RADHARD SYMPOSIUM

Book of Abstracts

June 6th - 7th, 2023

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Chairman‘s Invitation

On behalf of the organizing team, it is my great pleasure to invite you to the 8th edition of the annual RADHARD Symposium, held at Seibersdorf Laboratories, close to Vienna, Austria.

The mission of the RADHARD Symposium is to provide you, in addition to the RADECS conference, with a forum for the exchange of practical experience in the field of radiation hardness assurance (RHA). This information is important for both industrial applications as well as for research and science. Our vision is that the RADHARD Symposium will provide a place with plenty of room for communication, the exchange of ideas and the possibility to initiate new joint projects.

This year’s RADHARD Symposium focuses on:

- Automotive & Reliable Systems,
- COTS Components & SmallSat Missions,
- Practical Aspects of Radiation Hardness Assurance Testing, and
- RHA Developments

We are very pleased and proud to have two keynotes on highlighting and emerging RHA topics. On the first day of the Symposium, Victor Malherbe, RHA expert from STMicroelectronics Crolles in France, opens the session on “Automotive & Reliable Systems“ with his talk “Autonomous Car Meets Cosmic Ray: A Perspective on Radiation Reliability Challenges in Today’s and Tomorrow’s Automotive Systems”, exploring some of the challenges associated with implementing increasingly complex systems, and reviewing radiation effects in modern image sensors and lidar technologies and their implications at system level. The second day’s keynote is held by Viyas Gupta, RHA expert from the European Space Agency (ESA) presenting “ESA Mission Classification: Focus on RHA Tailoring & Impact on COTS-based Projects”.

The 8th RADHARD Symposium features three talks in the session “Automotive & Reliable Systems” from STMicroelectronics Crolles, DLR Germany and Siemens s.r.o, four talks in the session “Practical Aspects of Radiation Hardness Assurance Testing” from Datzmann interact & innovate, Paul Scherrer Institut, and the European Synchrotron Radiation Facility (ESRF), four talks in the session “COTS Components & SmallSat Missions” from ESA, the Nuclear Physics Institute of Czech Academy of Sciences, FHWN University of Applied Science Wiener Neustadt and the TU Wien Space Team, two talks in the session “RHA Developments” from Infineon Technologies, and Leibniz Institute for High Performance Microelectronics, two training lectures on space radiation environment and its effects on electronics by Seibersdorf Laboratories, as well as laboratory visits and plenty of room for discussions, exchange, and networking.

The RADHARD Symposium is aimed at space system integrators, manufacturers of electrical and electronic equipment, industry, research and science as well as students interested in radiation and its effects on components and systems. International experts present emerging topics and give a comprehensive overview of their current projects. We especially encourage students to present their research work on radiation hardness effects and discuss their work and ideas with experts from research and industry.

The 8th RADHARD Symposium is organized by Seibersdorf Laboratories and supported by the Austrian Research Promotion Agency (FFG), the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, AUSTROSPACE, ecoplus Aerospace Platform and in cooperation with the Graz University of Technology (TUG), the University of Applied Sciences Wiener Neustadt (FHWN) and the RADECS Association.

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Our special thanks go to our supporters, AUSTROSPACE, ecoplus Aerospace Platform and the Austrian Research Promotion Agency (FFG), who once again enabled us to provide the RADHARD Symposium without participation fee.

The 8th RADHARD Symposium is held on 6th – 7th June 2023 at Seibersdorf Laboratories. Additionally, the event is streamed and available for all registered participants (onsite and online) for rewatching for up to one month after the event as video on demand (VoD).

We wish you interesting days at the 8th RADHARD Symposium at Seibersdorf Laboratories!

Christoph Tscherne

On behalf of the entire organizing team of the RADHARD Symposium

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1st Day:
Tuesday, June 6th, 2023

Session:
Automotive & Reliable Systems

Keynote

Autonomous Car Meets Cosmic Ray: A Perspective on Radiation Reliability Challenges in Today's and Tomorrow's Automotive Systems

Victor Malherbe[1], Philippe Roche[1], Fady Abouzeid[1], Jean-Marc Daveau[1], Martin Duncan[2]

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[1] STMicroelectronics Agrate, Italy

Abstract

The growing complexity of today's automotive vehicles goes side by side with increasingly stringent and multifaceted safety requirements. Just like electromechanical systems in a car, semiconductor components now need to demonstrate high levels of reliability against a variety of failure modes, out of which radiation effects could arguably be among the most unpredictable at system level. While cosmic-ray induced errors may be rare at sea level, the sheer number of land vehicles in a manufacturer's fleet can raise the odds of critical failures quite dramatically, which has led to the pervasion of functional-safety (FuSa) culture from nuclear or avionics industries – to just name a few – into the automotive world.

In this talk, we will thus explore some of the challenges associated with implementing reliable – relating to both safety and security – and increasingly complex automotive electronic systems, which aim to achieve autonomous driving by incremental improvements on driver-assistance features. Such systems rely heavily on the massive computing power made available by modern multi-core CPUs and GPUs, enabled by advanced CMOS technology nodes beyond planar bulk. We will give an overview of new trends in FinFET process and 3D integration, with the automotive roadmap increasingly turning toward such technologies to support the need for performance from advanced driver assistance systems (ADAS). In addition, we will present new approaches of model-based safety assessment (MBSA), which strive to derive safety metrics in a systematic, automated way, when previous methods typically relied on manual analyses or semi-automated fault injections.

Furthermore, beside digital systems, driver-assistance systems evidently make great use of sensor fusion data, among which photosensitive components are key. We will thus review some radiation effects in modern image sensor and lidar technologies, and their implications at system level. Finally, in light of modern trends in vehicle electrification, we will briefly discuss radiation effects in power electronics, with an emphasis on new generations of wide bandgap components in gallium nitride (GaN). In the global automotive reliability picture, such aspects ought not to be neglected, especially considering the potentially destructive nature of radiation failures in power components.

EEE parts activities in the Space2Motion Initiative

Michael Steffens[1], Gonzalo Fernández Romero[2], Anita Weinschrott-Schaaf[3], Thilo Kaupisch[4]

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[2] ALTER Technology
[3] TESAT-Spacecom
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Contact: EEE-Bauteile@DLR.de

Abstract

The DLR EEE-components division initiated a working group within the Innospace® Space2Motion Network activity. The focus of this working group is enabling the use of automotive EEE-components (AEC-Q qualified) from German manufacturers in space applications.

The work packages include:

- identifying of the users‘ demand for components: this work was performed within the network and within a survey performed by HTV GmbH
- Performing a delta analysis between the AEC-Q requirements and ESCC requirements
- Developing a concept and means of verification, e.g. performing component-level tests or tests at higher integration levels and potentially on-orbit
- Perform these tests
- Develop an exchange platform to allow sharing information

From the list of identified AEC-Q components with user demand, several were procured and are currently undergoing screening, life testing, and radiation testing.

In the talk we give an overview over the current status of the activity, show some results and talk about the lessons learned so far.

References

https://www.space2motion.de/

Single / multiple bit flip events in industry computers (PLCs)

Viktor Žalud

Abstract

Industry computers are used for automated control for critical and not critical application. Since many applications request 24/7 hours performers for many years without any power reset. The soft errors cause be terrestrial radiation must be taken to the count during FW and HW development.

Our investigation covers the radiation testing with neutrons (37MeV) under particle accelerator. We are testing and validating soft error rates provided by vendor and future more we are implementing FW features to increase radiation robustness against soft errors. Our focus are SRAMs, Siemens ASICs and flashes. We are testing SIMATIC PLC with radiation dose which are approximately in range of 500 – 10 000 years of terrestrial radiation in one hour beam time. The testing is provided in distance 2-5m from particle accelerator with many samples (up to 20) for better statistical certainty. We developed our own "Golden samples" for better measurement comparation between tests and particle accelerator (according JEDES89B).

The particle accelerator in nuclear laboratory at Řež, Czech Republic has very wide range of provide neutron beam intensity. One of the key aspects of this beam is his beam width. This allows us to test many samples not in line but next each other. Our typical irradiation area is 50cm x 50cm.

Additionally, we develop our own method how to simulate single / multi bit error in not radiation environment by applying high level of electromagnetic disturbance directly or SRAM chip.

References

[1] JEDED89B

Session:
RADHARD Lecture Series

Introduction to Space Radiation Environment

Christoph Tscherne[1]

[1] Seibersdorf Labor GmbH, Austria

Abstract

Spacecraft in near-Earth orbits are exposed to a complex and harsh radiation environment that poses a great challenge to space mission design. Radiation accelerates the aging of EEE components, eventually leading to a decrease in performance or to a complete loss of functionality [1]. In order to face these challenges, it is necessary to understand the nature and effects of space radiation. The space radiation environments at Low Earth Orbits (LEO), Medium Earth Orbits (MEO) and Geostationary Earth Orbits (GEO) compose of three main types of primary radiation: Solar energetic particles (SEP), galactic cosmic radiation (GCR) and charged particles trapped in the Earth's magnetic field [2, 3]. All three types are of different origin, vary greatly in energy and flux and underlie short-term and long-term variations modulated by the sun's activity [4]. The presentation introduces the different types of orbits and discusses the origin and effects of the space radiation environment in detail. Characteristics of SEP, GCR and trapped particles are described and their influence on mission design and radiation hardness assurance (RHA) is reviewed [5, 6, 7].

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Acknowledgments

We acknowledge the insightful talks and presentations of the lecturers of the RADECS and NSREC short courses and the information provided by SPENVIS, ESA's Space Environment Information System (http://swe.ssa.esa.int/; https://www.spenvis.oma.be/).

Session:
Practical Aspects of Radiation Hardness Assurance Testing

$_{79}$Au Fever 2.0 - The search for heavy ions: Swift, LET-rich and highly penetrating

Gerd Datzmann[1], Ennio Capria[2], Heikki Kettunen[3], Rubén García Alía[4]

[1] Datzmann interact & innovate GmbH, Germany
[2] ESRF, France
[3] University of Jyvaskyla, Finland
[4] CERN, Switzerland

Abstract

Radiation hardness qualification procedures for electronic components and systems often require testing at facilities – providing highly energetic protons, heavy ions, neutrons and to some extent pulsed X-rays – emulating the radiation environment of the devices under test close to reality. These probing radiations are generated at particle accelerators or research reactors located almost exclusively at universities or publicly funded research institutions. Thus, users from industry as well as users from space agencies or academia are dependent on these organizations for providing them a fee-based service. An in-depth study has been performed focusing on the relationship between irradiation facilities and its industrial users. In the past 5 years, more than 50 expert interviews with European stakeholders from industry, space agencies and irradiation facilities, have been conducted for assessing the relevant factors and mechanisms that influence this relationship.

Recently, there are many signs all around the world that the availability of beam time, especially for testing with heavy ions and high energy protons, has decreased over the past years. The answers from the experts in the field show that a growing demand for testing versus a quasi-static offering from the facilities is perceived as one of the greatest challenges today and in the upcoming years. For exploring this more in detail, a dedicated survey with more than 10 users that regularly perform single event effect (SEE) testing at heavy ion facilities based in Europe has been conducted by the author. The aim of this study was to gain a better understanding of the root causes for this imbalance between offer and demand. The answer given by the experts in the field are divers and reveal a complex picture with a lot of technical driven issues and indirect mechanisms that lead to a growing demand. Furthermore, the fact that radiation hardness testing became a global marketplace has created and interdependence of beam time availabilities between North America and Europe. The mechanisms and root causes behind this availability bottleneck will be summarized and put into context from the perspective of the users.

In the case of heavy ion testing the growing usage of Commercial Of The Shelf (COTS) components has created a large impact on the testing procedures and on the choice of technical beam parameters. A significant number of COTS components require much higher penetration depths for SEE testing with heavy ions, even after intensive device preparation efforts. Removing packages, thinning of substrates and delidding of sample are often even not sufficient for performing standard qualification test with energies in the range of 10 – 20 MeV / nucleon. Not to mention the additional resource needed for time-consuming preparation steps as well as the associated risk to provide a sufficient number of devices that are fully operational in due time for the next test campaign. This is only one aspect out of a long list of reason why swift heavy ions with a large penetration depth provide an added value to commercial users.

This study tries to entangle on the one hand the demand for heavy ion testing in general, i.e. testing at the existing “low” energy facilities. On the other hand, the demand for high energy heavy ion testing with penetration depths that enable to characterize COTS components, 3D stacked devices as well as preforming board and box level testing. Answers from regular users of heavy ion facilities are presented that give insights on the evolution of the two types of demand in the past and in the future.

Radiation hardness assurance (RHA) with respect to single event effects of electronic devices foreseen for space application, are performed in a very limited number of facilities in Europe that offer professional beam time service on a regularly basis to external commercial customers. However, most of them are restricted in energy and therefore in penetration depth concerning heavy ions with sufficiently high LET-values as required in standards by space agencies like ESA and NASA. Only a few particle accelerators worldwide have the capability to provide heavy ions with energies fulfilling the “gold” standard in LET combined with millimeter ion ranges. Since these facilities have a dedicated focus for fundamental physics research their availability to commercial external users is by nature very limited or even excluded and in addition very expensive. In consequence many industrial users are in a “fever” for finding affordable SEE testing capabilities that supply them with a sufficient amount of heavy ions beam time. The European landscape of facilities with a particular focus on heavy ion facilities as of today will be depicted.

These challenges were one reason, why the European Union (EU) funded a network of 21 irradiation facilities in an infrastructure program called RADNEXT (RADiation facility Network for the EXploration of effects for indusTry and research). This 4-year project has been launched in June 2021 and aims – besides others – to tackle the aforementioned topics with a set of measures and initiatives. In general, RADNEXT has the goal to ease the access for external users and to harmonize the procedures. Via Transnational Access 6000 hours of beam time are awarded to users from academia and industry free of charge. Another work package deals with generating a roadmap and pre-design of future irradiation facilities. First results from the RADNEXT project running now for almost two years will be highlighted.

Acknowledgments

The author thanks the Accelerator Laboratory of the University of Jyväskylä (JYFL-ACCLAB) for the support

RADNEXT has received funding from the European Union‘s Horizon 2020 research and innovation programme under grant agreement No 101008126

2nd Day:
Wednesday, June 7th, 2023

Session:
RADHARD Lecture Series

Introduction to Space Radiation Effects

Michael Wind[1], Peter Beck[1], Christoph Tscherne[1], Lukas Huber[1], Marcin Latocha[1]

[1] Seibersdorf Labor GmbH, Austria

Abstract

Semiconductor devices are widely used in analog and digital applications on Earth and in space because they are cheap, small, fast, lightweight, and provide high functionality. When exposed to ionizing radiation, semiconductor devices are susceptible to a variety of damage mechanisms that have been observed and studied for many decades. Many findings on these phenomena have been compiled and documented in the literature (e.g. [1] - [6]). This presentation will give an overview on the main types of radiation effects, i.e., total ionizing dose (TID), single event effects (SEE), and total non-ionizing dose (TNID). The basic radiation effects that occur in electronics when exposed to the various radiation sources are presented. Knowledge on such effects is crucial for radiation effects engineers as semiconductor devices intended to be operated in a radiation environment, such as satellite electronics, require adequate knowledge of their sensitivity to the current radiation environment, which entails the need for dedicated radiation testing.

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Continuation of Session:
Practical Aspects of Radiation Hardness Assurance Testing

Proton Irradiation Facility and its use for COTS qualification

V. Kletzl[1] and W. Hajdas[1]

[1] Paul Scherrer Institut

Abstract

Proton Irradiation Facility PIF at PSI was designed to test electronics and devices for applications in radiation hazardous environments. The facility is widely used for qualifications of components primarily for use in ESA satellite programs. The main advantage of PIF is its ability to simulate radiation environment encountered in any possible satellite orbit in the laboratory on-ground. It allows to assess radiation risks and determine radiation hardness of electronic devices already during preparation phases before sending them with the mission to space. With entering the new space era one began to tests more and more COTS. We will review the facility and characteristics focusing on its ability for characterization of COTS. Selected examples of typical test campaigns will be presented and discussed.

Is there light outside the funnel? How synchrotron light sources can help to overcome the major limitations related to Heavy Ions Single Event Effects testing in electronic circuits

Ennio Capria[1]

[1] European Synchotron Radiation facility (ESRF)

Abstract

Traditionally, heavy ion (HI) tests for Single Event Effects (SEE) qualification are conducted at cyclotron facilities with energies around 10 MeV/n. However, this testing method presents several drawbacks. Firstly, a demanding sample preparation is needed to probe the sensitive part of the component, which may not be possible for novel flip chip bonding technologies or 3D packaging and stacked dies. Secondly, obtaining beamtime at the facilities is difficult due to overbooking, and thirdly, HI source beam sizes are large, making it challenging to identify the exact location of the sensitive part.

In recent years, methodologies that use photons (lasers) to generate electron-hole pairs in materials have been used and validated to emulate the effects of HIs. However, this does not solve the problem of sample preparation.

Pulsed synchrotron has been shown to be an effective tool to emulate HIs and test electronic circuit sensitivity to ionising radiation. X-ray beams with high-energy photons (1 keV $< E <$ 30 keV) can penetrate most metallization layers and have a large penetration depth in the semiconductor, enabling access to every embedded component within a 3D-chip. Furthermore, the X-ray beam can be focused below one micron.

This talk will discuss the challenges, opportunities, and trends of using pulsed synchrotron to emulate HIs and test electronic circuit sensitivity. The state of the art of this methodology, as well as the characteristics of different sources available, will be presented in the context of the synchrotron light sources landscape. Pioneering experiments carried at the APS in Chicago (USA) [1] and at the ESRF of Grenoble (France) [2] will also be reviewed.

References

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Qualification of COTS base electronics for POLAR instrument

W. Hajdas[1], R. Marcinkowski[2], H. Xiao[3]

[1] Paul Scherrer Institut
[2] SE2S GmbH
[3] University of Applied Sciences FHNW Brugg Windish

Abstract

POLAR instrument was designed for polarization measurements of Gamma Ray Bursts based on detections of hard X-rays. The instrument flew onboard of the Chinese TG-2 Space Laboratory in 2016 and 2017. The front-end electronics was developed using COTS components only. The radiation requirements related with the Low Earth Orbit environment and the instrument class allowed for simplified approach in radiation qualification. Critical components i.e. ASIC and FPGAs were tested at proton and heavy ion facilities to determine their SEE sensitivity. Several other components such as voltage regulators were also tested for TID and DD to assure stability of power systems of the instrument. Exposure levels used during qualification were applied with suitable margin factors. We will present the details of the qualification approach including modelling and radiation tests results for selected components.

Session: COTS Components & SmallSat Missions

Keynote

ESA mission classification: focus on RHA tailoring & impact on COTS-based projects

Viyas Gupta[1]

[1] ESA

Abstract

This keynote talk presents an overview of the current updates regarding the radiation hardness assurance (RHA) tailoring of each of the ESA mission classes. ESA is now classifying missions according to five classes: “1” being the lowest risk class, down to “5” being the highest risk class. For each mission class, the ECSS requirements are in the process of being tailored including system engineering and product assurance requirements. This talk will briefly introduce the current tailoring with respect to RHA requirements.

The talk will also include a discussion on the tailoring impact on largely COTS-based projects.

Examples of RHA activities on COTS-based projects will be provided, as well as some advice and reminders, based on recent experience, primarily focused towards “New Space” companies.

Acknowledgments

ESA’s TEC-QEC section

Radiation Protection at Earths Orbits and in Deep Space

Lembit Sihver

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Abstract

To enable the planned rapid growth of both government and private operators in space, including satellites, space tourism and manned missions to the Moon and to Mars, a realistic and holistic approach to radiation risk reduction is needed. At orbits close to Earths, the main parts of the ionizing radiation come from trapped particles. In deep space, radiation from Galactic Cosmic Rays (GCRs) and Solar Energetic Particles (SEPs) from the sun pose a critical threat to both humans and electronic equipment. GCRs provide a chronic, slowly varying, highly energetic background source of High-Z and high-Energy (HZE) particles, while the Sun‘s activity varies with an 11-year cycle during which the Sun produces Solar Wind (SW) at varying intensities and unpredictable bursts of SEPs. For successful missions, it is therefore very important to be able to apply the best possible radiation protection. Currently, the only proven and practical countermeasure to reduce the exposure to GCRs and SEPs is passive shielding. However, the currently used metal shielding can increase the damage to humans and electronic behind the shielding.

It is well known that low atomic number (Z) materials are most effective for shielding in space, and liquid hydrogen has the maximum theoretical performance as shield material. Hydrogen is however not a practical shield material, being a low temperature liquid associated with practical handling problems and explosion risks. Hydrogen concentrated in polymer-based composites, however, is ideal for stopping primary cosmic and solar radiation and slow fast secondary neutrons created when the HZE particles are impinging on the spacecraft. Addition of nuclides with different high capture cross sections increases the protection against different secondary particles present. By modifying the fiber/pore size and polymer chain orientation, the polymer materials can also be engineered to act as either efficient heat insulators or efficient heat conductors, providing a broad range of thermoregulation functionalities without compromising the ionizing radiation shielding properties. Polymers are also very suitable for space suits and other protection garments.The fundamental advantages of using polymers for multifunctional shielding purposes will be presented.

Irradiation Studies of space components at MedAustron

W. Treberspurg[1], R. Abbas[1], M. Eizinger[2,3], C. Scharlemann[1], B. Seifert[2], A. Stren[1], C. Tscherne[4], M. Wind[4]

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[2] FOTEC Forschungs- und Technologietransfer GmbH
[3] TU-Wien
[4] Seibersdorf Laboratories

Abstract

New space projects rely on extensively environmental testing, in order to exploit the performance of non-space-graded commercial of-the-shelf (COTS) components. FHWN, FOTEC and SL recently complemented their testing activities by establishing irradiation damage studies of space components at the medical accelerator MedAustron. They are conducted within the non-clinical operation of the proton synchrotron, dedicated for research projects. The capability to deposit a specified dose by scanning the device with a certain pattern, while controlling the intensity and beam energy, provides perfect preconditions for irradiation studies. In this context, displacement damage (DD) and single event effects (SEE) have been investigated. In addition, the commissioning of low flux settings (down to about 103 particles/s) with energies up to 800 MeV [1] enables single particle monitoring with conventional detectors for real time dosimetry.

We give an overview of performed irradiation studies for various projects and applications. **SEE** testing was done on system level for subsystems of the educational CubeSat CLIMB as well as on component level for specific integrated circuits (IC). CLIMB, which will lift its orbit by an electric propulsion up to the inner van Allen belt [2] and has to withstand a harsh radiation environment. Within this dynamic orbit change, the space environment will be characterized with a dosimeter and magnetometer payload. The irradiated subsystems include the electric propulsion unit, the on-board computer, a radiation dosimeter and a magnetometer.

A crucial concern of semiconductor sensors in space are **DD** effects, which damage the crystal lattice and introduce additional energy levels within the band gap. In order to introduce the expected damage, the protons need to be accelerated to an energy high enough to introduce cluster effects. In this context, we irradiate specific X-ray silicon detectors (DEPFETs), to characterize the impact on the spectral performance and the behavior after several low temperature annealing steps.

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CubeSat mission “SpaceTeamSat1”: A live lab in space

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TU Wien Space Team, Vienna, Austria

Abstract

The current advancement in space exploration has a significant influence on our society, particularly on the youth, who is greatly captivated by space topics also broadly visible in media. The key challenge is to provide young people opportunities to actively participate and incite interest in space related programs. Moreover, enabling such pathways allows them to pursue a career in the space and aeronautics field, whether it be in academia or industry. This is especially important since these subjects can appear unattainable to many students. To tackle this issue, educational initiatives such as AstroPi (offered by ESA) [1] and High School Aerospace Scholars (offered by NASA) [2] have been established to encourage and guide students towards these opportunities.

Nevertheless, the inhibition threshold for participation in engineering and science space projects is usually too high for pupils, as they often require an in-depth knowledge on certain topics, as e.g. advanced programming, electronics or mechanics skills and facilities. Moreover, in such initiatives, students often do not get support in technical manners. Therefore, the TU Wien Space Team provides a satellite platform for students with the 1U CubeSat „SpaceTeamSat1“ (STS1) mission, which offers a hands-on introduction to the topic of space technology and its individual facets.

STS1 allows secondary school pupils between the age of 15 and 19 to operate their own code on a Raspberry Pi payload, acting as a live lab in space. The payload is equipped with a diverse set of sensors and cameras, facilitating a wide range of experiments. For example, magnetometers can be accessed to evaluate Earth’s magnetic field or utilizing gyroscopes allows them to evaluate the rotation of the CubeSat itself. Another important aspect is the integration of a dosimeter fabricated by Seibersdorf Laboratories, which is also part of the sensor set accessible by the Raspberry Pi payload. Importantly, teachers can actively integrate these experiments into lessons. Moreover, a cooperation with ESERO Austria [3] further enhances the space education portfolio in Austria and shall encourage other university student associations operating in the field of space technology. This especially holds for providing and operating educational CubeSats, allowing society to participate and join space missions.

So far, the TU Wien Space Team is currently the only organization providing this kind of mission in Austria, promoting hands-on experiments on a CubeSat in space. This also includes close contact to schools and pupils for appropriate guidance in the scope of the mission, even including the assembly of their very own SatNOGS [4] ground station. Moreover, the expertise and technology generated during the STS1 mission will be open source. Hence, the experience and insights on the challenges gathered during the development of a spacecraft is shared with schools and students. This shall pave the way for more space-related lessons in schools as well as de-mystify space technology for young generations and opens paths to future space technologists and scientists.

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Acknowledgments

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Session:
RHA Developments

Radiation Hard AI Memory for Space Applications

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Abstract

We will present the fundamental capabilities of our SONOS charge trapping memory with respect to radiation tolerance and discretization capability which allows SONOS to be the only true radiation hard analog memory. We have demonstrated up to 64 levels of discretization without significant read disturb and excellent data retention. Several neural network model implementations will be presented to showcase the capability of the analog memory AI implementation for edge inference. In memory compute performance of up to 50 TOPS/W is achievable with this technology. SONOS is currently the only matured solution in a radiation and power limited space for AIM (AI Memory) implementation.

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On-chip infrastructure to leverage system reliability for space applications

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Abstract

Technology scaling, which made electronics accessible and affordable for almost everyone on the globe, has advanced IC and electronics since sixties. Nevertheless, it is well recognized that such scaling has introduced new (and major) reliability challenges to the semiconductor industry.

This tutorial describes on-chip rad-hard infrastructure such as sensors, self-adaptive fault resilience control logic [1,2] and dedicated HW redundancy under development at IHP Microelectronics to detect and correct single-event transients (SETs) in logic and predict aging [3,4] during IC lifetime. Single-event upsets (SEUs) can be detected and corrected for memory elements placed in logic, and detected, corrected and predicted at certain conditions for errors in SRAM.

Currently, this on-chip infrastructure is being implemented by IHP in different versions of a quad-core RISC-V processor and a European multi-channel beamforming core-chip, whose general architectures will be briefly described. Both ICs have been designed by using a CMOS 130nm rad-hard technology developed at IHP. If available by the date of the symposium, a demonstrator of the developed RISC-V processor (either running in a FPGA or implemented in the ASIC) and experimental results will be presented and discussed as well.

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List of Lecturers

CAPRIA Ennio, European Synchrotron Radiation Facility (ESRF), France
Is there light outside the funnel? How synchrotron light sources can help to overcome the major limitations related to Heavy Ions Single Event Effects testing in electronic circuits

DATZMANN Gerd, Datzmann interact & innovate, Germany
$_{79}$Au Fever 2.0 - The search for heavy ions: Swift, LET-rich and highly penetrating

GALAVICS Stefan, TU Wien Space Team, Austria
CubeSat mission „SpaceTeamSat1“: A live lab in space

GUPTA Viyas, European Space Agency, The Netherlands
Keynote: ESA Mission Classification: Focus on RHA Tailoring & Impact on COTS-based Projects

HAJDAS Wojtek, Paul Scherrer Institut, Switzerland
Qualification of COTS base electronics for POLAR instrument

KAUPISCH Thilo, DLR, Germany
EEE parts activities in the Space2Motion Initiative

KLETZL Victoria, Paul Scherrer Insitut, Switzerland
Proton Irradiation Facility and its use for COTS qualification

MALHERBE Victor, STMicroelectronics Crolles, France
Keynote: Autonomous Car Meets Cosmic Ray: A Perspective on Radiation Reliability Challenges in Today's and Tomorrow's Automotive Systems

PUCHNER Helmut, Infineon Technologies, USA
Radiation Hard AI Memory for Space Applications

SIHVER Lembit, NPI of the CAS, Czech Republic
Radiation Protection at Earths Orbits and in Deep Space

TREBERSPURG Wolfgang, FHWN University of applied Science Wiener Neustadt, Austria
Irradiation Studies of space components at MedAustron

TSCHERNE Christoph, Seibersdorf Laboratories, Austria
Introduction to Space Radiation Environment

VARGAS Fabian, IHP - Leibniz Institute for High Performance Microelectronics, Germany
On-chip infrastructure to leverage system reliability for space applications

WIND Michael, Seibersdorf Laboratories, Austria
Introduction to Space Radiation Effects

ŽALUD Viktor, Siemens, s.r.o, Czech Republic
Single / multiple bit flip events in industry computers (PLCs)

Notes

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