JPL
Jet Propulsion Laboratory
California Institute of Technology

CERN

HARRIS

TRAD
Tests & radiations

Rymdstyrelsen
Swedish National Space Agency

OHB

Microsemi
Power Matters.

MICROPAC

Texas Instruments

RADECS

IEEE

IEEE NPSS
NUCLEAR & PLASMA SCIENCES SOCIETY

Hosted by

COBHAM

Cobham Gaisler, Sweden

Cobham RAD Europe, UK

Cobham Semiconductor Solutions, USA

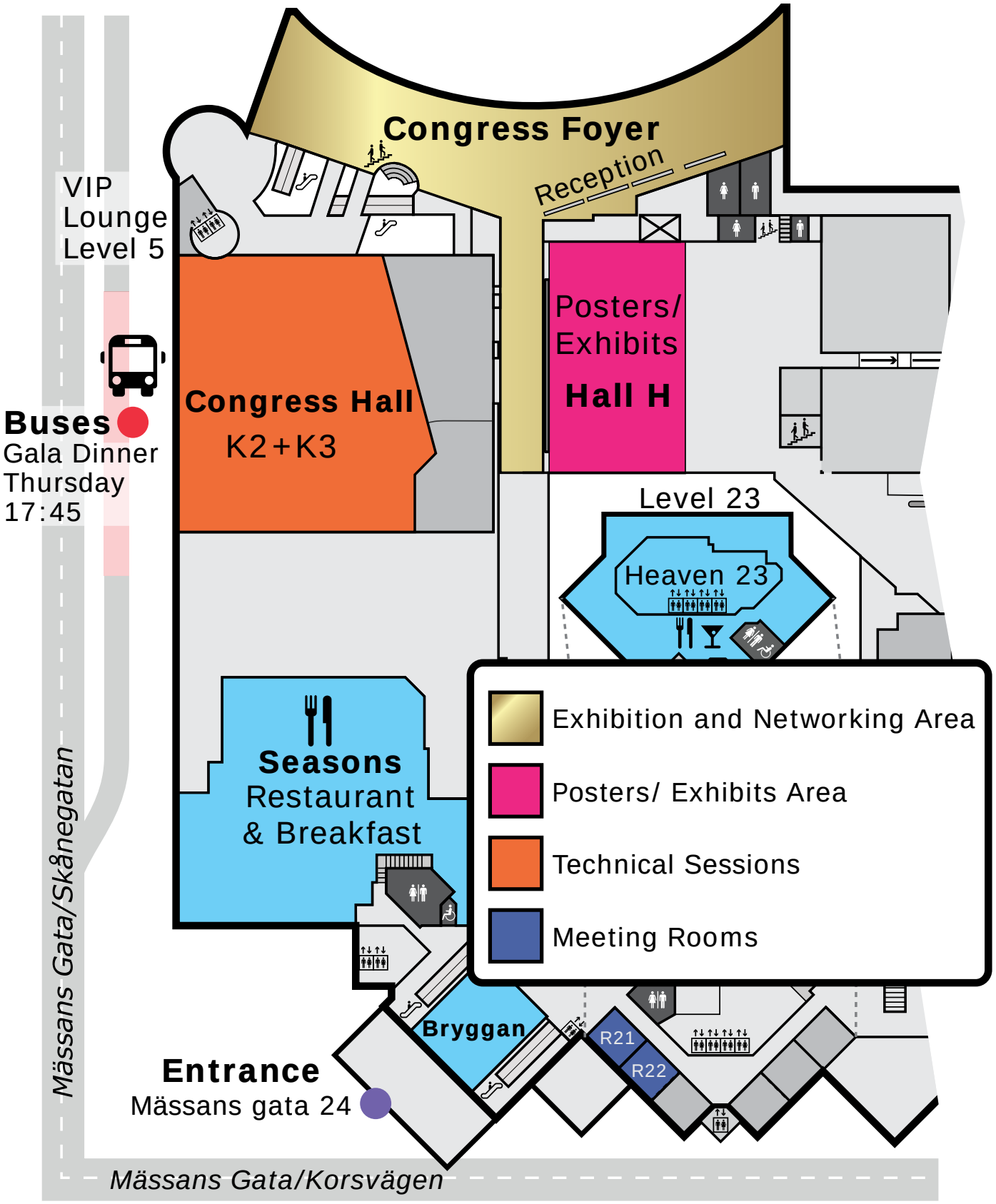
CONFERENCE PROGRAM

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Technical, Poster, Workshop Sessions - Tuesday through Friday.				
8 — **TOPICAL DAY**				
08:20 Introduction	**08:15 Conference Opening**	**08:20 Announcements**	**08:10 Announcements**	**08:10 Announcements**
8:30 — **08:30-09:35** NON-VOLATILE MEMORIES FOR SPACE: THE THREAT OF IONIZING RADIATION	**09:05 Session H: SEE IN DEVICES AND ICS** 09:10 – H1 09:25 – H2 19:40 – H3 09:55 – H4 10:10 – H5	**08:30 Session D: ENVIRONMENTS** 08:35 – D1 08:50 – D2 09:05 – D3 09:20 – D4 09:35 – D5	**08:20 Session E: PHOTONICS** 08:25 – E1 08:40 – E2 08:55 – E3 09:10 – E4 09:25 – E5 09:40 – E6	**08:20 - 09:05 INVITED TALK** *Dr. Steve Guertin, Jet Propulsion Laboratory*
9 — 9:30 — **09:35-10:05 BREAK**	**10:25 - 10:55 BREAK** Exhibits Foyer & Hall H	**09:50 - 10:20 BREAK** Exhibits Foyer & Hall H	**09:55 - 10:25 BREAK** Exhibits Foyer & Hall H **RAFFLE DRAW**	**09:05 Session A: BASIC MECHANISMS** 09:10 – A1 09:25 – A2 09:40 – A3 **09:55 - 10:25 BREAK** Foyer
10 — **10:05-11:10** WIDE-BANDGAP SEMICONDUCTORS IN SPACE: APPRECIATING THE BENEFITS BUT UNDERSTANDING THE RISKS	**10:55 Session G: SEE MECHANISMS** 11:00 – G1 11:15 – G2 11:30 – G3 11:45 – G4	**10:20 Session C: RADIATION HARD-NESS ASSURANCE (RHA)** 10:25 – C1 10:40 – C2 10:55 – C3 11:10 – C4	10:25 – E7 10:40 – E8 **10:55 Session J: DOSIMETRY AND FACILITIES** 11:00 – J1 11:15 – J2 11:30 – J3 11:45 – J4	**10:25 Session B: DEVICES AND ICS** 10:25 – B1 10:45 – B2 11:00 – B3 11:15 – B4 11:30 – B5 11:45 – B6
11 — 11:30 — **11:10-12:15** LEADING-EDGE CMOS ADOPTED FOR NEW SPACE AND SAFETY AUTOMOTIVE PRODUCTS		**11:25 - 12:00 INVITED TALK** *Elsa Modin, Hasselblad Foundation*		
12 — 12:30 — **12:15-13:45 LUNCH** at "Seasons"	**12:00 - 13:30 LUNCH** at "Seasons"	**12:00 – 13:30 LUNCH** at "Seasons" **- and - WOMEN IN ENGINEERING** *Beatriz Sanchez, OHB & Dr.Kelly Simmons-Potter, Uni. of Arizona* in "Bryggan" ***Ticket Required to Attend***	**12:00 - 13:30 LUNCH** at "Seasons"	**12:00 - 12:45 BEST STUDENT PAPER PRESENTATION** **& THE END OF RADECS 2018**
13 — 13:30 —	**13:30 - 14:20 INVITED TALK** *Melanie Berg,* AS&D Inc. in support of NASA/GSFC	**13:30 Session K: ALTERNATIVE TESTING AND RHA METHODS** 13:35 – K1 13:50 – K2	**13:30 - 14:30 INVITED TALK** *Christer Fuglesang*	
14 — 14:30 — **13:45-15:00** FROM COTS TO SPACE GRADE ELECTRONICS: WHICH IS THE BEST FOR YOUR MISSION?	**14:20 Session I: SEE TRANSIENTS** 14:25 – I1 14:40 – I2 **14:55 BREAK** Exhibits Foyer and Hall H	**14:05 - 16:40 POSTER SESSION – Hall H** **BREAK** in Exhibit Foyer & Hall H during Poster Session	**14:30 - 16:00 DATA WORKSHOP – Hall H** **BREAK** in Exhibit Foyer & Hall H during Poster Session	
15 — **15:00-15:30 BREAK**	**15:25 Session F: HARDENING BY DESIGN** 15:30 – F1 15:45 – F2 16:00 – F3 16:15 – F4 16:30 – F5		**16:00-18:00 RADECS GENERAL ASSEMBLY**	
15:30 — **15:30-16:45** NEXT GENERATION PROCESSING FOR SPACE SYSTEMS				
16 — **16:45 End of Day**	**16:45 End of Day**	**16:40 End of Day**		
18 — **SOCIAL PROGRAMME 18:00-19:00** MAYOR RECEPTION At "Imagine", Gothia Towers, 3rd tower, 29th floor	**SOCIAL PROGRAMME 17:30-19:00** Exhibit Reception	**SOCIAL PROGRAMME 17:00** FOOTBALL TOURNAMENT and ORIENTEERING At Ullevi football arena	**SOCIAL PROGRAMME 18:00** RADECS GALA DINNER 17:45 Bus to Eriksbergshallen	
Technical, Poster, Workshop Sessions - Tuesday through Friday.				

REGISTRATION OPEN HOURS
ON SITE

Sunday, Sep 16	17:00 – 19:00
Monday, Sep 17	7:30 – 16:00
Tuesday, Sep 18	7:30 – 16:00
Wednesday, Sep 19	7:30 – 16:00
Thursday, Sep 20	7:30 – 15:00
Friday, Sep 21	7:30 – 12:00

CONFERENCE MAP



SVENSKA MÄSSAN
THE SWEDISH EXHIBITION & CONGRESS CENTRE

GOTHIA TOWERS

WELCOME TO GOTHENBURG

Welcome to the Conference on Radiation Effects on Components and Systems (RADECS) in Gothenburg, Sweden in 2018.

The aim of RADECS conferences is to provide an annual European forum for the presentation and discussion of the latest advances in the field of radiation effects on electronic and photonic materials, devices, circuits, sensors, and systems. The scope of the conference encompasses technological processes and design techniques for producing radiation tolerant systems for space, aeronautical or terrestrial applications, as well as relevant methodologies for their characterization and qualification.

RADECS 2018 is hosted by Cobham Gaisler together with Cobham RAD Europe and Cobham Semiconductor Solutions with the support of the RADECS Association.

Gothenburg is located in the heart of Scandinavia, easily accessible from around Europe. It is a city that has always been open to the world. Throughout our history we have embraced people and influences from outside, and through the ages the city has been developed with ideas and knowledge from around the world. International contacts, new influences and new people are, and always have been, our strengths. With a stunning archipelago on the doorstep of Gothenburg we assure you'll get a whole new conference experience.

Welcome to Gothenburg!

Sandi Habinc
General Chair
RADECS 2018

RADECS
GOTHENBURG
16th - 21st
SEPTEMBER 2018
MMXVIII

CROSSOVER SPACE:
EMERGING CONCEPTS FOR SPACE SYSTEMS

The days of “traditional” space missions (large satellites and risk avoidance on electronics) has been replaced by “small space”, risk management, and a rapidly growing commercial presence.

This topical day discusses two sides of the burgeoning changes:

- Selective emerging electronic technologies that provide potential enabling characteristics for the new regime of space, and,
- Alternative concepts for systems risk management and evaluation.

Ken LaBel
NASA-NEPP
Topical Day Chair

TOPICAL DAY PROGRAM
MONDAY 17TH OF SEPTEMBER

All talks are 55 min + 5 min Q&A

08:20-08:30
INTRODUCTION

08:30-09:35

NON-VOLATILE MEMORIES FOR SPACE: THE THREAT OF IONIZING RADIATION

Marta Bagatin, University of Padova

An overview of radiation effects in non-volatile memories will be provided, with emphasis on Flash and Phase Change memories. Total ionizing dose and single event effects in NAND and NOR Flash technologies will be presented, discussing possible issues in both the memory cells and the control circuitry, and the underlying mechanisms. Technology scaling trends in Flash memories will be analyzed over the last decade, going from floating gate planar cells to recent 3D architecture. The synergies between SEE and TID, as well as the impact of radiation on long term performances, such as retention and endurance, will also be covered. Recent observations of upsets in PCM cells due to very highly ionizing particles impinging at an angle will be discussed. Finally, a brief overview of the state of other emerging technologies, such as ReRAM and ST-MRAM, will be provided.

09:35-10:05 **BREAK**

10:05-11:10

WIDE-BANDGAP SEMICONDUCTORS IN SPACE: APPRECIATING THE BENEFITS BUT UNDERSTANDING THE RISKS

Jean-Marie Lauenstein, NASA/GSFC

Dr. Jean-Marie Lauenstein, NASA Goddard Space Flight Center, will present the radiation challenges of adopting wide-bandgap semiconductors for space applications. Wide-bandgap devices are attractive for space applications due to improved performance such as faster switching speeds, lower power losses, and their ability to operate at higher temperature as compared with their silicon counterparts. Their tolerance to total ionizing dose levels (> 100 krad(Si)) further enhances the desirability of these technologies. This short course will focus on silicon carbide and gallium nitride power rectifying, switching, and RF devices as these technologies are now readily available commercially. The radiation hardness assurance issues presented by the heavy-ion radiation environment will be discussed. Effects include both catastrophic failure and cumulative degradation, challenging the practice of risk avoidance through derating and possibly requiring new test method standards unless or until truly radiation-hardened devices become available. The course will conclude with a brief survey of additional wide-bandgap technologies such as diamond and gallium oxide.

11:10-12:15

LEADING-EDGE CMOS ADOPTED FOR NEW SPACE AND SAFETY AUTOMOTIVE PRODUCTS

Philippe Roche, STMicroelectronics

Dr. Philippe Roche, STMicroelectronics Technical Fellow and High-Reliability R&D Director, will discuss radiation challenges with fast adoption of sub-28nm technologies for large commercial space and safety critical automotive programs. The radiation paradigm for risk management has already changed with shorter development programs (<5 years to effective use in harsh environments) and stronger requirements for ultra-performance in space and for smart autonomous driving (<20% of perf. loss vs. commercial parts). That trend might modify the links between semiconductor companies, aerospace industries, agencies and laboratories (paces, methods, roadmaps). Radiation experts have also now to handle new failure modes in leading-edge technologies (FDSOI, FinFET, PCM, ToF imagers), stronger impacts of single event transients (in clock trees, varactors), stronger coupling effects across reliability fail modes and test methods (TID, BTI, TID post-OLT) and broader circuit functions to harden while not compromising performances (analog, RF, sensors, GHz processors). Additional complexities arise from ultra-low error counting during ground testing (with robust SOI) vs. non-negligible error rate potentially in very-large systems in field (B's of latches), as well as with larger amounts of radiation-tolerant circuits to produce (10's to 100K's parts) vs. growing variabilities to control (natively or with embedded monitors for self-adjustments).

12:15-13:45 **LUNCH at "Seasons"**

13:45-15:00

FROM COTS TO SPACE GRADE ELECTRONICS: WHICH IS THE BEST FOR YOUR MISSION?

Robert Baumann, Radiosity Services, LLC

After a brief overview of chronic radiation exposure effects (total ionizing dose and neutron/proton dose) and single-event effects (SEEs) that plague microelectronics in space, we consider unintentional radiation performance enhancements that have occurred as a natural consequence of technology scaling. "Natural" technology hardening is one of the reasons consumer-off-the-shelf (COTS) parts can, in some cases, be used in commercial space applications. We then provide a couple of real-world examples of commercial manufacturing variations and demonstrate how these impact microelectronic radiation sensitivity. We conclude with a discussion of the value of lot control, screening, and custom packaging methods and how their use improves product reliability while ensuring that radiation performance meets mission needs.

15:00-15:30 **BREAK**

15:30-16:45

NEXT GENERATION PROCESSING FOR SPACE SYSTEMS

Raphael Some, Jet Propulsion Laboratory

Future NASA missions will require autonomous capabilities and onboard science data processing in order to overcome communications limitations including link bandwidth and round trip speed of light delays. Future United States Air Force (USAF) missions have similar requirements. The joint NASA-USAF High Performance Space Computing project (HPSC) is developing a radiation hardened, fault tolerant, modular processing element, termed "The Chiplet" to address these future needs. The chiplet concept seeks to develop a family of processors and associated system software that enables "plug and play" (PnP) "system in a package" (SIP) implementations of advanced rad hard computing architectures at an affordable development and deployment cost. The HPSC Chiplet project is the first element of this processor family and, if successful, is expected to lead to the development of an "ecosystem" comprising additional heterogeneous processor chiplets, memories, network elements, operating systems, middleware libraries, software development systems, and the packaging technologies required to achieve 2.5 and 3D SIP space based computing and avionics systems. In this talk we will discuss the concepts behind the HPSC Chiplet, the Chiplet architecture and specifications, the envisioned HPSC ecosystem, current status and future plans.

16:45 END OF DAY

TECHNICAL PROGRAM

TUESDAY WEDNESDAY THURSDAY FRIDAY

18TH - 21ST OF SEPTEMBER 2018

LATE NEWS PAPERS

A limited number of late news papers will be accepted and included in the Poster or Data Workshop Sessions.

Christian Poivey
ESA
Technical Programme Chair

LATE NEWS

OPENS 18TH OF JUNE
CLOSES 13TH OF JULY

SESSION A

BASIC MECHANISMS

Marc Gaillardin
CEA

Dan Fleetwood
Vanderbilt

Co-Chairs

SESSION B

DEVICES AND INTEGRATED CIRCUITS

Karin Eriksson
RUAG

Michael McLain
Sandia National Labs

Co-Chairs

SESSION C

RADIATION HARDNESS ASSURANCE (RHA)

Samya Ahdjoudj
TASF

Michael Campola
NASA

Co-Chairs

SESSION D

ENVIRONMENTS

Athina Varotsou
TRAD

Paul O'Brien
Aerospace Corporation

Co-Chairs

SESSION E
PHOTONICS


Thierry Nuns
ONERA

Kelly Simmons-Potter
University of Arizona

Co-Chairs

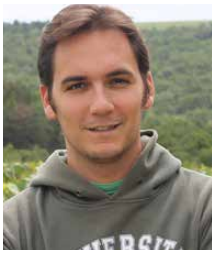
SESSION F
HARDENING-BY-DESIGN (HBD)


Gilles Gasiot
STMicroelectronics

Maxim Gorbunov
SRISA

Co-Chairs

SESSION G
SEE MECHANISMS




Ruben Garcia Alia
CERN

Satoshi Kuboyama
JAXA

Co-Chairs

SESSION H
SEE IN DEVICES AND INTEGRATED CIRCUITS


Hagen Schmidt
AIRBUS GMBH

Greg Allen
Jet Propulsion Lab.

Co-Chairs

SESSION I
SEE TRANSIENTS


Mirko Rostewitz
TESAT

Jeff Warner
Naval Research Laboratory

Co-Chairs

SESSION J
DOSIMETRY AND FACILITIES


Laurent Standaert
UCL

Mike Tostanoski
Radiation Test Solutions

Co-Chairs

SESSION K
ALTERNATIVE TESTING AND RHA METHODS


Francoise Bezerra
CNES

James Castillo
Space X

Co-Chairs

POSTER SESSION


Fredrik Sturesson
Cobham Gaisler

Dolores Black
Sandia National Labs

Co-Chairs

DATA WORKSHOP SESSION


Gonzalo Fernandez Romero
ALTER

Kirby Kruckmeyer
Texas Instruments

Co-Chairs

TUESDAY TECHNICAL PROGRAMME

CONGRESS HALL K2 & K3

08:15 **Conference Opening**

Robert Ecoffet, CNES, President of RADECS Association
Sandi Habinc, Cobham Gaisler, 2018 RADECS Chair
Greg Bagwell, Cobham plc, Executive Vice President
Anna Rathsman, Swedish National Space Agency, Director General

08:55 **Technical Program Introduction**

Christian Poivey, ESA, Technical Chair

09:05 Session H: SEE IN DEVICES AND ICS

Session Chairs: Hagen Schmidt (Airbus) & Greg Allen (Jet Propulsion Laboratory)

09:10 **H-1** **Atmospheric Neutron Soft Errors in 3D NAND Flash Memories**

M. Bagatin[1], S. Gerardin[1], A. Paccagnella[1], S. Beltrami[2], C. Cazzaniga[3], C. Frost[3]
1. University of Padova, Italy
2. Micron Technology, Italy
3. Rutherford Appleton Laboratory, United Kingdom

Neutron effects on 3D NAND Flash memories are investigated in terms of threshold voltage shifts and raw bit errors. Results are compared with heavy-ion data on 3D cells and with neutron data on planar cells.

09:25 **H-2** **SEU in SRAMs due to 2.5 MeV, 14 MeV and Reactor Neutrons**

X. Jin[1], C. Qi[1], S. Yang[1], R. Li[1], X. Bai[1], J. Li[1], C. Wang[1], Y. Liu[1]
1. Northwest Institute of Nuclear Technology, China

SEU in SRAMs are investigated due to 2.5 MeV, 14 MeV and reactor neutrons. The dependence of SEU sensitivity is studied with scaling of technologies, neutron energy, supply voltage, byte pattern and neutron fluence rate.

TUESDAY TECHNICAL PROGRAMME

09:40 H-3 **Similarity Analysis on Neutron- and Negative Muon-induced MCUs in 65-nm bulk SRAM**

W. Liao[1], M. Hashimoto[1], S. Manabe[2], S. Abe[3], Y. Watanabe[4]
1. Osaka University, Department of System Engineering, Japan
2. Kyushu University, Department of Advanced Energy Engineering Science, Japan
3. Japan Atomic Energy Agency, Japan

Similarity in voltage dependency, multiplicities and spatial patterns of negative muons- and neutron-induced MCUs were verified via irradiation using monoenergetic negative muons, quasi-mononenergetic and spallation neutrons in 65-nm bulk SRAM chips.

09:55 H-4 **Effects of Supply Voltage Variations on FinFET SEU Cross-Sections**

R. Harrington[1], J. Kauppila[1], J. Maharrey[1], T. Haeffner[1], A. Sternberg[1], E. Zhang[1], D. Ball[1], P. Nsengiyumva[1], B. Bhuva[1], L. Massengill[1]
1. Vanderbilt University, USA

At the 14/16nm FinFET node, experimental heavy-ion SE cross-section for a DFF along with 3D TCAD simulations are used to characterize factors affecting high-LET bias-dependent sensitive area for individual transistors.

10:10 H-5 **Single Event Latchup in a CMOS-based ASIC Using Heavy Ions, Laser Pulses and Coupled Simulation**

M. Mauguet[1], N. Andrianjohany[1], D. Lagarde[2], L. Gouyet[1], L. Azema[1], N. Chatry[1], X. Marie[2], D. Standarovski[3], R. Ecoffet[3]
1. TRAD, France
2. INSA Toulouse LPCNO, France
3. CNES, France

Single event latchup is investigated in CMOS-based test structures through measurements and cross-correlations using heavy-ion, laser pulses and coupled physical-electrical simulations.

PH-1 **Three Dimensional Heavy ion Induced SEE Mapping of Super- Junction power MOSFETs**

M. Gerold[1], G. Dollinger[2], M. Rüb[1], J. Reindl[2], A. Bergmaier[2]
1. Ernst Abbe Hochschule Jena, Germany
2. Universität der Bundeswehr München, LRT 2, Germany

A 3D heavy-ion induced SEE mapping of Power devices is presented. Goal is to find sensitive volumes and seperate effects which lead to failure. A possible link to cosmic radiation faillure and nowadays testing will be discussed.

TUESDAY TECHNICAL PROGRAMME

PH-2 High Current Event and Single Event Functional Interrupt in Non-Volatile Memories

J. Guillermin[1], B. Vandevelde[1], N. Chatry[1], F. Bezerra[2], D. Dangla[2], D. Standarovski[2], R. Ecoffet[2]
1. TRAD, France
2. CNES, France

Complex events such as HCE and SEFI were observed on non-volatile memories in a radiative environment. The objective was to characterize these complex events and to assess their impact on the operability of the devices.

PH-3 Estimation of Muon-Induced SEU Rates for 65 nm Bulk and UTBB-SOI SRAMs

S. Manabe[1], Y. Watanabe[1], L. Wang[2], M. Hashimoto[2], S. Abe[3]
1. Department of Advanced Energy Engineering Science, Kyushu University, Japan
2. Department of Information Systems Engineering, Osaka University, Japan
3. Nuclear Science and Engineering Center, Japan Atomic Energy Agency, Japan

We estimate negative and positive muon SEU rates for 65 nm bulk and SOTB SRAMs in terrestrial radiation environment. The result indicates that the negative muon SEU rate is significantly larger than the positive muon one.

PH-4 Atmospheric Real-Time Testing of Single-Bit and Multiple-Cell Upsets in 65 nm High-Speed Synchronous SRAM on Tibetan-Plateau

Z. Zhang[1], Z. Lei[1], T. Tong[2], X. Li[2], K. Xi[3], C. Peng[1], Q. Shi[1], Y. He[1], Y. Liu[1], Y. Huang[1], Y. En[1]
1. Science and Technology on Reliability Physics and Application of Electronic Component Laboratory, China Electronic Product Reliability and Environmental Testing Research Institute, China
2. Institute of High Energy Physics, Chinese Academy of Sciences, China
3. Institute of Microelectronics of Chinese Academy of Sciences, China

Real-time soft error rate of 65 nm QDR SRAM was measured on Tibetan Plateau with an altitude of 4300m. Error types including SBU, MCU, hard error, and burst errors were observed. Monte-Carlo simulations were further performed.

PH-5 Impact of Irradiation Side on Neutron-Induced Single Event Upsets in 65 nm Bulk SRAMs

S. Abe[1], W. Liao[2], S. Manabe[3], T. Sato[1], M. Hashimoto[2], Y. Watanabe[3]
1. Japan Atomic Energy Agency, Japan
2. Osaka University, Japan
3. Kyushu University, Japan

We simulate neutron-induced single event upsets for 65 nm bulk CMOS SRAMs using PHITS. The calculated soft error rate for sealant side irradiation is 30-50 % larger than that for board side irradiation.

TUESDAY TECHNICAL PROGRAMME

PH-6 Characteristics of Single Event Upsets induced by Heavy-Ions in 28nm UTBB-FDSOI SRAM with Several Types of Radiation Hardened Bit-cells

M. Bo[1], Y. Qingkui[1], S. Yi[1], L. Mengxin[2], G. Yong[3]
1. China Academy of Space Technology, China
2. Institute of Microelectronics of Chinese Academy of Sciences, China
3. China Aerospace Science and Technology Corporation, China

SEU in 28nm UTBB-FDSOI SRAM with several types of rad-had bt-cells are studied by heavy-ion irradiation test and TCAD simulation. Cross section and SEU rates in-orbit are showed for 3 harden bit-cells.

PH-7 Nonstationary Single Event Latch-up in CMOS ICs

D. Bobrovsky[1], A. Pechenkin[1], D. Savchenkov[1], A. Chumakov[1], G. Sorokoumov[1]
1. NRNU MEPHI/SPELS, Russian Federation

The paper presents experimental results about transient single event latch-up(SEL) in CMOS-ICs. A decrease of the voltage applied to n-p-n-p structure can be caused an additional current both in SEL and in IC dynamic mode.

PH-8 Assessment of Hardware-Implemented Support Vector Machine under Radiation Effects

M. Garay Trindade[1], A. Coelho[1], C. Valadares[1], R. Viera[1], S. Rey[2], B. Cheymol[2], M. Baylac[2], R. Velazco[1], R. Possamai Bastos[1]
1. Université Grenoble Alpes, Laboratoire TIMA, France
2. Université Grenoble Alpes, LPSC, France

This paper is the first to assess a FPGA-designed SVM architecture under radiation effects. Radiation test experiments were performed with a 14-MeV neutron generator. Results show that only 5% of the evaluated samples caused failure.

PH-9 Phenomenological Approach to Simulation of Proton Induced Upset Cross Sections in Commercial Memory Circuits

A. Galimov[1], G. Protopopov[2], G. Zebrev[3]
1. JSC NIIMA Progress, Russian Federation
2. Branch of JSC United rocket and space corporation - Institute of space device engineering, Russian Federation
3. Department of Micro- and Nanoelectronics of National Research Nuclear University MEPHI, Russian Federation

A procedure for proton-induced upset cross section simulation based on the limited heavy-ion experimental data is proposed. Validation and comparison to the existing techniques are provided as well.

TUESDAY TECHNICAL PROGRAMME

PH-1L **Analyzing the Influence of using Reconfiguration Memory Scrubber and Hardware Redundancy in a Radiation Hardened FPGA under Heavy Ions**

A. Oliveira[1], F. Benevenuti[1], L. Benites[1], G. Rodrigues[1], F. Kastensmidt[1], N. Added[2], V. Aguiar[2], N. Medina[2], M. Silveira[3], C. Debarge[4]

1. UFRGS, Brazil

2. USP, Brazil

3. FEI, Brazil

4. NanoXplore, France

This work investigates the influence of using the built-in configuration memory scrubber and triple modular hardware redundancy in the cross-section of a radiation-hardened SRAM-based FPGA from NanoXplore under heavy ions.

PH-2L **Single Event Effects Induced on Atom Switch based Field Programmable Gate Array**

K. Takeuchi[1], T. Sakamoto[2], M. Tada[2], A. Takeyama[3], T. Ohshima[3], S. Kuboyama[1], H. Shindo[1]

1. Japan Aerospace Exploration Agency, Japan

2. System Platform Research Laboratories, NEC Corp., Japan

3. National Institutes for Quantum and Radiological Science and Technology, Japan

The single event effects of Nano-Bridges (NBs) were investigated. NBs showed immunity to change the state. The CMOS layer caused transients and the NBs were not supposed to make any noise when the ions hit.

PH-3L **Impact of Neutron Irradiation on a 110-nm COTS Soft-Error free SRAM at Low Bias Voltage**

M. Rezaei[1], J. Fabero[1], H. Mecha[1], F. Franco[1], R. Solenne[2], B. Cheymol[2], M. Baylac[2], R. Velazco[3], J. Clemente[1]

1. Complutense University of Madrid, Spain

2. University of Grenoble-Alpes and CNRS/IN2P3, France

3. University of Grenoble-Alpes and CNRS, France

An experimental study on the sensitivity of a 110-nm A-LPSRAM to 14-MeV neutron radiation at low-bias voltage is presented. Isolated bitflips and clusters of bitflips may happen on this memory on bias voltages below 1.2~V.

10:25 - 10:55 BREAK - Exhibits Foyer and Hall H

TUESDAY TECHNICAL PROGRAMME

10:55 Session G: SEE MECHANISMS

Session Chairs: Ruben Garcia Alia (CERN) & Satoshi Kuboyama (JAXA)

11:00 G-1 Compact Modeling of Single Event Latchup of Integrated CMOS Circuit

A. Al Youssef[1], L. Artola[1], S. Ducret[2], G. Hubert[1]
1. ONERA, France
2. SOFRADIR, France

This paper presents a compact model of Latchup taking into account design and process dependence. This model was used to confirm the SEL robustness of DFFs used in readout circuit of infrared sensors developed by Sofradir.

11:15 G-2 Physical Analysis of Damage Sites Introduced by SEGR in Silicon Vertical Power MOSFETs and Implications for Post Gate-Stress Test

S. Kuboyama[1], E. Mizuta[1], Y. Nakata[1], H. Shindou[1]
1. JAXA, Japan

Damage sites introduced by SEGR in Silicon vertical power MOSFETs were physically analyzed to clarify their location and structures. The electrical properties attributable to the damage sites were successfully modeled by a device simulator.

11:30 G-3 Parasitic Bipolar Action in SiC Power MOSFETs Demonstrated by Two-Photon Laser Experiment

R. Johnson[1], A. Witulski[1], D. Ball[1], K. Galloway[1], A. Sternberg[1], E. Zhang[1], R. Reed[1], R. Schrimpf[1], JM. Lauenstein[2], A. Javanainen[3]
1. Vanderbilt University, USA
2. NASA/GSFC, USA
3. RADEF, Finland

A two-photon absorption technique is explored for SiC power MOSFETs. Experiments show variations in drain current relative to the position of the laser focus, which is explained by considering action of an intrinsic bipolar transistor.

11:45 G-4 The Effect of the Field Plate on Single Event Transients in AlGaN/GaN Schottky-Gate HEMTs

A. Khachatrian[1], S. Buchner[1], A. Koehler[1], D. Mcmorrow[1], S. Lalumondiere[2], E. Dillingham[2], J. Bonsall[2], A. Scofield[2], D. Brewe[3]
1. Naval Research Laboratory, USA
2. The Aerospace Corporation, USA
3. Argonne National Laboratory, USA

SETs are generated with focused pulsed X-rays in a GaN HEMT with and without field plate. SET shapes depend strongly on bias conditions, radiation strike location, X-ray photon energy, and presence of the field plate.

TUESDAY TECHNICAL PROGRAMME

PG-1 Two-Parameter Model for SEE Rate Estimation

A. Smolin[1], A. Sogoyan[1], A. Chumakov[1]
1. NRNU MEPhI, Russian Federation

The paper presents a new approach to SER estimation based on diffusion approximation of charge collection. The proposed model contains only two parameters uniquely determined from test data for normal incidence only.

PG-2 Neutron-Induced Multiple-Cell Upsets in 20 nm Bulk SRAMs: Angular Sensitivity and Impact of Multi-Well Potential Perturbation

T. Kato[1], T. Yamazaki[2], N. Saito[1], H. Matsuyama[1]
1. Socionext Inc., Japan
2. Fujitsu Laboratories Ltd., Japan

Neutron-induced multiple-cell upsets are studied in 20 nm SRAMs with varying incidence angle. Results show that multiple-bit upset rates increase at grazing incidence. Analyses of particular fail patterns reveal the effect of unbalanced well-potential perturbation.

PG-3 Circuit-Level Prediction of Charge Sharing Transients and Upsets

L. Ding[1], W. Chen[1], T. Wang[1], R. Chen[2], Y. Luo[1], F. Zhang[1], H. Sun[3], L. Chen[3]
1. State Key Laboratory of Intense Pulsed Radiation Simulation and Effect, Northwest Institute of Nuclear Technology, China, China
2. LIRMM, France
3. Beijing Microelectronics Technology Institute, China

A circuit-level approach is presented for simulating charge sharing effects in Single Event transients and upsets. Simulation results agree well with TCAD results, both on the pulse quenching in inverter chain and upsets in SRAM.

PG-4 About Physical Mechanisms Inducing Proton Single Event Upset in Integrated Memory Devices

P. Caron[1], C. Inguimbert[1], L. Artola[1], R. Ecoffet[2], F. Bezerra[2]
1. ONERA, France
2. CNES, France

Physical mechanisms induced by proton irradiation are analyzed as part of Single Event Effect studies. The importance of elastic contribution is pointed. Comparisons by a very simple approach with recent experimental measurements are made.

TUESDAY TECHNICAL PROGRAMME

PG-5 Evaluation of Heavy-Ion-Induced SEU Cross Sections of a 65 nm Thin BOX FD-SOI Flip-Flops Based on Stacked Inverter

J. Furuta[1], K. Kojima[1], K. Kazutoshi[1]
1. Kyoto Institute of Technology, Japan

We reveal that stack structure in FD-SOI becomes strong against soft error when impurity density in drain regions increases. Simulation results show the stacked FF with 5E20 impurity density is 4x stronger than with 2E20.

PG-1L Thermal Runaway in SiC Schottky Barrier Diodes Caused by Heavy Ions

S. Kuboyama[1], E. Mizuta[1], Y. Nakata[1], H. Shindou[1], A. Michez[2], J. Boch[2], F. Saigné[2], A. Touboul[2]
1. JAXA, Japan
2. Université de Montpellier, France

The thermal runaway in SiC Schottky barrier diodes caused by heavy ions was identified by a device simulator with parameters carefully extrapolated to the extended temperature range far exceeding the melting point of SiC

PG-2L Gate Leakage of SiC MOSFETs under Heavy Ion Irradiation

C. Martinella[1], A. Javanainen[2], T. Ziemann[3], R. Stark[4], U. Grossner[4], R. Garcia Alia[5], Y. Kadi[5]
1. CERN, University of Jyväskylä, Switzerland
2. RADEF, Finland
3. Advanced Power Semiconductor Laboratory Advanced Power Semiconductor Laboratory, ETH Zurich, Switzerland
4. Advanced Power Semiconductor Laboratory, ETH Zurich, Switzerland
5. CERN, Switzerland

Permanent leakage currents increase in SiC power MOSFETs under heavy-ion irradiation can be caused by induced charge under the gate oxide, generating prompt potential increase and gate leakage similar to SEGR in Si power devices.

12:00 - 13:30 LUNCH - SEASONS

INVITED TALK TUESDAY

- TUESDAY 18TH OF SEPTEMBER
- 13:30 - 14:20

FPGA MITIGATION STRATEGIES FOR CRITICAL SPACE APPLICATIONS

Technology is changing at a fast pace. Transistor geometries are getting smaller, voltage thresholds are getting lower, design complexity is exponentially increasing, and user options are expanding. Consequently, reliable insertion of error detection and correction (EDAC) circuitry has become relatively challenging. As a response, a variety of mitigation techniques are being evaluated. They range from weak EDAC circuits that save area and power to strong mitigation strategies that are a great expense to systems.

This presentation will focus on radiation induced susceptibilities of a variety of FPGA types and ASIC devices. In addition, the user will be provided information on applicable mitigation strategies per device.

Melanie Berg
AS&D Inc. in support of NASA/GSFC

Melanie Berg received her MS degree in Electrical Engineering from the University of Pittsburgh in 1990. She has 30 years of experience in the field of ASIC and FPGA application development. One of her more visible accomplishments was her role as a designer and verification engineer in the NASA sponsored New Horizons Pluto and Beyond Mission.

Ms. Berg is currently a member of the Radiation Effects and Analysis group at NASA Goddard Space Flight Center (GSFC). Her NASA/GSFC responsibilities include: developing flight designs, performing design reviews, investigating FPGA/ASIC mitigation strategies, and calculating mission reliability predictions.

Ms. Berg has published and presented several papers concerning such topics as: Reliable Synchronous Design Methodology, Robust Verification Techniques, Mitigation Strategies for Critical Circuitry, Survivability Predictions, Hardness Assurance for Space Flight Systems, and ASIC/FPGA Trust/Security Schemes.

TUESDAY TECHNICAL PROGRAMME

14:20 Session I: SEE TRANSIENTS

Session Chairs: Mirko Rostewitz (TESAT) & Jeffrey Warner (NRL)

14:25 I-1 Analysis of Nanowire Field Effect Transistors SET Response: Geometrical Issues

M. Gaillardin[1], M. Raine[1], M. Martinez[1], O. Duhamel[1], R. Jonathan[1], T. Lagutere[1], C. Marcandella[1], P. Paillet[1], N. Richard[1], M. Vinet[1], F. Andrieu[1], S. Barraud[1]

1. CEA, France

The SET response of SOI tri-gate silicon nanowires is investigated using direct measurements of current transients. The impact of the nanowire geometry is discussed using the major SET characteristics: duration, amplitude and integrated value.

14:40 I-2 Single-Event Transients in a PIN Photodiode and a Single-Photon Avalanche Diode Integrated in 0.35µm CMOS

M. Hofbauer[1], B. Steindl[1], K. Schneider-hornstein[1], B. Goll[1], K. Voss[2], H. Zimmermann[1]

1. Vienna University of Technology (TU Wien), Austria

2. GSI Helmholtzzentrum für Schwerionenforschung GmbH, Germany

Single-event transients in a PIN photodiode and a single-photon avalanche diode (SPAD) are investigated. Mainly the epitaxial region defines the collected charge. High current peaks at the SPAD output necessitate precautions in the quencher design.

PI-1 Experimental Study of Single Event Transient Characteristics on PDSOI CMOS Inverter Chain by Pulsed Laser Irradiation

M. Bo[1], Y. Qingkui[1]

1. China Academy of Space Technology, China

SET in a 0.18 µm PDSOI CMOS inverter chain are studied by pulsed laser. The SET pulses broaden with the propagation of the inverter chain. The threshold voltage hysteresis is the reason for pulses broadening.

PI-2 Impact of Complex-Logic Cell Layout on the Single-Event Transient Sensitivity

Y. Aguiar[1], F. Wrobel[1], J. Autran[2], P. Leroux[3], F. Saigné[1], A. Touboul[1], V. Pouget[1]

1. Université de Montpellier - IES/RADIAC, France

2. Institut Materiaux Microelectronique Nanoscience de Provence, Aix-Marseille University, France

3. Advanced Integrated Sensing Lab, KU Leuven University, Belgium

This paper evaluates the impact of Complex-Logic gate to SET sensitivity compared to basic logic gates. Results show only a slight reduction in the drain sensitive area and the suppression of logical masking are observed.

TUESDAY TECHNICAL PROGRAMME

PI-3 A Zero-Timing Overhead SET Mitigation Approach for Flash-based FPGAs

S. Azimi[1], B. Du[1], L. Sterpone[1]
1. Politecnico di Torino, Italy

This work presents a SET mitigation solution for Flash-based FPGA without introducing performance degradation by adding charge-sharing structures. The solution is verified using SET in-circuit fault injection on several benchmark circuits.

PI-4 Observation of Heavy-Ion Induced ASET and Charge Sharing on a Full-Custom CMOS OpAmp

A. Fontana[1], S. Pazos[2], F. Aguirre[2], N. Vega[3], N. Müller[3], E. De La Fourniere[3], F. Silveira[4], M. Debray[3], F. Palumbo[2]
1. UTN-FRBA, Argentina
2. CONICET / CNEA - GAIyANN / UTN-FRBA, Argentina
3. GIyA-CAC-CNEA, Argentina
4. UdeLaR - Facultad de Ingeniería - IIE, Uruguay

ASET in Custom OpAmp is observed experimentally using Heavy Ion Microbeam. Pulse quenching due to charge sharing in paired transistors shape the output transients. SPICE simulations and linear models are used to describe this effect.

PI-5 System Level Characterization, Modeling, and Probabilistic Formal Analysis of LEON3 Vulnerability to Transient Faults

G. Bany Hamad[1], M. Ammar[1], O. Ait Mohamed[1], Y. Savaria[2]
1. Concordia University, Canada
2. Polytechnique Montreal, Canada

This paper presents a continuous-time Markov chain modeling, analysis, and estimation of LEON3 processor vulnerability to Single Event Upsets (SEUs). At the system level, proposed technique provides new insights into SEU propagation probabilities and latency.

PI-6 Single-event Double Transients in Inverter Chains Designed with Different Transistor Widths

W. Zhao[1], R. Chen[2]
1. Xi'an Jiaotong University, China
2. Tsinghua University, France

Single-event double transients (SEDTs) in 65 nm bulk CMOS inverter chains designed with different transistor widths are measured under pulsed laser irradiation. The mechanism responsible for the SEDTs production is investigated by three-dimensional TCAD simulation.

14:55 – 15:25 BREAK – Exhibits Foyer and Hall H

TUESDAY TECHNICAL PROGRAMME

15:25 Session F: HARDENING-BY-DESIGN (HBD)

Session Chairs: Gilles Gasiot (STMicroelectronics) & Maxim Gorbunov (SRISA)

15:30 F-1 Fault-Tolerant Nanosatellite Computing on a Budget

C. Fuchs[1], N. Murillo[2], A. Plaat[3], E. Van der Kouwe[3], T. Stefanov[3]

1. Leiden Institute of Advanced Computer Science, Leiden Observatory, Leiden University, Netherlands

2. Leiden Observatory, Leiden University, Netherlands

3. Leiden Institute of Advanced Computer Science, Leiden University, Netherlands

A on-board-computer architecture using a non-standard approach towards fault-tolerant computing for miniaturized satellites, with fault-injection results. We utilize FDIR measures across the embedded stack to achieve FT with COTS FPGA, library IP, and commodity processor-cores.

15:45 F-2 Dynamic Heavy Ion SEE Testing of Microsemi RTG4 FLASH-based FPGA Embedding a Cobham Gaisler LEON4FT-based SoC

L. Tambara[1], J. Jalle[1], J. Andersson[1], F. Sturesson[1], R. Sharp[2]

1. Cobham Gaisler AB, Sweden

2. Cobham RAD Solutions, United Kingdom

This work performs a dynamic test of RTG4 FPGA embedding a LEON4FT-based SoC under heavy ion-induced single event effects. Results obtained demonstrate the effectiveness of the fault-tolerant techniques adopted at both device and design levels.

16:00 F-3 A SEE-Immune Phase Frequency Detector with Double Loop Self-Sampling Technology for Clock Data Recovery

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

1. National University of Defense Technology, China

A layout hardened phase frequency detector with the double loop self-sampling technology is proposed for clock and data recovery. It maintains the correct state and eliminate the error state. Laser experiments show good SEE immunity

16:15 F-4 Direct Experimental Performance Comparison of Two Microprocessors for the Efficiency Evaluation of Single Event Effects Mitigation Techniques

M. Gorbunov[1], A. Antonov[1], P. Monakhov[1], V. Anashin[2], A. Klyayn[2], K. Alexandr[2], E. Imametdinov[1], E. Marina[1]

1. SRISA, Russian Federation

2. Branch of JSC “United Rocket and Space Corporation” - “Institute of Space Device Engineering”, Russian Federation

We present the direct experimental vulnerability comparison of two microprocessor designs with different SEE mitigation techniques at different heavy-ion fluxes. The trade-off between the performance, fault-tolerance and power consumption is considered.

TUESDAY TECHNICAL PROGRAMME

16:30 F-5 Approximate TMR Based on Successive Approximation to Protect Against Multiple Bit Upset in Microprocessors

G. Rodrigues[1], F. Lima Kastensmidt[1], V. Pouget[2], A. Bosio[3]
1. UFRGS, Brazil
2. IES-CNRS, France
3. LIRMM-CNRS, France

This work proposes an Approximate TMR (ATMR) exploiting successive approximation. The microprocessor is exposed to laser pulses at the data cache memory. ATMR decreases time overhead compared to classical TMR keeping an acceptable fault masking.

PF-1 Error Detection through Trace Infrastructure in ARM Microprocessors

M. Peña-Fernandez[1], A. Lindoso[2], L. Entrena[2], M. Garcia-valderas[2], Y. Morilla[3], P. Martin-Holgado[3]
1. Arquimea Ingeniería S.L.U., Spain
2. University Carlos III Madrid, Spain
3. Centro Nacional de Aceleradores (CNA), Spain

This work presents a complete solution for error detection in ARM microprocessors based on the use of the trace infrastructure. The proposed approach is able to detect both control-flow and data-flow errors.

PF-2 A CMOS SET Hardened Phase-Locked Loop with Perturbation Compensated Charge Pump & Interleaved VCO

Y. Wei[1], H. Yang[1], T. Li[2], Z. Chen[2]
1. Institute of Electronics, Chinese Academy of Sciences
2. University of Chinese Academy of Sciences, China

A Single-Event-Hardened PLL in 0.13-μm CMOS technology is presented. The PLL employs a novel VCO hardened through adopting an interleaved architecture. Current Limiter circuit Controlled by Comparators (CLCBC) is designed to improve SET tolerance of the CP.

PF-3 Register File Criticality and Selective Hardening for Graphics Processing Units

F. Santos[1], M. Gonçalves[1], J. Azambuja[1], P. Rech[1]
1. UFRGS, Brazil

We investigate the probability for a fault in a register to affect GPU computation. We propose a selective hardening strategy to efficiently improve GPUs reliability by protecting only the most critical registers.

TUESDAY TECHNICAL PROGRAMME

PF-4 THERMIC: a Hardened Temperature Controller for Regenerating CMOS Circuits Exposed to Ionizing Radiation

J. Armani[1], A. Urena Acuna[1], P. Dollfus[2], M. Slimani[1]
1. CEA LIST, France
2. CNRS, France

A Radiation hardened temperature controller intended to regenerate CMOS circuits has been designed using commercial off-the-shelf components. Tested with Co-60 gamma rays, it has shown a radiation hardness greater than 65 kGy.

PF-5 Evaluation of PicoSkyFT Space-rated Microcontroller Softcore with High Energy Proton Beam

M. Gomboc[1], D. Gačnik[1], I. Kramberger[2]
1. SkyLabs d.o.o., Slovenia
2. University of Maribor, Slovenia

An overview of the radiation testing results of the PicoSkyFT soft-core processor, a 8/16-bit fault-tolerant (FT) core for embedded systems, targeting smaller cost effective and low power Field-programmable Gate Arrays (FPGAs).

PF-6 Study of VCO Delay Cell Topologies in a 3-stage DR-VCO for Radiation Hardening

K. Ka[1]
1. SSN Engineering College, India

Wide tuning range delay cell based 3-stage DR-VCO designed using 90nm CMOS process operating at 2.6 GHz frequency shows better SET tolerance compared to diode-connected, triode load and Maneatis load delay cell topologies.

PF-7 Realistic Radiation and PVTA Fault Simulation for OFDM Synchronization

K. Niederkleine[1], T. Hillebrand[1], S. Paul[1]
1. University of Bremen, Institute of Electrodynamics and Microelectronics, Germany

Semiconductor design for radiation environments usualy applies worst-case estimations to calculate the needs for reliable operation. The ability to simulate components for any mission is an advantage in this process and helps to save costs.

TUESDAY TECHNICAL PROGRAMME

PF-1L **Radiation-Hardened Structure to Reduce Sensitive Range of a Stacked Structure for FDSOI**

K. Yamada[1], M. Ebara[1], K. Kojima[1], Y. Tsukita[1], J. Furuta[1], K. Kobayashi[1]
1. Kyoto Institute of Technology, Japan

We propose a radiation-hardened structure for a stacked structure. Stacked structure has sensitive against heavy-ion with high energy. Proposed design maintains higher radiation-hardness up to 67.2 MeV-cm^2/mg than the stacked structure even at high angles.

PF-2L **Automatic Compiler-Guided Reliability Improvement of Embedded Processors under Proton Irradiation**

A. Serrano-Cases[1], Y. Morilla[2], P. Martín-Holgado[3], S. Cuenca-Asensi[4], A. Martínez-Álvarez[4]
1. University of Alicante, Spain
2. Centro Nacional de Aceleradores-Universidad de Sevilla, Spain
3. Centro Nacional de Aceleradores-Universidad de Sevilla, Spain
4. Universidad de Alicante, Spain

We investigate the automatic reliability improvement of software when applying non-intrusive softcomputing techniques to tune the compilation process. Our fault injection results are correlated with different protons experiments. ARM-based SoCs have been used to assess our technique

PF-3L **Analyzing Different Granularity Levels of TMR Applied Automatically on ARM Cortex-M0 in SRAM-based FPGA under Heavy Ions**

F. Lima Kastensmidt[1], L. Benites[1], F. Benevenuti[1]
1. UFRGS, Brazil

This work presents a tool that automatically implement and verify different approaches of triple modular redundancy (TMR) in a design, case-study ARM-M0 in Xilinx FPGA under heavy ions. Comparisons between TMR granularities and scrubbing.

16:45 **End of Tuesday Sessions**

17:30 – 19:00 EXHIBIT RECEPTION – Foyer and Hall H

WEDNESDAY TECHNICAL PROGRAMME

CONGRESS HALL K2 & K3

08:20 **RADECS Announcements** – *Sandi Habinc, Cobham Gaisler, 2018 RADECS Chair*

08:30 Session D: ENVIRONMENTS

Session Chairs:
Athina Varotsou (TRAD) & Paul O'Brien (The Aerospace Corporation)

08:35 **D-1** **A New Model for the Plasma Particles Fluxes (Part of GREEN Model)**

A. Sicard[1], D. Boscher[1], D. Lazaro[1], D. Standarovski[2], R. Ecoffet[2]
1. ONERA, France
2. CNES, France

A new specification model of low energy particles fluxes has been developed at ONERA and provides MLT dependent particles fluxes between L=2 and L=10 for energies between 0.19 keV and few 10s of keV.

08:50 **D-2** **Data Exploitation of New Galileo Environmental Monitoring Units: Initial Results**

I. Sandberg[1], S. Aminalragia-Giamini[1], G. Provatas[1], A. Hands[2], K. Ryden[2], D. Heynderickx[3], T. Antonis[1], C. Papadimitriou[1], T. Nagatsuma[4], H. Evans[5], D. Rodgers[5]
1. Space Applications & Research Consultancy (SPARC), Greece
2. Surrey University, United Kingdom
3. DH Consultancy, Belgium
4. National Institute of Information and Communications Technology, Japan
5. ESA, Netherlands

In the Galileo constellation, two Environmental Monitoring Units (EMU) are flying. The calibration of EMU sensors and application of data unfolding methods lead to the derivation of qualitative charged particle fluxes to characterize MEO environment.

09:05 **D-3** **Impact of the Earth Magnetic Field Secular Drift on the Low Altitude Proton Radiation Belt from Years 1900 to 2050**

S. Bourdarie[1], A. Fournier[2], A. Sicard[1], G. Hulot[2], D. Standarovski[3], R. Ecoffet[3]
1. ONERA, France
2. IPGP, France
3. CNES, France

The purpose of this paper is to extend the OPAL model capabilities by introducing a prediction of the Earth magnetic field model up to year 2050. Impact on low altitude spacecraft radiation specification is investigated.

WEDNESDAY TECHNICAL PROGRAMME

09:20 D-4 Roadmaps for Space Environments and Effects Research and Development

S. Huston[1], P. O'Brien[2], H. Evans[3], J. Likar[4], M. Xapsos[5]
1. Confluence Analytics, USA
2. The Aerospace Corporation, USA
3. ESA, Netherlands
4. JHU APL, USA
5. NASA, USA

A workshop held in September 2017 brought together researchers from the space physics and spacecraft engineering communities in order to develop roadmaps for improved space radiation environment models and data.

09:35 D-5 Using Science Imagers as Sensors of Jovian Energetic Electrons

A. Carlton[1], I. Jun[2], W. Kim[2], M. De Soria-Santacruz[2], T. Sevigny[1], K. Cahoy[1]
1. Massachusetts Institute of Technology, USA
2. NASA JPL, USA

We develop a technique to quantitatively characterize the Jupiter high-energy electron environment using two Galileo science imagers and particle transport simulations in Geant4. We find agreement with the energetic particle detector > 11 MeV MeV integral flux.

PD-1 Anisotropy in Radiation Belts seen by the A-Head of ICARE-NG

M. Ruffenach[1], S. Bourdarie[1], J. Mekki[2], D. Falguere[1], J. Vaille[3]
1. ONERA - The French Aerospace Lab, France
2. CNES, France
3. Université de Montpellier-IES, France

We investigate on the anisotropy seen by the A-head of ICARE-NG for protons in coincidence mode from Monte-Carlo simulations. We compare GEANT4 and MCNPX for protons. Then, we investigate on the anisotropy at low energy.

PD-2 Issues and Special Aspects of Electronic Component Flight Test Results Usage for Radiation Hardness Confirmation

G. Protopopov[1], V. Anashin[1], N. Balykina[1], A. Repin[2], V. Denisova[2], A. Tsurgaev[2]
1. Branch of JSC URSC - ISDE, Russian Federation
2. FSBI "Fedorov Institute of Applied Geophysics", Russian Federation

Issues of electronic component flight test results usage are shown in the paper using onboard measurements of space radiation environments in different orbits.

09:50 - 10:20 BREAK – Exhibits Foyer and Hall H

WEDNESDAY TECHNICAL PROGRAMME

10:20 Session C: RADIATION HARDNESS ASSURANCE (RHA)

Session Chairs:
Samya Ahdjoudj (Thales Alenia Space) & Michael Campola (NASA/GSFC)

10:25 C-1 Machine Learning Techniques for Mitigating Sensor Ionizing Dose Failures in Robotic Systems

L. Adams[1], W. Arthur[1], E. Barth[1], R. Reed[1], J. Howard[1], R. Peters[1], R. Schrimpf[1]
1. Vanderbilt University, USA

Machine learning is used to extend performance in robotic systems suffering from TID sensor failure. The method is implemented on a robotic manipulator to demonstrate reconstruction of encoder signals submitted to simulated radiation effects

10:40 C-2 Study of the Impact of the LHC Radiation Environments on the Synergistic Displacement Damage and Ionizing Dose Effect on Electronic Components

R. Ferraro[1], S. Danzeca[1], L. Dilillo[2], C. Cangialosi[1], R. Garcia Alia[1], F. Cerutti[1], A. Tsinganis[1], A. Masi[1], M. Brugger[1]
1. CERN, Switzerland
2. LIRMM, France

This paper presents a study of the impact of the LHC's radiations levels on the qualification process of synergistic effects sensitive components. The degree of synergistic interactions is investigated with tests under different TID-DD rates.

10:55 C-3 Risk Assessment of Electron Induced SEE during the JUICE Mission

N. Sukhaseum[1], B. Vandevelde[1], L. Salvy[1], G. Augustin[1], A. Varotsou[1], N. Chatry[1], M. Tali[2], F. Bezerra[3], R. Ecoffet[3], C. Boatella Polo[4]
1. TRAD, France
2. CERN, Switzerland
3. CNES, France
4. ESA, Netherlands

The SEU sensitivity of SRAM memories was studied under electrons, protons and heavy ions. The contribution of electrons and proton direct ionization to the SEU rate was assessed for the case of the JUICE mission.

WEDNESDAY TECHNICAL PROGRAMME

11:10 C-4 Identification of Stable Irradiation-Induced-Defects using Low Frequency Noise Spectroscopy

R. Coq Germanicus[1], B. Cretu[2], A. Touboul[3], C. Grygiel[4], F. Bezerra[5], G. Rolland[5], F. Lallemand[6], C. Bunel[6], P. Descamps[7]

1. CRISMAT UNICAEN ENSICAEN, France
2. GREYC/ENSICAEN, France
3. IES, University Montpellier, France
4. CIMAP, CEA-CNRS-ENSICAEN-UNICAEN, France
5. CNES, France
6. Murata Integrated Passive Solutions, France
7. UNIROUEN, ESIGELEC, IRSEEM, France

We demonstrate the capability to detect microscopic defects with a method based on low frequency noise spectroscopy. Results for a silicon test vehicle irradiated with proton fluence equivalent one year of space mission are reported.

PC-1 Worst-Case Test Vectors for FPGA Sequential Circuits Exposed to Total Dose

A. Abou-Auf[1], M. Abdel-Aziz[2], M. Abdelwahab[1]

1. The American University in Cairo, Egypt
2. Cairo University, Egypt

We introduce a novel methodology for identifying worst-test vectors for delay failures induced by total dose in sequential circuits implemented in FPGAs. We verified this methodology experimentally using Microsemi ProASiC3 FPGA's and Cobalt 60 facility.

PC-2 Single Event Effect Prediction Early in the Design Phase and Latchup Case Study on ASIC

N. Andrianjohany[1], G. Augustin[1], K. Coulié[2], L. Gouyet[1], W. Rahajandraibe[2], N. Chatry[1], D. Standarovski[3], R. Ecoffet[3]

1. TRAD, France
2. Im2np, France
3. CNES, France

The aim of this study is to bring contributions to the understanding of the prediction issues. We propose a feasibility study of the simulation methods integrated to the circuit development flow with experimental verifications.

PC-3 TID and Internal Charging Evaluation for Jupiter Orbiting Mission

J. Wang[1], Q. Zhang[1], Y. Zheng[1], D. Tian[1]

1. Beijing Institute of Spacecraft System Engineering, China

The evaluation methods of total dose and internal charging in Jupiter mission are developed. We considered the variability of environment and failure dose of devices, shielding effects of different materials, and electron depth-dose curves algorithm.

WEDNESDAY TECHNICAL PROGRAMME

PC-4 Simulation of Transistor-Level Radiation Effects On Board-Level Performance Parameters

W. Arthur1, N. Mahadevan[1], J. Kauppila[1], G. Karsai[1], P. Adell[2], H. Schone[2], R. Schrimpf[1]

1. Vanderbilt University, USA

2. Jet Propulsion Laboratory, USA

Impacts of transistor-level radiation effects from total ionizing dose are simulated on system-level parameters of a command and data handling board for deep-space CubeSats. Simulation of a temperature control loop shows TID changes temperature regulation significantly.

PC-5 Uncertainty Evaluation of the Displacement Damage Equivalent Fluence from Different Facilities and Devices

D. Lambert[1], O. Riant[1], D. Thouvenot[1], E. Feuilloley[1], T. Colladant[2]

1. Nucletudes, France

2. DGA, France

An uncertainty evaluation of the Displacement Damage Equivalent Fluence (DDEF) is presented for different neutron and proton facilities and devices.

PC-6 Using of Temperature-Switching Approach to Evaluate Low-Dose-Rate Ionizing Radiation Effects on SET in Linear Bipolar Circuits

S. Yao[1]

1. XTIPC, CAS, China

A temperature-switching approach is used to investigate TID-SET synergy effects in bipolar circuits. The influence of TID on SET is found to be similar when the circuits irradiated with temperature-switching approach or with low-dose-rate.

PC-7 Latent Single-Event Latchup-Induced damage in Complementary Metal-Oxide-Semiconductor Integrated Circuits

A. Tsirkov[1], D. Bobrovsky[1], A. Pechenkin[1], A. Chumakov[1], G. Sorokoumov[1]

1. NRNU MEPHI/SPELS, Russian Federation

Experimental results are presented for different CMOS ICs, evidencing latent damage induced by single event latch-up. Additive and non-additive destructive effects are analyzed.

11:25 - 12:00 INVITED TALK - *Elsa Modin, Hasselblad Foundation*
The Life of Erna and Victor Hasselblad and the Bird Camera that Flew to the Moon.

12:00 – 13:30 LUNCH Women In Engineering
Beatriz Sanchez, OHB & Dr. Kelly Simmons-Potter, Uni. of Arizona

INVITED TALK WEDNESDAY

- WEDNESDAY 19TH OF SEPTEMBER
- 11:25 - 12:00

THE LIFE OF ERNA AND VICTOR HASSELBLAD AND THE BIRD CAMERA THAT FLEW TO THE MOON

The pictures from Apollo 11 and the first moon landing with the astronauts Neil Armstrong, Buzz Aldrin and Michael Collins are some of the most iconic in the history of photography. The event was documented by a Swedish-made Hasselblad camera.

The Hasselblads interest in photography began at the end of the 19th century when Victor Hasselblad's grandfather met Kodak's founder George Eastman at a photography fair and got sole rights in Sweden on the sale of Kodak products.

Victor Hasselblad further developed the photographic business and, together with his wife Erna started a photography company in Gothenburg in 1937.

The couple had a great interest in nature and Victor was a devoted bird photographer. It was his need for a handy quality camera that led to the development of Swedish Aerial Surveillance Camera during the Second World War, and in 1948 to the civilian Hasselblad camera - the world's first medium format camera that was adaptable to the photographer's needs. These characteristics were important when NASA chose to use Hasselblad camera in the beginning of the 1960s.

Elsa Modin
Hasselblad Foundation

Elsa Modin has been working at the Erna and Victor Hasselblad Foundation since 1999. She is the chief librarian at the Foundation and responsible for The Erna and Victor Hasselblad's Historical Archives. The library is the largest photo library in Sweden with 16,000 volumes and a magazine collection.

The Erna and Victor Hasselblad's Historical Archives contains cameras, documents and photographs from the history of the couple and the Hasselblad camera.

RADECS GOTHENBURG 16th - 21st SEPTEMBER 2018 MMXVIII

Women In Engineering Lunch

- WEDNESDAY 19TH OF SEPT.
- 12:00 - 13:30
- LOCATION: "Bryggan"

Beatriz Sanchez, *OHB*

and

Dr. Kelly Simmons-Potter,

University of Arizona

YOU MUST HAVE A TICKET TO ATTEND!

Beatriz Sanchez

OHB

Beatriz Sanchez is EEE Components and Radiation Hardness Assurance Engineer at OHB, in Bremen, Germany, in the Design Assurance Quality department.

She graduated in Physics in 2006 in Complutense University of Madrid, specialising in Materials Physics. In addition, she completed two MSc, one MSc in Nanotechnology in Complutense University of Madrid, and another MSc in Renewable Energy Systems Technology in Loughborough University in the UK.

Creating a strong background in Semiconductors and Solid State Physics, Beatriz has continuously been developing several years of professional experience in Spain, England and Germany, working in the field of Touch Technology for smartphones, tablets and computers; contributing to the design and development of new technologies, as for High Density Interconnect panels and interconnections in Solar Cells; and finally gaining a large and significant expertise during the last years in EEE components and Radiation Hardness Assurance in Space.

WOMEN IN SCIENCE AND ENGINEERING

Beatriz will present a brief summary of a few of the most relevant women who contributed to Science and Engineering during the history, some interesting statistics, and she will also talk and share her personal experience as a woman engineer, opening a discussion on how to create a difference.

Women In Engineering Lunch

- WEDNESDAY 19TH OF SEPT.
- 12:00 - 13:30
- LOCATION: "Bryggan"

Beatriz Sanchez, *OHB*

Dr. Kelly Simmons-Potter, *University of Arizona*

FOOD, ENERGY, WATER SUSTAINABILITY FOR INDIGENOUS COMMUNITIES: IMPACTS ON LOCAL COMMUNITIES.

Approximately 35% of homes in the Navajo Nation - the largest Native American tribe in the United States – are not connected to central power or drinking water systems. To address this issue, the National Science Foundation Research Traineeship (NRT) award to the University of Arizona, in partnership with Diné College and Navajo Technical University, is developing a diverse STEM workforce with intercultural awareness and multidisciplinary knowledge/skills for high priority research in sustainable food, energy, and water systems (FEWS).

The project offers a pathway to efficient, economically achievable, dispersed water purification and greenhouse systems powered by solar energy. The research conducted in this program has the potential for relevant translation to many remote regions of the world, significantly impacting indigenous and gendered populations.

YOU MUST HAVE A TICKET TO ATTEND!

Dr. Kelly Simmons-Potter
University of Arizona

Dr. Kelly Simmons-Potter is a Professor of Electrical and Computer Engineering, Optical Sciences, and Materials Science and Engineering at the University of Arizona in Tucson, AZ.

Dr. Simmons-Potter received her B.S. in Physics from Florida State University and her M.S. and Ph.D. in Optical Sciences from the University of Arizona. In addition, she served as a research associate at the Massachusetts Institute of Technology, the Universite de Rennes (France), and the Naval Research Laboratories between 1985 and 1990. Dr. Simmons-Potter spent nearly 10 years at Sandia National Laboratories, from 1994 to 2003, ending in the position of Principal Member of Technical Staff and Project Manager for Advanced Optical Technologies.

In 2003, she left Sandia Labs to return to academia at the U.A. Dr. Simmons-Potter is a Fellow of the American Ceramic Society, Director of the Arizona Research Institute for Solar Energy (AzRISE), and is the current Vice-Chair of the Hardened Electronics and Radiation Technology (HEART) Society. She is the co-author of three text books in the field of optics, has authored more than 90 peer-reviewed journal and conference publications, has delivered more than 100 scholarly presentations, and holds several patents. Her research focuses on radiation-hardened optics, photosensitive materials and devices, and sustainable energy systems.

In addition, Dr. Simmons-Potter served as Advisor to the U.A. Society of Women Engineers student chapter for 8 years and is currently co-developing an initiative at the U.A. to address food, energy, and water challenges faced by indigenous communities under an NSF NRT grant.

WEDNESDAY TECHNICAL PROGRAMME

13:30 Session K: ALTERNATIVE TESTING AND RHA METHODS

Session Chairs:
Francoise Bezerra (CNES) & James Castillo (SpaceX)

13:35 K-1 Comparison Between In-Flight SEL Measurement and Ground Estimation Using Different Facilities

N. Kerboub[1], R. Garcia Alia[1], J. Mekki[2], F. Bezerra[2], A. Monteuuis[1], P. Fernandez Martinez[1], S. Danzeca[1], M. Brugger[1], D. Standarovski[2], J. Rauch[2]
1. CERN, Switzerland
2. CNES, France

This paper describes a comparison between in-orbit SEE rate measurement and estimation using mono-energetic and mixed field facilities SEE rate calculation. A comparison of both estimation with the in-flight measurement has been carried out.

13:50 K-2 Radiation Hardness Assurance for a COTS-based Power Converter for Accelerator Applications

J. Braun[1], J. Chanois[1], V. Herrero[1], L. Foro[1], Y. Thurel[1]
1. CERN, Switzerland

This paper presents the pragmatic strategy used for the RHA of CERN Power Converter. An extensive and succesful test campaign on COTS have been performed as well as a system level testing of an entire sub-converter.

PK-1 DC-DC Converters SEE Testing Procedure

T. Maksimenko1, A. Koziukov1, S. Iakovlev1, D. Aleksandrov1
1. Branch of Joint - Stock Company "United Rocket and Space Corporation"- "Institute of Space Device Engineering", Russian Federation

This paper presents the analysis of possible methodologies for destructive failure and single event effect testing of DC-DC converters, which are worked out on five types of different power converters.

14:05 POSTER SESSION INTRODUCTION

Poster Chairs:
Dolores Black (Sandia National Labs) & Fredrik Sturesson (Cobham Gaisler)

14:10 POSTER SESSION – Hall H - *Break in Foyer and Hall H during Poster Session*

16:40 End of Wednesday Sessions

17:00 FOOTBALL TOURNAMENT & ORIENTEERING

See detailed information in the Social Activities section.

THURSDAY TECHNICAL PROGRAMME

CONGRESS HALL K2 & K3

08:10 **RADECS Announcements** – *Sandi Habinc, Cobham Gaisler, 2018 RADECS Chair*

08:20 Session E: PHOTONICS

Session Chairs:
Thierry Nuns (ONERA) & Kelly Simmons-Potter (University of Arizona)

08:25 E-1 About the Scatter of Displacement Damage and its Consequence on the NIEL Scaling Approach

C. Inguimbert[1], T. Nuns[1]
1. ONERA, France

Deviations from the NIEL scaling laws, observed for high energy protons, are analyzed according to statistical fluctuations within the deposited damage energy. The reliability of the NIEL scaling approach is discussed.

08:40 E-2 Radiation Effects on High-Speed InGaAs Photodiodes

L. Olantera[1], F. Bottom[1], S. Detraz[1], A. Kraxner[1], P. Moreira[1], M. Menouni[2], C. Scarcella[1], C. Sigaud[1], C. Soos[1], J. Troska[1], F. Vasey[1]
1. CERN, Switzerland
2. CPPM, France

InGaAs photodiodes were exposed to high fluence radiation and a strong sensitivity penalty due to increased capacitance was observed. This penalty is reported for the first time and has significant implications on radiation-tolerant optical links.

08:55 E-3 Long-Term Degradation Study of CMOS SPADs in Space Radiation Environment

M. Campajola[1], F. Di Capua[1], D. Fiore[2], C. Nappi[3], E. Sarnelli[3], L. Gasparini[4]
1. University of Naples "Federico II" and INFN, Italy
2. Università della Calabria and INFN, Italy
3. CNR-SPIN Institute and INFN, Italy
4. Fondazione Bruno Kessler, Italy

CMOS SPADs have been tested for displacement damage dose test. Mitigation effects by possible in-flight cooling and annealing procedures have been addressed. The limit of operability in future space missions has been demonstrated.

09:10 E-4 Radiation Effects in Pinned Photodiode CMOS Image Sensors: Variation of Photodiode Implant Dose

J. Belloir[1], C. Virmontois[1], M. Estribeau[2], V. Goiffon[2], P. Magnan[2], A. Materne[1], A. Bardoux[1]
1. CNES, France
2. ISAE-SUPAERO, France

The influence of the photodiode implant dose on the radiation-induced degradations in pinned photodiode CMOS image sensors is studied. Devices with five different implant doses are irradiated with 50 MeV protons from 5 to 100 krad.

THURSDAY TECHNICAL PROGRAMME

09:25 E-5 **Effect of Radiation on Optical Characteristics of Bismuth-Doped High-GeO_2 Silica Fibers for Superluminescent Sources**

S. Firstov[1], V. Khopin[2], A. Kharakhordin[1], S. Alyshev[1], K. Riumkin[1], M. Melkumov[1], A. Khegai[1], P. Kashaykin[1], A. Guryanov[2], E. Dianov[1]
1. Fiber Optics Research Center, RAS, Russian Federation
2. Institute of Chemistry of High-Purity Substances, RAS, Russian Federation

We investigated the effect of ionizing radiation on optical characteristics of Bi-doped high-GeO_2 silica fibers as a laser-active medium for a superluminescent fiber source operating in the spectral region 1600 – 1800 nm.

09:40 E-6 **Distributed Optical Fiber Sensor for Temperature and Strain Discrimination in Radiation Environments**

C. Sabatier[1], V. Lecoeuche[2], S. Girard[3], G. Melin[4], T. Robin[4], B. Cadier[4], L. Mescia[5], A. Morana[3], Y. Ouerdane[3], A. Boukenter[3], A. Champavere[2], E. Marin[3]
1. LabHC, Univ Lyon, UJM-CNRS-IOGS / iXblue / Politecnico di Bari, France
2. Viavisolutions, France
3. LabHC, Univ Lyon, UJM-CNRS-IOGS, France
4. iXblue, France
5. Politecnico di Bari, Italy

We evaluated the potential of a new architecture of distributed optical fibers sensor (DOFS) to discriminate between temperature and strain changes along an optical fiber exposed to radiations up to 1.5MGy(SiO_2).

09:55 – 10:25 BREAK – Exhibits Foyer and Hall H – Raffle Draw!

10:25 E-7 **Effect of Ionizing Radiation on Optical Transmission of Actively Pumped Yb-Doped Fiber Amplifiers**

B. Fox[1], K. Simmons Potter[2]
1. Sandia National Laboratories, USA
2. University of Arizona, USA

Fibers doped with Yb3+ serve as optical amplification elements in many ground-based and space-based systems. We investigate the effects of gamma-radiation-induced photodarkening on the performance of such fibers.

10:40 E-8 **Infrared Radiation Induced Attenuation of Radiation Sensitive Optical Fibers: Influence of Temperature and Modal Propagation**

G. Livecchi[1], D. Di Francesca[1], C. Sabatier[2], S. Girard[3], Y. Kadi[1], M. Brugger[1]
1. CERN, Switzerland
2. LabHC / iXBlue / Politecnico di Bari, France
3. Univ. Lyon, Lab Hubert Curien, France

We study the influence of the irradiation temperature and modal propagation properties on the radiation induced attenuation of three different radiation sensitive single mode optical fibers in the near infrared domain.

THURSDAY TECHNICAL PROGRAMME

PE-1 Radiation Hardness of Highly Efficient Triple-Cation Perovskite Solar Cells under Proton Irradiation

F. Lang[1], M. Jost[1], J. Bundesmann[2], A. Denker[2], S. Albrecht[1], J. Rappich[1], H. Neitzert[3], N. Nickel[1]

1. Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Institut für Silizium Photovoltaik, Germany

2. Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Protons for Therapy, Germany

3. Dept. of Industrial Engineering (DIIn), Salerno University, Italy

In-situ measurements under high-energetic proton irradiation demonstrate, for the first time, that solar cells based on the triple-cation perovskite $Cs_{0.05}MA_{0.17}FAz_{0.83}Pb(I_{0.83}Br_{0.17})3$ are radiation hard and posses a negligible degradation at doses up to 10^{12} p/cm^2.

PE-2 Radiation Testing of Optical and Semiconductor Components for Radiation-Tolerant LED Luminaires

A. Floriduz[1], J. Devine[1]

1. CERN, Switzerland

This work describes the effects of gamma rays on borosilicate, quartz, PMMA, and polycarbonate up to 100 kGy, and 24GeV/c proton irradiation of Si and SiC diodes to qualify their use in rad-hard LED-based luminaires.

PE-3 Experimental Study of the NIEL Scaling for Silicon Devices

T. Nuns[1], C. Inguimbert[1], S. Soonckindt[1], B. Dryer[2], T. Buggey[2], C. Poivey[3]

1. ONERA, France

2. Open University CEI, United Kingdom

3. ESA, Netherlands

We propose some new experimental data comparing the damage factor of silicon devices with the NIEL after electron, proton and gamma irradiations. The data fit better with the “effective” NIEL than with the classical one.

PE-4 Radiation Effects on the Photometric Budget of a MGy Radiation-Hardened Camera

C. Muller[1], T. Allanche[2], P. Paillet[3], O. Duhamel[3], V. Goiffon[4], S. Rizzolo[4], T. Lépine[2], Y. Ouerdane[2], A. Boukenter[2], S. Girard[2]

1. CEA, DAM, DIF and LabHC, France

2. Univ-Lyon, Laboratory Hubert Curien, CNRS UMR 5516, France

3. CEA, DAM, DIF, France

4. ISAE-Supaero, France

We characterized the response of different subparts of a color-imaging camera at 1 MGy (SiO_2), namely white LEDs and radiation-hardened glasses and image sensor, to evaluate its photometric losses and potential color change under radiations.

THURSDAY TECHNICAL PROGRAMME

PE-5 Influence of Radiation-Induced Discharges on K-208 Glass Properties

R. Khasanshin[1], A. Galygin[1]
1. JSC "Kompozit", Russian Federation

Features of formation of electric discharges, changes of surface structure, optical properties of samples of cover glass and thermal control coating of GEO satellites irradiated by electrons have been investigated.

PE-6 Specific Radiation Resistant Single-Mode Fiber for Sensing in High Dose Radiation Environments

G. Melin[1], P. Guitton[1], R. Montron[1], T. Gotter[1], T. Robin[1], B. Overton[2], A. Morana[3], S. Rizzolo[4], S. Girard[3]
1. iXblue, France
2. Lenoir Material Science, USA
3. Laboratoire Hubert Curien, France
4. ISAE-SUPAERO, France

A radiation resistant single-mode optical fiber specifically developed for distributed sensing is described. Samples with different coatings (acrylate, polyimide, aluminum) are characterized in term of radiation inducted attenuation, fiber mechanical strength and coating thermal degradation

10:55 Session J: DOSIMETRY AND FACILITIES

Chairs: Laurent Standaert (UCL) & Mike Tostanoski (Radiation Test Solutions)

11:00 J-1 Development and Calibration of a New, Low Cost Radiation Monitor for High Radiation Orbits

D. Bamber[1], K. Ryden[2], D. Tye[1], C. Underwood[2]
1. Surrey Satellite Technology Ltd, United Kingdom
2. Surrey Space Centre, United Kingdom

This paper presents the development and calibration of a new, engineering focussed radiation monitor for high radiation environments. The new monitor includes particle telescopes, internal charging and ionising dose sensors building on SSTL heritage.

11:15 J-2 Investigation on Passive and Autonomous Mode Operation of Floating Gate Dosimeters

M. Brucoli[1], S. Danzeca[1], M. Brugger[1], A. Masi[1], A. Pineda[2], J. Cesari[2], L. Dusseau[3], F. Wrobel[4]
1. CERN, Switzerland
2. ICMalaga, Spain
3. University of Montpellier, France
4. Universite Montpellier 2, France

The operation modes of the Floating Gate Dosimeter and their implications on the dose meaurement are presented. The study sheds light on the flexibility of ASIC as radiation monitor.

THURSDAY TECHNICAL PROGRAMME

11:30 J-3 **An Innovative Dosimetry Method for Accurate and Real Time Dose Assessment for Radiation Hardness Assurance Tests**

P. Casolaro[1], G. Breglio[2], S. Buontempo[3], L. Campajola[1], M. Consales[4], A. Cusano[4], A. Cutolo[4], F. Di Capua[1], F. Fienga[3], P. Vaiano[5]

1. Università degli Studi di Napoli Federico II-Dipartimento di Fisica and INFN-Napoli, Italy
2. Università Degli Studi di Napoli Federico II-Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione and INFN-Napoli, Italy
3. INFN-Napoli, Italy
4. Università degli Studi del Sannio, Optoelectronic Division-Department of Engineering and INFN-Napoli, Italy
5. Università degli Studi del Sannio, Optoelectronic Division-Department of Engineering, Italy

A novel dosimetry methodology of real-time dose measurement with radiochromic films, for which a National Patent was filed, is for the first time proposed for reliable dose assessment and quality checks of Radiation Hardness Assurance tests.

11:45 J-4 **The Frascati Neutron Generator FNG: a Fast Neutron Facility for Irradiation Experiments**

S. Fiore[1]

1. ENEA, Italy

The ENEA Frascati Neutron Generator is a European Space Agency compliant, 1.5E11 n/cm2s fast neutron irradiation facility. Current research topics include radiation damage effects, detector R&D, nuclear fusion, high-energy physics. Higher intensity upgrade is ongoing.

PJ-1 **High-Speed Floating Gate Based Dosimeter System**

J. Cesari[1], B. Servera-Mas[1], S. Danzeca[2], M. Roca[3], A. Pineda[1], A. Masi[2], M. Brucoli[2], E. Isern[3]

1. Integrated Circuits Malaga SL, Spain
2. EN-SMM-RME / CERN, Switzerland
3. EEG-UIB, Spain

This work presents a characterization study of a High-Speed Floating Gate based dosimeter system. Two chip prototypes compose the system: one embeds basic floating gate structures and the other configurable transimpedance amplifiers.

THURSDAY TECHNICAL PROGRAMME

PJ-2 SEE Tests with Ultra Energetic Xe Ion Beam in the CHARM Facility at CERN

P. Fernandez-Martinez[1], R. García Alía[1], M. Cecchetto[1], M. Kastriotou[1], N. Kerboub[1], M. Tali[1], V. Wyrwoll[1], M. Brugger[1], C. Cangialosi[1], F. Cerutti[1], S. Danzeca[1], M. Delrieux[1], R. Froeschl[1], L. Gatignon[1], S. Gilardoni[1], J. Lendaro[1], F. Ravotti[1], H. Wilkens[1], R. Gaillard[2]

1. CERN, Switzerland
2. Consultant, France

Tests on radiation effects with UHE Xe beams were performed in the CERN experimental areas. The results of the test campaign carried out at the CHARM facility are presented and discussed in this contribution.

PJ-3 A Fast Neutron Monitor Based on Single Event Effects in SRAMs Using Commercial off-the-Shelf Components

L. Obermueller[1], C. Frost[2], C. Cazzaniga[2], K. Sahra[3]

1. Cardiff University/ ISIS Neutron and Muon Source, STFC, United Kingdom
2. ISIS Neutron and Muon Source, STFC, United Kingdom
3. University of Greenwich, United Kingdom

A simple, multi-deployable fast neutron monitor based on Single Event Upsets in SRAM devices has been designed and tested on an atmospheric neutron beamline.

PJ-4 Impact of Nuclear Data Uncertainty in the Modeling of Recoil Atom Energy Distributions in Silicon

P. Griffin[1]

1. Sandia National Laboratories, USA

A rigorous methodology based on TMC is presented for quantifying uncertainty in recoil energy distributions and LET metrics due to nuclear data. The uncertainty is captured in the form of energy or LET-dependent covariance matrices.

PJ-5 SEE Proton Testing Facility at iThemba LABS

A. Barnard[1], F.D. Smit[2], W.H. Steyn[1]

1. Stellenbosch University, South Africa
2. iThemba laboratory for Accelerator Based Sciences, Somerset West, South Africa

Development and verification of Single-Event-Effect Proton Testing at iThemba LABS using a novel Beam Line Monitor (BLM) based dosimetry system. This is the first high energy proton testing facility in Africa and the Southern hemisphere.

THURSDAY TECHNICAL PROGRAMME

PJ-6 Development of a Directionality Detector for RADEM, the Radiation Hard Electron Monitor aboard the JUICE Mission

M. Pinto[1], P. Gonçalves[1], W. Hadjas[2], A. Marques[3], J. Costa Pinto[3]
1. LIP, Portugal
2. PSI, Switzerland
3. EFACEC SA, Portugal

Development of a Directionality Detector for RADEM, the Radiation Hard Electron Monitor, to be flown in the JUICE mission. Detector capabilities to measure angular variability of electron flux in the Jovian system are presented.

PJ-7 Irradiation Facilities at the Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)

A. Denker[1], J. Röhrich[1]
1. Helmholtz-Zentrum Berlin, Germany

The HZB offers the possibility of γ– and proton irradiation under ambient atmosphere. Previous experiments include tests of dosimeters, radiation hardness tests of electronic components as well as TID tests.

PJ-8 Investigation of Low Flux Proton Beam at KOMAC for Space Applications

Y. Kim[1], S. Yun[1], S. Lee[1], H. Kwon[1], K. Kim[1], Y. Cho[1]
1. KOMAC, Korea, Republic of

Korea Multi-purpose Accelerator Complex (KOMAC) has been operating 20 MeV and 100 MeV proton beam lines since 2013. We introduce a new beam line with low-flux for space radiation test and results of preliminary beam characterization test.

PJ-9 TEC-Laboratory – Accredited Ionizing Radiation Exposure of Electronic Components and Systems Compliant with EN ISO/IEC 17025

M. Wind[1], P. Beck[1], M. Latocha[1], C. Tscherne[1]
1. Seibersdorf Laboratories, Austria

EN ISO/IEC 17025 accreditation requirements are discussed for the TEC-Laboratory for ionizing radiation testing of electronic components at Seibersdorf Laboratories. Uniformity and photon backscatter investigations of the Cobalt-60 irradiation field are presented.

THURSDAY TECHNICAL PROGRAMME

PJ-1L **Progress of CNA to become the Spanish Facility for Combined Irradiation Testing in Aerospace**

Y. Morilla[1], P. Martín-Holgado[1], J. Labrador[1], B. Fernández[1], J. Praena[2], A. Lindoso[3], M. García-Valderas[3]

1. CNA, Spain

2. Universidad de Granada, Spain

3. Universidad Carlos III de Madrid, Spain

The development of some Spanish national research projects have contributed to improve CNA capabilities to perform irradiation testing for aerospace applications. An overview on the Centre evolution during the last years will be presented.

PJ-2L **SEE Flux and Spectral Hardness Calibration of Neutron Spallation and Mixed Field Facilities**

M. Cecchetto[1], P. Fernandez Martinez[1], R. Garcia Alia[1], R. Ferraro[2], S. Danzeca[1], F. Wrobel[3], C. Cazzaniga[4], C. Frost[4]

1. CERN, Switzerland

2. CERN, France

3. University of Montpellier, France

4. ISIS facility RAL, United Kingdom

The approach of calibrating neutron environments through well-known SEU based SRAM memories is applied to a neutron spallation and mixed-field facility. The specra energy hardness is assessed carrying out SEL measurements with commercial components.

12:00 – 13:30 LUNCH - SEASONS

13:30 - 14:30 INVITED TALK - *Christer Fuglesang*

INVITED TALK THURSDAY

- THURSDAY 20TH OF SEPTEMBER
- 13:30 - 14:30

SPACE JOURNEYS

On Dec 9th (local time) 2006 I was onboard the space shuttle Discovery when it launched from Kennedy Space Center in Florida for a mission to the International Space Station (ISS). It was the beginning of a fabulous journey and adventure, with the main goal to continue building ISS for future research and exploration. To some extent it was also a final goal for me: 16 years earlier I had applied to become astronaut, two years later I had been selected – but only now was I finally on my way to space.

This story will be told, with pictures and video from space, also from my second space flight in 2009. I will discuss the science and technology on ISS – and daily life there. The science range from fundamental physics, to biology, to medicine. Astronauts are really guinea pigs in space. The human physiology changes a lot in the weightlessness and we need to understand these changes in order to send people safely further and longer into space in the future.

Another major obstacle is of course radiation in space due to all cosmic rays. A field I have been involved in research myself. However, it will not stop us from continue our human endeavor to journey further and deeper into space. There are many developments ongoing, with both new private actors, like Elon Musk´s SpaceX and Jeff Bezos´ Blue Origin, as well as among the old big space agencies NASA, ESA, CNSA, etc. I will end by presenting some of the major new ideas and share my view of the future for humankind in space.

Dr. Christer Fuglesang

Dr. Christer Fuglesang is an astronaut and professor at KTH Royal Institute of Technology, while also working half time as Space Advisor for Saab, in the Strategy Group. At KTH Fuglesang is responsible for the AeroSpace Master program and he teaches a course in Human Spaceflight. Fuglesang is Director of KTH Space Center, within which he initiated a student CubeSat satellite project, MIST.

Fuglesang´s own research is about particles in space: radiation on the International Space Station (ISS) since many years and lately he joined EUSO, a large international project to study ultra-high energy cosmic rays from ISS. Fuglesang retired from ESA in March 2017.

For 18 years, he was an active ESA astronaut. He trained one year at the European Astronaut Centre in Cologne, followed by three years in Russia where he was back-up for the EuroMir95 mission. In 1996 he moved to NASA´s Johnson Space Centre in Houston and became a Mission Specialist for the Space Shuttle. Fuglesang performed two missions with the Space Shuttle Discovery to the International Space Station in 2006 (STS-116) and 2009 (STS-128). During these missions he performed five EVAs (space walks).

Between 2010 and 2013 Fuglesang was Head of the Science and Applications Division in ESA's Human Spaceflight Directorate, stationed at ESTEC in the Netherlands. This was followed by four years of secondment from ESA to Sweden, working at KTH and for the Swedish National Space Board. Fuglesang's background is in experimental particle physics. In 1987 he earned a Ph.D. from Stockholm University in this field and worked at CERN 1988-1991.

THURSDAY TECHNICAL PROGRAMME

14:30 DATA WORKSHOP INTRODUCTION

Data Workshop Chairs:
Gonzalo Fernandez Romero (ALTER) & Kirby Kruckmeyer (Texas Instruments)

14:35 – 16:00 Data Workshop – Hall H

Break in Foyer and Hall H during Data Workshop

DW-1 Investigation of SEE Breakdown in CCD Image Sensor

R. Mozhaev[1]
1. Specialized Electronic Systems (SPELS), Russian Federation

The presented results reflect the ionizing breakdown effect in CCD sensor under the fluence of heavy charged particles confirmed on a simulating laser facility.
The primary analysis has been carried out.

DW-2 SEL and SEFI Discrimination in Kintex-7 using Focused Laser Irradiation

A. Pechenkin[1], D. Bobrovsky[1], A. Novikov[1], M. Novikova[1], G. Sorokoumov[1]
1. NRNU MEPHI/SPELS, Russian Federation

SEL was observed along with SEFI in Kintex-7 under focused laser irradiation.

DW-3 Evaluation of Radiation Effects on Laser Diodes and Photodiodes for Space Laser Communication

X. Gao[1]
1. Lanzhou Institute of Physics, China

Radiation investigations were carried out on semiconductor laser diodes, and on PIN photodiodes for use in space laser communication, by gamma-ray, electron, proton or neutron in order to assess their behavior in space radiation environments.

DW-4 Analysis of Heavy Ion Irradiation Test Results on Power Diodes

M. Mauguet[1], D. Lagarde[2], L. Azema[1], E. Le Goulven[1], A. Varotsou[1], X. Marie[2], C. Boatella-Polo[3]
1. TRAD, France
2. INSA LPCNO, France
3. ESA, Netherlands

This paper is an analysis of heavy ion test results over a large range of electrical and structural power diodes. Types and occurrence of failures are discussed.

THURSDAY TECHNICAL PROGRAMME

DW-5 Heavy-Ion SEE Test Results for Amplifiers

A. Kalashnikova[1], V. Anashin[1], P. Chubunov[1], A. Koziukov[1], S. Iakovlev[1], R. Mangushev[1], A. Nilov[1]

1. Branch of Joint - Stock Company "United Rocket and Space Corporation" - "Institute of Space Device Engineering" (Branch of JSC URSC - ISDE), Russian Federation

The paper presents heavy-ion test results of different amplifiers for a wide temperature range, including subzero. LET thresholds for SET, SEL, and Destructive Failure have been obtained. Supply voltage Safe Operating Area has been estimated.

DW-6 Aging and Gate Bias Effects on TID Sensitivity of Wide Bandgap Power Devices

K. Niskanen[1], A. Touboul[1], R. Coq Germanicus[2], F. Wrobel[1], F. Saigné[1], J. Boch[1], A. Michez[1], V. Pouget[3]

1. IES - University of Montpellier, France

2. University of Caen, France

3. IES-CNRS, France

The effect of oxide stress on the TID sensitivity of silicon carbide power MOSFETS and TID sensitivity of gallium nitride power transistor is reported. Difference in TID response for stressed and unstressed devices was observed.

DW-7 Proton Testing of the NXP P4080 Processor at the COSY Accelerator

S. Hoeffgen[1], M. Liebender[2], M. Baum[1], C. Carl[2], O. Felden[3], T. Kündgen[1], W. Lennartz[1], S. Metzger[1], S. Pletner[2], F. Schön[2]

1. Fraunhofer INT, Germany

2. Fraunhofer FOKUS, Germany

3. IKP-4, Forschungszentrum Jülich, Germany

The P4080 is tested for SEE using a proton beam of up to 500 MeV. Single and multiple bit upsets of the L2/L3 cache were measured as well as core crashes with different signatures.

DW-8 Proton SEL Test on dsPIC Microcontroller to be used in ExoMars 2020 Mission

P. Manzano[1], M. Álvarez[1], J. Manzano[1], M. Rivas[1], J. De mingo[1], A. Martín-Ortega[2], N. Andrés[2]

1. National Institute for Aerospace Technology - INTA, Spain

2. Engineering Systems for the Defence of Spain - ISDEFE, Spain

Proton latch-up test results are presented to complete the TID and heavy ions SEL tests performed previously on Microchip microcontroller to assess its suitability to be used in an instrument on-board ExoMars 2020 mission.

THURSDAY TECHNICAL PROGRAMME

DW-9 Single Event Latch-up and Total Ionizing Dose Test Results on a Cobham Designed 3.125 Gbps Crosspoint Switch

M. Von Thun[1], J. Pfeil[1], T. Engelbart[1]
1. Cobham Semiconductor Solutions, USA

Single event latch-up and total ionizing dose test data on the newly designed and fabricated Cobham radiation-hardened UT65CML8X8FD 3.125 Gbps Crosspoint Switch (XPS) switch will be presented.

DW-10 Irradiation Test Results on Electronic Cards using the Smartfusion2 FPGA

N. Trikoupis[1], J. Casas-cubillos[1], S. Danzeca[1]
1. CERN, Switzerland

Radiation tests up to a dose of 1 kGy were performed on the Smartfusion2 FPGA at CERN's CHARM facility. Its radiation tolerance and suitability for use in the Large Hadron Collider are analysed.

DW-11 Study of Degradation of High Voltage SiC Junction Barrier Schottky Diode irradiated with Heavy Ions

Q. Yu[1]
1. China Academy of Space Technology, China

Heavy ions induced degradation of SiC junction barrier Schottky diodes. The degradation mechanism was analyzed and discussed based on "micro-SEB" according the measurement results of failed diodes caused by heavy ion irradiation.

DW-12 Heavy Ion SEL/SEE Testing of Microsemi Integrated Motor Controller LX7720

M. Sureau[1]
1. Microsemi, USA

The Heavy Ion SEL/SEE testing results of the Microsemi radiation hardened analog mixed-signal motor controller IC, the LX7720, are presented.

DW-13 Total Ionizing Dose Characterization of a SRAM in 28 nm UTBB FDSOI Technology

Z. Qiwen[1], L. Mengxin[2], C. Jiangwei[1]
1. Xinjiang Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China
2. Key Laboratory of Silicon Device Technology, Chinese Academy of Sciences, China

Comprehensive TID Characterization of a SRAM fabricated in 28nm UTBB FDSOI Technology is presented. Functional failure of SRAM is observed after exposure to 30krad(Si) TID, and electrical parameters of device are affected obviously.

THURSDAY TECHNICAL PROGRAMME

DW-14 The Total Ionizing Dose Effect of Magnetometers System Based on Tunneling Magnetoresistance Sensor

L. Li Huang[1], T. Tianyang Zhang[2], B. Bo Li[3], Y. Yu Zhang[1], Y. Yuhong Zhao[4], H. Houfang Liu[5], Y. Yan Cui[2], X. Xiufeng Han[1]

1. Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, University of Chinese Academy of Sciences, Chinese Academy of Sciences, China

2. Key Laboratory of Silicon Device Technology, Chinese Academy of Sciences, China

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

4. The Academy of Electronic Information Engineering, North China University of Technology, China

5. Institute of Microelectronics, Tsinghua University, China

To evaluate the potential of a low-cost magnetometers system based on tunneling magnetoresistance sensor in harsh radiation environment, the irradiation behaviors were obtained and discussed with respect to the performances degradation in critical modules.

DW-15 The Radiation Effect on the Parameters of Reference Voltage Sources and Charge-Sensitive Amplifiers of the Structured Array MH2XA010

O. Dvornikov[1], V. Dziatlau[1], N. Prokopenko[2], V. Tchekhovski[3], A. Bugakova[4]

1. Plc., "Minsk research instrument- making institute" (MNIPI), Belarus

2. Don State Technical University; Institute for Design Problems in Microelectronics of RAS, Russian Federation

3. Institute for Nuclear Problems of Belarusian State University, Belarus

4. Don State Technical University, Russian Federation

The effect of 6 MeV fast electrons and Co-60 gamma radiation on the parameters of analog components of the structured array MH2XA010 – the reference voltage source and the charge-sensitive amplifier is compared.

DW-16 Total-Ionizing-Dose Induced Degradation of Several Quartz Oscillators

A. Demidova[1], M. Koroteev[1], D. Zavorotnov[1], D. Boychenko[1]

1. National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Russian Federation

The influence of TID on several types of XSIS and Epson quartz oscillators has been studied. Parameters of quartz resonator don't change much until functionality fails. It's recommended to check the OE or ST signal.

DW-17 Total-Ionizing-Dose Tolerance of the Configuration Function of MAX3000A CPLDs

T. Fujimori[1], M. Watanabe[1]

1. Shizuoka University, Japan

This paper shows the total-ionizing-dose tolerance measurement result of the configuration function of a complex programmable logic device MAX3000A. The total-ionizing-dose tolerances of the configuration function of six MAX3000A chips were up to 42 krad.

THURSDAY TECHNICAL PROGRAMME

DW-18 Neutron Irradiation of an ARM Cortex-M0 Core

F. Malatesta[1], M. Ottavi[1], G. Furano[2], A. Menicucci[3], G. Cardarilli[1], C. Cazzaniga[4], C. Andreani[1], C. Scatigno[1], R. Senesi[1]

1. University of Rome Tor Vergata, Italy

2. ESA, Netherlands

3. Delft University of Technology, Faculty of Aerospace Engineering, Space Systems Engineering, Netherlands

4. Rutherford Appleton Laboratory-ISIS, United Kingdom

This paper reports the results of Neutron irradiation tests conducted at the ISIS facility on an ARM Cortex M0 core. The test setup also included a CMOS camera sensor used for dosimetry estimation.

DW-19 Accelerated Test of ELDRS at Ultra-Low Dose Rates for Bipolar Devices

X. Wang[1], W. Lu[1], S. Yao[1], X. Li[1], Q. Guo[1], C. He[1], X. Yu[1], J. Sun[1]

1. The Xinjiang Technical Institute of Physics & Chemistry.CAS, China

We present accelerated evaluation results of temperature-switching irradiation (TSI) test for ELDRS in bipolar devices at ultra-low dose rates (<10mrad(Si)/s).

DW-20 Safe Operation Area Of Trench-Gate And Low-Charge Power MOSFET

G. Davydov[1], D. Boychenko[1], D. Pechenkina[1], A. Tararaksin[1], T. Kritskaya[2], A. Polokhov[2]

1. NRNU MEPhI / JSC "SPELS", Russian Federation

2. JSC "Angstrem", Russian Federation

The SEB test results of 3 kinds and 17 types of power MOSFET were systemized in this work. Several features of radiation behavior were found. The approach to increase SEB SOA of MOSFETs was discussed.

DW-21 Single-Event Damages on the Characteristics of 4H-SiC power MOSFETs for Space Application

P. Li[1], L. Zhen[2], X. Li[2], J. Yang[2], B. Mei[3], H. Lv[3], X. Li[3], Y. Sun[3], Q. Yu[3], M. Tang[3], W. Xu[4]

1. School of Materials Science and Engineering Harbin Institute of Technology; China Academy of Space Technology; National Innovation Center of Radiation Application, China

2. School of Materials Science and Engineering Harbin Institute of Technology, China

3. China Academy of Space Technology; National Innovation Center of Radiation Application, China

4. Jinan Semiconductor Devices Research Institute, China

The VTH and VDS of SiC power MOSFETs after single-particle irradiation was discussed. V-I output characteristic and drain source on-state resistance were analyzed. The safe operating voltage area of the device is obtained.

THURSDAY TECHNICAL PROGRAMME

DW-1L Proton Damage in Micropac 66183-300 Optocoupler

F. Irom[1], G. Allen[1], L. Edmonds[1], B. Rax[1]

1. Jet Propulsion Laboratory, USA

This paper reports proton damage in the Micropac 66183-300 optocoupler. Analysis of the test data reveals interesting information, such as the dependence of the transistor gain on irradiation and photocurrent. We present statistical analysis, using a one-sided tolerance method, on the optocoupler CTR data.

DW-2L Single Event Effects Characterization of UT200SpWPHY01 SpaceWire Physical Layer Transceiver

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

1. Jet Propulsion Laboratory, USA

We present SEE test results for the Cobham SpaceWire transceiver after dosing the device to 300 krad(Si). We performed SEU characterization with variable data rates and patterns. Events resembling SEFIs were also observed and recorded.

DW-3L Radiation Test Results in Newly Developed Super-Junction Power MOSFETs

E. Mizuta[1], Y. Nakada[1], S. Kuboyama[1], M. Inoue[2], Y. Kumagai[2], S. Tatemichi[2], T. Shiigi[2], T. Watashima[2], H. Shindou[1]

1. JAXA, Japan

2. Fuji Electric, Japan

We report the results of single-event effects testing by heavy ions in JAXA qualified super-junction power MOSFETs and COTS super-junction power MOSFETs manufactured by Fuji electric company.

DW-4L Radiation Testing and Characterization of the TPS50601A-SP Radiation Hardened Buck Converter

J. Cruz-Colon[1], J. Valle[1], H. Torres[1], V. Narayanan[1], R. Baumann[2]

1. Texas Instruments, USA

2. Radiosity Solutions LLC, USA

Single Events Effect (SEE) characterization results for the new TPS50601A-SP, 6 A, DC-DC converter are presented in this paper. The TPS50601A-SP is SEL-SEB-SEGR free up to LETEFF=75 MeV-cm2/mg. SET were characterized up to LETEFF=65MeV-cm2/mg.

16:00 - 18:00 RADECS GENERAL ASSEMBLY

18:00 RADECS GALA DINNER

FRIDAY TECHNICAL PROGRAMME

CONGRESS HALL K2 & K3

08:10 RADECS Announcements - *Christian Poivey, ESA, Technical Programme Chair*

08:20 - 09:05 INVITED TALK

Dr. Steve Guertin
Jet Propulsion Laboratory

Dr. Steve Guertin holds a Ph.D. in Physics from UCLA (2008), focused on particle production and detection in nucleus-nucleus collisions. He joined NASA's Jet Propulsion Laboratory, California Institute of Technology, radiation effects group in 1997 as an undergrad (BS Mathematics & Physics, California State Polytechnic University, Pomona, 1998). Owing to continuous development of computer software and equipment starting in grade school, he leads JPL's radiation effects group's processor and computer memory efforts.

He has written a chapter on microprocessor radiation effects and a NASA guideline on system on a chip single event effects testing. He was a coauthor on a NSREC best paper award in 1999, and three NSREC best data workshops in 2008, 2015 and 2017. For the last ten years he has been involved in methods to determine worst-case SEE performance of commercial processors and systems using proton-only component and board-level testing. He has written a NASA book of knowledge on this subject and is developing a guideline to assist test engineers in performing board-level proton testing.

PROTON BOARD-LEVEL TESTING: ACHIEVING LIMITED RADIATION ASSURANCE WITH MINIMAL TESTING

Many programs are searching for ways to reduce cost and radiation qualification is a common target. Traditional radiation is component-focused with testing to establish total ionizing dose performance of a component's flight lot and establish SEE performance of representative devices.

Most of the of the costs come from the number of components and the difficulty in preparing devices for testing, including delidding and test regime development. Most major costs are mitigated by simply taking a (usually commercial) flight-like board to a proton facility and using proton test results to establish worst case performance. This type of testing, however, provides terrible worst-case estimates based on results, with single event latchup, burnout, and gate rupture limited to board level worst-case rates of 0.1 to 0.03 per system-day in the International Space Station (ISS) environment, depending on test fluence.

In addition, the most likely performance is actually much better than the worst case. This leads programs to try to remove conservatism by using more favorable rates that apply to other event types like single bit upset. This is one of a myriad of potential mistakes that can be made in performing these tests and using the results.

We will discuss the board-level testing guideline currently in review, focusing on the challenges and avoiding these types of mistakes. The topics covered range from establishing if a program will benefit from this type of testing, other elements of test planning such as beam parameters and exposure plans, and through to interpretation of results.

FRIDAY TECHNICAL PROGRAMME

09:05 Session A: BASIC MECHANISMS

Session Chairs: Marc Gaillardin (CEA) & Daniel Fleetwood (Vanderbilt University)

09:10 A-1 TID Response of NanoWire Field-Effect Transistors: Impact of the Back Gate Bias

J. Riffaud[1], M. Gaillardin[1], C. Marcandella[1], N. Richard[1], O. Duhamel[1], M. Martinez[1], M. Raine[1], P. Paillet[1], T. Lagutere[1], F. Andrieu[2], S. Barraud[2], M. Vinet[2], O. Faynot[2]

1. CEA, France

2. CEA LETI, France

In this paper, the impact of the back gate bias on the Total Ionizing Dose (TID) response of NanoWireFETs (NWFETs) is investigated. The TID-induced threshold voltage shift is studied using two different NWFET widths.

09:25 A-2 Total-Ionizing-Dose Response of MoS_2 Transistors with ZrO_2 and h-BN Gate Dielectrics

P. Wang[1], K. Hirokjyoti[2], A. Krishnaprasad[2], D. Dev[2], A. O'Hara[1], R. Jiang[1], E. Zhang[1], D. Fleetwood[1], R. Schrimpf[1], S. Pantelides[1], T. Roy[2]

1. Vanderbilt University, USA

2. University of Central Florida, USA

The total-ionizing-dose response of few-layer MoS_2 transistors with ZrO_2 and h-BN gate dielectrics is investigated under different device bias conditions. Defects in both MoS_2 and surrounding dielectric layers significantly affect the observed response.

09:40 A-3 Interface Passivation Strategy for Ge PMOSFET from a TID Perspective

Z. Ren[1], X. An[1], J. Wang[2], G. Li[1], X. Zhang[3], X. Zhang[1], R. Huang[1]

1. Peking University, China

2. Beijing University of Technology, China

3. Xinjiang Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China

The impact of different interface passivation techniques on the TID effect of Ge PMOSFET is firstly experimentally investigated. The results show that N-passivated Ge PMOSFETs illustrate stronger radiation hardness than O-passivated device.

FRIDAY TECHNICAL PROGRAMME

PA-1 Electron and Proton Radiation Effects on Band Structure and Carrier Dynamics in MBE and MOCVD Grown Photovoltaic Test Structures

A. Hudson[1], A. Scofield[1], W. Lotshaw[1], S. Hubbard[2], M. Slocum[2], B. Liang[3], M. Debnath[3], B. Juang[4], D. Huffaker[4]

1. The Aerospace Corporation, USA

2. NanoPower Research Labs, Golisano Institute for Sustainability, Rochester Institute of Technology, USA

3. California NanoSystems Institute, USA

4. Electrical and Computer Engineering Department, University of California, Los Angeles, USA

P-type and n-type AlGaAs/GaAs heterostructures were exposed to electron and proton radiation. Proton exposure generated resolvable trap states. The damage and non-radiative coefficients suggest that the n-type samples are more radiation hard than the p-type.

PA-2 Monte Carlo Simulation of Displacement Damage in Graphene

W. Liao[1], M. Alles[1], E. Zhang[1], D. Fleetwood[1], R. Reed[1], R. Weller[1], R. Schrimpf[1]

1. Vanderbilt University, USA

We propose a Monte Carlo approach that uses the binary collision approximation to estimate defect densities in proton- and heavy-ion irradiated graphene layers. Calculations are compared with previously published experimental results.

PA-3 TID Effects on Breakdown and Self-heating Characteristics of 400V SOI NLDMOS

L. Shu[1], Y. Zhao[2]

1. Harbin Institute of Technology, China

2. Beijing Microelectronics Technology Institute, China

The breakdown voltage degradation and self-heating characteristic suppression of 400V SOI NLDMOS after irradiation under different bias conditions is discovered through experiments. The mechanisms of these phenomena are analyzed and confirmed by TCAD simulations.

PA-4 The Correlation between High Dose Rate Irradiation and Low Dose Rate Irradiation During the Switched Dose Rate Technique

X. Li[1], J. Yang[1], C. Liu[1], H. Li[1]

1. Harbin Institute of Technology, China

The correlation between high dose rate irradiation and low dose rate irradiation during the switched dose rate technique are investigated.

FRIDAY TECHNICAL PROGRAMME

PA-5 Synergistic Effects of TID and ATREE in Vertical NPN Bipolar Transistor

C. Wang[1], R. Li[1], W. Chen[1], G. Wang[1], J. Li[1], X. Bai[1], P. Cong[1], X. Guo[1]
1. Northwest Institute of Nuclear Technology, China

TID irradiation speeds up the decline rate of the secondary photocurrent and decreases the transient duration of VNPN transistor under pulsed X-ray irradiation. TID-induced Si/SiO_2 interface trap is the dominant cause of TID-ATREE synergistic effects.

PA-6 Total Ionizing Dose Effect in LDMOS Oxides and Devices

T. Borel[1], S. Furic[2], E. Leduc[2], A. Michez[3], J. Boch[3], A. Touboul[3], B. Azais[4], S. Danzeca[5], L. Dusseau[3]
1. Université de Montpellier - IES / CERN, France
2. Microchip Technology, France
3. Université de Montpellier - IES, France
4. Direction Générale de l'Armement, France
5. European Organization for Nuclear Research (CERN), Switzerland

Dose effect on PD-SOI LDMOS is investigated in this work based on experimental data. TCAD is used to explain the effect of the trapped charges in STI and buried oxides.

PA-7 ELDRS in p-MOS and p-MNOS Based RADFETs with Thick Gate Insulators: Experiment and Simulation

P. Zimin[1], G. Zebrev[2]
1. Branch of JSC USRC - ISDE, Russian Federation
2. National Research Nuclear University MEPHI, Russian Federation

It was shown that enhanced charge trapping takes place in thick gate dielectrics of p-MOS and MNOS dosimeters at low dose rates (ELDRS). The results are shown to be consistent with the previously proposed model.

PA-8 Comparison of 10 MeV Electron Beam Irradiation Effect on InGaN/GaN and AlGaN/GaN Multiple Quantum Wells

L. Wang[1], Q. Li[2], N. Liu[3], L. Song[4], B. Li[5], B. Li[5], M. Liu[5], Y. Huang[5], B. Zhang[2], Z. Chen[3], X. Cao[4], B. Wang[4], B. Mei[6], J. Luo[5], Z. Han[5]
1. Institute of Microelectronics, Chinese Academy of Sciences, China
2. Department of Physics & Department of Electronic Engineering, Xiamen University, China
3. Guangdong Institute of Semiconductor Industrial Technology, China
4. Institute of High Energy Physics, Chinese Academy of Sciences, China
5. Key Laboratory of Silicon Device Technology and Institute of Microelectronics, Chinese Academy of Sciences, China
6. China Academy of Space Technology, China

Irradiation damage of InGaN/GaN and AlGaN/GaN multiple quantum wells (MQWs) are analyzed and compared by multiple photoluminescence method. The mechanisms of the irradiation degradation of InGaN/GaN MQWs and irradiation hardness of AlGaN/GaN MQWs are revealed.

FRIDAY TECHNICAL PROGRAMME

PA-1L **Heavy Ion Radiation Effects on Hafnium Oxide based Resistive Random Access Memory**

S. Petzold[1], S. Sharath[1], J. Lemke[1], E. Hildebrandt[1], C. Trautmann[2], L. Alff[1]
1. Technische Universität Darmstadt, Germany
2. GSI Helmholtzzentrum, Germany

Hafnium oxide based Resistive Random Access Memory (TiN/HfOx/Pt/Au) stacks were irradiated with 1.1 GeV Au ions with fluences between 1E10 and 1E12 ions/cm^2 and evaluated regarding pristine resistance, forming voltage, and data retention.

09:55 - 10:25 BREAK – Foyer

10:25 Session B: DEVICES AND ICS

Session Chairs:
Karin Eriksson (RUAG Space AB) & Michael McLain (SANDIA National Laboratories)

10:30 B-1 **Spatial Distribution of Interface Traps in 65 nm pMOSFETs Irradiated to Ultra-High Doses**

S. Bonaldo[1], S. Gerardin[1], X. Jin[2], A. Paccagnella[1], F. Faccio[3], G. Borghello[3], D. Fleetwood[4]
1. University of Padova, Italy
2. Northwest Institute of Nuclear Technology, China
3. CERN, Switzerland
4. Vanderbilt University, USA

The spatial distribution of interface traps in pMOSFETs irradiated to ultra-high doses under different bias conditions is investigated through charge pumping measurements and by TCAD simulations.

10:45 B-2 **Gate Bias and Length Dependences of Total-Ionizing-Dose Effects in InGaAs FinFETs on Bulk Si**

S. Zhao[1], R. Jiang[1], H. Gong[1], P. Wang[1], E. Zhang[1], N. Waldron[2], B. Kunert[2], J. Mitard[2], N. Collaert[2], S. Sioncke[2], D. Linten[2], R. Schrimpf[1], R. Reed[1], D. Fleetwood[1]
1. Vanderbilt University, USA
2. IMEC, Belgium

We evaluate the radiation response of InGaAs nMOS FinFETs with different gate lengths. The degradation is strongly gate-length dependent. 1/f noise measurements demonstrate a strong variation of effective border-trap density with surface potential.

FRIDAY TECHNICAL PROGRAMME

11:00 B-3 **Gate Grounded n-MOS Sensibility to Ionizing Dose**

T. Borel[1], A. Michez[2], S. Furic[3], E. Leduc[3], J. Boch[2], A. Touboul[2], B. Azais[4], S. Danzeca[5], L. Dusseau[2]

1. Université de Montpellier - IES / CERN, France
2. Université de Montpellier - IES, France
3. Microchip Technology, France
4. Direction Générale de l'Armement, France
5. European Organization for Nuclear Research (CERN), Switzerland

Nowadays, most of the integrated circuits are design with inbuilt ESD protections structures. Only few studies of radiation-induced degradation were performed with those protections. TID degradation on Gate Grounded n-MOSFETs is investigated in this paper.

11:15 B-4 **Evaluating Memory Array Radiation Performance in Commercial DDR2 and MRAM Devices**

S. Guertin[1], R. Some[1], J. Yang-Scharlotta[1]

1. Jet Propulsion Laboratory, USA

Memory technologies were investigated for memory array radiation sensitivity using commercial devices. Test methods for highlighting the memory array within the device are developed. TID and SEE performance of DRAM and MRAM memory arrays is discussed.

11:30 B-5 **Total Ionizing Dose Effects in DDR3 SDRAMs under Co-60 and X-ray Irradiation**

P. Kohler[1], V. Pouget[2], F. Saigne[2], J. Boch[2], T. Maraine[2], P. Wang[1], M. Vassal[1]

1. 3D PLUS, France
2. IES, University of Montpellier, France

This paper presents an analysis of the TID sensitivity of DDR3 memories. Parametric drifts and functional failures, including data retention time test, are observed and discussed following Co-60 and X-ray characterization campaigns.

11:45 B-6 **Radiation-Hardened Stabilized Power Supply Unit based on a Lithium-ion Battery**

S. Fujisaki[1], M. Watanabe[1]

1. Shizuoka University, Japan

This paper presents the proposal of a radiation-hardened stabilized power supply unit based on a lithium-ion battery. The radiation tolerance of the radiation-hardened stabilized power supply unit has been experimentally confirmed as over 1 MGy.

FRIDAY TECHNICAL PROGRAMME

PB-1 Total Ionizing Dose effects in FDSOI Compact Model for IC Design

N. Rostand[1], S. Martinie[2], M. Gaillardin[3], O. Rozeau[2], J. Lacord[2], J. Barbe[2], T. Poiroux[2], G. Hubert[1]
1. ONERA, France
2. CEA/Leti, France
3. CEA, France

TID effects are included into FDSOI compact model. It describes uniform/ non-uniform energetic distributions of interface traps and contribution of oxide/ BOX traps. Model is validated with TCAD and used to extract experimental TID parameters.

PB-2 Assessing Radiation Hardness of SiC MOS Structures

J. Moreno[1], E. Cordero[1], D. López[1], S. Massetti[2], M. Cabello[3], P. Godignon[3], E. Maset[4]
1. ALTER TECHNOLOGY, Spain
2. ESA, Netherlands
3. CNM, Spain
4. University of Valencia, Spain

SiC power devices are promising but still need radiation hardening to be suitable for many space applications. Different experimental SiC MOS structures are evaluated in this study under gamma and heavy ions radiation.

PB-3 Radiation and Annealing Characteristics of Interface traps in SOI NMOSFETs by the Direct-Current Current-Voltage Technique

Y. Li[1], X. Li[1], B. Li[1], L. Gao[1], W. Yan[1], F. Wang[1], B. Mei[2], C. Zeng[1], Z. Han[1], J. Luo[1]
1. Institute of Microelectronics of the Chinese Academy, China
2. China Academy of Space Technology, China

The radiation and annealing characteristics of interface traps in SOI NMOSFETs is investigated. “U-shape” energy distribution of interface traps is obtained by DCIV after irradiation and its annealing response is dependent on irradiation dose.

PB-4 The enhanced MCU sensitivity of 65nm 6-T SRAM induced by Total Ionizing Dose

Z. Qiwen[1], C. Jiangwei[1], L. Wu[1], Y. Xuefeng[1], G. Qi[1]
1. Xinjiang Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China

The enhanced MCU sensitivity induced by TID irradiation is observed in 65 nm 6-T SRAM. PMOSFET drive current decrease and the strengthened parasitic bipolar effect are responsible for n-hits and p-hits MCU enhancement respectively.

FRIDAY TECHNICAL PROGRAMME

PB-5 TID Degradation in RF SOI NMOS

L. Xu[1], J. Chen[1], S. Wang[1], Z. Chai[1], B. Wang[1], W. Wu[1], P. Wang[2], E. Zhang[2], D. Fleetwood[2]
1. SIMIT, China
2. Vanderbilt University, USA

The TID degradation of RF SOI NMOS is mainly reflected by much off-state leakage due to the multi-finger structure. The degradation in cut-off frequency is revealed from transconductor and parasitic effects clearly.

PB-6 Low TID Effects on MOS Transistors

V. Bezhenova[1], A. Michalowska-Forsyth[1], W. Pflanzl[2]
1. Graz University of Technology, Austria
2. AMS AG, Austria

TID effects on DC and noise performance of NMOS and PMOS transistors with thick gate oxide at TID < 25 krad are discussed, on the example of a test-chip fabricated in a commercial 180nm CMOS technology.

PB-7 Enhanced Low Dose Rate Sensitivity of PNP Transistor at Extreme-Low Dose Rates

M. Liu[1], W. Lu[1]
1. Xinjiang Technical Institute of Physics & Chemistry, CAS, China

The ELDRS of PNP transistors were investigated at dose rates of 10, 5, 1, and 0.1mrad(Si)/s and dose rate 100rad(Si)/s. The estimated results using Temperature-Switching-Approach were in good agreement with the experimental data.

PB-1L Modeling of Annular Gate MOS Transistors

V. Bezhenova[1], A. Michalowska-Forsyth[1]
1. Graz University of Technology, Austria

STI stress effect is incorporated into simulation for enclosed layout transistor in order to evaluate accuracy of two equivalent aspect ratio evaluation models: the well-known mid-line approximation and the recently introduced isosceles trapezoid approximation.

12:00 BEST STUDENT PAPER PRESENTATION

& END OF RADECS 2018

MEET YOUR RADECS 2018 COMMITTEE

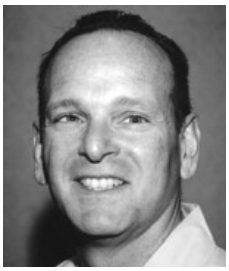
Sandi Habinc
Chairman
Cobham Gaisler

Robert Ecoffet
Advisor to Chair
CNES

Sven Raker
Advisor to Chair
Ariane Group

Christian Poivey
Technical Programme Chair
ESA

Richard Sharp
Advisor to TP Chair
Cobham RAD Europe



Ken LaBel
Topical Day Chair
NASA-NEPP

Joe Benedetto
VPT Components Chair

Teresa Farris
Local Arrangements
Cobham Semiconductor

Christian Chatry
Exhibit Chair
TRAD

Cristina Plettner
Exhibit Chair
Airbus

Steve McClure
Awards Chair
Jet Propulsion Laboratory

Vincent Pouget
Awards Chair
University of Montpellier

Philippe Paillet
RADECS Liaison
CEA

Jean-Luc Leray
Proceedings
CEA

Dan Fleetwood
IEEE Guest Editor
Vanderbilt

Carl Szabo
AV Coordinator

Tatiana Barataeva
Liaison Russia & Asia
TL ISDE

Mia Johansson
Publicity Chair
Cobham Gaisler

Mary Burdis
Web Developer
SBM

Paco Hernandez
Sports Authority
Cobham Gaisler

RADECS 2017-2022 STEERING GROUP

CONFERENCE INFORMATION

Europe's largest fully integrated hotel, exhibition and meeting facility. A global meeting point!

SVENSKA MÄSSAN
THE SWEDISH EXHIBITION & CONGRESS CENTRE

GOTHIA TOWERS

The Swedish Exhibition & Congress Centre/Gothia Towers
Visiting address: Mässans Gata/Korsvägen, SE-412 94 Göteborg, Sweden
Tel: +46 31-708 80 00, www.svenskamassan.se

LUNCH & BREAKS

RADECS 2018 will provide technical registrants lunch on Tuesday, Wednesday and Thursday in the conference venue, along with daily breaks.

VENUE - CONFERENCE HOTEL

The Swedish Exhibition & Congress Centre/Gothia Towers

4–Star modern hotel rooms - most with a magnificent view of the city.
Member of World hotels.

Book your room now!

RADECS 2018 ROOM BLOCK

is available from Thursday, September 13th through Saturday, September 22nd.

Visiting address:
Mässans gata 24
SE-412 94 Göteborg, Sweden
Switchboard: +031-750 88 00
www.gothiatowers.com

Book now!

https://online.gothiatowers.com/reserve/e/block/RAD160918/avail

DATE	RATE (Standard Room – Single)	RATE (Standard Room – Double)	RATE (Standard Small Room - Single)	RATE (Standard Small Room - Double)
Sept 13, Thur	1490 SEK	1690 SEK	1290 SEK	1490 SEK
Sept 14, Fri	1490 SEK	1690 SEK	1290 SEK	1490 SEK
Sept 15, Sat	1490 SEK	1690 SEK	1290 SEK	1490 SEK
Sept 16, Sun	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 17, Mon	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 18, Tues	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 19, Wed	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 20, Thur	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 21, Fri	1690 SEK	1890 SEK	1490 SEK	1690 SEK
Sept 22, Sat	1690 SEK	1890 SEK	1490 SEK	1690 SEK

The rates include:
Free Wifi
Fitness center access
VAT (12%)
Breakfast buffet

Children 12 and under are 100 SEK extra.

Cancellation is before 11:00 AM the day of arrival. If you have any questions please contact **room@gothiatowers.com** at Gothia or conference@gaisler.com

GETTING TO GOTHIA TOWERS FROM LANDVETTER AIRPORT:

Taxis: Typical price to Gothia Towers round trips is around 450 SEK.
Buses: Stop at Korsvagen at Gothia Towers/ Svenska Massan.

Bus Ticket type	App/Online	Full price
Adult, single	95 SEK	105 SEK
Adult, round trip	185 SEK	195 SEK
Youth, single	79 SEK	89 SEK
Youth, round trip	155 SEK	165 SEK
Adult, 10 One way	855 SEK	855 SEK

CONFERENCE REGISTRATION

Topical Day:
Monday, 17 September - Full day

Technical Sessions:
Start: Tuesday, 18 September - Morning
End: Friday, 21 September - Early afternoon

- All prices are shown in Swedish kronor (SEK).
- International delegates whose conference fee is paid by a VAT registered company do not pay Swedish VAT.
- Swedish VAT of 25% will be added to all other delegates conference fees.

ATTENDEE REGISTRATION >>

Attendee Type	Late (Aug 16-Sept 21)
Topical Day	4500,00 SEK *You will receive: 2 Receptions, Monday Lunch*
Technical Sessions	9600,00 SEK *You will receive: 2 Receptions, Gala Dinner, 3 Lunches*
Topical Day & Technical Sessions	14100,00 SEK *You will receive: 2 Receptions, Gala Dinner, 4 Lunches*

STUDENT REGISTRATION >>

Attendee Type	Late (Aug 16-Sept 21)
Topical Day	3400,00 SEK *You will receive: 2 Receptions, Monday Lunch*
Technical Sessions	6300,00 SEK *You will receive: 2 Receptions, Gala Dinner, 3 Lunches*
Topical Day & Technical Sessions	9700,00 SEK *You will receive: 2 Receptions, Gala Dinner, 4 Lunches*

COMPANION REGISTRATION >>

Attendee Type	Late (Sept 1-21)
Companion	2200,00 SEK *You will receive: 2 Receptions, Gala Dinner*

If you have any questions, please contact
congress.boras@resia.se >>
or conference@gaisler.com.

EXHIBITORS INFORMATION

Exhibit Chairs

Christian Chatry
TRAD
christian.chatry@trad.fr

Cristina Plettner
Airbus
cristina.plettner@airbus.com

EXHIBIT RULES & CANCELLATION DEADLINE

Please be aware of the Exhibit Rules and Cancellation deadline. If you have any questions please contact Cristina or Christian.

Cancellation Deadline: Cancellation after May 2, 2018, is non-refundable. If cancellation is made before May 2, 2018, you will receive a credit to your paid registration less the Cancellation Fee of SEK 1000 excl. VAT.

RADECS 2018 in Gothenburg, 16th-21st of September 2018 is a full 4 ½ day conference. RADECS will offer Technical and Poster Sessions and an Industrial Exhibit. We anticipate a strong attendance. RADECS is the most prestigious conference on Radiation Effects held in Europe!

RADECS sessions and exhibits are convenient to your Gothia Towers hotel room. Attendees will walk through the 40 exhibits to reach the Technical Sessions.

RADECS will host the daily breaks as well as an Exhibit Reception Tuesday evening in the Exhibit area. The Poster Sessions and Conference lunches are located next to the exhibit area.

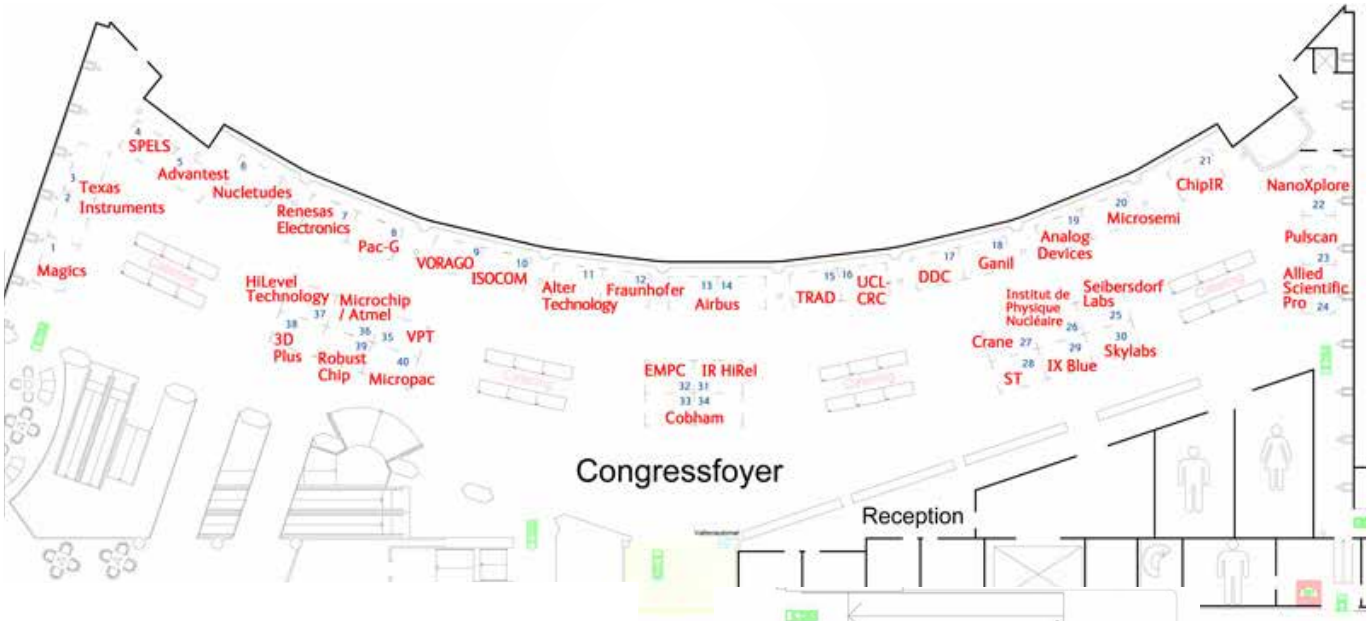
The tentative times for set-up of the Industrial Exhibition are:

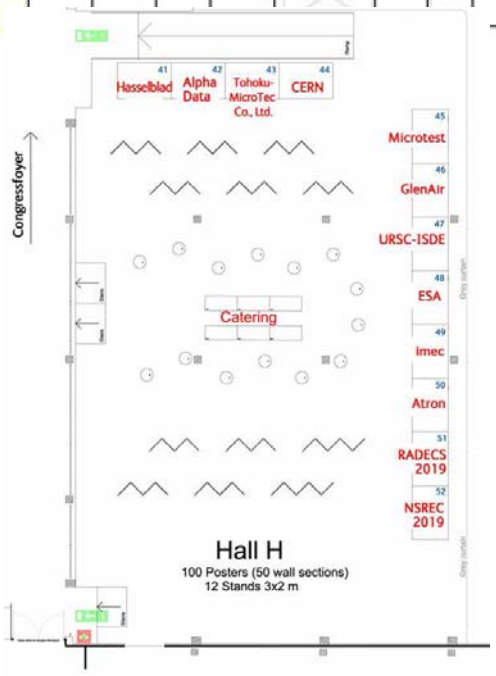
- Monday, 17th of September: 3:00- 5:00pm
- Tuesday, 18th of September: 7:30 – 8:30am

The RADECS Exhibitor Reception will be held Tuesday, 18th of September.

Exhibits will run through Thursday, 20th of September with tear down being in the afternoon.

LIST OF EXHIBITORS





EXHIBITORS - MAIN HALL (Alphabetical):

3D PLUS: 38
Advantest Europe GmbH: 5
Airbus: 13 & 14
Allied Scientific Pro: 24
Alter Technology Group: 11
Analog Devices GmbH: 19
ChipIR: Fast Neutron Test Facility: 21
Cobham: 33 & 34
Crane Aerospace & Electronics: 27
DDC: 17
EMPC: 32
Fraunhofer INT: 12
GANIL: 18
HiLevel Technology, Inc.: 37
Institut de Physique Nucléaire: 26
IR HiRel, An Infineon Technologies Company: 31
ISOCOM Limited: 10
iXblue: 29
Magics: 1
Microchip / Atmel: 36
Micropac Industries: 40
Microsemi: 20
NanoXplore: 22
Nucletudes: 6
Platform for Advanced Characterisation-Grenoble (PAC-G): 8
Pulscan: 23
Renesas Electronics (formerly Intersil): 7
Robust Chip: 39
Seibersdorf Labs: 25
Skylabs: 30
SPELS: 4
STMicroelectronics: 28
Texas Instruments: 2 & 3
TRAD: 15
Université Catholique de Louvain: 16
VORAGO Technologies: 9
VPT: 35

EXHIBITORS - HALL H (Alphabetical):

Alpha Data: 42
Atron: 50
CERN: 44
ESA: 48
GlenAir: 46
Hasselblad: 41
imec: 49
Microtest: 45
NSREC 2019: 52
RADECS 2019: 51
Tohoku-MicroTec: 43
URSC-ISDE: 47

If you have any questions regarding the exhibit please contact:
christian.chatry@trad.fr
cristina.plettner@airbus.com

EXHIBITOR BOOTH PACKAGE

BOOTH PACKAGE 2x3

BOOTH COST: SEK 38,000 (per booth)

Booth package:

- 2x3 meter shell scheme walls with:
  - Table
  - 2 chairs
  - Company name sign (adding logo is an additional charge)
  - Electricity
  - WiFi
  - Trash can
  - Exhibitor Manual to rent additional items will be provided
- Two complimentary registrations to RADECS 2018 Technical Sessions per booth, Tuesday-Friday, September 18-21
- NOTE: The Monday, September 20 Topical Day Course is not included, but may be purchased separately
- Entrance to the Monday, September 17, City Welcome Reception
- Entrance to the Tuesday, September 18, Exhibitors Reception
- Entrance to the Thursday, September 20, Gala Dinner
- Morning and Afternoon Coffee breaks - Tuesday, Wednesday, Thursday
- Lunches - Tuesday, Wednesday, Thursday
- Copy of the conference proceedings
- A hyperlinked logo on the RADECS 2018 website
- Sponsor opportunities

NOTE: Companion/Guest registrations for the social events can be purchased separately.

BOOTH PACKAGE 2x6

BOOTH COST: SEK 76,000 (per booth)

Booth package:

- 2x6 meter shell scheme walls with:
  - 2 Tables
  - 4 Chairs
  - Company name sign (adding logo is an additional charge)
  - Electricity
  - WiFi
  - 2 Trash cans
  - Exhibitor Manual to rent additional items will be provided
- Four complimentary registrations to RADECS 2018 Technical Sessions per booth, Tuesday-Friday, September 18-21
- NOTE: The Monday, September 20 Topical Day Course is not included, but may be purchased separately
- Entrance to the Monday, September 17, City Welcome Reception
- Entrance to the Tuesday, September 18, Exhibitors Reception
- Entrance to the Thursday, September 20, Gala Dinner
- Morning and Afternoon Coffee breaks Tuesday to Thursday
- Lunches Tuesday to Thursday
- Copy of the conference proceedings
- A hyperlinked logo on the RADECS 2018 website
- Supporter opportunities

NOTE: Companion/Guest registrations for the social events can be purchased separately.

RADECS GOTHENBURG 16th - 21st SEPTEMBER 2018

If you have any questions regarding the exhibit please contact:

christian.chatry@trad.fr or cristina.plettner@airbus.com

RADECS
GOTHENBURG
16th - 21st
SEPTEMBER 2018
MMXVIII

IF YOU WISH TO BE A RADECS 2018 SPONSOR, PLEASE CONTACT

Teresa Farris
Local Arrangements
Cobham Semiconductor
teresa.farris@cobham.com

HOW TO BE A SPONSOR

SPONSORSHIP OPPORTUNITIES:

Type	Cost
Official Sponsors	**SOLD OUT** Receives Publicity on Web pages, Email Blasts, Poster and AV Screen Signage
Pocket Brochure Sponsor	**SOLD OUT** Logo on Pocket Brochure Cover
Lunch Sponsors	**SOLD OUT** Signage at entrance and company flyer placed on attendees place mat
Registration Tote	**SOLD OUT** RADECS 2018 Registration Tote provided by sponsors
Lanyard Sponsors	**SOLD OUT** RADECS 2018 badge lanyard provided by sponsors

CURRENT SPONSORS

Official Sponsors

JPL
Jet Propulsion Laboratory
California Institute of Technology

CERN

Pocket Brochure Sponsor

HARRIS

Registration Tote Sponsor

TRAD
Tests & radiations

WIE Lunch Sponsor

OHB

Pens & Notepads Sponsor

Rymdstyrelsen
Swedish National Space Agency

Lunch and Lanyard Sponsor

Texas Instruments

Lunch Sponsors

Microsemi
Power Matters.

MICROPAC

City Reception sponsored by the City of Gothenburg

Göteborgs Stad

PRESS SPONSORS

Military Embedded Systems

How2Power.com

Military & Aerospace Electronics

SOCIAL PROGRAM RADECS 2018

SEPTEMBER
16
SUNDAY

Brunch Cruise

– In Gothenburg's archipelago. Departs from *Lilla Bommen* at **12:00** for a three hour brunch cruise.

Book ▸ STRÖMMA KANALBOLAGET

Welcome Reception

17:00-19:00

Please join us after you register for light refreshments and meet your fellow attendees. Registration will be at Gothia Towers Svenska Mässan.

SEPTEMBER
17
MONDAY

Mayor Reception

18:00 - 19:00 in "Imagine"

City Reception kindly sponsored by the City of Gothenburg

The City of Gothenburg hereby invites the delegates of the RADECS 2018 to a Welcome Reception. Representatives from the City of Gothenburg and of the Region Council will welcome you to Gothenburg by inviting you to a reception. Drinks and light snacks will be served.

Göteborgs Stad

SEPTEMBER
18
TUESDAY

Run Club Royal - Morning Jogging

06:30 Meet at Entrance; Mässans gata 24**.** No registration required, just show up!

Exhibit Reception

17:30-19:00

Please meet the RADECS Exhibitors to learn about their products, see their demonstrations, enter their raffles and enjoy refreshments!

SEPTEMBER
19
WEDNESDAY

Women In Engineering Lunch 12:00 - 13:30

LOCATION: "Bryggan"

You must have a ticket to attend!

Football Tournament & Orienteering

17:00 meet at Entrance, Mässans gata 24.

Location for Football: "Nya Ullevi", one of Sweden's largest football arenas. Come and play or come and cheer. Everyone is invited!

Please make sure to notify us by e-mail to: **francisco@gaisler.com** before 3rd of September, thank you!

SEPTEMBER
20
THURSDAY

Run Club Royal - Morning Jogging

06:30 Meet at Entrance; Mässans gata 24**.** No registration required, just show up!

Gala Social - RADECS Gala Dinner

17:45 buses start leaving for Eriksbergshallen (18.30-23.30)

The bus will leave from Svenska Mässan, Entrance 10. The bus will take you to Eriksbergshallen where you will experience an unforgettable night. The event will close at 23.30. Shuttle buses will bring you back to Gothia Towers and Svenska Mässan. Leave earlier using public transportation; either Älvsnabben boats or bus number 16.

SEPTEMBER
21
FRIDAY

Ruag Tour

Visit Ruag in Goteborg for a presentation and tour!

Attendees (limited to 25)
Bus leave at 13:15 to Ruag and will return to Gothia Towers at 15:30

SOLD OUT!

Together ahead. RUAG

BRUNCH CRUISE
IN GOTHENBURG'S ARCHIPELAGO

Saturday, 15th and/or Sunday, 16th of September 2018
Departs from Lilla Bommen at 12:00 for a three hour cruise
If you choose to walk to the harbor, please plan for a 45min-1hrs walk!
BOOK: https://**www.stromma.se**/en/gothenburg/dining-cruises/brunch-cruise/

From
SEK 490

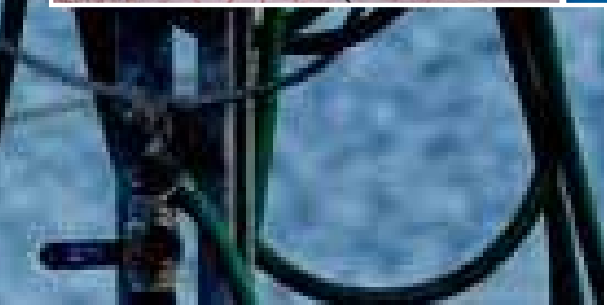
At noon every Saturday and Sunday *M/S Carl Michael Bellman* departs for a three hour brunch cruise in the Gothenburg archipelago.

Brunch buffet and a delicious dessert table
On the buffet table you will find everything from salmon and archipelago classical herrings to homemade meatballs, cheese platter and fresh salads. You have plenty of time to enjoy the delights – but make sure to leave some room for the desserts.

Relaxation and first class views
Sit back and enjoy the service and the beautiful environment. The comfortable and modern ship has a light and airy dining room with panoramic windows on the ground floor and offers you the unique view while the boat cruises through the archipelago. Upper deck with bar and lounge also houses a large sundeck where you can enjoy the sun and salty, fresh sea breezes.

One of Gothenburg's best brunches
Restaurateur Lotta Bäckström welcomes you with open arms to her restaurant on board. The brunch consists of fresh ingredients delivered in the morning and cooked on board.

Book



STRÖMMA KANALBOLAGET

www.stromma.se

RUN CLUB ROYAL
MORNING JOGGING

- Tuesday 6.30 am, Thursday 6.30 am
- Meet at Entrance of The Swedish Exhibition & Congress Centre, Mässans gata 24
- Contact point: fredrik@gaisler.com

Fredrik Sturesson
Cobham Gaisler
fredrik@gaisler.com

RUN CLUB ROYAL

Participants will meet on Tuesday and Thursday morning for jogging in the sunrise starting from the hotel and conference centre. We will split into pace groups. Details about routes will be provided on spot (pending weather).

We plan for two alternatives of routes: one flat in the city area on roads and one reaching out to the nearby recreation area including some elevation and tracks. Distance will be about 5km with possibility for short-cuts and extensions. The target duration is between 30 and 45 minutes.

No registration required, just show up 6.30 at the meeting point at the latest.

RADECS 2018 FOOTBALL **TOURNAMENT**

- 17:00, Wednesday, 19th of September
- Meet 17:00 at Entrance of The Swedish Exhibition & Congress Centre, Mässans gata 24
- Notify **francisco@gaisler.com** before the 3rd of September

Welcome to RADECS 2018 Football (soccer) Tournament!
After the successful events held at the RADECS Seville 2011, Oxford 2013, Bremen 2016 and Geneva 2017, we would like to invite you to participate in the RADECS 2018 Football Tournament.

The Tournament is free for all conference participants and companions. No footballing skills or experience is required. The aim of this event is to give you the opportunity to relax and have fun.

Come and play or come and cheer. Everyone is invited!

The Tournament will take place on Wednesday, 19th of September, at Gothenburg's "Nya Ullevi", one of Sweden's largest football arenas (https://gotevent.se/arenor/ullevi).

Going from the conference venue to the pitch is very simple, the arena is basically down the road from the conference centre. 15 minutes walk or 10 minutes using public transportation. A delegate from the RADECS committee will meet all players at the entrance of the conference centre and guide you to the pitch.

In case anyone is planning to get there on their own, the address is:
Ullevi, Ullevigatan, 41139 Göteborg.

We will have access to changing rooms and showers. Jerseys will be provided to all payers, but remember to **bring your football gear with you!**

The football tournament trophy award will take place during the conference dinner.

The Tournament can only take place if there are enough players/teams.
To help us make further arrangements, please make sure to notify us by e-mail to: francisco@gaisler.com before the 3rd of September, thank you.

Paco Hernandez
Sports Authority
Cobham Gaisler
francisco@gaisler.com

RADECS 2018 Park Orienteering Tournament

Wednesday, 19th of September
Ullevi, Ullevigatan, 41139 Göteborg
Notify **fredrik@gaisler.com** before lunch time Sept. 11th

Fredrik Sturesson
Cobham Gaisler
fredrik@gaisler.com

Richard Sharp
Cobham RAD Europe
Richard.Sharp1@cobham.com

Welcome to RADECS 2018 Park Orienteering Tournament!

We would like to invite you to participate in the RADECS 2018 Park Orienteering tournament on Wednesday September the 19th. This event will be held in parallel to the RADECS 2018 Football (soccer) Tournament.

Orienteering is a big sport in Sweden with more than 30,000 competitors of all ages, from 10 to above 90 years old. Most orienteering races take place in forests. However, the sprint distance modality is dedicated for parks or cities. An introduction to orienteering can be found at https://youtu.be/3S1a0IDOk4s. If time allows, a short presentation to orienteering will be given first thing in the morning or immediately before lunch on Wednesday the 19th of September at the conference centre.

This event is free for all conference participants and companions. No skills or experience is required. The aim of this event is to give you all the opportunity to have fun and try out this fantastic sport while socialising with other conference partakers. You can participate in this event individually or together with one or more friends in a team. **Come and join us!**

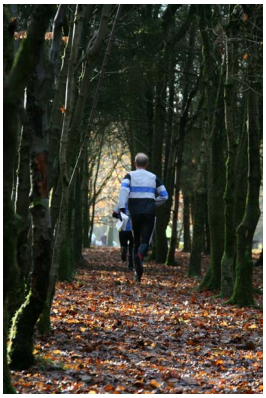
The park orienteering event will start and finish outside the "Nya Ullevi" football arena. Reaching the football arena is very simple. The arena is located down the road from the conference centre. 15 minutes' walk or 10 minutes using public transportation. A delegate from the RADECS committee will meet participants at the entrance of the conference centre and guide you to the location.

In case anyone is planning to get there directly, the address is:
Ullevi, Ullevigatan, 41139 göteborg.

No equipment will be needed, all you need is your shoes for walking, jogging or racing. You decide your pace!

Please register your participation via e-mail (fredrik@gaisler.com) before lunch time on Wednesday September the 11th and be part of this RADECS 2018 social event.

For any questions, please contact either Fredrik Sturesson (fredrik@gaisler.com) or Richard Sharp (Richard.Sharp1@cobham.com)



DIRECTIONS TO **ULLEVI ARENA**

How to get there?

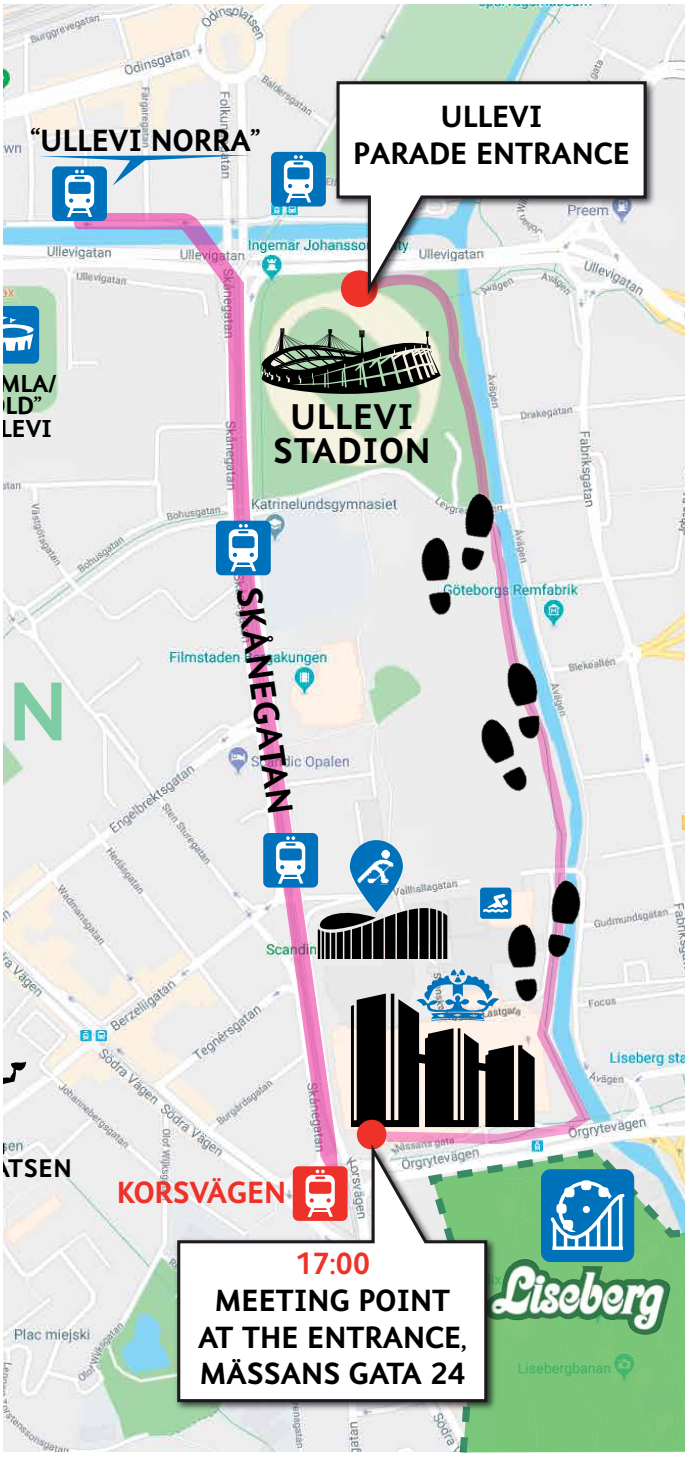
Walking:

Locate the Meeting Point at the Entrace “Mässans gata 24, Mässans gata/Korsvägen”. This has been denoted with a red point in your map. A delegate from the RADECS committee will be at the meeting point at 17:00 to guide you to the arena. Please don’t be late.

If you need/wish to make the way on your own, having your back to the entrance, turn left into Mässans gata (small road just in front of the Gothia Towers). Walk 300 metres down Mässans gata (i.e. pass the front of all the three hotel towers) until you reach a small bridge that crosses a water canal. Just before crossing the bridge, turn left into the pedestrian road that goes along the canal. Walk 950 metres down the pedestrian road. You will find Nya Ullevi arena on your left. You will need to walk pass the parking area of the arena towards the north side of the Stadium, towards Ullevigatan. You will find the “Parade entrance” to the arena on your left. There will be a delegate from the RADECS committee to meet all players at the entrance to the arena.

Public Transport:

Locate the Meeting Point at the Entrace “Mässans gata 24, Mässans gata/Korsvägen”. This has been denoted with a red point in your map. Having your back to the entrance, cross the road and walk to Korsvägen light-train stop. Because several light-trains “Spårvagn” and bussed make stop at this site, the site is divided into different stop locations labelled from A to E. All stop locations are clearly signed. Locate stop E “Läge E”. Take either light-train number 6 towards Kortedala (17:01, 17:12, 17:20, 17:29, etc…) or number 8 towards Angered (17:06, 17:15, 17:25, 17:34, etc…). Tickets must be bought in advance in any of the available shops or using the Västtrafik-To-Go mobile app (https://www.vasttrafik.se/biljetter/mer-om-biljetter/vasttrafik-to-go/). The cost of a single ticket is approximately 30 swedish crowns. Jump off the light-train at the third stop “Ullevi Norra”. The journey takes approximately 5 minutes. From Ullevi Norra, head southwest on Stampgatan toward lilla Stampgatan. Turn right toward Ullevigatan. The arena should be right in front of you. Turn left onto Ullevigatan and walk approximately 120 metres. The entrance to the arena (Parade entrance) should be visible on your right-hand side.



DISCOVER GOTHENBURG

On the following pages you will find suggestions for local activities during your stay in Gothenburg.
For more detailed information, please visit: **www.goteborg.com**

All information presented below has been retrieved from www.goteborg.com

GOTHENBURG (GÖTEBORG) is the second largest city in Sweden with a population of 550,000. Located on Sweden's west coast, it is on the doorsteps of a beautiful archipelago.

THE CULINARY CITY
Discover Gothenburg's amazing cafés, bars and restaurants.
World class restaurants, experimental food rebels, trendy bars and a rolling armada of food trucks – Gothenburg has it all. Book your trip, skip lunch and come hungry.

INTERNET & WIFI
There are several wifi hotspots around Gothenburg that gives you internet access.
https://www.goteborg.com/en/good-to-know/internet-and-wifi/

GOTHENBURG ARCHIPELAGO
From the city centre to the islands.

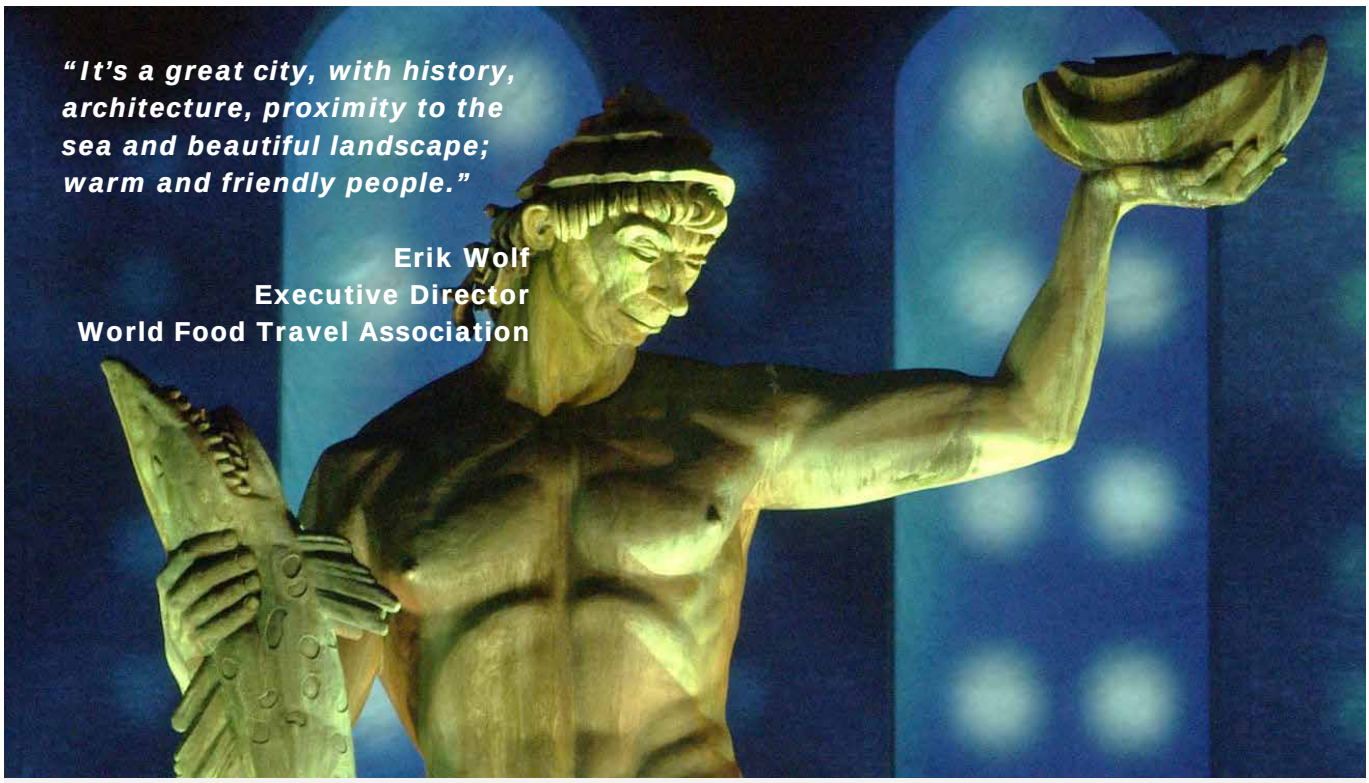
You'll reach the car-free southern islands by ferry from Stenpiren Travel Centre or the boat terminal Saltholmen. To get to the northern islands you take the ferry from Lilla Varholmen on Hisingen.

FESKEKÔRKA
A Mecca for seafood-lovers.

The fish market hall Feskekôrka, ('fish church' in Swedish) is an indoor fish and shellfish market where you can buy all kinds of sea-food delicacies caught on the day.

TAKE A WATERSIDE CITY TOUR ON THE PADDAN BOAT

This classic tour with a Paddan canal boat winds around the moat and canals of the city.



"It's a great city, with history, architecture, proximity to the sea and beautiful landscape; warm and friendly people."

Erik Wolf
Executive Director
World Food Travel Association

POSEIDON, THE SEA GOD, BY CARL MILLES
is one of Gothenburg's most famous landmarks situated at the top of the main boulevard Avenyn at the square Götaplatsen. The statue was inaugurated in September 1931.

THE SQUARE GÖTAPLATSEN
was contructed for the World Fair in Gothenburg in 1923 and a fountain was placed in the same location as Poseidon, before the statue was inaugurated nearly ten years later. The square is surrounded by beautiful buildings on three sides: **THE CONCERT HALL, THE CITY THEATRE AND GOTHENBURG MUSEUM OF ART.**

DISCOVER A WORLD OF DESIGN IN GOTHENBURG
Exciting design shops that will inspire you.
Gothenburg is a vibrant and creative city full of inspiring design shops. Here you will find everything from artisanal ceramics to iconic furniture pieces.

LISEBERG

Scandinavia's largest amusement park.

There is something for everyone at Liseberg, where you'll find the most fun in Scandinavia. Forty-one rides and attractions offer thrills, spills and laughter for kids and grown-ups.

TRÄDGÅRDSFÖRENINGEN

A beautiful garden located in the heart of the city.

The Garden Society of Gothenburg, Trädgårdsföreningen, is one of the best preserved 19th century parks in Europe.
Here you can find thousands of roses, carpet beddings and lush woodlands. The palm house from 1878 houses exotic plants in a Mediterranean climate.

TAKE A 'FIKA BREAK' IN HAGA

This charming neighbourhood has a wonderful selection of cafés and small artisan shops. You might like to try a giant cinnamon bun on Haga Nygata.

THE NEW YORK TIMES TRAVEL PORTRAIT

36 Hours in Gothenburg, Sweden

Jazz, street murals, distinctive architecture and world-class breweries in Sweden's second-largest city.

Go to online article

Ingrid K. Williams
for The New York Times
May 10, 2018

OFFICIAL REVIEWERS RADECS 2018

LAST NAME, FIRST NAME, E-MAIL

A Adell, Philippe
Al-Youssef, Ahmad
Andjelkovic, Marko
Arai, Yasuo
Artola, Laurent
Auden, Elizabeth

B Bagatin, Marta
Balbekov, Anton
Barbero, Juan
Beaumel, Matthieu
Begards, Frederic
Bird, John
Boatella-Polo, Cesar
Bosser, Alexandre
Buchner, Stephen

C Carriere, Thierry
Casey, Megan
Caussanel, Matthieu
Chatry, Natahlie
Chatterjee, Indranil
Chaumont, Geraldine
Chen, Dakai
Chubunov, Pavel
Chugg, Andrew
Clark, Lawrence
Clements, Keith
Costantino, Alessandra
Cueto, Juan

D Danilov, Igor
Danzeca, Salvatore
Davies, Robert
Deaton, Terry
Diggins, Zachary
Dooley, Maryanne
Dusseau, Laurent

E Ecoffet, Robert

F Ferlet-Cavrois, Veronique
Fisher, Jonathan
Fox, Brian

G Goldflam, Rudolph
Gomez-Rjoas, Luis
Gonzalez-Velo, Yago
Gouyet, Lionel
Graves, Russel,
Green, Janet
Gruermann, Kai
Guertin, Steve
Guild, Timothy
Guillermin, Jeremy

H Hansen, Dave
Hartig, Matthias
Hartojo, Kris
Hatch, Joel
Heynderickx, Daniel
Hoeffgen, Stefan
Huston, Stuart
Hynne, Jan-Magne

I Irom, Farokh

J Javanainen, Arto
Jiggens, Piers
Jones, Brian
Jun, Insoo

K Kauppila, Jeffrey
Kelly, Andrew
Kettunen, Heikki
Khachatrian, Ani
King, Michael
Kobayashi, Daisuke
Kobayashi, Kazutoshi
Koga, Rocky
Koziukov, Aleksandr

L Kuhnhenn, Jochen
Laa, Christian
Ladbury, Raymond
Lalumondiere, Stephen
Lewandowski, Simon
Li, Xingji
Likar, Justin
Lima Kastensmidt
Liu, Hongmin
Loveless, Daniel
Lueck, Volker
Lum, Gary

M Makino, Takahiro
Mancini, Roberta
Mangeret, Renaud
Marinoni, Mathias
Martinez, John
Martin Holgado
Massengill, Lloyd
Maximov, Igor
McMorrow, Dale
Melotte, Michel
Messenger, Scott
Mikkelson, Eric
Miller, Florent
Miller, Kyle
Moll, Michael
Morilla, Yolanda
Moscatello, Marie-Helene

N Narasimham, Balaji

O O'Donnell, Hugh

P Pater, Lee
Petrov, Konstantin
Plettner, Cristina
Poizat, Marc
Potter, Barrett
Privat, Aymeric
Prodhomme, Thibaut

R Raine, Melanie
Ratti, Lodovico
Rech, Paolo
Rezzak, Nadia
Rodriguez, Juan
Roed, Ketil
Romaniuk, George
Roussos, Elias

S Salzman, Jim
Samaras , Anne
Sanchez, Ivan
Sandberg, Ingmar
Schaefer, Justin
Scheick, Leif
Schlenvogt, Garrett
Scoby, Cheyne
Shindou, Hiroyuki
Shunkov, Valeriy
Sicard, Angelica
Solsjo, Olivia
Srour, Joe
Standarovski, Denis
Stefanov, Konstantin

T Tilhac, Frederic
Tostanoski, Mike
Tran-Thi, Chiara
Truscott, Pete
Tsiligiannis, Georgios
Tumlinson, Jessica
Turflinger, Thomas
Turowski, Marek

V Vermeire, Bert
Virmontois, Cedric

W Wang, Jih-Jong
Wang, Liang
Weigand, Roland
Wrobel, Frederic

X Xiao-Wang, Pierre
Xuan-Zhang, Cher

Z Zadeh, Ali
Zheng, Yihua