

PROCEEDINGS OF SPIE

High Energy, Optical, and Infrared Detectors for Astronomy V

Andrew D. Holland
James W. Beletic
Editors

1–4 July 2012
Amsterdam, Netherlands

Sponsored by
SPIE

Cooperating Organisations

American Astronomical Society (United States) • Netherlands Institute for Radio Astronomy (ASTRON) (Netherlands) • Ball Aerospace & Technologies Corporation (United States)
Canadian Astronomical Society (CASSCA) (Canada) • European Astronomical Society (Switzerland) • European Southern Observatory (Germany) • International Astronomical Union • Korea Astronomy and Space Science Institute (KASI) (Republic of Korea) • National Radio Astronomy Observatory • POPSud (France) • TNO (Netherlands)

Published by
SPIE

Part One of Two Parts

Volume 8453

Proceedings of SPIE 0277-786X, V.8453

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

High Energy, Optical, and Infrared Detectors for Astronomy V, edited by Andrew D. Holland, James W. Beletic,
Proc. of SPIE Vol. 8453, 845301 · © 2012 SPIE · CCC code: 0277-786X/12/\$18 · doi: 10.1117/12.2008635

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:

Author(s), "Title of Paper," in *High Energy, Optical, and Infrared Detectors for Astronomy V*, edited by Andrew D. Holland, James W. Beletic, Proceedings of SPIE Vol. 8453 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819491541

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 © 2012, 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/12/\$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

xv	Conference Committee
xix	<i>The cosmic microwave background: observing directly the early universe (Plenary Paper) [8442-506]</i> P. de Bernardis, Silvia Masi, Univ. degli Studi di Roma La Sapienza (Italy)

Part 1

CCDS I

8453 01	Photon counting EMCCDs: new opportunities for high time resolution astrophysics (Invited Paper) [8453-1] C. Mackay, K. Weller, F. Suess, Univ. of Cambridge (United Kingdom)
8453 02	Characterization results of EMCCDs for extreme low-light imaging [8453-2] O. Daigle, Nüvü Cameras Inc. (Canada); O. Djazovski, D. Laurin, Canadian Space Agency (Canada); R. Doyon, É. Artigau, Univ. de Montréal (Canada)
8453 03	Charge-coupled devices for the ESA Euclid M-class Mission [8453-3] J. Endicott, S. Darby, S. Bowring, D. Burt, T. Eaton, A. Grey, I. Swindells, R. Wheeler, e2v technologies (UK) Ltd. (United Kingdom); L. Duvet, European Space Agency (Netherlands); M. Cropper, D. Walton, Mullard Space Science Lab. (United Kingdom); A. Holland, N. Murray, J. Gow, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom)
8453 04	CCD research and development at Lawrence Berkeley National Laboratory [8453-4] C. J. Bebek, Lawrence Berkeley National Lab. (United States); R. A. Coles, Wayne State Univ. (United States); P. Denes, Lawrence Berkeley National Lab. (United States); F. Dion, Teledyne DALSA Semiconductor (Canada); J. H. Emes, Lawrence Berkeley National Lab. (United States); R. Frost, Teledyne DALSA Semiconductor (Canada); D. E. Groom, Lawrence Berkeley National Lab. (United States); R. Groulx, Teledyne DALSA Semiconductor (Canada); S. Haque, S. E. Holland, A. Karcher, W. F. Kolbe, J. S. Lee, N. P. Palaio, N. A. Roe, C. H. Tran, G. Wang, Lawrence Berkeley National Lab. (United States)

UV DETECTION I

8453 07	Far ultraviolet sensitivity of silicon CMOS sensors [8453-7] M. W. Davis, T. K. Greathouse, K. D. Retherford, G. S. Winters, Southwest Research Institute (United States); Y. Bai, J. W. Beletic, Teledyne Imaging Sensors (United States)
8453 08	UV photon-counting CCD detectors that enable the next generation of UV spectroscopy missions: AR coatings that can achieve 80-90% QE [8453-8] E. T. Hamden, Columbia Univ. (United States); F. Greer, Jet Propulsion Lab. (United States); D. Schiminovich, Columbia Univ. (United States); S. Nikzad, Jet Propulsion Lab. (United States); D. C. Martin, California Institute of Technology (United States)

CRYOGENIC DETECTORS

- 8453 0A **Optical lumped element microwave kinetic inductance detectors** [8453-11]
D. Marsden, B. A. Mazin, Univ. of California, Santa Barbara (United States); B. Bumble, Jet Propulsion Lab. (United States); S. Meeker, K. O'Brien, S. McHugh, M. Strader, E. Langman, Univ. of California, Santa Barbara (United States)

CMOS SENSORS

- 8453 0B **Backside-illuminated, high-QE, 3e- RoN, fast 700fps, 1760x1680 pixels CMOS imager for AO with highly parallel readout (Invited Paper)** [8453-12]
M. Downing, J. Kolb, D. Baade, European Southern Observatory (Germany); P. Balard, Lab. d'Astrophysique de Marseille (France); B. Dierickx, A. Defernez, B. Dupont, Caeleste (Belgium); P. Feautrier, Institut de Planétologie et d'Astrophysique (France); G. Finger, European Southern Observatory (Germany); M. Fryer, e2v technologies plc (United Kingdom); J.-L. Gach, Lab. d'Astrophysique de Marseille (France); C. Guillaume, Observatoire de Haute Provence (France); N. Hubin, O. Iwert, European Southern Observatory (Germany); P. Jerram, P. Jorden, A. Pike, J. Pratlong, e2v technologies plc (United Kingdom); J. Reyes, European Southern Observatory (Germany); E. Stadler, Institut de Planétologie et d'Astrophysique (France); A. Walker, e2v technologies plc (United Kingdom)
- 8453 0C **High-performance CMOS image sensors at BAE SYSTEMS Imaging Solutions** [8453-13]
P. Vu, B. Fowler, C. Liu, S. Mims, J. Balicki, P. Bartkovjak, H. Do, W. Li, BAE SYSTEMS Imaging Solutions (United States)

CMOS AND HYBRID X-RAY DETECTORS

- 8453 0D **Recent progress on developments and characterization of hybrid CMOS x-ray detectors** [8453-15]
A. D. Falcone, Z. Prieskorn, C. Griffith, S. Bongiorno, D. N. Burrows, The Pennsylvania State Univ. (United States)
- 8453 0E **Characterization of an x-ray hybrid CMOS detector with low interpixel capacitive crosstalk** [8453-16]
C. V. Griffith, S. D. Bongiorno, D. N. Burrows, A. D. Falcone, Z. R. Prieskorn, The Pennsylvania State Univ. (United States)
- 8453 0F **Development of monolithic CMOS detectors as x-ray imaging spectrometers** [8453-17]
A. T. Kenter, R. Kraft, Harvard-Smithsonian Ctr. for Astrophysics (United States); S. S. Murray, The Johns Hopkins Univ. (United States)

FOCAL PLANE ARRAYS

- 8453 0I **A gigapixel commercially manufactured cryogenic camera for the J-PAS 2.5m survey telescope** [8453-20]
P. R. Jorden, M. Bastable, e2v technologies plc (United Kingdom); M. Clapp, Rutherford Appleton Lab. (United Kingdom); S. Darby, M. Dryer, T. Eaton, G. Fenemore-Jones, P. Jerram, e2v technologies plc (United Kingdom); A. Marin-Franch, Ctr. de Estudios de Fisica del Cosmos de Aragon (Spain); I. Palmer, R. Pittcock, P. Pool, R. Rennshaw, e2v technologies plc (United Kingdom); K. Taylor, Univ. de São Paulo (Brazil); N. Waltham, Ctr. de Estudios de Fisica del Cosmos de Aragon (Spain); P. Wheeler, e2v technologies plc (United Kingdom)
- 8453 0J **GPC1 and GPC: the Pan-STARRS 1.4 gigapixel mosaic focal plane CCD cameras with an on-sky on-CCD tip-tilt image compensation** [8453-21]
P. Onaka, C. Rae, S. Isani, J. L. Tonry, A. Lee, R. Uyeshiro, L. Robertson, G. Ching, Institute for Astronomy, Univ. of Hawai'i (United States)
- 8453 0K **Development of the LSST raft tower modules** [8453-22]
P. O'Connor, I. Kotov, P. Z. Takacs, J. S. Frank, S. Plate, Brookhaven National Lab. (United States); R. Van Berg, M. Newcomer, Univ. of Pennsylvania (United States); P. Antilogus, H. Lebbolo, Institut National de Physique Nucléaire et de Physique de Particules, CNRS (France) and Univ. Pierre et Marie Curie (France) and Univ. Paris Diderot (France); V. Tocut, Linear Accelerator Lab., CNRS, Univ. Paris Sud 11 (France); C. Juramy, Institut National de Physique Nucléaire et de Physique de Particules, CNRS (France) and Univ. Pierre et Marie Curie (France) and Univ. Paris Diderot (France); P. Doherty, N. Felt, Harvard Univ. (United States)
- 8453 0L **4K×4K format 10µm pixel pitch H4RG-10 hybrid CMOS silicon visible focal plane array for space astronomy** [8453-23]
Y. Bai, W. Tennant, S. Anglin, A. Wong, M. Farris, M. Xu, E. Holland, D. Cooper, J. Hosack, K. Ho, T. Sprafke, R. Kopp, B. Starr, R. Blank, J. W. Beletic, Teledyne Imaging Sensors (United States); G. Luppino, GL Scientific (United States)

X-RAY DETECTORS I

- 8453 0M **New simulation and measurement results on Gatebale DEPFET devices** [8453-24]
A. Bähr, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); S. Aschauer, K. Hermenau, PNSensor GmbH (Germany); S. Herrmann, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); P. H. Lechner, G. Lutz, P. Majewski, PNSensor GmbH (Germany); D. Miessner, M. Porro, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); R. H. Richter, Max-Planck-Institut Halbleiterlabor (Germany) and Max-Planck-Institut für Physik (Germany); G. Schaller, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); C. Sandow, PNSensor GmbH (Germany); M. Schnecke, Max-Planck-Institut Halbleiterlabor (Germany) and Max-Planck-Institut für Physik (Germany); F. Schopper, A. Stefanescu, L. Strüder, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); J. Treis, PNSensor GmbH (Germany)

- 8453 0O **Design and performance of the eROSITA focal plane instrumentation** [8453-26]
 N. Meidinger, R. Andritschke, F. Aschauer, J. Elbs, T. Eraerds, S. Granato, O. Hälker, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); G. Hartner, Max-Planck-Institut für extraterrestrische Physik (Germany); D. Mießner, D. Pietschner, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); P. Predehl, Max-Planck-Institut für extraterrestrische Physik (Germany); J. Reiffers, L. Strüder, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany); A. von Kienlin, Max-Planck-Institut für extraterrestrische Physik (Germany); S. Walther, Max-Planck-Institut für extraterrestrische Physik (Germany) and Max-Planck-Institut Halbleiterlabor (Germany)
- 8453 0P **Integration and calibration of DEPFET macropixel detectors for MIXS** [8453-27]
 P. Majewski, PNSensor GmbH (Germany); F. Aschauer, A. Bähr, G. de Vita, B. Günther, Max-Planck-Halbleiterlabor (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); K. Hermenau, PNSensor GmbH (Germany); S. Herrmann, Max-Planck-Halbleiterlabor (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); M. Hilchenbach, Max-Planck-Institut für Sonnensystemforschung (Germany); T. Lauf, Max-Planck-Halbleiterlabor (Germany) and Max-Planck-Institut für extraterrestrische Physik (); P. Lechner, G. Lutz, PNSensor GmbH (Germany); D. Messner, M. Porro, J. Reiffers, G. Schaller, F. Schopper, Max-Planck-Halbleiterlabor (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); H. Soltau, PNSensor GmbH (Germany); A. Stefanescu, R. Strecker, L. Strüder, Max-Planck-Halbleiterlabor (Germany) and Max-Planck-Institut für extraterrestrische Physik (Germany); J. Treis, PNSensor GmbH (Germany)
- 8453 0Q **Performance of new generation swept charge devices for lunar x-ray spectroscopy on Chandrayaan-2** [8453-28]
 P. H. Smith, J. P. D. Gow, N. J. Murray, A. D. Holland, M. Anand, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom); P. Pool, e2v technologies plc (United Kingdom); P. Sreekumar, S. Narendranath, ISRO Satellite Ctr. (India)
- 8453 0R **Development status of a CZT spectrometer prototype with 3D spatial resolution for hard x-ray astronomy (Invited Paper)** [8453-29]
 N. Auricchio, E. Caroli, A. Basili, INAF - IASF Bologna (Italy); G. Benassi, Istituto per la Microelettronica e Microsistemi, CNR (Italy); C. Budtz Jørgensen, National Space Institute, Technical Univ. of Denmark (Denmark); R. M. Curado da Silva, Lab. de Instrumentação e Física Experimental de Partículas (Portugal); S. Del Sordo, INAF - IASF Palermo (Italy); I. Kuvvetli, National Space Institute, Technical Univ. of Denmark (Denmark); L. Milano, Univ. degli Studi di Ferrara (Italy); F. Moscatelli, Istituto per la Microelettronica e Microsistemi, CNR (Italy); J. B. Stephen, INAF - IASF Bologna (Italy); M. Zanichelli, A. Zappettini, Istituto per la Microelettronica e Microsistemi, CNR (Italy)

IR DETECTORS I

- 8453 0S **Evaluation and optimization of NIR HgCdTe avalanche photodiode arrays for adaptive optics and interferometry (Invited Paper)** [8453-30]
 G. Finger, European Southern Observatory (Germany); I. Baker, SELEX Galileo Infrared Ltd. (United Kingdom); D. Alvarez, D. Ives, L. Mehrgan, M. Meyer, J. Stegmeier, European Southern Observatory (Germany); P. Thorne, H. J. Weller, SELEX Galileo Infrared Ltd. (United Kingdom)

- 8453 0T **Operation and performance of new NIR detectors from SELEX** [8453-31]
D. Atkinson, N. Bezawada, UK Astronomy Technology Ctr. (United Kingdom);
L. G. Hipwood, N. Shorrocks, H. Milne, SELEX Galileo Infrared Ltd. (United Kingdom)
- 8453 0U **Development and production of the H4RG-15 focal plane array** [8453-32]
R. Blank, J. W. Beletic, D. Cooper, M. Farris, Teledyne Imaging Sensors (United States);
D. N. B. Hall, K. Hodapp, Institute for Astronomy, Univ. of Hawai'i (United States); G. Luppino,
GL Scientific (United States); E. Piquette, M. Xu, Teledyne Imaging Sensors (United States)
- 8453 0V **Performance of the first HAWAII 4RG-15 arrays in the laboratory and at the telescope**
[8453-33]
D. N. Hall, D. Atkinson, Institute for Astronomy, Univ. of Hawai'i (United States); J. W. Beletic,
R. Blank, M. Farris, Teledyne Imaging Sensors (United States); K. W. Hodapp, S. M. Jacobson,
Institute for Astronomy, Univ. of Hawai'i (United States); M. Loose, Markry Scientific, Inc.
(United States); G. Luppino, GL Scientific (United States)

IR DETECTORS II

- 8453 0Z **H2RG focal plane array and camera performance update** [8453-91]
R. Blank, S. Anglin, J. W. Beletic, S. Bhargava, Teledyne Imaging Sensors (United States);
R. Bradley, GL Scientific (United States); C. A. Cabelli, J. Chen, D. Cooper, R. Demers, M.
Eads, M. Farris, W. Lavelle, Teledyne Imaging Sensors (United States); G. Luppino, E. Moore,
GL Scientific (United States); E. Piquette, R. Ricardo, M. Xu, M. Zandian, Teledyne Imaging
Sensors (United States)
- 8453 11 **AQUARIUS, the next generation mid-IR detector for ground-based astronomy** [8453-38]
D. Ives, G. Finger, G. Jakob, S. Eschbaumer, L. Mehrgan, M. Meyer, J. Steigmeier, European
Southern Observatory (Germany)

IR DETECTORS III

- 8453 12 **Pixel classification for the JWST fine guidance sensor** [8453-39]
N. Rowlands, G. Warner, C. Berndt, COM DEV Space Systems (Canada); L. Albert, Univ. de
Montréal (Canada); P. Chayer, Space Telescope Science Institute (United States)

SPACE RADIATION DAMAGE

- 8453 13 **CMOS sensor and camera for the PHI instrument on board Solar Orbiter: evaluation of the radiation tolerance** [8453-40]
J. Piqueras, Max-Planck-Institut für Sonnensystemforschung (Germany) and Technische
Univ. Braunschweig (Germany); K. Heerlein, S. Werner, R. Enge, U. Schühle, J. Woch, Max-
Planck-Institut für Sonnensystemforschung (Germany); T. De Ridder, G. Meynants, B. Wolfs,
G. Lepage, W. Diels, CMOSIS NV (Belgium)
- 8453 14 **Modelling charge transfer in a radiation damaged charge coupled device for Euclid**
[8453-41]
D. J. Hall, A. Holland, N. Murray, J. Gow, A. Clarke, e2v Ctr. for Electronic Imaging at The
Open Univ. (United Kingdom)

- 8453 15 **Assessment of proton radiation-induced charge transfer inefficiency in the CCD273 detector for the Euclid Dark Energy Mission** [8453-42]
J. P. D. Gow, N. J. Murray, D. J. Hall, A. S. Clarke, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom); D. Burt, J. Endicott, e2v technologies plc (United Kingdom); A. D. Holland, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom)

X-RAY DETECTORS II

- 8453 17 **Characterization of the silicon drift detector for NICER instrument** [8453-44]
G. Prigozhin, Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology (United States); K. Gendreau, NASA Goddard Space Flight Ctr. (United States); R. Foster, G. Ricker, J. Villaseñor, Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology (United States); J. Doty, Noqsi Aerospace, Ltd. (United States); S. Kenyon, Z. Arzoumanian, NASA Goddard Space Flight Ctr. (United States); R. Redus, A. Huber, Amptek, Inc. (United States)
- 8453 18 **Development of a laboratory-based XRF facility for measuring elemental abundance ratios in planetary analogue powder samples** [8453-45]
T. E. Walker, D. R. Smith, Brunel Univ. (United Kingdom)
- 8453 19 **A compact high-speed pnCCD camera for optical and x-ray applications** [8453-46]
S. Ihle, PNSensor GmbH (Germany); I. Ordavo, PNSensor GmbH (Germany) and PNDetector GmbH (Germany); A. Bechteler, R. Hartmann, P. Holl, A. Liebel, PNSensor GmbH (Germany); N. Meidinger, Max-Planck-Institut für extraterrestrische Physik (Germany); H. Soltau, PNSensor GmbH (Germany); L. Strüder, Max-Planck-Institut für extraterrestrische Physik (Germany); U. Weber, PNDetector GmbH (Germany)

TESTING

- 8453 1A **Charge diffusion measurement in fully depleted CCD using ^{55}Fe X-rays** [8453-47]
I. V. Kotov, A. I. Kotov, J. Frank, Brookhaven National Lab. (United States); P. Kubanek, Institute of Physics of the ASCR, v.v.i. (Czech Republic); P. O'Connor, V. Raděka, P. Takacs, Brookhaven National Lab. (United States)
- 8453 1B **A test-based comparison between technologies implemented in commercial cameras for high contrast imaging applications** [8453-48]
M. Pancrazzi, Lab. d'Astrophysique de Marseille, CNRS, Aix-Marseille Univ. (France) and Univ. degli Studi di Firenze (Italy); F. Landini, Univ. degli Studi di Firenze (Italy); S. Vives, C. Escolle, M. N'Diaye, Lab. d'Astrophysique de Marseille, CNRS, Aix-Marseille Univ. (France); M. Focardi, Univ. degli Studi di Firenze (Italy); C. Guillot, Lab. d'Astrophysique de Marseille, CNRS, Aix-Marseille Univ. (France)

ELECTRONICS/READOUT

- 8453 1C **Development of a test system for the characterisation of DCDS CCD readout techniques** [8453-49]
M. J. Clapp, Rutherford Appleton Lab. (United Kingdom)

Part 2

- 8453 1D **Beating the 1/f noise limit on charge coupled devices [8453-50]**
J. Estrada, G. Cancelo, T. Diehl, Fermi National Accelerator Lab. (United States);
G. Fernandez-Moroni, Fermi National Accelerator Lab. (United States) and Univ. Nacional
del Sur (Argentina)
- 8453 1E **Reducing the read noise of HAWAII-2RG detector systems with improved reference
sampling and subtraction (IRS²) [8453-51]**
B. J. Rauscher, R. G. Arendt, D. J. Fixsen, M. Lander, D. Lindler, NASA Goddard Space Flight
Ctr. (United States); M. Loose, Markury Scientific, Inc. (United States); S. H. Moseley,
D. V. Wilson, C. Xenophontos, NASA Goddard Space Flight Ctr. (United States)
- 8453 1F **Temperature dependence of the dark current and activation energy at avalanche onset of
GaN avalanche photodiodes [8453-9]**
M. P. Ulmer, E. Cicek, R. McClintock, Z. Vashaei, M. Razeghi, Northwestern Univ. (United
States)

CCDS II

- 8453 1H **Device modelling and model verification for the Euclid CCD273 detector [8453-53]**
A. Clarke, D. Hall, N. Murray, A. Holland, e2v Ctr. for Electronic Imaging at The Open Univ.
(United Kingdom); D. Burt, e2v technologies plc (United Kingdom)

CCDS III

- 8453 1I **Charge-coupled devices for the ESA PLATO M-class Mission [8453-54]**
J. Endicott, A. Walker, S. Bowring, P. Turner, D. Allen, e2v technologies Ltd. (United
Kingdom); O. Piersanti, A. Short, European Space Agency (Netherlands); D. Walton,
Mullard Space Science Lab. (United Kingdom)
- 8453 1J **Persistence and charge diffusion in an E2V CCD42-90 deep-depletion CCD [8453-55]**
G. A. Barrick, J. Ward, J.-C. Cuillandre, Canada-France-Hawaii Telescope (United States)
- 8453 1K **Recent astronomical detector development at the University of Arizona [8453-56]**
M. Lesser, The Univ. of Arizona (United States)
- 8453 1L **STA1600LN: low-noise 10560 x 10560 pixel high-resolution CCD for astronomy [8453-57]**
R. Bredthauer, K. Boggs, G. Bredthauer, Semiconductor Technology Associates Inc. (United
States); M. Lesser, The Univ. of Arizona (United States)
- 8453 1M **A novel CCD for application in high-frame rate geostationary space-based imaging [8453-
58]**
R. Bredthauer, K. Boggs, G. Bredthauer, Semiconductor Technology Associates Inc. (United
States); E. Aamodt, Lockheed Martin Advanced Technology Ctr. (United States); H.
Christian, Ryco Design and Research, Inc. (United States); M. Lesser, The Univ. of Arizona
(United States); K. Gheno, B. Reeve, Lockheed Martin Advanced Technology Ctr. (United
States)

IR DETECTORS IV

- 8453 1N **Performance and calibration of H2RG detectors and SIDECAR ASICs for the RATIR camera** [8453-59]
O. D. Fox, NASA Goddard Space Flight Ctr. (United States); A. S. Kutyrev, NASA Goddard Space Flight Ctr. (United States) and Univ. of Maryland, College Park (United States); D. A. Rapchun, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); C. R. Klein, Univ. of California, Berkeley (United States); N. R. Butler, Arizona State Univ. (United States); J. Bloom, Univ. of California, Berkeley (United States); J. A. de Diego, A. Farah, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); N. A. Gehrels, NASA Goddard Space Flight Ctr. (United States); L. Georgiev, J. J. González, W. H. Lee, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); M. Loose, Markury Scientific, Inc. (United States); G. Lotkin, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); S. H. Moseley, NASA Goddard Space Flight Ctr. (United States); J. X. Prochaska, E. Ramirez-Ruiz, Univ. of California, Santa Cruz (United States); M. G. Richer, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); F. D. Robinson, NASA Goddard Space Flight Ctr. (United States) and Orbital Sciences Corp. (United States); C. Román-Zúñiga, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); M. V. Samuel, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); L. M. Sparr, NASA Goddard Space Flight Ctr. (United States); A. M. Watson, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico)
- 8453 1O **Hemispherical infrared focal plane arrays: a new design parameter for the instruments** [8453-60]
M. Fendler, D. Dumas, CEA - LETI (France); F. Chemla, M. Cohen, P. Laporte, Observatoire de Paris, CNRS, Univ. Paris Diderot (France); K. Tekaya, CEA - LETI (France); E. Le Coarer, IPAG, CNRS, Univ. Joseph Fourier (France); J. Primot, ONERA (France); H. Ribot, CEA - LETI (France)
- 8453 1P **Control electronics for large mosaics of SIDECAR ASIC driven detectors** [8453-61]
M. Loose, Markury Scientific, Inc. (United States); E. Cheng, Conceptual Analytics, LLC (United States); J. Lohr, B. Mott, A. Waczynski, Y. Wen, D. Wilson, NASA Goddard Space Flight Ctr. (United States)
- 8453 1Q **Characterization of HAWAII-2RG detector and SIDECAR ASIC for the Euclid mission at ESA** [8453-62]
P. Crouzet, J. ter Haar, F. de Wit, T. Beaufort, B. Butler, H. Smit, C. van der Luijt, D. Martin, European Space Agency, ESTEC (Netherlands)
- 8453 1R **Performance of the HgCdTe detector for MOSFIRE, an imager and multi-object spectrometer for Keck Observatory** [8453-63]
K. R. Kulas, I. S. McLean, Univ. of California, Los Angeles (United States); C. C. Steidel, California Institute of Technology (United States)
- 8453 1S **NIRSpec detectors: noise properties and the effect of signal dependent inter-pixel crosstalk** [8453-64]
G. Giardino, M. Sirianni, S. M. Birkmann, European Space Research and Technology Ctr. (Netherlands); B. J. Rauscher, D. Lindler, NASA Goddard Space Flight Ctr. (United States); T. Boeker, P. Ferruit, G. De Marchi, European Space Research and Technology Ctr. (Netherlands); M. Stuhlinger, P. Jensen, P. Strada, European Space Astronomy Ctr. (Spain)

POSTER SESSION

- 8453 1T **EMCCD camera noise performance for the Brazilian tunable filter imager** [8453-66]
D. Andrade, Univ. de São Paulo (Brazil); O. Daigle, Nüvü Caméras Inc. (Canada); B. Quint, K. Taylor, C. Mendes de Oliveira, J. Ramirez-Fernandez, Univ. de São Paulo (Brazil)
- 8453 1V **First results from a novel curving process for large area scientific imagers** [8453-68]
O. Iwert, European Southern Observatory (Germany); D. Ouellette, M. Lesser, The Univ. of Arizona (United States); B. Delabre, European Southern Observatory (Germany)
- 8453 1W **Hyper Suprime-Cam: characteristics of 116 fully depleted back-illuminated CCDs** [8453-69]
Y. Kamata, S. Miyazaki, H. Nakaya, Y. Komiyama, Y. Obuchi, S. Kawanomoto, F. Uraguchi, Y. Utsumi, National Astronomical Observatory of Japan (Japan); H. Suzuki, Y. Miyazaki, M. Muramatsu, Hamamatsu Photonics K.K. (Japan)
- 8453 1Y **Deep-depletion Hamamatsu CCDs for the Gemini multi-object spectrograph** [8453-71]
T. Hardy, National Research Council Canada (Canada); K. Hanna, Gemini Observatory (United States); K. Szeto, G. Burley, National Research Council Canada (Canada)
- 8453 21 **ESA's CCD test bench for the Euclid visible channel** [8453-74]
P. Verhoeve, European Space Research and Technology Ctr. (Netherlands); N. Boudin, European Space Research and Technology Ctr. (Netherlands) and Cosine Research BV (Netherlands); U. Telljohann, T. Oosterbroek, D. Martin, L. Duvet, T. Beaufort, B. Butler, I. Escudero-Sanz, H. Smit, F. de Wit, European Space Research and Technology Ctr. (Netherlands)
- 8453 22 **Preliminary results of CCD characterisation at ESA in support of the Euclid visible channel** [8453-75]
N. Boudin, European Space Research and Technology Ctr. (Netherlands) and Cosine Research BV (Netherlands); P. Verhoeve, H. Smit, U. Telljohann, L. Duvet, D. Martin, European Space Research and Technology Ctr. (Netherlands)
- 8453 23 **An advanced CCD emulator with 32MB image memory** [8453-76]
P. O'Connor, J. Fried, I. Kotov, Brookhaven National Lab. (United States)
- 8453 25 **PAU camera: detectors characterization** [8453-78]
R. Casas, Institut de Ciències de l'Espai (Spain); O. Ballester, L. Cardiel-Sas, Institut de Física d'Altes Energies (Spain); J. Castilla, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); J. Jiménez, M. Maiorino, C. Pío, Institut de Física d'Altes Energies (Spain); I. Sevilla, J. de Vicente, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain)
- 8453 26 **Performance characterization of the near infrared detector system for RSS-NIR on SALT** [8453-79]
M. J. Wolf, D. J. Thielman, G. Mosby, M. P. Smith, K. P. Jaehnig, B. L. Indahl, Univ. of Wisconsin-Madison (United States); A. I. Sheinis, Australian Astronomical Observatory (Australia)
- 8453 27 **Scientific CCD characterisation at Universidad Complutense LICa Laboratory** [8453-80]
S. Tulloch, FRACTAL S.L.N.E (Spain); A. Gil de Paz, J. Gallego, J. Zamorano, C. Tapia, Univ. Complutense de Madrid (Spain)

- 8453 2B **Test set up description and performances for HAWAII-2RG detector characterization at ESTEC [8453-81]**
 P.-E. Crouzet, J. ter Haar, F. de Wit, T. Beaufort, B. Butler, H. Smit, C. van der Luijt, European Space Research and Technology Ctr. (Netherlands); D. Martin, European Space Research and Technology Ctr (Netherlands)
- 8453 2D **Standard modes of MPIA's current H2/H2RG-readout systems [8453-86]**
 C. Storz, V. Naranjo, U. Mall, J. Ramos, P. Bizenberger, J. Panduro, Max-Planck-Institut für Astronomie (Germany)
- 8453 2E **Investigation of linear-mode photon-counting HgCdTe APDs for astronomical observations [8453-87]**
 M. L. Bryan, Institute for Astronomy, Univ. of Hawai'i (United States); G. Chapman, Raytheon Vision Systems (United States); D. N. B. Hall, Institute for Astronomy, Univ. of Hawai'i (United States); M. D. Jack, Raytheon Vision Systems (United States); S. M. Jacobson, Institute for Astronomy, Univ. of Hawai'i (United States); J. Wehner, Raytheon Vision Systems (United States)
- 8453 2F **Ultra-low noise large-area InGaAs quad photoreceiver with low crosstalk for laser interferometry space antenna [8453-88]**
 A. Joshi, S. Datta, J. Rue, Discovery Semiconductors, Inc. (United States); J. Livas, R. Silverberg, NASA Goddard Space Flight Ctr. (United States); F. Guzman Cervantes, Albert-Einstein-Institut (Germany)
- 8453 2G **Enabling large focal plane arrays through mosaic hybridization [8453-89]**
 T. M. Miller, C. A. Jhabvala, NASA Goddard Space Flight Ctr. (United States); E. Leong, N. P. Costen, MEI Technologies, Inc. (United States); E. Sharp, Global Science & Technology, Inc. (United States); T. Adachi, The Catholic Univ. of America (United States); D. J. Benford, NASA Goddard Space Flight Ctr. (United States)
- 8453 2H **EMIR high-dynamic range readout modes [8453-90]**
 M. Nuñez, Instituto de Astrofísica de Canarias (Spain); F. Gago, European Southern Observatory (Germany); F. Garzón, Instituto de Astrofísica de Canarias (Spain) and Univ. de La Laguna (Spain); J. J. Díaz, M. Barreto, J. Patrón, Instituto de Astrofísica de Canarias (Spain); C. González-Fenández, Univ. de Alicante (Spain); P. L. Hammersley, European Southern Observatory (Germany); L. López, N. Castro, Instituto de Astrofísica de Canarias (Spain)
- 8453 2I **X-ray performance of 0.18 μm CMOS APS test arrays for solar observation [8453-92]**
 B. J. Dryer, A. D. Holland, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom); P. Jerram, e2v technologies plc (United Kingdom); T. Sakao, Japan Aerospace Exploration Agency (Japan)
- 8453 2J **Experimental measurements of charge carrier mobility: lifetime products for large sample of pixilated CZT detectors [8453-93]**
 S. V. Vadawale, M. Shanmugam, S. Purohit, Y. B. Acharya, Physical Research Lab. (India); M. Sudhakar, ISRO Satellite Ctr. (India)

- 8453 2K **Modeling charge transport in swept charge devices for x-ray spectroscopy** [8453-94]
 P. S. Athiray, ISRO Satellite Ctr. (India) and Univ. of Calicut (India); S. Narendranath, P. Sreekumar, ISRO Satellite Ctr. (India); J. Gow, e2v Ctr. for Electronic Imaging at The Open Univ. (United Kingdom); V. Radhakrishna, ISRO Satellite Ctr. (India); B. R. S. Babu, Univ. of Calicut (India) and Sultan Qaboos Univ. (India)
- 8453 2M **High-resolution gamma-ray detection using phonon-mediated detectors** [8453-96]
 B. Cornell, D. C. Moore, S. R. Golwala, California Institute of Technology (United States); B. Bumble, P. K. Day, H. G. LeDuc, Jet Propulsion Lab. (United States); J. Zmuidzinas, California Institute of Technology (United States)
- 8453 2N **Circuit design of an EMCCD camera** [8453-98]
 B. Li, Kunming Univ. of Science and Technology (China); Q. Song, National Astronomical Observatories (China); J. Jin, C. He, Kunming Univ. of Science and Technology (China)
- 8453 2O **Architecture of PAU survey camera readout electronics** [8453-99]
 J. Castilla, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); L. Cardiel-Sas, Institut de Física d'Altes Energies (Spain); J. De Vicente, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); J. Illa, J. Jimenez, M. Maiorino, Institut de Física d'Altes Energies (Spain); G. Martinez, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain)
- 8453 2P **The Dark Energy Camera readout system** [8453-100]
 T. Shaw, Fermi National Accelerator Lab. (United States); O. Ballester, L. Cardiel-Sas, Institut de Física d'Altes Energies (Spain); J. Castilla, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); S. Chappa, Fermi National Accelerator Lab. (United States); J. de Vicente, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); S. Holm, D. Huffman, M. Kozlovsky, Fermi National Accelerator Lab. (United States); G. Martínez, Ctr. de Investigaciones Energéticas, Medioambientales y Tecnológicas (Spain); T. Moore, Univ. of Illinois at Urbana-Champaign (United States); J. Olsen, Fermi National Accelerator Lab. (United States); V. Simaitis, Univ. of Illinois at Urbana-Champaign (United States); W. Stuermer, Fermi National Accelerator Lab. (United States)
- 8453 2Q **Hyper Suprime-Cam: performance of the CCD readout electronics** [8453-101]
 H. Nakaya, National Astronomical Observatory of Japan (Japan); H. Miyatake, The Univ. of Tokyo (Japan); T. Uchida, High Energy Accelerator Research Organization (Japan); H. Fujimori, S. Mineo, H. Aihara, The Univ. of Tokyo (Japan); H. Furusawa, Y. Kamata, H. Karoji, S. Kawanomoto, Y. Komiya, S. Miyazaki, T. Morokuma, Y. Obuchi, Y. Okura, National Astronomical Observatory of Japan (Japan); M. Tanaka, High Energy Accelerator Research Organization (Japan); Y. Tanaka, F. Uraguchi, Y. Utsumi, National Astronomical Observatory of Japan (Japan)
- 8453 2R **Software solution for autonomous observations with H2RG detectors and SIDECAr ASICs for the RATIR camera** [8453-102]
 C. R. Klein, Univ. of California, Berkeley (United States); P. Kubánek, Institute of Physics of the ASCR, v.v.i. (Czech Republic); N. R. Butler, Arizona State Univ. (United States); O. D. Fox, NASA Goddard Space Flight Ctr. (United States); A. S. Kutyrev, NASA Goddard Space Flight Ctr. (United States) and Univ. of Maryland, College Park (United States); D. A. Rapchun, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); J. S. Bloom, Univ. of California, Berkeley (United States); A. Farah, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); N. Gehrels, NASA Goddard

- Space Flight Ctr. (United States); L. Georgiev, J. J. González, W. H. Lee, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); G. N. Lotkin, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); S. H. Moseley, NASA Goddard Space Flight Ctr. (United States); J. X. Prochaska, Univ. of California at Santa Cruz (United States); E. Ramirez-Ruiz, Univ. of California, Santa Cruz (United States); M. G. Richer, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); F. D. Robinson, NASA Goddard Space Flight Ctr. (United States) and Orbital Sciences Corp (United States); C. Román-Zúñiga, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); M. V. Samuel, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); L. M. Sparr, NASA Goddard Space Flight Ctr. (United States); C. Tucker, NASA Goddard Space Flight Ctr. (United States) and Global Science & Technology, Inc. (United States); A. M. Watson, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico)
- 8453 2S **Performances and results of the detector acquisition system of the GIANO spectrometer** [8453-103]
E. Oliva, V. Biliotti, C. Baffa, E. Giani, INAF - Osservatorio Astrofisico di Arcetri (Italy); M. Gonzalez, INAF - Telescopio Nazionale Galileo (Spain); M. Sozzi, A. Tozzi, INAF - Osservatorio Astrofisico di Arcetri (Italy); L. Origlia, INAF - Osservatorio Astronomico di Bologna (Italy)
- 8453 2U **A simple controller for bidimensional image detectors** [8453-105]
F. Angeles, L. A. Martínez, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico)
- 8453 2Z **Comparison of hybrid and SIDECAR ASIC measurements** [8453-111]
F. Marmol, Ctr. de Physique des Particules de Marseille (France); G. Smadja, Institut de Physique Nucléaire de Lyon (France); C. Cerna, Ctr. de Physique des Particules de Marseille (France); A. Castera, Institut de Physique Nucléaire de Lyon (France); A. Chapon, A. Ealet, Ctr. de Physique des Particules de Marseille (France)
- 8453 30 **The low Earth orbit radiation environment and its impact on the prompt background of hard x-ray focusing telescopes** [8453-112]
V. Fioretti, Univ. degli Studi di Torino (Italy) and INAF - IASF Bologna (Italy); A. Bulgarelli, G. Malagutti, V. Bianchin, M. Trifoglio, F. Gianotti, INAF - IASF Bologna (Italy)
- 8453 31 **The effects of radiation damage on the spectral resolution of the Chandrayaan-1 x-ray spectrometer over the full mission duration** [8453-113]
T. E. Walker, D. R. Smith, Brunel Univ. (United Kingdom)
- 8453 32 **A multiplexer for the AC/DC characterization of TES-based bolometers and microcalorimeters** [8453-114]
L. Gottardi, H. Akamatsu, M. Bruijn, SRON Netherlands Institute for Space Research (Netherlands); J. R. Gao, SRON Netherlands Institute for Space Research (Netherlands) and Kavli Institute of Nanoscience, Delft Univ. of Technology (Netherlands); R. den Hartog, R. Hijmering, H. Hoevers, P. Khosropanah, J. van der Kuur, T. van der Linden, M. Lindeman, M. Ridder, SRON Netherlands Institute for Space Research (Netherlands)

- 8453 33 **A system for the characterization of the HAWC PMTs sensitivity** [8453-115]
R. Langarica, G. Lara, L. A. Martinez, S. Tinoco, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); R. Alfaro, Instituto de Física, Univ. Nacional Autónoma de México (Mexico); A. Iriarte, Instituto de Astronomía, Univ. Nacional Autónoma de México (Mexico); A. Sandoval, P. Vanegas, Instituto de Física, Univ. Nacional Autónoma de México (Mexico)
- 8453 34 **BoGEMMS: the Bologna Geant4 multi-mission simulator** [8453-116]
A. Bulgarelli, INAF - IASF Bologna (Italy); V. Fioretti, Consorzio Interuniv. per la Fisica Spaziale Torino (Italy); P. Malaguti, M. Trifoglio, F. Gianotti, INAF - IASF Bologna (Italy)
- 8453 35 **HST/WFC3 UVIS detectors: radiation damage effects and mitigation** [8453-119]
S. M. Baggett, K. Noeske, J. Anderson, J. W. MacKenty, L. Petro, Space Telescope Science Institute (United States)

Author Index

Conference Committee

Symposium Chairs

Mark M. Casali, European Southern Observatory (Germany)
Kathryn A. Flanagan, Space Telescope Science Institute (United States)

Symposium Cochairs

Gillian S. Wright, UK Astronomy Technology Centre (United Kingdom)
Luc Smiard, National Research Council Canada (Canada)

Conference Chairs

Andrew D. Holland, e2v Center for Electronic Imaging at The Open University (United Kingdom)
James W. Beletic, Teledyne Imaging Sensors (United States)

Conference Program Committee

Megan E. Eckart, NASA Goddard Space Flight Center (United States)
Gert Finger, European Southern Observatory (Germany)
Fiona A. Harrison, California Institute of Technology (United States)
Paul Jorden, e2v technologies plc (United Kingdom)
Didier Martin, European Space Research and Technology Centre (Netherlands)
Satoshi Miyazaki, National Astronomical Observatory of Japan (Japan)
Peter C. Moore, National Optical Astronomy Observatory (United States)
S. Harvey Moseley, NASA Goddard Space Flight Center (United States)
Robert H. Philbrick, Ball Aerospace & Technologies Corporation (United States)
Roger M. Smith, California Institute of Technology (United States)
Lothar Strüder, Max-Planck-Institut Halbleiterlabor (Germany)
Tadayuki Takahashi, Japan Aerospace Exploration Agency (Japan)
Hiroshi Tsunemi, Osaka University (Japan)

Session Chairs

1 CCDs I

Andrew D. Holland, e2v Centre for Electronic Imaging at The Open University (United Kingdom)

- 2 UV Detection I
Andrew D. Holland, e2v Centre for Electronic Imaging at The Open University (United Kingdom)
- 3 UV Detection II
Tadayuki Takahashi, Japan Aerospace Exploration Agency (Japan)
- 4 Cryogenic Detectors
Tadayuki Takahashi, Japan Aerospace Exploration Agency (Japan)
- 5 CMOS Sensors
Tadayuki Takahashi, Japan Aerospace Exploration Agency (Japan)
- 6 CMOS and Hybrid X-Ray Detectors
Lothar Strüder, Max-Planck-Institut Halbleiterlabor (Germany)
- 7 Focal Plane Arrays
Satoshi Miyazaki, National Astronomical Observatory of Japan (Japan)
- 8 X-Ray Detectors I
Hiroshi Tsunemi, Osaka University (Japan)
- 9 IR Detectors I
Andrew D. Holland, e2v Centre for Electronic Imaging at The Open University (United Kingdom)
- 10 IR Detectors II
Gert Finger, European Southern Observatory (Germany)
- 11 IR Detectors III
Gert Finger, European Southern Observatory (Germany)
- 12 Space Radiation Damage
Didier D. Martin, European Space Research and Technology Centre (Netherlands)
- 13 X-Ray Detectors II
Andrew D. Holland, e2v Centre for Electronic Imaging at The Open University (United Kingdom)
- 14 Testing
Didier D. Martin, European Space Research and Technology Centre (Netherlands)

- 15 Electronics/Readout
Andrew D. Holland, e2v Centre for Electronic Imaging at The Open University (United Kingdom)
- 16 CCDs II
Paul Jorden, E2V technologies plc (United Kingdom)
- 17 CCDs III
Paul Jorden, E2V technologies plc (United Kingdom)
- 18 IR Detectors IV
James Beletic, Teledyne Imaging Sensors (United States)

