Space environment and Effects Final Presentation Days

06-07 March 2017, ESTEC

Véronique Ferlet-Cavrois, TEC-EES

Programme

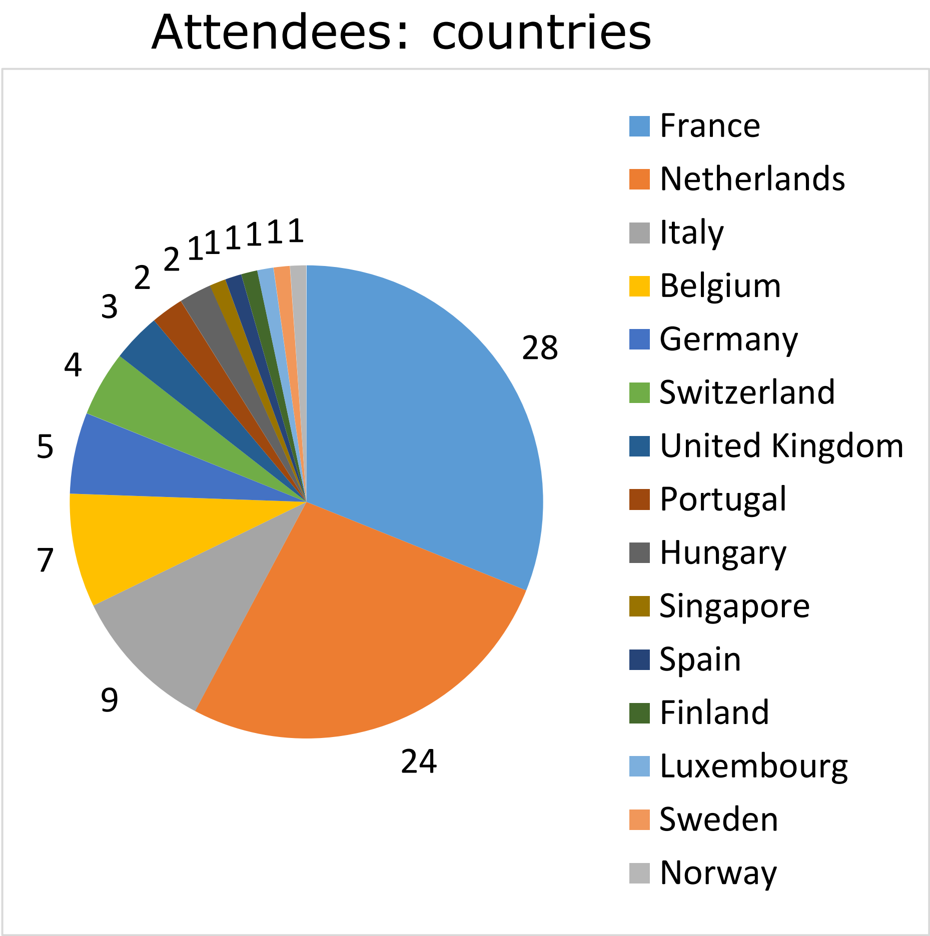
	Monday 6th	Speaker
09:45	Introduction & Executive summary	Véronique Ferlet-Cavrois
10:30	ESABASE2: Overview, Maintenance and Distribution Summary and Recent Developments	Karl Dietrich Bunte
11:40	Space debris from spacecraft degradation products	Paulo Gordo
12:20	Multi-Needle Langmuir Probe (M-NLP) development	Tore André Bekkeng
12:40	In-flight data from POLAR	Hualin Xiao
14:00	Dust electrostatic charging, transport and contamination model for Lunar Lander and human exploration missions	Benjamin Ruard
14:30	Numerical simulations of Solar Orbiter at its perihelion: spacecraft charging, effects on RPW and SWA-EAS instruments	Stanislas Guillemant
15:00	ODI databases maintenance	Daniel Heynderickx
16:00	PAMELA Data Exploitation	Alessandro Bruno
17:00	Two new ESA projects for radiation belt modelling	Daniel Heynderickx

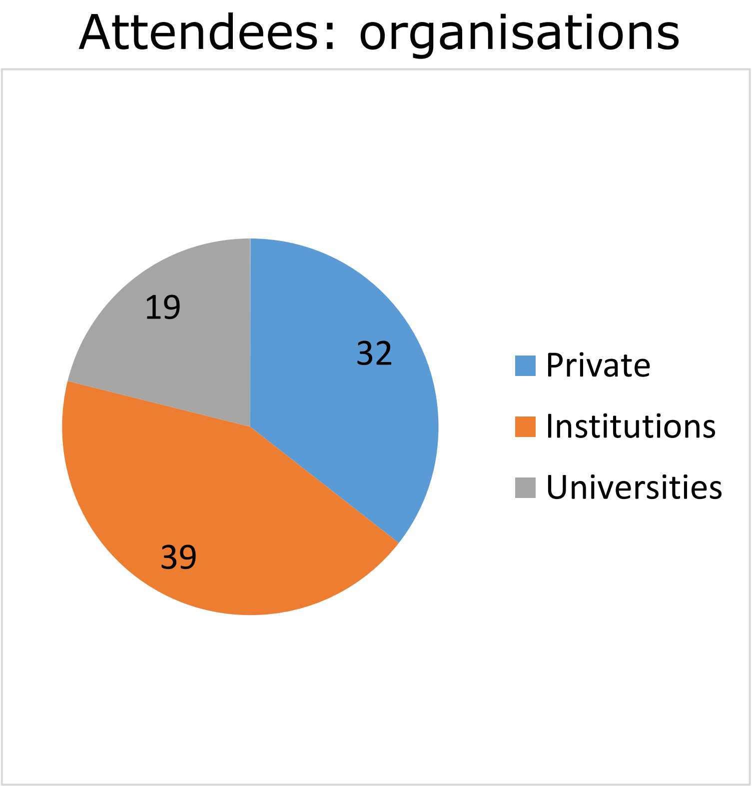
	Tuesday 7th	Speaker
09:20	SSA programme update	Juha-Pekka Luntama
09:40	SSA Space Weather Elements Radiation Expert Service Centre overview and coordination with TEC Space Environments and Effects activities	Alexi Glover
10:10	High LET radiation effects on DNA in water	Christian Schwarz
10:30	Non-Ionsing Energy Loss (NIEL) calculation software and verification	Pier Giorgio Rancoita
11:20	Recent vulnerability and hardening studies of optical systems, fibers and fiber sensors at high radiation doses	Sylvain Girard

Instrument
Data
Models
Tools

Statistics - attendance

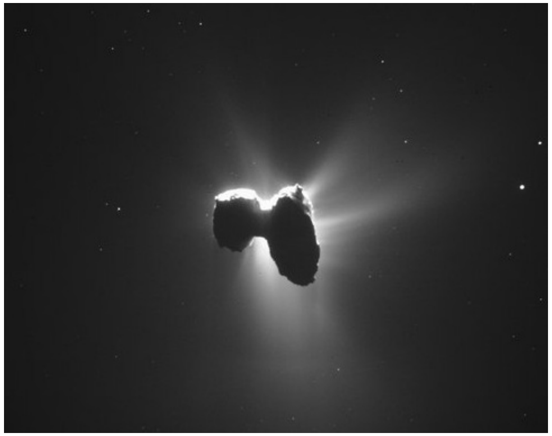
90 registered
Several webex connections
And about 25 ESA





Context

- Space Environments and Effects:
  - Project Support
  - R&D to develop support tools & Investigate emerging issues
- Project Contexts
  - Science missions:
    - demanding locations;
    - challenging payload requirements;
  - EO: very complex satellites;
    - proton SEEs; space debris;
  - GNSS: very "hot" environment;
    - dose & internal/surface charging;
  - GEO/EPOR(AES)/constellations/commercial;
    - low cost, long life; belt transits; poorly known locations;
    - doses, charging, SEEs, SA degradation…
  - Exploration – robotic/human;
    - complex environments (e.g. dust); the radiation "show stopper"?
  - SSA, SWE and NEO



TRP and CTP activities in the domain

Ref.	Contract	K&eurc	Title	Status	T.O.
T704-403EE;	4000113047,	250	WP2014 - Space debris from spacecraft degradation products (PTRP)	Completing	Millinger, M.
T204-046EE;	4000108668,	500	Collaborative iterative radiation shielding optimisation system (CIRSOS)	Running	SANTIN, G.
T304-402EE;	4000112525,	400	WP2014 - Testing of innovative materials for passive radiation shielding for Humar	Running	SANTIN, G.
T204-045EE;	4000107249,	250	Meteoroid environment for the Jovian system (new activity)	Running	Millinger, M.
T504-311EE;	4000110640,	200	WP2013 - AlphaSat TDP-8 MFS Particle Spectrometer Data Analysis (PTRP)	Running	EVANS, H.
T204-111EE;	4000109999,	300	Charging Tools for JUICE	Running	Rodgers, D.
T204-119EE;	4000118058,	300	WP2016 - Radiation environment at extremely low altitude and latitude (PTRP)	Running	EVANS, H.
T904-003EE;	4000114513,	300	Enhanced interplanetary meteoroid population model	Running	Millinger, M.
T504-303EE;	4000111684,	200	WP2011 - GEO telecoms radiation tools efficiency improvement with methods and	Running	SANTIN, G.
T204-116EE;	4000112670,	368	WP2014 - Three dimensional low-voltage silicon detectors (PTRP)	Running	Daly, E.
T204-120EE;	4000119541,	598	WP2016 - Focussing of Micrometeoroids in X-ray optics (PTRP)	Running	Millinger, M.
T704-402EE;	4000116103,	300	WP2015 - Improved modelling of electrical thruster induced plasma plume interac	Running	CIPRIANI, F.
T304-401EE;	4000119598,	400	WP2015 - Highly Miniaturised ASIC Radiation Detector (PTRP)	Running	Nieminen, P.
T604-401EE;	4000119253,	200	WP2014 - Data Exploitation of new Galileo Environmental Monitoring Units (EMUs)	Running	Rodgers, D.
T704-401EE;	4000117974,	300	WP2014 - Radiation Belt Model Development and Validation (PTRP)	Running	EVANS, H.
EE303;	4200022766,	40	CCN 4 Highly Miniaturised Active MEO Radiation Monitor Phase A-B	Running	Daly, E.
T704-302EE;	4000107025,	250	WP2012 - Improvement of energetic solar heavy ion environment models	Running	Jiggens, P.
T704-301EE;	4000000000,	400	WP2011 - Multi-scale high accuracy engineering tools for single event effects analy	In preparation	SANTIN, G.
T704-501EE;	4000000000,	350	WP2016 - Prototype Passive Field-Effect Electron Emitter for Charging Alleviation (	In preparation	Rodgers, D.
T704-502EE;	4000000000,	300	WP2016 - Solar Particle Radiation Advanced Warning System (SAWS) (PTRP)	In preparation	Jiggens, P.
T204-117EE;	4000000000,	600	RE-ISSUE WP2016 - Experimental evaluation of ATHENA charged particle backgrour	In preparation	Nieminen, P.
T204-118EE;	4000000000,	250	WP2016 - Modelling of Electrostatic Environment of Ion Emitting Spacecraft (PTRP)	In preparation	CIPRIANI, F.
CTP;	4000112863,	500	HERMES: Hellenic Evolution of Radiation data processing and Modelling of the Env	Running	Jiggens, P.
CTP;	4000116655,	600	Arembes: ATHENA Radiation Environment Models and X-Ray Background Effects Si	Running	Nieminen, P.
C204-116EE	new	500	G4G: Geant4-based Particle Simulation Facility for Future Science Mission Support	In preparation	VUOLO, M.

GSTP and ARTES activities in the domain

Ref.	Contract	K&eur	Title	Status	T.O.
G637-001TFe;	4000117620,	150	Cosmic Radiation and Magnetic Field (RadMag) Instrument Development Study	Running	SANTIN, G.
G533-010EE;	4000104812,	500	Next Generation Space Environment Information System	Running	EVANS, H.
G619-003EE;	4000117944,	150	Maintenance and Update of the European Mars Climate Database	Running	CIPRIANI, F.
G618-011EE;	4000115696,	1500	3D Energetic Electron Spectrometer Phases C1	Running	Rodgers, D.
G618-009EE;	4000119365,	700	Prototype Compact Wide Angle Coronagraph this contract replaces C4000116072	Running	Jiggens, P.
G617-191EE;	4000116146,	390	Non-Ionsing Energy Loss (NIEL) calculation software and verification	Running	Nieminen, P.
G618-009EE;	4000116072,	700	Prototype Compact Wide Angle Coronagraph	Running	Jiggens, P.
OPS-BP CCN3;	4000109398,	600	Multi-Needle Langmuir Probe (M-NLP) Development CCN3	Running	Rodgers, D.
G523-006EE2;	4000119931,	151	Next Generation Radiation Monitor (NGRM) THIS CONTRACT REPLACES C40001043	Running	Nieminen, P.
G533-009EE2;	4000107325,	149	High Performance Distributed Solar Imaging and Processing Prototype CCN2	In preparatio	Jiggens, P.
ARTES AT	new	500	Electrostatic Discharge Monitor	In preparatio	Rodgers, D.
ARTES AT	new	500	Low Cost Miniaturised Radiation Monitor	In preparatio	Nieminen, P.

Others: NPI and NMS

Ref.	Contract #	K&eur	Title	Status	T.O.
NPI 434-2015	4000115379/	90	Single Event Radiation Effects In Hardened and State-of-the-art Components for Space and Hig	Running	Daly, E.
NMH17-18;	Hungary.TF;	99	Electromagnetic monitoring of the Geospace environment for Space Weather/SSA purposes by	In preparation	Jiggens, P.
NMH16-09 H	Estonia.TF;	97	Infrared spectral analysis of meteorite powder to support the development and optimization c	In preparation	CIPRIANI, F.

Corporate Infrastructure

Programm	Ref.	Contract	K&eur	Title	Status	T.O.
INFRA;	E.SUP.T 2013;	4200016852	150	CCN10 - Multiyear maintenance/distrib. ESABASE2/Debris (2014/20	Completing	Millinger, M.
INFRA;	ENG SUP TOOL	5501091376	19	P1 NOVICE Radiation transport tool	Running	Nieminen, P
TAS;	TAS 2014-12;	4000111777	50	SREM and REM data consolidation	Running	EVANS, H.
INFRA;	EngST 2015D;	4200016852	135	CCN13- ESABASE	Running	Millinger, M.
TAS;	TAS 2015-07;	4000114116	49	Updating SOLPENCO2 and New Analysis on Downstream Fluence	Running	Jiggens, P.
ITI;	B00016923;	4000118162	150	MultiScreen Radiation Shield (MuSRAS)	Running	VUOLO, M.
INFRA;	EngST 2016;	4000108668	50	CCN1/ Collaborative Iterative Radiation Shielding Optimisation Syst	Running	SANTIN, G.
INFRA;	maint 2014;	4000111858	100	EXPRO / Geant4 toolkit multiyear maintenance	Running	SANTIN, G.
INFRA;	EngST 2015;	4000115930	35	ODI integration in SEPEM	Running	Jiggens, P.
INFRA;	EngST 2016;	4000107025	30	CCN 1 WP2012 - Improvement of energetic solar heavy ion environ	Running	Jiggens, P.
INFRA;	EngST 2014;	4000112669	50	EXPRO-Spenvis implementation of interplanetary Electron model	Running	Rodgers, D.
INFRA;	EngST 2016;	4000117649	25	ODI databases maintenance	Running	EVANS, H.
INFRA;	EngST 2017;	5000000000	25	MFS electron calibration	Planned	EVANS, H.
INFRA;	EngST 2017;	4000000000	30	GRAS calibration on small sensitive volume	Planned	Ferlet-Cavro
INFRA;	MAINT 2017;	4000111777	15	CCN1: SREM data processing	Planned	EVANS, H.
INFRA;	EngST 2017;	4000000000	25	GTREFF : Fastrad enhancement	Planned	SANTIN, G.
INFRA;	Maint 2017;	4200016852	210	CCN14: ESABASE2/Debris tool multi-year maintenance & upgrade	Planned	Millinger, M.
INFRA;	EngST 2017;	4000104812	25	CCN1: UNILIB development and updates	Planned	EVANS, H.
INFRA;	EngST 2017;	4000000000	30	SPIS tool for ESA missions - License EDGE Artenum	Planned	SANTIN, G.
INFRA;	Maint 2017;	4000117649	25	CCN1: ODI databases maintenance	Planned	EVANS, H.

SUMMARY OF PRESENTATIONS

- Status reports
- Final presentations
- Invited talks

ESABASE2 Extension

CCN13 to the ESA Contract "PC Version of Debris Impact Analysis Tool"

Also addressed: ESABASE2 Maintenance and Distribution (CCN10)

Funding programme: INFRA

Contract value:

- ESABASE2 Maintenance & Distribution 2014 – 2017: 150 k€
- ESABASE2/Debris Extension: 135 k€

Start and end dates:

- ESABASE2 Maintenance & Distribution: 2014-03-01 to 2017-02-28
- ESABASE2/Debris Extension: 2015-12-01 to 2017-03-31

Team: etamax space

- Kalle Bunte, Anatoli Miller, Matthias Zaake,
  Jewel Pervez, Florian Großmann-Ruh

MEMBER OF FEV GROUP

TO: Mark Millinger, Gerhard Drolshagen

Will be presented:
Mon. 06 March 10:30 – 11:10

Activity – Background & Objectives

Background:

- ESABASE2/Debris is used for meteoroid and orbital debris (M/OD) risk and damage assessments by all European LSIs and several further companies, research institutes and universities
- Implementation of new space debris and meteoroid environment models required
  - to address risk analysis requirements
  - to provide access to the latest findings of M/OD research
- Consideration of frequent user requests:
  - allow to run ESABASE2 in batch mode
  - allow scripting of important analysis parameters
  - make ESABASE2 available under Linux OS

Objectives:

- Implementation of NASA's latest meteoroid environment model MEMr2
- Provision of batch/scripting capabilities for ESABASE2/Debris
- Provision of a Linux version of ESABASE2/Debris

Activity – Summary of Results

MEMr2 implementation:

- method similar to that already used for MEMr1 and LunarMEM
- MEMr2 available for analysis of LEO, MEO, GEO, HEO missions, moon and moon transfer trajectories, L1/L2 missions
- excellent validation results

Batch/scripting capability:

- user survey conducted → requirements
- batch mode with integrated scripting capability developed
- user friendly input panels (GUI)

Linux version:

- target operating system: Ubuntu 14.04LTS
- meteoroid and space debris environment models are made available via WINE, in case no Linux version is available

Space Debris from Spacecraft Degradation Products

Funding programme TRP ; ESA Contract no. 4000113047/14/NL/LF

Contract value (250K€)

Start January 2015 and end March 2017

ESA Contract no: 4000113047/14/NL/LF

Entities involved:

FCUL (Faculty of sciences University of Lisbon)

ONERA (Office National d'Etudes et de Recherches Aérospatiales)

TUB (Technische Universität Braunschweig)

Key persons:

Paulo Gordo (main person from FCUL) email: prgordo@fc.ul.pt

Sophie Duzellier (main person from ONERA) email: Sophie.Duzellier@onera.fr

Andre Horstmann (main person from TUB) email: andre.horstmann@tu-braunschweig.de

Technical officer:

Mark Millinger email: Mark.Millinger@esa.int

Will be presented:
Mon. 06 March 11:40 – 12:20

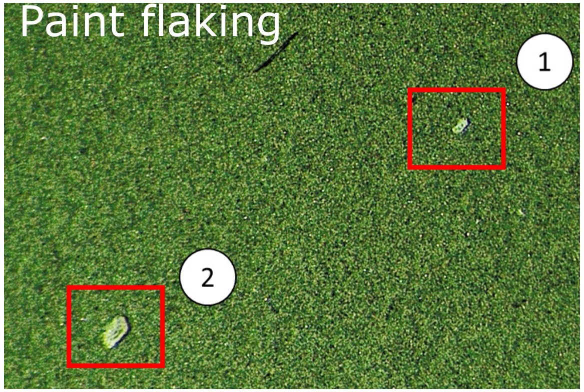
Activity – Background & Objectives

The project aim was to study the degradation and generation of debris of external spacecraft materials when exposed to long term space environment (for LEO and GEO conditions). The study consisted in the following major tasks:

- Identification of the most relevant space environment conditions for GEO and for LEO most populated orbits.
- Survey on relevant (i.e. most representative; most used) external spacecraft materials.
- LEO and GEO space materials environmental testing, for 20 years of GEO and 9.7 years LEO (800 km ± 75 degrees) simulated space environment.
- MASTER 2009 improvement with the test results of the environmental testing.

Activity – Summary of Results

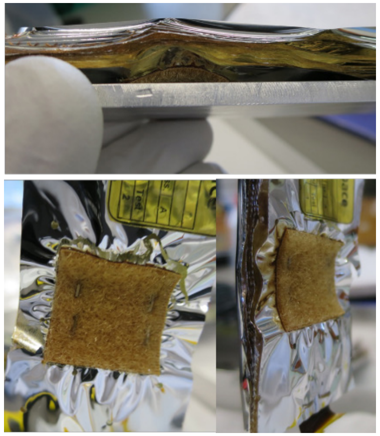
Observed in LEO material tests:



Observed in GEO material test:

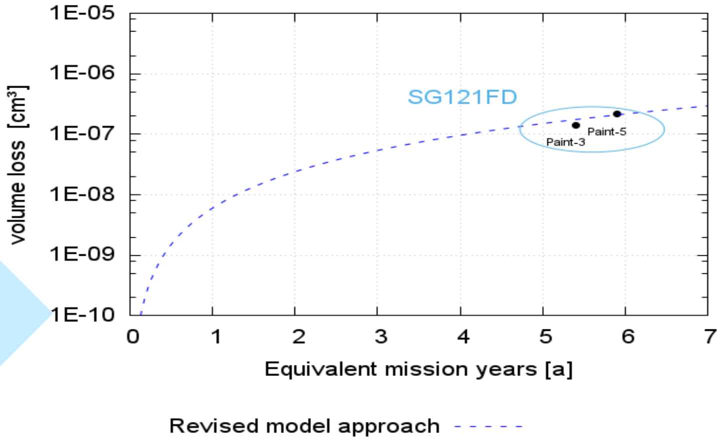
Debris of MLI internal layers

Velcro degradation



Master 2009 improvements

- Revision of mass loss calibration (LEO paints)



- Debris MLI size distribution revision (GEO)

Other observations:

- Discover that Velcro's severe degradation

Multi-Needle Langmuir Probe (m-NLP)

Rapid measurement of electron density (~7kHz, ~1m) and spacecraft potential in LEO plasmas for space weather and science applications.

CCN3 is redesigning the boom and deployment system after problems with the original design, in addition to the implementation of a SW bootloader.

Funding programme : GSTP

Contract value 2.697 M€, (incl. CCN1, CCN2 and CCN3)

Start and end dates: November 2013 to March 2018

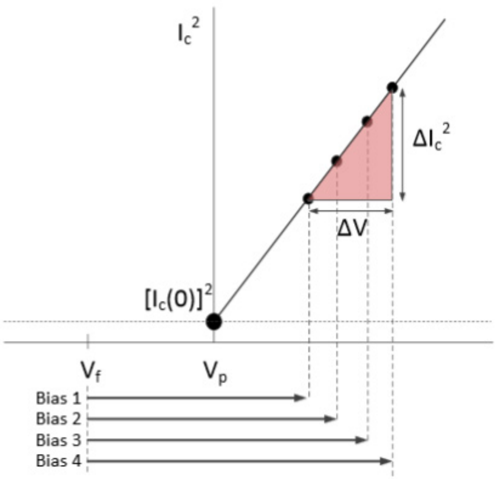
Team:

Eidsvoll Electronics AS (N)

Prototech (N)

University of Oslo (N)

TO: David Rodgers TEC-EPS (replacing Alain Hilgers)



Will be presented:
Mon. 6 March 12:20 – 12:40

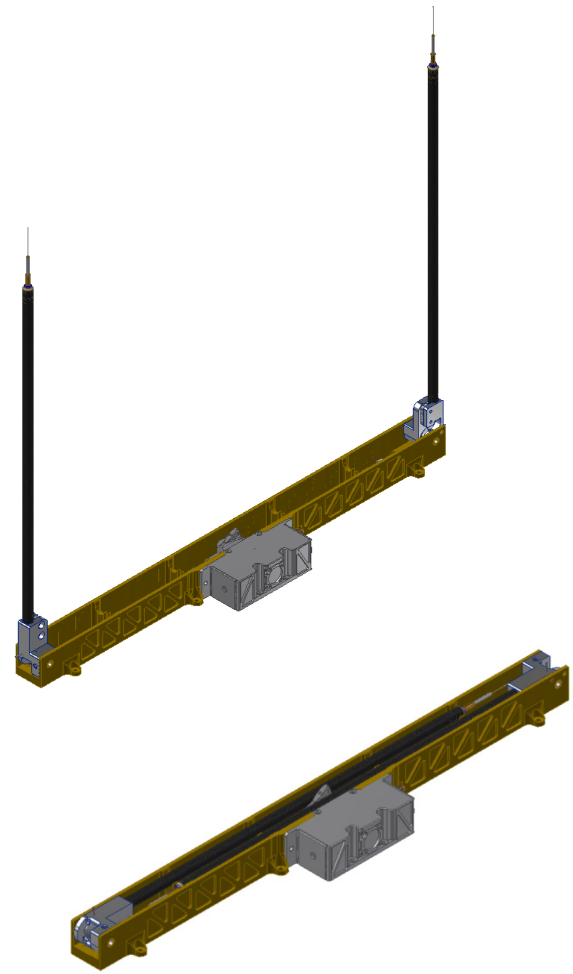
Activity – Status Update

Currently the m-NLP development project is in the manufacturing phase from the CCN3 updates / changes. Detailed Design Review of CCN3 changes was approval 26 January 2016.

Expected hardware delivery from subcontractors after manufacturing scheduled for late Q2 / early Q3 2017.

Qualification testing of design changes to be carried out Q3 / Q4 2017.

Final delivery of qualified EQM (Electronics Unit and Boom System) scheduled for late Q4 2017 or early Q1 2018.



Dust electrostatic charging, transport and contamination for Lunar Lander and Human exploration missions – SPIS Dust

ESA Contract: 40004107327/12/NL/AK

Funding programme: TRP

Contract value: 334 974 Euro   including CCN1

Start and end dates: December 2012 to September 2016

Technical officers: Fabrice Cipriani, David Rodgers

Study Team :

- Prime: ONERA, France
  Jean-Charles Matéo Vélez
  Pierre Sarrailh
  Sébastien Hess
- Partner: Artenum SARL, France
  Benjamin Jeanty-Ruard
  Julien Forest

Will be presented:
Mon. 06 March 14:00 – 14:30

Activity – Background & Objectives

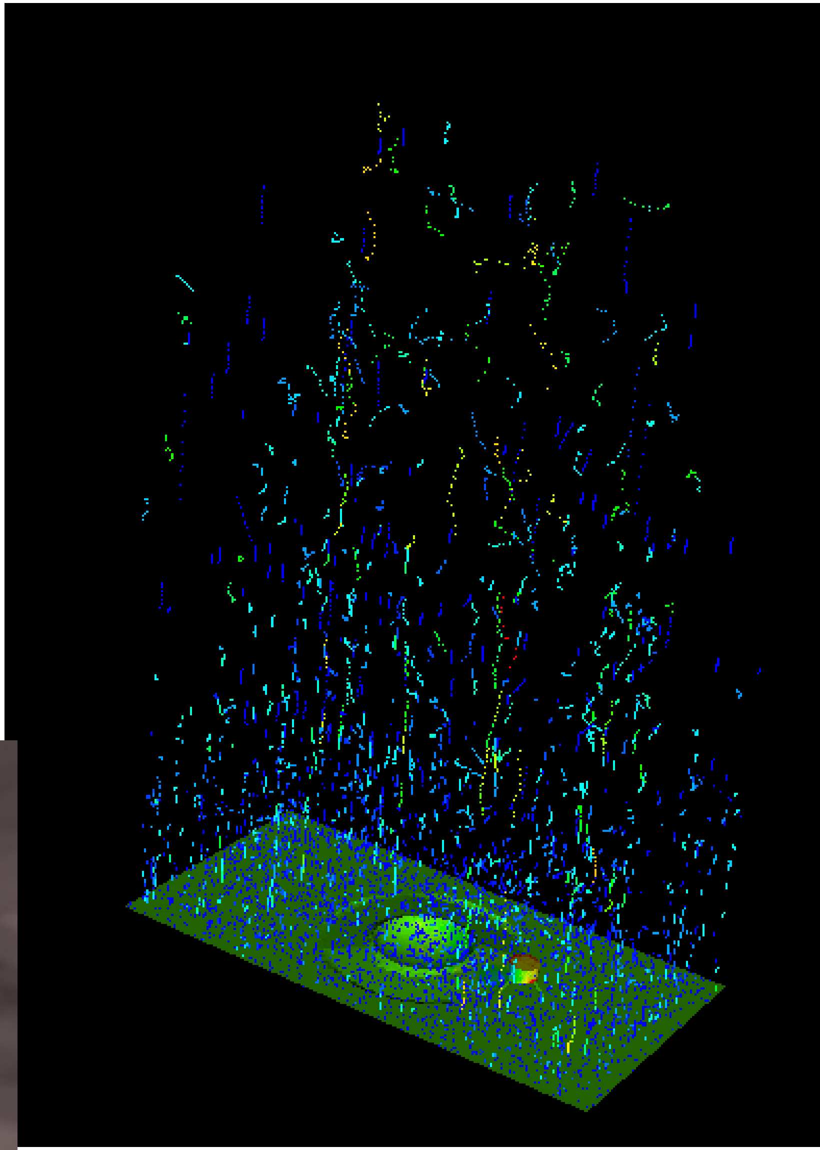
In the frame of the core contract (already presented in passed FPDs), make SPIS able to model the dust electrostatic charging, transport and contamination especially for lunar lander and human exploration missions.

The key objectives of the present CCN were consolidating the first results of the core contract by:

- Develop an automatic landing feature in pre-processing, including an improved lander gear / ground merging algorithm
- Introduce a rich shadowing function to visualise in a most realistic manner the whole modelled system (lander + ground + Sun).
- Improvement of SPIS-instruments for a better analysis (copy, import…)
- Improve kriging function for thinner ground topography reconstruction from digital terrain model
- Intensive validation of newly implemented models through new non-regressions tests
- New types of instruments for improved dust particles visualisation
- Merge the developments from this activity with the trunk of SPIS, package and submission to the SPINE community.

Activity – Summary of Results

- A new stable version of SPIS dedicated to dusty plasma is fully operational and should be soon available through the SPINE website.
- New implemented models for the dust electro-static charging, transport and redeposition.
- Good agreement between simulations and observations
- Realistic and thinner capability of topographic modelling of the ground surface
- Rich pre-processing tools for an user-friendly handling of the landing phase.
- Dedicated visualization tools for charged dusts.



Numerical simulations of Solar Orbiter at its perihelion (0.28 AU): spacecraft charging, effects on RPW and SWA-EAS instruments

Ref.: *Assessment of Solar Orbiter surface charging impact on plasma instruments*

ID: *ESA RFP/NC/IPL-PSS/JK/jk/419-2015*

Start and end dates: 14.10.2015 – 31.05.2017

Team: **Stanislas Guillemant**[1,2], **M. Maksimovic**[2], **F. Pantellini**[2], **L. Lamy**[2] and **A. Hilgers**[3], **F. Cipriani**[3], **C.-J. Owen**[4]

1. IRAP, 9, avenue du Colonel Roche, BP 44346, 31028 Toulouse, France
2. LESIA/CNRS, Observatoire de Paris, Section de Meudon, 5 place Jules Janssen, 92195 MEUDON, France
3. ESA Headquarters Paris and ESTEC Noordwijk
4. MSSL/UCL, Dorking, Surrey, United Kingdom

Will be presented:
Mon. 6 March 14:30 – 15:00

Activity – Status Update

- ✓ ***Context***: **Solar Orbiter** spacecraft at its perihelion will be submitted to hot and dense environment which will generate high SC electrostatic charging and secondary particle emission
- ✓ ***Goal***: estimate those SC/plasma interaction effects on 2 specific scientific instruments: **RPW** and **SWA-EAS**
- ✓ ***Approach***: numerical simulations performed with **SPIS** software, **modelling SC and instruments** immersed in this environment + **analyse of system behaviour** thanks to **advanced post-processing methods**
- ✓ ***Results***:
  - ✓ **Solar Orbiter + RPW**: estimations of **charging levels**, **effective lengths** and **biasing currents** for various environments
  - ✓ **Solar Orbiter + RPW + EAS**: estimations of disturbed **energy distribution functions of electrons**, **pollution** rates due to **secondary and photoelectrons** at low energy levels, with and without **potential EAS baffle**

ODI database maintenance

Funding programme: INFRA

Contract value: 25 kEUR

Start and end dates: Jul 2016 — Jun 2017

Team (prime and contractors)

D. Heynderickx (DH Consultancy), P. Wintoft (Solar Analytics)

Name of the TO in TEC-EPS: H. Evans

Will be presented:
Mon. 06 March 15:00 – 15:30

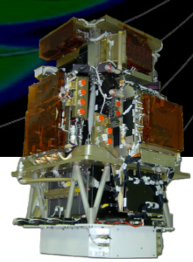
Activity – Status

- The ODI system was extended with:
  - 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)

- Currently in maintenance phase

PAMELA Data Exploitation

- Characterization of the high-energy trapped proton fluxes in the near-Earth radiation environment based on the observations of the PAMELA space mission
- Funding programme: RFP IPL-PTE/HK/mo/471.2014
- Contract value: 50k€
- Start and end dates: September 2014, October 2016
- Team: Alessandro Bruno, F. Cafagna
- INFN (Italian Institute for Nuclear Physics), Sezione di Bari, Italy
- TO in TEC-EES: H. Evans, A. Menicucci



INFN Istituto Nazionale di Fisica Nucleare

PaMeLa a Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics

Will be presented:
Mon. 6 March 16:00 – 17:00

Background & Objectives

- Despite the significant improvements made in the last decades, the modeling of the near-Earth proton radiation environment is still incomplete, with largest uncertainties affecting the description of the high-energy (>50 MeV) fluxes in the inner zone and the South Atlantic Anomaly (SAA).

- These are exactly the observational objectives that can be addressed by the PAMELA experiment at LEO

- The work is aimed to provide a comprehensive characterization (energy spectra, angular & spatial distributions, etc.) of the high-energy (>70 MeV) geomagnetically trapped proton fluxes in the SAA, and a preliminary comparison with the current empirical models

Summary of Results

- The low-altitude proton populations were analyzed and classified into geomagnetically trapped and albedo (quasi-trapped, un-trapped) components.

- Flux anisotropies were derived by properly taking into account the instrument directional response as a function of the spacecraft orientation with respect to the local geomagnetic field.

- Maps of high-energy (>70 MeV) proton fluxes were provided, by using both geographical and adiabatic invariants coordinates.

- Results were compared with the predictions of the theoretical and empirical proton models available in the same energetic region (AP8, PSB-97, AP9).

Two ESA projects for radiation belt modelling (VALIRENE & RENELLA)

Funding programme: TRP

Contract value: 600 kEUR

Start and end dates: Sep 2017 — Aug 2019

Team (prime and contractors)

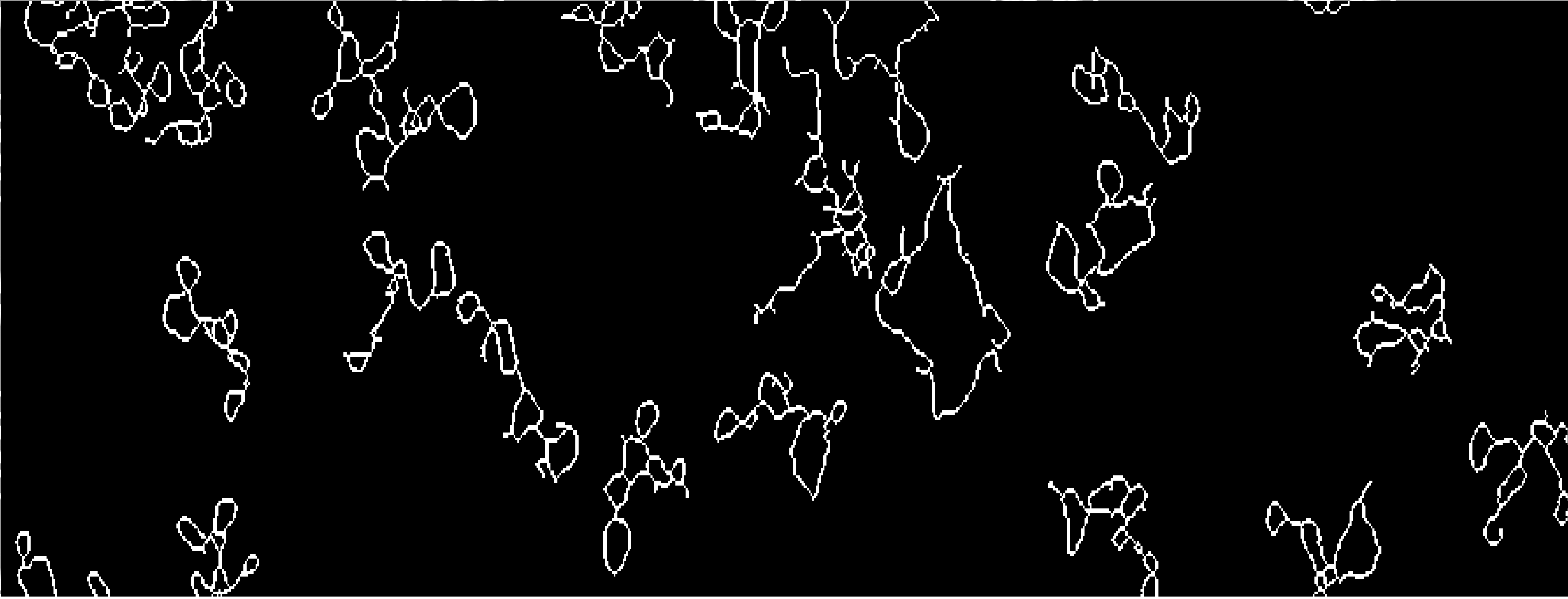
D. Heynderickx (DH Consultancy), F. Lei (RadMod Research), P. Truscott (Kallisto Consultancy), I.A. Daglis (IASA), I. Sandberg, C. Papadimitriou, S.A. Giamini (IASA/SPARC), M. Cyamukungu, S. Borisov (UCL/CSR), N. Messios, E. De Donder (RBISA)

Name of the TO in TEC-EES: H. Evans, P. Jiggens, D. Rodgers

Will be presented:
Mon. 06 March 17:00 – 17:20

Activity – Objectives

- VALIRENE
  - Detailed evaluation of the AP9/AE9/SPM (IRENE) models
  - Consolidation and calibration of in situ datasets
  - Ingestion in ODI database
  - Investigation of instrument calibration and cross calibration
  - Evaluation and enhancement of UNILIB/IRBEM
  - Model validation toolkit
  - Involvement of European industry
- RENELLA
  - XIPE (proposed X-ray mission) environment specification validation
  - Selection of primary datasets, ingestion in ODI database, cross-calibration
  - Definition of new LARB (Low Altitude Radiation Belt) proton model
  - Reconstruct PSB97 model for fast revision of XIPE radiation environment
  - Develop methodology for detailed new model development
  - Algorithms for propagation of fluxes to lower altitudes, uni<>omni, differential<>integral, East-West asymmetry
  - Secular change in IGRF, solar cycle
  - PLANETOCOSMICS for modelling support and validation
  - Production of new LARB model and implementation in SPENVIS



HIGH LET RADIATION EFFECTS ON DNA IN WATER

K. Pachnerova Brabcova
L. Sihver
E. Ukraintsev
M. Davidkova
Ch. Schwarz

Will be presented:
Tues. 07 March 10:10

MOTIVATION, GOAL, APPROACH & 1ST RESULTS

- Clustered DNA damage is a cell marker of cancer risk
- Quantitative experimental characterization of heavy ions induced clustered damage of DNA in water as a basis for computational models.
- Using agarose gel electrophoresis and Atomic Force Microscopy (AFM) in order to extract a detailed analysis of the DNA damage.
- A size distribution of DNA fragments is extracted.

Non-Ionising Energy Loss (NIEL) Calculation Software and Verification

Key people involved:

R. Campesato, M. Casale, M. Gervasi, E. Gombia, E. Greco, A. Kingma, P.G. Rancoita, D. Rozza, M. Tacconi

Institutions/Company: Univ. and INFN Milano-Bicocca, IMEM-CNR, CESI

General Support Technology Programme (GSTP)
Contract No.: 4000116146/16/NL/HK
Total Amount of Contract: € 390,000

Project Manager: Massimo Gervasi
ESA Technical Officer: Petteri Nieminem
Contract Duration: 17-12-2015 - December 2017

Will be presented:
Tues. 07 March 10:30

Background and First Year Objectives

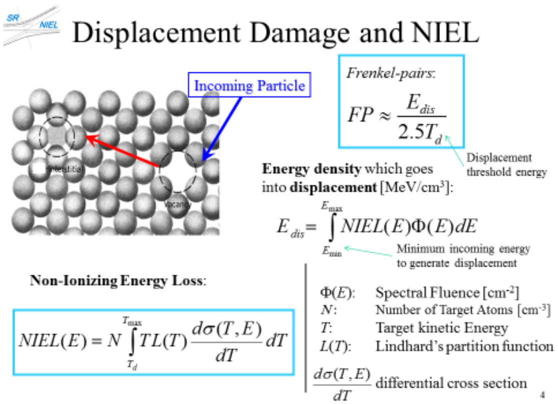
Displacement Damage in space environment is mostly generated by interactions of electrons, protons and ions.

SR (screened relativistic) – NIEL (non-ionizing energy-loss) treatment/framework allows one to detemine the amount of non-ionizing energy deposited by electrons, protons and ions at the energies of space environment.
Moreover, in the sr-niel framework, also neutron damage functions are available to users.

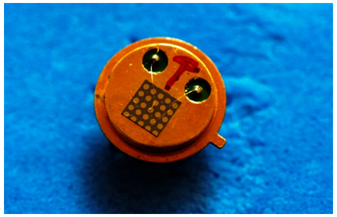
In particular for solar cell application, a crucial parameter to be experimentally found is the so-called displacement threshold energy.

The first year objectives, i.e., are twofold:

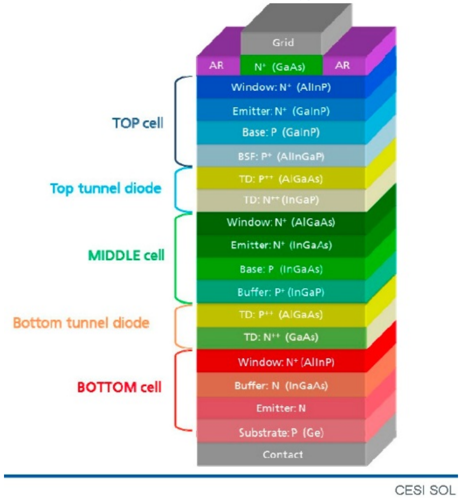
A) Consolidation and Further Development of SR-NIEL model for Implementation into ESA Software Frameworks, Treatment of Neutron and Heavy Ions;
B) Test plan and Experimental Irradiation Test Campaigns of triple junction solar cells in order to investigate the appropriate value of the displacement threshold energy, in particular for GaAs devices.



SR-NIEL implementation



Diodes with MESA technology



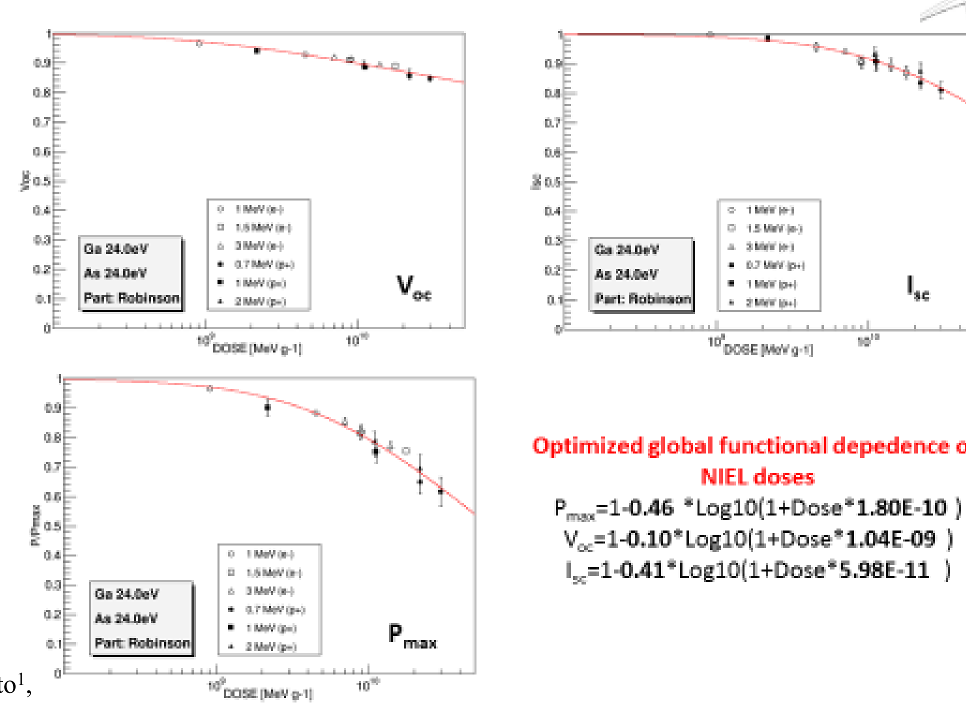
CESI Triple Junction Solar cells

So far achieved results:

- sr-niel framework (for nuclear stopping power and NIEL) is currently treating the interactions on screened nuclear potentials from protons, ions and electrons at low and relativistic energies,
- for any ELEMENT or COMPOUND (by means of Bragg's rule)
- It has currently embedded some relevant NIEL contribution made available in scientific literature
- The usage of the code(s) is (are) possible either via ESA codes (i.e., in SPENVIS, GRAS and is ready for Mulassis), or via GEANT4 or, by accessing to the dedicated website www.sr-niel.org (current version 3.6)
- So far - on the website -, there were more than 120,000 page accesses and more than 5,490 requests for sr-niel calculations (from European, American and Asian users)

- The irradiation campaign took place by end of July with electrons (3 energies) and protons (3 energies).
- Total irradiated samples: 168 3J solar cells and 1J cells from CESI; in addition, about 1400 diodes for DLTS purposes obtained using MESA structure on CESI top and medium 1J solar cells
- Preliminary results based on self-annealed 3J solar cells (i.e., kept on storage for a few weeks), indicated that the displacement threshold energy of 24 eV is well suited to describe the Pmax, Isc and Voc parameters, simultaneously.

GaAs NIEL with Ed=24 eV and Robinson partition function (self-annealing)



Optimized global functional depedence on NIEL doses

P_{max}=1-0.46 *Log10(1+Dose*1.80E-10)

V_{oc}=1-0.10*Log10(1+Dose*1.04E-09)

I_{sc}=1-0.41*Log10(1+Dose*5.98E-11)

Two abstract submitted:

a) To IEEE NSREC

Displacement Damage dose and DLTS Analyses on Triple and Single Junction solar cells irradiated with electrons and protons, Carsten Baur[5], Roberta Campesato[1], Mariacristina Casale[1], Massimo Gervasi [2,3], Enos Gombia [4], Erminio Greco[1], Aldo Kingma[4], P.G. Rancoita[2], Davide Rozza[2], Mauro Tacconi[2,3]

b) To IEEE PVSEC

NIEL DOSE Analysis on Triple Junction cells 30% efficient and related single junctions, Roberta Campesato 1, Erminio Greco1, , Mariacristina Casale1, Massimo Gervasi 2,3, P.G. Rancoita2, Davide Rozza2, Mauro Tacconi2,3, Enos Gombia 4, Aldo Kingma4, Carsten Baur5

Recent vulnerability and hardening studies of optical systems, fibers and fiber sensors at high radiation doses

esa

Sylvain GIRARD, Université de Saint-Etienne, France

(sponsors: iXBlue Photonics, CNES, AREVA, ANDRA, CEA)

This presentation reviews the radiation effects on optical fibers and fiber sensors.

Our objectives are to develop components and systems optimized for operation in the harsh environments associated with space, high energy physics, fusion or fission-related facilities.

In this talk we focus on our recent achievements regarding the development of radiation hardened optical amplifiers for space applications and fiber-based sensors for the nuclear industry.

UNIVERSITÉ JEAN MONNET SAINT-ÉTIENNE

Will be presented:
Tues. 07 March 11:20 – 12:00