume. A statement of the challenges confronted and the clever engineering remedies applied can be found in the papers contained in their Proceedings. In our age when digital publishing and record archiving have forced institutions of all types to re-evaluate their methods of capturing institutional knowledge, we are privileged with these Proceedings to be part of the SPIE’s digital library that can make the fruit of our labor permanently and readily available to all.

James B. Heaney
E. Todd Kvamme