
RADECS 2017
CERN, Geneva
CICG
Geneva, Switzerland
October 2nd - 6th 2017
CONFERENCE
PROGRAMME

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Message of the Conference Chair

Dear RADECS participants,

It is my pleasure welcoming you to this years' RADECS 2017 conference, held October 2nd – 6th 2017 at the CICG (Centre International de Conféerences de Genève) in Geneva, Switzerland. This is the first time that RADECS is being held in Switzerland and we truly hope that you will enjoy your stay.

Following RADECS now for several years, I appreciate RADECS as a scientific melting pot, at the same time bringing industrial exhibitors together, initiating contracts, collaborations and paving the way to tomorrow's requirements. In short, the place to be with plenty of opportunities.

From <Space to Ground and Below> is this years' conference theme, nicely fitting to the various application areas we all are concerned with. We'll start the week with a corresponding Short-Course with a large number of contributing authors across scientific and industrial fields. Along the same lines, a record number of submitted papers allowed us to compile for you a rich and dense technical programme, featuring also a few new sessions I cordially invite you to discover.

In good old RADECS tradition, we seek taking you along a journey throughout the week, including several invited talks, a daily evening programme, technical visits to CERN and finally a proposed social programme for accompanying people.

Located in the very heart of Europe, Switzerland is at the crossroad of the Alps and the Jura mountains and the home of magnificent glaciers, lakes and a picturesque landscape. In line with our conference theme, it is also a crossroad of cultures, scientific institutions and international organizations we invite you to discover not only during, but also before and after with the conference.

I take the occasion thanking the many people involved in the preparation of this conference. It is hard to express my gratitude to all of them, making events like this possible.

Enjoy the fruits of their efforts,

Markus Brugger
Conference Chair, RADECS 2017

How to get to the Conference Center
(CICG)

CICG profits from a privileged situation in the proximity of the Place des Nations, of main International Organisations and permanent missions based in Geneva.

The access is facilitated by good public transport services. The CICG is situated only 5 kilometres away from the international airport and from the Cornavin main railway station, in downtown.

PUBLIC TRANSPORT FROM THE INTERNATIONAL AIRPORT:

Take a free public transport ticket from the machine you will find at the exit of the baggage collection hall, just before customs control.
See the TPG web site for full details. **www.tpg.ch**

Bus 5 : Direction Thônex-Vallard. Bus stop «Vermont»
Bus 28 : Direction Jardin Botanique. Bus stop «Nations»

PUBLIC TRANSPORT FROM CORNAVIN MAIN RAILWAY STATION:

Bus 5 : Direction Aéroport. Bus stop «Vermont»
Bus 8 : Direction Nations. Bus stop «UIT»
Tramway 15 : Direction Nations. Stop «Nations»

How to get to CERN

PUBLIC TRANSPORT FROM THE INTERNATIONAL AIRPORT:

Take a free public transport ticket from the machine you will find at the exit of the baggage collection hall, just before customs control.
See the TPG web site for full details. **www.tpg.ch**

Taxi (from airport to CERN): approximately 35CHF.

Bus Y (direction CERN): Get off at the end of the line,
you will see the large Globe of CERN.

Bus 23, 28 or 57: Get off at station «Blandonnet»,
then catch **Tramway 18** to the end of the line CERN

PUBLIC TRANSPORT FROM CORNAVIN MAIN RAILWAY STATION:

Take the **Tramway 18** Direction CERN and get off at the end of the line «CERN».

Tickets are to be bought at the ticket machines (coins, or credit cards), located at every bus or tram stop in the city.
The most common ticket is valid for 60 minutes and is transferable (CHF 3).

BY CAR:

GPS location:
Address: 385, route de Meyrin, Meyrin, Switzerland
Reception: Lat: 46.233058, Long: 6.055692

From the Swiss side:
Follow «Aeroport», «Lyon» or «Meyrin». When in Meyrin head for «St. Genis» (which is just across the border in France). Before you get to St. Genis, CERN is on the left hand side of the «route de Meyrin», just before the border crossing.

From the French side:
Follow «Gex» or «St. Genis». When in St. Genis head for the border. CERN is on your right hand side immediately after the border crossing.

Accommodation

When you stay in a hotel, a youth hostel or a campsite in the canton, you will receive a «Geneva Transport Card» free of charge. With this card, public transport in Geneva is free for the full duration of your stay. This personal and non-transferable card will be given to you when you arrive at your accommodation. It permits unlimited travel on Geneva's public transport network (UNIRESO: bus (TPG), train (CFF) and boat (Mouettes Genevoises)) for the duration of your stay.

Stars	Address	Name
5	Quai Turrettini 1, 1201, Geneve	Mandarin Oriental
5	Route de Pré Bois 20, 1215, Geneva	Mövenpick Hotel
4	Avenue Louis Casaï 75-77, 1201, Geneva	Crowne Plaza
4	Rue de Lausanne 41-43, 1201, Geneva	Hotel Royal
3	Rue de la Navigation 27, 1201, Geneva	Hotel Kipling
3	Avenue Louis Casaï, 1201, Geneva	Novotel Suite
3	Route de Suisse 77, 1290, Versoix	Lake Geneva Hotel
3	Rue Rotschild 55, 1202, Genevae	Hotel Jade
3	Place de Cornavin 8, 1201, Geneva	Ibis Style
3	Les champs blancs, 1279, Chavannes de Bogis	Best Western Chavannes
2	10 Chemin de la Violette, 1216, Geneva	Ibis Airport
2	Rue du Grand Pré 33-35, 1201, Geneva	Ibis Nations
2	Chemin des Olliquettes 8, 1213, Geneva	Ibis Petit Lancy
2	Rue Voltaire 10, 1201, Geneva	Ibis Centre Gare
1	Avenue Louis Casaï 30, 1216, Geneva	Ibis Budget Balexert
1	Chemin des Olliquettes 6, 1213, Geneva	Ibis Budget Petit Lancy

Additional information on the website
www.radecs2017.com/Radecs2017/Accomodation.php

Conference Chairs

M. BRUGGER - CERN
General Chair

J. MEKKI - CNES
Technical Chair

Vice Conference Chairs

R. G. ALIA - CERN
Vice General Chairman

F. ANGHINOLFI - CERN
Vice Technical Chairman

Short Course Chairs

F. FACCIO
CERN

A.TOUBOUL
Montpellier University

Industrial Exhibition & Sponsoring

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Cobham

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Sponsorship

We would like to thank our sponsors, supporters and exhibitors for their constant support and generosity.

Our team appreciates your contribution and will be glad to see your representatives in **Geneva at Centre International de Conférences Genève (CICG)**

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REPUBLIQUE ET CANTON DE GENEVE

Conference General Information

Welcome to **RADECS 2017** and **Geneva**! Some call it the «world's smallest metropolis», others, the «peace capital». Whatever image it brings to mind, Geneva has always been a popular destination. Better known throughout the world as the United Nations' European headquarters and the head office of the International Committee of the Red Cross, our city draws thousands of people each year to events such as conferences, conventions and meetings.

Geneva is the smallest of the world's major cities. It is a world apart, with something for everyone. Located in the very heart of Europe, **Switzerland** is at the crossroad of the Alps and the Jura mountains and the home of magnificent glaciers, lakes and a picturesque landscape. It is also a crossroad of cultures, scientific institutions and international organizations that along provide an ideal location to promote research in the field of radiation and its effects on materials, components and systems!

The conference will be held at the **International Conference Centre of Geneva (CICG)**. The **CICG** is conveniently located near the International Airport and major highways, the railway station, the international organizations, Lake Geneva and the historic old town. A vast choice of hotels offers your guests and associates first-rate hospitality just a stone's throw from the conference centre.

The conference is hosted by **CERN**, **The European Organization for Nuclear Research**, physicists and engineers are probing the fundamental structure of the universe. The CERN uses the world's largest and most complex scientific instruments to study the basic constituents of matter – the fundamental particles. The particles are made to collide together at close to the speed of light. The process gives the physicists clues about how the particles interact, and provides insights into the fundamental laws of nature.

Founded in 1954, the CERN laboratory sits astride the Franco-Swiss border near Geneva. It was one of Europe's first joint ventures and now has 22 member states.

CICG address: 17 rue de Varembé CH - 1211 Genève 20
www.cicg.ch/en

CERN address: 385 Route de Meyrin 1217 Meyrin
home.cern

Registration

THE REGISTRATION FEES FOR THE SHORT COURSE ON DATE INCLUDE:

- Pass to Short Course
- Coffees Breaks and Lunch on date

THE REGISTRATION FEES FOR THE TECHNICAL SESSIONS INCLUDE:

- Pass to Technical Sessions, Round Tables and Industrial Exhibition
- Coffees Breaks and Lunches from October 3 to 6, 2017
- Pass to the social program: Welcome Reception, Industrial Cocktail and Conference Dinner

The registration fees for the Short Course and Technical sessions from October 2 to 6, 2017 include all opportunities from both categories.

NOTICE! If you would like to invite an accompanying person to go with you to the RADECS-2017 social program (Welcome Reception, Industrial Cocktail and Conference Dinner), you have to fill in the on-line registration form as Accompanying person category. The RADECS-2017 conference is being organized in accordance with the RADECS Association rules.

Organisers do not take any liability for loss, theft or damage to personal belongings and to equipment during the Conference; should not be liable to the participant for any special, consequential or incidental damages (personal injury or accident) howsoever arising during the period of the Conference It is the responsibility of the participants to take out medical insurance as well as liability insurance on their own

IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT:

Vitalis Events SA
Telephone: +41 22 519 08 00
E-mail: contact@radecs2017.com

Vitalis events

CICG Floor Plans

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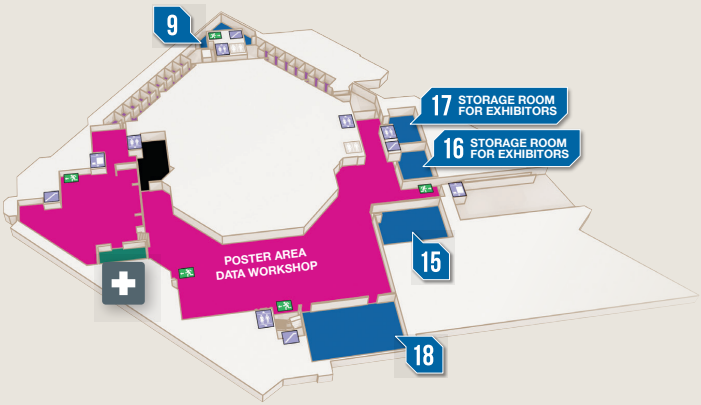

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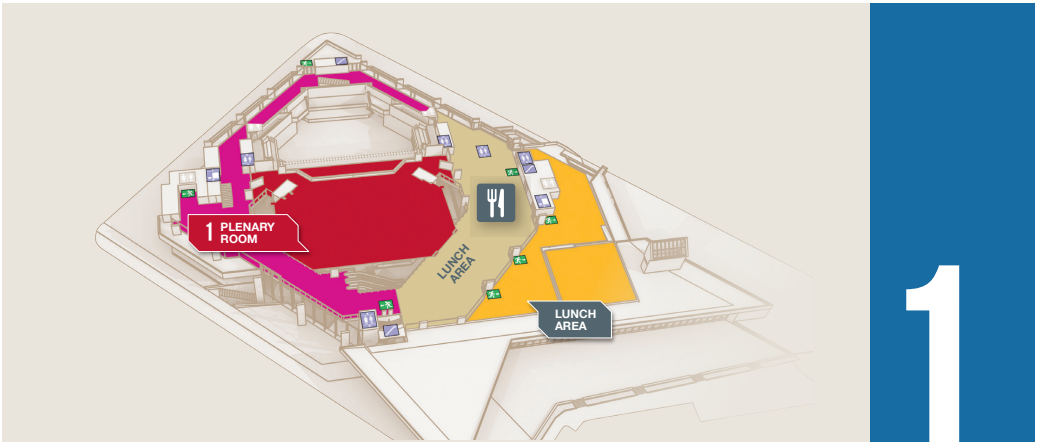
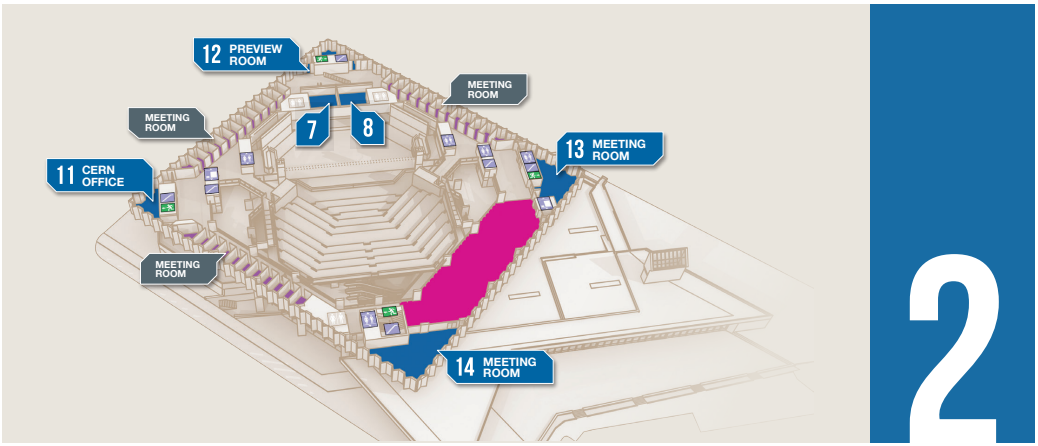
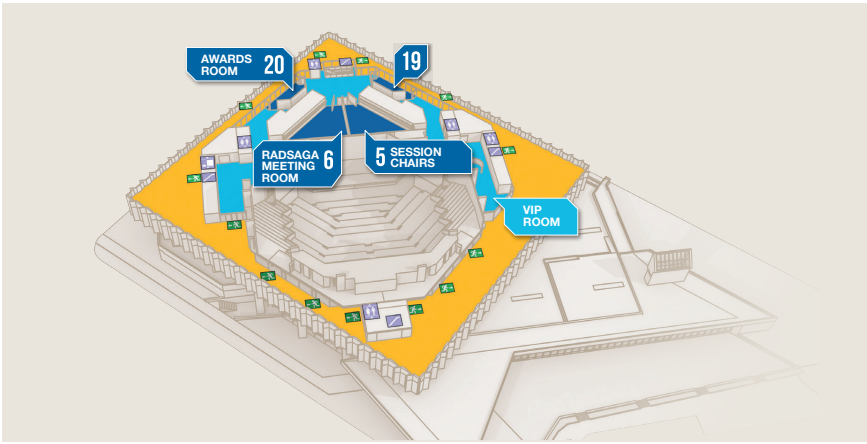
CICG Floor Plans





CICG Floor Plans



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Conference Programme

October 01 (SUNDAY) CICG	October 02 (MONDAY) CICG	October 03 (TUESDAY) CICG
		RADSAGA Student Breakfast Lecture 07h30 - 8h30
	Registration 08h00 - 16h30	Registration 08h00 - 16h30
	Short course Introduction 08h30 - 08h45	Conference Opening & Welcome 08h45 - 09h35
	G.Santin: Radiation environments: Space, Avionics, Ground and Below 08Hh45 - 10H	Session A. In-orbit Low Cost Radiation Studies 09h35 - 10h40
	Coffee Break	Coffee Break
	D.Fleetwood: Evolution of Total Ionizing Dose Effects in MOS Devices with Moore's Law Scaling 10H30 - 11H25	Session B. Radiation Effects on Optoelectronics and Photonics Devices 11h10 - 12h40
	F.Ravotti: Dosimetry Techniques and Radiation Test Facilities for Total Ionizing Dose Testing 11H25 -12H20	Opening of the Industrial Exhibition 12h00
	Lunch (CICG)	Lunch (CICG)
	C.Virmontois: Displacement Damage in Optoelectronics Devices Dedicated to Space Applications 13H30 - 14H25	Session C. Basics Mechanisms 14h00 - 15h20
	M.Moll: Displacement Damage in Silicon Detectors for High Energy Physics 14H25 - 15H20	
	Coffee Break	Coffee Break
	A.Carvalho: Industrial Point of View for Space Applications: Best Practices from Parts Selection to Flight 15h50 - 16h35	Round Table. Engineering Troubleshooting (1/2) 15h50 - 16h40
Registration 16h00 - 18h00	S.Uznanski: Qualification of Electronics Components for a Radiation Environment with Focus on Single Event Effects: When Standards do not Exist - High Energy Physics 16H35 - 17H25	Departure to EPFL (by bus) 16h40 - 17h30
	Women In Engineering Event 17H30 - 18H45	Welcome Reception - Swiss Tech / EPFL SWISS SPACE NIGHT Invted Talks: Claude Nicollier (Swiss Astronaut) CNES Proxima & CubeSat Exhibition (Lausanne) 17h30 - 23h00
	RADSAGA/RADECS Student Event (CERN Globe) 20H00 - 23H00	Industrial Exhibition 12h00 - 17h30

Conference Programme

October 04 (WEDNESDAY) CICG	October 05 (THURSDAY) CICG	October 06 (FRIDAY) CICG
RADSAGA Student Breakfast Lecture 07:30 - 8:20	RADSAGA Student Breakfast Lecture 07:30 - 8:20	
Registration 08:00 - 16:30	Registration 08:00 - 16:30	Invited Talk C. Rembser The miraculous world of particle beams at CERN 08:30 - 09:30
Invited Talk E. Klein What is the universe made of ? 08:30 - 09:30	Session H. Single Event Effects in Devices and Integrated Circuits 08:30 - 10:05	Session K. Radiation Hardness Assurance at Device and System levels 09:30 - 10:50
Session D. Radiation Effects on Materials 09:30 - 10:35		
Coffee Break	Coffee Break	Coffee Break
Session E. Single Event Transients and Laser Testing 11:05 - 12:10	Session I. Single Event Effects - Mechanisms and Modelling 10:35 - 11:40	Session L. Radiation Environments (Space, Atmospheric, Terrestrial and Accelerators) 11:20 - 12:25
Round Table. Engineering Troubleshooting (2/2) 12:10 - 12:45	Session J. Facilities and Dosimetry 11:40 - 12:45	End of Conference Closing Remarks 12:25 - 13:00
Lunch (CICG)	Lunch (CICG)	
Session F. Radiation effects in Devices and Integrated Circuits 14:00 - 15:20	Invited Talk R. Baumann Funny stories from terrestrial radiation effects 14:00 - 15:00	Departure to CERN (by bus) Only CERN Visits (14:30) and RADSAGA participants (15:00)
Session G. Radiation Hardening By Design 15:20 - 16:25	Poster and DataWorkshop Session With Coffee 15:00 - 17:00	**INFORMATION:** **CERN VISITS:** Mon - Wed - Thu 13:30 - 17:30 Fri 8:00 - 12:30 & 14:30 - 18:00 **Soccer Tournament** Satigny Pitch - Saint Genis Pouilly Mon 18:30 - 21:00
Poster and DataWorkshop Session With Coffee 16:25 - 18:30	RADECS Association General Assembly 17:00 - 18:30	
Industrial Reception CICG - Geneva 18:30 - 20:30	Conference Dinner Hôtel Président Wilson & Invited Talk with Anilore Banon (Geneva) 20:00 - 24:00	
Industrial Exhibition 8:30 - 20:30	Industrial Exhibition 8:30 - 19:00	

Conference General Chair

M. BRUGGER

obtained his master degree in 1999 from the Technical University, Graz, Austria, finalizing his master studies at CERN with the level-1 Trigger for the CMS experiment. He received his PhD in Theoretical Physics for activation modelling and benchmarking of Monte-Carlo codes working with the CERN radiation protection group. Building on his experience he then moved to the CERN FLUKA team in the context of the LHC machine to perform final design studies for LHC. In the context of the latter, as from 2008 he got more and more involved in radiation damage to electronics issues and raised possible respective constraints for the LHC machine, finally requiring significant mitigation measures to be implemented during the past years. Since 2010 he is the project leader of the 'Radiation To Electronics' (R2E) project for the CERN Accelerator and Technology Sector, with work spanning from radiation shielding, radiation monitoring, radiation testing, the construction of new test facilities and radiation tolerant developments of various critical LHC systems. Radiation to electronics, soon extended to radiation damage in general where he implemented a new CERN coordination and support structure. In the above listed context he has authored or co-authored more than 100 papers in various journals, conferences and workshops and is also regular reviewer for several related journals.

Monday Short Course Programme

08:00-16:30	Registration
08:30-08:45	Short Course Introduction
08:45-10:00	G. Santin: Radiation Environments: Space, Avionics, Ground and Below.
10:00-10:30	**Coffee Break** CICG Level 0 - Exhibits Area
10:30-11:25	D. Fleetwood: Evolution of Total Ionizing Dose Effects in MOS Devices with Moore's Law Scaling.
11:25-12:20	F. Ravotti: Dosimetry Techniques and Radiation Test Facilities for Total Ionizing Dose Testing.
12:20-13:30	**Lunch Break**
13:30-14:25	C. Virmontois: Displacement Damage in Optoelectronics Devices Dedicated to Space Applications
14:25-15:20	M.Moll: Displacement Damage in Silicon Detectors for High Energy Physics
15:20-15:50	**Coffee Break** CICG Level 0 - Exhibits Area
15:50-16:35	A. Carvalho: Industrial Point of View for Space Applications: Best Practices from Parts Selection to Flight
16:35-17:10	S. Uznanski: Qualification of Electronics Components for a Radiation Environment with Focus on Single Event Effects: When Standards do not Exist – High Energy Physics
17:10-17:20	Conclusion by the Short Course Chairs

WIE (Women In Engineering Event) CICG Level 1, Room 1 . . . . . **17:30-18:45**

SOCCER TOURNAMENT Savigny Pitch **18:30-21:00**

STUDENT EVENT CERN-Globe **19:30-22:00**

Short Course General Information

Following a long RADECS tradition, a full-day short course is organized on the first day of the RADECS 2017 conference. Intended for both beginners in the field and experienced scientists, the course will cover a variety of radiation effects seen from the different perspective of experts involved in applications sharing the common constraint of radiation tolerance: Space, Avionics, Ground, and High Energy Physics. This unique opportunity to learn from renowned professionals is conceived to expose the attendees to both basic mechanisms and best practices as they have been explored and developed in the different communities over the last decades. The ambition is to enlarge the limited representation of radiation effects our daily activities in a specialized field generates, and extend it to embrace the much richer, complex and – alas – often surprising reality.

SHORT COURSE CHAIRS

ANTOINE TOUBOUL

received the Ph.D. degree from Montpellier University in 2005. He worked in 2006 with Vanderbilt University, Nashville, TN, USA, as a research associate. Associate Professor at Montpellier University since 2006, he obtained the “HDR” (accreditation to supervise research) in 2013 and is currently Head of the technological school of engineering of Montpellier.
He is a specialist of oxide degradation under electrical or radiative stress. His research activities mainly focus on radiation effects on power devices and systems for space, aeronautic and terrestrial applications

DR. FEDERICO FACCIO

received the M.S. degree in physics from the University of Turin, Italy, in 1991 and the Ph.D. degree from the National Polytechnic Institute, Grenoble, France, in 1997.
He joined the Microelectronics Group at the European Centre for Nuclear Research (CERN) in 1991, where he has been mainly involved in the study of the radiation effects on semiconductor devices and technologies. As a microelectronics circuit designer, he has participated over the years in the development of different radiation-hard ASICs for the CERN experiments at the LHC accelerator: ADCs, optical receivers and data recovery circuits, linear regulators and DCDC converters. He is now leading an R&D project for the development of a radiation and magnetic field tolerant DCDC converter, and he is acting as senior engineer in the CERN efforts to select and qualify deep submicron CMOS technologies for use in harsh radiation environments.

Short Course Speakers

DR. GIOVANNI SANTIN

received his Bachelor's and his PhD degrees in physics from the University of Trieste, Italy. He worked at CERN (for the University of Geneva) and the University of Lausanne, before joining the European Space Agency in 2002 as a consultant from RHEA System, and is currently an analyst in the Space Environments and Effects Analysis section of ESA/ESTEC. Giovanni's current research interests are in the radiation monitoring, environment models, radiation transport and effects modelling for manned and unmanned missions.. He is a specialist in radiation transport codes for Monte-Carlo simulations. His work has supported the ESA Cosmic Vision mission to Jupiter, including radiation assessments and countermeasures against the harsh particle environment. He is responsible also for several developments aimed at improving spacecraft radiation effects predictions, and at making advanced Geant4-based physics and analysis techniques available and viable in engineering environments.

RADIATION ENVIRONMENTS: SPACE, AVIONICS, GROUND AND BELOW.
08:45-10:00

Dr. Giovanni Santin from ESA/ESTEC and RHEA System, in collaboration with Dr. Pete Truscott from Kallisto Consultancy, Dr. Remi Gaillard, Consultant, and Dr. Rubén Garcia Alia from CERN, will cover the similarities and distinctive traits of the diverse radiation environments to which electronics and humans are exposed in space, avionics, ground systems and at accelerators. For space, an introduction to new models for traditional Earth orbit scenarios shall be complemented with a discussion of challenges brought by extreme events, or by radiation exposure in ambitious deep space exploration programmes, including Jupiter missions or planetary habitats. The atmospheric environment will also be described with its implications on avionics reliability and radiation protection. The requirements posed by radiation at ground level to the development of high reliability systems will be addressed. The journey will end at underground modern accelerators with a review of the constraints imposed by the mixed radiation field on the design and operation of both detectors and accelerator systems.

Short Course Speakers

PROF. DAN FLEETWOOD

is the Landreth Professor of Electrical Engineering and Physics, Vanderbilt University. His research interests include ionizing radiation effects in microelectronic devices and materials, radiation hardness assurance test methods, interface charge trapping, single-event effects, and radiation effects modeling and simulation. He was a Member of the Technical Staff at Sandia National Laboratories from 1984 to 1999, and named Distinguished Member of the Technical Staff in 1990. He joined Vanderbilt University as a Professor of Electrical Engineering in 1999, and has served as Chair of the Electrical Engineering and Computer Science Department since 2003. He is the author or co-author of more than 500 publications on radiation effects in microelectronics and low frequency noise, 11 of which have been recognized with Outstanding Paper Awards at the IEEE Nuclear and Space Radiation Effects or Hardened Electronics and Radiation Technology Conferences. These papers have been cited more than 16,500 times (h = 72), according to Google Scholar. He received the IEEE Nuclear and Plasma Sciences Society's Merit Award in 2009, which is the society's highest technical honor, and is a Fellow of both the IEEE and American Physical Society.

EVOLUTION OF TOTAL IONIZING DOSE EFFECTS IN MOS DEVICES WITH MOORE'S LAW SCALING.
10:30-11:25

Prof. Dan Fleetwood from Vanderbilt University will present an overview of the basic mechanisms of MOS TID radiation response. These include charge generation, transport, trapping, and annealing. The nature of oxide, interface, and border traps in SiO2 will be discussed, from both the perspectives of defect microstructure and hardness assurance testing. Effects will be considered that occur at very high doses, e.g., in high-luminosity particle-accelerator applications, but are typically not observed below ~ 1 Mrad(SiO2). Charge trapping in high-K dielectrics in Si-based and alternative-channel devices will be briefly reviewed, with an emphasis on effects in advanced gate stacks and emerging nanoscale technologies. Finally, progress will be highlighted in modeling and simulation of radiation effects enabled by the rapid advances in computing technology and computational methods that have occurred over the last 50+ years due in large part to Moore's Law scaling.

Short Course Speakers

Dr. FEDERICO RAVOTTI

graduated in Nuclear Engineering from the Politecnico di Torino, Italy in 2002 and obtained his PhD in Electronics from the Montpellier University, France in 2006 with a PhD thesis about the development of solid-state radiation monitoring sensors for the High-Energy Physics experiments of the CERN Large Hadron Collider (LHC). After his PhD, he worked as a Postdoc for the TOTEM experiment at LHC where he had responsibilities in the installation, commissioning and operation of the Roman Pot Silicon detector system of the experiment. Since 2011, he is leading the team in charge for the new proton and gamma irradiation facilities infrastructures of the CERN Experimental Physics (EP) Department used for the qualification of the components for the High-Luminosity upgrade of the LHC (HL-LHC). He is also responsible for the development of radiation monitoring sensors for the current CERN experiments (RADMON project) as well as for the Future Circular Collider (FCC) being studied at CERN. He is Radiation Protection Expert and Radiation Safety Officer of the CERN EP Department and leader of Work Package 15 (upgrade of beam & irradiation test infrastructure) within the European project AIDA-2020.

DOSIMETRY TECHNIQUES AND RADIATION TEST FACILITIES FOR TOTAL IONIZING DOSE TESTING.
11:25-12:20

Dr. Federico Ravotti from CERN will address dosimetry and monitoring techniques for Total Ionizing Dose (TID) testing of electronics devices. He will first discuss the basic principles of dosimetry as well as the most common dosimetric quantities an units used for the measure of the energy deposited in a given medium by ionizing radiation. In a second chapter, he will give an overview of the available dosimetry techniques for ionizing radiation, along with the basic mechanisms exploited for their use. In a third section, he will address issues and factors affecting the dosimetry measurements, as well as some practical ‘hints’ about the selection and use of the presented techniques. Finally, a synthesis of the existing radiation test facilities for TID testing will be given. Their interest, limitations and some practical aspects involving the organization of radiation test campaigns will be discussed.

Short Course Speakers

CÉDRIC VIRMONTOIS

received the Engineering degree in Physics from the Institut National des Sciences Appliquées (INSA) of Toulouse in 2008 and the Ph.D. degree in Microelectronic from the Institut Supérieur de l'Aéronautique et de l'Espace (ISAE Supaero) of Toulouse in 2012. His Ph.D. research focused on displacement damage-induced degradation effects in CMOS image sensors. He modeled the degradation of the sensor parameter of performances, especially the dark current and it associated random telegraph signal and he deduced hardening-by-design techniques to mitigate space radiation effects in CMOS imagers. Cedric presently works for the Centre National d'Études Spatiales (CNES) in Toulouse, France, as Detection Chain Architect in the Payload and Imaging Division. His work involves the development of imagers for future space missions, electro-optical characterizations, analysis and testing of imagers and he is responsible for the technology watch on image sensors. Today, he extends his researches to several solid state imagers using ground and in-flight data in order to find generic ways to predict and mitigate space radiation effects. Cedric has served the radiation effects community as reviewer for the IEEE Nuclear and Space Radiation Effects Conference (NSREC) and for publications in the IEEE Transactions on Nuclear Science. He has authored or co-authored more than 30 papers in refereed journals, including the NSREC 2011 Outstanding Student Paper Award and the NSREC 2012 Outstanding Conference Paper Award. He also received the IEEE NPSS Phelps Award as a student in 2012. He is a Member of the IEEE and a Member of the NPSS and the EDS.

DISPLACEMENT DAMAGE IN OPTOELECTRONIC DEVICES DEDICATED TO SPACE APPLICATIONS.
13:30-14:25

Dr. Cédric Virmontois from CNES will present a review, compiled with his colleague Dr. Olivier Gilard, of radiation-induced displacement damage effects in optoelectronic devices operating in space radiation environments. The physics of the displacement damage mechanism and the electrical effects of induced defects will be discussed. Displacement damage-induced electrical degradation on silicon devices as well as other semiconductor type, as HgCdTe, InSb or InGaAs, will be addressed through the analysis of the key parameters of these components. Recent results concerning random telegraph signal and dark current spectroscopy in image sensors will be displayed. Then a section will illustrate prediction of the electrical degradation, comparison with in-orbit data and mitigation techniques. Finally, displacement damage testing will be discussed based on standards, guidelines and test sources.

Short Course Speakers

MICHAEL MOLL

is a Senior Physicist in the Experimental Physics Department at CERN, Geneva, Switzerland. He is co-spokesperson of the CERN RD50 Collaboration “Radiation hard semiconductor devices for very high luminosity colliders” (55 Institutions), and deputy group leader of the Detector Technologies Group, which participates in the development, construction and operation of particle detectors for experiments at CERN. This comprises detector consolidation and upgrade projects as well as infrastructure for experiments.

After receiving his Ph.D. in 1999 at the University of Hamburg on the characterization of radiation damage in silicon sensors, he moved to CERN where he contributed to the operation and construction of the Physics Department irradiation facilities, the development of radiation monitoring devices and the managing of service units for detector construction. His main research activity is the characterization and development of radiation tolerant silicon devices. He significantly contributed to the work of the RD48 and RD50 collaborations, which introduced technologies like oxygen enriched and p-type silicon sensors and the first industrial production of 3D sensors into the HEP community; all successfully implemented today in the LHC experiments and their upgrades. He gathered extensive expertise in the fields of radiation damage to semiconductor detectors, radiation testing and radiation monitoring with more than 60 publications on the subject.

DISPLACEMENT DAMAGE IN SILICON DETECTORS FOR HIGH ENERGY PHYSICS.
14:25-15:20

Dr. Michael Moll from CERN will focus on radiation damage issues caused by displacement damage in silicon sensors operating in the harsh radiation environments of High Energy Physics Experiments. The origin and parameterization of the changes in device parameters such as depletion voltage (effective doping concentration), leakage current and charge trapping, respectively charge collection efficiency, as function of particle type, particle fluence and annealing time and temperature will be reviewed. Impact of impurities in the silicon base material, material engineering approaches and NIEL hypothesis violations evidenced for example by exposing the sensors to radiation of different particle type will be presented. Differences on how segmented and non-segmented devices are affected and how device engineering can improve radiation hardness will be explained and characterization techniques used to study sensor performance and the electric field distribution inside the irradiated devices will be outlined. Finally, mitigation techniques, recent developments in radiation hardening and simulation techniques using TCAD modelling will be shown. Some material on silicon devices with intrinsic gain (SiPM, LGAD, APD) and non-silicon based detectors will be given. The course will conclude with radiation damage issues in presently operating experiments and give an outlook of radiation hardened technologies to be used in future upgrades of the present detection systems.

Short Course Speakers

Dr. AMINATA CARVALHO
received her PhD in Electronics from University of Montpellier 2, FRANCE in December 2008 in the Radiation Effects on Electronic Components for Space applications Department.
Since June 2009 she is working at AIRBUS Space Equipment in Elancourt, FRANCE as Radiation Effects Engineer. Her responsibilities include Radiation analyses at equipment level for Space applications (Telecom and Earth Observation programs, …) as Radiation Process Owner, participation on EEE part selection process, participation on SEE test definition, preparation and achievement. She carries out R&D studies for agencies (ESA, CNES) and for AIRBUS internal needs. Dr. CARVALHO has authored or co-authored about ten scientific publications.

INDUSTRIAL POINT OF VIEW FOR SPACE APPLICATIONS: BEST PRACTICES FROM PARTS SELECTION TO FLIGHT. 15:30-16:35

Throughout a course mainly focused on Single Events Effects (SEE) aspects, Dr. Aminata Carvalho from Airbus Defense and Space, will address the Space applications from the industrial standpoint. From parts selection to flight, from project definition to equipment qualification and mission lifetime, the radiation qualification process will be discussed. As starting point, the Space Radiation Hardness Assurance (RHA) standards will be briefly reviewed. To provide a better overview of the equipment supplier management procedure the key RHA flow will be presented through a practical case. Parts procurement, traceability, package selection and opening issues, concurrent engineering for equipment design, SEE characterization including heavy ions testing and proton issues handling, as well as mitigation techniques implementation, events rates estimation and risk ranking, will be dealt with.

Short Course Speakers

SLAWOSZ UZNANSKI

is a radiation effects engineer and a project leader at the European Organization for Nuclear Research (CERN). Slawosz' is leader of the radiation-tolerant power converter control electronics project, a control system for the Large Hadron Collider (LHC). Slawosz received his M.Sc. from the Technical University of Lodz, Poland in 2008 (with honors) and his Ph.D. from the University of Aix-Marseille, France in 2011 (with honors). His prior experience includes: Radiation Effects Engineer at STMicroelectronics (2008-2011) focusing on radiation-hardened digital 65nm CMOS technology for space applications, and R&D Engineer at Xilinx developing power-driven synthesis algorithms. He has co-authored a book on single event effect modelling and written over 50 articles in IEEE journals and conferences. Privately, Slawosz enjoys hiking and skiing in the Alps and wind-powered water sports.

QUALIFICATION OF ELECTRONICS COMPONENTS FOR A RADIATION ENVIRONMENT WITH FOCUS ON SINGLE EVENT EFFECTS: WHEN STANDARDS DO NOT EXIST - HIGH ENERGY PHYSICS. 16:35-17:10

Dr. Slavosz Uznanski from CERN will address the problem of components and systems radiation qualification in HEP applications, focusing on the recent experience with the Large Hadron Collider (LHC). The radiation environment inside the LHC accelerator and experiments varies significantly depending on the location: in some places it is comparable to avionic or LEO orbit applications while in others it significantly differs. Thus, the testing standards used for space are not directly applicable in all cases. This course will describe how the problem of testing and qualification of components and systems has been dealt with in view of ensuring the required reliability to the complex electronics systems at the LHC. The radiation hardness assurance policies of both the accelerator and experiments will be illustrated through practical examples of two different design cases: 1) an LHC accelerator control system and 2) a highly redundant LHC detector system.

Monday WIE (Women In Engineering)

WIE (WOMEN IN ENGINEERING) 17:30-18:45

Room 1 - Level 1

Please join five remarkable women to share their experiences in the field of engineering and science from the government, industry, research, and university perspective. They will provide inspiration, guidance, and tools for success in the field of engineering/science, still predominated by men. Students, young professionals and veterans of the RADECS community, both women and men, will benefit from the speakers diverse nationalities and their societal environments in which they have lived as women in STEM.

Each woman will share her personal accomplishments and struggles to reach her current career. Who motivated these women? Family, fellow students from their university days, colleagues? Who do they mentor? Interesting stories will be presented by the panelists which will enable questions and lively discussions!

The WIE panel looks forward to seeing you!

WIE EVENT ORGANISATION:

Teresa Farris
MARCOM Manager, for Cobham Semiconductor Solutions, Teresa has worked in the Radiation Field since 1983. She has been involved with RADECS for 20 years as Exhibit Chair and Steering Committee member; she is also Vice-Chair of Publicity for NSREC.

LIST OF SPEAKERS:

Tatiana Barateva
Head of group, Branch of Institute of Space Device Engineering - United Rocket and Space Corporation
Deputy director, LLC Galactic Flow - event planning company
Moscow, Russia

Melanie Berg
Sr. Consulting Subject Matter Expert (SME), ASRC Federal Space and Defense
Principal Investigator, NASA Goddard Radiation Effects and Analysis Group
Greenbelt, Maryland

Prof. Fernanda Lima Kastensmidt
Coordinator of Microelectronics Graduate Program (PGMICRO)
Professor at Instituto de Informatica
Universidade Federal do Rio Grande do Sul (UFRGS)
Porto Alegre - RS – Brasil

Cristina Plettner, Ph.D
System Engineer Radiation/Team Leader
On Orbit Avionics Subsystems
Airbus Defence and Space
Bremen Germany

Maris Tali
Graduate student
University of Jyväskylä
CERN, European Space Agency

THE EVENT WILL BE HOSTED BY:

Prof. Cinzia Da Via
IEEE NPSS WIE Liaison
The University of Manchester, UK & Stony Brook University, USA

Dr. Marta Bagatin
Research Fellow
DEI - University of Padova, Italy

SOCCER TOURNAMENT 18:30-21:00

Savigny Pitch
Bus transfer provided from CICG and CERN to Savigny Soccer Field and return to CERN

STUDENT EVENT 20:00-23:00

CERN - Globe

A student network evening will be held on Monday as of 19:30 in the CERN globe, including dinner and music

RADECS-2017 TECHNICAL CHAIR

JULIEN MEKKI

performed his PhD thesis at CERN between 2006 and 2009, and received his PhD degree in Electronics from the University of Montpellier, France, in 2009. His PhD thesis was based on the characterization of radiation monitoring sensors used for the Large Hadron Collider (LHC) and High-Luminosity LHC. After his PhD thesis, he joined the University of Montpellier from 2009 to 2011, and he became a fellow at CERN from 2011 to 2015. Part of his research was focused on the study and optimization of a radiation monitoring system, but also the development of several radiation tolerant electronics systems to be used inside the LHC. During his fellowship, he became the responsible of the construction, commissioning and operation of CHARM (the CERN mixed field test facility). Finally, in 2015 in joined the French Space Agency (CNES) where he acts as an optoelectronics devices and radiation effects engineer.

Julien is author and co-author of more than 35 publications in the field of radiation effects in electronics devices, including two outstanding best student paper awards at RADECS 2009 and 2013. He was also co-author of the CERN contribution to the NSREC 2014 short course, session chair at NSREC and RADECS conferences and reviewers of several peer-reviewed journals. He has been recently elected during the NSREC 2017 conference as Junior Member At Large of the IEEE Radiation Effects Steering Group (IEEE RESG).

RADECS-2017 VICE TECHNICAL CHAIR

FRANCIS ANGHINOLFI

received the M.S. degree in electronics from the Institut de Chimie et Physique Industrielle de Lyon (now ECP Lyon) in 1977. He specialized in analogue microelectronics design, working for STMicroelectronics and Motorola Inc. He is since 1988, at CERN, Geneva, Switzerland, developing low-power microelectronics analogue and digital circuits for the High-Energy-Physics experiments. He has contributed to several of the ASICs currently operating with the Large Hadron Collider (LHC) and is now engaged in the development of advanced ASICs for the future particle colliders with very high radiation field.

Tuesday Technical Programme

CONFERENCE OPENING 08:45-09:35

M. Brugger (CERN) - General Chair
P. Calvel (Thalès Alenia Space) - President of the RADECS Association
R. Losito (CERN) - Head of the Engineering Department
Marie-Anne Clair (CNES) - Director of Orbital Systems
Julien Mekki (CNES) - Technical Program Chair

SESSION A: In-Orbit Low-Cost Radiation Studies

Session Chairs: **Laurent Dusseau**[1] and **Philippe Adell**[2]
[1]Montpellier University/CSU, [2]JPL
9:35-9:40: Session opening

PROF LAURENT DUSSEAU

graduated with a Ph.D. from University of Montpellier in 1995. He was appointed full professor in 2004 and became Head of the electrical engineering department at the Institute of technology of Nîmes in 2005, position he held until 2011. Vice president of the RADECS association since 2012, he was also General Chair of the RADECS 2005 conference. He is currently head of the Montpellier University Space Center.

PHILIPPE ADELL

started working at the NASA-Jet Propulsion Laboratory, California Institute of Technology in Feb. 2007 after completing his MS (2003) and PhD (2006) in Electrical Engineering at Vanderbilt University. He graduated from the polytechnic institute of the University of Montpellier (France), with a MS (1999) in material science and technologies In the past four years, he has been involved with the CubeSat community at JPL and was appointed by Charles Elachi, JPL director, to be the JPL liaison for future international collaboration on interplanetary CubeSats with the French space agency and the Montpellier's Van Allen Consortium. Philippe has more than 70 international publications in the field of radiation effects in microelectronics and systems.

Tuesday Technical Programme

ORAL COMMUNICATIONS

A-1 | 09:40

Mission Assurance Approaches and Results for a Proposed Commercial Off the Shelf Mars Mission: Mars Helicopter

Gregory Allen[1], Philippe Adell[1], Sergeh Vartanian[1], Tien Nguyen[1]

[1]JPL

We present radiation mission assurance approaches for a short-duration, surface of mars mission. The instrument is proposed to be designed out of COTS components. Motivations, challenges, tests and results will be presented and discussed.

A-2 | 9:55

RadFxSat: A Flight Campaign for Modeling Single-Event Effects in COTS Microelectronics

Rebekah Austin[1], Brian Sierawski[1], James Trippe[1], Andrew Sternberg[1], Kevin Warren[1], Robert Reed[1], Robert Weller[1], Ron Schrimpf[1], Michael Alles[1], Lloyd Massengill[1], Daniel Fleetwood[1], Gerald Buxton[2], Brandenburg Jonathan[2], Burns Fisher[2], Robert Davis[2]

[1]Vanderbilt University, [2]Radio Amateur Satellite Corporation (AMSAT)

The RadFxSat flight campaign has 4 manifested CubeSats to study the effect of the space environment on different technology nodes through upset counts in SRAMs. Different orbits, technology nodes, and bias voltages can be compared.

A-3 | 10:10

System Level Radiation Characterization of a 1U CubeSat Based on CERN Radiation Monitoring Technology

Raffaello Secondo[1], Ruben Garcia Alia[2], Paul Peronnard[2], Markus Brugger[2], Alessandro Masi[2], Salvatore Danzeca[2], Anne-Sophie Merlenghi[1], Enrico Chesta[2], Jean-Roch Vaillé[1], Muriel Bernard[3], Laurent Dusseau[3]

[1]Université de Montpellier, [2]CERN, [3]Université de Montpellier/CSU

A CubeSat payload was designed at CERN and CSU Montpellier, for the measurement of radiation and SEL recording. The payload and the data handling modules were tested at CHARM in a LEO representative mixed-field environment.

A-4 | 10:25

Low Level Radiation and Fault Protection Techniques Suitable for Nanosatellite Missions

David Selcan[1], Gregor Kirbiš[1], Iztok Kramberger[1]

[1]University of Maribor

This paper presents radiation and fault protection techniques for nanosatellites, which are based on the use of flash-based FPGAs, hierarchical Latching Current Limiters, two types of Watchdog Timers, Error Correction Coding and Triple Modular Redundancy.

10:40-11:10:

Coffee Break - Level 0, Exhibits Area

POSTER SESSION

PA-1

Single Event Effect Analysis for Command and Data Handling Electronics of the Tropospheric Water Vapor and Cloud Ice (TWICE) Radiometer Instrument for 6U-Class Nanosatellites

Mehmet Ogut[1], Yuriy Goncharenko[1], Steven Reising[1], Braxton Kilmer[1], Pekka Kangaslahti[2], Erich Schlecht[2], Xavier Bosch-Lluis[2]

[1]Colorado State University, [2]California Institute of Technology

Radiation effects analysis for space missions is essential to increase reliability. This study analyses the SEEs for TWICE electronics and performs risk analysis and mitigation. The results can provide useful information for small satellite missions

PA-2

CELESTA Demonstrator Radiation Characterization in a LEO Representative Environment at CHARM.

Anne-Sophie Merlenghi[1], Markus Brugger[2], Enrico Chesta[2], Salvatore Danzeca[2], Ruben Garcia Alia[2], Alessandro Masi[2], Paul Peronnard[2], Raffaello Secondo[1], Muriel Bernard[1], Laurent Dusseau[1], Xavier Laurand[1], Jean-Roch Vaillé[1]

[1]Université de Montpellier, [2]CERN

The qualification process of CubeSat systems under radiation is long and requires tests at several facilities. An alternative, qualification methodology is being studied at the CHARM facility with the CELESTA radiation module demonstrator.

SESSION B: Radiation effects in Optoelectronics and Photonics devices and ICs

Session Chairs: **Vincent Goiffon**[1] and **M. Van Uffelen**[2]
[1]ISAE-SUPAERO, [2]FUSION FOR ENERGY (F4E)
11:10-11:15: Session opening

VINCENT GOIFFON

(MSEE 2005, Ph.D. EE 2008)
has been an Associate Professor at ISAE-SUPAERO since Dec. 2008. His research interests focus on solid-state image sensors and include CMOS integrated circuit design, pixel/device modeling/simulation/characterization, leakage/dark current, Random Telegraph Signals (RTS), radiation effects and hardening-by-design techniques. He is regularly involved in scientific image sensor R&D projects, especially for space and nuclear applications. He has authored or co-authored one book chapter and more than 50 journal papers, including one NSREC Outstanding Conference Paper Award and three Outstanding Student Paper Awards (at the IEEE Nuclear and Space Radiation Effects Conference (NSREC) and the Radiations Effects on Components and Systems (RADECS) conference).

M. VAN UFFELEN

After more than 3 years with the French Atomic Energy Commission (CEA) near Paris, where he obtained his PhD in the field of photonics exposed to nuclear environments in 2001, M. Van Uffelen joined the Belgian Nuclear research Centre SCK•CEN, where he conducted research for more than 10 years within the advanced nuclear instrumentation group. His main topics of interest dealt with the characterization of fibre-optic and opto-electronic components, finally also addressing the associated driving and read-out electronics, for their application and qualification in conventional power plants, the high energy physics installation of CERN, and also for fusion.
Since early 2010, Marco Van Uffelen joined the European Joint Undertaking Fusion for Energy (F4E) in Barcelona, Spain, where he is coordinator for the implementation of the Radiation Hardness Assurance for ITER.

ORAL COMMUNICATIONS

B-1 | 11:15

Multi-MGy Total Ionizing Dose Induced MOSFET Variability Effects on Radiation Hardened CMOS Image Sensor Performances

Sébastien Rolando[1], Philippe Paillet[2], Franck Corbière[1], Pierre Magnan[1], Laura Mont Casellas[3], Aziouz Chabane[1], Marius Sergent[1], Serena Rizzolo[1], Vincent Goiffon [1], Wouter De Cock[4], Claude Marcandella[2], Sylvain Girard[5], Marco Van Uffelen[3], Robin Scott[6]

[1]ISAE-SUPAERO, [2]CEA, DAM, DIF, [3]Fusion for Energy (F4E), [4]SCK-CEN, [5]Laboratoire Hubert Curien, [6]Oxford Technologies Ltd.(OTL)

MOSFETs variability in irradiated CIS up to 10 MGy(SiO2) is statistically investigated on about 65000 devices. Different variability sources are identified and the role played by the transistors composing the readout chain is clarified.

B-2 | 11:30

Radiation Induced Defects in 8T-CMOS Global Shutter Image Sensor for Space Application

Alexandre Le Roch[1], Cédric Virmontois[2], Vincent Goiffon [1], Laurie Tauziede[2], Jean-Marc Belloir[2], Pierre Magnan[1]

[1]ISAE-SUPAERO, [2]CNES

Displacement damage induced by Proton and Carbon ions irradiations is studied in 8T PPD global shutter CMOS image sensors, using both Dark Current Spectroscopy and RTS analysis. Investigations through annealing temperatures lead to defects identification.

B-3 | 11:45

Radiation hardness studies on a novel CMOS sensor process for Depleted Monolithic Active Pixel Sensors

Enrico Junior Schioppa[1], Richard Bates[2], Craig Buttar[3], Marco Dalla[4], Jacobus Willem Van Hoorne[1], Thanushan Kugathasan[1], Dima Maneuski[3], Cesar Augusto Marin Tobon[1], Luciano Musa[1], Heinz Pernegger[1], Petra Riedler[1], Christian Riegel[5], Carla Sbarra[4], Douglas Michael Schaefer[1], Abhishek Sharma[6], Walter Snoeys[1], Carlos Solans Sanchez[1]

[1]CERN, [2]Department of Physics and Astronomy-University of Glasgow, [3]University of Glasgow, [4]University of Bologna and INFN, [5]Bergische Universitaet Wuppertal, [6]University of Oxford

Monolithic CMOS sensors are being proposed for the upgrade of the ATLAS inner tracker. Sensors fabricated in a new TowerJazz 180nm process, feature full depletion of the sensitive layer and radiation tolerance up to 10^{15} n_{eq}/cm^2.

B-4 | 12:00

Investigation of the Influence of Annealing and Dose Rate on the Radiation Hardness of Silicon Mach-Zehnder Modulators

Andrea Kraxner[1], Stephane Detraz[1], Lauri Juhani Olantera[1], Carmelo Scarcella[1], Christophe Sigaud[1], Csaba Soos[1], Jan Troska[1], Francois Vasey[1], Marcel Zeiler[2]

[1]CERN, [2]Dublin City University

Significant post-irradiation annealing of custom-designed silicon photonics modulators exposed to high-rate ionising radiation has been measured for the first time. This is relevant for future device deployment in applications with low in-situ dose rates.

B-5 | 12:15

X-rays, Protons and Electrons Radiation Effects on Fiber Bragg Gratings

Thomas Blanchet[1], Adriana Morana[2], Timothé Allanche[2], Emmanuel Marin[2], Aziz Boukenter[2], Youcef Ouerdane[2], Philippe Paillet[3], Marc Gaillardin[3], Olivier Duhamel[3], Claude Marcandella[3], M. Trinczek[4], G. Assaillit[4], G. Auriel[4], D. Aubert[4], Guillaume Laffont[1], Sylvain Girard[2]

[1]CEA/DRT/LIST/DM2I/LCAE, [2]Université de Lyon, [3]CEA/DAM/DIF, [4]TRIUMF Laboratory

The effects of different irradiation types, including X-rays, protons and electrons, on Fiber Bragg Gratings written by UV laser in Germanium, Phosphorus/Cerium and Bore/Germanium doped single-mode optical fibers are characterized.

B-6 | 12:30

Dependence of the voids-fiber Bragg grating radiation response on temperature, dose and dose-rate

Adriana Morana[1], Sylvain Girard[1], Emmanuel Marin[1], Matthieu Lancry[2], Claude Marcandella[3], Philippe Paillet[3], Aziz Boukenter[1], Youcef Ouerdane[1]

[1]Université de Lyon, [2]Institut de Chimie Moléculaire et des Matériaux d'Orsay, Université Paris Sud, [3]CEA/DAM/DIF

We present a complete study on the radiation response of voids-fiber Bragg gratings, manufactured point by point by IR laser, highlighting its dependence on dose, dose-rate, irradiation temperature and pre-irradiation treatment.

OPENING OF THE INDUSTRIAL EXHIBITION

Teresa Farris

Industrial Exhibit Chair, Cobham/Aeroflex

12:50-14:00:

Industrial Exhibit Lunch - Level 0, Exhibits Area

POSTER SESSION

PB-1

Proton Damage in LED and phototransistor of Micropac 66296 Optocoupler

Farokh Irom[1], Larry Edmonds[1], Gregory Allen[1], Bernard Rax[1]

[1]Jet Propulsion Laboratory

This paper reports proton damage in LED and phototransistor of the Micropac 66296 optocoupler. Analysis of the test data reveals interesting information, such as the dependence of the transistor gain on irradiation and photocurrent.

PB-2

Coupled Effects of Radiation and Temperature on the Performances of Rayleigh and Raman Fiber-based Sensors

Isabelle Planes[1], Diego Di Francesca[2], Sylvain Girard[3], Antonino Alessi[4], A. Boukenter[3], Emmanuel Marin[3], Mélanie Osmond[5], Sylvie Delepine-Lesoille[1], Youcef Ouerdane[3]

[1]Andra, [2]CERN, [3]Université de Lyon, [4]Université de Lyon Laboratoire H. Curien, [5]IRSN

We evaluate the vulnerability of different distributed fiber sensors (based on Rayleigh and Raman scatterings) when the fibers are exposed to γ-rays up to 1°MGy(dose rate: 2.6 Gy(SiO2)/h) at different temperatures: 50, 100 and 120°C.

PB-3

6 Mev Electron exposure effects on OFDR-based distributed fiber sensors

Camille Sabatier[1], Serena Rizzolo[2], Adriana Morana[3], Timothé Allanche[3], Emmanuel Marin[3], Thierry Robin[4], Benoit Cadier[4], Philippe Paillet[5], Marc Gaillardin[5], Olivier Duhamel[5], Claude Marcandella[5], Aubert Damien[5], Gilles Assaillit[6], Gérard Auriel[6], Aziz Boukenter[3], Youcef Ouerdane[3], Luciano Mescia[7], Sylvain Girard[3]

[1]Laboratoire Hubert Curien, [2]ISAE-SUPAERO, [3]Université de Lyon, [4]iXBlue, [5]CEA/DAM/DIF, [6]DGA-Direction de l'Expertise Technique, Centre d'Etudes de Gramat, [7]Politecnico di Bari

We studied the impact on the performances of Optical Frequency Domain Reflectometry (OFDR) based optical fiber sensor response of 6 MeV electron exposure of differently doped and coated sensing fibers.

PB-4

Long Period Gratings written in B-Ge doped fiber under gamma irradiation for humidity sensing applications at CERN

Gaia Maria Berruti[1], Alajos Makovec[2], Marco Consales[3], Noemi Beni[2], Zoltan Szillasi[2], Giuseppe Quero[3], Salvatore Buontempo[4], Paolo Petagna[1], Andrea Cusano[3]

[1]CERN, [2]Hungarian Academy of Sciences, [3]Universita' degli Studi del Sannio, [4]INFN Napoli

The first collected results concerning the response of LPGs inscribed in a B/Ge doped optical fiber to γ-ionizing radiations are presented in this contribution, in view of their possible application in experiments running at CERN.

PB-5

Photobleaching effects in multi-mode radiation resistant optical fibres

Adrien Billat[1], Jeremy Blanc[1], Jochen Kuhnhenn[2], Daniel Ricci[1]

[1]CERN, [2]Fraunhofer INT

This work investigates radiation induced attenuation under gamma ray exposure in various multimode fibers intended for deployment in CERN accelerators. It reports photobleaching under injection of optical signals and characterizes the signal power influence.

PB-6

Analysis of Image Lag Degradation in PPD CISs Induced by Total Ionizing Dose and Displacement Radiation Damage

Wang Zujun[1], Xue Yuanyuan[1], Liu Jing[1], Chen Wei[1], Ma Wuying[1], He Baoping[1], Yao Zhibin[1], Sheng Jiangkun[1]

[1]Northwest Institute of Nuclear Technology

The experiments of TID and displacement radiation effects in PPD CISs are investigated. The image lag degradation mechanisms induced by Colbat60 gamma ray, proton, and neutron radiation are analyzed with TCAD and GEANT 4 simulation.

PB-7

Impact of the Electric Field in the Modelling of the Dark Current Non Uniformity in Pixel Arrays

Marie-Cécile Ursule[1], Thierry Nuns[1], Christophe Inguimbert[1], Henri Bugnet[2], Frédéric Mayer[2], Jérôme Pratlong[2]

[1]ONERA, [2]Teledyne e2v

We investigate the thermal generation enhancement due to high electric fields in the DCNU modelling. The result is compared with experimental data in term of number of hot pixels and global shape of the distribution.

PB-8

Random Telegraph Signal in Proton Irradiated Single-Photon Avalanche Diodes

Francesco Di Capua[1], Marcello Campajola[1], Ciro Nappi[2], Ettore Sarnelli[2], Hesong Xu[3], Leonardo Gasparini[3], Alberto Aloisio[1]

[1]Università di Napoli Federico II and INFN, [2]CNR-SPIN, [3]Fondazione Bruno Kessler

Single-Photon Avalanche Diodes is a very attractive solution for photon detection for excellent timing resolution achievable. In this work noise performance and Random Telegraph Signal have been investigated on a proton irradiated 150-nm CMOS device.

PB-9

Analysis of X-Ray Photo-Charge Induced Speckles in a Radiation Hardened CMOS Image Sensor

Timothé Allanche[1], Vincent Goiffon [2], Serena Rizzolo[2], Philippe Paillet[3], Aziouz Chabane[2], Olivier Duhamel[3], Cyprien Muller[4], Pierre Magnan[2], Raphaël Clerc[5], Alessandro Marini[6], Emmanuel Marin[1], Aziz Boukenter[1], Youcef Ouerdane[1], Alain Girard[7], Sylvain Girard[1]

[1]Université de Lyon, [2]ISAE-SUPAERO, [3]CEA/DAM/DIF, [4]CEA and Université de Lyon, [5]IOGS, [6]INFN, [7]CEA

We analyzed Photo-Charge Induced current in a Radiation Hardened CMOS Image Sensor in order to make a model that can be extrapolation at other dose rates and photon energies.

PB-10

Extrapolated degradation of optical systems at MGy levels due to radiation - induced refractive index change

Cyprien Muller[1], Thierry Lépine[2], Timothé Allanche[2], Philippe Paillet[3], Vincent Goiffon[4], Youcef Ouerdane[2], Aziz Boukenter[2], Sylvain Girard[2]

[1]CEA and Université de Lyon, [2]Université de Lyon, [3]CEA/DAM/DIF, [4]ISAE-SUPAERO

Based on literature data, we investigate how much radiation-induced refractive index change can affect the performances of optical systems made with lenses of diverse materials. Possible hardening solutions are discussed to limit the extrapolated degradation.

PB-11

Voltage dependent photocurrent in electron irradiated GaAs cells

Manuel Salzberger[1], Martin Rutzinger[1], Christel Nömayr[1], Paolo Lugli[2], Claus Zimmermann[1]

[1]Airbus DS GmbH, [2]Free University of Bozen-Bolzano

We present an electron irradiation study of GaAs isotype cells. In the light current-voltage curves a voltage, dependence is present which is attributed to the voltage dependence of the width of the space charge region.

SESSION C: BASIC MECHANISMS OF RADIATION EFFECTS

Session Chairs: **Ron Schrimpf**[1] and **Frédéric Saigné**[2]
[1]Vanderbilt University, [2]Montpellier University
14:00-14:05: Session opening

RON SCHRIMPF

received his B.E.E., M.S.E.E., and Ph.D. degrees from the University of Minnesota. He joined the University of Arizona in 1986, where he served as a Professor of Electrical and Computer Engineering. He joined Vanderbilt University in 1996, where he currently serves as a Professor of Electrical Engineering and Director of the Institute for Space and Defense Electronics. He has been the Chairman of the IEEE Radiation Effects Steering Group and the Nuclear and Space Radiation Effects Conference. He is President Elect of the IEEE Nuclear and Plasma Sciences Society.

DR. FRÉDÉRIC SAIGNÉ

graduated in Electronics at the University of Montpellier 2. He spent a research period at Vanderbilt University and after appointment at the Reims Champagne Ardennes University, he is now Professor in the Radiation Effects on Components (RADIAC) research team at the University of Montpellier. His research activity has been directed to the study of dose effect in electronics, and reliability of semiconductor devices. He has authored or co-authored over 200 papers in referenced journals or conferences. In 2010, he created the first national research group on radiation effects on electronic devices at ground and atmospheric level in France. In collaboration with CNES and ESA, he has also founded, in 2013, the Van Allen Fundation dedicated to the development of universitary nanosatellites. He has been member of the RADECS steering committee from 2002 to 2007, technical chair at RADECS 2005 in Cap d'Agde (France) and short course chair at NSREC 2014 in Paris.

ORAL COMMUNICATIONS

C-1 | 14:05

Molecular dynamics simulations of heavy ion induced defects in SiC Schottky diodes

Arto Javanainen[1], Henrique Vazquez Muinos[2], Kai Nordlund[2], Flyura Djurabekova[2], Kenneth Galloway[3], Ron Schrimpf[3], Marek Turowski[4]

[1]University of Jyväskylä, Dept. of Physics, [2]University of Helsinki, Department of Physics, [3]Vanderbilt University, Dept. of EECS, [4]Silvaco Inc.

Heavy ions are known to induce leakage degradation in reverse-biased SiC Schottky diodes. This work gives insights into the ion-induced defects in SiC structure via molecular dynamics simulations.

C-2 | 14:20

Effects of SiH Groups on ELDRS Quantified with a Combined Use of X-ray, Gamma-ray, and Electron-beam Irradiation

Shintaro Toguchi[1], Kazuyuki Hirose[2], Daisuke Kobayashi[2], Takahiro Makino[3], Takeshi Ohshima[3]

[1]The University of Tokyo, [2]ISAS/JAXA, [3]QST

SiH densities in silicon dioxide films are measured and compared with interface trap densities developed in different dose rates. A straight-line relationship is revealed, indicating observed ELDRS is caused by the direct proton release mechanism.

C-3 | 14:35

Dose rate sensitivity of 65 nm MOSFETs exposed to ultra-high doses

Giulio Borghello[1], Federico Faccio[2], Edoardo Lerario[3], Stefano Michelis[2], Szymon Kulis[2], Daniel Fleetwood[4], Ron Schrimpf[4], Simone Gerardin[5], Alessandro Paccagnella[6], Stefano Bonaldo[7]

[1]Universita degli Studi di Udine (IT), [2]CERN, [3]INFN Lecce e Universita del Salento (IT), [4]Vanderbilt University, [5]Padova University, [6]Universita e INFN, Padova (IT), [7]Università di Padova - DEI, Padova, Italy

65 nm MOSFETs irradiated above 20 Mrad (SiO2) exhibit larger degradation at lower dose rates. The low electric field in STI and LDD spacer oxides appears to cause effects similar to ELDRS.

C-4 | 14:50

Mechanism behind Ultralong MCUs in Thin-BOX SOI Devices and Its Countermeasure

Chin-Han Chung[1], Daisuke Kobayashi[2], Kazuyuki Hirose[2]

[1]The University of Tokyo, [2]ISAS, JAXA

Ultralong MCUs have been recently discovered in thin-BOX SOI SRAMs. This work gives a new full description on its mechanism through simulation and proposes a direction for design optimisation to counter the ultra long MCUs.

C-5 | 15:05

Improved Model for Excess Base Current in Irradiated Bipolar Junction Transistors

Blayne Tolleson[1], Philippe Adell[2], H. J. Barnaby[1], Aymeric PRIVAT[3], Xu Han[1], Adnan Mahmud[1]

[1]Arizona State University, [2]JPL, [3]Arizona State University

An improved total ionizing dose model for bipolar junction transistors is described. The model captures the impact of charged defects on radiation-induced excess base current. Failure to incorporate this mechanism in model underestimates gain degradation.

POSTER SESSION

PC-1

Hydrogen Soaking and Displacement Damage Effects in Gated Lateral Bipolar Junction Transistors

Xingji Li[1], Jianqun Yang[1], Chaoming Liu[1], Daniel M. Fleetwood[2], H. J. Barnaby[3], K. F. Galloway[2]

[1]Harbin Institute of Technology, [2]Vanderbilt University, [3]Arizona State University

Effects of 70-keV and 1-MeV electron irradiation on gate controlled lateral PNP (GLPNP) transistors are evaluated with and without molecular hydrogen (H2) soaking. Relative differences in displacement damage and ionization effects are discussed.

PC-2

Molecular dynamics simulations of energetic atom channeling effects in the nuclear collision regime by simulated channeling maps

Kai Nordlund[1], Flyura Djurabekova[2]

[1]University of Helsinki, Department of Physics, [2]Helsinki Institute of Physics (FI)

We describe molecular dynamics simulations as a tool to predict the nature of radiation damage in materials in the nuclear collision regime, and how it can be used to analyze systematically ion channeling effects.

PC-3

CMOS Chip Level Global Leakage Physics-Based Modeling

Vasily Orlov[1], Gennady Zebrev[1], Maxim Gorbunov[2]

[1]National Research Nuclear University MEPHI, [2]SRISA

Compact modeling of inter-device radiation-induced leakage underneath the gateless thick STI oxide is presented and validated taking into account CMOS technology and hardness parameters, dose-rate and annealing effects, and dependence on electric modes under irradiation.

15:20-15:50:

Coffee Break - Level 0, Exhibits Area

PC-4

Temperature dependence of the radiation degradation at high total dose levels

Alexander Bakerenkov[1], Viacheslav Pershenkov[1], Vladimir Belyakov[1], Vitaly Telets[1], Vladimir Shurenkov[1], Vladislav Felitsyn[1], Alexander Rodin[1]

[1]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)

The physical model of the saturation of radiation-induced degradation in bipolar devices was proposed. The model can be used for hardness assurance applications for high total dose levels at different irradiation temperatures.

PC-5

Study of Point- and Cluster-Defects in Radiation-Damaged Silicon

Robert Klanner[1], Elena Donegani[1], Eckhart Fretwurst[2], Erika Garutti[1], Gunnar Lindstroem[1], Ioana Pintilie[3], Roxana Radu[3], Joern Schwandt[1]

[1]University of Hamburg, [2]II. Institut fuer Experimentalphysik, [3]NIMP Bucharest-Magurele, Romania

TSC measurements on silicon pad diodes irradiated by electrons, neutrons, and protons of different energies are presented. A new method based on SRH statistics is introduced, which allows determining point and cluster defects.

PC-6

Charge Deposition Analyses of Heavy Ion and Proton in C(diamond), Si, Ge, and GaAs

Zhenyu Wu[1], Shuming Chen[1]

[1]National University of Defence Technology

Charge deposition of heavy ion and proton in C(diamond), Ge and GaAs was analyzed, with Si used as a reference. C(diamond) is more suitable for future space applications for its less charge deposition characteristics.

ROUND TABLE - PART 1: Radiation Tests and Components Qualification Engineering Troubleshooting

Session Chairs: **Kenneth A. LaBel**[1] and **Wojtek Hajdas**[2]

[1]NASA/GSFC, [2]PSI

15:50-15:55: Round Table opening

KENNETH A. LABEL

(BES IN EECS WITH MINOR IN MATHEMATICAL SCIENCES, 1983)
His career at NASA has included development of: Fault tolerant computing, Hardware/software for ground systems, Advanced technology, Spaceflight hardware, Systems engineering, Radiation hardness assurance/research for >50 NASA projects, and Radiation effects and reliability assurance leadership. He is currently co-manager of the NASA Electronic Parts and Packaging (NEPP) Program as well as senior staff engineer for the Radiation Effects and Analysis Group (REAG) at NASA GSFC. He has won multiple awards at NASA including both the prestigious National Resource and Moe I. Schneebaum Awards. Mr. LaBel has published over 100 papers as author/co-author (multiple best papers), has taught multiple short courses at IEEE Nuclear and Space Radiation Effects Conference (NSREC), Hardened Electronics and Radiation Technology (HEART) Conference, Radiation Effects on Components and Systems (RADECS) Conference, and others, and is a recognized expert in radiation effects systems engineering. He was the 2009 IEEE NSREC Short Course Chair and was the 2012 IEEE NSREC General Chair.

WOJTEK HAJDAS

graduated at the Jagellonian University (UJ) in Cracow Poland and continued his education in the Swiss Federal Institute of Technology in Zürich (ETHZ) obtaining a PhD as Dr. sc. nat. in the Institute of Middle Energy Physics. His professional carrier started as a physics assistant at UJ and ETHZ. Subsequently he became a research scientist in the Laboratory for Astrophysics of the Paul Scherrer Institut (PSI) in Switzerland. Currently he is affiliated with the PSI Laboratory for Particle Physics being a head of the Applied Particle Physics and Irradiations group (APPI). His main activities are related with particle irradiation facilities for components testing (PIF, EMON), space instrumentation for radiation environment and solar observations (SREM, NGRM, RHESSI) as well as novel detection technologies for particle (RADEM) and X-rays measurements (POLAR-TG2). He also participates in design, modelling and data analysis being involved in several international collaborations.His group participates in more than 15 grants including SNF, ESA, EU and CAS financed projects. PSI Proton Irradiation Facility operated by APPI became ESA Center of Excellence and is a host for radiation hardness assurance testing of all major ESA space missions. W. Hajdas is an author and co-author of about 170 peer reviewed scientific papers and co-author of two books on space and solar astrophysics. His research tasks include numerous seminars and talks, paper and conference reviews as well as being a chairman at RADECS workshops (Seville, 2003, 2008, 2011) and a conference organizer (ESA-CNES FPD 2009). He also supervises apprentices and students at PSI and is a member of the Swiss Physical Society and a board member of the Swiss Institute of Particle Physics (CHIPP).

ORAL COMMUNICATIONS

ET-1 | 15:55

Incidents and Accidents: The Way of the Single Event Tester

Kenneth Label[1]

[1]NASA/GSFC

When performing a single event effect (SEE) test during a test campaign, flexibility and out of the box thinking is often required for unexpected and unplanned events.

ET-2 | 16:10

Testing the Tester: Lessons Learned During the Testing of a State-of-the-Art Commercial 14nm Processor Under Proton Irradiation

Carl Szabo[1], Adam Duncan[2], Kenneth Label[3]

[1]AS&D, Inc., [2]NSWC Crane, [3]NASA/GSFC

Testing of an Intel 14 nm desktop processor was conducted under proton irradiation. We share lessons learned, demonstrating that complex devices beget further complex results requiring practical and theoretical investigative expertise to unravel.

ET-3 | 16:25

SEE Testing of the Snapdragon 820: On-Site Annealing and POP Challenges

Steven M. Guertin[1], Sergeh Vartanian[1], Matthew Cui[2]

[1]Jet Propulsion Laboratory, [2]University of Michigan

SEE test results are presented for the Qualcomm Snapdragon 820 and its DDR4 device. On-site annealing of DDR4 stuck bits allowed continued testing of previously failed POP stacks. Processor crashes are the other primary SEE.

TUESDAY 3rd OCTOBER 2017
INVITATION

reservation : contact@radecs2017.com

RADECS 17 WELCOME EVENT
SWISS SPACE NIGHT

17:15 - 18:15 **Transfer by Bus** from the CICG to Lausanne

WELCOME

18:30 **Opening Speeches**

Reception Cocktail
Introduction Words: **Markus Brugger**
CERN Welcome: **Martin Steinacher**
ESA Welcome: **Carla Signorini**
Swiss Space Office Welcome: **Johann Richard**

INTRODUCTION TO EVENING HIGHLIGHTS

Swiss Space Night and Microsat Exhibition Presentation

Reception Cocktail
Presentation of the Swiss Space Industry: **Grégoire Bourban**
Presentation of the CubeSat Exhibition: **Laurent Dusseau**

19:30 **EXHIBITION, NETWORKING & COCKTAIL DINNER - PART 1**

Cocktail Dinner - Part 1: Finger Food Buffet, Wine and Draft beer
Swiss Space Night: Industry Networking
Exhibition: The World of Micro/Nano Satellites

INVITED PRESENTATIONS

20:30 **Keynote Speakers**

Claude Nicollier: Memories from LEO, where radiation hits but does not hurt
Mauro Augelli (CNES): Proxima, a new batch for Human Space Flight experiments

21:30 **EXHIBITION, NETWORKING & COCKTAIL DINNER - PART 2**

Cocktail Dinner - Part 2: Dessert and Coffee
Swiss Space Night: Industry Networking
Exhibition: The World of Micro/Nano Satellites

23:00 **END OF THE EVENT** (last arrival in Geneva ~23:45h)

From 22:00 until 23:00, Transfer by Bus from Lausanne to the CICG
First Transfer back to the CICG @21:45 | Bus departure every 30 min

RADECS 2017
CERN, Geneva

Swiss Tech Conference Center | Lausanne, Switzerland

KEYNOTE SPEECH 20:30

"Memories from LEO, where radiation hits but does not hurt"

The Space Shuttle era (1981 to 2011) was a very productive period of exploitation of the Low Earth Orbit (LEO) by a multi-purpose reusable manned space vehicle. Operational missions launched several satellites, interplanetary probes, and the Hubble Space Telescope (HST), conducted numerous science experiments in orbit; and participated in assembly of the International Space Station (ISS). As an ESA astronaut, the speaker took part in four Shuttle missions, two of which were high-altitude missions (600 km) to service HST. The preparation needed for such missions, as well as the execution of these missions will be described, highlighting the challenge of achieving success during a very limited time on orbit. Radiation effects on astronauts were not too dramatic in LEO, but still detectable!

CLAUDE NICOLLIER

has been for 30 years a European Space Agency (ESA) astronaut of Swiss nationality. He graduated from the University of Lausanne in 1970 (Bachelor of Science in physics) and the University of Geneva in 1975 (Master of Science in astrophysics). He also graduated as a Swiss Air Force pilot in 1966, an airline pilot in 1974 (flew DC-9s for Swissair 1974-1976), and a test pilot in 1988 (Empire Test Pilot's School, Boscombe Down, United Kingdom).
He was a member of the first group of ESA astronauts selected in 1978. He then joined Group 9 of NASA astronauts in 1980 for Space Shuttle training at the Johnson Space Center, Houston, Texas, where he was stationed until September 2005. During his assignment in Houston, he also maintained an active duty status within the Swiss Air Force with a rank as Captain, flying Hawker Hunter, Northrop F-5E "Tiger", and Pilatus PC-9 aircraft until end of 2004. He has logged more than 6500 flight hours, 4000 of which in jet aircraft.
He retired from ESA in 2007, and is currently a member of the Swiss Space Center and honorary professor at the Swiss Federal Institute of Technology in Lausanne or EPFL (Ecole Polytechnique Fédérale de Lausanne) where he teaches a course on "Space Mission Design and Operations". He also provides assistance to students on various space related projects.
Claude Nicollier has been a crewmember on four Space Shuttle flights, STS-46 in 1992 (EURECA deployment and first test of a Tethered Satellite System or TSS), STS-61 in 1993 (first servicing mission of the Hubble Space Telescope), STS-75 in 1996 (second flight of TSS, and USMP-3 microgravity investigations), and STS-103 in 1999 (third servicing mission of the Hubble Space Telescope). He has logged more than 1000 hours in space, including a spacewalk of more than 8 hours duration to install new equipment on the Hubble Space Telescope on STS-103. He is a recipient of Honorary Doctorates from EPFL, and the Universities of Geneva and Basel.

KEYNOTE SPEECH 20:30

«Proxima: a new batch for human space flight experiments»

CADMOS was not only the Greek hero who founded Thebes city after killing a malevolent dragon, it is also the acronym for the French Human Space Flight Mission Center (Centre d'Aide au Développement des activités en Micropesanteur et des Opérations Spatiales).
CADMOS mission center started its activities in 1993, participating in all French-Russian cooperation in human spaceflights before continuing during shuttle and ISS era.Today, CADMOS prepares and operates microgravity experiments with Russia, USA and all over Europe. It covers almost all science topics from human physiology to Matter or Fundamental Science as well as innovative technology demonstrtors. CADMOS latest achievement was the Proxima Mission with Thomas Pesquet. The 6 innovative experiments developed and operated by CADMOS will be described. Effect of radiation on human is still a topic studied on the ISS !

MAURO AUGELLI

completed his studies in Aerospace Engineering at the University of Pisa in 1996.
He worked for three years at the Italian Space Agency (ASI) on nuclear propulsion and manned exploration missions.
In 2001 he moved to the French Space Agency (CNES) as a propulsion specialist.
In 2006 Mauro Augelli joined the ESA Automated Transfer Vehicle (ATV) operations working for two missions as Flight Dynamics Team leader and as ATV flight Director for the remaining three missions.
Since the end of the ATV project, in 2015, Mauro Augelli is working as mission and operations manager of the European ISS external scientific payload ACES (Atomic Clocks Ensemble in Space), to be launched early 2019. Mauro Augelli is also project manager for all the ISS science operational activities performed at the ISS French USOC (CADMOS).

INVITED TALK 8:30-9:30

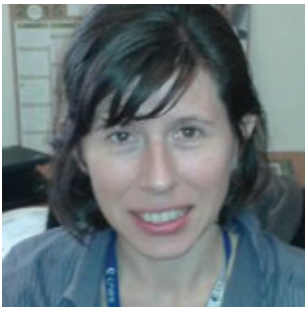
What is the universe made of ?

Recent results coming from particle physics, astrophysics and cosmology have modified and enriched our representation of the universe : detection in 2012 of the Higgs boson by the LHC at CERN, very precise images of the cosmic diffuse background obtained in 2013 by the satellite Planck, first detection in 2016 of gravitational waves by LIGO experiment… We will comment the consequences of these huge discoveries. We will also explain the "though experiments" thanks to which Einstein was put on the road of a new description of gravitation, i.e. the theory of general relativity, which has opened the way to scientific cosmology.

Born in 1958, **ETIENNE KLEIN** is physicist at CEA, the French Atomic Energy Commission, at Saclay near Paris. Since 2007, he is the Director of the Research Laboratory on Matter Sciences at CEA (LARSIM). His research interests include the foundations of physics, the interpretation of quantum mechanics, the question of time in physics and the relationship between science and society. He is professor at Ecole Centrale de Paris, both in physics and philosophy of science. He is member of the French Academy of Technologies.

SESSION D: Radiation Effects on Materials

Session Chairs: **Elisabeth Laurent**[1] and **Marc Tavlet**[2]
[1]CNES, [2]CERN
9:30-9:35: Session opening



ELISABETH LAURENT

received her PHD in supra and macromolecular chemistry in 2008, at Paul Sabatier University, Toulouse. For 7 years, she has been working as materials and processes engineer in the quality department, specialized in the field of polymers and composites materials at CNES Toulouse Center (Centre National d'Etudes Spatiales). She follows activities for selecting and qualifying organic materials for space projects and leads R&T activities on identifying tests parameters effects on materials properties in the frame of radiation qualification tests with industrial and academic partners. She is involved in new technologies regarding thermoplastic materials and composite materials for various applications (structure, antennas...). She has run materials competence technique of CNES for 5 years by organizing regularly seminar and workshop for industrials, SMEs and labs on materials used in aerospace and associated problems (regulations, space constraints, and innovative materials).

MARC TAVLET

obtained diplomas in nuclear sciences (ISIB, Brussels) and in material sciences (UCL, Louvain-la-Neuve). At CERN, he was in charge, for close to 20 years, of material qualification with respect to their fire and radiation behaviours, as well as of high dose dosimetry around accelerators and irradiation facilities. During this period, he regularly participated among others to Radecs and IRaP conferences, where he was several times invited to provide short courses or give invited talks. He also often gave talks which were published in the respective proceedings, in addition to some specific publications. His work has been much referenced in the famous Handbook of Radiation Effects (Oxford U.P. 2002). Within the Beams Department, he is now in charge of operational safety of all CERN accelerators.

ORAL COMMUNICATIONS

D-1 | 9:35

Electrical Ageing of Space Used Polymers Under High Energy Electron Irradiation

Thierry Paulmier[1], Bernard Dirassen[1], Aurélien Roggero[2], Eric Dantras[2], Claire Tonon[3], Sabine Dagras[3], Denis Payan[4]

[1]ONERA, [2]CIRIMAT, [3]Airbus Defense and Space, [4]CNES

This work aims at studying ageing of electric properties of space used polymers. Significant evolutions of their electrical conductivity and chemical structure have been observed with the increasing dose, which can affect charging behavior.

D-2 | 9:50

Evaluation of the JUICE materials behavior to spacecraft environment (synergistic effect of radiations and cold temperature)

Sabine Dagras[1], Julien Eck[1]

[1]Airbus Defense and Space

Two extended tests campaigns were performed on JUICE spacecraft materials to evaluate their behavior to Jovian environment. This study was specifically focused on the synergistic effects of radiations and very low temperature on materials.

D-3 | 10:05

Growth and Decay Kinetics of Radiation-Induced Attenuation in Bulk Optical Materials

Sylvain Girard[1], Timothé Allanche[1], Philippe Paillet[2], Vincent Goiffon[3], Marco Van Uffelen[4], Laura Mont Casellas[4]

[1]Université de Saint-Etienne, [2]CEA DAM DIF, [3]ISAE SUPAERO, [4]Fusion for Energy (F4E)

These kinetics are monitored in situ up to MGy doses in the visible domain for different optical glasses. The crucial impact of the transient losses in the vulnerability of optical systems is highlighted

D-4 | 10:20

Selection and qualification strategy of new technologies for safety instrumentation in extreme radiation environments

Carl Zinoni[1], Loic Janvier[1], Symoens Benoit[1]

[1]TechnicAtome

Qualification of safety instrumentation for nuclear reactors is a challenging issue in extreme radiation environments: strategies for qualifying limit switches based on optical fibers at 800MGy and polymer embedded reed switches at 60kGy are presented.

10:35-11:05:

Coffee Break - Level 0, Exhibits Area

POSTER SESSION

PD-1

Alpha radiation testing of materials: a technique with excellent dosimetry and no radioactive contamination

Richard Sharp[1]

[1]Cobham RAD Solutions

This abstract describes a technique by which to carry out the alpha radiation testing of materials samples without the use of radioactive materials and with vastly improved dosimetry than offered by traditional methods.

PD-2

The structural changes of surfaces of solar cell protective coatings under combined electron-proton irradiation

Rashid Khasanshin[1], Lev Novikov[2]

[1]OAO "Kompozit", [2]Lomonosow Moscow State University, Skobeltsyn Institute of Nuclear Physics

The work shows that the nature of structural changes of surfaces of solar cell protective coatings under combined electron-proton irradiation is determined by flux densities of electrons and protons and the ratio of the fluxes.

PD-3

Complex environmental and synergetic effects on space materials: lesson learned from THERME in-flight data

Sophie Duzellier[1], Emilie Vanhove[1], Delphine Faye[2], Stéphanie Remaury[2]

[1]ONERA, [2]CNES

Space materials are exposed to harsh, complex environments. Various effects i.e. contamination, ageing, erosion arise and synergy is at play to induce severe degradations. THERME flight data illustrates this problematic and representativeness of ground simulation

PD-4

Ni-ions and γ-ray irradiated Silica-based Glasses characterized by Luminescence and Raman Spectroscopies

Antonino Alessi[1], Sylvain Girard[2], Melanie Raine[3], Mattia Fanetti[4], Diego Di Francesca[5], Layla Martin-Samos[4], Imene Reghioua[1], Marc Gaillardin[3], Nicolas Richard[3], Philippe Paillet[3], Matjaz Valant[4], Aziz Boukenter[1], Youcef Ouerdane[2]

[1]Université de Lyon Laboratoire H. Curien, [2]Université de Lyon, [3]CEA/DAM/DIF, [4]Materials Research Laboratory, University of Nova Gorica, [5]CERN

We studied γ and Ni irradiation effects on glass samples monitoring structural changes and some induced green emissions, which until now have been not fully characterized to improve the understanding of the optical induced modification.

PD-5

Degradation of KNN-based Lead Free Piezoelectric material under Gamma Irradiation

Gang Dai[1], Yijia Du[1], Quanfeng Zhou[1], Ke Wang[2], Jian Zhang[1]

[1]Microsystem and Terahertz Research Center, China Academy of Engineering Physics; Institute of Electronic Engineering, China Academy of Engineering Physics, [2]State Key Laboratory of New Ceramics and Fine Processing, School of Materials Science and Engineering, Tsinghua University

The piezoelectric and ferroelectric response of KNN-based lead free piezoelectric ceramics under gamma irradiation are much worse than PZT. The degradation of d33 and shift of hysteresis loop indicate the TID tolerance is about 40 Mrad(Si).

SESSION E: Single Event Transients and Laser testing

Session Chairs: **Nicolas J-H. Roche**[1] and **Françoise Bezerra**[2]
[1]Montpellier University, [2]CNES
11:05-11:10: Session opening

DR. NICOLAS J-H. ROCHE

received the Ph. D. ès Electronics from Montpellier University in October 2010. In parallel to his PhD studies, Dr. Roche was the technical deputy for embedded payload on board 1U nano-class satellite (ROBUSTA) and technical deputy for FRP (Franco Russian Project) equipment design embedded onboard Baumanets-2 satellite (Bauman Moscow State Technical University). In 2011, Dr. Roche was appointed by the CNRS and the DGA to the U.S. Naval Research Laboratory. In July 2012, Dr. Roche joined The George Washington University, actively working with the U.S. Naval Research Laboratory on ultrafast laser measurements and analyses, and computer modeling of the performance of devices in radiation environment. His research interests include: the effects of both natural space radiation environment and very high dose rate pulsed environment on electronic circuits and systems; the development of new methodologies to study and model ASET, ATREE and synergistic effects (TID/SEE and NITD/SEE); the design and development of radiation hardening by design techniques. Today, Dr. Roche is the Montpellier University Space Center Chief Technology Officer where he is working on the development of NewSpace CubeSat based systems.

FRANÇOISE BEZERRA

received her degree in electronic engineering from the French Civil Aviation National School in 1991. She joined the CNES, the French Space Agency, in 1992 as a quality insurance engineer in charge of micro-processors, ASICs and FPGAs. In 1999, she moved to the radiation group where she still coordinates the radiation test campaigns, supports projects for the selection and use of electronic devices regarding their behavior versus radiation effects and also manages R&D studies in the same topic. She is also Principal Investigator of the CARMEN/MEX instrument that studies radiation effects on electronic devices on board of JASON2, JASON3 and SAC-D satellites and Radiation Safety Officer for the CNES Toulouse. Françoise Bezerra has coauthored more than 80 papers in radiation testing or in-flight experiments and has also chaired sessions at various RADECS conferences. Two studies she has driven were awarded as best data workshop paper at the RADECS 2011 and 2012 conferences respectively and she was in charge of a short course upon Facilities & Methods for Radiation Testing at NSREC 2014 conference. She will be RADECS 2019 technical chair.

ORAL COMMUNICATIONS

E-1 | 11:10

Effect of Device Variants on Single-Event Transients in a 14nm Bulk FinFET Technology

Rachel Harrington[1], Jeff Maharrey[1], Jeffrey Kauppila[1], Patrick Nsengiyumva[1], Dennis Ball[1], Tim Haeffner[1], Enxia Zhang[1], Bharat L Bhuva[1], Lloyd Massengill[1]

[1]Vanderbilt University

Single-event transient data for 14nm bulk FinFETs are presented and analyzed for variations in threshold voltage and number of fins in the gate.

E-2 | 11:25

Comparison of Single Event Transients in AlGaN/GaN Schottky-Gate HEMTs Using Four Sources of Charge Injection.

Ani Khachatrian[1], Nicolas Roche[2], Stephen Buchner[1], Andy Koehler[1], Travis Anderson[1], Karl Hobard[1], Dale McMorrow[1], Stephen LaLumondiere[3], Nathan Wells[3], M Tockstein[3], Eric Dillingham[3], J Bonsall[3], P Karuza[3], William Lotshaw[3], Steven Moss[3], David Brewe[4], Veronique Ferlet-Cavrois[5], Michele Muschitiello[6]

[1]Naval Research Laboratory, [2]University of Montpellier, [3]The Aerospace Corporation, [4]Argonne National Laboratory, [5]European Space Agency/ESTEC, [6]European Space Agency

The shapes of single-event transients produced by heavy ions, focused pulsed laser-light, and focused pulsed x-rays in an AlGaN/GaN HEMT were compared.

E-3 | 11:40

Single event burnout induced by heavy ions and Laser pulses in silicon Schottky diodes

Maxime Mauguet[1], Fabien Widmer[2], Eric Lorfevre[3], Delphine Lagarde[4], Nathalie Chatry[2], Xavier Marie[4]

[1]TRAD - LPCNO INSA Toulouse, [2]TRAD, [3]CNES, [4]LPCNO INSA Toulouse

In addition to heavy ions, the spatio-temporal resolution of LASER pulses was used to trigger SEB in two types of silicon Schottky diodes. The SEB phenomenon and the impact of the tests parameters are discussed.

E-4 | 11:55

Move the Laser Spot, Not the DUT: Investigating the New Micro-mirror Capability and Challenges for Localizing SEE Sites on Large Modern ICs

Matthew Cannon[1], Andrés Pérez-Celis[1], Gary Swift[2], Richard Wong[3], Shi-Jie Wen[3], Michael Wirthlin[1]

[1]Brigham Young University, [2]Swift Engineering & Radiation Services, LLC, [3]Cisco System Inc.

Techniques for mirror-based X-Y scanning of advanced large die with small features using a TPA laser to characterize and localize SEEs are developed and demonstrated on 65nm and 28nm FPGAs.

POSTER SESSION

PE-1

Numerically supported interpretation of experimental GaN HEMT Single-Event Transients induced by heavy ions and X-ray beam

Marek Turowski[1], Ani Khachatrian[2], Stephen Buchner[2], Andy Koehler[2]

[1]Silvaco, [2]Naval Research Laboratory

Physics-based simulations indicate that point defect trap models reproduce well steady-state and transients in pristine HEMTs, but not the enhanced decay times and collected charge in proton-irradiated HEMTs, which may be of more complex nature.

PE-2

Strong Correlation Between Heavy-Ion LET and Laser Equivalent LET in a Diode Device Using One- and Two-Photon Absorption

Joel Hales[1], Ani Khachatrian[1], Stephen Buchner[1], Nicolas Roche[1], Jeffrey Warner[1], Zachary Fleetwood[2], Adrian Ildefonso[2], John Cressler[2], Dale McMorrow[1], Marek Turowski[3], Klas Lilja[4], Veronique Ferlet-Cavrois[5]

[1]Naval Research Laboratory, [2]Georgia Institute of Technology, [3]Silvaco, [4]Robust Chip, Inc, [5]European Space Agency/ESTEC

One-to-one correlation between heavy-ion and laser-equivalent LET is found for a diode device using both single- and two-photon absorption. These results suggest a pathway for developing a laser-ion correlation methodology for more complex devices.

PE-3

28nm UTBB-FDSOI SET Study with Two-Photon Absorption Laser

Xuantian Li[1], Rui Liu[1], Li Chen[1], Yuanqing Li[1], Adrian Evans[2], Maximilien Glorieux[2], Joao Cunha[3], Leopold Summerer[3], Shi-Jie Wen[4], Richard Wong[4]

[1]University of Saskatchewan, [2]IROC, [3]ESA/ESTEC, [4]CISCO

Laser experiments were carried out at the NRL to measure the SET-induced SERs and the SET pulse widths in the 28nm FDSOI logic circuits at various clock frequencies and laser energy levels.

PE-4

Implications of Work-Function Fluctuation on Radiation Robustness of FinFET XOR Circuits

Ygor Quadros de Aguiar[1], Fernanda Lima Kastensmidt[1], Cristina Meinhardt[2], Ricardo Reis[1], Laurent Artola[3], Guillaume Hubert[3]

[1]UFRGS, [2]FURG, [3]ONERA

It is evaluated the implications of the Work-Function Fluctuation (WFF) on the SET pulse-width in FinFET XOR circuits. Results show that WFF can lead from 10% wider transient pulse to 200% in lower power designs.

PE-5

Effective Characterization of Radiation-induced SET on Flash-based FPGAs

Luca Sterpone[1], Sarah Azimi[1]

[1]Politecnico di Torino

Single Event Transients (SETs) are one of the major concern for Flash-based Field Programmable Gate Arrays (FPGAs). In this paper, we propose a new analysis to characterize the SET phenomena within Flash-based FPGAs

PE-6

Experimental Investigation of the Joint Influence of Reduced Supply Voltage and Charge Sharing on Single-Event Transient Waveforms in a 65 nm Triple-Well CMOS

Mladen Mitrovic[1], Michael Hofbauer[1], Kay-Obbe Voss[2], Horst Zimmermann[1]

[1]TU Wien, [2]GSI Darmstadt

Full waveforms of single-event transients were measured under focused heavy-ion microbeam irradiation. The influence of changing supply voltage from subthreshold to nominal level on SET forming and propagation was investigated and discussed.

PE-7

Radiation Effects on 1 Mb HfO2-based Resistive Memory

Jinshun Bi[1], Bo Li[1], Chen Li[2], Feng Zhang[1], Kai Xi[1], Ming Liu[1], Yuan Duan[1]

[1]IMECAS, [2]University of Saskatchewan

Radiation effects on 1 Mb HfO2-based RRAM with 1T1R structure are investigated. TID-induced leakage current causes '0-1' type error bits. SELs in peripheral circuits occur, but no SEUs in memory array have been observed.

ROUND TABLE PART 2 : Radiation Tests and Components Qualification Engineering Troubleshooting

12:10-12:15: Round Table opening

ORAL COMMUNICATIONS

ET-4 | 12:15

The Difficulties and Solutions in SEE Radiation Experiments, Test Samples and Setup Preparation

Aleksandr Koziukov[1], Vasily Anashin[1], Sergei Yakovlev[1], Anton Bychkov[1], Vadim Mazharov[1]

[1]Branch of JSC "URSC" - "ISDE"

This paper presents a collection of difficult technical issues and the experience obtained of solutions for SEE test process management including test samples preparation, test bench development and adjustment, test software creation.

ET-5 | 12:30

Advanced In-Situ Instrumentation of RF Circuits for Mixed-Field Irradiation Testing Purpose

Steffen Mueller[1]

[1]Friedrich-Alexander University of Erlangen-Nuremberg

This paper presents a method that applies multiplexing and in-line calibration technique in order to qualify for efficient instrumentation of multiple RF circuits up to 6 GHz during mixed-field irradiation.

12:45-14:00:

Lunch - Level 1, Restaurant

SESSION F: Radiation Effects in Devices and ICs

Session Chairs: **Marta Bagatin** and **Yago Velo Gonzalez**
[1]Padova University, [2]Arizona State University
14:00-14:05: Session opening

MARTA BAGATIN

received the Laurea degree (cum laude) in Electronic Engineering from the University of Padova, Italy, in 2006. In 2010 she earned the Ph.D. degree at the School in Information Science and Technology at the Department of Information Engineering, University of Padova. She is now a research fellow in the same University. Her research interests concern radiation and reliability effects on electronic devices, especially on non-volatile semiconductor memories. Marta has authored or co-authored more than 50 articles in peer-review journals, 4 book chapters, and more than 60 presentations in conferences. The results of her work were recognized with the Outstanding Student Paper Award at NSREC 2008 and NSREC 2009, the Best Student Presentation Award at RADECS 2008, the Best Paper Award in RADECS 2010, and the NPSS Phelps Grant in 2009, and the Meritorious Paper Awards at NSREC 2013 and NSREC 2014.

YAGO VELO GONZALEZ

is an Assistant Research Professor within the department of ECEE at Arizona State University, in Tempe, Arizona. His research focuses on the implementation characterization and reliability of novel nano-ionics devices for diverse types of applications, among which cybersecurity, anti-tampering, anti-counterfeiting and neuromorphic applications. His main reliability research is oriented towards radiation effects on devices and microcircuits, from impact at the material level up to the electrical behavior of devices. He has been an active researcher in the radiation effects community for 10 years, focusing on total dose and dose-rate effects.

ORAL COMMUNICATIONS

F-1 | 14:05

TID Response of PMOS Nano Wire Field-Effect Transistors: Geometry and Bias Dependence

Jonathan Riffaud[1], Marc Gaillardin[1], Claude Marcandella[1], Nicolas Richard[1], Olivier Duhamel[1], Martial Martinez[1], Melanie Raine[1], Philippe Paillet[1], Thierry Lagutere[1], F Andrieu[2], S Barraud[2], M Vinet[2], Olivier Faynot[2]

[1]CEA/DAM/DIF, [2]CEA LETI

The TID response of nanowires PMOS NWFETs during x-ray irradiation is investigated. Geometry and bias dependence on the electrical characteristics as the threshold voltage, oxide and interface trapped charge contribution are addressed.

F-2 | 14:20

Anomalous Total Dose Response and Room-Temperature Annealing Behavior in Bulk nFinFETs

Ling Yang[1], Zhongshan Zheng[1], Bo Li[1], Binhong Li[1], Qingzhu Zhang[1], Xingyao Zhang[2], Huiping Zhu[1], Huaxiang Yin[1], Qi Guo[2], Jiajun Luo[1], Zhengsheng Han[1]

[1]Institute of Microelectronics, [2]Xinjiang Technical Institute of Physics and Chemistry

The total dose response of bulk nFinFETs with various gate lengths and fins is investigated under on-state bias condition. The results show anomalous positive threshold voltage shifts and room-temperature annealing behaviors.

F-3 | 14:35

CMOS SPAD sensors for particle tracking exposed to ionizing and non-ionizing radiation

Lodovico Ratti[1], Paolo Brogi[2], Gianmaria Collazuol[3], Gian-Franco Dalla Betta[4], Andrea Ficorella[4], Luca Lodola[2], Pier Simone Marrocchesi[5], Fabio Morsani[6], Marco Musacci[1], Lucio Pancheri[7], Aurore Savoy Navarro[6], Carla Vacchi[1]

[1]University of Pavia and INFN, [2]INFN, [3]University of Padova and INFN, [4]University of Trento and INFN, [5]University of Siena, [6]University of Pisa and INFN, [7]University of Trento

The radiation tolerance of single photon avalanche diodes (SPADs) fabricated in a 180 nm CMOS technology has been studied in view of applications to dual-tier particle trackers at future linear colliders.

F-4 | 14:50

TCT Measurements and Analyses of Proton Irradiated LGADs

Sofia Otero Ugobono[1], Matteo Centis Vignali[2], Marcos Fernandez Garcia[3], Christian Gallrapp[2], Salvador Hidalgo Villena[4], Isidre Mateu Suau[5], Michael Moll[2], Giulio Pellegrini[6], Ivan Vila Alvarez[3]

[1]CERN and Universidade de Santiago de Compostela, [2]CERN, [3]Universidad de Cantabria, [4]Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC), [5]Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, [6]Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)

Silicon detectors with internal gain (Low Gain Avalanche Detectors) for the HL-LHC were characterised before and after 24-GeV/c proton irradiation (up to 1E15 1 MeV n_eq/cm2) by means of the Transient Current Technique.

F-5 | 15:05

Temperature Effects on the Total Ionizing Dose Response of TaOx-based Memristive Bit Cells

Michael McLain[1], Kyle McDonald[1], Harry Hjalmarson[1], Don Hanson[1], Jason Serrano[1], Roy Cuoco[1], David Hughart[1], Matt Marinella[1]

[1]Sandia National Laboratories

The effects of temperature on the total ionizing dose (TID) response of TaOx memristors are investigated. The results indicate that there is not an increased susceptibility to TID at elevated temperatures.

POSTER SESSION

PF-1

The Phenomenon and Mechanism of an Increase in TDDB Lifetime of Partial Depleted SOI Devices Exposed to Protons

Teng Ma[1], Dandan Su[1], Hang Zhou[1], Jiangwei Cui[1], Qi Guo[1], Xuefeng Yu[1], Zheng Qiwen[1]

[1]XinJiang Technical Institute of Physics and Chemistry Chinese Academy of Sciences

The effects of proton irradiation on the subsequent TDDB of PD-SOI devices are experimentally investigated. Based on the results, we found an increase in the TDDB lifetime and a decrease in the gate leakage current.

PF-2

An Effective Method to Compensate TID Induced Degradation on DSOI Structure

Yang HUANG[1], Binhong LI[1], Xing ZHAO[1], Zhongshan ZHENG[1], Jiantou GAO[1], Gang ZHANG[1], Guohe ZHANG[2], Kai TANG[2], Bo LI[1], Zhengsheng HAN[1], Jiajun LUO[1]

[1]IMECAS, [2]XJTU

To mitigate the TID induced degradation effectively, DSOI structure is studied in this paper. Impact of negative back gate bias to transistor parameter degradation is investigated. An improved back gate compensated strategy is proposed.

PF-3

Radiation hardening by the modification of shallow trench isolation process in partially-depleted SOI MOSFETs

Chao Peng[1], Zhiyuan Hu[2], Yunfei En[1], Zhifeng Lei[1], Yuan Liu[1]

[1]Science and Technology on Reliability Physics and Application Technology of Electronic Component Laboratory, [2]Chinese Academy of Sciences

Two radiation hardening processes for STI, i.e. Si+ implantation and STI oxide nitridation are investigated, including the impact on nominalelectrical characteristics and radiation hardness. Then a 130 nm radiation-hardened PDSOI technology has been developed.

PF-4

Architecture Choice for Radiation-Hard AlGaN/GaN HEMT Power Devices

Dirk Wellekens[1], Steve Stoffels[1], Aurore Luu[2], Magali Haussy[3], Michel Mélotte[3], Dries Agten[3], Stefaan Decoutere[1]

[1]IMEC, [2]Engibex, [3]Thales Alenia Space Belgium

The robustness of GaN-on-Si AlGaN/GaN HEMT power devices against heavy ion and neutron irradiation is investigated. Two different HEMT architectures are compared under identical irradiation conditions to define the optimum solution for radiation hard applications.

PF-5

Total Ionizing Dose influence on the Single Event Upset sensitivity of 65nm DICE SRAM

Qiwen Zheng[1], Jiangwei Cui[1], Hang Zhou[1], Mohan Liu[1], Qi Guo[1], Wu Lu[1], Xuefeng Yu[1]

[1]Xinjiang Technical Institute of Physics and Chemistry

Increased heavy ion SEU sensitivity of 65nm DICE SRAM after TID irradiation is observed in this work. The mechanism under above experimental result is the enhanced NMOSFET and PMOSFET charge sharing caused by TID.

PF-6

The Impact of X-ray and Proton Radiation on a CMOS Physically Unclonable Function Based on Oxide Breakdown

Pengfei Wang[1], Enxia Zhang[1], Kai Hsin Chuang[2], Wenjun Liao[1], Huiqi Gong[1], Pan Wang[1], Charles N. Arutt[1], Kai Ni[1], Mike McCurdy[1], Ingrid Verbauwhede[3], Erik Bury[2], Dimitri Linten[2], Daniel Fleetwood[1], Ron Schrimpf[1], Robert Reed[1]

[1]Vanderbilt University, [2]IMEC, [3]KU Leuven

TID effects are investigated on a physically unclonable function (PUF) based on CMOS breakdown. The PUF is resilient to low-dose X-ray exposure, but the read-out window of programmed PUFs decreases at high dose proton irradiation.

PF-7

Total dose radiation hardening of MOS transistors by fluorine implantation

Chris Shaw[1], Cornelis de Groot[2], Katrina Morgan[2], Ken Potter[2], Peter Ashburn[2], Redman-White Bill[2]

[1]AWE PLC, [2]University of Southampton

Fluorine-doped NMOS transistors have been designed and fabricated for their improved hardness to total ionizing dose radiation, showing negligible threshold shifts at maximum dose of 1MRad (Si) due to full passivation of the interface states.

PF-8

TCAD prediction of dose effects on MOSFETs with ECORCE

Alain Michez[1], Jérôme Boch[1], Jason Dardié[1], Frédéric Wrobel[1], Antoine Touboul[1], Tadec Maraine[1], Frederic Saigne[1], Eric Lorfèvre[2], Françoise Bezerra[2]

[1]Université de Montpellier, [2]Centre National d'Etudes Spatiales

To ease testing of components for space application, we propose to build a TCAD model from a reduce set of experiments, and then use this TCAD model to predict the behavior of components.

PF-9

Internal Electrostatic Discharge Testing of a RF Cable and Connectors

Wousik Kim[1], James Chinn[1], Harry Figueroa[1], Dennis Thorbourn[1]

[1]JPL, NASA

The Internal Electrostatic Discharge (IESD) tests and 3D simulations on a RF coax cable with three different connectors (SMA, 2.92 mm, and 3.5 mm) are performed to assess the iESD threat at Europa Clipper Environment.

SESSION G: Radiation Hardening by Design

Session Chairs: **Lawrence T. Clark**[1] and **Fernanda Lima Kastensmidt**[2]
[1]Arizona State University, [2]UFGRS
15:20-15:25: Session opening

LAWRENCE T. CLARK

(B.S. CS 1982, M.S.EE 1987, PhD EE 1992)
is a Professor at Arizona State University. He had approximately 15 years of experience in the semiconductor industry at VLSI Technology and Intel prior to transitioning to academia in 2003. He was a consultant and then Chief architect at SuVolta from 2009-2014. His research interests are VLSI design, CAD, and reliable system architectures. Dr. Clark holds over 120 US patents, is an Intel Achievement Award recipient, and has co-authored over 130 peer reviewed technical publications and nine book chapters.

PR. FERNANDA LIMA KASTENSMIDT

joined the Instituto de Informática faculty in 2005. She received a PhD in 2003 and MSE in 1999 both in Computer Science from Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre, RS, Brazil. Dr. Fernanda's current research focuses on soft error mitigation techniques for SRAM- based FPGAs and integrated circuits, such as microprocessors, memories and network-on-chips (NoCs), and the analysis and modelling of radiation effects in those circuits. She currently advises the MSE and PhD thesis at the Computer Science Graduation Programme http://ppgc.inf.ufrgs.br/ (PPGC) and at the Microelectronics Programme www.inf.ufrgs.br/pgmicro/ (PGMICRO). She has published more than 80 papers in Scientific conferences and journals, she wrote many books such as Fault-Tolerance Techniques for SRAM-based FPGAs in 2006, and she has been participating in payload projects on nano satellites. She is currently the coordinator of the Microelectronics Programme PGMICRO at UFRGS and she is an IEEE member.

ORAL COMMUNICATIONS

G-1 | 15:25

Comparative Analysis of Unhardened and Hardened Sequential Circuits for Low Power Applications in 16-nm Bulk FinFET CMOS Technology

Hui Jiang[1], Hangfang Zhang[1], Jeffrey Kauppila[1], Bharat Bhuva[1], Lloyd Massengill[1]

[1]Vanderbilt University

A comparative analysis of power versus single-event cross-sections for three representative RHBD flip-flops and an unhardened FF fabricated in 16-nm bulk FinFET CMOS process.

G-2 | 15:40

On the Efficacy of ECC and the Benefit of FinFET Transistors Layout in GPUs Reliability

Caio Lunardi[1], Fritz Previlon[2], David Kaeli[2], Paolo Rech[1]

[1]UFRGS, [2]Northeastern University

We investigate the efficacy of using ECC to mask neutron-induced faults in GPUs. We consider both CMOS and FinFET GPUs, showing that improved transistor technology can be as beneficial as ECC in reducing SDC rates.

G-3 | 15:55

Design and test with proton beam of a 1.2 Gb/s semi-custom serializer implemented in 180 nm CMOS with SEU mitigation by TMR

Matteo Lupi[1], Gianluca Aglieri Rinella[2], Matthias Bonora[3], Daehyeok Kim[4], Thanushan Kugathasan[2], Alessandra Lattuca[5], Gianni Mazza[5], Krzysztof Marek Sielewicz[6], Walter Snoeys[2]

[1]Johann-Wolfgang-Goethe Univ. (DE), [2]CERN, [3]University of Salzburg (AT), [4]Yonsei University (KR), [5]Universita e INFN Torino (IT), [6]Warsaw University of Technology (PL)

This contribution describes the design of a semi-custom serializer in 180nm CMOS technology. The design is verified for SEU immunity and BER with 30 MeV protons.

G-4 | 16:10

Muller C-element Self-corrected Triple Modular Redundant Logic with Multithreading and Low Power Modes

Chandarsekaran Ramamurthy[1], Aditya Gujja[1], Srivatsan Chellappa[1], Vinay Vashishtha[1], Lawrence T. Clark[1]

[1]Arizona State University

Voting feedback circuits for TMR self-correcting flip-flops that reduce area by 20% and energy by 10% over majority gates are described. Variations allow multi-threading and power saving non-redundant modes.

POSTER SESSION

PG-1

Hardened By Design All-Digital Pulsed Multiplying DLL for DDR2-3 Interfaces

Chandarsekaran Ramamurthy[1], Lawrence T. Clark[1]

[1]Arizona State University

A novel radiation hardened, all-digital, pulse-clocked, multiplying DLL for DDR2 and DDR3 interfaces with a peak-to-peak jitter of 22 ps and active energy of 14 pJ/cycle at 850 MHz operation is presented.

PG-2

Radiation-Hardened Flip-Flops with Low Delay Overheads Using PMOS Pass-Transistors to Suppress a SET Pulse in a 65 nm FDSOI Process

Kodai Yamada[1], Haruki Maruoka[1], Jun Furuta[1], Kazutoshi Kobayashi[1]

[1]Kyoto Institute of Technology

We propose radiation-hardened Flip-Flops with low delay overheads using PMOS pass-transistors to suppress a SET pulse in a 65nm thin BOX FDSOI. They have 100x, higher soft-error tolerance than the conventional radiation-hardened stacked FF.

PG-3

Dual Interlocked Logic for Single-Event Transient Mitigation

Jeff Maharrey[1], Jeffrey Kauppila[1], Rachel Harrington[1], Patrick Nsengiyumva[1], Tim Haeffner[1], En Xia Zhang[1], Bharat Bhuva[1], Tim Holman[1], Lloyd Massengill[1]

[1]Vanderbilt University

A novel combinational logic family designed for SET mitigation has been fabricated in a 14nm bulk finFET technology and irradiated with heavy-ions. Results are compared to cascode voltage switch and standard logic.

PG-4

Single-Event Transient Analysis and Hardening in a 180 nm CMOS Embedded Low-Dropout Regulator

Liang Wang[1], Yuanfu Zhao[1], Xupeng Han[1], Qiang Bian[1], Suge Yue[1], Shijin Lu[1], Lei Shu[2], Jiaqi Liu[1], Tongde Li[1]

[1]Beijing Microelectronics Technology Institute, [2]Harbin Institute of Technology

SET sensitivity of a 180 nm CMOS embedded LDO is studied by experiments and simulations. Different output responses for different block striking are observed and methods to mitigate each influence are given.

PG-5

Analyzing the Impact of Software Optimizations in Lockstep Dual-Core ARM A9 under Heavy Ion Induced Soft Errors

Ádria Barros de Oliveira[1], Fernanda Lima Kastensmidt[1]

[1]UFRGS

This paper explores different software optimizations applied to dual-core lockstep implemented in APSoC and analyzes the impact in performance and error mitigation. Results show that SDC cross-section is reduced up to two orders of magnitude.

PG-6

Experimental methods and results for the evaluation of triple modular redundancy SEU mitigation techniques with the Kintex-7 FPGA

Krzysztof Marek Sielewicz[1], Gianluca Aglieri Rinella[2], Joachim Schambach[3], Marcus Johannes Rossewij[4], Matthias Bonora[5], Piero Giubilato[6], Tomas Vanat[7]

[1]Warsaw University of Technology (PL), [2]CERN, [3]University of Texas (US), [4]Nikhef National institute for subatomic physics (NL), [5]University of Salzburg (AT), [6]Universita e INFN, Padova (IT), [7]Acad. of Sciences of the Czech Rep. (CZ)

This paper describes experimental methods and results for the evaluation of triple modular redundancy SEU mitigation techniques with the Kintex-7 FPGA. Testing was performed both in the beam and fault injection tests.

PG-7

Investigation into SEU Effects and Hardening Strategies in SRAM Based FPGA

Tianwen Li[1], Haigang Yang[1], He Zhao[1], Nan Wang[1], Gang Cai[1], Yuanfeng Wei[1], Yiping Jia[1]

[1]Institute of Electronics, Chinese Academy of Sciences (IECAS)

As DFF and memory are the key elements of SRAM based FPGA,SEU hardened DFF and memory for FPGA are proposed with MBU protection. The radiation test results prove the hardening efficiency.

PG-8

A novel combined charge balance termination structure insensitive to ionizing radiation effect

Limei Song[1], Chao Xiao[1], Yanfei Zhang[1], Botao Sun[1], Lixin Wang[1], Jiajun Luo[1]

[1]The Institute of Microelectronics of Chinese Academy of Sciences, Beijing, China

A novel rad-hardened combined charge balance termination was proposed. A 300V SJ MOSFET with this termination was fabricated and exposed to γ-rays up to 150k rad (Si), the degradation of BV is less than 1V.

PG-9

The STG DICE cell with the decoder for reading data in steady and unsteady states for hardened SRAM

Yuri Katunin[1], Vladimir Stenin[2]

[1]Scientific Research Institute for System Analysis of the Russian Academy of Sciences, [2]National Research Nuclear University (Moscow Engineering Physics Institute)

We proposed new design of memory elements the reading data from which is not sensitive to single-event transients. The STG DICE cell with decoder for reading was simulated through TCAD and implemented to multiport RAM

PG-10

Superimposed In-Circuit Fault Mitigation for Dynamically Reconfigurable FPGAs

Alexandra Kourfali[1], Dirk Stroobandt[1], David Merodio Codinachs[2]

[1]Ghent University, [2]ESA

In order to ensure fault tolerance for COTS FPGAs, we propose a superimposed fault tolerant architecture for FPGA overlays, that provides fast run-time recovery from SEUs with minimal resources, via multiple layers of mitigation.

Wednesday Technical Programme

POSTER AND RADIATION EFFECTS DATA WORKSHOP (REDW) SESSIONS

16:25-18:30

For more details, please see p.52-59

Poster Session Chairs:
Marty Shaneyfelt[1] and **Philippe Paillet**[2]
[1]Sandia National Laboratories, [2]CEA DAM DIF

Data Workshop Session Chairs:
Nathalie Chatry[1] and **Stefan Metzger**[2]
[1]TRAD, [2]Fraunhofer INT

16:30-17:00:
Coffee Break - Level -1, Poster Area

INDUSTRIAL RECEPTION 18:30-20:30

Level 0, Exhibit Area, CICG - Geneva

SESSION H: Single Event Effects in Devices and ICs

Session Chairs: **Michael P. King**[1] and **Ketil Røed**[2]

[1]Sandia National Laboratories, [2]Oslo University

8:30-8:35: Session opening

MICHAEL P. KING

received the B.S. degree in applied mathematics from the University of California at Los Angeles, Los Angeles, CA, USA, in 2007, and the M.S. and Ph.D. degrees in electrical engineering from Vanderbilt University, Nashville, TN, USA, in 2011 and 2014, respectively. His research interests include semiconductor device physics, reliability, and defect physics with particular interests in optoelectronics, power electronics, and advanced CMOS devices. He is currently a Senior Member of the Technical Staff with Sandia National Laboratories, Albuquerque, NM, USA.

KETIL RØED

received his M.Sc. and Ph.D degrees from the Department of Physics and Technology at the University of Bergen, Norway, in 2004 and 2009. From 2009 to 2011 he was a fellow in the Radiation to Electronics (R2E) project at CERN working on Monte Carlo modelling and monitoring of radiation environments. Since 2012 he has been an associate professor at the Department of Physics at the University of Oslo, Norway. His research interests includes development of instrumentation for high energy physics experiments (ALICE at CERN) and space applications with particular interests in radiation effects in electronics and radiation transport calculations using Monte Carlo tools.

ORAL COMMUNICATIONS

H-1 | 08:35

Momentum and Supply Voltage Dependences of SEUs Induced by Low-energy Negative and Positive Muons in 65-nm UTBB-SOI SRAMs

Seiya Manabe[1], Yukinobu Watanabe[2], Wang Liao[3], Masanori Hashimoto[3], Keita Nakano[2], Hikaru Sato[2], Tadahiro Kin[2], Koji Hamada[4], Motonobu Tampo[4], Yasuhiro Miyake[5]

[1]Kyushu University, [2]Department of Advanced Energy Engineering Science, Kyushu University, [3]Department of Information Systems Engineering, Osaka University, [4]Muon Science Laboratory, High Energy Accelerator Research Organization (KEK), [5]Muon Science Laboratory, High Energy Accelerator Research Organization (KEK) / Materials and Life Science Division, J-PARC Center

The first measurement of SEUs induced by low-energy negative and positive muons has demonstrated that the negative muon SEUs occur at higher rate than the positive muon ones because of negative muon capture process.

H-2 | 08:50

A mechanism for Destructive Single-Event Efect in Gallium Nitride Power HEMTs

Leif Scheick[1]

[1]NASA/JPL

The destructive Single-Event Effects in GaN HEMTs are varied and complicated. This paper presents a mechanism of the effect.

H-3 | 09:05

Single-Event Effects in the Peripheral Circuitry of a Commercial Ferroelectric Random-Access Memory

Alexandre Bosser[1], Viyas Gupta[2], Arto Javanainen[3], Georgios Tsiligiannis[4], Veronique Ferlet-Cavrois[5], Stephen Buchner[6], Ari Virtanen[3], Frédéric Wrobel[7], Frédéric Saigné[7], Stephen LaLumondiere[8], Luigi Dilillo[9], Dale Brewe[10], Helmut Puchner[11]

[1]University of Jyväskylä/LIRMM, [2]LIRMM-Radiac-CSU-JPL, [3]University of Jyväskylä, [4]CERN, [5]European Space Agency/ESTEC, [6]Naval Research Laboratory, [7]Université de Montpellier, [8]The Aerospace Corporation, [9]LIRMM/CNRS, [10]Advanced Photon Source, Argonne National Laboratory, [11]Cypress Semiconductor

This study identifies the failure modes of a commercial 130 nm ferroelectric random-access memory (FRAM) during irradiations with heavy-ion and pulsed focused X-ray beams, and discusses their origins.

H-4 | 09:20

Radiation Effects on Deep Sub-micron SRAM-based FPGAs for CERN applications

Georgios Tsiligiannis[1], Salvatore Danzeca[1], Ruben Garcia Alia[1], Angelo Infantino[1], Austin Lesea[2], Simone Gilardoni[1], Markus Brugger[1], Alessandro Masi[1], Frédéric Saigné[3]

[1]CERN, [2]Xilinx, [3]Université de Montpellier

In this study, the Radiation Effects on a 28nm SRAM-based FPGA under CERN's mixed particle field are analyzed. The work presents the methodology for CERN Hardness Assurance and the particularities of testing under a mixed-field

H-5 | 09:35

Effects of Total-Ionizing-Dose Irradiation on Single-Event Responses for Flip-flop Designs in a 16-nm Bulk FinFET Technology

Hangfang Zhang[1], Hui Jiang[1], Xue Fan[2], Jeffrey Kauppila[1], Bharat Bhuva[1], Lloyd Massengill[1]

[1]Vanderbilt University, [2]University of Electronic Science and Technology of China

Characterization on single-event responses of flip-flop designs in a 16-nm bulk FinFET technology after total-ionizing-dose irradiations has been carried out with alpha particle exposure. Results show increased SE vulnerability after TID exposures.

H-6 | 09:50

Mechanisms of Electron-Induced Single Event Effects in Medical and Experimental Linacs

Maris Tali[1], Ruben Garcia Alia[2], Markus Brugger[2], Veronique Ferlet-Cavrois[3], Roberto Corsini[2], Wilfrid Farabolini[4], Arto Javanainen[1], Maria Kastriotou[2], Heikki Kettunen[1], Giovanni Santin[3], Ali Zadeh[3], Salvatore Danzeca[2], Georgios Tsiligiannis[2], Cesar Boatella Palo[3], Ari Virtanen[1]

[1]University of Jyväskylä, [2]CERN, [3]European Space Agency/ESTEC, [4]CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette

We perform an in-depth analysis of the single-event effects observed during testing at medical electron linacs, widely-used due to their availability and flexibility. Irradiations with varying energies and fluxes were performed on two devices.

POSTER SESSION

PH-1

Correlating single event upset performance of EDAC SRAM at earth-based accelerators and space environments

Zhang Zhangang[1], Zhao Guilin[2], Juan Yang[2], Yue Long[1], Lei Zhifeng[1], Liu Yuan[1], He Yujuan[1], Peng Chao[1], Zhu Junhua[1], Huang Yun[1], En Yunfei[1]

[1]China Electronic Product Reliability and Environmental Testing Research Institute, [2]China Electronics Technology Group Corporation No. 58 Research Institute

On-orbit soft error rates (SER) of EDAC SRAM are extrapolated from accelerator heavy-ion data and compared with RPP-predicted SER, based on an experimental-verified formula. The method can guide the optimization of EDAC SRAM hardening.

PH-2

Impact of D-Flip-Flop Architecture and Design on Single Event Upset Induced by Heavy Ions

Laurent Artola[1], Guillaume Hubert[1], Samuel Ducret[2], Julien Mekki[3], Nicolas Ricard[2]

[1]ONERA, [2]SOFRADIR, [3]CNES

This work highlights the impact of design on the single event upset sensitivity of D-Flip-Flops of readout circuit under heavy ions. Fault injections are used to investigate the failure occurrences at the circuit level.

PH-3

Analysis of Temporal Masking on Master and Slave Type Flip-Flop SEUs and Related Applications

Rongmei Chen[1], Bharat L Bhuva[2], Enxia Zhang[2], Nihaar Mahatme[3], Zachary Diggins[2], Liang Wang[4], Yanran Chen[2], Yinong Liu[1], Balaji Narasimham[5], Arthur Witulski[2], Daniel Fleetwood[2]

[1]Tsinghua University, [2]Vanderbilt University, [3]NXP, [4]Beijing Microelectronics Technology Institute, [5]Broadcom

Analysis of temporal masking of SEUs in master-slave flip-flops is provided. Implication for SEE hardening and evaluations of SEE for sequential circuits are presented.

PH-4

Effects of Total Ionizing Dose on Single Event Upset Sensitivity of FRAMs

Qinggang Ji[1], Jie Liu[1], Tianqi Liu[1], Bin Wang[1], Bing Ye[1], Yanan Yin[1], Peixiong Zhao[1], Jie Luo[1], Mingdong Hou[1]

[1]Institute of Modern Physics, Chinese Academy of Sciences

The impact of total ionizing dose (TID) on single event upset (SEU) sensitivity was studied in ferroelectric random access memories (FRAMs). The influence of different test modes and memory patterns on this memory was investigated.

PH-5

SEL and cell failures in MRAM under ion and focused laser irradiation

Alexander A. Pechenkin[1], Anna Boruzdina[1], Andrey Yanenko[1], Dmitry Protasov[1], Ivan Shvetsov-Shilovskiy[1], Anton Sangalov[1]

[1]NRNU MEPhI and SPELS

MRAM cell permanent failures were observed along with SEL under laser and ion beam irradiation. Sample preparation for back side was proposed to safe MRAM functionality.

PH-6

Evaluation of the suitability of SIMD microprocessor extensions in radiation environments

Almudena Lindoso[1], Mario Garcia Valderas[1], Luis Entrena[1], Yolanda Morilla[2], Pedro Martin[2]

[1]University Carlos III de Madrid, [2]Centro Nacional de Aceleradores

This work analyzes the suitability of SIMD (Single Instruction Multiple Data) extensions of microprocessors under radiation environments. Radiation experiments have been performed to ARM 9 microprocessors to explore the behavior of its SIMD coprocessor, NEON.

PH-7

Identification of Pulsed-Neutron-Induced Upset Bursts in Static Random Access Memories using Monte-Carlo Simulations

Chao Qi[1], Wei Chen[1], Yan Liu[1], Xiaoming Jin[1], Shanchao Yang[1], Xiaoqiang Guo[1]

[1]State Key Laboratory of Intense Pulsed Radiation Simulation and Effect, Northwest Institute of Nuclear Technology

Pulsed-neutron experiments are performed on SRAMs using a nuclear reactor. The observed upset bursts are identified to be caused by the same accumulation process as SEUs induced by neutrons generated at steady-state modes of reactors.

PH-8

SEU Sensitivity Trends of Three Successive Generations of COTS SRAMs at Ultra Low Bias Voltage

Juan Antonio Clemente[1], Juan A. Fraire[2], Miguel Solinas[3], Francisco J. Franco[4], Francesca Villa[5], Solenne Rey[5], Maud Baylac[5], Helmut Puchner[6], Hortensia Mecha[1], Raoul Velazco[3]

[1]Departamento de Arquitectura de Computadores y Automatica (DACyA), Facultad de Informatica, Universidad Complutense de Madrid (UCM), [2]National University of Cordoba-CONICET, [3]TIMA Labs, INPG, University of Grenoble-Alpes, [4]Departamento de Fisica Aplicada III, Facultad de Ciencias Fisicas, Universidad Complutense de Madrid (UCM) , [5]Laboratoire de Physique Subatomique et de Cosmologie (LPSC), University of Grenoble-Alpes, [6]Cypress Semiconductor, Technology R&D

Radiation tests with 14.2 MeV neutrons were performed at ultra low bias voltages on COTS SRAMs manufactured on 130nm, 90nm and 65nm CMOS processes. Experimental results with power supplies in 0.5V-3.17V are presented and discussed

PH-9

Error-rate prediction for applications implemented in Multi-core and Many-core processors

Pablo Ramos[1], Vanessa Vargas[1], Maud Baylac[2], Francesca Villa[2], Solenne Rey[2], Nacer-Eddine Zergainoh[3], Raoul Velazco[4]

[1]Universidad de las Fuerzas Armadas ESPE, [2]Laboratoire de Physique Subatomique et de Cosmologie (LPSC), University of Grenoble-Alpes, [3]University of Grenoble - Alpes, [4]TIMA Labs, INPG, University of Grenoble-Alpes

This work proposes a methodology for predicting the error rate of applications implemented in COTS multi/many-core processors. For validating the approach, predicted error-rates of three devices are compared to results issued from 14MeV neutron tests

10:05-10:35:

Coffee Break - Level 0, Exhibit Area

Thursday Technical Programme

SESSION I: Single Event Effects Mechanisms and Modelling

Session Chairs: **Laurent Artola**[1] and **Pavel Chubunov**[2]

[1]ONERA, [2]Branch of JSC «URSC» - «ISDE»

10:35-10:40: Session opening

LAURENT ARTOLA

(MSEE 2007, Ph.D. EE 2011)
is a research engineer at ONERA since 2012. His researches are focused on radiations effects in devices and integrated circuits, modeling and characterization of Single Event Effects and total ionization dose. He is regularly involved in radiations R&D projects for space applications. He has served the radiation effects community as reviewer, session chairman, and member of the award committee for the IEEE Nuclear and Space Radiation Effects Conference (NSREC) and Space RADiation Effects in Components and Systems (RADECS) european conference. Laurent serves as reviewer in more than 10 journals. He has authored and co-authored more than 20 papers, including one best paper award at RADECS conference paper.

PAVEL CHUBUNOV

was born in Moscow in 1982. After graduated from the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Department of Micro and nanoelectronics as an Engineer-Physicist (2006) he started his career in the field of radiation effects in spacecraft electronics. Pavel passed the professional way from the research engineer to head of the department in the Test Laboratory of Institute of Space Device Engineering (TL ISDE) and now he is one of the most experienced experts in Russia on the topic of outer space ionizing radiation influence at spacecraft electronics and systems lifetime. Pavel also gives classes for students in MEPhI. His scientific activity relates to the development of the radiation hardness assurance approaches and testing methodology for electronic components and systems, including creation test facilities and the research of ionizing radiation impact on the reliability of integrated circuits and other semiconductor devices. Pavel Chubunov is the author and co-author of more than 100 works in Russian and international published journals and collected papers of conference materials, including more than 10 at RADECS conferences and workshops. During RADECS 2015, he was one of the key person in organizing committee and at the same time REDW session co-chairman. In 2017, he was technical chair of RADECS workshop RAD-TEST 2017. From 2015, he has been a member of Council Board of RADECS association.

ORAL COMMUNICATIONS

I-1 | 10:40

Measurement and Mechanism Investigation of Negative and Positive Muon Induced Upsets in 65nm Bulk SRAMs

Wang Liao[1], Masanori Hashimoto[2], Seiya Manabe[3], Yukinobu Watanabe[4], Keita Nakano[4], Hikaru Sato[4], Tadahiro Kin[4], Koji Hamada,[5], Motonobu Tampo[5], Yasuhiro Miyake[6]

[1]Osaka University, [2]Department of Information Systems Engineering, Osaka University, [3]Kyushu University, [4]Department of Advanced Energy Engineering Science, Kyushu University, [5]Muon Science Laboratory, High Energy Accelerator Research Organization (KEK), [6]Muon Science Laboratory, High Energy Accelerator Research Organization (KEK) / Materials and Life Science Division, J-PARC Center

Negative and positive muon irradiation tests on 65nm bulk SRAMs reveal parasitic bipolar action contributes to upsets and large-bit MCUs under negative muon irradiation whereas positive muon induces fewer upsets and MCUs.

I-2 | 10:55

Physical mechanisms inducing electron Single Event Upset

Pablo Caron[1], Christophe Inguimbert[1], Françoise Bezerra[2], Robert Ecoffet[2], Nathalie Chatry[3], Nicolas Sukhaseum[3], Laurent Artola[1]

[1]ONERA, [2]CNES, [3]TRAD

All the physical processes involved in the triggering of electron induced SEUs are studied in detail. Some comparisons made with experimental measurements show the importance of the coulombic scattering process.

I-3 | 11:10

Analysis of SEB Physics in SiC Power MOSFETs

Arthur Witulski[1], Dennis Ball[1], K. F. Galloway[1], Arto Javanainen[2], Jean-Marie Lauenstein[3], Andrew Sternberg[1], Ron Schrimpf[1]

[1]Vanderbilt University, [2]University of Jyväskylä, [3]NASA Goddard Spaceflight Center

Experiments show that single-event burnout thresholds of 1200 V SiC power MOSFETs are about half rated voltage at high LET, but nearly the rated voltage at low LET. Simulations explain the physical mechanisms.

I-4 | 11:25

The Impact of Multiple-Cell Charge Generation on Single Event Upset in a 20 nm Bulk SRAM

Daisuke Kobayashi[1], Hideya Matsuyama[2], Hiroaki Itsuji[1], Kazunori Maruyama[3], Kazuyuki Hirose[1], Takashi Kato[2], Takashi Yamazaki[3], Takeshi Soeda[3]

[1]The University of Tokyo, ISAS/JAXA, [2]Socionext Inc., [3]Fujitsu Laboratories Ltd.

Single event upsets induced by multiple-cell charge generation are studied in a 20 nm bulk SRAM using single-pulse two-photon absorption. Results indicate that potential fluctuations in multiple wells lead to particular patterns of fail bits.

POSTER SESSION

PI-1

Impact of Heavy Ion Energy on Charge Yield in Silicon Dioxide

Vladimir Emeliyanov[1], Alexander Vatuev[1], Rustem Useinov[1]

[1]RISI

The heavy ion energy impact on charge yield in SiO2 was investigated by irradiating VDMOSFETs with 3 to 25 MeV/A heavy ions. A strong dependence of charge yield on the ion energy is revealed.

PI-2

Single-Event Damages observed in Gallium Nitride (GaN) HEMTs for Power Handling Applications

Eiichi Mizuta[1], Satoshi Kuboyama[1], Yuki Nakada[1], Akinori Takeyama[2], Takeshi Ohshima[2], Koichi Suzuki[1]

[1]JAXA, [2]QST

Single-event damages observed in AlGaN/GaN High Electron Mobility Transistors (HEMTs) with normally–off operation were investigated. A majority of failures were caused by leakage current between drain and substrate via buffer layer.

PI-3

Multiple Cell Event Partitioning for Simulation of Soft Error Rates in Space Systems with Embedded Error Correcting Codes

Gennady Zebrev[1], Artur Galimov[1], Maxim Gorbunov[2]

[1]National Research Nuclear University MEPHI, [2]SRISA

A self-consistent procedure for ion-induced soft error rate calculation in space environment taking into account Error Correcting Codes is proposed. The method is based on partitioning of multiple cell events into groups with different multiplicities.

PI-4

Simulation and Experiment in Neutron Induced Single Event Effects in SRAM

Xiaoming Jin[1], Chenhui Wang[1], Xiaoqiang Guo[2], Chao Qi[2], Shanchao Yang[2], Yan Liu[2], Wei Chen[1], Simone Gerardin[3], Marta Bagatin[3], Stefano Bonaldo[3], Alessandro Paccagnella[4]

[1]Northwest Institute of Nuclear Technology, [2]State Key Laboratory of Intense Pulsed Irradiation Simulation and Effect, Northwest Institute of Nuclear Technology, [3]Padova University, [4]University and INFN Padova

We applied Geant4 to quantitatively describe the SEU cross section evolution with the technological nodes and neutron energy. The neutron radiation experiment results on SRAM with different technological nodes are consistent with the simulation results.

PI-5

SEVAT: A Modeling System for SER Variation Analysis in Advanced CMOS Technologies

Ruiqiang Song[1], Shuming Chen[1], Yaqing Chi[1], Zhenyu Wu[1], Bin Liang[1], Jianjun Chen[1]

[1]National University of Defense Technology

This paper presents a simulation system for the analysis of SER variations. The capabilities and accuracy of the introduced simulation system are demonstrated against heavy ion experimental results.

PI-6

Analysis of the Charge Collection Mechanism in 28nm FD-SOI by Simulations

Vincent Correas[1], Issam Nofal[1], Jacques Cerba[1], Frederic Monsieur[2], Gilles Gasiot[2], Dan Alexandrescu[1], Philippe Roche[2], Roberto Gonella[2]

[1]iRoC Technologies, [2]STMicroelectronics

Parasitic currents are not predominantly composed of bipolar current. The collection is strongly affected by the vds value. A quantitative effect thereof was simulated for the pass-gates in an SRAM cell.

PI-7

Circuit-Level Layout-Aware Modeling of Single Event Effects in 65 nm CMOS ICs

Anton Balbekov[1], Maxim Gorbunov[1], Gennady Zebrev[2]

[1]SRISA, [2]National Research Nuclear University MEPHI

We present two circuit-level layout-aware Single Event Effects modeling approaches: single spot and distributed circuit. Simulation results are compared to experimental data for 65 nm CMOS 6T SRAM cells and majority voters.

SESSION J: Facilities and Dosimetry

Session Chairs: **Arto Javanainen**[1] and **Michael Trinczek**[2]

[1]Jyväskylä University, [2]TRIUMF Laboratory

11:40-11:45: Session opening

ARTO JAVANAINEN

received his MSc in 2002, and PhD in 2012 from the University of Jyväskylä (JYU), Finland. He works as a Senior Researcher in the RADEF group at the Accelerator Laboratory of JYU. He also has a position as Adjoint Assistant Professor in Electrical Engineering at Vanderbilt University, Nashville, TN, USA. The subject of his current research is the ion-induced effects in SiC power devices. He also studies basic ion-matter-interactions, such as LET (and stopping force). He has been IEEE member since 2009. He teaches basic electronics at JYU, and supervises master and PhD students, has authored and co-authored several papers in various journals and conferences. He is also a regular reviewer for RADECS and NSREC conferences, as well as for different journals.

MICHAEL TRINCZEK

received his Ph.D. in experimental nuclear physics from Simon Fraser University, Canada in 2001 after completing a B.Sc. (Honours) in chemistry. After a post-doctoral research term at the Max-Planck-Institute for Nuclear Physics in Heidelberg, Germany, he returned to TRIUMF where he has held various roles in facilities and operations. In 2010, Michael assumed responsibility for TRIUMF's Irradiation Facilities and helps support the Proton Therapy Facility for the treatment of ocular melanoma. Since then he has been involved in the NSREC and RADECS community and was part of the research collaboration that won the Outstanding Paper Award at NSREC in 2014 and 2015. In addition to his research activities, Michael sits on the TRIUMF Innovations and Industrial Partnerships panel that is responsible for knowledge and technology transfer activities between TRIUMF and other organizations, is the secretary for the TRIUMF Life Sciences Projects Evaluation Committee, and is a member of both the IEEE and the Canadian Association of Physicists.

ORAL COMMUNICATIONS

J-1 | 11:45

Distributed Optical Fiber Radiation Sensing in the Proton Synchrotron Booster at CERN

Diego Di Francesca[1], Iacopo Toccafondo[1], Stefano Calderini[2], Gaetano Li Vecchi[1], Sylvain Girard[3], Antonino Alessi[4], Rudy Ferraro[5], Salvatore Danzeca[1], Yacine Kadi[1], Markus Brugger[1]

[1]CERN, [2]Universita & INFN, Pisa (IT), [3]Université de Lyon, [4]Université de Lyon, Laboratoire H. Curien, [5]Universite Montpellier II (FR)

We report on the development and first deployment of an operational prototype of distributed optical fiber radiation sensor for the online monitoring of radiation levels in one of the accelerator facilities of CERN, the Proton-Synchrotron-Booster.

J-2 | 12:00

Thermal neutron SRAM detector and its characterization at the CERN Mixed Field Facility, CHARM

Chiara Cangialosi[1], Salvatore Danzeca[1], Matteo Brucoli[2], Markus Brugger[1], Alessandro Masi[1]

[1]CERN, [2]Universite Montpellier II (FR)

In the LHC the ThN affects electronics and a knowledge of the SRAM thermal cross section is required. This paper aims to explore the capabilities of CHARM facility, to measure ThN sensitivity.

J-3 | 12:15

Investigation on the Sensitivity Degradation of Dosimeters based on Floating Gate Structure

Matteo Brucoli[1], Salvatore Danzeca[2], Joan Cesari[3], Markus Brugger[2], Alessandro Masi[2], Simone Gilardoni[2], Alvaro Pineda[3], Laurent Dusseau[1], Frédéric Wrobel[1]

[1]Université de Montpellier, [2]CERN, [3]ICMalaga

The sensitivity degradation of Floating Gate dosimeter is investigated by experimental analysis. The study sheds light on the importance of the choice of the linear range and the dose rate effect.

J-4 | 12:30

Ultra High Fluence Radiation Monitoring Technologies for the Future Circular Collider at CERN

Georgi Gorine[1], Mar Capeans Garrido[2], Vladimir Cindro[3], Igor Mandic[3], Michael Moll[2], Giuseppe Pezzullo[2], Federico Ravotti[2], Jean-Michel Sallese[1], Luka Snoj[3]

[1]Ecole Polytechnique Federale de Lausanne (CH), [2]CERN, [3]Jozef Stefan Institute (SI)

The development of a new Ultra High Fluence sensor is a key element to allow irradiation tests at CERN FCC. In this paper, we present an innovative dosimetry solution based on thin layers of metals.

12:45-14:00:

Lunch - Level 1, Restaurant

POSTER SESSION

PJ-1

MELAF - a 50 MeV Electron Accelerator Facility for Research in Radiation Effects

Andreas Schüller[1], Christoph Makowski[1], Ralf-Peter Kapsch[1], Ralf Nolte[1], Peter Beck[2]

[1]Physikalisch-Technische Bundesanstalt (PTB), [2]Seibersdorf Laboratories

The Metrological Electron Accelerator Facility (MELAF) of the Physikalisch-Technische Bundesanstalt (PTB) offers access to well characterized high energy (0.5-50 MeV) electron and photon radiation fields. This work outlines the capabilities to foster new collaborations.

PJ-2

Irradiation Facilities at CERN

Blerina Gkotse[1], Markus Brugger[2], Pierre Carbonez[2], Salvatore Danzeca[2], Adrian Fabich[2], Ruben Garcia Alia[2], Maurice Glaser[2], Georgi Gorine[3], Martin Richard Jaekel[2], Isidre MATEU[4], Giuseppe Pezzullo[2], Fabio Pozzi[2], Federico Ravotti[2], Marco Silari[2], Maris Tali[5]

[1]Université Européenne de Bretagne UEB (FR), [2]CERN, [3]Ecole Polytechnique Federale de Lausanne (CH), [4]Centro de Investigaciones Energéti cas Medioambientales y Tecno, [5]European Space Res. & Tech. Cent. (NL)

CERN provides unique irradiation facilities for applications in many scientific fields. This paper summarizes the facilities currently operating at CERN, including their main usage, characteristics and information about their operation.

PJ-3

Environmental Monitoring, Control and Data Management System of the CERN Proton Irradiation Facility

Blerina Gkotse[1], Maurice Glaser[2], Emanuele Matli[2], Giuseppe Pezzullo[2], Federico Ravotti[2]

[1]Université Européenne de Bretagne UEB (FR), [2]CERN

Qualification of components against possible radiation effects requires testing in irradiation facilities that usually are complex to operate. This paper describes the environmental monitoring, the control and data management system of the CERN IRRAD facility.

PJ-4

SEE testing in the 24 GeV proton beam at the CHARM facility

Ruben Garcia Alia[1], Markus Brugger[1], Matteo Cecchetto[2], Francesco Cerutti[1], Salvatore Danzeca[1], Maria Kastriotou[1], Maris Tali[3], Slawosz Uznanski[1]

[1]CERN, [2]Universita e INFN, Padova, [3]European Space Res. & Tech. Cent

A 24 GeV proton beam is available at the CHARM facility, which can be used to test components and boards for SEEs at a worst-case energy for both accelerator and interplanetary space applications.

PJ-5

Assessment of a Setup for the Characterization of Electronic Devices under Protons at Cryogenic Temperature.

Françoise Bezerra[1], Mathieu Boutillier[1], Bernard Baradat[1], Nathalie Chatry[2], Cedric Dossat[2], Pierre Garcia[2], Pierre Pourrouquet[2]

[1]CNES, [2]TRAD

In space applications, components may be used at cryogenic temperature. We have studied dosimetry and radiation safety concerns for the use under protons of the CNES custom-designed cryostat allowing temperature as low as 80K.

PJ-6

New low electron flux facility in the 0 to 3.5 MeV range for the study of induced signal in JUICE instruments UVS and MAJIS measurements

Alain Carapelle[1], Denis Grodent[1], John Carter[2], Yves Langevin[2], Antoine Arondel[2], Mathieu Vincendon[2], Pierre Guiot[2], Kurt Retherford[3], Michael Davis[3], Sylvie Liebecq[1], Etienne Renotte[1]

[1]University of Liège, [2]University Paris Sud, [3]Southwest Research Institute

We built a new test facility to investigate signal induced by electrons in the 0-3.5MeV in JUICE's instruments. Low flux (< 6000electrons/cm².s) are produced by radioisotopes. Capabilities and measurements on UVS and MAJIS are presented

PJ-7

AXEL lab.: Representative Ground Simulation for Investigating Radiation effects in Materials and Electronics

Sophie Duzellier[1], Christophe Inguimbert[1], Laurent Artola[1], Guillaume Hubert[1], Thierry Nuns[1], Thierry Paulmier[1], Simon Lewandowski[1], Romain Rey[1], Bernard Dirassen[1], Claude Pons[1]

[1]ONERA

This paper describes the investigation capabilities at the AXEL lab. of ONERA. Van de Graaff machines and dedicated target chambers allow for studying radiation effects in materials and components and qualifying sub-systems for specific missions.

PJ-8

UCL irradiation facilities status

Laurent Standaert[1], Marc Loiselet[1], Nancy Postiau[1]

[1]Université catholique de Louvain

This paper reports the last developments and the status of the UCL irradiation facilities for radiation hardness assurance. Protons up to 62MeV, heavy ions up to Xenon, neutrons and Co-60 are available.

PJ-9

New Setup for SEE Measurements in South America

Eduardo Luiz Augusto Macchione[1], Nilberto Medina[1], Vitor Aguiar[1], Nemitala Added[1], Marcilei Silveira[2], Saulo Nascimento[1], Alisson Leite[1]

[1]Universidade de Sao Paulo, [2]FEI

The new beam line dedicated for SEE studies in Brazil is produces large area, high uniformity and low intensity heavy-ions beams. Defocusing and multiple scattering techniques are used to achieve beam uniformity better than 90%.

PJ-10

Study of Floating Gate MOS Structures to improve the noise and sensitivity as Radiation Dosimeter

Joan Cesari[1], Matteo Brucoli[2], Salvatore Danzeca[2], Alvaro Pineda[1], Alessandro Masi[2], Markus Brugger[2], Simone Gilardoni[2], Eugeni Isern[3], Miquel Roca[3], Eugeni Garcia-Moreno[3]

[1]ICMalaga, [2]CERN, [3]Electronics Engineering Group - University of Balearic Islands

This work is focused on the active sensor part and it extrapolates the key parameters influencing the sensitivity and the noise of the floating gate by means of real measurements and models.

PJ-11

Review and comparison of irradiation response and annealing models for high-sensitivity RADFETs

Marina Benito-Parejo[1], Sergio Ibarmia[1], Pablo Portillo[1]

[1]Instituto Nacional de Técnica Aeroespacial (INTA)

A comparison between different RADFET response models to irradiation and annealing processes has been carried out, comparing them against high-sensitivity RADFETs experimental data obtained during a high-dose rate irradiation campaign with 60Co.

PJ-12

Accelerated Neutron Testing with Multiple Printed Circuit Boards: Flux and Spectrum Modifications

Carlo Cazzaniga[1], Bharat L Bhuva[2], Marta Bagatin[3], Simone Gerardin[3], Nicolò Marchese[4], Christopher Frost[1]

[1]STFC Rutherford Appleton Laboratory, [2]Vanderbilt University, [3]University of Padova - DEI, [4]University of Calabria

The attenuation of an atmospheric-like neutron spectrum by silicon and fiberglass is evaluated with simulations of the neutron transport. Measurements were performed during neutron irradiation experiments of multiple boards using a beam monitor.

PJ-13

X-ray Monitoring using Optically Stimulated Luminescence in Cerium-doped Sol-gel Silica Glasses

Nissrine Al Helou[1], Hicham El Hamzaoui[2], Bruno Capoen[2], Géraud Bouwmans[2], Youcef Ouerdane[3], Aziz Boukenter[3], Sylvain Girard[3], Geneviève Chadeyron[4], Rachid Mahiou[4], Mohamed Bouazaoui[2]

[1]Laboratoire de Physique des Lasers, Atomes et molécules, [2]Université de Lille, [3]Université de Lyon, [4]Université Clermont Auvergne

We extended the use of ionic cerium-doped sol-gel silica to monitor X-radiation, using Optically Stimulated Luminescence technique, up to doses of 150 Gy independently of the dose rate.

PJ-14

Proton dosimetry at the accelerator COSY for radiation effect testing

Max Baum[1], Olaf Felden[2], Udo Weinand[1], Stefan Höffgen[1], Jochen Kuhnhenn[1], Stefan Metzger[1]

[1]Fraunhofer INT, [2]Forschungszentrum Jülich, IKP

We present a comprehensive survey of different dosimetry systems for the proton accelerator COSY. Emphasis is set on the evaluation of radiochromic films. The developed capability helps to conduct proton irradiations with spatial resolved dosimetry.

PJ-15

Development of a portable readout system for the RADMON dosimeters

Isidre Mateu[1], Maurice Glaser[2], Georgi Gorine[3], Michael Moll[2], Giuseppe Pezzullo[2], Federico Ravotti[2]

[1]Centro de Investigaciones Energéti cas Medioambientales y Tecno, [2]CERN, [3]Ecole Polytechnique Federale de Lausanne (CH)

The development of a portable readout system for the Radiation Monitoring (RADMON) sensors used in the LHC experiments is presented. The first test results, obtained at CERN proton irradiation facility (IRRAD), are also discussed.

PJ-16

Farmer chamber response to different filter box and surrounding configurations

Pedro Martin-Holgado[1], Yolanda Morilla[1], Manuel Dominguez[2], Gonzalo Fernandez[2]

[1]CNA, [2]ALTER TECHNOLOGY

The use of a filter box for TID test is a recommendation present in the more relevant test method standards. However, the absence of specific details can produce discrepancies between different radiation facilities.

PJ-17

Design of an in-air heavy ion irradiation facility at KVI-CART

Brian Jones[1], Marc-Jan van Goethem[2], Emiel van der Graaf[2], Sytze Brandenburg[2]

[1]KVI Center for Advanced Radiation Technology, University of Groningen, [2]University of Groningen

The specifications of a new heavy ion irradiation facility for masses up to xenon at 30 MeV/u in air at KVI-CART will be presented. The facility is planned to become operational in 2018.

Thursday Invited Talk

INVITED TALK 14:00-15:00

"Funny stories from terrestrial radiation effects"

In "The Structure of Scientific Revolutions", Thomas Kuhn suggests that science does not advance in smooth fashion but rather at a slow rate for long periods punctuated by short frenetic periods where revolutionary new ideas challenge and disrupt the established world-view. Ultimately the new ideas topple the establishment view and allow rapid progress that would have been impossible without the disruptive idea. In this retrospective talk, we look at some of the key "disruptive" discoveries and sometimes humorous events that challenged the status quo but ultimately clarified our understanding of the terrestrial environment and the response of devices to single-event effects from alpha particles, high-energy and thermal cosmic ray neutrons.

ROBERT C. BAUMANN

received the B.A. degree in Physics (cum Laude) from Bowdoin College, in 1984, and the Ph.D. degree in Electrical Engineering from Rice University, in 1990. He Joined Texas Instruments in 1989, focused on improving the dielectric reliability and soft error rate of DRAM. In 1993 he moved to TI Japan to focus on DRAM and logic reliability development. Robert then created and led an advanced failure analysis group in TI Japan's Tsukuba R&D Center in 1995 providing cutting-edge, rapid response analyses on high-profile field-return issues. In 1998 he returned to the U.S. Silicon Technology Development Group in Dallas where he led terrestrial radiation effects characterization and modelling for TI. He was a co-author and leader for the drafting of the JEDEC JESD89/89A, the first comprehensive industry standard for radiation testing of commercial microelectronics and co-led the SIA panel mitigating the impact of ITAR on commercial semiconductors that was directly responsible for 2007 changes preventing U.S. semiconductors from being inadvertently export-controlled. Robert was elected to TI and IEEE Fellow in 2005. He has spent the last 5 years in TI's High Reliability Group (now Aerospace & Defense Products) driving space radiation effects characterization and modelling capabilities as well consulting on new space product developments. He has co-authored more than 70 publications, two book chapters, and 12 patents.

Thursday Technical Programme

POSTER AND
RADIATION EFFECTS DATA WORKSHOP (REDW) SESSIONS
15:00-17:00

For more details, please see p.52-59

Poster Session Chairs:
Marty Shaneyfelt[1] and **Philippe Paillet**[2]
[1]Sandia National Laboratories, [2]CEA DAM DIF

Data Workshop Session Chairs:
Nathalie Chatry[1] and **Stefan Metzger**[2]
[1]TRAD, [2]Fraunhofer INT

16:30-17:00:
Coffee Break - Level -1, Poster Area

RADECS ASSOCIATION GENERAL ASSEMBLY
17:00-18:30
P. Calvel, President of Radecs Association
RADECS bureau

Conference Dinner

HÔTEL PRÉSIDENT WILSON - GENÈVE

KEYNOTE SPEECH: ANILORE BANON 20:00-24:00

THE VITAE PROJECT:
A MILLION HANDPRINTS ON A LUNAR SCULPTURE

VITAE PROJECT is a science and art project, which seeks to unite people across the 7 continents around a participatory sculpture, breathing and visible from Earth at selected moments. The sculpture contains a million handprints, collected around the world. Vitae is a living sculpture realised for a lunar environment in shape memory material reacting to heat.

The work of **Anilore Banon** celebrates the immense power of women and men to change their fate and bring the impossible within reach, putting them at the core of life and of her work. Anilore works the monumental – the monumental which allows her to be directly in contact with others, without advance notice. The monumental to provoke interrogation, surprise and emotion. Anilore Banon works with the settings, integral part of the story she tells. The artistic work of Anilore begins at the postulate of her intentions. The intention, for what it expresses of remarkable and powerful, for the abstract, yet so anchored values she wants to bestow, for this impulse of life she aspires to express again and again, for the paths she decides to travel, the intention is already an artistic creation. Anilore told the courage (The Braves installed in the sea on Omaha Beach), the upright man (The Doors of Light at the French Mint in Paris), the Words which, at the dawn of the third millennium, inspire a gathered humanity ("The 10 Commandments for a new Millennium" installed Place Vendôme in Paris).

www.anilorebanon.net | www.vitaeproject.com

Friday Technical Programme

INVITED TALK 8:30-9:30

THE MIRACULOUS WORLD OF PARTICLE BEAMS AT CERN

The European Organization for Nuclear Research CERN in Geneva/Switzerland operates the largest particle physics laboratory in the world. Its most famous accelerator is the Large Hadron Collider LHC.
However, there is also a rich and exciting physics programme which is carried out at the LHC injector accelerators, the CERN Proton-Synchrotron (PS) and the Super-Proton-Synchrotron (SPS). Large scientific communities from the various fields of physics – material science, precision measurements of anti-matter, medical applications, research on climate models, searches for new particles, future particle acceleration techniques and many more - are attracted by the experimental opportunities which the particle beams at CERN offer.

CHRISTOPH REMBSER
had his first high-energy experience as a CERN summer student in 1989. Since then he has worked on the ZEUS and OPAL experiments, gaining expertise in various types of detectors and searching for new physics phenomena.
After an intermezzo in 2004 and 2005 as a professor at the University of Erlangen, teaching about experimental techniques and learning about astroparticle physics, he returned to CERN to find new particles with the ATLAS detector at the LHC.
For ATLAS, he served from 2008 until 2013 as project leader for the Inner Detector and the Transition Radiation Detector, devices to reconstruct the tracks and to identify the particles coming out of the proton collisions, the experimental tools which played a major role in finding the Higgs boson. Since 2016, Christoph is the leader of the CERN ATLAS team, which plays a mayor role in operating, maintaining and upgrading the ATLAS experiment.
Christoph is convinced that with the LHC we will see more new particles which will help to tackle the questions of dark matter and dark energy in our universe.
CERN offers great physics opportunities also at its other accelerators, so Christoph, from 2005 until 2007, also served as physics coordinator for the CERN PS and SPS physics programme. Since 2010 he acts as scientific secretary of the SPS and PS experiments Committee.

SESSION K: RHA AT DEVICES AND SYSTEM LEVEL

In this RADECS 2017 edition, a flavour of Hardness approach at system level has been introduced in the standard Radiation Hardness Assurance session. For this reason, this year, the session has been renamed Radiation Hardness Assurance at Device and System Level and it is managed by 4 chairmen.

Session Chairs

Radiation Hardness Assurance: **César Boatella Polo**[1] and **Koziukov Aleksandr**[2]
Radiation Hardness Approach at System Level: **Dr. Salvatore Danzeca**[3] and **Florent Miller**[4]
[1]ESA, [2]Branch of JSC «URSC» - «ISDE», [3]CERN, [4]Nuclétudes
9:30-9:35: Session opening

RADIATION HARDNESS ASSURANCE:

CÉSAR BOATELLA POLO

is a radiation effects engineer at European Space Agency (ESA) since august 2011. He worked at the French Space Agency (CNES) from 2007-2011 as a radiation environment and effects engineer. Previously, he worked in the Institute of Space Studies of Catalonia (IEEC) from 2004 till 2006 as and electronic design engineer in the Spanish contribution to LISA Pathfinder ESA mission were he contributed to the design of a radiation monitor and other diagnostic subsystems. He has contributed as a radiation effects engineer to many different space missions from different space agencies. His main interest is radiation hardness assurance and testing of complex devices and systems.

KOZIUKOV ALEKSANDR (26.04.1988, MOSCOW)

graduated from the National Research Nuclear University Moscow Engineering Physics Institute (MEPhI), Department of Micro- and Nano- electronics, and is an Engineer – Physicist (2011). Mr. Koziukov graduated from the post – graduate studies in 2014.
His scientific activity is related to electronic components radiation hardness control methods and facilities development especially research of single event latch-up cross- section and linear energy transfer thresholds dependence on the operational temperature range for digital integrated circuits during heavy ions irradiation . Mr. Koziukov has been working in the Branch of JSC United Rocket Space Corporation Institute of Space Device Engineering since 2010 as a technician, experimental engineer, head of group. Mr. Koziukov is one of the leading experts of the Russian rocket and space industry in the area of electron components hardness control for space related applications. Mr. Koziukov is the author and co-author of more than 20 works in Russian and international published works and collected papers of conference materials.

RADIATION HARDNESS APPROACH AT SYSTEM LEVEL:

Dr. SALVATORE DANZECA
received his master degree in 2012 from the University Federico II of Naples, Italy, finalizing his master studies already at CERN developing a radiation tolerant embedded system for the readout of a sub-micron position sensor. He then received his Ph.D in Electronic Engineering working in the context of the Radiation to Electronic project (R2E) on the characterization and the qualification of the radiation sensors to embed on the Radiation Monitor (RadMon) for the electronics in the accelerator. He is the responsible for the operation, monitoring and maintenance of more than 500 RadMon installed in the LHC and in the injectors chain. He is the chairman of the RADiation Working Group (RADWG) that provides support to the accelerator sector equipment groups for the assessment of radiation tolerance of electronic equipment to be installed in radiation exposed areas. He coordinates the CHARM (the CERN mixed field test facility) and CC60 facility operations and irradiations.

FLORENT MILLER (PH.D. 2006)
has been in the Aeronautics and Space industry for more than 15 years, first in Airbus Group (Airbus Group Innovations) and now in ArianeGroup (Nuclétudes). He is head of a department focused on the vulnerability analysis of electronic systems and has been leading research activities in the development of laser test approaches, fault injection tools and prediction software. He co-authored more than 25 journal papers.

ORAL COMMUNICATIONS

K-1 | 09:35

Estimation of System Survival Reliability in a Radiation Environment Based on the Available Radiation Data at Component Level

Rudy Ferraro[1], Salvatore Danzeca[2], Luigi Dilillo[3], Markus Brugger[2], Alessandro Masi[2], Simone Gilardoni[2]
[1]Universite de Montpellier, [2]CERN, [3]LIRMM/CNRS

A methodology is described to estimate the survival reliability of system against radiation-induced failure. A case study is presented illustrating the use of this method to estimate the system reliability based on component data.

K-2 | 09:50

Reliability-Performance Analysis of Hardware and Software Co-Designs in SRAM-based APSoCs

Lucas Antunes Tambara[1], Fernanda Lima Kastensmidt[1], Paolo Rech[1], Nilberto Medina[2], Nemitala Added[2], Vitor Aguiar[2], Marcilei Silveira[3]

[1]UFRGS, [2]USP, [3]FEI

We perform a reliability and performance analysis of hardware and software co-designs in APSoCs. Results reveal that performance and reliability can be improved up to 117 times by offloading the system workload to hardware.

K-3 | 10:05

Worst-Case Trapped Proton Contribution to the Direct Ionization SEU rate

Jérémy Guillermin[1], Nicolas Sukhaseum[1], Pierre Pourrouquet[1], Thibault Cardaire[1], Nathalie Chatry[1], Françoise Bezerra[2], Robert Ecoffet[2]

[1]TRAD Tests & Radiations, [2]CNES

Highly integrated electronic devices can exhibit a sensitivity to proton direct ionization phenomenon. This study presents an assessment of the impact of the radiative and mechanical environments on the calculated in-orbit rates.

K-4 | 10:20

Analyzing System on A Chip Single Event Upset Responses using Single Event Upset Data, Classical Reliability Models, and Space Environment Data

Melanie Berg[1], Kenneth LaBel[2], Michael Campola[2], Michael Xapsos[2]

[1]AS&D in support of NASA, [2]NASA Goddard

We propose a method for applying single event upset (SEU) data towards the analysis of complex systems using transformed reliability models (from the time domain to the particle fluence domain) and space environment data.

K-5 | 10:35

SEE Test Guidelines and Characterisation of GaAs Power Devices

Juan Cueto[1], Luis De Pablo Martínez[1], Jeffrey Chuan[1], Alexandre Rousset[2], Gael Vignon[2], Ronan Marec[3], Jean Luc Muraro[3], Antoine Guillope[3], Cesar Boatella Palo[4]

[1]Thales Alenia Space España, [2]TRAD, [3]Thales Alenia Space, [4]European Space Agency/ESTEC

Traditionally, GaAs devices were assumed to be relatively insensitive to space radiation. However, it has been shown that some GaAs devices can be sensitive to destructive events depending on the technology and the biasing conditions.

POSTER SESSION

PK-1

Hardening application programs by the operating system on COTS processors: what level of protection to SEU can be expected and at what performance cost?

Emery Assogba[1], Marc Lobelle[2]

[1]Université d'Abomey-Calavi and Université catholique de Louvain, [2]Université catholique de Louvain

An operating system is used to protect its users applications against SEU effects on COTS processors. The overhead is 250% for pure computation programs.The residual FIT is 6,66 10^2 for 14 nm technology.

PK-2

TID test on ITER Interlock Discharge Loop Interface Box (DLIB) system, an example of radiation test at equipment level.

Gonzalo Fernandez Romero[1], Javier Bárcena Ruiz[1], Eugenio Muñoz Plaza[1]

[1]ALTER TECHNOLOGY TÜV NORD

We present a radiation test at equipment level process and results on an electronic equipment for ITER application which will operate under radiation environment and it is designed/built with COTS devices.

PK-3

Impact of the Detector Definition on TID Reverse Monte Carlo Calculation Results

Pierre Pourrouquet[1], Athina Varotsou[1], Guy Rolland[2], Robert Ecoffet[2], Vincent Traisnel[1]

[1]TRAD, [2]CNES

FASTRAD®'s Reverse Monte Carlo method has been used to compare TID calculation results in electronic devices obtained using volume and point detectors. Multiple geometrical models allowed to make recommendations on the detector choice.

PK-4

Approach to estimation of modern IC sustainability after series of single events

Georgii G. Davydov[1], Petr K. Skorobogatov[1], Dmitry V. Boychenko[1]

[1]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)

Developed approach allows estimating the limiting characteristics of single or series of impacts to provide guaranteed further functionality of modern ICs. It may be used also to estimate fault probability after impact with known characteristics.

PK-5

Bayesian Modeling of COTS Power MOSFET Ionizing Dose Impact on Circuit Response

Arthur Witulski[1], Michael Smith[1], Nagabushan Mahadevan[1], Andrew Sternberg[1], Charles Barnes[2], Douglas Sheldon[2], Gabor Karsai[3], Ron Schrimpf[1]

[1]Vanderbilt University, [2]Jet Propulsion Laboratory, [3]Vanderbilt University

Threshold voltage variation with ionizing dose was measured for a commercial power MOSFET. Variation of radiation response was captured using a Bayesian linear model, which enabled a Monte Carlo simulation of variation in circuit performance.

PK-6

Estimation of the Radiation Hardness of Bipolar Voltage Comparators in Wide Operation Temperature Range

Vladislav Felitsyn[1], Alexander Bakerenkov[1], Alexander Rodin[1], Viacheslav Pershenkov[1], Valentin Butin[1]

[1]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)

Radiation induced degradation of widely used bipolar voltage comparators was investigated in wide temperature range from high to liquid nitrogen temperatures. It was obtained, that the parametric degradation is significantly greater at low temperature measurements.

10:35-11:20:

Coffee Break - Level 0, Exhibit Area

Friday Technical Programme

SESSION L: Radiation Environments (SPACE, ATMOSPHERIC, TERRESTRIAL AND ACCELERATORS)

Session Chairs: **Dr Sébastien Bourdarie**[1] and **Pr. Frédéric Wrobel**[2]
[1]ONERA, [2]Montpellier University
11:20-11:25: Session opening

DR SÉBASTIEN BOURDARIE

has worked at the Space Environment Department (now the Physics, Instrumentation, Environment and Space Department) of ONERA since 1993. He is now team leader of the Space Environment Modeling and Measure group. He is currently involved in physical modelling of electron radiation belts (Salammbo code) for the Earth and Jupiter, as well as artificial radiation belts created by high-altitude nuclear weapons. Related to this activity, he acquired a great experience in processing and interpreting data from particle detectors onboard different satellites. He has developed a space radiation database from various monitors. He is involved in data assimilation tool development, in particular an ensemble Kalman filter for the Earth electron radiation belt. He is also involved in spacecraft anomaly analysis. He is also in charge of supervision and examination of PhD students. He is teacher in space environment.
Responsibilities and achievement: 2010-2016: Member of the science committee board of the Sun-Earth system (PNST) division of CNRS, 2009-today: Member of the science committee board of the Physics division at ONERA, 2006-2016: Member of the RADECS (RADiation Effects on Components and Systems) council board, 2004-today: Chairman of the COSPAR PRBEM panel, 1997-2009: Manager for DESP computer infrastructure, Referee for J. Geophys. Res., Geophys. Rev. Lett., Adv. Space. Res., Referee for NASA NRA and NSF scientific proposals.

PR. FRÉDÉRIC WROBEL

received his PhD degree in electronics from the Université de Montpellier (France) in 2002. From 2002 to 2007, he was associate Professor at the Université de Nice where he worked on thermoluminescent properties of wide gap semiconductors. Since 2008 he worked at the université de Montpellier where he became full Professor in 2014. His field of expertise includes radiation matter interaction, Single Event Effects prediction tools and contamination of semiconductor by alpha emitters. He was awarded by the Great Price of electronics “General Ferrié” in 2010 for his work on nuclear physics codes and their original validations by stratospheric balloon flights. He is currently member of the « Institut Universitaire de France » and is author or co-author of 80 international scientific papers.

ORAL COMMUNICATIONS

L-1 | 11:25

Validation of flux models to characterize the radiation environment in space based on current Rosetta-data

Vanessa Wyrwoll[1], Sascha Lüdeke[1], Hugh Evans[2], Björn Poppe[1]

[1]WG Medical Radiation Physics and Space Environment Studies Faculty VI Medicine and Health Sciences Carl von Ossietzky University of Oldenburg, [2]ESA/ESTEC

The thermal neutron contribution to the atmospheric soft error rate is investigated for 3 devices with feature sizes below 65nm. We conclude that the thermal neutron induced SEUs may not be ignored for avionic applications.

L-2 | 11:40

Contribution of Thermal Neutrons to Soft Error Rate

Cécile Weulersse[1], Sabrine Houssany[2], Nicolas Guibbaud[2], Jaime Segura-Ruiz[3], Jérôme Beaucour[3], Florent Miller[4], Maria-Magdalena Mazurek[5]

[1]Airbus Group, [2]Airbus Defence and Space, [3]Institut Laue Langevin, [4]Nuclétudes, [5]Airbus Operations SAS

GREEN (Global Radiation Earth ENvironment) is a new model providing fluxes between L*=1 and 8 and for any energy from 0.001 to 10 MeV for electrons and from 0.001 to 800 MeV for protons.

L-3 | 11:55

GREEN: a new Global Radiation Earth ENvironment model for electrons and protons

Angelica Sicard[1], Daniel Boscher[1], Sébastien Bourdarie[1], Didier Lazaro[1], Guy Rolland[2], Denis Standarovski[2]

[1]ONERA, [2]CNES

In-flight dark current non uniformity measurements performed on different satellites are compared to ground calculations. The predictions performed with AP8 and AP9 environment models are compared to those made with measured spectrometers proton fluxes.

L-4 | 12:10

Inflight dark current non uniformity used for space environment model benchmarking

Christophe Inguimbert[1], Sebastien Bourdarie[1], Matthieu Beaumel[2], Marie-Cecile Ursulle[1], Robert Ecoffet[3]

[1]ONERA, [2]SODERN, [3]CNES

Validating interplanetary flux models using Monte Carlo simulated response functions of the Standard Radiation Environment Monitor (SREM). Accomplished by comparing theoretical countrates to measured data of the Rosetta mission which was successful within error estimation.

POSTER SESSION

PL-1

Impact of the Trapped Proton Anisotropy on the Ionizing Dose at Low Earth Orbits

Athina Varotsou[1], Pierre Pourrouquet[1], Romain Fonta[1], Daniel Boscher[2], Robert Ecoffet[3]

[1]TRAD, [2]ONERA, [3]CNES

The impact of considering the trapped proton anisotropy is evaluated for the TID calculation at component level. The radiation model of the SAC-D satellite has been used to take into account the real shielding distribution.

PL-2

High energy electrons in the inner zone

Daniel Boscher[1], Sébastien Bourdarie[1], Vincent Maget[1], Angelica Sicard[1], Guy Rolland[2], Denis Standarovski[2]

[1]ONERA, [2]CNES

The existence of high energy (E>1MeV) electrons in the inner zone is always a debate issue. We tried with several clues to solve the problem they arise.

PL-3

Electron Environment Characteristics and Internal Charging Evaluation for MEO Satellite

Jian-zhao Wang[1], Yan-qi Hu[1], Zhen-bo Cai[1]

[1]Beijing Institute of Spacecraft System Engineering, CAST

By analyzing in-situ data in MEO, spatiotemporal distribution and statistic characteristics of electrons over one solar cycle are studied. The internal charging behavior and worst-case flux of different dielectric constants are also discussed.

PL-4

Calculation Method of Maximum Radiation Conditions and Reliability using Quasi-Dynamic Radiation Belt Model

Haruhisa Matsumoto[1]

[1]Japan Aerospace Exploration Agency

We have developed a new dynamic model for the flux of energetic particles trapped in the Earth's radiation belts. This model also includes a magnetic activity variation, solar wind velocity variation and pitch angle distributions.

PL-5

SEP Electrons in GEO measured with the ESA MultiFunctional Spectrometer

Luisa Ferreira Da Gama Velho Arruda[1], Patricia Goncalves[1], Filipe Carvalho[1], Arlindo Marques[2], João Costa Pinto[2], Adolfo Aguilar[2], Pedro Marinho[2], Tiago Sousa[2], Hugh Evans[3], Petteri Nieminen[3]

[1]LIP, [2]EFACEC, [3]ESA/ESTEC

The MFS is a radiation monitor on board of the Alphasat satellite to characterize GEO radiation environment. Ground and flight data for electron fluxes will be presented.

PL-6

Validation of a Geant4 full model for the MIXS instrument at BepiColombo

Pablo Portillo[1], Marina Benito-Parejo[1], Sergio Ibarmia[1]

[1]Instituto Nacional de Técnica Aeroespacial (INTA)

We have constructed a Geant4 model for the MIXS instrument onboard the BepiColombo satellite. Our model has been preliminary validated against design reference simulations and with experimental testing data.

PL-7

Radiation induced background characterization for a next generation of space telescope

Luz Maria Martinez Sierra[1], Insoo Jun[1], Patrick F. Morrissey[1]

[1]NASA Jet Propulsion Laboratory

A comprehensive Monte Carlo analysis was performed to model the space environment's impact to a next generation of ultra-sensitive space telescope from radiation-induced background from various physical processes in representative spacecraft shielding materials.

PL-8

Impact of thermal and intermediate energy neutrons on SRAM SEE rates in the LHC accelerator

Matteo Cecchetto[1], Ruben Garcia Alia[2], Simone Gerardin[3], Markus Brugger[2], Salvatore Danzeca[2], Angelo Infantino[2]

[1]University of Padova and INFN, [2]CERN, [3]University of Padova

We studied SEU and SEL SRAM cross-sections using the CHARM mixed-field facility with contribution from thermal and intermediate energy neutrons, introducing an experimental procedure to unfold the thermal and high-energy-hadron impacts to the SEE rate.

PL-9

Mapping the space radiation environment in LEO orbit with the SATRAM/Timepix radiation monitor on board the Proba-V satellite

Carlos Granja[1], Zdenek Dvorak[1]

[1]CSRC

The miniaturized payload in LEO orbit since 2013 provides precise dose rates and wide-range particle fluxes in the satellite environment with quantum imaging sensitivity and energy loss and directional sensitivity for energetic charged particles.

Poster Session & Data Workshop

WED: 16:25-18:30 AND THU: 15:00-17:00

Poster Session Chairs: **Marty Shaneyfelt**[1] and **Philippe Paillet**[2]

[1]Sandia National Laboratories, [2]CEA DAM DIF

MARTY SHANEYFELT

is a Distinguished Member of the Technical Staff at Sandia National Laboratories and a Fellow of the IEEE with over 32 years of experience developing radiation-hardened bulk and SOI CMOS technologies, characterizing the physical mechanisms responsible for the radiation response of ICs, and developing hardness assurance approaches. He has authored or co-authored more than 195 publications and short courses, including 13 IEEE Nuclear and Space Radiation Effects Conference (NSREC) Outstanding Conference Papers and 2 Hardened Electronics and Radiation Technology (HEART) Conference Outstanding Papers. He is presently the Executive Past-Chair of the Radiation Effects Steering Group overseeing the NSREC.

PHILIPPE PAILLET

received his PhD degree in Electrical Engineering from the Université Montpellier II, France, in 1995, and then joined the Commissariat à l'Energie Atomique (CEA) in Arpajon, France, where he is a senior expert of radiation effects in electronic and optoelectronic devices, developing radiation hardened technologies and hardness assurance approaches. Philippe has served the radiation effects community as reviewer and Session Chairman for the IEEE Nuclear and Space Radiation Effects Conference (NSREC) and the RADiation Effects in Components and Systems (RADECS) European conference. He served as Guest Editor from 2004 to 2007 for the journal IEEE TRANSACTIONS ON NUCLEAR SCIENCE. He has authored and co-authored more than 150 publications, articles, short courses and book chapters, including two Best Papers at RADECS, one Best Paper Award at HEART, two Meritorious Paper Awards and five Outstanding Conference Paper Awards at NSREC.

Poster Session & Data Workshop

WED: 16:25-18:30 AND THU: 15:00-17:00

ANALOG AND MIXED-SIGNAL INTEGRATED CIRCUITS FOR USE IN RADIATION ENVIRONMENTS

Session Chairs: **Boris Glass**[1] and **Kenneth Wyllie**[2]

[1]ESA, [2]CERN

In this RADECS 2017 edition, the topic "Analog and Mixed-Signal Integrated Circuits for use in Radiation Environments" has been introduced as a new theme.
In addition to the posters from all the other sessions, conference attendees will be able to find 3 presentations about this theme during the poster sessions which will be held on Wednesday (16:25-18:30) and Thursday (15:00-17:00).

BORIS GLASS

received his Master degree in physics from the University of Heidelberg in 1997, specializing in analogue readout and trigger electronics for particle accelerators. From 1998 to 2002 he was a research assistant at the Federal Institute of Technology (ETH) Zürich developing the QR-RLS Filtering ASIC for wireless LAN diversity combining. In 2003 he became a member of the micro-electronics section of the European Space Agency, graduated in 2005 from the International Space University and became a certified ESA astronaut instructor in 2009. At the Agency he manages research and development activities with the European space industry and provides support to ESA satellite and space probe programs. From 2005 he organizes the Agency conference for Analogue and Mixed-Signal Integrated Circuits for Space Applications (AMICSA).

DR KENNETH WYLLIE

received his PhD from the University of Cambridge in 1997. He then joined the European Organization for Nuclear Research (CERN), specialising in microelectronics design using deep sub-micron technologies for radiation–tolerant tracking and photon-detection applications in particle physics experiments. Since 2008 he has coordinated the electronics R&D, production and maintenance for one of the experiments at the Large Hadron Collider. He is also the leader of the front-end section of the Electronics Systems for Experiments Group at CERN, which supports the development, testing and mass-production of electronics used in the radiation environments of CERN's particle detectors. His current research interests are on the development of radiation-hard gigabit optical links for data transmission in extreme environments. He has authored/co-authored numerous publications in the field of instrumentation for particle detectors.

Poster Session & Data Workshop

WED: 16:25-18:30 AND THU: 15:00-17:00

POSTER SESSION

PM-1

600 Mrad TID effects on a new generation high rate Pixel Readout ASIC in 65nm CMOS with low-power, low noise synchronous analog front-end using Fast ToT encoding and auto-zeroing

Ennio Monteil[1], Lino Demaria[1], Luca Pacher[1], Andrea Paterno[1], Angelo Rivetti[1], Manuel Dionisio Da Rocha Rolo[1], Richard Wheadon[2], Serena Panati[1]

[1]Universita e INFN Torino (IT), [2]INFN Torino

An innovative synchronous analog front-end for pixel detectors at HL-LHC has been designed. 600 Mrad TID irradiation at -20°C has been performed. Measurement results are presented and discussed.

PM-2

Design of a Radiation Hardened Power-On-Reset in RD53 Collaboration

Enrique López[1], Francisco Rogelio Palomo[1], Fernando Márquez[1], Fernando Muñoz[1]

[1]Departamento de Ingeniería Electrónica, Escuela Técnica Superior de Ingenieros, Universidad de Sevilla

We present a RD53 IP block, the Power On Reset, for the RD53 collaboration, a RHBD design to withstand the HL-LHC tracker radiation environment. Simulations and experiments to obtain the final IP qualification are presented.

PM-3

Radiation Hardening of Bandgap Voltage References Using Verilog-A Total Dose Simulation

Valeriy Shunkov[1], Vladimir Butuzov[2], Maxim Gorbunov[3], Oleg Kus[4], Vitaly Prokopyev[17], Pavel Rubanov[5], Gennady Zebrev[6], Yury Bocharov[6]

[1]Megarad LLC, [2]Megarad LLC, National Research Nuclear University “”MEPhI”””, [3]SRISA RAS, National Research Nuclear University “”MEPhI”””, [4]OKB Fifth Generation LLC, [5]Tomsk Polytechnic University, [6]National Research Nuclear University “MEPhI”, [7]Novosibirsk State University

Radiation hardened bandgap voltage reference was designed using Verilog-A physical modeling of total ionizing dose effects. Predictive simulation applications to radiation hardened analog circuits design are discussed.

Poster Session & Data Workshop

WED: 16:25-18:30 AND THU: 15:00-17:00

RADIATION EFFECTS DATA WORKSHOP (REDW)

Session Chairs: **Nathalie Chatry**[1] and **Stefan Metzger**[2]

[1]TRAD, [2]Fraunhofer INT

NATHALIE CHATRY

received her PhD in Artificial Intelligence from Paris VI University in 1997. She started her career at TRAD Tests & Radiations in October 1997. Initially specialized in the radiations effects on electronic components and materials, Nathalie expanded TRAD activities towards engineering services, research and simulation software edition in the early 2000's. With more than 20 years of experience in the field of particles interaction, design and testing of electronic components in space environment, she is now Head of Radiation Engineering Department of TRAD. She co-authored several papers, mainly published in the IEEE Transactions on Nuclear Sciences.

STEFAN METZGER

received his diploma degree in nuclear physics from the Technical University Darmstadt in 1989 and his PhD. in nuclear solid state physics from the University of Siegen in 1994. For more than 20 years, he has been working for the Fraunhofer INT in the field of radiations effects in semiconductor devices. In 2011 he became head of the business unit "Nuclear Effects in Electronics and Optics". Currently he is the head of the department "Nuclear and Electromagnetic Effects". He has authored and co-authored more than 30 papers in various journals, conferences and workshops. He is a member of the RADECS Association council board and had the honor to serve as Technical Programme Chair of the 2016 RADECS in Bremen.

Poster Session & Data Workshop

WED: 16:25-18:30 AND THU: 15:00-17:00

DW-1

Pulsed laser beam identification of SEE-sensitive regions and observation of additional failure modes relevant for RHA in Digital Isolators

Raphael Wolf[1], Michael Steffens[1], Stefan Metzger[1], Peter Beck[2], Michael Wind[2], Marc Poizat[3]

[1]Fraunhofer INT, [2]Seibersdorf Laboratories, [3]ESA/ESTEC

Two digital isolators, previously tested with Heavy Ions, are investigated using an SEE-laser system with picosecond pulses. Sensitive areas are identified, some showing effects not seen with heavy ions.

DW-2

Total ionizing dose tests of Power Bipolar Transistors and SiC power devices for JUICE

Michael Steffens[1], Stefan Höffgen[1], Marc Poizat[2]

[1]Fraunhofer INT, [2]ESA/ESTEC

We present radiation tests performed on Power Bipolar Transistors (high dose and ELDRS tests up to 200 krad(Si)) and SiC power devices (1 Mrad(Si) total dose).

DW-3

SEE Testing on PADI-X for JUICE, 8-Channel Ultrafast Charge Pre-Amplifier ASIC

I. Lopez-Calle[1], A. Sirin[2], H. Anderson[2], M. Kerenyi[2], J.J. Gonzalez[1], C. Poivey[3], L. Bonora[3], E. Muñoz[1], M. Dominguez[1], G. Fernandez[1]

[1]ALTER Technology, [2]Swedish Institute of Space Physics (IRF), [3]European Space Agency (ESA)

SEE testing carried out on PADI-X charge amplifier ASIC within ESA-JUICE mission context. Not SEL or permanent damage was detected. Full SEFI/CEM cross sections are provided with an ion LET range of 1-63 MeV·cm2/mg

DW-4

Radiation-induced failures on NAND flash memories

Duc Nguyen[1]

[1]Bastion Technologies, Inc.

This paper investigates the signature of radiation-induced failures in NAND flash memories. We present the direct evidence of radiation effects that lead to the malfunction of program and erase operations in flash memory component.

DW-5

Quantitative Assessment of Space Environment Characteristics Dynamics at Different Orbits

Grigory Protopopov[1], Vasily Anashin[1], Igor Lyakhov[1], Sergey Rukavichnikov[1], Valentina Denisova[2], Alexey Tsurgaev[2]

[1]Branch of JSC URSC- ISDE, [2]FSBI Fedorov Institute of Applied Geophysics

Dynamics of absorbed dose, electron and proton flux accumulation on base of on-board measurements at different orbits is presented.

DW-6

Study of Total Ionizing Dose Effects in 65nm Digital Circuits with the DRAD Digital RADiation Test Chip

Luis Miguel Jara Casas[1], Davide Ceresa[2], Szymon Kulis[2], Sandeep Miryala[3], Rui De Oliveira Francisco[2], Dario Gnani[4]

[1]Centro de Investigaciones Energéti cas Medioambientales y Tecno, [2]CERN, [3]Fermi National Accelerator Lab. (US), [4]Lawrence Berkeley National Lab. (US)

A Digital RADiation (DRAD) test chip has been designed to study the impact of Total Ionizing Dose on digital logic gates in a 65nm CMOS technology. Results up to 1Grad under different conditions are reported.

DW-7

Radiation Hard Optical Link Developments at CERN

Lauri Juhani Olantera[1], Andrea Kraxner[1], Stephane Detraz[1], Carmelo Scarcella[1], Christophe Sigaud[1], Csaba Soos[1], Jan Troska[1], Francois Vasey[1]

[1]CERN

The development and qualification of high-speed radiation-hard optical links for use in high energy physics experiments is presented. An outlook to next generation data links for upgraded experiments is also given.

DW-8

Radiation Testing of an SAR ADC for Use in Quench Detection Systems for the HiLumi LHC

Jelena Spasic[1], Reiner Denz[1], Josef Kopal[1], Jens Steckert[1]

[1]CERN

This work presents a radiation assessment of a successive-approximation-register analog-to-digital converter for purposes of a new generation of quench detection systems that will be used in the radiation environment of High-Luminosity Large Hadron Collider.

DW-9

Negative bias temperature instability on γ ray irradiated 90nm and 65nm PMOSFET

Jiangwei Cui[1], Qiwen Zheng[1], Dezhao Yu[1], Hang Zhou[1], DanDan Su[1], Teng Ma[1], Xuefeng Yu[1], Qi Guo[1], Wu Lu[1], Chengfa He[1]

[1]Xinjiang Technical Institute of Physics and Chemistry, Chinese Academy of Sciences

Negative bias temperature instability on 90nm and 65nm PMOSFET is studied. There is more parameter degradation in a narrower channel device, and less degradation in γ ray irradiated device than that of un-irradiated device.

DW-10

Evaluation of an alternative low cost approach for SEE assessment of a SoC.

Françoise Bezerra[1], David Dangla[1], Florent Manni[1], Julien Mekki[1], Denis Standarovski[1], Ruben Garcia Alia[2], Markus Brugger[2], Salvatore Danzeca[2]

[1]CNES, [2]CERN

Before using a complex device in space, one shall evaluate its behavior in radiative environment. We present here the work performed to estimate the Single Event Effect response of a Zynq® processor for a nanosatellite.

DW-11

Compendium of Recent SEE, and TID Test Results conducted by CNES from 2011-2016

Roberta PILIA[1], Florence Malou[1], David Dangla[1], Françoise Bezerra[1], Denis Standarovski[1], Robert Ecoffet[1], Pierre Tastet[1]

[1]CNES

This paper reports the results and analysis of various total ionizing dose (TID) and single event effects (SEE) tests. The compendium covers devices tested by CNES from 2011 to 2016.

DW-12

TID in-situ measurement of temperature coefficient of various commercial voltage references

Jiri Hofman[1], Richard Sharp[1], Jiri Haze[2]

[1]Cobham, [2]Brno University of Technology

A set of commercial voltage references was tested for TID induced changes of their temperature coefficients. The goal is to understand the influence of the radiation on accuracy of data acquisition systems for space applications.

DW-13

Preliminary SEL and TID Test Results on Cobham uController

Matt Von Thun[1], Anthony Wilson[1], Brian Baranski[1]

[1]Cobham Semiconductor Solutions

Single event latch-up and total ionizing dose test data on the newly designed and fabricated Cobham radiation-hardened UT32M0R500 ARM® Cortex®-M0+ 32-bit based micro-controller will be presented.

DW-14

Assessment of Proton Radiation Effects on Hamamatsu InGaAs PIN Photodiodes and Simulated Radiation Responses Using Defect-Based TCAD Modeling

Garrett Schlenvogt[1], Kerri Cahoy[2], Raichelle Aniceto[3], Randall Milanowski[4], Slaven Moro[3]

[1]Silvaco, Inc., [2]Massachusetts Institute of Technology, [3]Facebook, [4]Milanowski & Associations Inc.

Proton test campaign at 105 MeV was completed to assess radiation effects on Hamamatsu InGaAs PIN photodiode dark current. The radiation response of photodiodes was simulated using defect-based TCAD modeling.

DW-15

Radiation Tolerant 6.25 Gbps 850nm Optical Transceiver

A Tanskanen[1], M Karppinen[1], C Boatella Polo[2], R. J. E. Jansen[2], I Mckenzie[2]

[1]VTT Technical Research Centre of Finland Oulu, Finland, [2]European Space and Technology Centre, Noordwijk, The Netherlands

The paper presents the radiation test results of the VTT SolidOpto SPFI-(003)-6G 6.25 Gbps optical transceiver. It is found to be SEL immune and have a low radiation SET cross-section and radiation induced BER.

DW-16

A Survey on Analog-to-Digital Converter Performance with Respect to Ionizing Radiation

Steffen Mueller[1], Robert Weigel[2], Alexander Koelpin[3]

[1]Friedrich-Alexander University of Erlangen-Nuremberg, [2]Friedrich-Alexander-University of Erlangen-Nuremberg, [3]Brandenburg University of Technology Cottbus-Senftenberg

This paper discusses radiation performance evolution of analog-to-digital converters, based on a comprehensive empirical analysis of both, experimental reports and datasheet specifications including commercial devices, radiation hardened parts, and scientific converters.

DW-17

The Radiation Performance of Intersil's Commercial Space Plastic Parts

Warren H. Newman[1], Nicolaas van Vonno[1], Eric J Thomson[1], Lawrence G. Pearce[1]

[1]Intersil, a Renesas Company

In response to the commercial space industry's need for low-cost, highly-reliable, radiation-tolerant parts, Intersil has combined its automotive quality knowledge with its radiation-hardened legacy to develop a line of space-grade parts in plastic packages.

DW-18

Total Dose and Single-Event Effects Testing of the Intersil ISL70040SEH Gallium Nitride (GaN) FET Driver

Nicolaas van Vonno[1], H. W. Satterfield[1], Lawrence G. Pearce[1], Frank C. Ballou[1], Warren H. Newman[1], James S Gill[1], Eric J Thomson[1]

[1]Intersil, a Renesas Company

We report the results of destructive and nondestructive single-event effects and total dose testing of the Intersil ISL70040SEH GaN FET driver, with a brief discussion of the part's functionality, electrical specifications and fabrication process.

DW-19

Total Ionizing Dose Measurements of a Commercial Samsung NAND Flash Memory for a High Dose Mission

Gregory Allen[1], Farokh Irom[1], Duc Nguyen[1], Leif Scheick[1], Steve McClure[1]

[1]JPL

We present TID measurements of a commercial Samsung NAND flash memory intended for use on a high dose mission. Statistical variation in the first measurements necessitates a second set of measurements with increased samples.

DW-20

Options for Radiation Tolerant High Performance Memory

Steven M. Guertin[1], Jean Yang-Scharlotta[2], Raphael Some[2]

[1]Jet Propulsion Laboratory, California Institute of Technology, [2]Jet Propulsion Laboratory

Memory technologies were reviewed for radiation effects. TID and SEL trends cannot be trusted to improve. SEE hardening of memory arrays is prohibitive. Rad hard cells and custom controllers are recommended for future memory developments.

DW-21

Radiation Evaluation of Analog Devices' RT6804-1 Radiation Tolerant Multicell Battery Monitor

Shirley Hart[1], Philip Pandol[2], Nathan Wendel[3], Ryan Peralta[3]

[1]Jet Propulsion Laboratory, [2]SSL/MDA, [3]Analog Devices

Radiation Tolerant Multicell Battery Monitor RT6804-1 from Analog Devices has been evaluated for total dose radiation performance and Single event effect characterization. Results and discussions are presented in this work.

DW-22

Destructive Single-Events and Latchup in Radiation-Hardened Switching Regulators

Sergeh Vartanian[1], Gregory Allen[1], Leif Scheick[1], Farokh Irom[1], Nicolaas van Vonno[2], Larry Pearce[2], Shirley Hart[1]

[1]Jet Propulsion Laboratory, [2]Intersil Corporation

Single-event destructive behavior and latchup has been observed in two separate radiation-hardened switching regulators. We discuss the test conditions and observed results.

DW-23

Proton Test Results for Commercial Fanout Buffer, Variable Gain Amplifier and +/-40V Operational Amplifier

Randall Milanowski[1], Norm Hall[2], Bert Vermeire[2], Slaven Moro[3], Neal Nicholson[4]

[1]M&A Inc, [2]Space Micro, [3]Facebook Inc., [4]Blue Marble Communications Inc.

We provide proton radiation test results for three commercial analog integrated circuits that have no space-qualified equivalents. Results suggest the components are suitable for space. Enhanced low-dose-rate sensitivity testing is also planned.

DW-24

Combined x-ray and gamma ray testing to investigate the TID tolerance of RTG4 flip-chip Flash-Based FPGAs

Nadia Rezzak[1], Jih-Jong Wang[1], Victor Nguyen[1]

[1]Microsemi

X-ray testing on RTG4 flip-chip Flash-based FPGA to study the TID tolerance is investigated. Shielding is used to identify the most sensitive circuits. X-ray testing is complemented with gamma irradiation to understand RTG4's TID limit.

DW-25

In-beam programming of radiation-hardened flash-based FPGA-RTG4

Jih-Jong Wang[1], Nadia Rezzak[1], Stephen Varela[1], Victor Nguyen[1], Salim Samiee[1], Frank Hawley[1], Esmat Hamdy

[1]Microsemi-SoC

In-beam programming Flash-based FPGA RTG4 is performed. The acquired Weibull curve predicts very high programming-in-space successful rate. The cause of programming interruptions is identified by laser scanning to be registers upset in programming circuits.

DW-26

Radiation Hardness Testing on Mixed Signal Telemetry LX7730 Controller

Mathieu Sureau[1], Russell Stevens[1], Marco Leuenberger[1], Nadia Rezzak[1], Dorian Johnson[1]

[1]Microsemi

TID, ELDRS and SEE characterizations were performed on the first radiation hardened analog mixed-signal telemetry controller IC LX7730. Testing results are presented

DW-27

The effect of preliminary neutron irradiation on IR-LED characteristics during operation

Anastasiia Simonova[1], Alexandr Gradoboev[1], Ksenia Orlova[1]

[1]National Research Tomsk Polytechnic University, Tomsk, Russia

The purpose is to research effect of preliminary neutron irradiation on reliability of IR-LEDs based upon AlGaAs heterostructures. Using of optimal level of preliminary neutrons irradiation of LEDs makes it possible to increase their reliability.

DW-28

Ionizing Radiation Response of the 4530 Parallel-to-Serial Driver and 4527 Registered Receiver

Steven Witczak[1], Eric Williamson[1], Matthew Calderone[1], David Jarvis[1], Kristin Marino[1], Glen Macejik[1]

[1]Northrop Grumman

The Northrop Grumman 4530 Parallel-to-Serial Driver and 4527 Registered Receiver were assessed for ionizing radiation tolerance through 19.8 krd(Si). Neither irradiation nor post-irradiation anneal has a measurable effect on the performance parameters.

DW-29

Ionizing/Displacement Synergistic Effects in Bipolar Amplifiers and Comparators Exposed to Mixed Neutrons and Gamma Rays

Chenhui Wang[1], Wei Chen[1], Yan Liu[1], Xiaoming Jin[1], Chao Qi[1], Shanchao Yang[1], Xiaoqiang Guo[1]

[1]State Key Laboratory of Intense Pulsed Irradiation Simulation and Effect, Northwest Institute of Nuclear Technology

The influence of displacement damage on total ionizing dose effects in the bipolar devices is studied at doses up to 148 krad(Si). The impacts of the types of input transistors are evaluated.

DW-30

Single Event Effects and Total Dose Testing of Digital to Analog Converters

Andrey Karakozov[1], Pavel Nekrasov[1], Dmitry Bobrovsky[1], Georgy Sorokoumov[1], Vitaly Telets[2]

[1]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)/ Specialized Electronic Systems (SPELS), [2]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)

In the article we introduce histogram method for digital to analog converters' space radiation testing including both total dose and single event effects.

DW-31

Single Event Effect susceptibility of a CMOS Image Sensor destined for Jupiter

Matthew Soman[1], Edgar Allanwood[1], Konstantin Stefanov[1], Mark Leese[1], Daniel-Dee Lofthouse-Smith[1], Jérôme Pratlong[2], Peter Turner[2], Andrew Holland[1]

[1]Open University, [2]Teledyne e2v

The CIS115 is a CMOS Image Sensor being qualified for the focal plane of an optical telescope on JUICE. Results from the Single Event Effect campaign undertaken with Heavy Ions will be presented here.

DW-32

Radiation Evaluation of Digital Isolators for Space Applications

Peter Beck[1], Michael Wind[1], Peter Clemens[2], Tobias Kündgen[2], Marcin Latocha[1], Wilhelm Lennartz[2], Stefan Metzger[2], Marc Poizat[3], Sven Ruge[2], Michael Steffens[2], Christoph Tscherne[1]

[1]Seibersdorf Laboratories, [2]Fraunhofer INT, [3]ESA/ESTEC

Recently we presented preliminary results on TID and SEE testing of digital isolators. Here we give comprehensive radiation-hardness characterization for three digital isolator's technologies. We provide conclusions on suitability for space applications and recommendations.

DW-33

Single event latchup in ICs with integrated latchup protection technology

Denis Kostyuchenko[1], Andrey Karakozov[2], Alexander A. Pechenkin[2], Pavel Nekrasov[2], Dmitry V. Savchenkov[3], Anastasiya Ulanova[1], Alexander Nikiforov[2]

[1]SPELS, [2]NRNU MEPhI and SPELS, [3]NRNU MEPhI

Test method is described and obtained results presented for ADC 7809ALP with internal latchup protection system.

DW-34

Microdose effects in SRAM cells under heavy ion irradiation

Anna Boruzdina[1], Andrey Yanenko[1], Anastasia Ulanova[1], Alexander Chumakov[2], Dmitriy Bobrovskiy[1], Vyacheslav Uzhegov[1]

[1]SPELS, [2]NRNU MEPhI

The paper presents experimental data of single event hard errors (SEHEs) in commercial SRAM cells during SEE testing and TID tests.

DW-35

Dynamic SEE Testing of Selected Architectural Features of Xilinx 28 nm Virtex-7 FPGAs

Gary Swift[1], Stephen Stone[2], Sebastian Garcia[3], Kevin Wray[4], Kyle Robinson[4], Andrés Pérez-Celis[5]

[1]Swift Engineering & Radiation Services, llc, [2]Lockheed-Martin, [3]S Labs, [4]Boeing, [5]Brigham Young University

Recent proton and heavy ion SEE data are presented for selected Virtex-7 architectural features requiring dynamic in-beam testing: IO blocks in various modes, IOSERDES, digital- and phase-locked loop clocks, and block memory's error correction circuitry.

DW-36

Low-cost and High-flexibility SEL Testing Unit

Juan Cueto[1], Gaizka Eiguren[1], Marcos Martinez Alejandro[1], Fátima García Donday[1]

[1]Thales Alenia Space

This paper describes the characteristics and specifications of a low-cost and high-flexibility SEL testing unit developed by Thales Alenia Space Spain in order to increase the number of devices that could be tested per campaign.

DW-37

ELDRS Characterization to of Texas Instruments LMP2012 RRO Precision Amplifier

Kirby Kruckmeyer[1]

[1]Texas Instruments

The LMP2012 is a dual, rail-to-rail output, precision operational amplifier with chopper inputs. It went through total ionizing dose testing at 10 mrad/s and was found to be ELDRS-free.

DW-38

Radiation-Induced Attenuation Data of Polarization-Maintaining Fibres

Matthieu CAUSSANEL[1], Gwendal BEAUVOIS[1], Hervé DUVAL[1], Stéphane GRIEU[1], Guillaume MONTAY[2], Olivier GILARD[3]

[1]Université de Perpignan Via Domitia, [2]Sodern, [3]CNES

Radiation-induced attenuation measurements have been carried out on four different commercial optical fibres, three of them being polarization-maintaining. Photobleaching effect greatly varies from one fibre to another.

DW-39

COTS Components Radiation Test Activity and Results at MSSL part 2

Hu Daohua[1]

[1]UCL - Mullard Space Science Lab

This paper reports a full radiation test results for three analogue COTS devices AD8065, DG612 and EL7457, all targeted for use in MSSL's VIS instrument on ESA's EUCLID mission.

DW-40

Investigation on the Single Event Burnout threshold behaviour of Power MOSFETs under atmospheric-like neutron spectrum irradiation

Nicolò Marchese[1], Andrea Solano[2], Carlo Cazzaniga[3], Christopher Frost[3], Elio Angelo Tomarchio[4], Calogero Pace[2]

[1]University of Calabria, University of Palermo, [2]University of Calabria, [3]STFC Rutherford Appleton Laboratory, [4]University of Palermo

N-channel power MOSFETs were tested at ChipIr (ISIS-RAL) with atmospheric-like neutron spectrum. Voltage thresholds for Single Event Burnout were evaluated and their correlations with the devices characteristics (V(BR)DSS) were investigated.

DW-41

Destructive Failure Heavy Ion Testing of Different Amplifiers

Anastasia Kalashnikova[1], Pavel Chubunov[1], Vasily Anashin[1], Sergei Iakovlev[1], Aleksandr Koziukov[1], Konstantin Faradian[1], Aleksandr Chlenov[2]

[1]Branch of JSC "United Rocket and Space Corporation"-"Institute , [2]Research Institute of Scientific Instruments (RISI)

In this work we present single event effects (SEE) test results for selection of amplifiers which are potential space candidates obtained at Roscosmos Test Facilities during test campaigns in 2016.

DW-42

MOSFETs SEB & SEGR Qualification Results with SOA Estimation

Sergei Iakovlev[1], Vasily Anashin[1], Pavel Chubunov[1], Aleksandr Koziukov[1], Kais Bu-Khasan[1], Timofey Maksimenko[1], Aleksandr Chlenov[2]

[1]Branch of JSC "United Rocket and Space Corporation"-"Institute of Space Device Engineering", [2]Research Institute of Scientific Instruments (RISI)

the paper presents single event effects (SEE) test results for some commercial power MOSFETs obtained at Roscosmos SEE Test Facilities during test campaign in October 2016.

Awards

RADECS 2017 AWARDS

It is a tradition that presentations and proceedings at the RADECS conference are peer evaluated in order to identify and give public recognition to the best studies presented that year:

Best RADECS 2017 Paper
Best RADECS 2017 Data Workshop Paper.

In addition the Jean-Marie Palau Award is given in memoriam of Pr. Jean Marie Palau from University of Montpellier to recognize the best “student paper” of the conference. The Jean-Marie Palau Award will be given at the RADECS 2017 Conference closure.

To this aim, each session will be separately evaluated by members of the Awards Committee. This committee is composed of about 20 international experts in the various fields covered by the conference.

After the conference closure, a meeting will take place at CERN in order to select the best Data Workshop paper and to select a limited number of studies (typically 10-12) that will compete for the Best Paper.

At this stage, the selection will be performed by the Awards Committee basing on RADECS Proceedings or IEEE Transaction on Nuclear Science articles submitted by the authors before the conference.

Both the best RADECS 2017 Data Workshop Paper and the best RADECS 2017 Paper will be given at RADECS 2018 in Gothenburg, Sweden.

Knowledge Transfer Group

KNOWLEDGE TRANSFER AT CERN

Technologies from CERN, and the human expertise associated with them, translate into positive impact on society in many different fields. The Knowledge Transfer (KT) group aims to engage with experts in science, technology and industry in order to create opportunities for the transfer of CERN's technology and know-how. The ultimate goal is to accelerate innovation and maximise the global positive impact of CERN on society. This is done by promoting and transferring the technological and human capital developed at CERN.

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Aerospace is a field in which CERN is playing a critical and increasingly recognised role from both the scientific and the technological point of view. This domain is considered as highly strategic by many of CERN's institutional and industrial partners in the Member States and beyond.

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CERN's technologies, facilities and know-how have concrete applications in space, and the KT group is committed to exploring synergies and establishing partnerships with institutional, research and commercial organisations active in the aerospace sector.

The aerospace related activities of CERN include:

- Support of scientific space missions, including on ISS, mainly in astroparticle physics, astronomy, cosmology and earth observation (e.g., AMS, Euclid, Proba-V). Instrument performance characterisation and calibration; space and ground segment contributions.
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- Technologies development: from microelectronics to data handling, from radiation monitoring to cryogenics and from thermal management to superconducting magnets.
- Flight demonstrators: CELESTA (CERN Latchup Experiment Student sAtellite), first CERN-driven nanosatellite (a KT Fund project), will flight-prove RadMon technology and validate CHARM facility for LEO radiation environment testing.

CONTACT:

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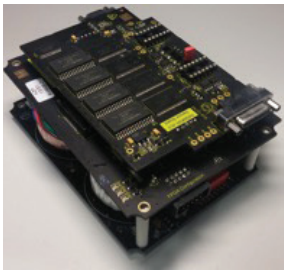
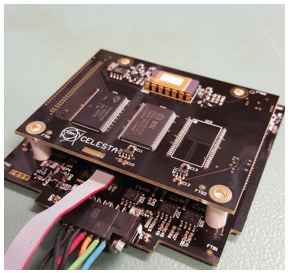
CERN - Knowledge Transfer Group
Aerospace Applications Coordinator
enrico.chesta@cern.ch

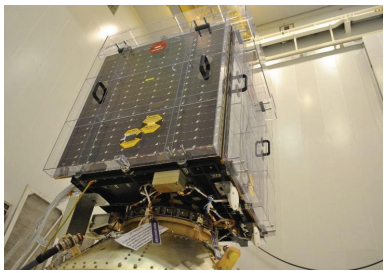
KT
Accelerating innovation

EXAMPLES OF CERN TECHNOLOGIES WITH AEROSPACE APPLICATIONS:



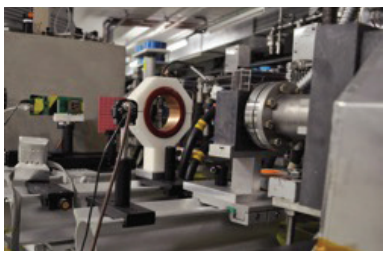


RadMon V6 radiation monitoring system and CELESTA CubeSat payload test board



Timepix3 chip (multipurpose hybrid pixel detector developed within the Medipix3 Collaborations) and Timepix-based radiation detector (SATRAM) aboard Proba-V

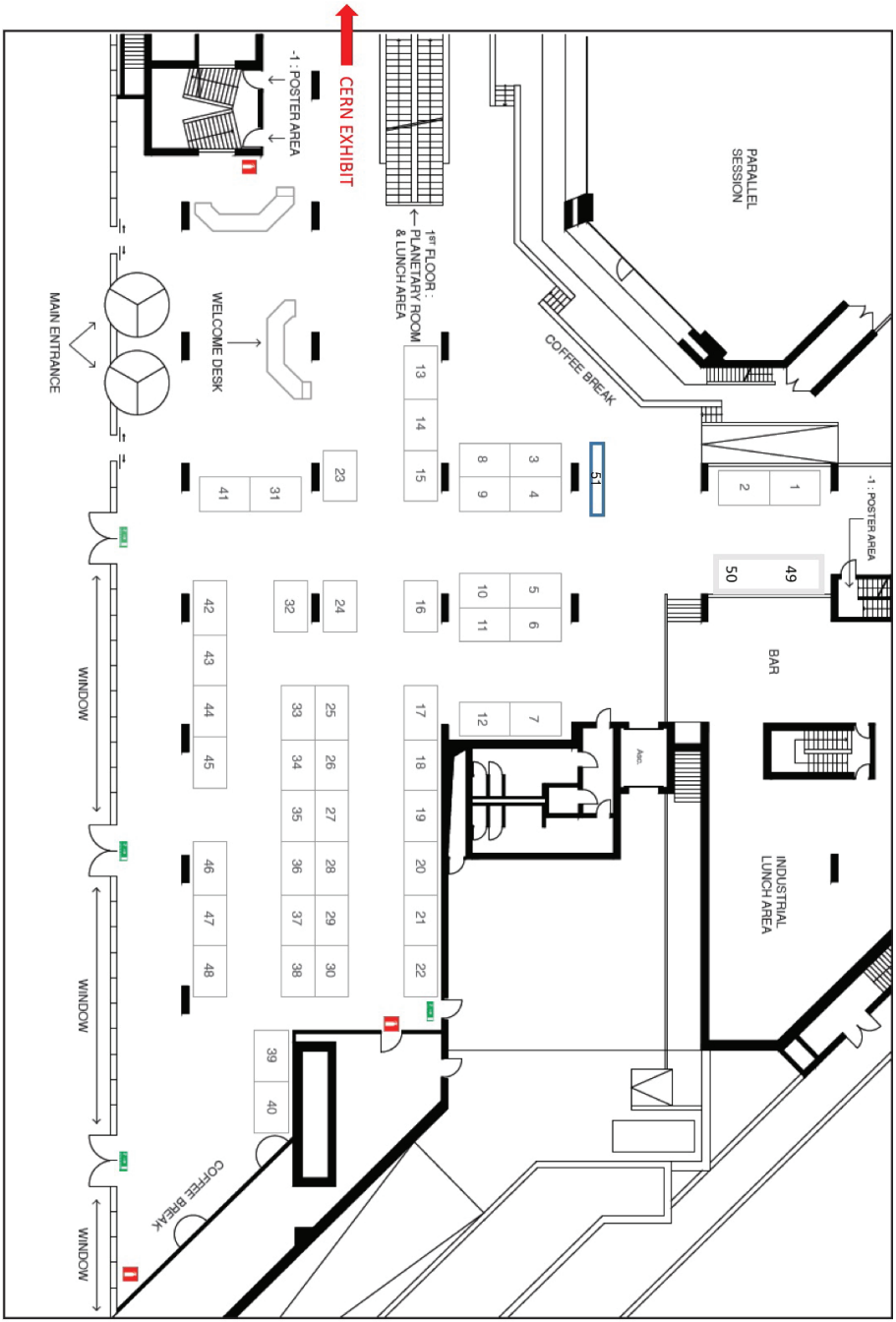
EXAMPLES OF CERN FACILITIES WITH AEROSPACE APPLICATIONS:



VESPER (Very energetic Electron facility for Space Planetary Exploration missions in harsh Radiative environments) www.cern.ch/vesper

CHARM (Cern High energy AcceleRator Mixed field/facility) - www.cern.ch/charm

Industrial Exhibits



Industrial Exhibits

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MICROSEMI	3	CACEC	31
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