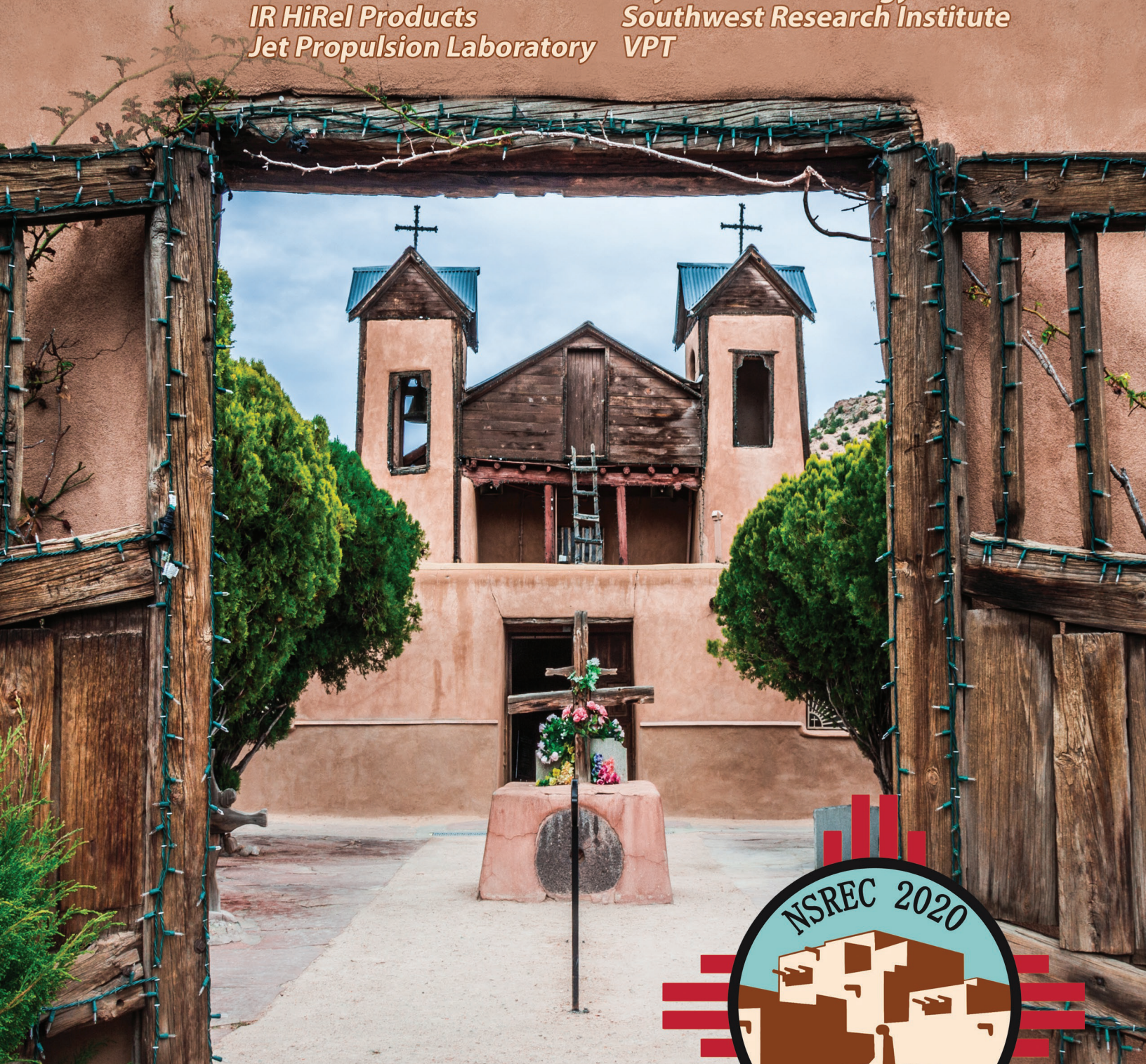


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November 29 - December 30, 2020

Virtual Santa Fe, NM

Sponsored by: IEEE/NPSS Radiation Effects Committee

NSREC VIRTUAL SCHEDULE

Sunday, November 29 - Tuesday, December 8, 2020

(Times listed as EST)

**On-Demand Recordings and Exhibit Hall Also
Open December 5-30, 2020**

Sunday, Nov. 29 AND Monday, Nov. 30

15 Minutes	Introduction: Short Course , Dr. Ken Galloway, Chair	Pre-recorded & ON DEMAND for 48 hours, starting at 00:01 Sunday and ending at 24:00 EST Monday
75 Minutes	Part 1: RADIATION EFFECTS IN A POST-MOORE WORLD , Dr. Dan Fleetwood	
75 Minutes	Part 2: RADIATION EFFECTS IN EMERGING MEMORIES , Dr. Matthew Marinella	
75 Minutes	Part 3: WIDE-BANDGAP POWER - SiC and GaN – RADIATION RELIABILITY , Dr. Jean-Marie Lauenstein	
75 Minutes	Part 4: RADIATION HARDNESS ASSURANCE IN THE "WILD WEST" OF COMMERCIAL SPACE , Dr. Robert Baumann	

Tuesday, December 1

9:00 - 10:00	Short Course Q and A , Ken Galloway and Short Course Presenters	LIVE CHAT
10:00 - 10:10	Opening Remarks , Hugh Barnaby, Chair	Pre-Recorded
10:10 - 10:30	Awards , Janet Barth, Radiation Effects Steering Group Chair	
10:30 - 10:40	Technical Session Introduction , Philippe Adell, Technical Program Chair	
10:40 - 12:20	Introductions: Session A - Basic Mechanisms of Radiation Effects , Philippe Paillet; Session B - Single Event Effects: Mechanisms and Modeling , Philippe Roche (Room 1: A1 - A3; Room 2: B1 - B5)	
11:30 - 13:00	Visit the Exhibits - Exhibit Hall (exhibits will be staffed)	LIVE
12:20 - 12:50	BREAK & WEBINARS	LIVE
12:20 - 12:50	Renesas/Intersil Space – A New Radiation Hardened Precision ADC	
12:20 - 12:50	Oak Ridge National Lab – SEEMS – A New Facility for SEE Testing & Muon Spectroscopy	
12:50 - 13:50	Live Q and A for Sessions A, B (Room 1: Q and A Session A; Room 2: Q and A Session B)	LIVE CHAT

Wednesday, December 2

8:30 – 9:00	Cobham – CAES New Product Webinar	LIVE
9:00 - 10:00	Manhattan: The View from Los Alamos of History's Most Secret Project , Alan B. Carr	Pre-Recorded
10:00 - 12:30	Introductions: Session C - Radiation Effects in Devices and Integrated Circuits , Randall Milanowski; Session D - Photonic Devices and Integrated Circuits , Adriana Morana (Room 3: C1 - C9; Room 4: D1 - D4)	Pre-Recorded
11:30 - 13:00	Visit the Exhibits - Exhibit Hall (exhibits will be staffed)	LIVE
12:30 - 13:00	BREAK & WEBINARS	LIVE
12:30 - 13:00	3D-Plus USA – New Product Overview	
12:30 - 13:00	TRAD – FASTRAD® Live Demonstration	
13:00 - 14:00	Live Q and A for Sessions C, D (Room 3: Q and A Session C; Room 4: Q and A Session D)	LIVE CHAT

On-Demand Recordings and Exhibit Hall Also Open December 5-30, 2020

Thursday, December 3

8:00 – 8:30 9:00 – 10:00	Cobham Gaisler – Live Webinar My Search for Roswell , Tom Carey	LIVE Pre-Recorded
10:00 – 12:30	Introductions: Session E - Single Event Effects: Devices and Integrated Circuits , Georgios Tsiligiannis; Session F - Terrestrial and Space Environments , Athina Varotsou; Session G - Dosimetry , Peter Beck (Room 5: E1 - E6; Room 6: F1 - F2; Room 7: G1 - G5)	
11:30 – 13:00	Visit the Exhibits - Exhibit Hall (exhibits will be staffed)	LIVE
12:30 – 13:00 12:30 – 13:00 12:30 – 13:00	BREAK & WEBINARS Robust Chip - Rad Hard Standard Cell Libraries in Advanced FinFET Technology EPC Space – Gallium Nitride (GaN) in Space	LIVE
13:00 – 14:00	Live Q and A for Sessions E, F, G (Room 5: Q and A Session E; Room 6: Q and A Session F; Room 7: Q and A Session G)	LIVE CHAT

Friday, December 4

9:00 – 11:30	Introductions: Session H - Hardness Assurance Technologies, Modeling, and Testing , Greg Allen; Session I - Radiation Hardening by Design , Jeffrey Maharrey (Room 8: H1 - H6; Room 9: I1 - I5)	Pre-Recorded
11:30 – 12:00 11:30 – 12:00 11:30 – 12:00	BREAK & WEBINARS Apogee Semiconductor – Product and Services Overview ST - RHRPMPOL01, a 7A Monolithic Synchronous Step-Down Regulator for Rad-Hard Point of Load Applications	LIVE
12:00 – 13:00	Live Q and A for Sessions H, I (Room 8: Q and A Session H; Room 9: Q and A Session I)	LIVE CHAT
13:00 – 15:00 13:00 – 13:30 13:00 – 13:30 13:30 – 14:00 13:30 – 14:00 14:00 – 14:30 14:00 – 14:30 14:30 – 15:00 14:30 – 15:00	Exhibit Reception & Webinars - Exhibit Hall ProNova – ProNova Solutions Radiation Effects Overview Presentation Silicon Technologies - RadHard Precision Analog in a Digital Timescale SkyWater - Update on 90 nm Strategic Rad-Hard by Process Platform Silvaco – Building Reliable Electronics from Atoms to Systems TopLine – Solder Columns - Extending Operating Life For 20 Year Missions Analog Devices - Commercial Space Products for Lower Cost Satellites IR HiRel - Upgrading a Flight-Proven DC-DC Converter with R9 Silicon MOSFETs Tower Jazz – Tower Semiconductor Aerospace and Defense Technology Solutions	LIVE

Monday, December 7

9:00 – 10:00	Young Professionals Talk: Space Community Microelectronics Workforce Development for the 21st Century – Diverse, Intentional, Scalable , Dr. Jonathan Pellish, NASA GSFC	Pre-Recorded & LIVE CHAT
10:00 – 12:30	Radiation Effects Data Workshop Session with Introduction : Farokh Irom	
11:30 – 13:00	Visit the Exhibits - Exhibit Hall (exhibits will be staffed)	LIVE
12:30 – 13:00 12:30 – 13:00 12:30 – 13:00	BREAK & WEBINARS EMPC – High Density RayTrace Analysis and Mapping Options using NOVICE Texas Instruments – High Speed Data Converters for Space	LIVE
13:00 – 14:00	RADIATION EFFECTS COMMITTEE ANNUAL OPEN MEETING	LIVE CHAT

Tuesday, December 8

9:00 - 10:00	Women in Engineering Talk: Success and Failure: Tales of Celebration and Learning from the Scientist's Perspective , Lisa Danielson, Los Alamos National Laboratory	Pre-Recorded & LIVE CHAT
10:00 - 13:00	Poster Session with Introduction: Andrew Sternberg	
11:30 - 13:00	Visit the Exhibits & Webinars - Exhibit Hall	LIVE
11:30 - 12:00	Renesas/Intersil Space – RadHard Plastic Components	
11:30 - 12:00	Alpha Core - High Performance FDSOI Mixed Signal IP and Rad-Hard Technology	
12:00 - 12:30	Analog Devices - Commercial Space Products for Lower Cost Satellites	
12:00 - 12:30	Texas Instruments – High Speed Clocking for Space	
12:30 - 13:00	ProNova - ProNova Solutions Radiation Effects Overview Presentation	
12:30 - 13:00	EPC Space - Gallium Nitride (GaN) in Space	

Chairman's Invitation



"It is my great pleasure to invite you to attend the first virtual IEEE NSREC. Our conference committee has assembled an outstanding technical and short course program for all attendees, with many interesting and important presentations on radiation effects. While fully online, the conference will offer an array of opportunities for attendees, authors, and industrial exhibitors to interact in live venues and other online platforms. It will be different for sure, but we are confident that the program will be well worth it! I would like to thank the many volunteers, supporters, staff, authors, exhibitors, and attendees for their important contributions to making the NSREC 2020 conference a great success."

Hugh Barnaby
NSREC 2020 General Chair
Arizona State University

2020 is unlike any other year we have experienced. The pandemic has caused tragic loss of human life and upended life as we have known it. Businesses have struggled to keep afloat or to meet their obligations. Many individuals have suffered unemployment. Medical facilities and medical personnel have been stressed. Educational institutions – kindergarten to the university – have been challenged to find a balance between online learning and in-person classes.

IEEE NSREC 2020 – the 57th - will not be like any other.

Early in this year, the NSREC 2020 Committee was busily organizing for an on-site, in-person conference in the beautiful and historic Santa Fe New Mexico area. A strong technical program was coming together, sponsors and exhibitors signed, and local arrangements were being made for an exceptional social program. Then it became clear that, due to public health precautions and travel restrictions, our plans had to change.

It is my pleasure to invite you to attend the first virtual IEEE NSREC. I do so on behalf of the IEEE, its Nuclear and Plasma Sciences Society (NPSS), the Radiation Effects Steering Group (RESG) and the 2020 IEEE Nuclear and Space Radiation Effects Conference (NSREC) committee and volunteers. The conference will "go live" on-line from November 29 through December 8 (see detailed schedule in this brochure). We have added opportunities for the attendees to interact with speakers, exhibitors, and one-another. The content will continue to be available on-line until December 30.

As is customary, the conference begins with a Short Course "New Technologies Meet Radiation Effects" organized by **Ken Galloway**, Vanderbilt University. The course consists of four lectures given by subject matter experts. An extensive set of written notes (that can be downloaded) will be a useful study guide and a valued technical reference. This year the Short Course will be available to all registered attendees.

The Technical Program will occur "live" from December 1 to December 8. **Philippe Adell**, NASA Jet Propulsion Laboratory, the Technical Program Chair, along with his technical committee, have chosen an outstanding set of contributed papers for presentation. And, a useful and high quality Radiation Effects Data Workshop will be part of the program. Finally, Philippe has invited two engaging speakers to give general interest presentations as part of the schedule.

Scott Jordan, Jazz Semiconductor Trusted Foundry, has organized a virtual Industrial Exhibit. It will allow one-on-one discussions between attendees and exhibitors in areas such as radiation survivable electronics, test resources, engineering services, equipment, and modeling. Please visit these outstanding exhibitors who have continued to support NSREC as we enter this "brave new world."

Your Conference Committee members hope that you join us on-line for the first virtual NSREC. Our international radiation effects community is strong and resilient. We anticipate a technically excellent, very interesting, and different IEEE NSREC 2020 experience.

Visit us on the web at:
www.nsrec.com

Short Course Program

NEW TECHNOLOGIES MEET RADIATION EFFECTS

IEEE NSREC 2020 VIRTUAL SHORT COURSE

The IEEE NSREC 2020 Short Course will be available on-demand for 48 hours starting 00:01 EST Sunday November 29 and ending at 24:00 EST Monday November 30. It will also be available on-demand from December 5 through December 30 to registered attendees. A live Q&A session will be held with the lecturers on Tuesday December 1 from 09:00 until 10:00 EST. Questions for this session will be selected from questions provided by “chat” during the lectures.

The Short Course Notes will be available for download by registered attendees. Please remember that the Short Course material has an IEEE copyright and is intended for the use of the attendee.

SHORT COURSE INTRODUCTION

Dr. Ken Galloway, *Vanderbilt University*

PART I - RADIATION EFFECTS IN A POST-MOORE WORLD

Dr. Dan Fleetwood, *Vanderbilt University*

PART II - RADIATION EFFECTS IN EMERGING MEMORIES

Dr. Matthew Marinella, *Sandia National Laboratories*

PART III - WIDE-BANDGAP POWER - SIC AND GAN – RADIATION RELIABILITY

Dr. Jean-Marie Lauenstein, *NASA Goddard Space Flight Center*

PART IV - RADIATION HARDNESS ASSURANCE IN THE "WILD WEST" OF COMMERCIAL SPACE

Dr. Robert Baumann, *Radiosity Solutions LLC and Southern Methodist University*

EXAM (available online only for students requesting CEU credit)

Short Course attendees will receive an electronic copy of the 2020 Short Course Notes.

Short Course

COURSE DESCRIPTION

A one-day short course entitled “*New Technologies Meet Radiation Effects*” will be presented at the 2020 IEEE Nuclear and Space Radiation Effects Conference. Feature-size scaling, new materials, and new device concepts enable new and improved capabilities that are desirable for space-borne electronic systems. How these new technologies respond in the space radiation environment and how they are qualified for use need careful evaluation. This short-course will address challenges of using faster, smaller and higher functioning devices developed by the semiconductor industry in the space radiation environment.

The short course will consist of four lectures. Each lecture will include introductory material and advanced topics. The first lecture will discuss the effects of scaling device and circuit geometries and how scaling affects radiation response. The second focuses on new and emerging non-volatile memory technologies and their radiation survivability. The third lecture deals with advances in wide-bandgap power devices and the radiation reliability of these technologies. The final lecture addresses the use of commercial-of-the-shelf components (COTS) and radiation hardness assurance for commercial space systems. A description and a brief outline for each lecture follows. The topics covered should be of benefit to those new to the field, as well as experienced engineers and scientists, by providing up-to-date material and insights.

The intended audience is radiation effects engineers, component specialists, system designers, and other technical and management personnel involved in developing reliable systems designed to operate in radiation environments. It provides a unique opportunity for IEEE NSREC attendees to benefit from the expertise of excellent instructors, along with a critical review of state-of-the-art knowledge in the field. Electronic copies of detailed course notes will be provided to those who attend the short course.

CONTINUING EDUCATION UNITS (CEUs)

For those interested in Continuing Education units (CEUs) will be available. For those attendees interested, an exam will be available online only for students requesting CEU credit. The course is valued at 0.6 CEUs, and is endorsed by the IEEE and by the International Association for Continuing Education and Training (IACET).

SHORT COURSE CHAIRMAN



*Ken Galloway
Vanderbilt University
School of Engineering
Short Course Chair*

Ken Galloway is a Distinguished Professor of Engineering, *Emeritus*, and Dean of the School of Engineering, *Emeritus*, at Vanderbilt University. His research has focused on radiation effects in semiconductor electronics including device modeling and simulation and device and circuit characterization. He has contributed to both fundamental and applied studies of bipolar and MOS technologies, power semiconductor devices, and devices based on emerging materials. He served as Technical Chair of the 1982 IEEE Nuclear and Space Radiation Effects Conference (NSREC), General Chair of NSREC 1985, and Chairman of the IEEE NPSS Radiation Effects Steering Group (1991-1994). He was a short course presenter at NSREC 1996 and 2013. He is currently a member of the IEEE NPSS AdCom representing the Radiation Effects Technical Committee. Professor Galloway is an IEEE Fellow and received the IEEE NPSS Radiation Effects Committee’s Radiation Effects Award, the IEEE NPSS Richard F. Shea Distinguished Member Award, and the Yuri Gagarin Award from the RADECS Association.

Short Course



Dan Fleetwood received his Ph.D. from Purdue University in 1984. He joined Sandia National Laboratories, Albuquerque, in 1984, and was named a Distinguished Member of Technical Staff in 1990. Dan joined Vanderbilt University as a Professor of Electrical Engineering in 1999. In 2003, he was named Chairman of Vanderbilt's Department of Electrical Engineering and Computer Science, and in 2009, he was named Olin H. Landreth Chair in Engineering. He is the author of more than 600 publications in the areas of radiation response and reliability of microelectronic devices and materials, low-frequency noise, and defects in microelectronic materials and devices. He serves as senior editor for radiation effects of the IEEE Transactions on Nuclear Science, distinguished lecturers chair of the IEEE Nuclear and Plasma Sciences Society, and vice-chair for publications of the Radiation Effects Technical Committee of the IEEE NPSS. Professor Fleetwood received the 2009 IEEE NPSS Merit Award, the society's highest technical honor, and he is a Fellow of IEEE, the American Physical Society, and the American Association for the Advancement of Science.

RADIATION EFFECTS IN A POST-MOORE WORLD

Dr. Dan Fleetwood
Vanderbilt University

Dr. Dan Fleetwood, Vanderbilt University, will provide an overview of Moore's Law scaling and its significant influences on radiation effects on microelectronics over the last ~55 years, focusing on historical trends and future needs. The first part of the presentation will highlight milestones in the understanding and evolution of total-ionizing-dose effects, single-event effects, and displacement damage in the era of classical Dennard scaling. The second part of the presentation will illustrate the significant ways in which the end of Dennard scaling has influenced radiation effects due to the increasingly complex and diverse materials and devices that are incorporated in recent CMOS technology nodes. The presentation will conclude with a look forward to a future in which many types of devices are both increasingly vulnerable to radiation effects and difficult to test in a practical and cost-effective manner. The radiation responses of devices with alternative channels to silicon and transistors based on two-dimensional materials will also be discussed, with an emphasis on opportunities and challenges for ultimately scaled devices.

A top-level outline of the presentation is as follows:

- Moore's Law (1965 - ?)
 - o Historical trends and future needs
 - o Dennard scaling/consequences
 - o Technology innovations/impacts
- Radiation Effects Overview (1965 – 2020)
 - o Total ionizing dose effects
 - o Single event effects
 - o Displacement damage effects
- Looking ahead: Post-Moore
 - o Increasing complexity
 - o Alternative channel devices
 - o Two-dimensional materials
 - o Limits to ultimate scaling

Short Course



Matthew Marinella is a Principal Member of the Technical Staff in the Microsystems S&T Center at Sandia National Laboratories, where he leads the Secure, Efficient, Extreme Environment Computing (SEEEEC) Grand Challenge, the Non-volatile Memory Technology Development Program, and projects on neuromorphic and low energy computing hardware. He previously led the neuromorphic hardware task in the HAANA Grand Challenge, as well as internal and externally funded projects involving neuromorphic and low-power computing with emerging electronic devices. Dr. Marinella has served in technical advising and leadership roles in various Lab- and DOE-level initiatives on next-generation computing for government applications. Dr. Marinella is a senior member of IEEE, Executive Committee member of the SRC Decadal Plan, chairs the Emerging Memory Devices Section for the IRDS Roadmap Beyond CMOS Chapter, and has served on various technical program committees including chairing the IRPS Neuromorphic Computing Committee. Prior to starting at Sandia in 2010, he was as a Device Engineer in Microchip's Technology Development Group. He received a Ph.D. in electrical engineering from Arizona State University under Dieter K. Schroder in 2008.

RADIATION EFFECTS IN ADVANCED AND EMERGING NON-VOLATILE MEMORIES

Dr. Matthew Marinella
Sandia National Laboratories

Dr. Matthew Marinella, Sandia National Laboratories, will present an overview of device science, technology, and radiation effects in emerging non-volatile memories. Although NAND Flash remains king of the >\$50B non-volatile memory market, emerging technologies including spin transfer torque magnetic memory (STT-MRAM), resistive memory (ReRAM), phase change memory (PCRAM), conductive bridge memory (CBRAM), and ferroelectric memories (FRAM and FeFET) are all under development by major commercial foundries and/or in small volume production. The tutorial will review the relevant materials science, device physics, reliability, basic array circuitry, and commercial status for each these technologies. This includes a discussion of the effects of radiation on each memory, including the effects of total-ionizing-dose irradiation and displacement damage on switching properties, retention, and endurance of devices. Array-level single event effects such as read and write upsets will be described, as well as combined effects that increase the bit error rate and retention failure probability of a system. Finally, the tutorial will provide an outlook on the role of emerging technologies in future radiation-hard electronics.

A top-level outline of the presentation is as follows:

- Introduction
 - o Memory Technology Overview and Hierarchy
 - o Non-volatile Memory Key Concepts
- Radiation Effects in Charge-Based Memory
 - o Floating Gate and Charge Trapping Memories
 - o Ferroelectric Memories
- Radiation Effects in Emerging Resistive Non-volatile Memories
 - o Spin Transfer Torque Magnetic Memory (STT-MRAM)
 - o Resistive RAM (ReRAM)
 - o Phase Change Memory (PCRAM)
 - o Conducting Bridge Memory (CBRAM)
 - o Array-Level Radiation Effects
- Conclusions

Short Course



Jean-Marie Lauenstein received her Ph.D. degree in electrical engineering from the University of Maryland, College Park, in 2011. She has worked in the NASA Goddard Space Flight Center's Radiation Effects and Analysis Group for 15 years, where she focuses on radiation effects in power devices as well as in detectors and image sensors. She serves as the NASA Electronic Parts and Packaging Program Wide Band Gap Power Device Subtask Lead. Her current focus is on SiC power device susceptibility to heavy-ion induced single-event effects. She has received several awards including the NASA Exceptional Engineering Achievement Medal in 2017, the NASA Early Career Achievement Medal in 2013, and the Barry M. Goldwater Scholarship in 2003. Dr. Lauenstein has served as reviewer and session chair for both the IEEE NSREC and RADECS, and was a short-course presenter at the Topical Day for RADECS 2018.

WIDE BANDGAP POWER – SIC, GAN – RADIATION RELIABILITY

Dr. Jean-Marie Lauenstein

NASA Goddard Space Flight Center

Dr. Jean-Marie Lauenstein, NASA Goddard Space Flight Center, will present radiation effects and mechanisms in silicon carbide (SiC) and gallium nitride (GaN) wide-bandgap power technologies. Both SiC and GaN power devices have undergone several generations of maturation since becoming commercially available. Although these technologies have penetrated into the automotive, wireless, and industrial power markets, their adoption into space applications is hindered in part by their susceptibility to permanent degradation and catastrophic failure from heavy-ion exposure. Recently, substantial progress has been made in understanding heavy-ion effects on wide-bandgap power devices. The modes and mechanisms of damage will be examined and contrasted with those that occur in silicon power devices under heavy ion exposure. The impact of these differences on radiation test methodology and reliability will be presented. This lecture will also cover total-ionizing and non-ionizing dose tolerance and will conclude with a look toward future power technologies, giving a brief snapshot of the status of ultra-wide bandgap gallium oxide.

A top-level outline of the presentation is as follows:

- Introduction
 - Bandgaps simply explained
 - Wide-bandgap technology advantages & applications
 - Inherent radiation hardness from wide bandgaps
- Single-event effects in discrete silicon power devices: a review
- Silicon carbide and gallium nitride power device heavy-ion effects
 - Discrete device structures
 - Modes of damage
 - Mechanisms of effects
- Radiation hardness assurance challenges
 - Test methodology
 - Rate prediction and reliability uncertainties
- A look to the future

Short Course



Robert Baumann earned his Ph.D. in Electrical Engineering from Rice University ('90), while developing ferroelectric thin-film technology for optoelectronic applications. In 1989, he joined Texas Instruments (TI) focusing on DRAM dielectric and soft error reliability. He discovered the reaction of B-10 (in boron-doped glass) with low-energy cosmic-ray neutrons to be a dominant failure mode and developed mitigation that improved reliability by an order-of-magnitude. From 1993 to 1998, he worked at TI Japan on DRAM/CPU/Logic reliability and created a cutting-edge failure analysis team providing decisive root-cause analyses for production issues. In 1998, Robert returned to Dallas where he continued to develop TI's radiation effects program. In 2012, he joined TI's HiRel Group where as chief technologist, he improved radiation characterization capabilities while guiding the development of new aerospace products. In 2018, he retired from TI and started Radiosity Solutions, offering technical consulting, training, and assistance for radiation test campaigns. He is also an adjunct research professor at Southern Methodist University. Robert is an IEEE Fellow and TI Fellow (emeritus). He has authored/presented more than 90 papers, one radiation handbook, two book chapters, and fifteen patents.

RADIATION HARDNESS ASSURANCE IN THE "WILD WEST" OF COMMERCIAL SPACE

Dr. Robert Baumann

Radiosity Solutions LLC and Southern Methodist University

Dr. Robert Baumann, Radiosity Solutions LLC and Southern Methodist University (SMU), will commence with a brief historical examination of how the early space-race zeitgeist of "failure is not an option" defined by the heavy use of aggressively-qualified, highly-customized, and hardened components and solutions, has ultimately been morphed by today's "new space" sector into a mantra of "good enough for the mission" with a focus on employing systems composed largely of up-screened commercial-of-the-shelf (COTS) components. The presentation takes a detailed look at the physical and chemical effects responsible for manufacturing variations in microelectronics quality and reliability and provides specific examples of how these variations impact total ionizing dose and single-event effect performance. The presentation will conclude with a discussion of technology choices, sampling, up-screening, and system-design mitigation approaches to deal with the mission risks posed by using COTS components in spacecraft electronics.

A top-level outline of the presentation is as follows:

- Introduction: Traditional space vs. "new space"
- Microelectronics scaling and manufacturing variation
 - Process and Package
 - Grades
- TID and SEL
 - Very brief review of mechanisms/impact
 - Example of variation changing TID/SEL responses
- Risk mitigation techniques when using COTS
 - Risk of using COTS
 - Process & design choices
 - Technology and operational choices
 - Sampling and qualification
 - System approaches to mitigate risk
- Conclusions

Technical Program

TECHNICAL INFORMATION



"On the behalf of the Technical Program Committee, I would like to invite you to attend the 2020 NSREC Virtual and On-Demand Technical Sessions.. The chairpersons have assembled an exceptional program covering the latest developments about radiation effects in electronic materials, devices and systems. A special thanks to the many dedicated authors and reviewers who work so hard to successfully maintain the high quality standard of this unique technical meeting."

*Philippe Adell,
NASA - Jet Propulsion Laboratory
Technical Program Chair*

The NSREC technical program consists of contributed oral and poster papers, a data workshop and invited talks. The oral presentations will be 12 minutes in duration with an additional three minutes for questions. The technical sessions and their chairpersons are:

- **Basic Mechanisms of Radiation Effects**
Chair: Philippe Paillet, CEA
- **Dosimetry**
Chair: Peter Beck, Seibersdorf Laboratories
- **Hardness Assurance Technologies, Modeling, and Testing**
Chair: Gregory Allen, NASA-JPL
- **Radiation Hardening by Design**
Chair: Jeff Maharrey, Boeing
- **Radiation Effects in Devices and Integrated Circuits**
Chair: Randall Milanowski, Milanowski & Assoc.
- **Photonic Devices and Integrated Circuits**
Chair: Adriana Morana, University of Saint Etienne
- **Single-Event Effects: Mechanisms and Modeling**
Chair: Philippe Roche, ST
- **Single-Event Effects: Devices and Integrated Circuits**
Chair: Georgios Tsiligiannis, University of Montpellier
- **Space and Terrestrial Environments**
Chair: Athina Varotsou, TRAD

POSTER SESSION

Posters are available for viewing December 1- 8. The Virtual Poster Session is Tuesday, December 8 from 10:00 – 13:00 EST with Presenter Live Chat.

RADIATION EFFECTS DATA WORKSHOP

Posters are available for viewing December 1-December 8. The Virtual Poster Session is Monday, December 7 from 10:00 – 12:30 EST with Presenter Live Chat.

INVITED SPEAKERS

There will be two invited talks:

- **Manhattan, The View from Los Alamos of History's Most Secret Project**
Alan Brady, Senior Historian for Los Alamos National Laboratory
- **My Search for Roswell**
Tom Carey, UFO special investigator and anthropologist

Session Chairs



Philippe Roche, STmicroelectronics
Single-Event Effects:
Mechanisms and
Modeling



Randall Milanowski, Milanowski & Associates
Radiation Effects in
Devices and Integrated
Circuits



Georgios Tsiliogiannis, University of Montpellier
Single-Event Effects:
Devices and Integrated
Circuits



Peter Beck, Seibersdorf Laboratory
Dosimetry



Athina Varotsou, TRAD
Space and Terrestrial
Environments



Philippe Paillet, CEA
Basic Mechanisms of
Radiation Effects



Jeff Maharrey, Boeing
Radiation Hardening by
Design



Adriana Morana, University of Saint Etienne
Photonic Devices and
Integrated Circuits



Greg Allen, NASA-JPL
Hardness Assurance
Technologies, Modeling,
and Testing

Technical Program

(all times Eastern Standard Time)

Tuesday, December 1, 2020

10:00 - 10:10

OPENING REMARKS

Hugh Barnaby, Arizona State University, General Chairman

10:10 - 10:30

AWARDS PRESENTATION

Janet Barth, Radiation Effects Steering Group, Executive Chair

10:30 - 10:40

TECHNICAL SESSION OPENING REMARKS

Philippe Adell, Technical Program Chairman

DAY I TECHNICAL SESSIONS (run concurrently)

Session A: BASIC MECHANISMS OF RADIATION EFFECTS

Session B: SINGLE EVENT EFFECTS: MECHANISMS AND MODELING

SESSION A

10:40 - 12:20

BASIC MECHANISMS OF RADIATION EFFECTS

SESSION INTRODUCTION

Chair: Philippe Paillet, CEA

ORAL PRESENTATIONS

A-1

Effects of Bias and Temperature on the Dose-Rate Sensitivity of 65 nm CMOS Transistors

G. Borghello, F. Faccio, G. Terzo, S. Costanzo, H. Koch, CERN, Switzerland, D. Fleetwood, Vanderbilt University, USA

The true dose-rate sensitivity of 65 nm CMOS transistors is evaluated at different temperatures and applied biases. The increased sensitivity is more evident in short-channel transistors and is primarily attributable to spacer-related effects.

A-2

Heavy-ion-induced Displacement Damage Effects in Magnetic Tunnel Junctions with Perpendicular Anisotropy

T. Xiao, C. Bennett, J. Manuel, D. Hugart, R. Jacobs-Gedrim, E. Bielejec, G. Vizkelethy, S. Agarwal, R. Arghavani, M. Marinella, Sandia National Laboratories, USA, F. Mancoff, J. Sun, Everspin Technologies, USA

The resilience of MgO-based perpendicular-anisotropy magnetic tunnel junctions to heavy-ion induced displacement damage is evaluated. Insensitivity to fluences up to 1×10^{11} ions/cm² is demonstrated, and physical mechanisms are proposed to explain the observed degradation.

A-3

Simulation and Modeling of Time-Resolved X-Ray Detector for the Saturn Accelerator

X. Gao, Q. Looker, B. Ulmen, L. Musson, T. Webb, A. McCourt, S. Coffey, Sandia National Laboratories, USA

We present TCAD simulation and modeling of silicon X-ray detectors. Simulations not only reproduce DC characteristics and time-dependent dose-rate responses, but also predict new behavior at high dose rates, providing in-depth physics understanding and guidance.

Technical Program

(all times Eastern Standard Time)

Tuesday, December 1, 2020

POSTER PAPERS

PA-1

LET and Range Characteristics of Proton Recoil Ions in Gallium Nitride (GaN)

J. Osheroff, Science Systems Applications, Inc., USA, J. Lauenstein, R. Ladbury, NASA GSFC, USA

A better understanding of the linear energy transfer and range of proton recoil ions in gallium nitride (GaN) is provided to facilitate proper evaluation of GaN device radiation tolerance.

PA-2

Impact of Total Ionizing Dose on Analog Synaptic Characteristics of CBRAM

P. Apsangi, H. Barnaby, N. Chamele, Y. Gonzalez-Velo, K. Holbert, M. Kozicki, Arizona State University, USA

The changes caused by total ionizing dose in the conductance and linearity of analog CBRAM synapses are studied. FESEM imaging supports the conclusion that changes in conductance are due to loss of filament contact after irradiation.

PA-3

Laser and Heavy Ion Irradiation Effects on Advanced Perpendicular Anisotropy Spin Transfer-Torque Magnetic Tunnel Junctions

O. Coi, G. Di Pendina, E. Gautier, CEA, France, N. Andrianjohany, N. Chatry, TRAD, France, K. Gaarello, IMEC, Belgium, R. Ecoffet, D. Dangla, CNES, France, L. Torres, LIRMM-University of Montpellier 2, CNRS, France

This paper investigates laser and heavy ion radiation effects on perpendicular-anisotropy spin transfer-torque magnetic tunnel junction devices and film stacks.

PA-4

Mapping Radiation Damage in Integrated Circuits Using Single Photon Absorption Charge Injection

E. Auden, Los Alamos National Laboratory, USA, J. Gutierrez, Northeastern University, USA, K. Gnawali, Southern Illinois University Carbondale, USA

Laser-induced single photon absorption charge injection is used to map damaged transistors in integrated circuits irradiated with gamma rays or neutrons. Radiation damage suppresses the charge injection response, resulting in darkened areas in laser scans.

PA-5

Simplified Calculations of Radiation Dose-Rate Sensitivity of Bipolar Transistors

H. Hjalmarson, T. Buchheit, Sandia National Laboratories, USA, H. Barnaby, Arizona State University, USA, P. Adell, NASA-JPL, USA, S. Witczak, Northrop Grumman, USA

A simplified approach to estimating radiation-induced Si-SiO₂ interface trap densities, based on steady-state populations of relevant mobile species, is presented. Calculations are consistent with known trends in dose, dose rate, hydrogen content and temperature.

Technical Program

(all times Eastern Standard Time)

Tuesday, December 1, 2020

SESSION B
10:40 - 12:20

SINGLE EVENT EFFECTS: MECHANISMS AND MODELING

SESSION INTRODUCTION

Chair: Philippe Roche, STMicroelectronics

ORAL PRESENTATIONS

B-1 TIARA: Industrial Platform for Monte Carlo Single Event Simulations in Planar Bulk, FD-SOI and FinFET

T. Thery, G. Gasiot, V. Malherbe, P. Roche, STMicroelectronics, France, J. Autran, Aix-Marseille University, France

We present a Monte Carlo SER simulator for CMOS cells under terrestrial and space environments, illustrated by three use cases: flip-flop comparison in FD-SOI, MCU evaluation in planar bulk, and alpha/neutron simulations in FinFET.

B-2 Analysis of SEGR in Silicon Planar Gate Super-Junction Power MOSFETs

K. Muthuseenu, H. Barnaby, A. Privat, Arizona State University, USA, K. Galloway, Vanderbilt University, USA, T. Maksimenko, V. Anashin, K. Bukhasan, A. Kalashnikova, A. Koziukov, Branch of JSC URSC - ISDE, Russian Federation

Experimental results show that super-junction silicon power MOSFETs have better tolerance to SEGR than VDMOS devices for angular heavy ion strikes. TCAD analysis is used to understand the improved SEGR tolerance in SJ devices.

B-3 Mapping the Spatial Dependence of Charge Collection Efficiency in Devices Using Pulsed-Laser Testing

J. Hales, A. Khachatryan, S. Buchner, D. McMorrow, Naval Research Laboratory, USA, D. Monahan, S. LaLumondiere, The Aerospace Corporation, USA

By scanning the charge deposition profile produced by a pulsed laser throughout a device, the spatially-dependent charge collection efficiency can be determined. This is demonstrated by extracting the depth-dependent charge collection efficiency in two photodiodes.

B-4 Comparison of Single-Event Transients in an Epitaxial Silicon Diode Resulting from Heavy Ion-, Focused X-Ray-, and Pulsed Laser-Induced Charge Deposition

K. Ryder, L. Ryder, A. Sternberg, J. Kozub, E. Zhang, R. Weller,
R. Schrimpf, S. Weiss, R. Reed, Vanderbilt University, USA, S. LaLumondiere, The Aerospace Corporation, USA, A. Khachatryan, S. Buchner, D. McMorrow, Naval Research Laboratory, USA, J. Hales, KeyW Corporation, USA, Y. Zhao, L. Wang, C. Wang, Beijing Microelectronics Technology Institute, China

Heavy ion, focused x-ray, and pulsed laser SET experiments are performed on a Si diode and SET shape characteristics are compared between the different methods. It is shown that test method impacts SET shape characteristics.

Technical Program

(all times Eastern Standard Time)

Tuesday, December 1, 2020

B-5 Laser-Induced Transients in SiGe HBTs Generated via Two-Photon Absorption Using Gaussian and Quasi-Bessel Beams

A. Ildefonso, G. Tzintzarov, D. Nergui, A. Omprakash, J. Cressler, Georgia Institute of Technology, USA, J. Hales, KeyW Corporation, USA, A. Khachatrian, S. Buchner, D. McMorro, Naval Research Laboratory, USA

A comparison of laser-induced single-event transients in SiGe HBTs generated via two-photon absorption using Gaussian and quasi-Bessel beams is presented. Laser and ion data are compared. TCAD simulations are used to explain the differences observed.

POSTER PAPERS

PB-1

Muon-Induced Single-Event Upsets in 20-nm SRAMs: Comparative Characterization with Neutrons and Alpha-Particles

T. Kato, H. Matsuyama, Socionext, Inc., Japan, M. Tampo, S. Takeshita, Y. Miyake, High Energy Accelerator Research Organization, Japan, H. Tanaka, Kyoto University, Japan, M. Hashimoto, Osaka University, Japan

Negative and positive muon-induced single-event upsets are studied in 20-nm planar SRAMs. Results from muon irradiation are compared with results from high-energy and thermal neutrons and alpha particle irradiation. The underlying mechanisms are discussed.

PB-2

An Investigation of SET Charge Transport Mechanisms in SiGe HBTs

D. Nergui, A. Ildefonso, G. Tzintzarov, A. Omprakash, J. Cressler, Georgia Institute of Technology, USA

A fully calibrated 3-D TCAD model is used to investigate charge transport mechanisms during heavy-ion-induced single-event transients in SiGe HBTs.

PB-3

Impact of SiC VD-MOSFET Technology on Terrestrial Neutron Reliability

C. Martinella, R. Garcia Alia, A. Coronetti, Y. Kadi, CERN, Switzerland, R. Stark, U. Grossner, APS - ETH Zurich, Switzerland, C. Cazzaniga, M. Kastriotou, STFC, United Kingdom, A. Javanainen, RADEF, Finland

Commercial SiC power MOSFETs were exposed to terrestrial neutron irradiations. The breakdown voltage degradation and the impact of the SEGR in planar and trench gate design are discussed, highlighting the differences between device technologies.

PB-4

Low and Medium Earth-Orbit Rates Using Design-of-Experiments and Monte-Carlo Methods

D. Hansen, Data Device Corporation, USA

Upset rates in low- and medium-earth orbits were calculated using CREME96 with design of experiments and Monte-Carlo methods. Calculations are compared to on-orbit data. Implications for data collection are discussed.

Technical Program

(all times Eastern Standard Time)

Tuesday, December 1, 2020

PB-5 Mesoplasma Formation and Thermal Destruction in 4H-SiC Power MOSFET Devices Under Heavy Ion Bombardment

J. McPherson, C. Hitchcock, T. Chow, W. Ji, Rensselaer Polytechnic Institute, USA, A. Woodworth, NASA Glenn Research Center, USA

We investigate mesoplasma formation from heavy ion strikes in 4H-SiC power MOSFETs. Simulations involving the time evolution of several parameters have determined that the formation of a mesoplasma occurs within the device.

PB-6L Behavior of Leakage Current in SiC MOS Capacitors Introduced by Heavy Ions

M. Takahashi, Y. Nakada, E. Mizuta, H. Shindou, J. Senzaki, A. Takeyama, T. Makino, T. Ohshima, and S. Kuboyama, Japan Aerospace Exploration Agency (JAEA), Japan

The behavior of leakage current induced by heavy ions in SiC MOS capacitors was found to be quite different from that observed in corresponding capacitors on Si. The responsible mechanism was identified by detailed analysis.

12:20 - 12:50 BREAK

SESSION A BASIC MECHANISMS OF RADIATION EFFECTS

12:50 - 13:50

LIVE QUESTION AND ANSWER SESSION

ROOM 1 *Moderated by Philippe Paillet with Oral Paper Presenters*

SESSION B SINGLE EVENT EFFECTS: MECHANISMS AND MODELING

12:50 - 13:50

LIVE QUESTION AND ANSWER SESSION

ROOM 2 *Moderated by Philippe Roche with Oral Paper Presenters*

END OF TUESDAY SESSIONS

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

INVITED TALK
9:00 - 10:00

Manhattan, The View from Los Alamos of History's Most Secret Project
Alan Carr, Senior Historian for Los Alamos National Laboratory



In August 1942, the Manhattan Project was formally established. Its mission: build an entirely reliable atomic bomb as quickly as possible. It's been estimated that half a million people worked on the project in some capacity at one point or another during the war at installations all over the country. The three main sites were Oak Ridge, Hanford and Los Alamos: MANHATTAN tells the story of the project from the Los Alamos perspective. Led by J. Robert Oppenheimer, the Los Alamos technical staff of approximately 1700 employees designed, built, tested and helped deliver the world's first nuclear weapons in combat only 27 months after the Laboratory held its first, major technical conference. Atomic bombs helped bring history's deadliest conflict to a victorious conclusion, but not before 60-80 million people had been killed worldwide.

Alan B. Carr currently serves as the Senior Historian for Los Alamos National Laboratory. During his tenure as Laboratory Historian, Alan has produced several publications pertaining to the Manhattan Project, nuclear weapons testing, and the Laboratory's development during the Cold War years. He has lectured for numerous professional organizations and been featured as a guest on many local, national, and international radio and television programs. Before coming to Los Alamos, Alan completed his graduate studies at Texas Tech University in Lubbock.

DAY 2 TECHNICAL SESSIONS (run concurrently)

Session C: RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS

Session D: PHOTONIC DEVICES AND INTEGRATED CIRCUITS

SESSION C
10:00 - 12:30

RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS

SESSION INTRODUCTION

Chair: Randall Milanowski, Milanowski & Associates

ORAL PRESENTATIONS

C-1 Depth Dependence of Threshold Voltage Shifts in 3D Flash Memories Exposed to X-rays

M. Bagatin, A. Paccagnella, University of Padova, Italy, S. Gerardin, DEI - University of Padova, Italy, B. Silvia, Micron Technology, Italy

The effects of total ionizing dose on 3D floating gate cells are analyzed as a function of depth. Due to the manufacturing process and geometry of the pillars, shifts are larger at the bottom.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

C-2 Heavy Ion Irradiation Effects on Perpendicular-Anisotropy Spin-Orbit-Torque Magnetic Tunnel Junctions

M. Alamar, L. Chang, C. Cui, Y. Liu, E. Antunano, J. Incorvia, University of Texas at Austin, USA, J. Manuel, G. Vizkelethy, R. Jacobs-Gedrim, C. Bennett, T. Xiao, D. Hughart, E. Bielejec, M. Marinella, Sandia National Laboratories, USA, L. Xue, Applied Materials, USA

We study the impact of heavy ion irradiation on magnetic tunnel junctions with perpendicular magnetic anisotropy and spin orbit torque switching. We show how the domain structure and magnetic material behavior depend on irradiation fluences.

C-3 Structures for Characterizing TID-induced inter-device leakage in 14nm Bulk FinFET Technologies

A. Privat, H. Barnaby, L. Clark, J. Brunhaver, D. Alen, K. Holbert, Arizona State University, USA, M. McLain, M. Matt, M. King, Sandia National Laboratories, USA

The total ionizing dose response of 14nm bulk-Si FinFETs has been studied with specially designed test chips containing several logic gates. TCAD simulations were performed and are consistent with the experimental data.

C-4 Total Ionizing Dose Response of 22 nm FDSOI Charge-Trap Transistors

R. Brewer, D. Ball, B. Sierawski, P. Wang, E. Zhang, D. Fleetwood, R. Schrimpf, M. Alles, Vanderbilt University, USA, J. Cox, S. Moran, S. Iyer, University of California Los Angeles, USA

Total ionizing dose effects are investigated for 22 nm FDSOI charge-trap memory transistors. Electron trapping in the gate dielectric establishes the programmed memory state. Hole trapping in the buried oxide dominates the TID response.

C-5 C-5 Combined Total Ionizing Dose and Single-Event Effects on a 22 nm Fully-Depleted Silicon-on-Insulator Test Vehicle

M. Casey, J. Pellish, NASAGSFC, USA, S. Stansberry, Science Systems and Applications, Inc., USA

Total ionizing dose irradiations were performed on a 22 nm fully-depleted silicon on insulator static random access memory. There is a strong well-bias effect in the TID response. Combined TID and SEE results are also presented.

C-6 Total-Ionizing-Dose Response of Highly-Scaled Gate-All-Around Si Nanowire CMOS Transistors

M. Gorchichko, E. Zhang, P. Wang, R. Schrimpf, R. Reed, D. Fleetwood, Vanderbilt University, USA, S. Bonaldo, University of Padova, Italy, D. Linten, J. Mitard, IMEC, Belgium

The total-ionizing-dose response of GAA Si NW CMOS transistors is investigated under different bias conditions. Devices demonstrate outstanding ionizing radiation tolerance due to enhanced electrostatic control and suppression of parasitic leakage current paths.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

C-7 Ultra-High Total Ionizing Dose Effects on MOSFETs for Analog Applications

H. Dewitte, V. Goiffon, ISAE-SUPAERO, France, S. Rizzolo, Airbus Defence and Space, France, P. Paillet, C. Marcandella, CEA, France

The influence of the bias, the gate thickness and the rad-hard designs (ELTs, Butterflies,...) on the apparition of effects such as RINCE, RISCE, Gate-induced or source to drain leakages is studied for MOSFETs under high-TID.

C-8 Donor- and Acceptor-Like Defects in Irradiated AlGaIn/GaN HEMTs

P. Wang, X. Li, E. Zhang, M. McCurdy, R. Schrimpf, D. Fleetwood, Vanderbilt University, USA

Donor- and acceptor-like defects are observed during 10-keV and 1.8-MeV irradiations of AlGaIn/GaN HEMTs. ON donors dominate the response at low fluence, and VN-related acceptors dominate at high fluence.

C-9 Defect Densities and Energies in As-Processed and Irradiated Fully-Depleted Silicon on Insulator MOSFETs Fabricated Using 3D Sequentially Integrated Technology

S. Toguchi, E. Zhang, P. Wang, D. Fleetwood, R. Schrimpf, R. Reed, M. Alles, Vanderbilt University, USA, S. Moreau, S. Cheramy, P. Batude, L. Brunet, F. Andrieu, CEA-LETI, France

Added thermal cycles associated with forming upper-layer transistors via 3D sequential integration do not significantly affect post-irradiation densities of oxide, interface, or border traps of FD SOI transistors built in the lower stack layer.

POSTER PAPERS

PC-1 Total Ionization Dose Effects on NAND Flash Memory Based Physical Unclonable Function

S. Sakib, B. Ray, The University of Alabama in Huntsville, Huntsville, AL, USA

We investigate the total ionization dose (TID) effects on flash memory-based physically unclonable functions (PUFs). We find that flash-PUF accuracy degrades significantly with TID~10 krad. We proposed an electrical-annealing technique to improve the PUF accuracy.

PC-2 An Ionizing-Dose-Aware Behavioral Model of a Successive-Approximation Analog to Digital Converter

M. Rony, E. Zhang, M. Reaz, K. Li, R. Reed, J. Kauppila, A. Witulski, R. Schrimpf, Vanderbilt University, USA, B. Rax, A. Daniel, P. Adell, NASA-JPL, USA

ADCs of different structures respond differently to Total Ionization Dose (TID). Dynamic gain and dynamic offset are the key parameters that are sensitive to TID in successive-approximation-register (SAR) ADCs.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

PC-3 Electron-Induced Upsets and Stuck Bits in SDRAMs in the Jovian Environment

D. Soderstrom, University of Jyväskylä, Finland, L. Matanuliza, L. Dilillo, LIRMM, France, H. Kettunen, A. Javanainen, RADEF, Finland, W. Farabolini, A. Coronetti, CERN, Switzerland, C. Poivey, ESA, Netherlands

This study investigates the response of SDRAMs to electron irradiation. Stuck bits, SEUs and memory cell degradation is presented in this paper, in a memory that will be part of the ESA JUICE mission.

PC-4 Investigating Heavy Ion Effects on 14 nm-Process FinFETs: Displacement Damage Versus Total Ionizing Dose

M. Esposito, J. Manuel, E. Bielejec, G. Vizkelethy, J. Dickerson, P. Kerber, M. King, A. Tali, D. Ashby, M. McLain, M. Marinella, Sandia National Laboratories, USA, A. Privat, H. Barnaby, J. Brunhaver, Arizona State University, USA

Heavy ion irradiation was examined on a commercial 14-nm n-type FinFET technology to investigate displacement damage and total ionizing dose effects. Low temperature measurements were conducted to reveal underlying physics.

PC-5 Gamma Ray Induced Error Pattern Analysis for MLC 3D-NAND

U. Surendranathan, B. Timothy, B. Ray, The University of Alabama in Huntsville, USA

Data corruption rate on the shared pages of MLC 3-D NAND under Co-60 Gamma rays (20-krad) shows a unique correlated behavior. The error location within a given page remains uncorrelated.

PC-6 Impacts of Through-Silicon Vias on Total-Ionizing-Dose Effects and Low-Frequency Noise in FinFETs

K. Li, E. Zhang, M. Gorchichko, P. Wang, S. Zhao, M. Alles, R. Reed, D. Fleetwood, R. Schrimpf, Vanderbilt University, USA, G. Hiblot, S. Huylensbroeck, A. Jourdain, IMEC, Belgium

Total-ionizing-dose effects and low-frequency noise are evaluated in advanced bulk FinFETs with and without TSV via-last integration. The presence of the TSVs does not affect threshold voltage, Ion/Ioff, or noise.

PC-7 Influence of Total Ionizing Dose on Magnetic Tunnel Junctions with Perpendicular Anisotropy

B. Zink, J. Wang, J., University of Minnesota, USA, Yang-Scharlotta, M. Han, NASA-JPL, USA, F. Mancoff, J. Sun, Everspin Technologies., USA

Spin-transfer torque magnetic random-access memory (STT-MRAM) is a promising solution for onboard, radiation-tolerant memory. In this study, we examine the effect of TID exposure on the MTJ's thermal stability and its critical switching voltage.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

PC-8 Total Ionizing Dose Effects on Multi-state HfO_x-based RRAM Synaptic Arrays

X. Han, A. Privat, K. Holbert, J. Seo, H. Barnaby, Arizona State University, USA, S. Yu, Georgia Institute of Technology, USA

The impact of total ionizing dose on the multi-states of HfO_x-based RRAM is investigated by irradiating the 1-transistor-1-resistor 64kb array with CMOS peripheral decoding circuitry fabricated at 90 nm node.

PC-9 Foundry Dependence of Total Ionizing Dose Effects of FinFET Transistor in 14-nm Technological Node

L. Artola, T. Chiarella, T. Nuns, G. Cussac, ONERA, France, J. Mitard, IMEC, Belgium

This work presents a new set of data of TID responses under Co60 irradiation. Process dependences of degraded transistor operating characteristics are quantified as a function of three different manufacturer lines of 14-nm FinFET technology.

PC-10 Comparison of TID-induced Degradation of Programmable Logic Timing in Bulk 28 nm and 16 nm FinFET System-on-Chips under Local X-ray Irradiation

I. Lopes, V. Pouget, F. Wrobel, A. Touboul, F. Saigné, J. Boch, T. Maraine, University of Montpellier 2, France, K. Roed, University of Oslo, Norway

This paper presents the comparison of TID-induced timing degradation of two system-on-chip generations. The degradation was analyzed using local X-ray irradiation. Timing degradations for each technology were presented, compared and discussed.

PC-11L Ionizing Radiation Effect in SONOS-based Neuromorphic Inference Accelerators

T. P. Xiao, C. H. Bennett, S. Agarwal, D. Hughart and M. Marinella, Sandia National Laboratories, USA; H. J. Barnaby, Arizona State University, USA, H. Puchner and V. Prabhakar, Infineon Memory Solutions - USA

The sensitivity of SONOS-based neuromorphic inference accelerators to total ionizing dose is evaluated. An experimentally validated model is proposed for the radiation response of SONOS synapses, and inference accuracy is simulated up to 1000 krad(Si)

PC-12L Pre-charge Optimization in Sidewall Spacer Memory Bit Cell with Respect to Total Ionizing Dose

T. Vincenzi and G. Schatzberger, AMS AG, Austria, A. Michalowska Forsyth, Graz University of Technology, Austria

This paper analyses a charge-based Non-Volatile Memory device: the Sidewall Spacer. Multiple test-dies from a 55nm standard CMOS process are tested up to 500krad assessing data retention depending on charge injection in the nitride spacer.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

SESSION D

10:00 - 12:30

PHOTONIC DEVICES AND INTEGRATED CIRCUITS

SESSION INTRODUCTION

Chair: Adriana Morana, Laboratory Hubert Curien and University of Saint Etienne, France

ORAL PRESENTATIONS

D-1 Dark Current Random Telegraph Signal in Short-Wavelength Infrared Image Sensor Based on InGaAs

C. Virmondois, J. Belloir, A. Bardoux, L. Pistre, L. Patier, O. Gilard, CNES, France, V. Goiffon, ISAE-SUPAERO, France

This paper focuses on the radiation-induced dark current and its associated random telegraph signal in short-wavelength infrared image sensor based on InGaAs.

D-2 Displacement Damage Characterization of CMOS Single-Photon Avalanche Diodes: Alpha-Particle and Fast-Neutron Measurements

V. Malherbe, S. De Paoli, B. Mamdy, G. Gasiot, P. Roche, STMicroelectronics, France

We report on alpha and neutron irradiation of 7.8 μm Single-Photon Avalanche Diodes (SPADs) manufactured in 40 nm CMOS. Displacement damage leads to dark count rate degradations, with implications for the reliability of SPAD-based systems.

D-3 Optical Single-Event Transients (OSETs) Induced in Integrated Silicon-Photonic Waveguides by Two-Photon Absorption

G. Tzintzarov, A. Ildefonso, J. Teng, M. Frounchi, A. Djikeng, P. Iyengar, P. Goley, R. Bahr, J. Cressler, Georgia Institute of Technology, USA, A. Khachatrian, S. Buchner, D. McMorro, Naval Research Laboratory, USA

Optical single-event transients (OSETs) are measured in an integrated silicon-photonic waveguide. The results raise possible concerns for the potential use of integrated optical communications systems in space.

D-4 Coupled Temperature and Radiation Effects on Erbium and Erbium-Ytterbium Doped Fiber Amplifiers

M. Aubry, S. Girard, Université de Saint Etienne, France, C. Campanella, E. Marin, Y. Ouerdane, A. Boukenter, Laboratoire Hubert Curien, France, L. Mescia, Politecnico di Bari, Italy, A. Morana, Laboratory Hubert Curien, France, J. Mekki, CNES, France, A. Laurent, T. Robin, iXblue Photonics, France

We investigated the coupled radiation and temperature effect on Erbium Doped Fiber Amplifier and erbium-ytterbium doped fiber amplifier from -40°C to 120°C with an X-ray machine. The results show that there is no coupled effects.

Technical Program

(all times Eastern Standard Time)

Wednesday, December 2, 2020

POSTER PAPERS

PD-1

Single Event Transient Response of Vertical and Lateral Waveguide-Integrated Germanium Photodiodes

L. Ryder, K. Ryder, A. Sternberg, J. Kozub, E. Zhang, R. Weller, R. Schrimpf, S. Weiss, R. Reed, Vanderbilt University, USA, D. Linten, K. Croes, IMEC, Belgium

The impact of device geometry on single event transient response of waveguide-integrated germanium photodiodes is examined using pulsed laser testing. Experimental results show vertical PIN diodes consistently exhibit shorter transient durations than lateral PIN diodes.

PD-2

PD-2 Radiation Effects on the Static and Dynamic Characteristics of 850 nm 10 GHz GaAs Based Vertical Cavity Surface Emitting Lasers

X. Shan, Y. Sun, M. Xun, F. Zhao, B. Li, L. Wang, J. Gao, R. Gu, J. Luo, Z. Han, X. Liu, Key Laboratory of Silicon Device Technology and Institute of Microelectronics, Chinese Academy of Sciences, China, J. Liu, Institute of Modern Physics, Chinese Academy of Sciences, China, J. Wang, S. Wang, School of Physics, Peking University, China, Y. Xie, B. Wu, C. Xu, Beijing University of Technology, China

The radiation effects of Ta ion on static and dynamic characteristics of VCSEL were studied. Light-output power and current-voltage degraded, but modulation-current efficiency factor increased. DBR reflectivity reduction and defects in QWs were radiation mechanisms.

12:30 - 13:00

BREAK

SESSION C

13:00 - 14:00

RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS

LIVE QUESTION AND ANSWER SESSION

ROOM 3

Moderated by Randall Milanowski with Oral Paper Presenters

SESSION D

13:00 - 14:00

PHOTONIC DEVICES AND INTEGRATED CIRCUITS

LIVE QUESTION AND ANSWER SESSION

ROOM 4

Moderated by Adriana Morana with Oral Paper Presenters

END OF WEDNESDAY SESSIONS

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

INVITED TALK

9:00 - 10:00

"My Search for Roswell"

Tom Carey, UFO special investigator and anthropologist



The so-called "Roswell Incident," the alleged crash of an extraterrestrial spacecraft with crew, was a two-day story when it happened back in July of 1947. One day the Air Force announced that it had "captured" a flying saucer; and the next day it said it was all a mistake – that it was nothing more than a common "weather balloon," which ended of story. The case lay dormant for the next thirty-one years until a chance phone call to a first-hand military participant/witness instigated a civilian investigation of the case that lasts to this very day. As a result, the Roswell crash story has become the most famous UFO case of all time with the term "Roswell" becoming known throughout the world. In his talk, the speaker, who has co-authored seven books on the subject, will use Power Point projections to highlight his discussion of his now thirty-year investigation into this case.

Tom Carey is a native Philadelphian, holds degrees from Temple University (B.S. in Business Administration) and California State University, Sacramento (M.A. in Anthropology), and also attended the University of Toronto's Ph.D. Program in Anthropology. An Air Force veteran who held a TOP SECRET/CRYPTO clearance, Tom is now a retired Philadelphia area businessman. He has been a Mutual UFO Network (MUFON) State Section Director for Southeastern Pennsylvania from 1986 to 2001, a Special Investigator for the J. Allen Hynek Center for UFO Studies (CUFOS) from 1991 to 2001, and a member of the CUFOS board of directors from 1997 to 2001.

Tom has authored or coauthored more than 40 published articles about the Roswell events of 1947, and has contributed to a number of books on the subject as well. He has appeared as a guest on many radio and TV shows throughout the country, including Coast to Coast AM with Art Bell and George Noory, Fox and Friends, Comcast Network Friends and Larry King Live! and has contributed to a number of Roswell-related documentaries, on-screen and behind the scenes.

DAY 3 TECHNICAL SESSIONS (run concurrently)

Session E: SINGLE EVENT EFFECTS: DEVICES AND INTEGRATED CIRCUITS

Session F: SPACE AND TERRESTRIAL ENVIRONMENTS

Session G: DOSIMETRY

SESSION E

10:00 - 12:30

RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS

SESSION INTRODUCTION

Chair: Georgios Tsiligiannis, University of Montpellier 2

ORAL PRESENTATIONS

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

E-1 Single-Event-Induced Charge Collection in Ge-Channel pMOS FinFETs

M. Rony, I. Samsel, E. Zhang, A. Sternberg, M. Reaz, S. Austin, R. Reed, D. Fleetwood, M. Alles, J. Mitard, R. Schrimpf, Vanderbilt University, USA, K. Li, D. Linten, IMEC, Belgium

Single-event charge collection in Ge-channel pMOS FinFETs exhibits a different spatial dependence than planar Ge pMOS devices. The total collected charge depends on applied gate bias, whereas the peak transient does not.

E-2 Electrical Measurement of Cell-to-Cell Variation of Critical Charge in SRAM and Sensitivity to Single-Event Upsets by Low-Energy Protons

J. Cannon, University of Tennessee at Chattanooga, USA and Macalester College, USA, R. Estrada, University of Tennessee at Chattanooga, USA, and New Mexico Institute of Mining and Technology, USA, R. Boggs, University of Tennessee at Chattanooga, USA and NASA GSFC, USA, B. Patel, G. Santos, T. Loveless, University of Tennessee at Chattanooga, USA, M. McCurdy, A. Sternberg, Vanderbilt University, USA, T. Finzell, Macalester College, USA

Low-energy proton irradiation of COTS SRAMs shows that SEU cross-sections near the LET threshold are dominated by nominally weak cells. An electrical procedure is presented to map cell critical charge values, allowing customized part usage.

E-3 Single-Event Upsets in a 7-nm Bulk FinFET Technology with Analysis of Threshold Voltage and Bias Dependencies

J. V. D'Amico, J. Cao, L. Xu, J. Kauppila, L. Massengill, Vanderbilt University, USA, B. Bhuva, M. Rathore, S. Wen, R. Fung, Cisco Systems, Inc., USA, B. Narasimham, Broadcom, Inc., USA

Single-event upset responses of D-FF designs with different threshold voltage (VT) options in a 7-nm bulk FinFET technology are evaluated. Results show that single-event cross-section depends heavily upon supply voltage and particle LET values.

E-4 Direct Ionization from Low-Energy Electrons in a Highly-Scaled CMOS Process

M. Casey, J. Pellish, NASA GSFC, USA, S. Stansberry, Science Systems and Applications, Inc., USA, M. Breeding, R. Reed, Vanderbilt University, USA

Low-energy-electron-induced single-event upsets are observed in a 22 nm fully-depleted silicon-on-insulator process at nominal and higher supply voltages. Electron dose enhancement was also observed.

E-5 Single-Event Latchup in a 7-nm Bulk FinFET Technology

C. Sheets, L. Xu, J. Cao, S. Ball, J. Kauppila, B. Bhuva, L. Massengill, Vanderbilt University, USA, R. Fung, S. Wen, Cisco Systems, Inc., USA, C. Cazzaniga, Rutherford Appleton Laboratories, United Kingdom

Single-event-induced latchup at the 7nm bulk FinFET node is characterized as a function of supply voltage and temperature. Results show the holding voltage as low as 0.85 V at elevated temperature.

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

E-6 Observation of Low-Energy Proton Direct Ionization in a 72-Layer 3D NAND Flash Memory

E. Wilcox, M. Casey, J. Pellish, NASA GSFC, USA

Single-event upsets are observed in a 72-layer 3D NAND flash memory operated in SLC mode with low-energy proton (500 keV-1.2 MeV) and heavy ion irradiation. Direct ionization by low-energy protons is analyzed three-dimensionally.

POSTER PAPERS

PE-1 Updates on Testing Microprocessors Effectively

H. Quinn, Los Alamos National Laboratory, USA, K. Gnawali, S. Tragoudas, Southern Illinois University Carbondale, USA

Updates to the software benchmark for radiation testing mitigated software codes are presented. The updates include new memory testing algorithms, a new sorting algorithm, and an update to the standard matrix multiply code.

PE-2 Influence of Supply Voltage and Body Biasing on Single-Event Upsets and Single-Event Transients in UTBB FD-SOI

C. Lecat-Mathieu De Boissac, F. Abouzeid, V. Malherbe, G. Gasiot, P. Roche, STMicroelectronics, France, J. Autran, Aix-Marseille University, France

We present a study of single-event effects through supply voltage and body bias variations in 28 nm UTBB FD-SOI. Heavy ion experiments were performed, showing the variation of SEE sensitivity in both sequential and logic cells.

PE-3 PE-3 Stuck-Bits Screening in a 512Mb SDRAM Induced by Proton and -Rays

S. Bounasser, C. Boatella Polo, T. Borel, C. Poivey, ESA, Netherlands

TID and Proton tests have been made in order to evaluate the SEU/SB/SEFI sensitivity of a 512Mb SDRAM. Root-cause analysis of stuck-bits formation is discussed as well as the VRT phenomenon induced by proton irradiation.

PE-4 Microbeam Heavy Ion and Event Tree Analysis Investigating Single Event Effect Propagation in System-on-Chip

W. Yang, School of Nuclear Science and Technology, China and Politecnico di Torino, Italy, S. Azimi, B. Du, L. Sterpone, School of Nuclear Science and Technology, China, X. Du, Y. Li, C. He, S. Shuting, L. Cai, National Innovation Center of Radiation Application, China, G. Gant, Politecnico di Torino, Italy

This paper presents heavy ion induced SEE propagation on 28 nm System-on-Chip SRAM reconfigurable devices. Results obtained by microbeam radiation test show sensitivity location and cross-section for functional blocks such as ALU, user-registers, D-Cache and Peripherals.

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

PE-5 Developing Benchmarks for Radiation Testing of Microcontroller Arithmetic Units Using ATPG

K. Gnawali, S. Tragoudas, Southern Illinois University Carbondale, USA, H. Quinn, Los Alamos National Laboratories, USA

Reliability-focused benchmarks are used to test systems in harsh operating conditions. This paper proposes a mechanism to develop such benchmarks for radiation testing of microcontroller arithmetic and logical units using automatic test pattern generation (ATPG).

PE-6 Neutron-Induced Pulse Width Distribution of Logic Gates Characterized Using a Pulse Shrinking Chain Based Test Structure

N. Pande, S. Kumar, L. Everson, G. Park, I. Ahmed, C. Kim, University of Minnesota, USA

This work presents measured data corresponding to neutron-induced pulse width distributions for standard logic gate types together with detailed analysis on the range of design choices impacting the former.

PE-7 Comparison of Low-Energy Proton-Induced Single-Event-Upsets in 7-nm and 14-/16-nm FinFET Flip-Flops

N. Ogden, A. Feeley-Lamb, Y. Xiong, B. Sierawski, R. Reed, B. Bhuvva, J. Maharrey, R. Harrington, T. Haeffner, K. Warren, M. McCurdy, M. Howell, J. Kauppila, L. Massengill, Vanderbilt University, USA

Low-energy proton-induced upset data are presented for 7-nm and 14-/16-nm FinFET flip-flop shift-registers. The 7-nm flip-flop upset cross-section was less pronounced than 14-/16-nm, but larger at higher energies.

PE-8 Evaluating the Impact of Reducing Data Precision on the Reliability of Neural Networks on FPGAs

F. Libano, J. Brunhaver, Arizona State University, USA, P. Rech, Universidade Federal do Rio Grande do Sul, Brazil and Los Alamos National Laboratory, USA, B. Neuman, Los Alamos National Laboratory, USA, J. Leavitt, M. Wirthlin, Brigham Young University, USA

Through neutron beam experiments, we analyze how precision reduction of neural networks on FPGAs can effectively deliver lower radiation sensitivity, while maintaining high accuracy levels. We compare 32-bit to 16-bit floating-point and 8-bit integer implementations.

PE-9L Heavy Ions Radiation Effects on 4kb Phase-Change Memory

A. L. Serra, G. Bourgeois, M. C. Cyrille, C. Charpin-Nicolle, G. Navarro and E. Nowak, CEA-LETI-MINATECH, France, T. Vogel, S. Petzold, N. Kaiser, L. Alff, Advanced Thin Film Technology, University of Darmstadt, Germany, G. Lefevre, C. Vallée and D. Sylvain, CNRS-LTM Laboratoire des Technologies de la Microelectronique, France, C. Trautmann, Material Research Department, Darmstadt GSI, Germany

In this work we analyze, thanks to both material and 4kb memory arrays characterization, the different effects of heavy ion radiation at high fluences on Ge₂Sb₂Te₅ and Ge-rich GeSbTe based Phase-Change Memory (PCM).

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

SESSION F
10:00 - 12:30

SPACE AND TERRESTRIAL ENVIRONMENTS

SESSION INTRODUCTION

Chair: Athina Varotsou, TRAD

ORAL PRESENTATIONS

F-1 Displacement Damage Dose Analysis for Solar Cells in a Jovian Radiation Environment

J. Warner, Johns Hopkins Applied Physics Laboratory, USA, L. Martinez-Sierra, I. Jun, NASA-JPL, USA

The displacement damage dose (DDD) analysis for solar cells operating in a Jovian combined particle radiation environment, specifically Europa Clipper Mission, is presented. The importance of DDD calculations as a function of shielding are discussed.

F-2 1-10 MeV Neutron SER in Accelerator and Atmospheric Environments

M. Cecchetto, R. Garcia Alia, A. Coronetti, CERN, Switzerland, F. Wrobel, University of Montpellier 2, France S. Fiore, G. Bazzano, ENEA Frascati, Italy

Low-energy neutrons between 1-10 MeV can significantly impact the SER in scaled technologies, down to 40 nm SRAMs, with respect to high-energy neutrons. Their contribution is evaluated in accelerator and ground level environments.

POSTER PAPERS

PF-1 Neutron Environment at High-Altitude High-Performance Computing Facilities

S. Nowicki, E. Mullin, L. Ferres, S. Blanchard, N. Debardeleben, S. Wender, G. McMath, G. McKinney, Los Alamos National Laboratory, USA

Cosmic-ray induced neutrons can have large effects on computing systems when they interact with the electronics. In an effort to monitor the neutron environment in the LANL high-performance computing facility, we have deployed neutron detectors.

PF-2 Hybrid Shielding Configuration for Sensitive Space Electronics Subjected to Extreme Space Weather

R. Pal Chowdhury, L. Stegeman, A. Bahadori, Kansas State University, USA, M. Lund, University of Utah, USA, D. Fry, NASA-Johnson, USA, S. Madzunkov, NASA-JPL, USA

In this study, a novel hybrid radiation shielding configuration is proposed. The efficacy of this configuration in terms of protecting space-based electronics against extreme solar weather and the reduction of mass-penalty is analyzed

PF-3 The Compact Environmental Anomaly Sensor Risk Reduction (CEASE-RR): On-Orbit Measurements

C. Lindstrom, D. Barton, E. Friedman, Air Force Research Laboratory, USA, K. Greene, University of New Mexico (COSMIAC), USA

CEASE RR is a new compact sensor designed for anomaly attribution due to the space radiation environment launched in April 2018. Cross-comparison campaigns with GOES are presented, and inner Van Allen belt measurements during ascent.

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

PF-4 Jason-2 Measurements Compared with AP9 (v. 1.50.001) & AP8

C. Lindstrom, A. Andersen, J. Insoo, NASA-JPL USA

AP9 (also known as IRENE) version 1.50.001 is compared to Jason-2 measurements. It is shown that the measurements are in better agreement than previous comparisons with version 1.20 of the AP9 model.

SESSION G

10:00 - 12:30

DOSIMETRY

SESSION INTRODUCTION

Chair: Peter Beck, Seibersdorf Laboratories

ORAL PRESENTATIONS

G-1 A Heavy-Ion Beam Monitor Based on 3D NAND Flash Memories

S. Gerardin, M. Bagatin, A. Paccagnella, University of Padova, Italy, S. Beltrami, Micron Technology, Italy, A. Costantino, G. Santin, A. Pesce, V. Ferlet-Cavrois, ESA, Netherlands, K. Voss, GSI, Germany

A heavy-ion beam monitor based on 3D NAND Flash memories was designed and tested with heavy ions at low LET. The capability of measuring fluence, angle, and LET of impinging particles is discussed.

Multi-Layered Solid-State Neutron Sensor

G-2 *W. Rice, Northrop Grumman, USA, J. Levy, D. Adams, D. Nichols, R. Harrison, M. Jordan, L. Claus, D. Dorsey, Sandia National Laboratories, USA*

A solid-state neutron sensor with exceptional efficiency at reduced size consists of a multi-layered stack alternating between converter material (boron-10) and collector material (silicon photodiode). The sensor offers a unique advantage for low-profile in-situ dosimetry.

Radiation Shielding Evaluation of Spacecraft Walls Against Heavy Ion Beams using Micro-dosimetry

G-3 *S. Peracchi, L. Tran, B. James, F. Pagani, V. Pan, J. Vohradsky, D. Bolst, S. Guatelli, M. Petasecca, M. Lerch, A. Rosenfeld, University of Wollongong, Australia, D. Prokopovich, ANSTO, Australia, S. Lee, T. Inaniwa, N. Matsufuji, NIRS, Japan, A. Kok, M. Povoli, SINTEF MiNaLab, Norway, M. Jackson, University of Sydney, Australia*

Radiation shielding evaluation of spacecraft walls is studied. A micro-dosimetry approach is used against heavy ions.

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

G-4 Operating Temperature Range of Phosphorus-doped Optical Fiber Dosimeters Exploiting Infrared Radiation-Induced Attenuation

A. Morana, C. Campanella, E. Marin, A. Boukenter, Y. Ouerdane, S. Girard, Laboratory Hubert Curien, France, G. Mélin, T. Robin, iXBlue Photonics, France, G. Li Vecchi, D. Di Francesca, CERN, Switzerland, F. Mady, M. Benabdesselam, Université de Nice, France, J. Mekki, N. Balcon, CNES, France

The temperature dependence of the radiation-sensitivity at 1550 nm of two P-doped optical fibers is investigated between -80°C and 300°C up to 1 kGy dose, resulting in a variation within 10% between 40°C and 80°C.

G-5 Floating Gate Dosimeter for Single Ion Detection

M. Brucoli, A. Waage, R. Ferraro, S. Danzeca, A. Masi, R. Garcia Alia, CERN, Switzerland, A. Pineda, B. Severa Mas IC-Malaga, Spain, V. Ferlet Cavrois, ESA, Netherlands

The capability of the floating gate dosimeter to detect single ions is investigated by heavy-ion microbeam experiments. The mechanism inducing the SET is experimentally explored by irradiating test chips with ions at different LETs.

POSTER PAPERS

PG-1

Characterization of a Certified Exposure Facility for Total Ionizing Dose Testing of Electronic Components

C. Tscherne, M. Wind, M. Latocha, P. Beck, Seibersdorf Laboratories, Austria

We characterize the Co-60 field of the TEC-Laboratory Seibersdorf, a certified TID testing facility. We investigate the dose effects of low-energy backscatter photons from the concrete walls with and without the use of lead boxes.

PG-2

Study of SEU sensitivity of SRAM-Based Radiation Monitors in 65 nm CMOS

J. Wang, J. Prinzie, KU Leuven, Belgium, A. Coronetti, CERN, Switzerland, P. Leroux, Leuven University, Belgium

A flexible SRAM based SEU radiation monitor has been designed, simulated and tested with heavy ions and protons. Its SEU sensitivity can be tuned by varying the cells' supply voltage.

PG-3

Dosimetry of Thermal Neutron Beamlines at a Pulsed Spallation Source for Application to the Irradiation of Microelectronics

C. Cazzaniga, D. Raspino, J. Sykora, C. Frost, STFC, United Kingdom

Activation foils and a GEM detector, with time of flight technique, are used for dosimetry of thermal beamlines of a pulsed neutron source. These can be applied to the irradiation of microelectronics for SEE testing.

Technical Program

(all times Eastern Standard Time)

Thursday, December 3, 2020

PG-4 Investigations on Spectral Photon Radiation Sources to Perform TID experiments in Micro- and Nano-Electronic Devices

M. Gaillardin, D. Lambert, D. Aubert, M. Raine, C. Marcandella, G. Assaillit, G. Auriel, M. Martinez, O. Duhamel, M. Ribière, N. Rostand, T. Lagutère, P. Paillet, N. Richard, C. Delbos, D. Poujols, S. Ritter, CEA, France

The TID sensitivity of mature and innovative technologies is investigated using both ionizing radiation experiments and Monte-Carlo simulations to discuss the potential of spectral photon radiation sources as an alternative for radiation effects studies.

12:30 - 13:00 BREAK

SESSION E SINGLE EVENT EFFECTS: DEVICES AND INTEGRATED CIRCUITS
13:00 - 14:00

LIVE QUESTION AND ANSWER SESSION

ROOM 5 *Moderated by Georgios Tsiligiannis with Oral Paper Presenters*

SESSION F SPACE AND TERRESTRIAL ENVIRONMENTS
13:00 - 14:00

LIVE QUESTION AND ANSWER SESSION

ROOM 6 *Moderated by Adriana Morana with Oral Paper Presenters*

SESSION G DOSIMETRY
13:00 - 14:00

LIVE QUESTION AND ANSWER SESSION

ROOM 6 *Moderated by Peter Beck with Oral Paper Presenters*

END OF THURSDAY SESSIONS

Technical Program

(all times Eastern Standard Time)

Friday, December 4, 2020

DAY 4 TECHNICAL SESSIONS (run concurrently)

**Session H: HARDNESS ASSURANCE TECHNOLOGIES,
MODELING, AND TESTING**

Session I: RADIATION HARDENING BY DESIGN

SESSION H
9:00 - 11:30

HARDNESS ASSURANCE TECHNOLOGIES, MODELING, AND TESTING

SESSION INTRODUCTION

Chair: Greg Allen NASA-JPL

ORAL PRESENTATIONS

H-1 Assessment of Proton Direct Ionization RHA for Deep Sub-micron SRAMs used in Space Applications

A. Coronetti, R. Garcia Alia, M. Cecchetto, CERN, Switzerland, J. Wang, P. Leroux, KU Leuven, Belgium, C. Cazzaniga, STFC, United Kingdom, Y. Morilla, P. Martin-Holgado, CNA, Spain, M. Van Goethem, S. Brandenburg, KVI-CART, Netherlands, A. Javanainen, University of Jyväskylä, Finland, F. Saigné, University of Montpellier 2, France

The proton direct ionization impact on the soft error rate of typical space applications is analyzed for SRAMs showing a strong cross section enhancement through experimental data folding and Monte-Carlo simulations.

H-2 H-2 Variability in Total-Ionizing-Dose Response in 4th-Generation SiGe HBTs

J. Teng, A. Ildefonso, G. Tzintzarov, A. Moradinia, J. Cressler, Georgia Institute of Technology, USA, P. Wang, X. Li, E. Zhang, D. Fleetwood, Vanderbilt University, USA

TID response statistics are characterized in SiGe HBTs, exhibiting increasing variance with dose. Both analytical theory and TCAD are used to explain potential causes. Implications for assurance testing and radiation-tolerant design are discussed.

H-3 RHA Through System Level Testing: Risk Acceptance, Facility Requirements, Test Methodology and Applications

A. Coronetti, R. Garcia Alia, R. Ferraro, S. Danzeca, CERN, Switzerland, J. Budroweit, German Aerospace Center (DLR), Germany, T. Rajkowski, P. Wang, 3D-Plus, France, I. da Costa Lopes, K. Niskanen, V. Pouget, F. Saigné, A. Touboul, University of Montpellier 2, France, D. Soderstrom, A. Javanainen, H. Kettunen, University of Jyväskylä, Finland, C. Cazzaniga, STFC, United Kingdom, J. Mekki, F. Manni, D. Dangla, CNES, France, A. Koelpin, BTU, Germany, R. Germanicus, University of Caen Normandie, France

A first guideline for system level testing of electronic equipment is provided through general definitions, risk acceptance assessments, facility requirements, methodologies and application examples.

Technical Program

(all times Eastern Standard Time)

Friday, December 4, 2020

H-4 Threats to Resiliency of Redundant Systems Due to Destructive SEE

R. Ladbury, NASA GSFC, USA, J. Zinchuk, M. Bay, Bay Engineering Innovations, USA

Destructive SEE pose serious challenges for the reliable use of COTS devices in space systems. We use system-level modeling and non-parametric statistics to assess the threat posed to redundant systems by destructive SEE.

H-5 Multiscale System Modeling of Single Event Induced Faults in Advanced Node Processors

M. Cannon, A. Rodrigues, D. Black, J. Black, L. Bustamante, B. Feinberg, M. McLain, S. Aggarwal, M. Marinella, Sandia National Laboratories, USA, L. Clark, J. Brunhaver, H. Barnaby, Arizona State University, USA

We propose a new simulation environment which allows the ability to track and incorporate experimental effects of single event-induced faults from transients on individual transistors to complex systems with multiple processors, memories and other devices.

H-6 Quantification of Fault Consequences to Track and Mitigate Risk in a CubeSat Experiment Using Model-Based Systems Analysis

R. Austin, K. Ryder, B. Sierawski, R. Reed, R. Schrimpf, N. Mahadevan, G. Karsai, A. Witulski, Vanderbilt University, USA

Functional models are used to identify possible faults and system-level fault consequences. A risk factor is calculated to evaluate mitigation. The risk factor from different radiation-induced faults is compared with system telemetry from on-orbit data.

POSTER PAPERS

PH-1 In-Situ Testing Methods for Mixed-Mode Harsh Environments

L. Scheick, T. Dennis, S. Woo, W. Kim, S. Dawson, N. Low, A. Boca, E. Martin, J. Chinn, J. Foster, R. Davies, NASA-JPL, USA

This paper describes JPL's Dynamitron capabilities and recent modernization. Recent results are presented including solar cells, Internal Electrostatic Discharge (IESD), parts dose effects and system level assurance in extreme radiation and temperature environments.

PH-2 Identifying Radiation-Induced Micro-SEFIs in SRAM FPGAs

A. Perez-Celis, C. Thurlow, M. Wirthlin, Brigham Young University, USA

This paper presents a method to identify micro-single event functional interrupts from beam-test data in the configuration memory and BRAM of SRAM-based FPGAs. The results show the cross-section of these events for three SRAM FPGAs.

PH-3 TID Effects Evaluation Induced by Photon Sources in MOS Devices: Impact of Sensitive Volume Thickness and BEOL Layers

D. Lambert, M. Gaillardin, M. Raine, P. Paillet, O. Duhamel, C. Marcandella, M. Martinez, N. Rostand, T. Lagutere, D. Aubert, G. Assaillit, C. Delbos, CEA, France

TID effects induced by different photons sources are studied in MOS devices. Monte-Carlo modeling is performed to estimate energy depositions in sensitive volume behind device shielding and packaging. An effective TID approach is proposed.

Technical Program

(all times Eastern Standard Time)

Friday, December 4, 2020

PH-4 Single-Event Transient Case Study for System-Level Radiation Effects Analysis

M. Campola, R. Ladbury, R. Austin, NASA GSFC, USA, E. Wilcox, J. Pellish, NASA, USA, H. Kim, K. LaBel, Science Systems Applications, Inc., USA

Analog single-event transient results are analyzed for two applications with a system architecture in mind. Application-specific analyses are presented on the MAX4595 commercial device using single-event effects criticality and goal structuring notation.

PH-5 A Comprehensive Comparison Between Design for Testability Techniques for Total Dose Testing of Flash-Based FPGAs

A. Ibrahim, M. Abdelwahab, A. Mohamed, N. Soliman, A. Abou-Auf, American University in Cairo, Egypt, M. Abdel-Aziz, Cairo University, Egypt

We compare several design-for-testability techniques to generate worst-case test vectors for delay failure induced by total dose in sequential FPGAs. The comparison was validated experimentally using Microsemi ProASIC3 FPGA's and Cobalt 60 facility.

PH-6 Analysis of System Level TID Test Results of a System in Package Point of Load Converter

T. Rajkowski, P. Kohler, P. Dubus, P. Wang, 3D-Plus, France, F. Saigné, K. Niskanen, J. Boch, T. Maraine, A. Touboul, University of Montpellier 2, France

Test at system level is evaluated by measuring the sensitivity of point-of-load converter parameters, exposed to total ionizing dose irradiations, at both system and component levels.

PH-7L Modeling COTS System TID Response with Monte Carlo Sampling and Transistor Swapping Experiments

M.B. Smith, A.F. Witulski, J.S. Kauppila, A.L. Sternberg, K.L. Ryder, N. Mahadevan, and R.D. Schrimpf, Vanderbilt University, USA

Modeling the TID response of COTS systems is difficult due to each part's parameters distributions. This work predicts the system-level output modeled with a small population of parts, which are used for experimental verification

SESSION I
9:00 - 11:30

RADIATION HARDENING BY DESIGN

SESSION INTRODUCTION

Chair: Jeffrey Maharrey, Boeing

ORAL PRESENTATIONS

I-1 Understanding How Software Properties Impact the Effectiveness of Automated Software Fault Tolerance

J. Benjamin, J. Goeders, M. Wirthlin, Brigham Young University, USA

We present a model for understanding fault coverage when using COAST, our fully automated, compiler-based tool that adds fault mitigation to user code, backed up by data from neutron beam testing on the ARM A9 platform.

Technical Program

(all times Eastern Standard Time)

Friday, December 4, 2020

I-2 Partial TMR Selection for Improving the Soft Error Reliability of SRAM-Based FPGA Designs

A. Keller, M. Wirthlin, Brigham Young University, USA

The effectiveness of partial triple modular redundancy depends greatly upon component selection. Random selection provided no reliability improvement in neutron radiation testing. Maximizing protected routes reduced the failure rate by 20% with only 9% coverage.

I-3 Radiation Hardened Millimeter-Wave (mmW) Receiver Implemented in 90 nm, SiGe HBT Technology

S. Dash, E. Al Seragi, K. Muthuseenu, H. Barnaby, S. Zeinolabedinzadeh, Arizona State University, USA, J. Cressler, Georgia Institute of Technology, USA, A. Khachatrian, S. Buchner, U.S. Naval Research Laboratory, USA

This paper investigates a novel technique to substantially reduce single-event-effects in high-frequency receivers. Two-photon-absorption pulsed laser experiments validate the proposed hardening technique. A custom designed W-band (75-110 GHz) SiGe HBT receiver was used for this investigation.

I-4 I-4 Radiation Induced Error Mitigation by Shifted-Read Technique for 3-D NAND Flash Memory

P. Kumari, B. Ray, W. Dorlus, University of Alabama in Huntsville, USA

We are proposing an algorithm to reduce the data corruption rate caused by total ionization dose on the MLC 3-D NAND flash memory using the shifted-read method. We find that the error rate significantly improves with shifted-read.

I-5 Radiation Hardened Cortex-R4F System-on-Chip Prototype with Total Ionizing Dose Dynamic Compensation in 28nm FD-SOI

F. Abouzeid, C. Lecat-Mathieu de Boissac, J. Daveau, C. Timineri, V. Bertin, P. Roche, STMicroelectronics, France, J. Autran², Aix-Marseille University, France

This paper presents a radiation hardened Cortex-R4F System-on-Chip prototype with integrated total ionizing dose dynamic compensation capabilities, designed and fabricated in 28nm FD-SOI. The system immunity, while performing at 500 MHz, was experimentally verified under radiation.

POSTER PAPERS

PI-1 Evaluating Architectural, Redundancy, and Implementation Strategies for Radiation Hardening of Integrated Circuits

S. Pagliarini, TalTech, Estonia, L. Benites, F. Lima Kastensmidt, UFRGS, Brazil, M. Martins, Mentor Graphics, USA, P. Rech, LANL/UFRGS, USA

Nine variants of matrix multiplication were taped-out in 16nm FinFET silicon and irradiated with neutrons. Simulation-based fault injection was utilized to validate measurements and to explore the effects of different implementation strategies on failure rates.

Technical Program

(all times Eastern Standard Time)

Friday, December 4, 2020

PI-2 Linux TMR RISC-V Soft-core Fault Injection and Neutron Radiation Tests

A. Wilson, C. Thurlow, S. Larsen, M. Wirthlin, Brigham Young University, USA

The fault injection and neutron radiation results of a TMR RISC-V soft processor running Linux showed a 10× improvement in SEU reliability with a cost of around 4× resource utilization.

PI-3 Voltage-Controlled Oscillator Utilizing an Inverse-Mode SiGe-HBT Biasing Circuit for SET Mitigation

I. Song, J. Meang, Oklahoma State University, USA, A. Khachatrian, S. Buchner, D. McMorrow, Naval Research Laboratory, USA, P. Paki, DTRA, USA, M. Cho, J. Cressler, Georgia Institute of Technology, USA

A VCO using inverse-mode SiGe HBTs is proposed. A through-wafer two-photon absorption pulsed-laser experiment was conducted. The proposed VCO exhibited mitigated SET response.

PI-4 A Self-Compensated Preamplifier Providing Linear Output up to 0.6 Mrad of Total Ionizing Dose Based on Miller Capacitor Compensation

C. Lee, G. Cho, Korea Advanced Institute of Science and Technology, Republic of Korea, I. Kwon, Korea Atomic Energy Research Institute, Republic of Korea

A preamplifier for robustness to TID is presented. This circuit provides less amplitude and SNR degradation. It is operated by monitoring on amplitude of a replicated preamplifier and compensating gain bandwidth product with Miller capacitors.

11:30 - 12:00 BREAK

SESSION H HARDNESS ASSURANCE TECHNOLOGIES, MODELING, AND TESTING
12:00 - 13:00

LIVE QUESTION AND ANSWER SESSION

ROOM 8 *Moderated by Greg Allen with Oral Paper Presenters*

SESSION I RADIATION HARDENING BY DESIGN
12:00 - 13:00

LIVE QUESTION AND ANSWER SESSION

ROOM 9 *Moderated by Jeffrey Maharrey with Oral Paper Presenters*

13:00 - 15:00 **INDUSTRIAL EXHIBITS VIRTUAL RECEPTION**

END OF FRIDAY SESSIONS

Technical Program

(all times Eastern Standard Time)

Monday, December 7, 2020



9:00 - 10:00

YOUNG PROFESSIONALS TALK:

Space Community Microelectronics Workforce Development for the 21st Century – Diverse, Intentional, Scalable

Jonathan Pellish, NASA Goddard Space Flight Center



Jonathan “Jonny” Pellish is employed at the Goddard Space Flight Center as the National Aeronautics and Space Administration (NASA) Electronic Parts Manager, responsible for workforce development and stewardship as well as coordinating Agency-wide technical activities in the electronic parts and radiation effects engineering communities. Jonny is also the deputy manager for the NASA Electronic Parts and Packaging (NEPP) Program, which is operated by NASA Goddard for the NASA Office of Safety and Mission Assurance.

Prior to assuming his latest position, Jonny served on detail in the NASA Headquarters Office of the Chief Financial Officer, as an Associate Chief in the Goddard Electrical Engineering Division, and as an Associate Head in the Flight Data Systems and Radiation Effects Branch, where he began his NASA career in 2008.

Jonny received the B.S. degree in physics from Vanderbilt University in 2004, and the M.S. and Ph.D. degrees in electrical engineering from Vanderbilt University in 2006 and 2008. From 2007–2008 Jonny held an IBM Ph.D. Fellowship, which included a co-op position at the IBM Austin Research Laboratory. Jonny has authored or co-authored over 60 refereed publications in addition to numerous conference and workshop presentations. He is a member of the American Institute of Aeronautics and Astronautics and the Institute for Electrical and Electronics Engineers.

Technical Program

(all times Eastern Standard Time)

Monday, December 7, 2020

10:00 - 12:30

RADIATION EFFECTS DATA WORKSHOP

LIVE QUESTION AND ANSWER SESSION

Farokh Irom, Jet Propulsion Laboratory



DW-1 Single Event Effect Evaluation of the Jetson AGX Xavier Module Using Proton Irradiation

D. Hiemstra, MDA., Canada, C. Jin, Z. Li, S. Shi, L. Chen, University of Saskatchewan, Canada, R. Chen, National Space Science Center, Chinese Academy of Sciences., China

The single event effect cross-sections in different running modes of a Jetson AGX Xavier GPU module were evaluated using proton beams. The results show that the error rate can be reduced with redundancy techniques.

DW-2 Total Dose and SEE Test of Intel Movidius Myriad2 VPU and First Flight Data.

G. Furano, A. Tavoularis, ESA/TEC-EDD, Netherlands, J. Byrne, D. Moloney, Intel, Ireland, D. Buckley, L. Buckley, Ubotica Technology LTD, Ireland, M. Psarakis, University of Piraeus, Greece, G. Meoni, L. Fanucci, University of Pisa, Italy

In this paper we will present the TID and SEE result of 5 sessions of ^{60}Co , proton, Heavy Ion tests performed on Intel Movidius Myriad2 VPU and its in orbit performance data on PhiSat-1 Cubesat.

DW-3 Impact of Beam Collimation for Single Event Effects Testing Using a Clinical Proton Delivery System

J. Younkin, H. Stuckey, J. Shen, J. Stoker, D. Robertson, Mayo Clinic Arizona, USA, J. Bird, Radiation Test Solutions, Inc., USA

Collimators used in proton SEE testing impact the beam energy profile. These impacts have been modeled using TOPAS/Geant4 and verified with measurements. The TID, TNID, fluence, and uniformity impacts to electronics under test are discussed.

DW-4 In-Situ Measurement of the Effect of 1-MeV Electrons Irradiation on III-V/Si at LILT Conditions

K. Medjoubi, R. Cariou, L. Vauche, C. Jan, C. Rostaing, V. Amalbert, F. Chabuel, B. Boizot, CEA, France

In this study, we investigate the potential of III-V/Si solar cell technology for space applications. We present here the experimental results before and after 1 MeV electrons irradiation at NIRT and LILT conditions.

Technical Program

(all times Eastern Standard Time)

Monday, December 7, 2020

DW-5 Total Dose Performance at High and Low Dose Rate of Switching Regulators

D. Hiemstra, V. Kirischian, MDA, Canada, S. Shi, L. Chen, University of Saskatchewan, Canada

Results of Cobalt-60 irradiation of switching regulators at high and low dose rates are presented. Performance in the space radiation environment is discussed.

DW-6 Single Event Upset Results from the Radiation Hardened Electronic Memory Experiment in a Polar Orbit

D. Alexander, University of New Mexico (COSMIAC), USA, A. Vera, Ideas Tek, USA

Results are presented from the Radiation Hardened Electronic Memory Experiment (RHEME-2) performed on the STPSat-5 mission in a polar orbit.

DW-7 SEE and TID Test Results Compilation for Candidate Spacecraft Electronics

A. Kalashnikova, T. Maksimenko, M. Kuznetsov, M. Vyrostkov, R. Mangushev, A. Drokin, A. Nilov, N. Bondarenko, K. Bukhasan, A. Malova, A. Kukharev, A. Koziukov, Branch of JSC URSC - ISDE, Russian Federation

The results of the single effect events and total ionizing dose testing of VCOs, amplifiers, regulators and DC/DC converters are presented. We obtained SOA, LET thresholds and TID for SEL and destructive failure.

DW-8 A Novel Facility for Accelerated System Level Radiation Effects Testing Using a High-Flux Neutron Generator

W. Goodman, K. Rittenhouse, L. Jacobson, Phoenix LLC, USA

A new neutron source for accelerated testing of electronic components and systems has been built and modeled neutron flux has been measured. Neutron irradiation of a rack mount power supply has been performed.

DW-9 TID Sensor Based on a Bipolar Transistor

A. Bakerenkov, V. Pershenkov, V. Felitsyn, A. Rodin, V. Telets, V. Belyakov, A. Zhukov, N. Glukhov, National Research Nuclear University MEPhI, Russian Federation

The performance of the total ionizing dose sensor based on a bipolar transistor were researched in this work.

DW-10 Heavy Ion-Induced SEE and ⁶⁰Co TID Effects Testing on Commercial Logic Devices

P. Kohler, T. Rajkowski, P. Wang, 3D PLUS, France, F. Saigné, University of Montpellier 2, France, A. Sanchez, VPT Rad, USA, L. Buybusque, L. Gouyet, TRAD, France

This paper presents the investigation of heavy-ion induced Single-Event Effects, and gamma ray induced Total Ionizing Dose effect on commercial logic devices including buffers and transceivers.

Technical Program

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Monday, December 7, 2020

DW-11 SET Results of the Intersil ISL7202xSEH CAN Transceivers in a Two Node Bus System

W. Newman, N. van Vonno, A. Robinson, L. Pearce, O. Mansilla, E. Thomson, Renesas Electronics America, USA

We report the results of SET testing of a two-node Intersil CAN Bus system. Based on those results, CRÈME96 provided an estimated system error rate in a geosynchronous orbit and a typical low earth orbit.

DW-12 Proton-Induced Output Clock SEU and SEFI Characterization of the ADC12D1620 12-Bit Analog-to-Digital Converter

R. Dungan, E. Nakamura, T. Tran, J. Myer, J. Parker, F. Suela, Northrop Grumman, USA

Proton-induced SEE results are reported for the ADC12D1620. Output clock SEU cross sections were measured over a range of proton energies. No SEFI events were observed at 250 MeV to a fluence of 2.0×10^{11} p/cm².

DW-13 Updated Compendium of Total Ionizing Dose (TID) Test Results for the Europa Clipper Mission

S. Zajac, A. Bozovich, B. Rax, J. Davila, D. Nguyen, W. Parker, A. Kenna, S. McClure, J. Thomas, K. Stanford, M. Sundgaard, NASA-JPL, USA

We present the results of total ionizing dose testing and analysis on electric, electronic, and electromechanical (EEE) parts, tested by the Jet Propulsion Laboratory in support of the Europa Clipper Mission.

DW-14 SEL and TID Characterization of a Cobham SONOS Nonvolatile Memory

M. Von Thun, D. Bass, R. Dimitru, R. Anderson, J. Benthem, A. Turnbull, Cobham, USA

A Cobham SONOS based NOR Flash non-volatile memory has been designed, manufactured, and characterized for radiation effects. The radiation effects results will be presented.

DW-15 Single Event Effects Characterization of Microchip Programmable Current Limiting Power Switch LX7712

M. Leuenberger, M. Sureau, R. Stevens, N. Rezzak, D. Johnson, Microchip Technology, USA

The heavy ions single event effect characterization results of Microchip Technology's radiation hardened programmable current limiting power switch IC, the LX7712, are presented. The data shown are based on single event testing campaign of November 2019.

DW-16 Single Event Transients Detection in AD844 Operational Amplifier by Utilizing Ultra-fast Pulsed Laser System

C. Gu, L. Chen, University of Saskatchewan, Canada, D. Hiemstra, V. Kirischian, MDA Corporation, Canada

Single event transients have been observed in five regions of interest of AD844 operational amplifiers by utilizing an ultra-fast laser with three different energy levels through two photon absorption. A SET detecting system is also described.

Technical Program

(all times Eastern Standard Time)

Monday, December 7, 2020

DW-17 DW-17 Single-Event Effects Test Results of the Intersil ISL73141SEH Precision SAR ADC

J. Harris, N. van Vonno, L. Pearce, E. Thomson, Renesas Electronics America, USA

We report the results of destructive and nondestructive single-event effects (SEE) testing of the Intersil ISL73141SEH 14-bit 750/1000ksp/s precision SAR ADC.

DW-18 Impact of Low-Energy Proton (10 MeV) Sensitivity to SEU on Microcontroller and Microprocessor Performance in Low-Earth Orbit

S. Damkjar, I. Mann, D. Elliott, University of Alberta, Canada

Proton beam testing was performed on several devices. Some showed high SEU sensitivity to low energy protons while others did not. Consequences of this low energy peak on performance and mitigation by shielding are investigated.

DW-19 Single Event Latch-up and Total Ionizing Dose Characterization of a Cobham Designed Smart Power Switch Controller

M. Von Thun, Y. Lotfi, T. Meade, A. Turnbull, Cobham, USA

Single event latch-up and total ionizing dose characterization data will be presented for the newly designed and fabricated Cobham radiation-hardened Smart Power Switch Controller.

DW-20 Single-Event Effects Testing of the Renesas ISL70005SEH Dual Output Point-of-Load Regulator

N. van Vonno, O. Mansilla, J. Gill, F. Ballou, W. Newman, E. Thomson, L. Pearce, Renesas Electronics America, USA, H. Satterfield, Retired

We report SEE testing results of the Renesas ISL70005SEH point-of-load regulator, which includes a synchronous buck and low dropout regulator in a single IC. We also provide a brief functional description of the part.

DW-21 Investigation of Application-Specific Bias Conditions and Dose Rate Dependence in Total Ionizing Dose (TID) Response

A. Bozovich, D. Nguyen, J. Davila, S. Zajac, NASA-JPL, USA

This paper investigates flight circuit application bias and irradiation dose rate dependencies ("test as you fly" conditions) in the total ionizing dose response of various electronic components considered for use in a space radiation environment.

DW-22 The Aerospace Corporation's Compendium of Recent Radiation Effect Results

S. Davis, D. Mabry, A. Yarbrough, R. Koga, C. Roske, K. MacGowan, V. Hunt, A. Wright, J. Taggart, C. Langford, The Aerospace Corporation, USA

Single event effects and total ionizing dose testing was performed on several commercial components to determine the response of these components to the space radiation environment. Testing used heavy ions, protons, and gamma rays.

Technical Program

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Monday, December 7, 2020

DW-23 NASA Goddard Space Flight Center's Compendium of Radiation Effects Test Results

A. Topper, M. Berg, E. Wyrwas, J. Forney, H. Kim, J. Osheroff, A. Phan, D. Cochran, M. Obryan, Science Systems Applications, Inc., USA, J. Lauenstein, M. Campol, T. Carstens, NASA GSFC, USA, M. Casey, E. Wilcox, J. Pellish, P. Majewicz, C. Fedele, NASA, USA, M. Chaiken, NASA GRC, USA

Total ionizing dose, displacement damage dose, and single-event effects testing were performed to characterize and determine the suitability of candidate electronics for NASA space utilization. Devices tested include FETs, flash memory, optoelectronics, and bipolar devices.

DW-24 SEU Characterization of Commercial and Custom-designed SRAMs based on 65 nm Technology and Below

A. Coronetti, M. Cecchetto, Fernandez Martinez, A. Papadopoulou, K. Bilko, R. Garcia Alia, CERN, Switzerland, J. Wang, KU Leuven, Belgium, M. Tali, Ampyx Power, Netherlands, P. M. Kastriotou, C. Cazzaniga, STFC, United Kingdom, F. Castellani, ISAE Supaero, France

The R2E group at CERN has tested a few SRAMs whose data are complementary to various scientific publications. The experimental data include low and high energy protons, heavy ions and more.

DW-25 Single Event Latchup Results for COTS Devices Used on SmallSat Missions

S. Vartanian, G. Allen, F. Irom, W. Parker, M. D. Conner, NASA-JPL, USA

We present single event latchup (SEL) results for a variety of microelectronic devices frequently designated for SmallSat missions. The data presented is only a small representation of all the SEL tests performed in 2019.

DW-26 Ultra-High Total Ionizing Dose Effects in a Highly-Integrated and RF-Agile Transceiver

J. Budroweit, J. Mattis, DLR, Germany, G. Borghello, European Organization for Nuclear Research, Switzerland

Characterization of TID effects on a highly-integrated RF-agile transceiver to ultra-high dose levels. The DUT shows no degradation up to 40 Mrad(SiO₂). Beyond 45 Mrad(SiO₂), malfunctions and annealing effects are observed.

DW-27 DW-27 Energy-Dependent Single-Event Effects in Power MOSFETs from a Broad-Spectrum Neutron Beam

J. Pritts, S. Wender, J. George, T. Fairbanks, J. O. Donnell, Los Alamos National Laboratory, USA

We present an approach for extracting energy-dependent cross sections from broad-spectrum pulsed neutron beams using time-of-flight measurements. Data for destructive single-event burnout in several n-channel power MOSFET devices are presented.

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DW-28 Total Dose Testing of the ISL70061SEH and ISL70062SEH PMOS and NMOS Load Switches

N. van Vonne, L. Pearce, D. Turner, W. Newman, Renesas Electronics America, USA

We report the results of low and high dose rate total ionizing dose testing of the Renesas ISL70061SEH and ISL70062SEH PMOS and NMOS load switches together with a brief functional description of the parts.

DW-29 Radiation Test Results for ISSI 1 Gb DDR2

S. Guertin, A. Daniel, W. Parker, N. Duc, D. Sam, NASA-JPL, USA

ISSI IS46DR16640B and IS46DR81280B DDR2 1Gb devices are studied for radiation effects. TID and SEE results are provided. Key results are presented for SEFI, stuck bits, and TID performance.

DW-30 Single Event Effects in Power MOSFETs with Mono-energetic Neutron Beams

J. George, J. Pritts, T. Fairbanks, S. Wender, E. Auden, H. Quinn, Los Alamos National Laboratory, USA

Neutron-induced single event burnout cross sections for n-channel power MOSFET devices using mono-energetic neutron beams are presented. Advantages and challenges for destructive single event effects testing with these beams are also discussed.

DW-31 Trends in Measured SEL Sensitivity with Increasing Proton Induced Total Ionizing Dose to 1 Mrad(Si) on Zynq UltraScale Plus XCZU9EG FPGA

R. Koga, S. Davis, D. Mabry, The Aerospace Corporation, USA

Experimental observation of the trend in SEL sensitivity was made for increasing proton induced TID/DD. The test samples were the Zynq UltraScale Plus XCZU9EG FPGAs. The cumulative TID on one sample was near 1 Mrad(Si).

DW-32 Guide to the 2019 IEEE Radiation Effects Data Workshop Record

D. Hiemstra, MDA, Canada

The 2019 Workshop Record has been reviewed and a table prepared to facilitate the search for radiation response data by part number, type, or effect.

DW-33 Total Ionizing Dose and Single Event Effects Characterization of Texas Instruments LMX2615-SP 40 MHz to 15 GHz Wideband Synthesizer with Phase Synchronization and JESD204B Support

K. Kruckmeyer, H. Castro, T. Thang, A. Black, Texas Instruments, USA

The LMX2615-SP is a frequency synthesizer (clock) with integrated PLL and VCO that can generate frequencies up to 15 GHz. TID, ELDRS, SEL, SEFI and SEU test data are presented.

Technical Program

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Monday, December 7, 2020

DW-34 Total Ionizing Dose Test Results of Texas Instruments LMK04832-SP 3.2 GHz JESD204B Clock Jitter Cleaner with 14 Outputs

K. Kruckmeyer, H. Castro, T. Trinh, A. Black, Texas Instruments, USA

The LMK04832-SP is a radiation hardened JESD24B compliant clock conditioner with integrated VCOs that can provide clock signals up to 3.2 GHz on up to 14 outputs. TID test data are presented.

DW-35L Proton Characterization for a Dual 12bits 1.5Gbps Analog to Digital Converter Dedicated up to S-Band Domain

O. Bonnet, R. Pilard, E. Savasta, J. Palmigiani and V. Hibon, Teledyne E2, France

Here are the results of a proton test which has been done on the Dual 12bits 1.5Gbps Analog to Digital Converter to validate the previous Proton estimation made with PROFIT with heavy ions results.

DW-36L Neutron Radiation Failure-in-time Test of 1200V and 1700V SiC Power Transistors

Moinuddin Ahmed, Christopher Stankus, Angel Yanguas-Gil, John Hryn, Stephen A. Wender, and Kranti Gunthoti, Los Alamos National Laboratory, USA

Accelerated neutron radiation failure-in-time test (sea-level height) was performed on 144 SiC power transistors from 3 different manufacturers. A maximum FIT of 8 and 28 were measured for 1200V and 1700V devices respectively.

DW-37L Recent Single Event Transients, Upsets, and Latchup Test Results for TPS3307-I8, TLI431, INAI29, AM26LV31 & 32 Electronic Parts

Joel Hatch, The Ohio State University Nuclear Reactor Laboratory, USA, Brittany Butterworth, L3 Cincinnati Electronics Corporation, USA

Automotive grade parts provide a commercial "off- the-shelf" (COTS) active electronic part alternative for application in satellite and launch vehicles. The results of heavy ion induced Single Event Effects (SEE) measured in various automotive parts are put forth for examination

12:30 - 13:00 BREAK

13:00 - 14:00 **RADIATION EFFECTS COMMITTEE ANNUAL OPEN MEETING**

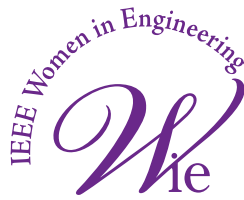
END OF MONDAY SESSIONS

Technical Program

(all times Eastern Standard Time)

Tuesday, December 8, 2020

9:00 - 10:00



WOMEN IN ENGINEERING TALK: Women in STEM at the time of COVID-19

Dr. Cinzia Da Vià, Professor of Physics at the University of Manchester UK

Cinzia Da Vià is a Professor of Physics at the University of Manchester UK, she received her PhD at Glasgow University in 1998 and is an expert in radiation detectors for High-Energy Physics and Medical applications. She has been working on radiation hard silicon detector development for the Large Hadron Collider (LHC) since 1998 and in 1995 she participated in the discussions which led to the design of 3D silicon sensors and has been working on the development of this technology ever since. She formed and led the 3D ATLAS pixel R&D Collaboration (2007-2014), which successfully designed and industrialized the first 3D sensors to be installed in an experiment. 3D sensors are operating in the ATLAS experiment since 2015. In 2010, she proposed the use of Micro-Electro-Mechanical Systems (MEMS) technology to fabricate sensors for micro-dosimetry in Hadron therapy and is currently involved in vertical integration of smart-systems. She is in the scientific committee of several international conferences on Radiation Detectors and Instrumentation and is the co-founder of the ERDIT (European Radiation Detector and Imaging Technology) Network to promote Radiation Imaging Technology research across different fields of application in Europe. Since 2014 she is an elected member of the IEEE NPSS RISC Committee.

10:00 - 13:00

POSTER SESSION

LIVE QUESTION AND ANSWER SESSION

Andrew Sternberg, Vanderbilt University



END OF LIVE SESSION

DECEMBER 9 – 30, 2020

All technical content available to attendees on demand



Janet Barth
Executive Chair



Robert Reed
Executive Vice-Chair

The purposes of the Radiation Effects Committee (REC) of the IEEE Nuclear and Plasma Sciences Society are to advance the theory and application of radiation effects and its allied sciences, to disseminate information pertaining to those fields, and to maintain high scientific and technical standards in our community. The REC aids in promoting close cooperation and the exchange of technical information among its members. This is done by running conferences for the presentation and discussion of original contributions, assisting in the publication of technical papers on radiation effects in the IEEE Transactions on Nuclear Science, coordinating development of radiation effects measurement definitions and standards within IEEE and other standards organizations, providing a sounding board for radiation effects specialists, providing for the continued professional development and needs of its members, and providing liaisons between IEEE and other technical organizations in the areas of radiation effects.

Each year, the REC provides a forum for the technical exchange of information by holding the Nuclear and Space Radiation Effects Conference (NSREC). The NSREC is an international forum for presentation of research papers on nuclear and space radiation effects. This includes effects on electronic and photonic materials, devices, circuits, sensors, and systems, and semiconductor processing technology and design techniques for producing radiation-tolerant (hardened) devices and integrated circuits. Papers presented at the NSREC are submitted for possible publication in the January issue of the IEEE Transactions on Nuclear Science in the year following the conference, subject to an additional review. A data workshop is also held each year at the NSREC. The REC oversees publication of a special Data Workshop issue of papers presented at the conference. The Data Workshop is published in the fall of the year, **but for NSREC 2020, it will be published by June 2021.**

NSREC 2020 will be held virtually November 29-December 8 with On-Demand Viewing through December 30, 2020. Hugh Barnaby of Arizona State University is the Conference Chair. Supporters of the 2020 NSREC include The Aerospace Corporation, Analog Devices, BAE Systems, Boeing, Cobham, IR HiRel Products, an Infineon Technologies Company, Jet Propulsion Laboratory, L3 Harris, Radiation Test Solutions, Renesas, Skywater Technology, Southwest Research Institute, and VPT, Inc. We thank our supporters for their significant and continuing commitments to the conference and welcome other organizations to consider becoming supporters of the IEEE NSREC.

NSREC 2021 will be held in Ottawa, Ontario, Canada, July 19-23, 2021, at the Shaw Conference Center. Steve McClure, Jet Propulsion Laboratory, is the 2021 NSREC Chair. Tom Turflinger, The Aerospace Corporation, is the Chair of NSREC 2022, which will be held in Provo, Utah.

Papers presented at the 2020 NSREC are eligible for publication in the April 2021 issue of the IEEE Transactions on Nuclear Science. Authors must upload their papers prior to the conference for consideration for publication in the April 2021 TNS Special Issue. Detailed instructions can be found at **www.nsrec.com**.

Keep visiting our web site at **www.nsrec.com** for author information, paper submission details, exhibitor links, on-line registration, and the latest NSREC information.

EDITORS

Dan Fleetwood
Vice-Chair of Publications

All papers accepted for oral or poster presentation in the technical program will be eligible for publication in a special issue of the *IEEE Transactions on Nuclear Science* (April 2021), based on a separate submission of a complete paper. Each paper will be subject to the standard full peer review given all papers submitted to the *IEEE Transactions on Nuclear Science*. All papers must be submitted on IEEE ScholarOne. Instructions for submitting papers can be found at the Conference web site **www.nsrec.com**. The deadline for submission of papers is October 2, 2020. Data Workshop papers are published in a Workshop Record and are not candidates for publication in the *IEEE Transactions on Nuclear Science*. The process for the Workshop Record is managed by the Workshop Chair.

The review process for papers submitted to the *Transactions* is managed by a team of editors. To provide consistent review of papers, this editorial team manages the review process for all radiation effects papers submitted to the *Transactions* throughout the year. The editorial team consists of a senior editor and seven associate editors who are technically knowledgeable in one or more specializations and are experienced in the publication process. If you would like to serve as a reviewer for the December issue of the *Transactions* or for radiation effects papers submitted throughout the year, please contact one of the editors. The editors for the 2020 NSREC are:

Dan Fleetwood, Senior Editor, Vanderbilt University
Email: dan.fleetwood@vanderbilt.edu

Dennis Brown, Associate Editor, IEEE NPSS
Email: brownden_1@yahoo.com

Heather Quinn, Associate Editor, Los Alamos National Laboratory
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William Robinson, Associate Editor, Vanderbilt University
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RESG NEWS

ARE YOU A MEMBER OF IEEE?

Now is the time to join the Institute of Electrical and Electronics Engineers (IEEE) and the Nuclear Plasma Sciences Society (NPSS). Why? First of all, you'll become a member of the largest professional engineering society in the world. About 60% of NSREC attendees are IEEE members. The cost of membership in the IEEE depends on your country and your career phase. IEEE members receive access to a broad range of benefits, including a terrific insurance program, on-line access to IEEE publications, and reduced rates at all IEEE sponsored conferences, including, of course, the IEEE NSREC and Short Course!

NPSS membership is \$35. NPSS members receive a free subscription to *NPSS News*, and free on-line electronic access via *IEEE Xplore* to the *IEEE Transactions on Nuclear Science (TNS)* and the *NSREC Data Workshop Record*. Now members can search and view digital copies of all *IEEE TNS* papers on-line all the way back to the first IEEE NSREC in 1964. NPSS members get to vote in our NSREC elections, held at the annual open meeting on Thursday of the conference. What are you waiting for? Apply for membership at <http://ieee-npss.org/why-join-npss-and-ieee/> or visit the IEEE registration desk at the conference.

NSREC PUBLICATIONS

NSREC has two publications each year:

- ***IEEE Transactions on Nuclear Science***. This IEEE journal, which will be published this year in April 2021, is the official archive of research papers presented at NSREC. Papers presented at the conference undergo an additional review before they are accepted for the April 2021 issue.
- ***Radiation Effects Data Workshop Record***. Published each year in October, this IEEE proceedings has become the source for radiation test data on semiconductor components.

A complimentary copy of the 2020 *IEEE Radiation Effects Data Workshop Record* and the June 2021 special NSREC issue of the *IEEE Transactions on Nuclear Science* will be mailed to each NSREC technical session attendee if the attendee registered to be listed on the attendee list.

RADITION EFFECTS COMMITTEE ANNUAL OPEN MEETING

**MONDAY, DECEMBER 7
13:00 – 14:00**

You are invited to attend the IEEE Radiation Effects Committee's Virtual Annual Open Meeting on Monday, December 7, 13:00 – 14:00 EST. All conference attendees are encouraged to attend.

During the meeting we will discuss the 2020 conference and future IEEE Nuclear and Space Radiation Effects Conferences. A report on the nomination processes for the 2020 Junior Member-at-Large on the Radiation Effect Steering Group and the 2021 nominating committee will be presented. Voting instructions for IEEE NPSS members will be provided.

Awards

2019 OUTSTANDING PAPER AWARD

New Approach for Pulsed-Laser Testing That Mimics Heavy-Ion Charge Deposition Profiles

J. M. Hales, A. Khachatrian, S. Buchner, J. Warner, A. Ildefonso, G. N. Tzintzarov, D. Nergui, D. M. Monahan, S. D. LaLumondiere, B. Lotshaw, J. D. Cressler, and D. McMorro

2019 MERITORIOUS PAPER AWARD

Radiation Induced Variable Retention Time in Dynamic Random Access Memories

V. Goiffon, T. Bilba, T. Deladerriere, G. Beaugendre, A. Le-Roch, A. Dion, C. Virmondois, J. M. Belloir, M. Gaillardin, A. Jay, and P. Paillet

2019 OUTSTANDING STUDENT PAPER AWARD

Total-Ionizing-Dose Effects and Low-Frequency Noise in 16-nm InGaAs FinFETs With HfO₂/Al₂O₃ Dielectrics

S. Bonaldo, S. E. Zhao, A. O'Hara, M. Gorchichko, E. X. Zhang, S. Gerardin, A. Paccagnella, N. Waldron, N. Collaert, V. Putcha, D. Linten, S. T. Pantelides, R. A. Reed, R. D. Schrimpf, and D. M. Fleetwood

2019 OUTSTANDING DATA WORKSHOP PRESENTATION AWARD

Radiation Tests of a 500°C Durable 4H-SiC JFET Integrated Circuit Technology

J.-M. Lauenstein, K. Ryder, E. Wilcox, M. Carts, S. Wrbanek, J. Wrbanek, P. Neudeck, and R. Buttler

2019 RADIATION EFFECTS AWARD

Dr. Gary Lum, Lockheed Martin Corporation, received the 2019 IEEE/NPSS Radiation Effects Award for contributions to the fundamental understanding of space radiation effects in microelectronics influencing spacecraft survivability; through research, testing, and his inquisitive nature.

2019 RADIATION EFFECTS EARLY ACHIEVEMENT AWARD

Dr. T. Daniel Loveless, University of Tennessee at Chattanooga, received the inaugural 2019 Radiation Effects Early Achievement Award for contributions to radiation effects research in high-speed analog and mixed-signal electronics and student mentorship in the radiation effects community.

2020 RADIATIONS EFFECTS AWARDS

The winners of the 2020 Radiation Effects and Radiation Effects Early Achievement Awards will be announced Tuesday, December 1, 10:10-10:30 EST. The purpose of the Radiation Effects Award is to recognize individuals who have had a sustained history of outstanding and innovative technical and/or leadership contributions to the radiation effects community. The purpose of the Radiation Effects Early Achievement Award is to recognize an individual early in his or her career whose technical contributions and leadership have had a significant impact on the field of radiation effects.

2021 RADIATIONS EFFECTS AWARDS

Nominations are currently being accepted for the 2021 IEEE Nuclear and Plasma Sciences Society (NPSS) Radiation Effects Award. The basis of the award is for individuals who have: (1) a substantial, long-term history of technical contributions that have had major impact on the radiation effects community. Examples include benchmark work that initiated major research and development activities or a major body of work that provided a solution to a widely recognized problem in radiation effects; and/or (2) a demonstrated long-term history of outstanding and innovative leadership contributions in support of the radiation effects community. Examples include initiation or development of innovative approaches for promoting cooperation and exchange of technical information or outstanding leadership in support of the professional development of the members of the radiation effects community.

Awards

Nominations are currently being accepted for the 2021 Radiation Effects Early Achievement Award. The basis of the award is for individuals whose technical contributions and leadership during the first ten years of the recipient's career that have had a major impact on the Radiation Effects Community. Examples include work that provides a solution to important technical problems in radiation effects or work that identifies significant new issues in the field. Other factors are cumulative research contributions over the first part of the career, internationally recognized leadership, and mentorship. It is the intent of the RESG to give special consideration for this award to members of the community who are IEEE/NPSS members.

Cash awards and plaques will be presented at the 2021 IEEE NSREC, Ottawa, Ontario, Canada in July 2021. Nomination forms are available electronically in PDF Format or in Microsoft Word format at [**http://ieee-npss.org/technical-committees/radiationeffects/**](http://ieee-npss.org/technical-committees/radiationeffects/). Forms should be sent to Kyle Miller, Member-at-Large, Ball Aerospace, for the Radiation Effects Steering Group. Kyle can be reached at [**kbmiller@ball.com**](mailto:kbmiller@ball.com).

Registration and Travel

CONFERENCE REGISTRATION

NSREC encourages Pre-Registration and offers a lower registration rate, “Early Registration”, if the payment is received no later than Friday, November 13. After that date, the “Late Registration” rates apply.

There are three acceptable forms of payment for registration and activity fees:

- 1) check made payable to “IEEE NSREC” in U.S. dollars and drawn on a U.S. bank,
- 2) MasterCard, VISA, Discover and American Express credit card.

Registrations can be submitted by using the link at the NSREC website:

www.nsrec.com. E-mailed or faxed registrations will be accepted with a credit card payment or you can mail the conference registration form, along with your payment, to ETCic. All mailed registration payments must arrive by no later than November 13. Telephone registrations will not be accepted.

ETC Incentives & Conferences (ETCic)
2254 Emerald Drive
Castle Rock, CO 80104
Tel: 720-733-2003
Fax: 720-733-2046
etc@etcic.us

CONFERENCE CANCELLATION

A \$50 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after November 13, 2020 cannot be guaranteed. Consideration of requests for refunds will be processed after the conference. To request a refund, you must notify ETCic by fax at 720-733-2046 or e-mail at **etc@etcic.us**.

Industrial Exhibits



Scott Jordan
Industrial Exhibits Chair
JSTF, Inc.

The **2020 NSREC Industrial Exhibits** will feature the leading worldwide suppliers of radiation hardened products, related materials, services, and research and development.

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Exhibit Registration is open and will end October 5, 2020.

To see the current Exhibitors and or more information contact::

Scott Jordan
JSTF, Inc.

Phone: 1-949-291-2649

Email: Jordans1@jazztrusted.com

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2020 IEEE NSREC Technical Sessions and Short Course Registration Form



Registration is available on-line at www.nsrec.com

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A \$50 processing fee will be withheld from all refunds. Due to advance financial commitment, conference registration fee refunds requested after November 13, 2020, cannot be guaranteed. Consideration of requests for refunds will be processed after the conference. You must notify NSREC Registration by no later than November 13, 2020 via E-mail: etc@etcic.us or Fax: 720 -733 -2046,

REGISTRATION FEES (in U.S. dollars)

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	Early	Late
IEEE Member *		
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Short Course & Technical Sessions	\$375	\$450
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Short Course & Technical Sessions	\$100	\$360

TOTAL AMOUNT ENCLOSED: \$ _____

PAYMENT OF FEES

☐ Enclosed is a check in **U.S. DOLLARS ONLY**, drawn on or payable through a U.S. bank.
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2020 IEEE NSREC Technical Sessions and Short Course Registration Form



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ANNOUNCEMENT and FIRST CALL FOR PAPERS



2021 IEEE NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE Short Course and Radiation Effects Data Workshop

July 19-23, 2021
Shaw Centre
Ottawa, Canada

www.nsrec.com

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You are cordially invited to attend the 2021 IEEE Nuclear and Space Radiation Effects Conference to be held July 19-23, 2021 at the Shaw Centre, in Ottawa, Canada. The conference features a technical program consisting of eight to ten technical sessions of contributed papers describing the latest observations in radiation effects, a Short Course on radiation effects issues with current relevance offered on July 19, a Radiation Effects Data Workshop, and an Industrial Exhibit. The technical program includes oral and poster sessions.

Papers on nuclear and space radiation effects on electronic and photonic materials, devices, circuits, sensors and systems, as well as semiconductor processing technology and design techniques for producing radiation-tolerant (hardened) devices and integrated circuits, will be presented at this meeting of engineers, scientists and managers. International participation is strongly encouraged.

We are soliciting papers describing significant new findings in the following or related areas:

Basic Mechanisms of Radiation Effects in Electronic Materials and Devices

- Single Event Charge Collection Phenomena and Mechanisms
- Ionizing Radiation Effects
- Displacement Damage
- Radiation Transport, Energy Deposition, and Dosimetry
- Materials and Device Effects
- Processing-Induced Radiation Effects

Radiation Effects on Electronic and Photonic Devices, Circuits, and Systems

- Single Event Effects, Total Dose, and Displacement Damage
- MOS, Bipolar, and Advanced Technologies
- Systems on a Chip, GPUs, FPGAs, Microprocessors
- Isolation Technologies, such as SOI and SOS
- Methods for Hardened Design and Manufacturing
- Modeling and Hardening of Devices and Circuits
- Cryogenic or High Temperature Effects
- Novel Device Structures, such as MEMS and Nanotechnologies
- Emerging Modeling and Experimental Techniques for Hardening Systems

Space, Atmospheric, and Terrestrial Radiation Effects

- Characterization and Modeling of Radiation Environments
- Space Weather Events and Effects
- Spacecraft Charging
- Predicting and Verifying Soft Error Rates (SER)

Hardness Assurance Technologies, Modeling, and Testing

- New Modeling and Testing Techniques, Guidelines, and Hardness Assurance Methodologies
- Unique Radiation Exposure Facilities or Novel Instrumentation Methods
- Dosimetry

New Developments of Interest to the Radiation Effects Community

PAPER SUMMARY DEADLINE: FEBRUARY 5, 2021

PROCEDURE FOR SUBMITTING SUMMARIES

Authors must conform to the following requirements:

1. Prepare a single Adobe Acrobat file consisting of a cover page and an informative two to four page summary describing results appropriate for 12-minute oral or poster presentation. The cover page must provide an abstract no longer than 35 words, the title, name and company affiliation of the authors, and company address (city, state, country). Identify the author presenting the paper and provide telephone, and email address. The summary must include sufficient detail about the work to permit a meaningful technical review. In the summary, clearly indicate (a) the purpose of your work, (b) significant new results with supporting technical material, and (c) how your work advances the state of the art. Show key references to other related work. The summary must be no less than two and no more than four pages in length, including figures and tables. All figures and tables must be large enough to be clearly read. Note that this is more than an abstract, but do not exceed four pages.
2. Prepare your summary in single-column or IEEE TNS standard two-column format, using 11 point or greater font size, formatted for either U.S. Standard (8.5 x 11 inch) or A4 (21 x 29.7 cm) page layout, with 1 inch (2.5 cm) margins on all four sides.
3. Obtain all corporate, sponsor, and government approvals and releases necessary for presenting your paper at an open attendance international meeting.
4. Summary submission is electronic only, through www.nsrec.com. The submission process consists of entering the paper title, author(s) and affiliation(s), an abstract no longer than 35 words, and uploading the summary. Authors are prompted to state their preference for presentation (oral, poster, or data workshop poster) and for session. Details of the submission process may be found at www.nsrec.com. The final category of all papers will be determined by the Technical Program Committee, which is responsible for selecting final papers from initial submissions.

**Summaries must be received by
February 5, 2021**

**Detailed submission and
formatting instructions
will be available after
December 1, 2020
at www.nsrec.com**

Papers accepted for oral or poster presentation at the technical program are expected to be submitted for publication in the IEEE Transactions on Nuclear Science (January 2022). Selection for this issue will be based on a separate submission of a complete paper. These papers will be subject to the standard full peer review given all papers submitted to the *IEEE Transactions on Nuclear Science*. Further information will be sent to prospective authors upon acceptance of their NSREC summary. It is not necessary to be an IEEE member to present a paper or attend the NSREC. However, we encourage IEEE and NPSS membership of all NSREC participants.

RADIATION EFFECTS DATA WORKSHOP

The Radiation Effects Data Workshop is a forum for papers on radiation effects data on electronic devices and systems. Workshop papers are intended to provide radiation response data to scientists and engineers who use electronic devices in a radiation environment, and for designers of radiation-hardened systems. Papers describing new simulation or radiation facilities are also welcomed. **The procedure for submitting a summary to the Workshop is identical to the procedure for submitting NSREC summaries.** Radiation Effects Data Workshop papers will be published in a Workshop Record and are not candidates for publication in the Conference issue of the *IEEE Transactions on Nuclear Science*.

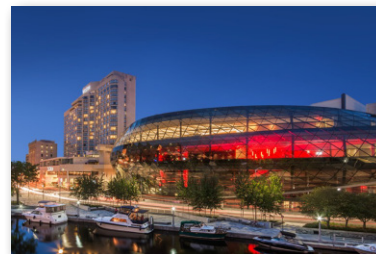
OTTAWA, CANADA

The Westin Ottawa with the adjoining Shaw Centre is the location for NSREC 2021. Ottawa is Canada's capital, a dynamic showcase city of more than one million people. Located in Ontario at the Quebec border, it's a place where you'll hear English and French spoken in the streets; where you can discover Canada's proud heritage at impressive national sites and famous landmarks, including the Rideau Canal, a UNESCO World Heritage Site. It's a city steeped in culture, with world-class museums and galleries displaying stunning national collections and special exhibitions from Canada and around the world.

This city is a uniquely beautiful place: an urban centre on the edge of nature where you can enjoy the great outdoors either just outside your hotel room or nearby in the surrounding countryside. There's an easy cosmopolitan vibe here, and Ottawa is known for being both welcoming and walkable. Explore the distinctive local neighbourhoods, including the historic ByWard Market: by day this area boasts a bustling farmers' market and chic shops, by night it hums with activity at the restaurants, pubs, and nightclubs.

This is also a city that enjoys the finer things in life, with a culinary community that's earning wide acclaim, unique boutiques and shopping districts, a lively local music and art scene, and always exciting nightlife. The Westin Ottawa is ideally located right downtown, mere steps away from the historic sites and landmarks, and only a short drive from Ottawa's international airport.

This is Ottawa, Canada's capital. Please join us for NSREC 2021 and experience it for yourself.



Courtesy of Tourism Ottawa