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PROGRAM

Conference
on Radiation and its Effects
on Components and Systems

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Tuesday 26th September >> Pierre Baudis Congress Centre

07:30 - 08:30 Registration

08:30 - 09:20 Conference Opening Session

09:20 - 10:10 Session A: SINGLE EVENT EFFECTS: MECHANISMS & MODELLING

Chairs: Adrian Ildefonso (US Naval Research Laboratory, USA) & Philippe Paillet (CEA, France)

09:25 – A1 **Heavy-ion Effects in SiC power MOSFETs with Trench-gate Design**

C. Martinella[1], S. Race[1], N. Fuer[1], A. Brandl[1], U. Grossner[1]

1. ETH Zurich, Switzerland

SiC power MOSFETs with trench-gate structure have been irradiated with heavy-ion beams. Micro-breaks in the gate oxide induced by single event leakage current (SELC) and complete gate rupture are observed during broad-beam and microbeam experiments

09:40 – A2 **Impact of Tier Pitch Scaling on Heavy-ion Sensitivity of 3D NAND Flash**

M. Bagatin[1], S. Gerardin[1], A. Paccagnella[1], A. Benvenuti[2], S. Beltrami[2]

1. University of Padova, Italy, 2. Micron Technology, Italy

We study the impact of tier pitch scaling on 3D NAND Flash heavy-ion sensitivity. Single-event-effect cross section increasesmore than proportionally to the reduction in tier pitch. Ion-induced threshold voltage shifts are analyzed and discussed.

A3 Withdrawn by the author

09:55 – A4 **Proposal of a Multi-Scale High Accuracy Engineering approach for Single Event Effects Analysis in Modern Technologies**

L. Coïc[1], N. Andrianjohany[1], N. Sukhaseum[1], J. Guillermin[1], A. Varotsou[1], G. Santin[2]

1. TRAD, France, 2. ESA, Netherlands

This paper presents the design and validation of a novel MC-based SEE rate calculation method. It is intended as an extension to the IRPP method for advanced technologies with an emphasis on user assumptions reduction.

Poster – PA1 **Comparison of Neutron-Induced Single Event Upset and Latch-up Cross Sections**

M. Cecchetto[1], R. Garcia Alia[1], G. Lerner[1], F. Salvat Pujol[1], F. Cerutti[1]

1. CERN, Switzerland

Single event latch-up (SEL) cross sections of SRAMs at high-energy are generally not reproducible with 14-MeV neutrons, differently from single event upset (SEU) ones. We explain this phenomenon by analysing the nuclear interactions through simulations.

Poster – PA2 **Fast Neutron-Induced Single-Event Effects in Power UMOSFETs**

S. Alberton[1,2],V. Aguiar[1], N. Added[1], A. Boas[3], M. Guazzelli[3], C. Federico[4], O. Gonçalez[4], J. Wyss[5], **A. Paccagnella[2]**, N. Medina[1]

1. University of Sao Paulo, Institute of Physics, Brazil, 2. University of Padova, Italy, 3. Centro Universitário FEI, Brazil, 4. Instituto de Estudos Avançados, Brazil, 5. Università degli Studi di Cassino e del Lazio Meridionale, Italy

We present comparative experimental results of SEEs induced by mono- energetic fast neutrons provided by a Deuteron-Tritium neutron generator in Si-based DMOS/UMOS FETs. Results demonstrate enhanced charge multiplication effect in the intermediate to high voltage UMOSFETs.

Tuesday 26th September >> Pierre Baudis Congress Centre

10:10 - 10:50 Coffee Break - Exhibit Area

10:50 - 12:10 Session B: SINGLE EVENT EFFECTS: DEVICES & ICS

Chairs: Michael King (SANDIA National Labs, USA) & Frédéric Wrobel (Université de Montpellier, France)

10:55 – B1 **Worst Case Heavy Ion Testing Condition for Normally Off GaN-Based High Electron Mobility Transistor**

J. Sauveplane[1], C. Chabot[2], C. Ngom[3],[4], M. Orsatelli[2], A. Gutierrez- Galeano[2], E. Marcault[2], V. Pouget[3], M. Zerarka[4], M. Matmat[4]

1. CNES, France, 2. CEA, France, 3. Université de Montpellier, France, 4. IRT Saint Exupéry, France

Paper presents two alternatives SEE testing conditions on GaN power devices to investigate for the worst case that are switching and high tilt beam condition. Results obtained are discussed with the help of TCAD modeling.

11:10 – B2 **Long-term On-Orbit Upset Rate Prediction of 28-nm UTBB FD-SOI Technology**

M. Mounir Mahmoud[1], J. Prinzie[1], A. Cathelin[2], S. Clerc[2], P. Leroux[1]

1. KU Leuven, Belgium, 2. STMicroelectronics, France

This work predicts the long-term on-orbit upset-rate of 28-nm UTBB FD- SOI technology. This prediction is based on investigating the effect of aging degradation on the heavy-ion SEU radiation sensitivity utilizing a custom designed test vehicle.

11:25 – B3 **Single Event Transient Study of Ga2O3 Devices**

A. Khachatrian[1], S. Pearton[2], F. Ren[2], A. Ildefonso[1], J. Hales[1], D. McMorrow[1]

1. US Naval Research Laboratory, USA, 2. University of Florida, USA

Single event effects studies are carried out on Ga2O3 devices using ultrafast laser pulses. Two-photon absorption technique is used to determine how the device transient response changes with deposited charge, bias, and presence of defects.

11:40 – B4 **Effects of Scaling on Logic Single Event Upsets for Advanced Bulk FinFET Technology Nodes**

Y. Xiong[1], N. Pieper[1], Y. Chiang[2], R. Fung[3], S. Wen[3], B. Bhuva[1]

1. Vanderbilt University, USA, 2. Taiwan Semiconductor Manufacturing Company, Ltd., Taiwan, 3. Cisco Systems, USA

Latch and logic errors are analyzed for the 5-nm, 7-nm, and 16-nm bulk FinFET technology nodes to identify trends in threshold frequency at which logic errors exceed latch errors.

11:55 – B5 **Methods for Proton Direct Ionization SEU Characterization and Orbital Error Rate Estimation**

M. Glorieux[1], T. Bonnoit[1], T. Lange[1], R. Gaillard[1], I. Nofal[1], L. Artola[2], C. Poivey[3], D. Levacq[3], R. Rey[2], H. Kettunen[4]

1. IROC Technologies, France, 2. ONERA, France, 3. ESA, Netherlands, 4. RADEF, Finland

Two methodologies are proposed for experimental characterization of proton direct ionization induced SEU and the calculation of corresponding orbital error rates. Both approaches are cross-validated on four SRAM devices, from 65nm down to 16nm FinFET.

Poster – PB1 **Analysis of the Single-Event Latch-up Cross Section of a 16nm FinFET System-on-Chip using Backside Single-Photon Absorption Laser Testing and Correlation with Heavy Ion Data**

M. Fongral[1], V. Pouget[1], F. Saigné[1], M. Ruffenach[2], J. Carron[2], F. Malou[2], J. Mekki[2]

1. Université de Montpellier, France, 2. CNES, France

The SEL cross-section of a 16nm finFET programmable SoC is investigated by combining SPA laser testing, emission microscopy and embedded instrumentation. Results indicate the origin of latch-ups and present excellent correlation with heavy ion data.

Poster – PB2 Investigation on Radiation-Induced Single-Event Latch-up in SRAM Memories on-Board PROBA-V

A. Martins Pio de Mattos[1], D. Santos[1], V. Gupta[2], T. Borel[2], L. Dilillo[1]

1. Université de Montpellier, France, 2. ESA, Netherlands

This work is a study on Single-Event Latch-up on an SRAM memory used in the PROBA-V mission. We investigate and draw hypotheses about the behavior observed in the mission by comparing the experimental results with the in-flight data.

Poster – PB3 Proton and Neutron SEB Testing and Electrical Analysis on 4H-SiC MOSFETs and Diodes

D. Bae[1], S. Khan[1], K. Kim[1], S. Chung1, K. Joongsik[1], S. Woo[1], C. Cho[1], J. Kim[1], S. Yoon[1], S. Wender[2], Y. Kim[1]

1. QRT Inc, Republic of Korea, 2. LANSCE, USA

In this study, degradation of electrical characteristics in SiC power devices under neutron and proton beam irradiation are analyzed. Single event effects (SEE) tolerance and correlation between the both beams test results are also analyzed.

Poster – PB4 Impact of Radiation-Induced Soft Error on Object Detection Algorithm of Unmanned Surface Vehicles

M. Fleck[1], E. Pereira[1], J. Gava[2],F. Moraes[1], N. Calazans[2], F. Meneguzzi[1], R. Possamai Bastos[3], R. Reis[2], L. Ost[4], **R. Garibotti[1]**

1. PUCRS, Brazil, 2. UFRGS, Brazil, 3. Univ. Grenoble Alpes, France, 4. Loughborough University, United Kingdom

This work explores the effects caused by neutron radiation on an object detection algorithm for unmanned surface vehicles. Results show that radiation-induced soft errors contributed to missed and false detections of existing and non-existent objects.

Poster – PB5 Soft Errors Rate Assessment in SRAM and Sequential Circuits manufactured in ST 40 nm BCD Technology

A. Benfante[1], D. Crippa[1], A. Jain[2], A. Veggetti[1], M. Bagatin[3], S. Gerardin[3]

1. STMicroelectronics, Italy, 2. STMicroelectronics, India, 3. University of Padova, Italy

We investigate radiation robustness of the brand-new high density 40 nm ST BCD MOS technology against soft errors by analyzing both SRAMs and Flip-Flops response after exposure to both alpha particles and heavy ions.

Poster – PB6 Single Event Effect of SiGe HBT irradiated by Protons and Heavy Ions

J. Zhang[1], W. Hajdas[2], X. Wang[3], H. Guo4, and Y. Yan[1]

1. Xidian University, China, 2. PSI, Switzerland, 3. Xinjiang Technical Institute of Physics & Chemistry, China, 4. Northwest Institution of Nuclear Technology, China

The SEE on SiGe HBT were investigated in protons and heavy ions irradiation experiments. The SEE transient currents of collector and base were measured for different values of particle energies and ions LETs.

Poster – PB7 Soft Error Assessment of Attitude Estimation Algorithms Running in a Resource-constrained Device under Neutron Radiation

J. Gava[1], T. Sartori[2], A. Hanneman[3], R. Garibotti[4], N. Calazans[1], R. Possamai Bastos[2], R. Reis[1], **L. Ost[3]**

1. UFRGS, Brazil, 2. Univ. Grenoble Alpes, France, 3. Loughborough University, United Kingdom, 4. PUCRS, Brazil

This paper assesses the soft error reliability of attitude estimation algorithms running on a resource-constrained microprocessor under neutron radiation. Results suggest that the EKF algorithm has the best trade-off between reliability and runtime overhead.

Poster – PB8 Comparing 3rd-Order Digital Modulation Schemes for SEU Resilience in SiGe RF Receivers

D. Nergui[1], Z. Brumbach[1], A. Ildefonso[2],J. Teng[1], A. Khachatrian[2], D. McMorrow[2], J. Cressler[1]

1. Georgia Institute of Technology, USA, 2. US Naval Research Laboratory, USA

Two 3rd-order digital modulation schemes are compared for receiver-level SEU sensitivity using pulsed laser. The modulation schemes showed a significant difference in SEU response, suggesting that optimizing the modulation scheme can effectively mitigate SEUs.

Poster – PB9 Fusion Neutron-Induced Soft Errors During Long Pulse D-D Plasma Discharges in the WEST Tokamak

S. Moindjie[1], D. Munteanu[1], J. Autran[1], M. Dentan[2], P. Moreau[2], F-P. Pelissier[2], B. Santraine[2], J. Bucalossi[2], V. Malherbe[3], T. Thery[3], G. Gasiot[3], P. Roche[3], M. Cecchetto[4], R. Garcia Alia[4]

1. Aix-Marseille University, France, 2. CEA-IRFM, France, 3. STMicroelectronics, France, 4. CERN, Switzerland

We conducted real-time SER measurements on bulk 65 nm SRAMs in the WEST tokamak during long pulse deuterium-deuterium plasma discharges (~60 s), evidencing bursts of SEUs during the most efficient shots and 12% of MCUs.

Poster – PB10 Analyzing the SEU-induced Error Propagation in Systolic Array on SRAM-based FPGA

E. Vacca[1], S. Azimi[1], L. Sterpone[1]

1. Politecnico di Torino, Italy

In this paper, we evaluated the radiation-induced Single Event Upset of an open-source TPU-like platform implemented on SRAM-based FPGA while its high performance parallel datapath is exploited to implement multiple feature extractions task.

Poster – PB11 Single-Event Effects in Heavy-Ion Irradiated 3kV SiC Charge-Balanced Power Devices

A. Sengupta[1], D. Ball[1], A. Witulski[1], S. Islam[1], A. Senarath[1], K. Galloway[1], R. Schrimpf[1], E. Zhang[1], R. Reed[1], M. Alles[1], J. Osheroff[2],R. Ghandi[3], B. Jacob[3]

1. Vanderbilt University, USA, 2. NASA Goddard Space Flight Center, USA, 3. General Electric Global Research, USA

Experimental heavy-ion responses of 3 kV charge-balanced SiC power devices are presented. Their SEB threshold is similar to that of the 3.3 kV planar SiC devices and independent of the structural differences between these devices.

Poster – PB12 Muon-Induced SEU Cross Sections of 12-nm FinFET and 28-nm Planar SRAMs

Y. Gomi[1], K. Takami[1], R. Mizuno[2], M. Niikura[3], Y. Deng[4], S. Kawase[4], Y. Watanabe[4], S. Abe[5], W. Liao[6], M. Tampo[7], I. Umegaki[7], S. Takeshita[7], K. Shimomura[7], Y. Miyake[7], M. Hashimoto[1]

1. Kyoto University, Japan, 2. University of Tokyo, Japan, 3. RIKEN, Japan, 4. Kyushu University, Japan, 5. Japan Atomic Energy Agency, Japan, 6. Kochi University of Technology, Japan, 7. KEK and J-PARC, Japan

We performed positive and negative muon irradiation experiments on 12- nm FinFET and 28-nm planar SRAMs. We present the SEU dependencies on muon momentum and operation voltage and show the MCU proportion and size distribution.

12:10 - 14:00 Lunch - Room Caravelle

Tuesday 26th September >> Pierre Baudis Congress Centre

14:00 - 15:20 Session C: PHOTONICS, OPTOELECTRONICS & SENSORS

Chairs: Clémentine Durnez (CNES, France) & Milos Burger (University of Michigan, USA)

14:05 – C1 **A Comparison of Total-Ionizing-Dose Effects in Silicon and Silicon- Nitride Waveguides**

B. Ringel[1], J. Teng[1], M. Hosseinzadeh[1], D. Sam[1], P. Francis[1], H. Parameswaran[1], J. Cressler[1]

1. Georgia Institute of Technology, USA

The TID response of silicon and silicon-nitride integrated MZIs are evaluated. TID-induced phase-shifts and transmission losses were observed above 5 Mrad(Si). For high X-ray doses, silicon waveguides are more resilient to TID than silicon-nitride waveguides.

14:20 – C2 **Total Ionizing Dose Effects on a CDTI based CCD-on-CMOS through Buildup of Interface Traps and Oxide Charges**

A. Salih Alj[1,2,3], P. Touron4, F. Roy4, S. Demiguel[2], C. Virmontois[3], V. Lalucaa[3], J. Michelot[5], P. Magnan[1], V. Goiffon[1]

1. ISAE-SUPAERO, France, 2. Thales Alenia Space, France, 3. CNES, France, 4. STMicroelectronics, France, 5. Pyxalis, France

Total Ionizing Dose effects are explored in a CCD-on-CMOS based on Capacitive Deep Trench Isolation (CDTI). The root cause of the observed degradation is investigated by discriminating the role of interface states and oxide traps.

14:35 – C3 **Effects of X-ray and Gamma Ray Irradiations on 2D and 3D CMOS SPADs**

A. Jouni[1], B. Mamdy[2], V. Malherbe[2], V. Lalucaa[1], C. Virmontois[1], G. Gasiot[2], V. Goiffon[3]

1. CNES, France, 2. STMicroelectronics, France, 3. ISAE-SUPAERO, France

X-ray and gamma irradiations were performed on 2D and 3D CMOS single photon avalanche diodes. Both ionizing effects and displacement damages are observed and characterized in terms of dark count rate degradation.

14:50 – C4 **Electrical Characterization of Type II Superlattice Midwave Infrared Photodetectors under protons at cryogenic temperature**

C. Bataillon[1], M. Tornay[1], M. Bouschet[1], J. Perez[1], A. Michez[1], O. Saint- Pé[2], O. Gilard[3], P. Christol[1]

1. Université de Montpellier, France, 2. Airbus Defense and Space, France, 3. CNES, France

Influence of proton irradiation on dark current of InAs/InAsSb T2SL MWIR infrared barrier photodetectors is studied. A damage of current is observed under 60 MeV protons with fluence up to 8e11 H+/cm², at 150 K.

15:05 – C5 **Investigating Dark Current Random-Telegraph-Signal in an HgCdTe H4RG-10 Infrared Detector for Space Application**

A. Antonsanti[1], L. Ryder[2], A. Le Roch[2], A. Waczynski[2], L. Miko[2], G. Delo[2], S. Waczynski[2], K. Feggans[3], J. Barth[2], V. Goiffon[1], C. Virmontois[4], J-M. Lauenstein[2]

1. ISAE-SUPAERO, France, 2. NASA GSFC, USA, 3. Sigma Space Corp. for NASA GSFC, USA, 4. CNES, France

This work explores the Dark Current Random Telegraph Signal (DC-RTS) characteristics of astronomical H4RG-10 HgCdTe infrared sensors for cumulative radiation doses up to ~5 krad(Si) and subsequent thermal annealing.

Poster – PC1 **Radiation Detection with Radiosensitive Pure-Silica Core Ultra-Low Loss Optical Fiber**

L. Weninger[1], A. Morana[1], C. Campanella[1], J. Vidalot[1], E. Marin[1], Y. Ouerdane[1], A. Boukenter[1], R. Garcia Alia[2], S. Girard[1]

1. Université de Saint Etienne, France, 2. CERN, Switzerland

We present a new prospect for radiation detection exploiting the high radiation-induced attenuation sensitivity and almost complete recovery after irradiation of an ultra-low loss pure-silica core optical fiber.

Poster – PC2 Radiation Responses of Pure-Silica Core Multimode Optical Fibers in the UV to near-IR Domains at MGy Dose Levels

C. Campanella[1], A. Morana[1], E. Marin[1], Y. Ouerdane[1], A. Boukenter[1], S. Girard[1]

1. Université de Saint Etienne, France

We study the Radiation-Induced Attenuation (RIA) of four solarization- resistant commercially-available optical fibers manufactured by Polymicro, optimized for the transmission ranging from the Deep Ultra-Violet (DUV) to the Near InfraRed (NIR).

Poster – PC3 Temperature Effect on the Radioluminescence of Differently doped Silica-based Optical Fibres

N. Kerboub[1,2,3], D. Di Francesca[2], A. Morana[3], Y. Ouerdane[3], G. Bouwmans[4], R. Habert[4], A. Boukenter[3], B. Capoen[4], E. Marin[3], M. Bouazaoui[4], D. Ricci[2], R. Garcia Alia[2], J. Mekki[1], O. Gilard[1], N. Balcon[1], S. Girard[3]

1. CNES, France, 2. CERN, Switzerland, 3. Université de Saint Etienne, France, 4. Université de Lille, France

We evaluate the temperature effect on the X-ray Radiation Induced Luminescence (RIL) Response of differently doped silica fibres obtained via the sol-gel route.

Poster – PC4 Calibration of Ge/P-doped Silica-Based Optical Fibers for Radiation Monitoring

E. Tagkoudi[1], K. Kandemir[1], **N. Kerboub**[1], D. Di Francesca[1], D. Ricci[1]

1. CERN, Switzerland

We study the radiation response of twelve Ge/P-doped single-mode silica fibers and identified the most suitable ones for use in combination with the Distributed Optical Fiber Radiation Sensors (DOFRS) installed in CERN accelerator complex.

Poster – PC5 Dark Current Random Telegraph Signal in Proton Irradiated Single InGaAs Photodiodes

M. Benfante[1,2,3], J. Reverchon[1], C. Durnez[2], C. Virmontois[2], S. Demiguel[3], V. Goiffon[4]

1. III-V Lab, France, 2. CNES, France, 3. Thales Alenia Space, France, 4. ISAE-SUPAERO, France

In this work we study the Dark Current Random Telegraph Signal on three 14.4 MeV proton-irradiated InGaAs single photodiodes. In particular, the effects of diode size, temperature and bias are investigated.

Poster – PC6 Radiation Hardness of Modern Photogate Pixels Under Total Ionizing Dose: Impact of Pixel Pitch and Electron or Hole Collection

V. Malherbe[1], O. Nier[1], P. Roche[1], F. Roy[1]

1. STMicroelectronics, France

Gamma and X-ray irradiation results are reported on several variants of deep-trench photogate R&D pixels from STMicroelectronics. Dark current performances are compared for electron and hole-collecting pixels (n, p-type) of 2 and 1 µm pitch.

Poster – PC7 Neutron damage analysis in single- and dual-layer 150 nm CMOS SPADs

L. Ratti[1], P. Brogi[2], G. Collazuol[3], G. Dalla Betta[4], P. Marrocchesi[2], J. Minga[1], F. Morsani[5], L. Pancheri[4], F. Shojaei[1], G. Torilla[1], C. Vacchi[1]

1. University of Pavia, Italy, 2. University of Siena, Italy, 3. University of Padova, Italy, 4. University of Trento, Italy, 5. INFN, Italy

Dark count rate characterization is performed in single- and dual-layer CMOS SPADs exposed to increasing neutron fluences up to 4.3E10 cm-2. The effectiveness of the dual-layer approach in improving the SPAD radiation hardness is demonstrated.

Poster – PC8 **Defects studies towards more-radiation-tolerant Silicon Photomultipliers**

F. Acerbi[1], S. Merzi[1], A. Gola[1]

1. FBK, Italy

We irradiated several Silicon Photomultipliers with protons and X-ray. We investigated activation energy, noise variation down to cryogenic levels as well as the damage effects in the microcells by means of EMMI and other techniques.

Poster – PC9 **Proton Radiation Damage in Silicon Photomultipliers for Gamma-Ray Spectroscopy**

A. Panglosse[1], A. Materne[2], M. Ruffenach[2], J. Carron[2], C. Aicardi[2], D. Pailot[3]

1. Expleo (CNES), France, 2. CNES, France, 3. Laboratoire AstroParticule et Cosmologie, Paris, France

Results of proton radiation tests on three Silicon PhotoMultipliers for spaceborne detection of Gamma-Ray Flashes are presented with focus on dark current noise impact on Gamma-Ray photons energy threshold of the spectrometer.

Poster – PC10 **Machine Learning Approaches for Analysis of Transient Response in the Pixel Array of CMOS Image Sensor Induced by Gamma/X rays with Different Energies and Doses**

Y. Xue[1], Z. Wang[2], T. Zhang[3]

1. Peking University, China, 2. Northwest Institute of Nuclear Technology, China, 3. Xian Jiaotong University, China

A convolutional neural network is designed to classify and remove the transient response in the pixel array of the CMOS image sensor induced by gamma rays with different energies and doses.

15:20 - 16:00 **Coffee break - Exhibit Area**

16:00 - 17:20 **Session D: RADIATION EFFECTS IN DEVICES & ICS**

Chairs: Hugh Barnaby (ASU, USA) & Michael Steffens (Fraunhofer INT, Germany)

16:05 – D1 **Effects of TID on SRAM Stability at the 5-nm Node**

N. Pieper[1], Y. Xiong[1], J. Pasternak[2], D. Ball[1], Y. Chiang[3], B. Bhuva[1]

1. Vanderbilt University, USA, 2. Synopsys. Inc., USA, 3. Taiwan Semiconductor Manufacturing Company, Taiwan

Single-port and two-port SRAM arrays exposed to TID show a decrease in storage stability at reduced supply voltages. Degradation is dependent on supply voltage and input pattern during irradiations.

16:20 – D2 **Radiation-Induced Multi-Level Cell Behavior in TaOx/NiO-based Resistive Random Access Memory**

J. Sari[1], C. Huang[1], C. Chung[1]

1. National Yang Ming Chiao Tung University, Taiwan

The radiation effects on bilayer dielectric TaOx/NiO-based resistive random-access memory using 60Co γ-ray were investigated. A multi-level cell (MLC) behavior was observed for the irradiated device which might be caused by radiation-induced oxygen vacancy generation.

16:35 – D3 Radiation Tolerance of Low-Noise Photoreceivers for the LISA Space Mission

P. Colcombet[1], N. Dinu-Jaeger[2], C. Inguimbert[1], T. Nuns[1], S. Bruhier[2], N. Christensen[2], P. Hofverberg[3], N. Van Bakel[4], M. Van Beuzekom[4], T. Mistry[4], G. Visser[4], D. Pascucci[4], K. Izumi[5], K. Komori[5], G. Heinzel[6], G. Fermandez Barranco[6], J. in't Zand[7], P. Laubert[7], M. Frericks[7]

1. ONERA, France, 2. Observatoire de la Côte d'Azur, France, 3. Institut Méditerranéen de ProtonThérapie, France, 4. National Institute for Subatomic Physics Nikhef, Netherlands, 5. JAXA, Japan, 6. Albert Einstein Institute, Germany, 7. SRON Netherlands Institute for Space Research, Netherlands

Investigation of protons, electrons, and gamma radiation tolerance of InGaAs QPDs designed for LISA. QPD dark current, capacitance, and responsivity were measured. QPR noise and interferometric performance were evaluated. Results show good resilience and potential.

16:50 – D4 Total Ionizing Dose in FD-SOI 28-nm Technology Node Using Large Programmable Test Arrays

M. Mounir Mahmoud[1], J. Prinzie[1], S. De Raedemaeker[1], A. Adebabay Belie[1], A. Cathelin[2], S. Clerc[2], P. Leroux[1]

1. KU Leuven, Belgium, 2. STMicroelectronics, France

This article presents TID effects in 28-nm UTBB FD-SOI technology using custom-designed large-scale programmable device arrays chip, which contains about 28,000 devices. The impact of device geometric dimension, type, and stacking orientation was presented.

17:05 – D5 Neutron- and Proton- Induced Degradation of MOS Transistors in 28 nm CMOS Technology

G. Termo[1], G. Borghello[2], F. Faccio[2], S. Michelis[2], A. Koukab[1], J. Sallese[1]

1. EPFL, Switzerland, 2. CERN, Switzerland

Displacement damage effects on transistors in 28 nm CMOS technology were investigated through proton and neutron irradiation. The observed radiation-induced effects were related to the amount of total ionizing dose rather than displacement damage.

Poster – PD1 Exploring the Effect of Back-Gate Bias on Stability of DSOI SRAM- Based Physical Unclonable Function

Z. Su1, B. Li[1], H. Ren[1], S. Ma[1], G. Zhang[1], W. Zhang[1], Z. Han[1], **X Zhang**[1]

1. Institute of Microelectronics, Chinese Academy of Sciences, China

Two types of SRAM PUF were tested under various back-gate bias. The bit error rate can be reduced by 4.1% and 11.46% through selecting appropriate transistor type and back-gate bias before and after radiation.

Poster – PD2 The Effects of Gamma Ray Dose on Dynamic Operation of a Commercial FRAM Device

W. Stirk[1], M. Wirthlin[1], J. Goeders[1]

1. Brigham Young University, USA

This works presents dose rate testing of an FRAM device in dynamic operation during radiation pulses. Above a certain integrated dose, it was possible for 8-bytes of FRAM memory to be corrupted.

Poster – PD3 TID System-Level Testing and Qualification Methodology of COTS SD and SSD NAND Flash Memories

A. Urena-Acuna[1], J. Favrichon[1], P. Robin[2], M. Lissandre[2], A. Ballier[2], T. Maraine[3], F. Saigné[3], J. Boch[3]

1. CEA, France, 2. Isymap, France, 3. Université de Montpellier, France

In this work, we propose a system-level test methodology to qualify a set of COTS MLC-type SD and SSD NAND Flash memories exposed to ionizing radiation for nuclear decommissioning applications.

Poster – PD4 Analysis of Mobility Scattering Coefficients for Gamma-Irradiated Power MOSFETs

S. Witczak[1], D. Fleetwood[2], J. Theogene[1], K. Galloway[2], M. Langlois[1], R. Schrimpf[2], B. Song[1]

1. Northrop Grumman, USA, 2. Vanderbilt University, USA

Mobility degradation was characterized for three types of commercial power MOSFETs following ionizing irradiation and anneal. Scattering coefficients for interface traps and oxide-trapped charge, inferred from charge separation analysis and empirical modeling, are analyzed.

Poster – PD5 Effects of X-ray and Cobalt 60 irradiations on advanced Si/SiGe:C HBTs DC characteristics

J. El Beyrouthy[1], B. Sagnes[1], F. Pascal[1], A. Hoffmann[1], **A. Ayenew**[1], J. Boch[1], T. Maraine[1], S. Haendler[2], P. Chevalier[2], D. Gloria[2], B. Manel[3]

1. Université de Montpellier, France, 2. STMicroelectronics, France, 3. University of Constantine 1, Algeria

The impact of X-ray and cobalt 60 irradiations on Dc characteristics of two advanced BiCMOS technologies Si/SiGe:C HBTs are compared and analyzed. The effect of geometry, post-irradiation time and annealing are investigated

Poster – PD6LN Synergistic Interaction of Total Ionizing Dose and Hot Carrier Stress on 12nm FinFETs

D. Hughart[1], C. Mckay[1], J. Trippe[2], G. Haase[1], A. Vidana[1], N. Dodds[1], S. Holloway[3], M. Siath[3], M. Marinella[3]

1. Sandia National Laboratories, USA, 2. Vanderbilt University, USA, 3. Arizona State University, USA

12nm FinFETs exhibit a combined effect where total ionizing dose irradiation before hot carrier stress reduces the drive current degradation. TCAD simulations show positive charge trapping in the spacer can cause this beneficial synergy.

17:20 - 17:30 Tuesday closure session

19:00 - 23:00 Industrial Exhibit Reception - Exhibit Area | Concorde Level-1

Wednesday 27th September >> Pierre Baudis Congress Centre

08:00 - 08:45 Registration

08:45 - 09:00 Students day introduction

The RADECS2023 conference is voluntary oriented toward students and young professionals. With the support of the local IEEE Student Branch, we have imagined various events, all along the week, that aim to make their entry in the RADECS community easier.

Book of Opportunities

As a common initiative of the RADECS2023 organizing committee, the ISAE SUPAERO IEEE Student Branch proposes to every attendee of the conference (researchers and industrial exhibitors) to submit job opportunities that can be shared during the conference. This includes internships, PhD positions, post-PhD positions and permanent/full positions. Our objective is to gather and share these opportunities with attendees and create in-person exchanges at the Student Branch booth throughout the conference. Please use the following link if you wish to share any job opportunities (names and e-mails will be removed for GDPR reasons): isae.ieeestudentbranch@gmail.com

Student Special Day

This is a unique feature of this year's RADECS edition. About 40 students from Toulouse engineering schools (INSA, Univ. Paul Sabatier, ISAE, ENSEEIHT, IPSA, ENAC) and RADMEP are invited to join the conference on Wednesday the 27th of September. They will attend both an oral and a poster session, an invited talk as well as the "Women in Engineering" round table, making it a unique opportunity for them to discover the scientific community through the environment of an international conference. Moreover, a dedicated space will be allocated during lunchtime for networking and creative interactions. This is fully sponsored by the IEEE Student Branch.

09:00 - 09:50 Invited paper | Greg Allen The evolution of the Mars Helicopter – Ingenuity and beyond

Greg Allen [1]

1. Jet Propulsion Laboratory, California Institute of Technology

Bio: Gregory Allen is a senior radiation effects engineer at the Jet Propulsion Laboratory, California Institute of Technology. He has spent the last 20 years working in the radiation effects field, focusing on single event effects and technology infusion. Greg is the co-lead for the Jet Propulsion Laboratory's Center for Space Radiation and Group Lead for the Radiation Effects Group.

Abstract: On April 19, 2021, in the Jezero Crater on Mars, the Ingenuity rotorcraft performed the first powered flight on another planet marking a milestone in interplanetary exploration. Designed as a technology demonstrator and a secondary payload for NASA's Mars 2020 mission, its primary purpose was to prove that powered flight is possible in the extremely thin Martian atmosphere. It wasn't intended for transportation but rather to test the concept of aerial exploration on Mars. However, Mars Ingenuity's success demonstrated the potential for aerial exploration on Mars, paving the way for future missions to use helicopters and drones for scientific exploration, mapping, and reconnaissance on other planets. We celebrate Ingenuity's success, explore the path it took to get there, and look at the future of autonomous flight on Mars.

Wednesday 27th September >> Pierre Baudis Congress Centre

09:50 - 11:50 Session E: RADIATION EFFECTS ON COMPLEX DEVICES AND SYSTEMS

Chairs: Cristina Plettner (ESA, Netherlands) & Bharat Bhuva (Vanderbilt University, USA)

09:55 – E1 Neutrons Sensitivity of Deep Reinforcement Learning Policies on EdgeAI Accelerators

B. Pablo[1], M. Saveriano[2], A. Kritikakou[3], **P. Rech[1,2]**

1. UFRGS, Brazil, 2. University of Trento, Italy, 3. INRIA Rennes, France

We measure the reliability of Deep Reinforcement Learning models, used to control autonomous robots, executed on TPUs. We found that the propagation of faults induces the robot to fall in the vast majority of cases.

10:10 – E2 Analysing the Influence of Memory and Workload on the Reliability of GPUs under Radiation

G. Leon[1], J. Badia[1], **J. Belloch[2]**, M. Garcia-Valderas[2], A. Lindoso[2], L. Entrena[2]

1. Universitat Jaume I, Spain, 2. Universidad Carlos III de Madrid, Spain

Paper evaluates low-power GPU reliability under neutron irradiation, considering memory type and computational load via microbenchmark. Optimizing resource use compensates for failure rate, allowing for more computations before failure.

10:25 - 11:05 Coffee Break - Exhibit Area

11:05 – E3 Neutron-Induced Error Rate of Vision Transformer Models on GPUs

F. Santos[1], P. Rech[2], A. Kritikakou[1], O. Sentieys[1]

1. INRIA Rennes, France, 2. University of Trento, Italy

Vision Transformers (ViTs) are the new trend to improve performance and accuracy of machine learning. Through neutron beam experiments we show that ViTs have a higher FIT rate than traditional models but similar error criticality.

11:20 – E4 Hybrid Hardening Approach for a Fault-Tolerant RISC-V System-on- Chip

D. Santos[1], P. Aviles[2], A. Martins Pio de Mattos[1], M. García Valderas[2], L. Entrena[2], A. Lindoso[2], L. Dilillo[1]

1. Université de Montpellier, France, 2. Universidad Carlos III de Madrid, Spain

We propose fault tolerance strategies applied to a soft-core RISC-V-based System-on-Chip. Notably, we investigate the effectiveness of a multilayer hardening strategy, which combines software recoverability and hardware redundancy. As validation, a neutron irradiation campaign was performed.

11:35 – E5 Assessing the Arm Cortex-M under Radiation with and without a Real- time Operating System

F. Benevenuti[1], L. Reinehr Gobatto[1], R. Possamai Bastos[2], J. Furlanetto de Azambuja[1], **F. Lima Kastensmidt[1]**

1. UFRGS, Brazil, 2. Univ. Grenoble Alpes, France

Radiation tests in the Arm Cortex-M indicate that the nature of the algorithms executed has more impact on reliability than the operating system layer, which is relevant regarding where to introduce selective software hardening techniques.

Poster – PE1 An Examination of Heavy Ion-Induced Persistent Visual Error Signatures in an Electronic Display Driver Integrated Circuit

L. Ryder[1], E. Wyrwas[1], G. Cisneros[2], J. Bautista[2], X. Xu[3], T. Garrett[2], **M. Campola[1]**, R. Gaza[2]

1. NASA GSFC, USA, 2. NASA Johnson Space Center, USA, 3. NASA Langley Research Center, USA

Heavy ion irradiation of a display driver integrated circuit was performed, and persistent visual error signatures were captured. Localization of the error signatures to configuration registers motivate potential mitigation techniques and observations relating to susceptibility.

Poster – PE2 Radiation Effects in Real-Time Soft Processors: Relating Software Errors to Hardware Faults

C. De Sio[1], D. Rizzieri[1], S. La Greca[1], S. Azimi[1], L. Sterpone[1]

1. Politecnico di Torino, Italy

In this paper, we propose an analysis of the effects on soft processors of radiation-induced microarchitectural faults propagating to the software level, such as silent data corruption and system exception mechanisms.

Poster – PE3 Heavy ion and proton Single Event Effect (SEE) characterization of 7nm FinFET Xilinx VersalTM

A. Dufour[1], F. Manni[1], F. Pierron[2], D. Dangla[1], F. Bezerra[1], J. Mekki[1], P. Maillard[3]

1. CNES, France, 2. Bibench, France, 3. XILINX Inc., USA

Paper on test setup and SEE results obtained under heavy ions and protons on 7nm FinFET Xilinx Versal™. SEU Sensitivity curves are presented both from processing system and programmable logic units. SEFI are also discussed.

Poster – PE4 On the Evaluation of Fault Mitigation Techniques Based on Approximate Computing Under Radiation

A. Martínez-Álvarez[1], G. Darío[1], A. Serrano[2], A. Aponte-Moreno[3], R. Felipe[3], Y. Morilla[4], P. Martin Holgado[4], S. Cuenca-Asensi[1]

1. University of Alicante, Spain, 2. Barcelona Supercomputing Center, Spain, 3. Universidad Nacional de Colombia, Colombia, 4. Centro Nacional de Aceleradores, Spain

This paper assesses an approximate computing-based mitigation technique for radiation-induced soft errors in COTS microprocessors. Experimental results show it can detect and correct single event events keeping the accuracy under control and without compromising performance.

Poster – PE5LN Enhancement of System Observability During System-Level Radiation Testing through Total Current Consumption Monitoring

I. Slipukhin[1], A. Coronetti[1], R. García Alía[1], F. Saigné[2], J. Boch[2], L. Dilillo[2], Y. Quadros de Aguiar[1], C. Cazzaniga[3], M. Kastriotou[3], T. Dodd[3]

1. CERN, Switzerland, 2. Université de Montpellier, France, 3. STFC, United Kingdom

In a system-level test of electronics, the monitoring of total current consumption combined with other observations improves the analysis of system performance and allows for more efficient identification of radiation - induced errors during the test execution.

11:50 - 12:10 - 2023 IEEE Marie Sklodowska-Curie Award

This award is sponsored by the IEEE Nuclear and Plasma Sciences Society. Recipient selection is administered by the Technical Field Awards Council of the IEEE Awards Board. The 2023 recipient of the Marie Sklodowska-Curie Award is Janet L. Barth for leadership of and contributions to the advancement of the design, building, deployment, and operation of capable, robust space systems. The award ceremony will be chaired by Dr. Vesna Sossi, from University of British Columbia, Vancouver, B.C., Canada, who is the 2023 President of the IEEE Nuclear and Plasma Sciences Society.

Janet Barth

As chief of the Electrical Engineering Division at NASA's Goddard Space Flight Center, Janet Barth was responsible for the delivery of spacecraft and instrument avionics to numerous NASA missions. Early on, she recognized that the increased use of emerging technologies and highly integrated electronics in space systems was rapidly outpacing the knowledge of space radiation environments. Focusing on the shortcomings of the radiation models that were then current, she established a path forward for standardized next-generation models. She captained the effort to replace the decades old Van Allen radiation belt models and define requirements for space plasma models for use in the space systems development community. An IEEE Life Fellow Member, Barth is an advisor at Miller Engineering & Research Corporation (MERC), Greenbelt, Maryland, USA.

12:10 - 14:00 Lunch - Room Caravelle

14:00 - 15:00 Women in Engineering

Chair: Géraldine Chaumont (ST Microelectronics)

Why, when we have 48% women at the first level of recruitment, do we only have 26% of them who reach the end of the pipeline? This observation is all the more marked in the scientific fields.

Through the testimony of women who have reached the highest level of their respective organizations, we will try to understand the challenges they have encountered throughout their journey, how they have overcome them, how being a woman in a technical environment has made it possible to stand out from men, etc.

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Invited speakers:

- Janet BARTH – Former NASA
- Patricia CHOMAZ – GANIL – Director
- Corinne CREGUT – ST Grenoble – Head of Back-end R&D group
- Vesna SOSSI – University of British Columbia – IEEE/NPSS President

15:00 - 15:35 Session F: RADIATION HARDENING TECHNIQUES

Chairs: Fernanda Lima Kastensmidt (UFRGS, Brazil) & Gilles Gasiot (STMicroelectronics, France)

15:05 – F1 Design Choices for SET Mitigation in SiGe Cascode Low-Noise Amplifiers

J. Teng[1], D. Nergui[1], Y. Mensah[1], A. Ildefonso[2], J. Cressler[1]

1. Georgia Institute of Technology, USA, 2. US Naval Research Laboratory, USA

Parametric analysis of electrical performance and SET amplitude in a SiGe-HBT cascode LNA was performed using calibrated mixed-mode TCAD simulations. A gain vs. SET-amplitude trade-off was observed, suggesting that designers should avoid over-designing their gain.

15:20 – F2 Single Event Transient Filtering Transfer Gate: A Layout-Aware Simulation Study

K. Takeuchi[1], K. Sakamoto[1], T. Sakamoto[1], M. Miyamura[1], M. Tada[1], T. Sugibayashi[1], H. Shindo[1]

1. Japan Aerospace Exploration Agency, Japan, 2. NanoBridge Semiconductor Inc., Japan

Single event transient mitigated inverter circuit, which is the SIngle event transient Filtering Transfer gate (SIFT), is proposed in this paper. A layout- aware simulation of the technology computer-aided design is performed.

Poster – PF1 A Radiation-tolerant, Temperature-Insensitive and Bandwidth- adaptive CPPLL with Synchronous-bias-voltage Technique for SerDes

Q. Guo[1], B. Liang[1], J. Chen[1], **H. Yuan**[1], X. Chen[1], Y. Guo[1]

1. National University of Defense Technology, China

This paper presents a synchronous-bias-voltage technique to improve CPPLL's stability and radiation-hardened property. Test results show bandwidth changes about -2.99%-2.41%; jitter's temperature-drift is 12.1% in -55°C-125°C; unlocked and unrecoverable cross-section decreases from 2×10-7 cm^2 to 1×10-7 cm^2.

Poster – PF2 A SET-tolerant Wide-band PLL with High-PSRR SFRVCO for Serial Rapid I/O

H. Sang[1], H. Yuan[1], Y. Guangda[1], Y. Guo[1], W. Xu[1]

1. National University of Defense Technology, China

A 0.9~6.6GHz SET-tolerant wide-band PLL with low phase noise and high PSRR source-feedforward ring VCO is proposed. The phase noise of VCO is -96.7dBc/Hz@1MHz at 2.5GHz. Laser experiments show that the irradiation threshold is 600pJ.

Poster – PF3 **Design and Implementation of a High-Speed Low-Power KNN-based Algorithm for Detecting Micro-Single-Event-Latchup**

J. Zhao[1], Y. He[1], Z. Qin[1], P. Zou[1], K. Chong[1], **W. Shu[1]**, Y. Sun[1], P. Chan[1], J. Chang[1]

1. Nanyang Technological University, Singapore, 2. Zero-Error Systems Pte Ltd, Singapore

We present a software-hardware co-design of a k-nearest-neighbors-based algorithm for detecting micro-Single-Event-Latchup. Our FPGA-based prototype dissipates ~61mW, and achieves a detection time within ~510µs with ~93% accuracy vis-à-vis ~50s with ~70% accuracy using reported work.

Poster – PF4 **Hardening a Neural Network on FPGA through Selective Triplication and Training Optimization**

W. Guilleme[1], Y. Helen[1], R. Priem[1], A. Kritikakou[1], D. Chillet[1], C. Killian[1]

1. Université de Rennes, France, 2. DGA, France

The proposed approach identifies SEU sensitive flip-flops and optimizes the training phase of a neural network. With this information, selective triplication is applied to improve the reliability with limited resource overhead on an FPGA device.

Poster – PF5 **Hardening Architectures for Multiprocessor System On Chip**

P. Aviles[1], L. Garcia[1], L. Entrena[1], M. Garcia-Valderas[1], P. Martin Holgado[1], Y. Morilla[1], **A. Lindoso[1]**

1. University Carlos III Madrid, Spain, 2. Centro Nacional de Aceleradores, Spain

This work presents two hardened architectures for Multiprocessor Systems on Chip that combine multicore processor and programmable logic. Both architectures are evaluated under proton irradiation showing a high error coverage and cross-section reduction.

15:35 - 15:45 **Poster session introduction** (Auditorium)

15:45 - 17:45 **Poster Session - Foyer Concorde**

Chairs: Michael Trinczek (TRIUMF, Canada) & Christian Poivey (ESA, Netherlands)

18:30 - 21:30 **Soccer Tournament** (More information Click HERE)

Thursday 28th September >> Pierre Baudis Congress Centre

08:00 - 08:30 Registration

08:30 - 09:20 Invited paper | Alexis Paillet **Spaceship FR's Progress and Contributions to Space Exploration and Human Spaceflight**

Alexis Paillet [1]

1. CNES, PhD in Planetary study , Toulouse, France

Bio: Alexis PAILLET is Head of the Spaceship FR Project and in charge of the technologies for exploration at the Center National d'Etudes Spatiales (CNES) in Toulouse. He is an Aeronautic and Space engineer from Supaero in Toulouse, France and PhD in Planetary study.

Alexis joined the French space agency in 2005 to work in the development, assembly and testing of space instruments intended in particular for the robotic exploration of the planet Mars (ChemCam on board the Curiosity rover and the main seismometer of the Martian lander Insight).

Since 2019, Alexis has been Head of the Spaceship FR project, which aims to prepare human SpaceFlight and robotic space exploration, by validating, promoting French technologies on Earth, deploying them on test bases in order to begin exploration of the Moon and to export the model to the planet Mars.This project is a laboratory of ideas and demonstration of technologies at the service of a future lunar base, which is being prepared under the impetus of the American program Artemis.

Abstract: To achieve our collective objectives for this new era of Space Exploration, multiple actors across the Space Sector have launched initiatives to support the advancement of scientific research and technology development. These advancements have allowed the space industry to thrive under new development environments, increasing the Technology Readiness Level (TRL) of innovative space technology concepts that will have a critical role in future space missions.

In 2019, CNES (French Space Agency) decided to support these efforts through "Spaceship FR", establishing a collaborative effort with ESA (European Space Agency) under the Exploration Preparation Research and Technology (ExPeRT) initiative, which is part of the European Exploration Envelope Programme (E3P). This action created a network of working groups, "Spaceships", that operate as agile innovation environments, efficiently studying new operational concepts and technologies with controlled and shared costs, connecting experts from space agencies, research entities, academia, and the private sector. Also, due to the wide range of multidisciplinary collaborators, Spaceship FR acts as a liaison between the space and non-space sector, enabling Earth applications for Space Technologies and vice-versa.

Today, the Spaceship FR team stands strong, continuously learning, and fastly increasing in relevance as an essential European asset for advancing space exploration technologies, alongside its counterparts in Germany (Spaceship EAC) and the UK (Spaceship ECSAT).

This paper aims to present the progress made by the Spaceship FR team, including how Spaceship FR contributes to Space Exploration and Human Spaceflight based on its three core objectives (Inspire, Federate and Support). Also, it would describe how the team collaborates with different space actors through R&T studies and incubation initiatives, discussing the progress accomplished and future projects. Lastly, this work will describe the experience gained from multiple student projects and internships in Spaceship FR's Technical Areas: Habitat, Robotics, Life Support, Human Health & Performance, Energy, In-Situ Resource Utilization, and Digital Technologies.

Thursday 28th September >> Pierre Baudis Congress Centre

09:20 - 11:20 Session G: DOSIMETRY AND FACILITIES

Chairs: Anatoly Rosenfeld (University of Wollongong, Australia) & Benedikt Bergmann (Czech Technical University, Czech Republic)

09:25 – G1 Characterisation of Fragmented Ultra-high Energy Heavy Ion Beam and its Effects on Electronics Single Event Effect Testing

M. Sacristan Barbero[1,2], I. Slipukhin[1], M. Cecchetto[1], D. Prelipcean[1], Y. Aguiar[1], N. Emriskova[1], A. Waets[1], A. Coronetti[1], M. Kastriotou[3], C. Cazzaniga[3], T. Dodd[3], F. Saigné[2], V. Pouget[2],R. Garcia Alia[1]

1. CERN, Switzerland, 2. Université de Montpellier, France, 3. STFC, United Kingdom

Ultra-high energy heavy ion beam fragmentation has important implications concerning electronics testing. Primary ion beam and its fragments are characterised by means of electronic detectors, deepening in the consequences for SEE testing in commercial components.

09:40 – G2 Assessment of the Quironsalud Proton Therapy Centre Accelerator for Single Event Effects Testing

A. Coronetti[1], **N. Emriskova**[1], R. Garcia[1], J. Vera Sanchez[2], A. Mazal[2]

1. CERN, Switzerland, 2. Quironsalud, Spain

Beam characterization and SEE measurements on electronic devices have been performed at the high-energy proton facility at the Quirónsalud proton therapy centre and are compared with those collected in standard European proton facilities.

09:55 – G3 Very High Dose Rate Proton Dosimetry with Radioluminescent Silica- based Optical Fibers

F. Fricano[1], A. Morana[1], D. Lambert[2], C. Hoehr[3], C. Campanella[1], C. Bélanger-Champagne[3], M. Trinczek[3], H. El Hamzaoui[4], B. Capoen[4], A. Cassez[4], M. Bouazaoui[4], A. Boukenter[1], E. Marin[1], Y. Ouerdane[1], P. Paillet[2], S. Girard[1]

1. Université de Saint Etienne, France, 2. CEA, France, 3. TRIUMF, Canada, 4. Université de Lille, France

We investigated the radiation-induced luminescence of Cerium or Nitrogen doped optical fibers at high dose-rates (>40 Gy(H2O)/s) using proton beams at different currents and energies. These fibers show promising results for dosimetry in such environments.

10:10 - 10:50 Coffee break - Exhibit Area

10:50 – G4 LET Calibration of Microbeams on EBIF and its SEE Cross Section Characterisation

S. Peracchi[1], R. Drury[1], Z. Pastuovic[1], J. Williams[2], L. Tran[2], S. Guatelli[2], A. Rosenfeld[2], A. Coronetti[3], N. Ermiskova[3], R. Garcia Alia[3], D. Button[1], M. Mann[1], D. Cohen[1], C. Brenner[1]

1. ANSTO, Australia, 2. University of Wollongong, Australia, 3. CERN, Switzerland

The ANSTO CAS External Beam Irradiation Facility has been calibrated in terms of direct LET measurement by using a silicon on insulator microdosimeter. SEE cross-section measurements were performed with a commercial SRAM.

11:05 – G5 Floating Gate Dosimeter Characterization for Space Applications

W. De Meyere[1], A. Shanbhag[1], A. Menicucci[1]

1. TU Delft, Netherlands

A floating gate dosimeter was characterized using proton beam irradiation. Dose resolution, temperature sensitivity and other properties were experimentally studied. Results show the sensor is able to combine low power consumption with high dose resolution.

Poster – PG1 Simulation-assisted Methodology for the Conception of Fiber-based Dosimeters for a Variety of Radiation Environments

D. Lambert[1], S. Girard[2], G. Santin[3], M. Gaillardin[1], A. Morana[2], A. Meyer[2], J. Vidalot[2], J. Baggio[1], J. Mekki[4], H. Cintas[4], O. Duhamel[1], C. Marcandella[1], P. Paillet[1]

1. CEA, France, 2. Université de Saint Etienne, France, 3. ESA, Netherlands, 4. CNES, France

We present a methodology combining experiments and Geant4 Monte Carlo simulations to evaluate the potential of dosimeters exploiting radiation-induced attenuation in a single-mode phosphosilicate optical fiber for a variety of radiation environments.

Poster – PG2 Solar Particle Event Detection with the LUMINA Optical Fiber Dosimeter aboard the International Space Station

M. Roche[1,2,3], N. Balcon[2], F. Clément[2], P. Cheiney[3], A. Morana[1], D. Di Francesca[4], J. Malapert[2], L. Oromarot[2], D. Ricci[4], J. Mekki[2], R. Canton[2], E. Marin[1], G. Melin[3], T. Robin[3], G. De la Fuente[5], S. Girard[1]

1. Université de Saint-Etienne, France, 2. CNES, France, 3. EXAIL, France, 4. CERN, Switzerland, 5. ESA, Netherlands

Lumina dosimeter is operational inside the International Space Station since August 2021. We discussed its capability to detect possible signatures of recent solar particle events through the induced increase of radiation level within the ISS.

Poster – PG3 CHARM High-energy Ions for Micro Electronics Reliability Assurance (CHIMERA)

K. Bilko[1,2], R. Garcia Alia[2], A. Coronetti[2], S. Danzeca[2], M. Delrieux[2], N. Emriskova[2], M. Fraser[2], S. Girard[1], E. Johnson[2],M. Sebban[1], F. Ravotti[2],A. Waets[2,3]

1. Université de Saint Etienne, France, 2. CERN, Switzerland, 3. University of Zurich, Switzerland

We present the progress related to CERN's capacity of delivering highly penetrating high-LET ions for electronics testing, including a summary of the beam properties and their intercomparison through SRAM SEE cross section measurements.

Poster – PG4 High-Energy Heavy Ion Beam Dosimetry using Solid State Detectors for Electronics Testing

A. Waets[1,2], K. Bilko[1,3], N. Emriskova[1], A. Coronetti[1,4], M. Sacristan Barbero[1,4], R. Garcia Alia[1], M. Durante[4], C. Schuy[4], T. Wagner[4], P. Nieminen[5], U. Schneider[2]

1. CERN, Switzerland, 2. University of Zurich, Switzerland, 3. Université de Saint-Etienne, France, 4. Université de Montpellier, France, 4. GSI, Germany, 5. ESA, Netherlands

Very high-energy, heavy ion beam dosimetry using a silicon detector is presented for 100 – 1000 MeV per nucleon energy. This study involves a combination of measurements at the GSI SIS18 accelerator and Monte Carlo simulations.

Poster – PG5 PIX: an Instrument to Measure Atmospheric Ionizing Particles based on a Single MiniPIX Sensor

M. Ruffenach[1], F. Bezerra[1], H. Cintas[1], J. Mekki[1], J. Richard[1], S. Louvel[1], A. Vargas[1], R. Chatry[1], M. Tornay[1], M. Levantino[2], M. Kastriotou[3], C. Cazzaniga[3], J. Hofverberg[4]

1. CNES, France, 2. ESRF, France, 3. STFC, United Kingdom, 4. Centre Antoine Lacassagne, France

This paper presents the PIX instrument as well as measurements performed onboard stratospheric balloons. The methodology to calculate fluxes is explained. Proton and electron fluxes are presented and compared to the MAIRE+ model.

Poster – PG6 Fast Neutron Measurements for the Characterization of the ChipIr beamline

C. Cazzaniga[1], M. Kastriotou[1], N. Bhuiyan[1], T. Dodd[1], D. Chiesa[2], S. Lilley[1], C. Frost[1]

1. STFC, United Kingdom, 2. University of Milano - Bicocca, Italy

Dosimetry measurements of the atmospheric neutron beam of ChipIr have been performed with different methods. We present results of neutron spectroscopy and beam profiles.

Poster – PG7 Low Energy, High Flux, Uniform and Large Field Size Electron Beam Facility

A. Alpat[1], **G. Bartolini[2]**, T. Wusimanjiang[2], G. Mattausch[3], T. Teichmann[3], R. Bluethner[3], M. Müller[4], C. Zschech[4], A. Coban[5], A. Bozkurt[5], D. Cegil[5]

1. INFN Sezione di Perugia, Italy, 2. BEAMIDE srl, Italy, 3. Fraunhofer FEP, Germany, 4. Leibniz-Institute of Polymer Research, Germany, 5. IRADETS A.S., Turkey

The present collaboration has developed different irradiation test setups and procedures, adapted to the existing electron beam generators at IPF in Dresden, Germany covering an energy range between 100 keV to 1.5MeV.

Poster – PG8 Embedded Total Ionizing Dose Estimator exposed to Large Ionizing Doses via Focused and Pulsed X-ray Beam

S. De Paoli[1], **V. Bertin[1]**, F. Abouzeid[1], V. Malherbe[1], V. Lorquet[1], G. Gasiot[1], P. Roche[1]

1. STMicroelectronics, France

This paper presents the response of an embedded Total Ionizing Dose Estimator exposed to large ionizing doses produced by the ID09 time- resolved synchrotron X-ray beamline at ESRF. Results are compared to a 60Co gamma irradiation.

Poster – PG9LN Quantification of neutron-induced SEUs in a SRAM memory by clinical 15 MV photon beam

L. Gabrisch[1], M. Cecchetto[2], B. Delfs[3], H. Looe[3], J. Budroweit[4], R. Garcia Alia[2], B. Poppe[1], V. Wyrwoll[1]

1. Carl von Ossietzky Universität Oldenburg, Germany, 2. CERN, Switzerland, 3. Pius Hospital, Germany, 4. DLR, Germany

A SRAM memory has been successfully used to measure the neutron flux of a 15 MV photon beam in a medical radiation treatment facility. Additionally, the measurement results have been confirmed by FLUKA Monte-Carlo simulations.

Poster – PG10LN Characterization of Radio-Photo-Luminescence dosimeters under X- ray irradiation

M. Ferrari[1], **Y. Q. Aguiar[2]**,A. Hasan[1], A. K. Alem[1], R. Garcia Alia[2], A. Donzella[3], D. Pagano[3], L. Sostero[3], A. Zenoni[3], **S. Girard[1]**

1. Université de Saint-Etienne, 2. CERN, Switzerland, 3. Università degli Studi di Brescia, Italy

This study characterizes RPL dosimeters under X-ray irradiation for radiation monitoring. Simulation and experimental results reveal a uniform dose distribution in the dosimeter volume reached by employing a thin Al filter. Agreement with standard 60Co calibration, improving calibration efficiency for high-dose applications, is found.

11:20 - 12:10 Session H: BASIC MECHANISMS OF RADIATION EFFECTS

Chairs: Elizabeth Auden (Los Alamos National Laboratory, USA) & Stefano Bonaldo (University of Padova, Italy)

11:25 – H1 Comparative Study of Collision Cascades and Resulting Displacement Damage in GaN, Si and Ge

J. Parize[1], T. Jarrin[1], D. Lambert[1], A. Jay[2], V. Morin[2], A. Hemeryck[2], N. Richard[1]

1. CEA, France, 2. LAAS-CNRS, France

To assess the sensitivity of microelectronic devices to displacement damage, molecular dynamics simulations of collision cascades in GaN and Si are performed. Results confirm that GaN is intrinsically more resistant to non-ionizing radiations than Si.

11:40 – H2 Random Telegraph Noise and Radiation Response of 80 nm Vertical Charge-Trapping NAND Flash Memory Devices with SiON Tunneling Oxide

I. Wynocker[1], E. Zhang[1], R. Reed[1], R. Schrimpf[1], D. Fleetwood[1], A. Arreghini[2], J. Bastos[2], G. Van den Bosch[2], D. Linten[2]

1. Vanderbilt University, USA, 2. IMEC, Belgium

Random telegraph noise (RTN) measurements are performed on as- processed, programmed, erased, and irradiated vertical charge-trapping NAND memory transistors. RTN magnitudes exceed those predicted by number fluctuation models by up to 3-times.

11:55 – H3 Total Ionizing Dose Effects Sensitivity of Unsalicided Polysilicon Resistors

M. Gorbunov[1], E. Boufouss[1], Z. Li[1], B. Vignon[1], M. Van de Burgwal[1], L. Berti[1], G. Thys[1]

1. IMEC, Belgium

We present the TID dependencies of the SSTL18/15 output resistances in 65 nm CMOS technology. The analysis showed the resistance growth that was attributed to the interface trap build-up accelerating at a low dose rate.

Poster – PH1 Threshold Damage Energy Anisotropy in Non-Ionizing Energy Loss Calculation

C. Inguimbert[1]

1. ONERA, France

This paper reports a new method to include, within the NIEL calculation, a damage energy threshold distribution related to the crystallographic anisotropy. It induces significant changes in electron's NIEL and below ~1 keV for protons.

Poster – PH2 Analysis of Optically Detected Magnetic Resonance to Identify Si Vacancies in SiC

D. Fehr[1], H. Kraus[2], C. Cochrane[2], **M. Flatté**[1]

1. University of Iowa, USA, 2. NASA JPL, USA

For decades, silicon carbide has been an important material in spaceflight electronics, which require operation at high temperatures and irradiation. We present a theory for characterizing the density of silicon vacancy defects with magnetic resonance.

Poster – PH3 Nonlinear Absorption in SiC Photodiode by Ultrafast Laser Irradiation in The Infrared

C. Chong[1], J. Rushton[2], A. Crombie[1], R. Sharp[1]

1. Radtest Ltd, United Kingdom, 2. Rushton Electronics Ltd, United Kingdom

We report on nonlinear three-photon absorption in a commercial 4H-SiC photodiode upon ultrafast laser irradiation in the infrared revealing that all laser wavelengths tested can be useful to screen SiC space electronics for radiation effects.

Poster – PH4 Comparison of High Energy X-rays and Cobalt 60 irradiations on MOS capacitors

V. Girones[1], J. Boch[1], F. Saigne[1], A. Carapelle[2], A. Chapon[3], T. Maraine[1], R. Garcia Alia[4]

1. Université de Montpellier, France, 2. CSL, Belgium, 3. ATRON Metrology, France, 4. CERN, Switzerland

The use of a high energy X-rays generator for electronic device testing is studied on MOS capacitors and compared to cobalt-60. Experimental results are presented and discussed.

12:10 - 12:20 DATA Workshop Session introduction

Chairs: Jérémy Guillermin (TRAD, France) & Lili Ding (Northwest Institute of Nuclear Technology, China)

12:20 - 14:10 Lunch - Room Caravelle

14:10 - 15:45 DATA Workshop Session

Chairs: Jérémy Guillermin (TRAD, France) & Lili Ding (Northwest Institute of Nuclear Technology, China)

Poster – DW1 Total Ionizing Dose and Single Event Effect Test Results on Radiation Hardened By System DC-DC power converter

P. Kohler[1], A. Bosser[1], D. Desdoits[1], G. Vignon[2], P. Garcia[2], P. Wang[1]

1. 3D PLUS, France, 2. TRAD, France

This paper presents the results of Single Event Effects (SEE) and Total Ionizing Dose (TID) test campaigns carried out on a commercial DC-DC buck converter, both with and without a radiation hardening feedback loop.

Poster – DW2 Radiation Tolerance Assessment of COTS Components for an Optoelectronic System to Measure Polymer Aging in Nuclear Environments

M. Boussandel[1], A. Fathallah[1], J. Armani[2], F. Armi[1], M. Ben Chouikha[1]

1. Sorbonne Université, France, 2. CEA, France

The radiation dose tolerance of several microcontrollers, LED drivers and differential amplifiers was tested using 60Co gamma-rays. We found that the tested devices are tolerant up to a dose comprised between 130 and 1000 Gy.

Poster – DW3 A Decade of Single Event Effects on SWARM's On-Board Computer

M. Pinto[1], **C. Poivey**[1], M. Poizat[1], C. Boatella-Polo[1], V. Gupta[1], T. Borel[1], A. Pesce[1], M. Falcolini[1], I. Clerigo[2], G. Albini[2], A. Neto[2], H. Schmidt[3]

1. ESA, Netherlands, 2. ESOC, Germany, 3. AIRBUS, Germany

A decade of radiation effects to the On-Board Computer of European Space Agency SWARM constellation is analysed. OMERE overestimates Single Event Effects flight rates except in one SRAM. New SEFI structures and effects were found.

Poster – DW4 UV Irradiation Facility for Solar Effects Simulations

G. Bartolini[1], A. Alpat[2], P. Di Lazzaro[3], D. Murra[3], S. Bollanti[3], T. Wusimanjiang[1]

1. BEAMIDE Srl, Italy, 2. INFN, Italy, 3. ENEA-Frascati, Italy

We describe an experimental setup developed aiming to irradiate under UV for accelerated test for solar effects on the samples according the relevant ECSS/ESA standards.

Poster – DW5 Single-Event Effects Measurements on COTS Electronic Devices for Use on NASA Mars Missions

F. Irom[1], S. Vartanian[1], G. Allen[1]

1. NASA JPL, USA

This paper reports recent single-event effects measurements results for a variety of microelectronic devices that include a D-type flip flops, Mixed- Signal Microcontrollers, High Speed Low Drop Out (LDO) Voltage Regulators, and LDO Linear Regulator. The data were collected to evaluate these devices for possible use in NASA Mars missions.

Poster – DW6 LEON5FT and NOEL-VFT System-on-Chip: STM 28 nm FDSOI Test Chip SEE Characterization

A. Barros de Oliveira[1], L. Antunes Tambara[1], O. Lexell[1], M. Hjorth[1], J. Andersson[1], F. Abouzeid[2], P. Roche[2], V. Malherbe[2]

1. Frontgrade Gaisler, Sweden, 2. STMicroelectronics, France

This work presents the SEE characterization of the first STM 28 nm FDSOI test chip implementing a LEON5FT and NOEL-VFT system-on-chip. Results show the effectiveness of technology and processors' fault tolerance in handling soft errors.

Poster – DW7 Temperature Dependence of Neutron Interaction with SiC power MOSFETs

F. Pintacuda[1], F. Principato[2], C. Cazzaniga[3], M. Kastriotou[3], C. Frost[3], L. Abbene[2]

1. STMicroelectronics, Italy, 2. Palermo University, Italy, 3. CHIP-Ir, United Kingdom

Neutron tests on SiC power MOSFETs at different temperatures were performed at the ChipIr facility. Preliminary results of an alternative method to investigate the effects of the temperature on the neutron interaction is presented.

Poster – DW8 Radiation-Induced Effects on AlGaAs Optocouplers to New Space

A. Romero-Maestre[1], P. Martin-Holgado[1], J. de-Martin-Hernandez[2], J. Gonzalez-Lujan[2], A. Ricca-Soaje[2], M. Jalon[2], M. Dominguez[2], Y. Morilla[1]

1. Centro Nacional de Aceleradores, Spain, 2. ALTER TECHNOLOGY., Spain

This work presents the degradation of AlGaAs hybrid technology optocouplers as a result of irradiation testing by using neutron and proton beams. The degradation of the most interesting parameters is presented for the cases of study.

Poster – DW9 Heavy-Ion Induced Single Event Effects on an Ultra-Wideband Transceiver

J. Budroweit[1], G. Fischer[2], M. Ehrig[2]

1. DLR, Germany, 2. IHP, Germany

This paper presents the latest single event effect test results of an ultra- wideband transceiver under heavy-ion acceleration.

Poster – DW10 RADECS 2023 DDR4T04G72 comparison

W. Bertrand[1], M. Ball[1], T. Porchez[1], M. Rivadeneira[1], O. Bonnet[1], T. Guillemain[1], G. Chalmé[1]

1.Teledyne e2v, FranceS

This paper will present the comparison between the DDR4T04G72 rev A and the revision B in radiation performance. the product will be presented, then the test setup, after that the results, to finish the conclusion

Poster – DW11 TID Lot-To-Lot Variability of COTS Investigated in the Framework of the ESA CORHA Study

M. Wind[1], **C. Tscherne[1]**, L. Huber[1], M. Bagatin[2], S. Gerardin[2], M. Latocha[1], A. Paccagnella[2], M. Poizat[3], P. Beck[1]

1. Seibersdorf Laboratories, Austria, 2. University of Padova, Italy, 3. ESA, Netherlands

We present investigations on lot-to-lot variation in total ionizing dose (TID) radiation testing of three commercial devices (memory, operational amplifier, microcontroller) as part of the ESA CORHA study.

Poster – DW12 Ionizing Radiation Effects in Non-Radiation-Tolerant Digital Video Cameras

E. Simova[1], K. Stoev[1], J. Devreede[1]

1. Canadian Nuclear Laboratories, Canada

Commercial digital video cameras were irradiated with ionizing radiation at various dose rates (DRs) up to the total ionizing dose (TID) for catastrophic failure. Camera performance with respect to both DRs and TID were analysed.

Poster – DW13 Transceivers and SEL/NVM Heavy Ion Characterization on Microchip RT PolarFire® FPGA

N. Rezzak[1], R. Chipana[1], M. Reaz[1], G. Bakker[1], F. Hawley[1], E. Hamdy[1]

1. Microchip Technology, USA

The Single-Event response of Microchip 28 nm RT PolarFire® RTPF500ZT SONOS-based FPGA is characterized using heavy ion. SEL, NVM and SERDES Transceivers with hardened CoreABC controller are evaluated.

Poster – DW14 Total Ionizing Dose Characterization of Microchip Quad RLCL Power Switch LX7714

M. Leuenberger[1], R. Stevens[1], D. Johnson[1]

1. Microchip Technology, USA

The 100krad total ionizing dose characterization results of Microchip Technology's radiation-hardened quad re-triggerable latching current limiter (RLCL) power switch IC, the LX7714, are presented.

Poster – DW15 MIC69303RT Single Supply Low Vin, 3A LDO Single Event Effect and Total Ionizing Dose

B. Treuillard[1], G. Bourg-Cazan[1], E. Leduc[1], E. Daumain[1], S. Ngo[2]

1. Microchip Technology, France, 2. Microchip Technology, USA

This paper reports the results of Single Event Effects (SEE) and Total Ionizing Dose (TID) test campaigns conducted by Microchip on single supply low Vin, 3A LDO (Low DropOut regulator) MIC69303RT.

Poster – DW16 LDR Testing of 2N4861 JFET and RH1009 2.5V Reference for Europa Clipper UVS

Z. Olson[1], R. Monreal[1]

1. Southwest Research Institute, USA

The 2N4861 JFET and RH1009 2.5V reference intended for the Europa Clipper mission were tested under low dose rate conditions (10 mRad/s). Both devices performed within acceptable tolerances of their applications, up to 100 krad.

Poster – DW17 Radiation-hardened space STT MRAM on FDSOI process test results

P. Wang[1], P. Kohler[1], A. Bosser[1], S. Gerardin[2], M. Bagatin[2], L. Gouyet[3], G. Vignon[3], P. Zuber[4], G. Thys[4]

1. 3D PLUS, France, 2. Padova University, Italy, 3. TRAD, France, 4. IMEC, Belgium

This paper presents the radiation results of the first STT-MRAM on FDSOI process designed for space under EUH2020 program Mnemosyne project. The results include TID, HI-SEE and laser test results on the Initial-RHBD- Chips and Initial-RHBD-Chips.

Poster – DW18 Withdrawn by the author

Poster – DW19 Stuck Errors in Bits and Blocks in GDDR6 Under High-energy Neutron Irradiation

M. Yoshida[1], R. Iwamoto[2], M. Itoh[3], M. Hashimoto[1]

1. Kyoto University, Japan, 2. Osaka University, Japan, 3. Tohoku University, Japan

We observed stuck block errors in GDDR6 under neutron irradiation, while temporary block errors and stuck bits errors are reported in the literature. We also found the stuck block errors disappeared after power cycling.

Poster – DW20 Gamma and Proton Irradiation Possibilities at HZB

A. Dittwald[1], J. Bundesmann[1], A. Denker[1], G. Kourkafas[1], T. Fanselow[1], F. Lang[2]

1. Helmholtz-Zentrum Berlin, Germany, 2. University of Potsdam, Germany

HZB offers gamma irradiation at max. 150 Gy/h (H2O) and proton irradiation with flexible time structures up to 68 MeV, diameter max. 40 mm, and intensities up to 1013 protons/cm^2 in air (more in vacuum).

Poster – DW21 Total Ionizing Dose testing of Shunt Reference as Battery Balancers for Space Applications

H. Gunasekar[1], H. Kuhm[1], D. Gomez Toro[1], M. Eilenberger[1], N. Aksteiner[1], S. Ansar[1], C. Bänsch[1]

1. DLR, Germany

This paper presents and compares the Total Ionizing Dose (TID) testing and results of commercial off-the-shelf (COTS) shunt references used as battery balancers under 60Co irradiation at progressive dose rates in biased and unbiased conditions.

Poster – DW22 Proton Single Event Upsets Characterization of the NOEL-V Processor on the Xilinx Kintex Ultrascale FPGA

A. Menicucci[1], **T. Hendrix[2]**, S. Di Mascio[3]

1. TU Delft, Netherlands, 2. Ubotica Technologies, Netherlands,3. Leonardo, Italy

This paper evaluates the Single Event Upset (SEU) proton susceptibility of the NOEL-V processor, a novel and highly modular Intellectual Property (IP) Core by Cobham Gaisler on the Xilinx Kintex Ultrascale SRAM FPGA.

Poster – DW23LN Single Event Effects Performance of Rad-Hard SoC-FPGA NG-ULTRA

K. Akyel[1], R. Fascio[1], **K. Chopier[1]**, C. Debarge[1], A. Demol[1], D. Dangla[2], J. Mekki[2]

1. Nanoxplore, France, 2. CNES, France

This paper presents the heavy ion test results of NG-ULTRA, the first rad- hard SoC-FPGA designed with 28nm FDSOI technology node.

Poster – DW24LN SEE characterization for a Ka-band capable, low power, 10 bits ADC

O. Bonnet[1], H. Barneoud[1], S. Renane[1], A. Dezzani[1], F. Malou[2], N. Kerboub[2], G. Lesthievent[2], J. Mekki[2]

1. Teledyne e2v, France, 2. CNES, France

EV10AS940 is a 10-bit, 12.8GSps Analog-to-Digital Converter that allows sampling of signals up to the Ka-band with its bandwidth of 32GHz. this paper presents the preliminary results of SEE tests performed in May 2023.

Poster – DW25LN Total Ionizing Dose and Proton Characterization of 12 LP+ FinFET Technology

N. Rezzak[1], R. Chipana[1], M. Reaz[1], A. Cai[1], G. Bakker[1], F. Hawley[1], E. Hamdy[1]

1. Microchip, USA

TID and SE response of GF 12LP+ bulk FinFET process is characterized. Low/high voltage transistors and SRAMs are irradiated up to 300 krad(SiO2). Proton-induced SEU and SEL in FF, SRAMs and ESD circuits are presented.

15:45 - 17:00 RADECS General Assembly

The General Assembly / open meeting, animated by the RADECS Association Bureau, will provide feedbacks and plans for RADECS 2022, 2024 and 2025 Conferences, NSREC 2024 and 2025, RADECS Workshops 2023-2024.

18:30 - 01:30 Gala Dinner

Friday 29th September >> Pierre Baudis Congress Centre

08:30 - 09:00 Welcome desk and locker room

09:00 - 09:50 Invited paper | Olivier Berné | IRAP James Webb telescope and the "Early Release Science" Research programme

Olivier Berné [1]

1. IRAP

Bio: Olivier Berné is a research director at CNRS (National Center for Scientific Research) and an astrophysicist at the Institute of Research in Astrophysics and Planetology in Toulouse. He has been involved in the James Webb Space Telescope mission since 2015 and is one of the leaders of an international observation program focused on the Orion Nebula.

Abstract: The James Webb Space Telescope is the most expensive and complex space mission ever designed by humanity. Its ambition matches this grandeur, as since its launch in 2021, it has revealed some of the most precise and distant images of the Universe. Olivier Berné, a specialist in the Orion Nebula, led one of the very first scientific programs with this telescope: the observation of this splendid nursery filled with stars in formation, where the great mysteries of the origin of celestial bodies, planets, and life are at play. Over the months, him and team have faced numerous surprises, joys, fears, and discoveries that he will share during this keynote presentation.

09:50 - 11:50 Session I: RADIATION ENVIRONMENTS

Chairs: Janet Barth (NASA (ret), USA) & Pete Truscott (Kallisto Consultancy, United Kingdom)

09:55 – I1 Benchmarking Trapped Proton Specification Models along an EOR Orbit

S. Bourdarie[1], P. Caron[1], M. Ruffenach[2], F. Bezerra[2], R. Ecoffet[2]

1. ONERA, France, 2. CNES, France

During the E7C spacecraft cruise to GEO, the ICARE-NG instrument has measured electron and proton flux as well as SEU effect affecting various SRAMs and DRAMs. In this paper, SEU events recorded by IACRE-NG are used to benchmark proton specification models, AP8, AP9, GREEN-p and spectrometer data

10:10 – I2 In-flight Measurements of Radiation Environment Observed by Hotbird 13F and Hotbird 13G (Electric Orbit Raising Satellites)

P. Caron[1], S. Bourdarie[1], J. Carron[2], R. Ecoffet[2], M. Calaprice[2], M. Ruffenach[2], B. Taponat[3], P. Bourdoux[3], R. Mangeret[4], A. Samaras[4]

1. ONERA, France, 2. CNES, France, 3. EREMS, France, 4. Airbus Defense and Space, France

Measurements of particle fluxes obtained with the latest version of ICARE, called ICARE_NG^2, on board Hotbird 13F and Hotbird 13G satellites, are presented. Measurements of low-energy protons (down to 5 MeV) are presented.

10:25 – I3 Energetic Particle Contamination in STIX during Solar Orbiter's Passage through Earth's Radiation Belts and an Interplanetary Shock

H. Collier[1,2], O. Limousin[3], H. Xiao[1], A. Claret[3], F. Schuller[4], A. Fedeli[5], S. Krucker[1,6]

1. Fachhochschule Nordwestschweiz, Switzerland, 2. ETH Zürich, Switzerland, 3. CEA, France, 4. Leibniz-Institut für Astrophysik Potsdam, Germany, 5. University of Turku, Finland, 6. University of California, Switzerland

Solar Orbiter's STIX is a solar dedicated hard X-ray space telescope. During energetic particle events the signal is contaminated. We identify 0.03-0.5 MeV electrons as the dominantly responsible species via secondary Bremsstrahlung and tungsten fluorescence.

10:40 - 11:20 Coffee break - Exhibit Area

11:20 – I4 Climate Reanalysis of Electron Radiation Belt Long-term Dynamics, using a Dedicated Numerical Scheme

N. Dahmen[1], A. Sicard[1], A. Brunet[1]

1. ONERA, France

We present in this paper, the new numerical solver of Salammbô. The latter provides stronger accuracy and robustness arguments that will ensure the foundation of a reliable reanalysis database to improve the GREEN specification model.

11:35 – I5 Evaluation of SHIELDOSE-2 for Thin Target Applications in Space Environment

I. Jun[1], R. Benacquista[2], H. Evans[3], S. Gentz[4], M. Goodman[5], A. Henderson[4], T. Jordan[6], L. Martinez Sierra[1], G. Santin[3], S. Stephen[7], R. Singleterry[8], T. Slaba[8], P. Truscott[9], A. Varotsou[2], E. Willis[4], X. Zhu[1]

1. NASA JPL, USA, 2. TRAD, France, 3. ESA, Netherlands, 4. NASA Marshall Space Flight Center, USA, 5. Peraton, USA, 6. EMPC, USA, 7. NIST, USA, 8. NASA Langley Research Center, USA, 9. Kallisto Consultancy Ltd, United Kingdom

We provide a review on the capability and limitation of the SHIELDOSE-2 radiation-analysis tool, especially in the light of the lack of documented knowledge on its validity range for thin shielding materials.

Poster – PI1 L2-Charged Particle Environment (L2-CPE) Low Energy Radiation Fluence Model

J. Minow[1], A. Diekmann[2], E. Willis[1], V. Coffey[1]

1. NASA Marshall Space Flight Center, USA, 2. Jacobs Space Exploration Group, USA

The L2-CPE engineering model specifies low energy electron, proton, and alpha particle environments in the solar wind and Earth's distant magnetosheath and magnetotail at energies of importance to surface dose in space exposed materials.

Poster – PI2 Investigation of Cis-lunar Plasma Environment using THEMIS- ARTEMIS Data

W. Kim[1], B. Zhu[1], I. Jun[2]

1. NASA JPL, USA

The two THEMIS-ARTEMIS spacecraft have been orbiting the Moon and measuring plasma fluxes and spacecraft potentials. We fit the data using Maxwellian+Kappa distributions and characterize the plasma variability via statistical analysis of the fitted parameters.

Poster – PI3 Proton and Electron Pulse Shape Discrimination for In-Situ Radiation Belt Monitoring

M. Pinson[1], P. Caron[1]

1. ONERA, France

The goal of this paper is to develop the necessary numerical models to study the differences of the induced pulse shapes of proton and electrons, all while validating these models with an experimental test bench.

Poster – PI4 The CELESTA CubeSat In-Flight Radiation Measurements and their Comparison with Ground Facilities Predictions

A. Coronetti[1,2], A. Zimmaro[1,2], R. Garcia Alia[1], S. Danzeca[1], A. Masi[1], **I. Slipukhin**[1,2], A. Amodio[1], J. Dijks[1], P. Peronnard[1], R. Secondo[1], M. Brugger[1], E. Chesta[1], M. Bernard[3], L. Dusseau[3], T. Allain[3], R. Mendes Duarte[3], J-R. Vaillé[2], F. Saigné[2], J. Boch[2], L. Dilillo[2]

1. CERN, Switzerland , 2. Université de Montpellier, France, 3. Centre Spatial Universitaire Montpellier, France

The CELESTA CubeSat radiation monitoring system collected in-flight SEU and SEL data in a MEO. A comparison with cross sections and rate predictions from ground facilities is proposed, showing good agreement for the CHARM facility.

Poster – PI5 Proton and Electron Flux Measurement and Simulation during Stratospheric Balloon Flights

H. Cintas[1,2,3], F. Wrobel[2], F. Saigné[2], M. Ruffenach[1], F. Bezerra[1], D. Herrera[3], J. Mekki[1], A. Varotsou[3]

1. CNES, France, 2. Université de Montpellier, France, 3. TRAD, France

We compare simulation results to the fluxes recorded by the CNES PIX instrument during stratospheric balloon flights. The Radiations Atmospheric Model for SEE Simulation (RAMSEES) predictions are in good agreement with PIX fluxes for protons.

Poster – PI6LN Long-Term Measurements of Solar Particles Events and Inner Belt Protons by GOSAT

H. Matsumoto[1]

1. Japan Aerospace Exploration Agency, Japan

Clear solar cycle variability that is anticorrelated with solar radio wave strength (F10.7) from long-term trapped proton data observed by the GOSAT satellite and the range of energy-by-energy variability is reported.

11:50 - 12:25 Session J: RADIATION HARDNESS ASSURANCE

Chairs: Anastasia Pesce (ESA, Netherlands) & Philippe Adell (NASA JPL, USA)

11:55 – J1 Investigation of SEE Laser Testing for COTS Batch Screening

S. Morand[1], S. Dubos[2], L. Foro[1], D. Dam[1], L. Gouyet[2], J. Guillermin[2], C. Binois[1], A. Varotsou[2], R. Mangeret[1], T. Borel[3], C. Poivey[3]

1. Airbus Defence and Space, France, 2. TRAD, France, 3. ESA, Netherlands

In this work, we evaluate the pulsed laser test method for SEE screening of different procurement lot of COTS devices, w.r.t different nature of SEE.

12:10 – J2 Review of Alternatives to Heavy Ions Broad Beam for SEL Screening of COTS

S. Dubos[1], J. Guillermin[1], A. Rousset[1], M. Laborde[1], F. Bezerra[22], J. Mekki[2], M. Ruffenach[2], J. Bertrand[2], L. Gouyet[1]

1. TRAD, France, 2. CNES, France

In this work, we evaluate different facilities and methods, alternatives to heavy ion broad beam, for assessing the sensitivity of SEL to COTS: pulsed Laser, Pulsed X-rays and a Cf-252 source.

Poster – PJ1 Evaluation of Back End Of Line Rerouting on Single Event Latchup Occurrence in Readout Integrated Circuits

L. Artola[1], G. Hubert[1], A. Al Youssef[2], P. Garcia[2]

1. ONERA, France, 2. TRAD, France

The impact of the rerouting of the BEOL on the SEL sensitivity is presented and discussed. Heavy ions data are presented. In addition, the change in the BEOL design is also investigated by simulation tools.

Poster – PJ2 Study of the impact on the Radiation Design Margin of the statistical distributions used to analyze radiation degradation data

F. Voltine[1], F. Miller[1], T. Cheviron[1]

1. Nucletudes, France

This study proposes a methodology to assess the relevancy of the statistical distribution chosen for the analysis of degradation data of Total Ionizing Dose and Total non-Ionizing Dose and to evaluate the impact on the calculated Radiation Design Margin.

Poster – PJ3 A Comparison Of Board-Level Lot Acceptance Testing Method With Worst-Case Analysis Results

G. Montay[1], M. Beaumel[1], F. Rifa[1], B. Huret[1], C. Poivey[2]

1. SODERN, France, 2. ESA, Netherlands

A WCA on a DC/DC converter board based on radLAT results and the available component data has been performed according to current standards, in all the conditions fully functional board samples have been tested to.

Poster – PJ4 Correlation of High Energy Proton and Atmospheric Neutron Destructive and Non-Destructive Single-Event Effect Tests of a 1200V SiC MOSFET

H. Rizk[1], C. Ngom[2,3], V. Pouget[3], A. Michez[3], F. Lachaud[1], G. Le Morvan[1], F. Miller[1], M. Zerarka[2], O. Perrotin[2], F. Coccetti[2]

1. Nucletudes, France, 2. IRT Saint Exupery, France, 3. Université de Montpellier, France

We present the correlation of high energy proton and atmospheric neutron single-event test results on a recent 1200V SiC MOSFET, obtained with destructive and non-destructive methods. TCAD modelling is used to investigate the failure mechanisms.

Poster – PJ5 A Characterization Method for TID vs Temperature Synergistic Effects

M. Rizzo[1], M. Muschitiello[1], V. Gupta[1], M. Poizat[1]

1. ESA, Netherlands

This article presents a new TID-Temperature synergistic effect assessment method. LT1521 samples were irradiated at ambient temperature, then measured under thermal cycling. Early failures were detected for TID degradation of the thermal compensation circuitry.

Poster – PJ6 Assessment of SER Predictions for Radiation Hardness Assurance of SRAMs in Harsh Proton Space Environments

B. Ruard[1], L. Artola[2], G. Hubert[2], J. Matéo Vélez[2], J. Forest[1]

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In this paper, prediction methodologies to compute SER are discussed due to the limits of relevant parameters of current methods for sub nanometer devices under heavy ions but mostly protons.

Poster – PJ7 The Influence of Bias, LET and Fluence on Latent Damage in SiC MOSFET

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The fluence should be selected according to spacecraft mission to evaluate the effect of latent damage. PIGS test should be performed to evaluate the degradation due to latent damage in SiC MOSFET SEE test method.

Poster – PJ8LN Radiation Design Margin estimation in the case of Degradation Data from an Inhomogeneous Lot

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This work proposes a method for calculating the Radiation Design Margin for degradation data obtained on an inhomogeneous lot and for which the use of an encompassing normal distribution would be too conservative.

12:25 - 12:40 RADECS 2023 Conference Closure Best Student Paper Award

13:30 - 17:30 Technical visits AIRBUS or CNES