ESA & CNES Final Presentations : Space Environments and Radiation Effects on EEE components

Monday 06 March 2017 - Thursday 09 March 2017

ESA/ESTEC

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ODI databases maintenance

Upgrade of Open Data Interface (ODI)

D. Heynderickx, DH Consultancy, Leuven, Belgium P. Wintoft, Solar Analytics, SE H. Evans, ESA/ESTEC, Noordwijk, The Netherlands
ODI is a MySQL database framework developed for streamlined ingestion and storage of time series of spacecraft and ground based data.
The latest upgrades of the framework consist of: - functionality for ingesting netCDF data files - support of SPASE metadata - development of a Python native client interface - development of reporting, plotting and status tools - enhancements of the REST interface - upgrade of the Excel client connection - support for new datasets (e.g. DSCOVR)

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Risk assessment of SEE events due to high energy electrons during the JUICE mission

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Single Event Burnout testing of high power schottky diodes

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Re-issue Radiation Characterisation of GaAs power devices in support of European Radiation Hardness

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Comprehensive SEE Component Qualification

This presentation provides a snapshot of the AO8191 TRP activity which involves the comprehensive radiative characterization of 6 components (4 SRAMs, 1 SoC and 1 FPGA) using heavy-ions, high- and low-energy protons and electrons. The test setups and methodologies will be presented as well as initial heavy-ion test results. In one SRAM component, an unusual SEFI failure mode was identified and was investigated in detail using the SPA laser at the CNES, Toulouse.

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Laser Study of SETs in 65nm Bulk Technology

In this presentation, we review current work on SET measurement including on-chip and off-chip techniques. We present test results for SET measurements using the SPA laser at the CNES, Toulouse and the TPA laser at NRL, Washington. Results are presented for SETs in elementary transistors, logic gates as as for complex digital circuits

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High LET radiation effects on DNA in water

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Impact of the detector definition on the Reverse Monte Carlo calculation result

Different types of detectors are used for the TID calculation based on the RMC method: points and volumes. The impact of their location, their dimensions and their shape has been studied taking into account different geometric models with an increasing complexity. The impact depends on the particle environment and on whether the detector is located inside or at the surface of the spacecraft.

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Comparison of TNID calculation methods

Different types of shielding geometry are considered as input for a TNID sector analysis calculation: sphere and slab. TNID calculations using the Reverse Monte Carlo method have also been performed. Analysis of the results allows to make recommendations on the choice of the calculation method based on the complexity of the radiation model.

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Electron SEE- background and current status

A brief overwiew of on-going actions, an example of harmonized R&D.

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Proton direct ionisation

The aim of this study is to investigate the proton direct ionization sensitivity of integrated circuits. This work includes the development of a calculation methodology to assess the direct ionization contribution to the proton SEE rate, the experimental characterization of a 45nm CMOS SRAM-based FPGA under low energy proton, as well as the space environment and calculation parameter impact on the presented methodology.

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TRADCARE: tool for SEE prediction in a radiation environment

TRADCARE (Tool for RADiation Constraints Analysis and Reliability Enhancement) is a tool allowing to predict SEE sensitivity of ASIC during its design phase. It is composed of interchangeable modules for each calculation step, starting from the whole IC design up to the SEE reliability prediction. Application cases will be presented.

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Recoil atom flux calculation in electronic components by Monte Carlo method

The evolution in the microelectronic field leads to the presence of high Z materials close to the sensitive volume of electronic components. Through interactions with highly energetic protons, as is the case in irradiation facilities or in space, recoil atoms can reach these sensitive volumes with high LET. Based on worst case hypotheses, this study showed the presence of high LET recoil particles in the component sensitive area, displayed their LET distribution and located their volume of origin.

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Weakened Cell /stuck bit

Status on the various actions on this subject and latest results

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Flash TID/SEE

This study is based on the work of Kay et al. [2012][2013] and investigates the effects of preliminary multiple write cycles on the radiation hardness of NAND Flash memories. This work includes the experimental characterization of 2 references under TID and heavy ions, and the test data post-treatment and analysis.

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Test facilities

This contribution will focus on recent prospective actions on « new » test facilities, e.g. 6-20 MeV electrons at Carcassonne Hopital, France, CHARM (CERN), new ion cocktail at UCL, etc. . .

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Results from the ICARE-NG detectors onboard SAC-D, JASON 2 and JASON 3 satellites

15 years ago, CNES and ONERA developed a low mass and low power solid state detector named ICARE-NG. This monitor has been flying on the SAC-D and JASON 2 satellites and is currently monitoring the Earth radiation belts onboard JASON-3 spacecraft. We review here the benefits of such a detector (much simpler than a scientific one) providing multi-spacecraft measurements in Low Earth Orbit. In particular, these monitors are a rare opportunity to observe both long term variations in LEO and gradients between orbits.

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Highly energetic electrons in the inner zone

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. First, using NOAA measurements and in particular a proton channel contaminated by E>1.2MeV electrons, the slot filling was studied over solar cycles. Then the found profiles were compared to the CRRES and SAMPEX measurements. Finally, using a simplistic physical model derived from Salammbô, the variations were estimated to understand the long term behavior of the electrons in the inner belt.

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Impact of the consideration of the LEO trapped proton anisotropy on dose calculation at component level

Trapped proton fluxes are anisotropic at Low Earth Orbits (LEO). However, this characteristic is not taken into account in the radiation environment specification of space missions. The goal of the study was to show if such a consideration has an impact on the radiation analysis results. The proton anisotropy was considered and doses were calculated at component level taking into account the orientation and full geometry of the satellite.

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A New Proton Model for Low Altitude High Energy Specification (OPAL)

A model of high energy protons for low altitude (below 800 km) mission specification has been developed at ONERA. This model is based on the long duration NOAA measurement series. We used only the highest omnidirectional channel from SEM on board the old NOAA satellites, and the corresponding channel from SEM-2 on board the new NOAA ones, as the other channels are contaminated by electrons. This gives us a basis for the model for >82 MeV protons. This model was extended in energy by using ICARE-NG measurements on board JASON-2 and HEPAD measurements on board NOAA-6. It gives integrated proton flux in the range 80-600 MeV at altitudes lower than 800 km along the solar cycle.

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A new Global Radiation Earth Environement (GREEN) model

The well known AP8 and AE8 NASA models are commonly used in the industry to specify the radiation belt environment. Unfortunately, there are some limitations in the use of these models, first due to the covered energy range, but also because in some regions of space, there are discrepancies between the predicted average values and the measurements. Therefore, a new model has been developped at ONERA, GREEN (Global Radiation Earth ENvironement) covering a large region of space and energy, from LEO altitudes to GEO and above, and from plasma to relativistic particles and depending of the year of the solar cycle. The aim for the first version of this new model is to correct the AP8 and AE8 models where they are deficient or not defined, by using local models as IGE-2006, Slot model, OZONE, OPAL,...

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Impact of the consideration of AE9/AP9 models on the space radiation environment specification

AE9/AP9 radiation belt models were developed to substitute the commonly used AE8/AP8 models for trapped particles. This study explored the impact of the integration of these new models into environment specifications. Multiple mission types were considered such as LEO, MEO and electrical orbital rising trajectories. Dose and displacement damage calculations were performed using FASTRAD® and applying both Ray Tracing and Reverse Monte Carlo methods on actual satellite radiation models.

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Benchmarking Ionising Space Environment models

In flight feedback data are collected such as displacement damage doses, ionizing doses, cumulated SEUs, and DSNU on Star Tracker on board various space vehicles and are compared to predictions performed with (1) proton measurements performed with spectrometers data on board the same spacecraft if any and (2) protons spectrum predicted by the legacy AP8min model and the AP9 and OPAL models. When an accurate representation of the 3D spacecraft shielding as well as appropriate ground calibrations are considered in the calculations such comparisons provide powerful metrics to investigate engineering model accuracy. To describe $>$ 30 MeV trapped protons fluxes, AP8 min model is found to provide closer predictions to observations than AP9 V1.30.001 (Mean and Perturbed mean).

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Impact of the mission definition parameters on the space radiation environment specification

For the definition of the space radiation environment, missions are usually defined with a standard number of orbits and number of points per orbit. It has been shown that the modification of these parameters can induce differences on the results. The purpose of this study was to determine the impact of the definition of the mission parameters on the fluxes of particles but also on the calculated dose and displacement damage. Six representative orbits were selected but also six cases of electrical orbital rising trajectories were studied. The results allow to make recommendations for each mission type.

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OMERE space radiation environment and effects tool: new developments and new interface

OMERE is a freely distributed tool allowing to perform radiation environment and effects calculations (TID, TNID, SEE) for space missions. OMERE is developed by the engineering department of TRAD with the support from the CNES and it is used by engineers from the private and public sector all over world. The new developments and new interface of the latest OMERE version will be presented.

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Two new ESA projects for radiation belt modelling

New ESA Projects of Radiation Belt Modelling
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Two contracts on radiation belt modelling have been initiated by ESA recently:
VALIRENE is a two year project (ESA Contract No 4000117974/16/NL/LF) to: 1) perform a detailed evaluation of the IRENE models against in situ datasets and other radiation environment models (including ECSS); 2) consolidate and (cross-) calibrate in situ datasets; 3) perform a detailed evaluation and comparison of the UNILIB and IRBEM libraries; 4) develop a toolkit to facilitate model validation activities.
European space industry will be briefed and consulted throughout the activity.
RENELLA - Radiation Environment at Extremely Low Latitude and Altitude (ESA Contract No 4000118058/16/NL/LF/hh): 1) XIPE environment specification validation; 2) dataset selection, acquisition and cross calibration; 3) development of algorithms of flux spectra propagation to lower altitudes; 4) development of a Low Altitude Radiation Belt (LARB) Model.
Both projects started very recently. As such, no results are available yet, and the current presentation aims at announcing the activity to the radiation belt community and to foster collaboration.

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In-flight data from POLAR

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Data assimilation technique applied to electron Earth radiation belts

An Ensemble Kalman filter combined with the Salammbô 3D tool has been used to produce a re-analysis data base of the electron radiation belt from September 2012 to end of 2015. RBSP-A&B/MagEis data, GOES-13/MagEd and GOES-13/SEM data were ingested by the system. So far only omni-directional fluxes have been considered in this study. The time resolution of the re-analysis data base is 10 minutes and covers electron energies above 300 keV. The results obtained are compared/validated against INTEGRAL/SREM data. Performance of the data assimilation tool will be discussed as well as ways of improvement for the future.

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Introduction to "CNES Radiation Effects on EEE components" Session

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_____schedule updated to include 20min delay