2024 IEEE Radiation Effects Data Workshop (REDW 2024) (in conjunction with 2024 NSREC)

Ottawa, Ontario, Canada 22-27 July 2024



IEEE Catalog Number: CFP24422-POD

ISBN: 979-8-3503-8208-2

Copyright © 2024 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:
 CFP24422-POD

 ISBN (Print-On-Demand):
 979-8-3503-8208-2

 ISBN (Online):
 979-8-3503-8207-5

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



Table of Contents

Guide to the 2023 IEEE Radiation Effects Data Workshop Record	1
David M. Hiemstra; MDA Space Missions, Brampton, Ontario L6Y 0R9 Canada	
Compendium of NASA Goddard Space Flight Center's Recent Radiation Effects Test Results	6
Compendium of Single-Event Effects Test Results for Candidate Electronics at NASA Johnson Space Center from 2023	15
Evan C. Agarwal, Joshua M. Pritts, Kyson V. Nguyen; Jacobs Technology Incorporated, Clear Lake Group, Ryan D. Rinderknecht; CACI International Inc, Stephen J. Martinez; Jacobs Technology Incorporated, Clear Lake Group, Razvan Gaza, Charles R. Bailey, and Brandon D. Reddell; NASA Johnson Space Center, EV5 Electronic Design and Manufacturing Branch, 2101 NASA Parkway, Houston, Texas 77058	13
2024 Compendium of Radiation-Induced Effects for Candidate Particle Accelerator	22
IRRAD/CHARM, a CERN Irradiation Facility for Accelerator and Experiments Radiation Hardness Qualification	20
P. Pelissou; Experimental Physics Department in the Detectors and Technology Group (EP-DT) at CERN, Switzerland, S. Danzeca; Beams Department in the Controls Electronics & Mechatronics Group (BE-CEM) at CERN, Switzerland, D. Bozzato; Health & Safety and Environmental Protection Department in the Radiation Protection Group (HSE-RP) at CERN, Switzerland, F. Ravotti; Experimental Physics Department in the Detectors and Technology Group (EP-DT) at CERN, Switzerland, R. Froeschl; Health & Safety and Environmental Protection Department in the Radiation Protection Group (HSE-RP) at CERN, Switzerland, S. Fiore, J. Lendaro; Beams Department in the Controls Electronics & Mechatronics Group (BE-CEM) at CERN, Switzerland, B. Gkotse, J. Szumega, and G. Pezzullo; Experimental Physics Department in the Detectors and Technology Group (EP-DT) at CERN, Switzerland	30
Heavy-Ion Radiation Effects Facility Developments at Michigan State University	36
Abe Yeck, Scott Cogan, Douglas McNanney, Brandon Phan, Hannah Eastman, Randy Rencsok, Guillaume Machicoane, and Steve Lidia; Facility for Rare Isotope Beams at Michigan State University; East Lansing, USA	
Results of Single Event Effect Testing at the New HEARTS@CERN High-Energy Heavy Ion	/11
Facility at CERN. Andrea Coronetti, Mario Sacristan Barbero; CERN, CH-1211 Geneva, Switzerland; Institute d'Électronique et des Systemes, Université de Montpellier, 34090 Montpellier, France, Kacper Bilko, Natalia Emriskova, Eliott Johnson, Karolina Maria Klimek, Andreas Waets, and Rubén García Alía; CERN, CH-1211 Geneva 23, Switzerland	41

High Energy, Heavy Ion Testing at Brookhaven National Laboratory: Facility & Operations Update
Trevor Olsen; Collider-Accelerator Department, Brookhaven National Laboratory, Upton, NY 11973, USA and Kevin A. Brown; Collider-Accelerator Department, Brookhaven National Laboratory, Upton,
NY 11973, USA; ECE Department, Stony Brook University, Stony Brook NY, 11794, USA
New Fusion Linear Accelerator for Radiation Effects (FLARE TM) Testing Facility Proof of Concept Tests and Potential Use Cases
Catherine Kolb, Martin Wissink, and Lucas Jacobson; SHINE Technologies, LLC; Janesville, WI, USA
Assessing the Suitability of a 28nm European FPGA for CERN LHC Environments: An In-Depth Radiation Qualification Study
Lars Koers, Richard Jung; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland; University of Applied Sciences and Arts Dortmund, 44139 Dortmund, Germany, Antonio Scialdone; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland; IES-UMR UM/CNRS 5214, Üniversite de Montpellier, 34095 Montpellier, France, Rudy Ferraro; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland, Michael Karagounis; University of Applied Sciences and Arts Dortmund, 44139 Dortmund, Germany, Salvatore Danzeca, and Alessandro Masi; European Organization for Nuclear Research (CERN), 1211 Geneva, Switzerland
Irradiation Campaign on TinyVers: A System-on-Chip for Ultra-Low Power NN Inference
Single Event Effects and TID Characterization of the Frontgrade Technologies UT24CP1008 CertusProTM-NX-RT FPGA for Space Applications
Thun, and Owen Watry; Frontgrade Technologies, 4350 Centennial Blvd., Colorado Springs, CO 80907
Proton Testing of Texas Instruments TDA4VM SoC74
S. C. Davis, N. Belstein, J. K. Crook, D. P. Enright, and J. L. Taggart; The Aerospace Corporation, El Segundo, CA 90245
Single Event Upset Characterization of the LS1046A Microprocessor using Proton Irradiation79 David M. Hiemstra; MDA, Brampton, Ontario L6Y OR9 Canada and Nelson Hu; Brampton, Ontario L6S 4J3 Canada
Single Event Upset Characterization of the Versal® XCVC1902 Dual-Core ARM® Cortex TM A72 Application Processor Unit using Proton Irradiation
David M. Hiemstra and Nelson Hu; MDA, Brampton, Ontario L6Y 0R9 Canada
Single Event Upset Characterization of Microsemi RISC-V Softcore Processors on Polarfire MPF300T-1FCG1152E FPGA using Proton Irradiation
Devin P. Ramaswami; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, David M. Heimstra; MDA, Brampton, Ontario L6S 4J3 Canada, Shuting Shi, Zongru Li, and Li Chen; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
Protons Evaluation of 7nm Versal [™] AI Engine (AIE) Based Radiation Tolerant Platform for Deep Learning Applications89
Pierre Maillard, Abhijitt Dhavlle, Yanran Paula Chen, Nicholas Fraser, Yushan Chen, Nicholas Vacirca, Jeff Barton, Martin L. Voogel, and Minal Sawant; AMD/XILINX, 2100 logic drive, 95124, San Jose, CA, USA

Proton and Heavy-Ion Characterizations on Microchip PolarFire® SoC FPGA Microprocessor Subsystem
Shintaro Toguchi, Nadia Rezzak; Microchip Technology Inc, San Jose, CA 95134, USA, Daire McNamara; Microchip Technology Inc, The Liberties, Dublin D08 C6XP, Ireland, Ian Bryant; Microchip Technology Inc, Caldicot Np26 5YW, UK, Maddie Madugoda, Raul Chipana Quispe, and Mahmud Reaz; Microchip Technology Inc, San Jose, CA 95134, USA
Single Event Effects and Total Ionizing Dose Characterization of MNEMOSYNE STT MRAM Prototype with 1.8V SPI Interface
Simone Gerardin, Marta Bagatin; Padova University, via Gradenigo 6B, 35131 Padova, Italy and with with Istituto Nazionale di Fisica Nucleare (INFN), Padova, Italy, Pierre-Xiao Wang, Pierre Kohler, Alexandre Bosser; 3D PLUS, 408 rue Hélène Boucher, 78532 BUC CEDEX, France, Lionel Gouyet, Gaël Vignon; TRAD, 907, voie l'Occitane, 31670 - Labège, France, Paul Zuber, and Geert Thys; IMEC, Kapeldreef 75, 3001, Leuven, Belgium
Analysis of Threshold Voltage Options on Flip-Flop SEU Performance at GF 12-nm FinFET Node108 Jiesi Xing, Christopher J. Elash, Peiman Pour Momen, Dylan Lambert, Jaime Cardenas Chavez; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon, SK S7N 5A9, Canada, Shi-Jie Wen, Rita Fung; Cisco Systems, San Jose, CA 95134, USA, and Li Chen; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon, SK S7N 5A9, Canada
SEU and SEFI Characterization of a Frontgrade 18GB DDR4 Memory for Space Applications
Testing of Radiation Hardened Power MOSFET Fabricated at LA Semiconductor115 Adalin Benedetto; Member is with Alphacore Inc., 304 S Rockford Dr, Tempe, AZ 85288, USA and Paul Benedetto; LA Semiconductor LLC, 2300 W Buckskin Rd, Pocatello, ID 83201, USA
Radiation Evaluation of the TPS7H6003-SP Radiation-Hardness-Assured (RHA) Gallium Nitride
(GaN) Field Effect Transistor (FET) Gate Driver
Radiation Evaluation of the TPS7H2140-SEP 32V, 160mΩ Quad-Channel eFuse124
A. Marinelarena, J. Cruz-Colon, and T. Lew; Texas Instruments Inc. 12500 TI Blvd Dallas, TX 75243
Understanding Commercial Power MOSFET Survivability in a Heavy-Ion Environment using High Throughput Screening
Dante Castelli, Omair Ahmad, Cedric Kong, Henry Diggins, Kirsten Diggins, and Zachary J. Diggins; Cyclo Technologies DBA Nucleon; Bellevue, WA USA
Total Dose and Single-Event Effects Testing of the ISL73006SLH and ISL73007SEH Point-Of-Load Regulators
M. L. Campanella, W. H. Newman, N. W. van Vonno, B. J. Rabel, L. G. Pearce, C. E. Thomson, and E. J. Thomson; Radiation Hardened Communications Group of Renesas Electronics America, Palm Bay, FL 32905, USA
Heavy Ion and Laser-Induced Single-Event Effects Test Results for a Low-Dropout Regulator and
Voltage Feedback Amplifiers

Total Ionizing Dose and SEE Testing of the TPS7H4011-SP 14V, 12A Synchronous Buck Converter144 <i>Kyle Rakos, Trevor Hubbard, Anthony Marinelarena, and Tyler Lew; Space Power, Texas Instruments, Dallas, Texas, USA</i>
LDR Testing of 2N4861 JFET and RH1009 2.5V Reference for Europa Clipper UVS
Total Non-Ionizing Dose Characterization of Microchip LX7720
Radiation Effects Testing of the LTC3115-1 DC/DC Voltage Converter with Heavy Ions and Protons
R. Koga, S. Davis, and A. Yarbrough; The Aerospace Corporation, El Segundo, CA 90245
Single Event Effects Testing for Integrated GaN Power Devices
Total Ionizing Dose Testing of a Current Sense Amplifier for Space Applications
A Space Qualified High Accuracy Linear-in-dB RMS Detector with High Dynamic Range
TID and ELDRS Evaluation of SiGe HBTs Integrated in a 45-nm PDSOI BiCMOS Process
Functional Failure and Parametric Degradation of Commercial-off-the-Shelf Electronics Irradiated with High Energy Protons
Combined Total Dose and Displacement Damage Testing of the ISL71831SEH 32-Channel
N. W. van Vonno, W. H. Newman, L. G. Pearce, E. J. Thomson, and M. L. Campanella; Renesas Electronics America, Palm Bay, Florida 32905

TID Effects on Random Telegraph Signals in GF 12LP FinFET Devices	188
J. Neuendank; Department of Electrical, Computer and Energy Engineering, Arizona State University;	
Tempe, AZ, 85287, USA, S. Bonaldo; Department of Information Engineering, University of Padova,	
Italy, 35131, F. Mamun, Z. Giorno, H. J. Barnaby, T. Wallace; Department of Electrical, Computer and	
Energy Engineering, Arizona State University; Tempe, AZ, 85287, USA, M. Nour; SkyWater Technology,	
Bloomington, MN, 55425, USA, M. Spear, T. Kirby, and R. Dempsey; Department of Electrical,	
Computer and Energy Engineering, Arizona State University; Tempe, AZ, 85287, USA	
Computer and Energy Engineering, Artzona state Oniversity, Tempe, AZ, 05207, 0521	
Radiation Effects Characterization of TI AFE11612-SEP High-Density General-Purpose Monitor	
and Control Systems (July 2024)	197
R. Jain and V. Narayanan; Texas Instruments Incorporated, Dallas, TX 75243 USA	
Heavy Ion Characterization of GaN HEMT Hybrids under RF Loading	202
Justin J. Likar, Justin Dennison; Johns Hopkins University Applied Physics Laboratory, Laurel, MD	
USA, Jason Osheroff; Jason Osheroff is with NASA Goddard Space Flight Center; Greenbelt, MD USA,	
Sam Reynolds, Keyshawn Nunely, and Maile Harris; Johns Hopkins University Applied Physics	
Laboratory, Laurel, MD USA	
Heavy-Ion SET and SEL Response of a Wide-Band Operational Amplifier Fabricated in the	• • •
SkyWater S90LN 90 nm Process	209
J. L. Carpenter, T. D. Loveless, J. Kim; Intelligent Systems Engineering Department, Indiana University	
Bloomington, 2425 N. Milo B. Sampson Lane, Bloomington, IN, 47408, USA, J. Pew, R. Young;	
Electrical Engineering Department, University of Tennessee at Chattanooga, Chattanooga, TN, M. Nour,	
P. Manos, M. Chambers; SkyWater Technologies, Bloomington, MN, H. J. Barnaby, and J. Neuendank;	
Electrical Engineering Department, Arizona State University, Tempe, AZ	
CEE I T-4-I D DI464b - ICI 711 40CI HM 0 -Ch I H' I D 1.4 L'4 000h	
SEE and Total Dose Results of the ISL71148SLHM 8-Channel High Precision 14-bit, 900ksps SAR ADC	215
W. H. Newman, N. W. van Vonno, M. Campanella, J. Harris, J. Brik, D. Thornberry, C. Michalski, and E.	213
J. Thomson; Advanced Mixed Signal and ASIC Solutions Group of Renesas Electronics America, Palm	
Bay, FL 32905, USA	
Radiation Characterization Results of AF54RHC 300 krad (Si) Logic Family	220
A. Ghoshal, A. Billings, J. Cortman, M. Hamlyn, A. Quiroz; Apogee Semiconductor, Plano, TX 75074	220
USA, and T. Farris; Archon, LLC, Grapevine, TX 76051 USA	
Cost, with 1.1 with, illevioli, EEC, Grapeville, 111 / 0001 Cost	
Radiation Effects Characterization of TI ADC128S102-SEP Analog to Digital Converter	
(ADC) (July 2024)	224
V. Narayanan, R. Jain, and T. Senter; Texas Instruments Incorporated, Dallas, TX 75243 USA	
	220
Radiation Test Results from a Survey of Recent e.MMC Managed Flash Devices	228
Ian A. Troxel and Matthew Gruber; Troxel Aerospace Industries, Inc., 2023 NE 55th Blvd. Gainesville	
FL 32641	
TID and SEE Degrange of the AD524CD7 Instrumentation Amplifica	221
TID and SEE Response of the AD524CDZ Instrumentation Amplifier	231
J. Cardenas Chavez; Department of Electrical and Computer Engineering, University of Saskatchewan,	
Saskatoon, Saskatchewan, Canada, D. M. Hiemstra; MDA, Brampton, Ontario L6S 4J3 Canada, A.	
Noguera Cundar, B. Johnson, D. Baik, and L. Chen; Department of Electrical and Computer	
Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada	

TID and SEE Response of the COTS LI-OV9712-USB-M8 Camera	235
A. Noguera Cundar; Department of Electrical and Computer Engineering, University of Saskatchewan,	
Saskatoon, Saskatchewan, Canada, D. M. Hiemstra; MDA, Brampton, Ontario L6S 4J3 Canada, J.	
Cardenas Chavez, N. Phonsavath; Department of Electrical and Computer Engineering, University of	
Saskatchewan, Saskatoon, Saskatchewan, Canada, M. Pajuelo; Department of Biomedical Engineering,	
University of Victoria, Victoria, British Columbia, Canada, and L. Chen; Department of Electrical and	
Computer Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada	
TID and SEE Evaluation of the ADALM PlutoSDR Transceiver	239
R. Moody; Department of Electrical and Computer Engineering, University of Saskatchewan, Saskatoon,	
Saskatchewan, Canada, J. Yang; Department of Mechanical Engineering. University of Alberta,	
Edmonton, Alberta, Canada, D. M. Hiemstra; MDA, Brampton, Ontario L6S 4J3 Canada, B. Sun, J.	
Cardenas Chavez, A. Noguera Cundar, and L. Chen; Department of Electrical and Computer	
Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada	
TID Response of Commercial-of-the-Shelf Operational Amplifiers	241
B. Sun, R. Moody; Department of Electrical and Computer Engineering, University of Saskatchewan,	
Saskatoon, Saskatchewan, Canada, D. M. Hiemstra; MDA, Brampton, Ontario L6S 4J3 Canada, J. Yang;	
Department of Mechanical Engineering. University of Alberta, Edmonton, Alberta, Canada, A. Noguera	
Cundar, J. Cardenas Chavez, and L. Chen; Department of Electrical and Computer Engineering,	
University of Saskatchewan, Saskatoon, Saskatchewan, Canada	
Onversity of Suskutchewan, Suskutoon, Suskutchewan, Canada	
Irradiation of Commercial Equipment for Robotic Applications in a Highly Ionizing	244
Radiation Field	244
E. Simova and K. Stoev; Canadian Nuclear Laboratories, Chalk River, Ontario, Canada	
Electron Transport in Solid and Shell Geometries	250
Thomas M. Jordan; Founder and Chief Physicist, Experimental and Mathematical Physics Consultants,	
North Potomac, MD USA, Philippe Calvel; Founder and Chief Executive, RADCONSULT, Muret,	
Occitanie, France, and Marc Marin; Technical Director, Alter Technology TüV Nord, Toulouse, France	
Cumulative Index	255
Author Index	302