News from ESA-CNES Final Presentation Days 2013

A. Masi

Contents

1–COTS radiation tests

Radiation-Induced Attenuation On Commercial Optical Fibers

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[(a)] *PROMES-CNRS Laboratory, University of Perpignan, France*

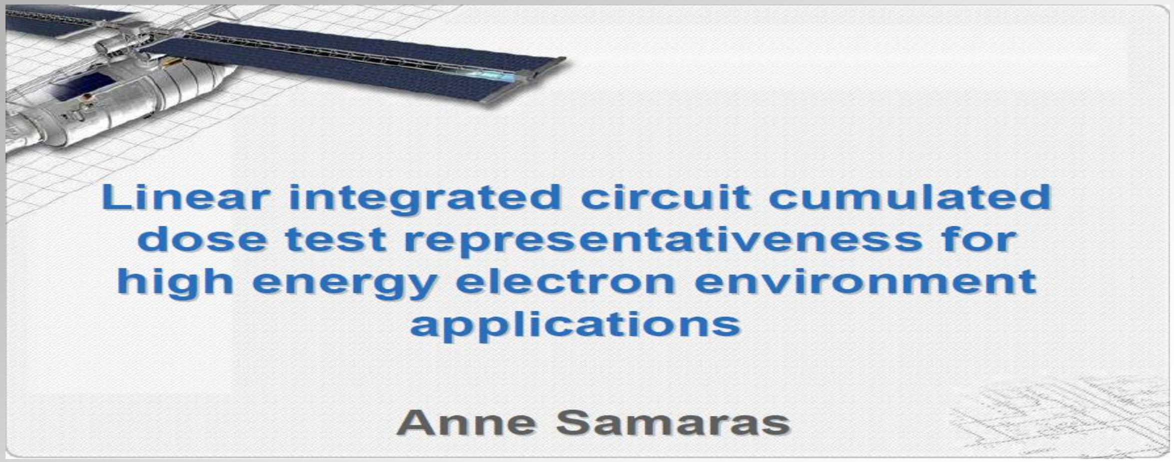
[(b)] *CNES, Quality Assurance Department, Toulouse, France*

- *Development of a test bench to evaluate the RIA (Radiation Induced Attenuation)*
- *Characterized under Gamma radiation a variety of optical fibers. RIA as function of the wavelength and the TID*
- *Results organized in a online Database "RadFiber"*

Conclusions:

- *At certain wavelengths non rad-hard devices can be harder than rad-hard fibers*

1–COTS radiation tests



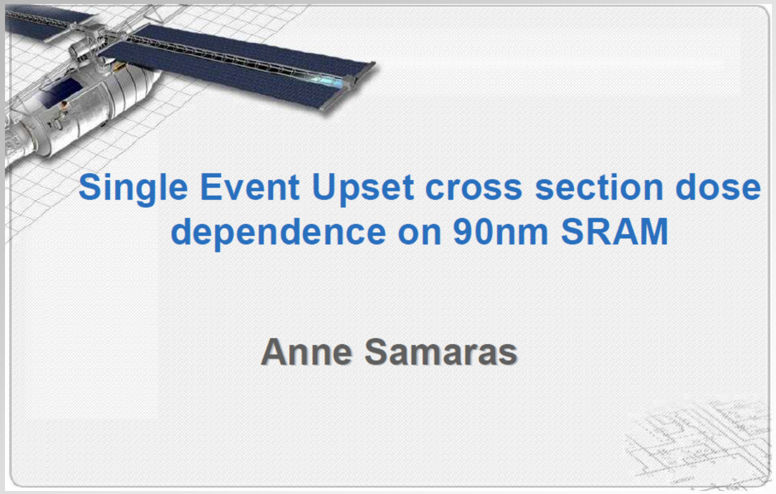
The aim of the study is to evaluate the representativeness of usual cumulated dose test procedures for device qualification used for severe electron space environment applications

Type	Function	Manufacturer	Qual. level
LM139J	Volt. comparator	National Semi.	Commercial
LM111H	Volt. comparator	National Semi.	Commercial
LM117H	Volt. regulator	National Semi.	Commercial
LM124AWG	Op. amplifier	National Semi.	Radhard ELDRS 100 krad

Conclusions:

- *The degradation due to high energy electron is lower, or in the same order of magnitude, as the cumulated drift under 60Co and 1MeV neutrons*
- *In the perspective of qualifying devices for severe electron environment space application, the 60Co low dose rate test combined with neutron irradiation should be conservative for linear devices*

1–COTS radiation tests



- *Synergistic effects between Dose and SEU / SEL on 90 nm Cypress SRAM memories 4 and 16 Mbit*
- *Four electrical parameters are chosen to follow the device degradation due to total dose: Write mode supply current, Read mode supply current, Stand-by supply current, Data retention voltage*

Conclusions:

- *No SEL and stuck bit are observed whatever the deposited dose*
- *SEU error patterns have the same occurrence probability whatever the dose level*
- *No correlation between cross sections and received dose*
- *Burst events and SEU are observed under heavy ions*
- *Complementary 252Cf characterizations show that burst events are ignited in the memory array*

Remarks:

- *On the Cypress 8 Mbit (different package) we observed instead that the memory cross section decreases with the TID*

"Studies of radiation effects in new generations of non-volatile memories"

Alessandro Paccagnella, Simone Gerardin, Marta Bagatin,
DEI, University of Padova, Italy
Véronique Ferlet-Cavrois,
ESA-ESTEC, The Netherlands

Study of the effects of ionizing radiation in state-of-the-art non volatile memories (NVM):

- *NAND Flash memories Micron Technology MT29F32G08CBACA: 25-nm Multi-Level Cell (MLC) - 2 bits per cell,* MT29F16G08ABABA: 34-nm, 16 Gbit Single Level Cell (SLC) *and*
- *New Phase Change Memories (they are not based on charge storage)* Micron Technology *(formerly Numonyx)* P8P: 90-nm PCM

Conclusions:

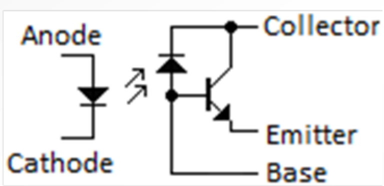
- *Micron 25-nm MLC NAND Flash are interesting for space due to high density and low cost. However, their poor TID hardness (few tens of krad) and the low threshold LET for Single Event Functional Interrupts may be an issue in space*
- *Micron 90-nm PCM samples, in spite of the very good TID tolerance, feature a non-negligible rate of Single Event Latchup which may threaten their correct operation in space.*

Data overview of opto-couplers degradation under irradiation and how different electrical layout, construction and operational (bias) conditions impact on the radiation hardness

Result of separated emitter and receiver irradiation - to estimate the dominant part in the total degradation

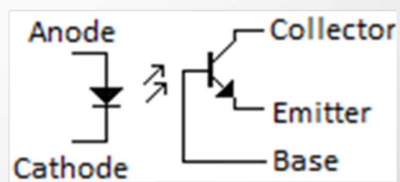
Investigation on screening methodology for parts selection, based on reverse recovery time of the LEDs was analysed to assess its applicability to the DUTs

Receiver: Photodiode and transistor



Micropac: 66191-303, 66191-313, 66223-001, 66226-001,

Receiver: Phototransistor



Micropac: 66266-001
Isolink:OLH249, OLS449

Dose Rate Effect on Bipolar Circuits Degradation

Contract #11407/95/NL CO010

ESA Technical Officer: M. Poizat

J.-P. David, S. Duzellier, M. Muschitiello, S. Soonckindt

ELDRS remain a difficult hardness assurance problem as there is no universal convenient method to bound the degradation

Test performed on 9 device types (5 parts for each one)

Three dose rates:

- ✓ Moderated Dose Rate (MDR): 100 krad(Si) at 360 rad/h
- ✓ Recommended Low Dose Rate (LDR): 100 krad(Si) at 36 rad/h
- ✓ Extreme Laboratory Low Dose Rate (ELDR): 45 krad(Si) at 10 rad/h

Two bias conditions:

- ✓ Static ON
- ✓ All pins grounded

2–Low dose effects study

Device reference	Man.	Function	Technology	Qual. level	Packaging
AD574ATD	ADI	Complete 12-Bit A/D Converter		883B	DIL28
AD584SH	ADI	Precision Voltage Reference		883B	CAN8
OP15AZ	ADI	Precision J-FET Input Op. Amp.		QMLV	DIL8
UC1834J (diffusion lot)	TI	High Efficiency Linear Regulator		883B	DIL16
JL117BXA	NSC	Voltage Regulator	Bipolar	883B	TO39
LM111	TI	Precision voltage comparator	Bipolar	883B	DIL8
UCC1806J (diffusion lot)	TI	Low-Power, Dual-Out., Current-Mode PWM Controller	BiCMOS	883B	DIL16
RH 1021CMH	LTC	Precision 5V Reference	Bipolar	Rad-Hard	TO5
RH 1013MJ8	LTC	Dual Precision Op. Amp.	Bipolar	Rad-Hard	DIP8

Conclusions:

- *In many cases, the degradation at 10rad/h is larger than at 36rad/h*
- *For some devices, different conclusions are drawn with or w/o 10rad/h testing:* OP15 Vos shows a large underestimate of the degradation with 36 rad/h testing UCC1806 cmos-like => moderated eldrs
- *ELDRS response of devices varies with bias, tested parameter and TID level*

ENHANCED LOW-DOSE RATE SENSITIVITY ANALYSIS

Summary Test Results and Analysis on Bipolar Devices.

ESA CONTRACT Nº: 4000100717/2010/F/WE

Prepared by: Demetrio López / Presented by: Gonzalo Fdez.

Test and analyse ELDRS sensitivity of bipolar linear devices and RadFETs, of relevance for the Galileo project and GNSS Evolution.

Function	Part Type
Converters	AD565
Voltage Reference	AD584 / REF02
Amplifier	LMH6702 / OP27 / OP470
Optocoupler	OLH249 / OLH449 / 66183-105
Comparators	PM139
Transistor	SOC5551
PWM	UC1525 / UC1825 / UC1843 / UC1846

2–Low dose effects study

Level of Interest	100 krad(Si)
Dose rates	Range of 36 rad(Si)/h versus Range of 360 rad(Si)/h
Energy	1.33/1.17 MeV
Radiation Source	Cobalt-60
Proposed Steps	5 krad, 10 krad, 20 krad, 35 krad, 50 krad, 100 krad, ann24h, ann168h
Bias distribution	50% bias and 50% unbiased A total of 20 samples were tested per part type.

Conclusions:

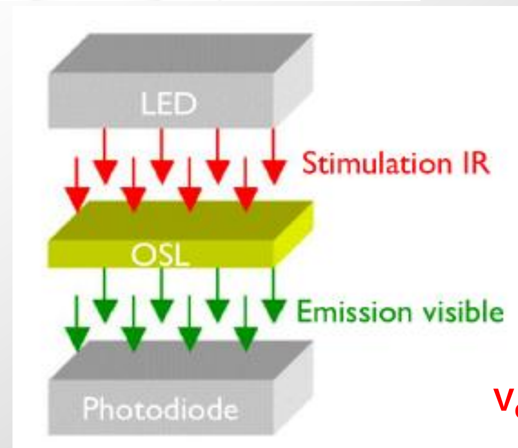
- *The parts off biased normally have higher radiation degradation than the biased ones*
- *There are types in which the ELDR suppose an increase of degradation, others the standard LDR is the worst condition, but also there are several cases in which no big differences are observed between both test conditions.*

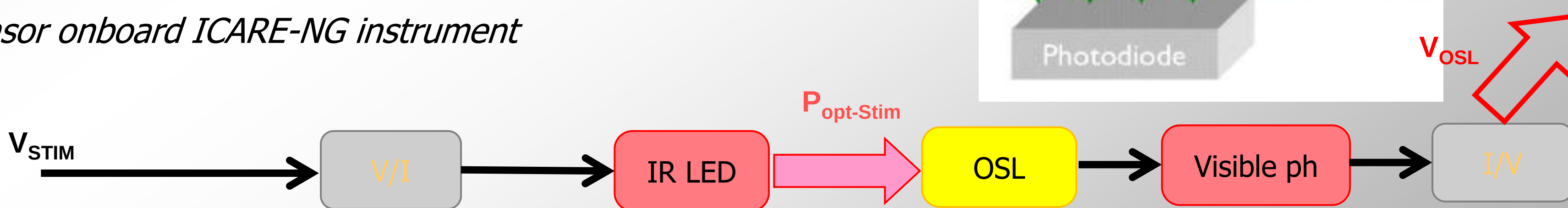
Calibration of the OSL sensors and feasibility study of a new generation dosimeter

C. Deneau[1], J. R. Vaillé[1,2], F. Bezerra[3], E. Lorfèvre[3], R. Ecoffet[3] and L. Dusseau[1]
[1]Université Montpellier 2 – IES
[2]Université de Nîmes
[3]Centre National d'Etudes Spatiales

OSL = Optically Stimulated Luminescence

- *Old Osl generation failed on CARMEN3*
- *All the problem fixed on the new generation- First promising results*
- *OSL sensor onboard ICARE-NG instrument*





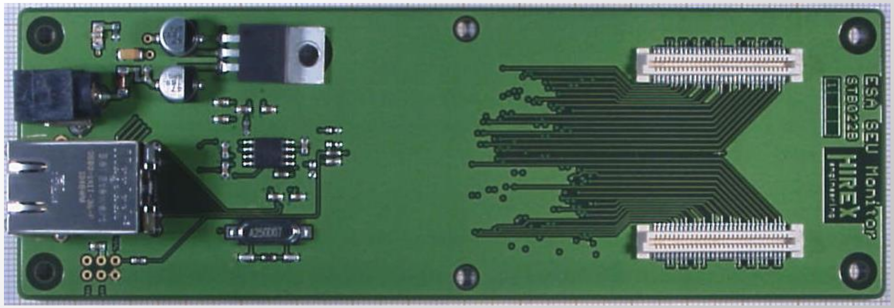
3- Dosimetry

Power consumption in standby mode	P < 150 mW (+5 V : 20 mA, -5V : 5mA)
Power consumption in read mode	P < 300 mW (+5 V : 50 mA, -5V : 7mA) At the mission start, example : CARMEN-2
Communication	ECAN, RS232, asymetric or differential analog bus
Measurements	Temperature, Total Ionizing Dose, Displacement Damage Dose
Sensitivity	TID : 8 $mV \cdot mGy^{-1}$, error < 7% DDD : 8.60×10^{-8} $V \cdot g \cdot MeV^{-1}$, error < 4% Temperature : 2 °C
Packaging	DIL24 wide, Plastic (EX200), 33 mm x 20 mm x 14 mm, 10 g
Space qualification	In progress under ESA ECSS standards Radiation tests to do

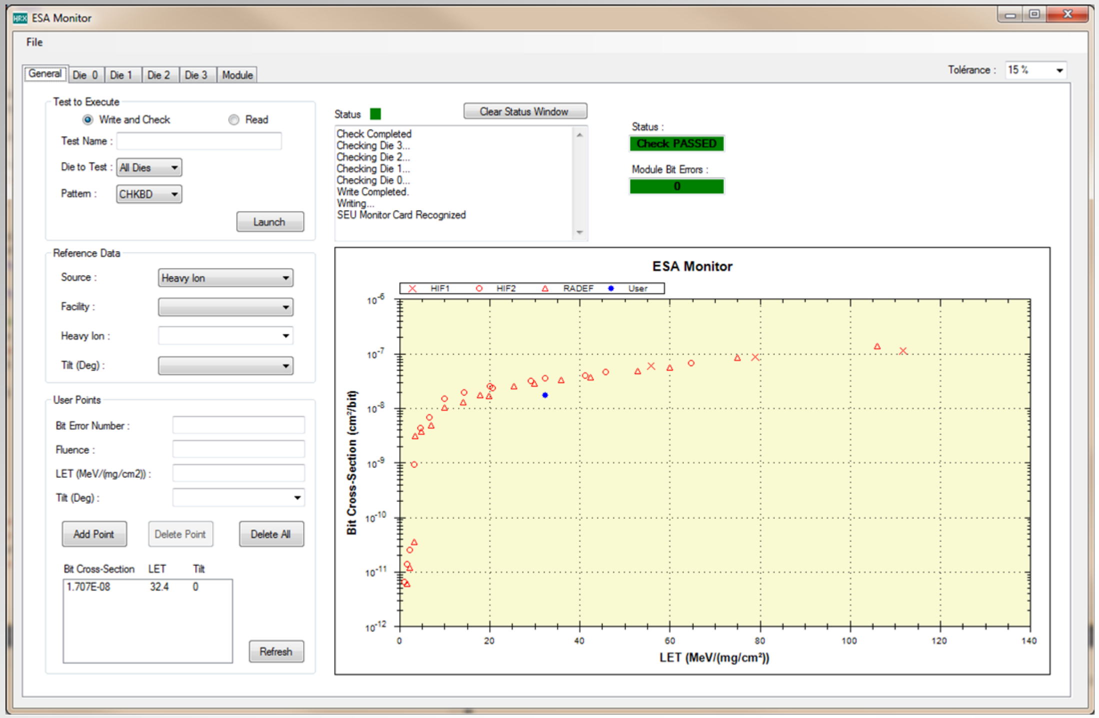
NEW VERSION OF THE ESA SEU MONITOR

- François-Xavier Guerre
- Hirex Engineering

- New version of SEU monitor
- developped in 2009
- Memory device used:
  4 die module
  ATMEL AT60166F 16Mbit SRAM
- Overall 4 Die area:
  ~ 19.5mm*19.5mm
- Link to PC via Ethernet cable



3- Dosimetry



- This monitor allows for beam fluence check at a given LET
- Provides a SEU event distribution using 128*4 zones on an overall 4 die area of about19.5*19.5 mm^2

3- Dosimetry

Calibration of RADFETs for the Component Technology Test-Bed (CTTB) of the Alphasat spacecraft radiation Environment and Effects Facility (AEEF)

ESA/1-6403/10/NL/SFe

Patrícia Gonçalves, Ana Keating, Andreia Trindade, Pedro Rodrigues, Miguel Ferreira, Pedro Assis, Michele Muschitiello, Bob Nickson, Christian Poivey

- *Study of the variation of the RADFET voltage threshold shift, ΔVth as function of the dose, for different temperatures, and assessment of long-term annealing effects*
- *Characterization of 18* RADFET 02-400nm IMPL units, manufactured by Tyndall National Institute (Ireland)*
- *The RADFETS were irradiated at the ESA/ESTEC Cobalt-60 facility, up to ~50 krad*
- *HDR : High Dose Rate 5 krad/hour : total 50 krad (H2O), LDR: Low Dose Rate, 0.036 krad/hour : total 58 krad (H2O)*

Conclusions:

- *Established a model for the Radfets calibration*
- *At HDR irradiation no temperature dependency is observed*
- *At LDR the model takes into account the temperature dependency*
- *Annealing is taken into account both in the model at HDR and LDR*

Radiation tests under controlled temperature and vacuum conditions: why and how

ALTER TECHNOLOGY TÜV NORD
Innovation Department

- *Motivation for radiation tests under controlled temperature: space missions, annealing recovery reduced at low temperature, electronics performance improved at low temperature*
  - *Liquid Nitrogen Proposed setup*
  - *Future Options: Helium close loop*
  - *Controlled atmosphere (vaccum)*

Liquid Nitrogen Deposit

Turbo Pump System

Climatic Chamber

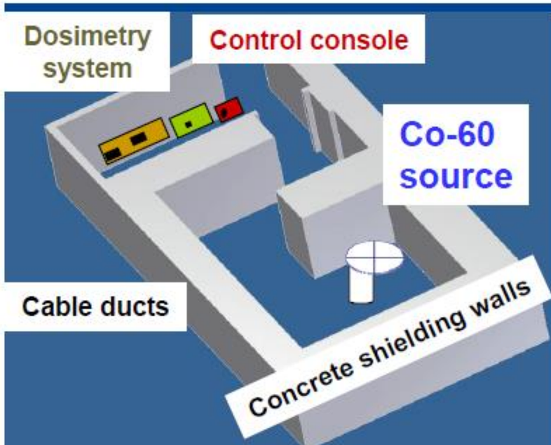
Radiation

Vacuum Chamber

Feed-throughs

4- Facilities

RADLAB Facilities outline



Bunker volume
5.8 m x 4.8 m x 3 m

1. Co60 nominal activity 444 TBq (12 kCi)
2. Range of dose rate :
   0.36 - 360 Gy/h // 36rad(Si)/h to 36krad(Si)/hr.
3. Dose rate uncertainty ≤ 10%
4. Maximum radiation field non-uniformity of 10% in a wide surface
5. Gamma-ray dose rate calibrated to ≤ 5 %.
6. Dosimetry traceable to international standards and patterns.
7. Environmental conditions (temperature, humidity) controlled and monitored.
8. Different field size and dose rate can be achieved by attenuation. i.e. 1 m of distance: 120 Gy/h (200 rad/min), min 5x5 cm2 and max 43x43 cm2

4- Facilities

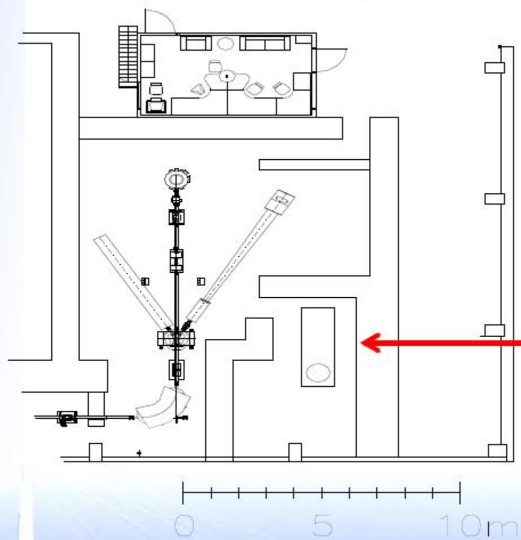
RADEF status report

ESA/ESTEC Contract No. 18197/04/NL/CP:
"High Energy Heavy Ion Test Facility for Component Radiation Studies"

Arto Javanainen/
Ari Virtanen, JYFL

Coming upgrades: A new electron accelerator

- Our aim is to install Varian Clinac 2100CD radiation therapy accelerator in the RADEF cave
- It can provide intense electron and x-ray beams up to 20 MeV and 15 MeV, respectively
- It expands the selection of radiation from heavy-ion and proton beams available at RADEF
- Among irradiation studies we foresee the large-scale satellite mission of ESA, JUICE = Jupiter Icy moon Explorer



Coming upgrades: A new ECRIS

The objective is to improve the ECRIS (Electron Cyclotron Resonance Ion Source) capability to produce more intense and energetic ion beams. The special objective is to develop a new high-energy ion cocktail to be used at RADEF with the following properties:

- increase the highest LET-value to 80 MeV/(mg/cm^2) in silicon
- extend the lowest Bragg Peak location close to 100 µm in silicon

This helps the European radiation effects community to be more competitive compared to the US facilities, because of:

- the extended needs of higher LET and range values
- the possibility to test at large tilt incidence or in air for example in the case of complex structures and modern nano-scale components with multiple connections
- the need of long ion ranges for back-side irradiations when testing flip-chip components (for example all DDR2-DDR3 memories). Long range beams make the preparation of components easier (and with a better yield) by reducing the substrate thinning

A challenge could be to get as close as possible to the 15 MeV/nucleon cocktail, used at TAMU, where the heaviest ion is Au with a surface LET of 80 MeV/(mg/cm^2) and the Bragg peak at 108 µm.

UCL Irradiation Test Facility

Status Report

Marc Loiselet

Heavy Ion Facility (HIF)

- Development of a new ion source to produce beam with higher penetration depth:

  Xe with a range of about 80µm

  -status: installed on a test bench

  -goal: connected to the accelerator in January 2014

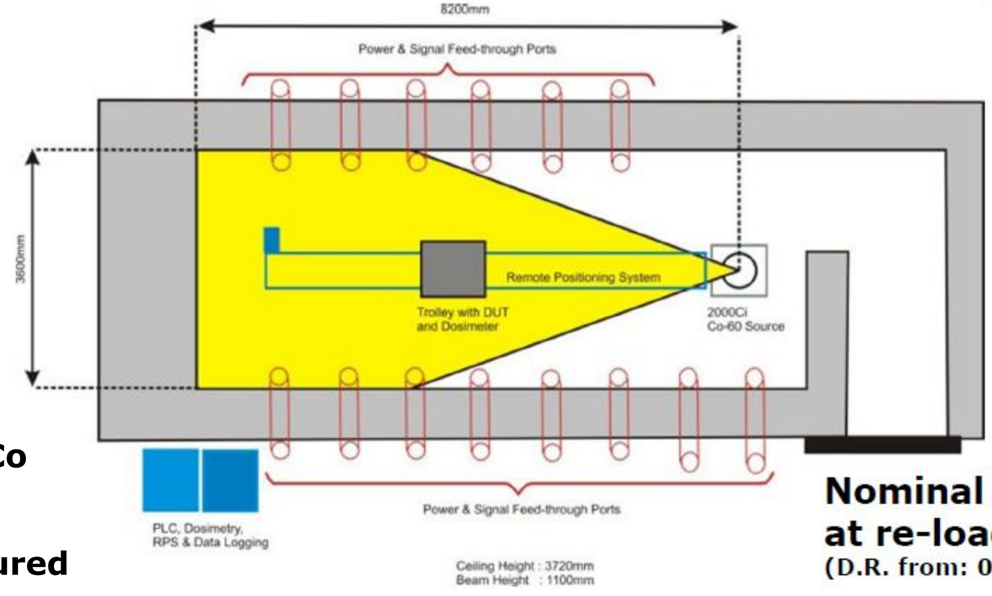
ion	E [MeV]	LET [MeV/mg/cm²]	Range [µm]
N	60	3,3	65
Ne	78	6,4	45
Ar	151	15,8	42
Kr	305	40,4	42
Xe	420	67,8	40

ion	E [MeV]	LET [MeV/mg/cm²]	Range [µm]
C	133	1,1	292
Ne	240	3	216
Ar	369	10,2	117
Ni	577	20,4	100
Kr	747	32,6	91

ECF Esa estec 60Co Facility

Source Activity: 63 TBq (today)

The Dose Rate can be varied from: 0.28 to 115Gy/h (28 –11500 rad/h)



Source Last Reloaded in November 2011

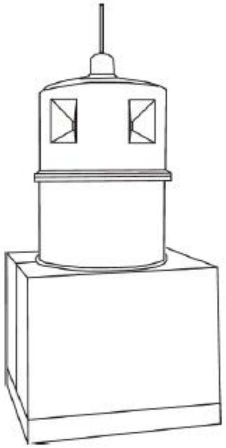
Nominal Source Activity at re-load: 75 TBq
(D.R. from: 0.33 to 129 Gy/h)

According to TEC-QEC-PR001 60Co Facility Dosimetry Procedure:

- ✓**The uncertainty of the measured TID [Gy] is 4.2%**
- ✓**The uncertainty of the measured D.R.[Gy/h] is 4.4%**

4- Facilities

New Dosimetry Chain based on a Keithley KE3571A/B electrometer connected to a 600cc ionization chamber for ELDRS tests



Modification of the irradiator head with a new collimator to double the test capacity (mainly for High Dose Rate tests)

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European Space Agency