2023 IEEE Radiation Effects Data Workshop (REDW 2023) (in conjunction with 2023 NSREC)

Kansas City, Missouri, USA
27 July 2023

IEEE Catalog Number: CFP23422-POD
ISBN: 979-8-3503-5821-6

Copyright © 2023 by the Institute of Electrical and Electronics Engineers, Inc.
All Rights Reserved

Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

****** This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP23422-POD
ISBN (Print-On-Demand):	979-8-3503-5821-6
ISBN (Online):	979-8-3503-5820-9
ISSN:	2154-0519

Additional Copies of This Publication Are Available From:

Curran Associates, Inc
57 Morehouse Lane
Red Hook, NY 12571 USA

Phone:	(845) 758-0400
Fax:	(845) 758-2633
E-mail:	curran@proceedings.com
Web:	www.proceedings.com

CURRAN ASSOCIATES INC.
proceedings
.com

Table of Contents

Guide to the 2022 IEEE Radiation Effects Data Workshop Record 1
David M. Hiemstra; MDA Space Missions, Brampton, Ontario L6S4J3 Canada

The Aerospace Corporation's Compendium of Recent Radiation Testing Results...6
S. C. Davis, A. D. Yarbrough, R. Koga, A. W. Wright, J. A. Shanney, Kenneth. G. Pham, Kevin G. Pham, C. Cao, J. M. Dixon, J. L. Taggart; The Aerospace Corporation, El Segundo, CA 90245, B. N. Davis; The Aerospace Corporation, and D. J. Mabry; The Aerospace Corporation, El Segundo, CA 90245

Single-Event Effects Measurements on COTS Electronic Devices for use on NASA Mars Missions.............12
Farokh Irom, Sergeh Vartanian, and Gregory R. Allen; Jet Propulsion Laboratory, California Institute of Technology Pasadena, CA 91109

NASA Goddard Space Flight Center's Current Radiation Effects Test Results...16
Martha V. O'Bryan; Science Systems and Applications (SSAI), Edward P. Wilcox, Thomas A. Carstens, Kaitlyn L. Ryder, Jonathan D. Barth, Jason M. Osheroff, Landen D. Ryder, Megan C. Casey, Matthew B. Joplin, Jean-Marie Lauenstein; NASA/GSFC, Code 561.4, Greenbelt, MD 20771 (USA), Kenneth A. LaBel; Science Systems and Applications (SSAI), Michael J. Campola; NASA/GSFC, Code 561.4, Greenbelt, MD 20771 (USA), Edward J. Wyrwas; Science Systems and Applications (SSAI), Aubin P. Antonsanti; NASA/GSFC, Code 561.4, Greenbelt, MD 20771 (USA), Melanie D. Berg, Donna J. Cochran; Science Systems and Applications (SSAI), Peter J. Majewicz, and Jonathan A. Pellish; NASA/GSFC, Code 561.4, Greenbelt, MD 20771 (USA)

2023 Compendium of Radiation-Induced Effects for Candidate Particle Accelerator....................................29
Rudy Ferraro, Panagiotis Gkountoumis, Gilles Foucard, Antonio Ventura; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland, Antonio Scialdone, Alessandro Zimmaro; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland, and also with IES-UMR UM/CNRS 5214, Université de Montpellier, 34095 Montpellier, France, Bruno Glecer, Sokratis Koseoglou, Cai Arcos Botias, Alessandro Masi, and Salvatore Danzeca; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland

Review of TID Effects Reported in ProASIC3 and ProASIC3L FPGAs for 3D PLUS Camera Heads.........37
A. L. Bosser, P. Kohler, J. Salles, M. Foucher, J. Bezine, N. Perrot, and P.-X. Wang; 3D PLUS, 408 rue Hélène Boucher, 78530 Buc, France

Investigation of the Zynq-7000 Integrated XADC under Proton Irradiation 43
F. Eichstaedt, J. Budroweit, and F. Stehle; The German Aerospace Center (DLR), Institute for Space Systems, Robert-Hooke-Str. 7, 28359 Bremen, Germany

Investigation of the Xilinx SEM Core on a Zynq-Based Software-Defined Radio under Proton Irradiation 47
F. Stehle, J. Budroweit, and F. Eichstaedt; The German Aerospace Center (DLR), Institute for Space Systems, Robert-Hooke-Str. 7, 28359 Bremen, Germany

Radiation Effects Testing of the Agilex Commercial Off-the-Shelf CMOS Field Programmable Gate Array with Protons...51
R. Koga, S. Davis, A. Yarbrough, J. Shanney, Kenneth Pham, C. Cao, Kevin Pham, and J. Dixon; The Aerospace Corporation, El Segundo, CA 90245

Heavy-Ion and Proton Evaluation of AMD 7nm Versal™ Multicore Scalar Processing System (PS)...........56
Pierre Maillard, Yanran P. Chen, Jue Arver, Venkatesh Merugu, Ava Shui, Abhijitt Dhavlle, and Martin Voogel; AMD, 2100 All Programmable Dr., San Jose, CA 95124, USA

Follow-On Testing of the Xilinx Versal Prime...62
Heather Quinn; Los Alamos National Laboratory, ISR-3 Space Data Systems, Charles Corley; Department of Electrical & Computer Engineering, University of Texas at Austin, George Tompkins; Los Alamos National Laboratory, Los Alamos, and Paul Thelen; Sandia National Laboratories, Albuquerque

Single Event Effects and TID Characterization of the Frontgrade Technologies UT24C407 Certus^{TM}-NX-RT FPGA for Space Applications...71
Matt Von Thun, Brian Baranski, Aaron Turnbull; Cobham Semiconductor Solutions, 4350 Centennial Blvd., Colorado Springs, CO 80907, Melanie Berg, and Scott Linton; Space R3 LLC, Melbourne, FL, 32935, US

Single Event Effects Results for COTS Microcontrollers and Microprocessors...78
Sergeh Vartanian, Gregory R. Allen, Farokh Irom, Andrew Daniel, and Stephanie Zajac; Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 USA

Single Event Effects Characterization of the GR716A Rad-Hard LEON3FT Microcontroller....................83
Lucas Antunes Tambara, Ádria Barros de Oliveira, Francisco Hernandez, Jörgen Trabjerg Martinsson, Fredrik Johansson, and Jan Andersson; Frontgrade Gaisler AB, Gothenburg, Sweden

NVIDIA Jetson TX2i TID and Proton SEE Testing: Results and a Comparison of Two Proton Beam Facilities...89
Sarah L. Katz; Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 USA, Christopher Heistand; Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 USA. He is now with STOKE Space Technologies Colorado, Centennial, CO 80122 USA, and Eric N. Miller; University of Georgia Small Satellite Research Laboratory, Athens, GA 30602 USA. He is now with Amazon.com, Inc. Seattle, WA 98121 USA

Proton and Heavy Ion SEE Data on NVIDIA and AMD GPUs...95
Matthew Cannon, William Evans, David Lee; Sandia National Laboratories, Albuquerque, NM, 87123, Ian Troxel, Matthew Gruber, and Daniel Sabogal; Troxel Aerospace Industries, Gainesville, FL, 32653

Total Ionizing Dose and Proton Single Event Effects in AMD Ryzen Processor Fabricated in a 12-nm Bulk FinFET Process...103
Jennifer L. Taggart, Scott C. Davis, Richard Daniel, Brendan J. Foran, Dhruv L. Bohra, Andrew J. Hall, Aaron W. Wright, and Hope Hunnicutt; The Aerospace Corporation, El Segundo, CA 90245

Single Event Effects and Total Ionizing Dose Radiation Testing of NVIDIA Jetson Orin AGX System on Module...109
Windy S. Slater; U.S. Air Force Research Laboratory, Kirtland Air Force Base, NM, United States, Benjamin B.W. Rutherford; The University of New Mexico COSMIAC R&D Center, Albuquerque, NM, United States, Jesse K. Mee, Ryan E. Pinson; U.S. Air Force Research Laboratory, Kirtland Air Force Base, NM, United States, Matthew Gruber, Daniel Sabogal, and Ian A. Troxel; Troxel Aerospace Industries Inc., Gainesville, FL, United States

Consistent and Repeatable Transistor Level TID Transistor Array Measurement....................................115
Ryan Melendez, Leonardo Martinez, Lawrence T. Clark, Cliff S. YoungScioritino, Steven M. Guertin, and Jean Yang-Scharlotta

SEE Test Results for SRAM and Register Files Compiled on 22nm Fully-Depleted-Silicon-on-Insulator (22FDX) 119
Ryan M. Melendez, Steven M. Guertin, Jean Yang-Scharlotta; Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 (USA), and Lawrence Clark; LTC Design LLC and Arizona State University (ASU)

SEU and SEFI Characterization of a Frontgrade QCOTS 512 Gb NAND Flash Nonvolatile Memory for Space Applications 122
Peter Nelson, Matt Von Thun, Aaron Turnbull, Brian Baranski, and Tim Meade; Frontgrade Technologies, 4350 Centennial Blvd., Colorado Springs, CO 80907

Irradiation Effects on Power and Timing Characteristics of Commercial 3-D NAND Flash Memories 131
Md Raquibuzzaman, Umeshwarnath Surendranathan, Matchima Buddhanoy, and Biswajit Ray; Department of Electrical and Computer Engineering, The University of Alabama in Huntsville, Huntsville, AL, 35899, USA

Single-Event Effects Response of 96- and 176-Layer 3D NAND Flash Memories 136
Edward P. Wilcox, Matthew B. Joplin; NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA, and Melanie D. Berg; SSAI, Inc. contracted by NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA

Neutron Induced Single Event Testing of Commercial Ferroelectric Memory Device (FRAM) 142
Terrence F. Deaton, Michael J. Tostanoski, Michael K. Peters, Kristianto Hartojo; Radiation Test Solutions, Inc., Colorado Springs, CO, Gerard Lachiewicz, and Travis Z. Fullem; Fluor Marine Propulsion LLC, Naval Nuclear Laboratory, West Mifflin, PA

A53 SEE Performance in Raspberry Pi and MX8M 148
Steven M. Guertin; Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 (USA)

Accelerated Nuclear Radiation Effects on the Raspberry Pi 3B+ and Pi 4 153
Charles J. Corley; University of Texas at Austin, Heather M. Quinn; Los Alamos National Laboratory, and Earl E. Swartzlander; University of Texas at Austin, TX

Total Dose and Single-Event Effects Testing of the Intersil ISL73041SEH 12V Half Bridge GaN FET Driver 162
M. L. Campanella, W. H. Newman, N.W. van Vonno, D. Wackley, T. Lok, L. G. Pearce, and E. J. Thomson; Renesas Electronics America, Palm Bay, Florida 32905

Total Dose Performance at Low Dose Rate of Isolated Switching Regulator Evaluation Kits 167
D. M. Hiemstra; MDA, Brampton, Ontario L6S 4J3 Canada, S. Shi, and L. Chen; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

High-Energy Atmospheric Neutrons Characterization of Microchip LX4580 171
Marco Leuenberger, Russell Stevens, Sorin Spanoche; Microchip Technology, San Jose, CA 95134 USA, and Dorian Johnson; Microchip Technology, Irvine, CA 92618 USA

A Rad-Hard Time-to-Digital Converter ASIC with a sub-10 ps Single-Shot Precision 176
B. Van Bockel, S. Ali, N. Jadhav, D. Hendrickx, Y. Cao, and H. Marien; Magics Technologies nv, Belgium

Combined Displacement Damage and LDR Results of the Intersil ISL73141SEH 3.3 V Analog to Digital Converter 180
W. H. Newman, N.W. van Vonno, C. Michalski, D. Thornberry, J.M. Harris, and L. G. Pearce; Radiation Hardened Communications Group of Renesas Electronics America, Palm Bay, FL 32905, USA

SEE and TID Test Results of Radiation Hardened Superjunction P-Channel MOSFETs 185
Oscar Mansilla; IR HiRel, an Infineon Technologies Company, 35 New England Business Center Drive, Suite 100, Andover, MA, 01810 USA, and Rushi Patel; IR HiRel and is currently with Blue Origin, 300 Continental Blvd, El Segundo, CA 90245,USA

Total Dose and SEE Testing of the ISL73847SEH Single/Dual Phase Current Mode PWM Controller 189
N. W. van Vonno, W. H. Newman, L. G. Pearce, E. J. Thomson, and Hy Trang; Renesas Electronics America, Palm Bay, Florida 32905

Proton Radiation Effect on Barrier Infrared Detector Focal Plane Arrays 194
Alireza Azizi, Siamak Forouhar, Sarath Gunapala, Sir Rafol, Alexander Soibel, Yuki Maruyama, Sam Keo, David Ting, and Sergeh Vartanian; Jet Propulsion Laboratory, California Institute of Technology

An Examination of the Radiation Sensitivity of Electronic Display Pixel Technologies 199
Landen D. Ryder; NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA, Edward J. Wyrwas; SSAI Inc., Greenbelt, MD 20771 USA, Geraldo A. Cisneros, Justin R. Bautista; NASA Johnson Space Center, Houston, TX 77058 USA, Xiaojing Xu; NASA Langley Research Center, Hampton, VA 23666 USA, Tyler M. Garrett; NASA Johnson Space Center, Houston, TX 77058 USA, Michael J. Campola; NASA Goddard Space Flight Center, Greenbelt, MD 20771 USA, and Razvan Gaza; NASA Johnson Space Center, Houston, TX 77058 USA

Characterization of Low Dose Rate Ionizing Radiation Effect on the Micropac 66266-303 Optocoupler 206
Yonghua Liu, Gene Armstrong, Bob Campanini; Micropac Industries, Inc., Garland, Texas 75040, USA, Scott Messenger, and John Rodriguez; Northrop Grumman Corporation, Linthicum Heights, Maryland 21090, USA

Effects of Neutron Radiation on the Current Transfer Ratio of GaAsP and AlGaAs Optocouplers 210
Pedro Martín-Holgado, Amor Romero-Maestre; Centro Nacional de Aceleradores (Universidad de Sevilla, CSIC, JA). Avda. Tomás A. Edison number 7, E-41092 Sevilla, Spain, José de-Martín-Hernández, José J. González-Luján, María Ángeles Jalón, Álvaro Ricca-Soaje, Manuel Domínguez; Alter Technology. Avda. Tomás A. Edison number 4, E-41092 Sevilla, Spain, Rudy Ferraro, Rubén García Alía; European Organization for Nuclear Research, CH-1211 Geneva, Switzerland, and Yolanda Morilla; Centro Nacional de Aceleradores (Universidad de Sevilla, CSIC, JA). Avda. Tomás A. Edison number 7, E-41092 Sevilla, Spain

Recent Developments to the Texas A&M University Cyclotron Institute Radiation Effects Facility from 2019-2023 217
Miltiadis Kennas, Brian Roeder, Bruce Hyman, Cody Parker, Gabriel Tabacaru, Geoffrey Avila, George Kim, Henry Clark, Hyo-In Park, and Vladimir Horvat

Comparison of MSU and TAMU Heavy Ion Test Results and Evaluation Output Dependencies of SEUs for the LMK04832-SP 221
Kirby Kruckmeyer; Texas Instruments, Santa Clara, CA. USA, Ram Gooty; Texas Instruments, Tucson, AZ, USA, Samantha Williams; Texas Instruments, Dallas, TX, USA, Vibhu Vanjari; Texas Instruments, Santa Clara CA, USA, and Derek Payne; Texas Instruments, Federal Way, WA, USA

Qualification of a New Total Ionizing Dose Facility using a Hopewell GR420 Irradiator 226
Tamara Vigilant; Texas Instruments Inc., Dallas, Texas 75243 USA, and Shahid Khan; Texas Instruments Inc., Dallas, TX 75243 USA

Single Event Upset Results from the Radiation Hardened Electronic Memory Experiment in a Geostationary Orbit 230
David Alexander; COSMIAC R&D Center of the University of New Mexico, 2350 Alamo Avenue SE, Albuquerque, NM 87106, USA, Jeffrey Love, Alonzo Vera; Ideas Engineering and Technology, 10520 Research Rd. SE, Suite 100, Albuquerque, NM87123, Adam Cover, Zach Daniels; COSMIAC R&D Center of the University of New Mexico, 2350 Alamo Avenue SE, Albuquerque, NM 87106, USA, Wesley Morris; Silicon X, Inc., Austin, Texas, 78726, USA, and David Gifford; Vorago Technologies, 1501 S. MoPac Expressway, Suite 350, Austin, TX 78746-7673, USA

Comparison of Figure of Merit Calculations to On-Orbit Data 234
D. L. Hansen, S. Resor, B. Vermeire, and D. Czajkowski

Cumulative Index 242

Author Index 287