Radiation Hardness Assurance for New Space Missions and Advanced Electronics: Challenges, Risks and Approaches for Success

Announcement for the 2026 IEEE NSREC Short Course

**MONDAY
JULY 20, 2026
SAN JUAN,
PUERTO RICO,
USA**

On behalf of the 2026 IEEE Nuclear and Space Radiation Effects Conference (NSREC) Committee, I am pleased to invite you to attend the 47th IEEE NSREC Short Course, where a distinguished group of technical experts will address the latest challenges, risks, and strategies for ensuring radiation hardness assurance in new space missions and advanced electronics.

Dr. Pascale Gouker, MIT Lincoln Laboratory

SHORT COURSE CHAIR

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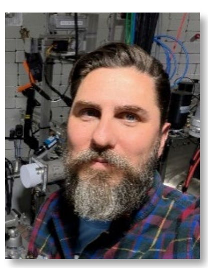
COURSE DESCRIPTION

A short course entitled "Radiation Hardness Assurance for New Space Missions and Advanced Electronics: Challenges, Risks and Approaches for Success" will be presented at the 2026 IEEE Nuclear and Space Radiation Effects Conference. New space missions span an unprecedented range of objectives (*i.e.*, exploration and surveillance, planetary science, meteorology and space weather, communications, Earth observation, and commercial services), architectures (*i.e.*, single spacecraft, constellations, hosted payloads, CubeSats, and surface systems), and radiation environments (from LEO/GEO/cislunar to deep space, with both ionizing and non-ionizing particle effects). This short course will review the challenges, risks, and practical approaches to radiation hardness assurance (RHA) for devices, circuits, and subsystems including commercial off-the-shelf (COTS), emerging system-on-chip (SoC), and 2.5D/3D integrated technologies in those missions.

The short course is organized into four parts. The first part will review the natural space environment and the radiation interaction with matter to provide practical guidance for heavy-ion single-event-effects (SEE) testing. Differences between radiation testing facilities, device design and circuit complexity will be discussed. The second part will cover more specifically the various methods used for the SEE rate calculation, and will include a comparison with on-orbit data and different device technologies. The third part will review the lessons learned from past European Space missions and what RHA mitigation approaches implemented at the system level are flow down to the subsystem and part level. The fourth part will review how the current commercial space market competition and limited testing resources are changing the mission assurance practices and moving toward exploring new approaches.

The short course is intended for students, researchers and engineers working in the field of radiation effects and radiation hard electronics as well as device, circuit, and system designers and managers implementing those systems. It is a unique opportunity for IEEE NSREC attendees to benefit from the expertise of the instructors who will provide a critical review of state-of-the-art knowledge in the field. Digital short course notes will be provided to each participant. Continuing Education Units (CEUs) will be available to interested attendees. An exam valued at 0.6 CEUs will be given at the end of the short course. It is endorsed by IEEE and the International Association for Continuing Education and Training.

PART I – APPLICATIONS OF THE NATURAL SPACE ENVIRONMENT TO HEAVY ION SINGLE EVENT EFFECTS TESTING



Justin Likar of Johns Hopkins University Applied Physics Laboratory will describe the natural space environment with specific practical applications for Heavy Ion Single Event Effects (SEE) testing. The discussion will begin with an overview of the charged particle environments in which all modern space systems operate and include methods for modelling and developing project test requirements. Applications to Heavy Ion SEE testing will be explored, and will consider particle accelerator environments, principles of operation and benefits, limitations and considerations of specific laboratories. Pertinent elements of radiation transport through matter will be discussed with the focus being on practical implementation and methods for determining the sensitive volume (SV). Several illustrative examples of the linear energy transfer (LET) determination will be reviewed, comparing the LET at one (or more) SV in in-flight applications with those achievable using mono-energetic or fragmented Heavy Ion beams; exemplar test articles represent modern, complex systems offering multiple, deep SV and a variety of composition materials requiring high energy Heavy Ion or protons to test. Practical applications for SEE test design and execution will be highlighted throughout.

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PART II – SINGLE EVENT EFFECTS UPSET RATE ANALYSIS FOR DEVICES AND SYSTEMS

The space radiation effects community has developed a number of techniques to predict the single event upset rate of semiconductor devices. While there has been a significant amount of work in this field, in many cases the guidelines presented by different authors are in conflict, or the parameterization of the methods is unclear. In addition, with the advent of more complex, devices, as well as board level testing, and hardening by architecture methods many of the older techniques are not adequate to handle modern technologies.

This course, led by **Dr. David Hansen** of L3Harris, will review the calculation methods for single event upset rates. The methods presented are based on insights gained from on-orbit data and many discuss many of the holes in current rate calculation methodologies.

PART III – RADIATION HARDNESS ASSURANCE IMPLEMENTATIONS IN THE EUROPEAN SPACE AGENCY (ESA) PROJECTS

Cristina Plettner of the European Space Research and Technology Center, Avionics and EEE Division will describe the principles of the radiation hardness assurance (RHA) methodology at ESA, encompassing Total Ionizing Dose (TID), Displacement Damage and Single Event Effects aspects. The presentation will kick off with some lessons learned from the distant past spacecraft anomalies or failures as motivation. Then, a short overview of the specific space environment will be given, with the emphasis of few models of the solar flares. Each mission, depending on its criticality, needs to include and design for a certain class of solar flare. A short overview of ESA missions, cosmic and solar system explorers, will be highlighted. The TID and total non-ionizing dose (TNID) effects will be discussed, with an emphasis on the lot-to-lot variability and how the RHA can mitigate that effectively. The system requirements flow down to subsystem and part level, respectively, will be explained, along with the necessary RHA activities, which need to take place as a function of the specific project phase. Two examples of ESA projects will be focused on: one mission envisaged for the Lagrange L5 point, able to detect a major solar flare and emitting warnings to Earth and a Cube Sat mission aimed at LEO. A comparison between the different RHA implementations will be discussed.

PART IV – RADIATION HARDNESS ASSURANCE THROUGH SYSTEM-LEVEL TESTING FOR COMMERCIAL SPACE

The growing competitiveness and time-to-market pressures in the space industry are reshaping mission assurance practices. Schedule and budget constraints increasingly drive design choices, encouraging exploration of alternative approaches regarding radiation hardness assurance (RHA). Yet, the field remains fragmented and lacks standardization, particularly at higher integration levels. This course, led by **Dr. Andrea Coronetti** of The Exploration Company, introduces the methodology of system-level radiation testing as a practical pathway to address this gap. Participants will learn how to design and conduct meaningful tests of commercial off-the-shelf components and systems and manage black-box scenarios. Special focus will be placed on test planning, beam selection, test execution logic, and common pitfalls to avoid, ensuring interpretable and useful outcomes. By the end, attendees new to RHA will be equipped with the tools to craft a balanced RHA strategy that aligns with schedule, budget, and acceptable risk—while making informed decisions that connect test results to real-world space environments. The course will also showcase the complementary value of test-as-you-fly approaches and verification of radiation effects mitigations that are paramount when using commercial off-the-shelf electronics in space systems.