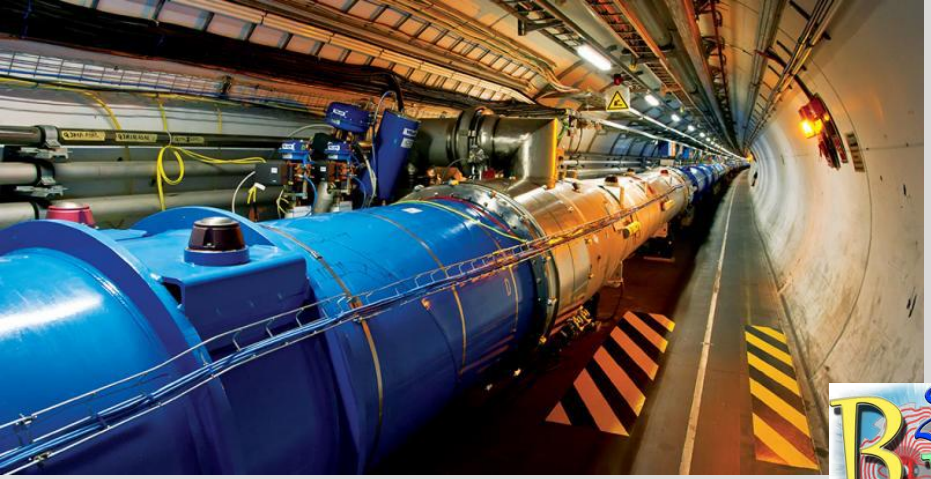

CERN



From Accelerators to Space Applications: Projects within the collaboration agreement with CNES

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Comparison of CHARM estimation and in-flight measurement

Main goal : *Investigate the relevance of CHARM to reproduce the LEO orbit* dominated by trapped protons within the radiation hardness assurance.

Context : A SRAM memory (Brillance SemiConductor) with very low LET threslhold is placed in a CNES satellite in LEO orbit (1336km,61°) and monitored to detect SELs. On ground :

- A CHARM measurement gives the HEH cross section.
  - Mixed field estimation of the SEL rate
- Mono-energetic measurement
  - Standard estimation of the SEL rate

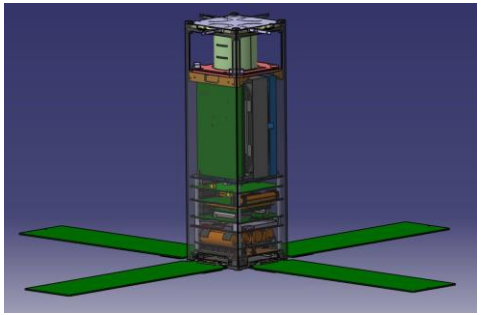
Results presented as oral presentation at RADECS 2018, under review process for IEEE TNS

	BSI 1	BSI 2	
SELs during mission	6882	7279	Relative Error
SELs per day	12,58	13,30	
Mono-energetic estimation	14,7 SEL/day		10,5-16,8%
CHARM estimation	20,03 SEL/day		50,9-59,6%

✓ **Relative good agreement of the CHARM estimation with respect to space measurement**

CHARM

NIMPH Cubesat: A CERN payload to be flown in LEO orbit



NIMPH: Nanosatellite to Investigate Microwave and Photonics Hardware

Main goal : Evaluate the behaviour of an EDFA (Erbium doped Optical fiber amplifier).

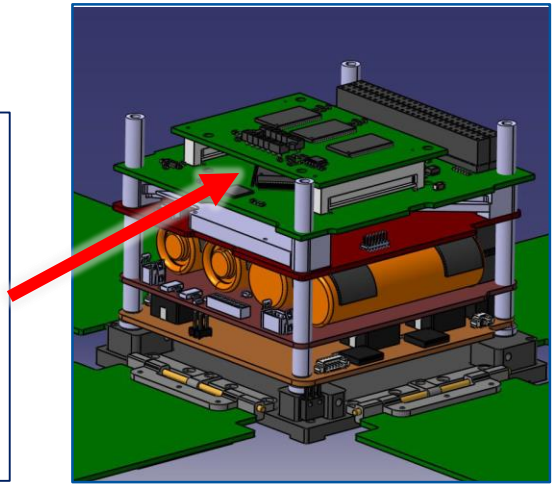
The fiber is meant to be subject of harsh environment (20krad) in LEO orbits during 2years and monitored by radfets from LAAS's (Toulouse) and CERN's payloads.

Payload developped by CERN for CELESTA cubesat adapted from the RADMON system used in LHC and CERN's tunnels.

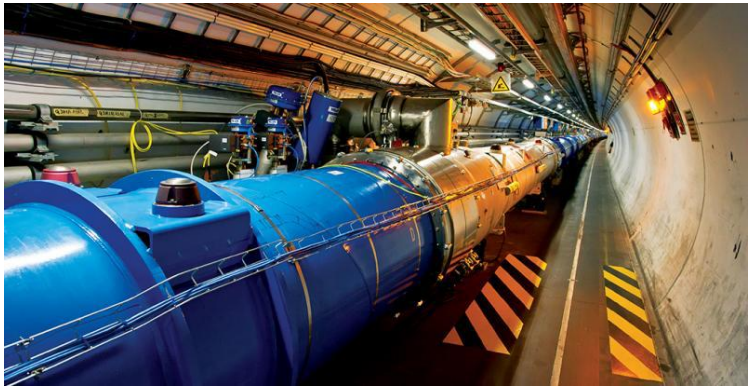
Main features - Measurement of the radiation environment by means of its effects on electronics:

- TID through Radfets
- HEH flux through SRAMs memories
- 1MeV.neutrons equivalent fluence with PIN diodes

More informations here : https://cds.cern.ch/record/2276097 (Rafaello Secondo's thesis - Datasheet available soon)



Optical sensing : A future dosimeter for Space and Accelerator applications



- Project included in the cooperation agreement between CNES/CERN signed in 2017.
- Currently in strong collaboration with Hubert Curien laboratory (Saint-Etienne,France)
- CNES R&D study on-going led by the Hubert Curien laboratory

Developpement of a New dosimeter using optical sensing suitable for :

- **Space application in CNES projects**
- **Monitoring of the radiation level in CERN accelerators and facilities.**

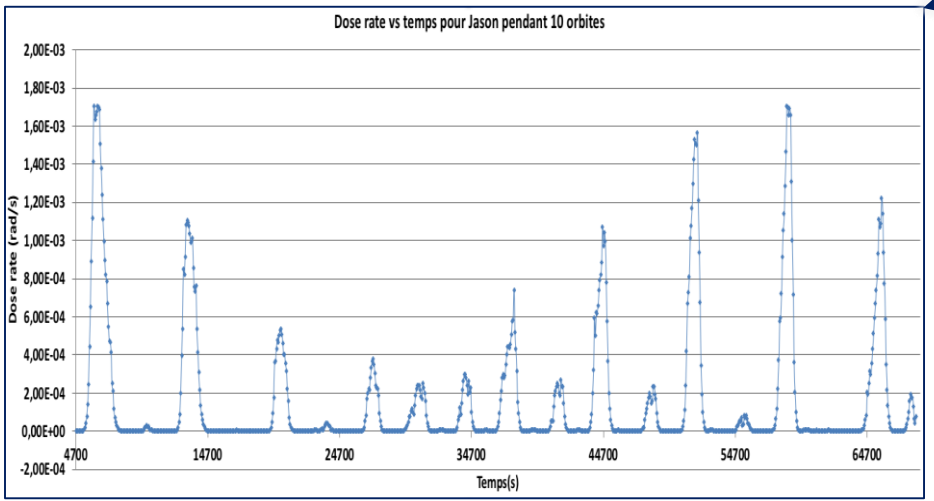
Specifications definition

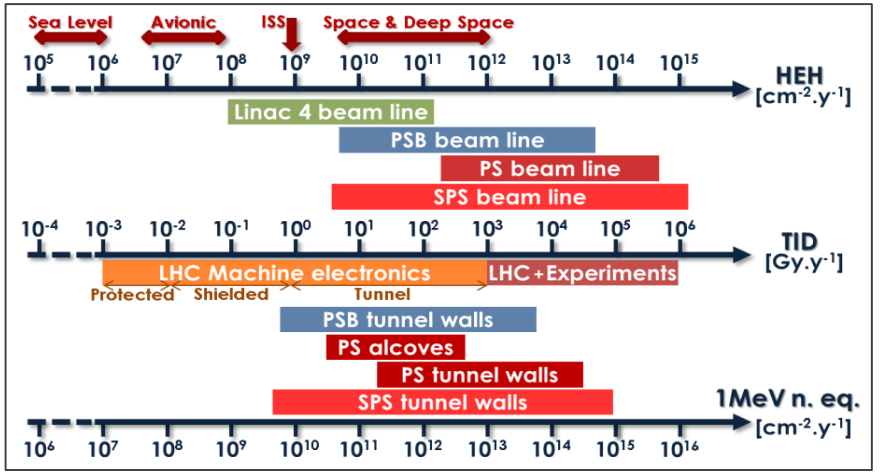
Steps followed:

- CNES needs → Specifications
- CERN needs → Specifications
- Experimental measurements

➔ **Overlaps between CNES and CERN needs**

Example of variations of dose rate seen along orbite





Preliminary specifications of the expected dosimeter

Paramètres	CNES	CERN
Plage de dose	500krad	Jusqu'à 100kGy (10Mrad)
Débit de dose	$1x10^{-8}$ à 1rad/s	$1x10^{-5}$ à 100 rad/s
Plage de température	Entre -50°C et +80°C	0-50°C

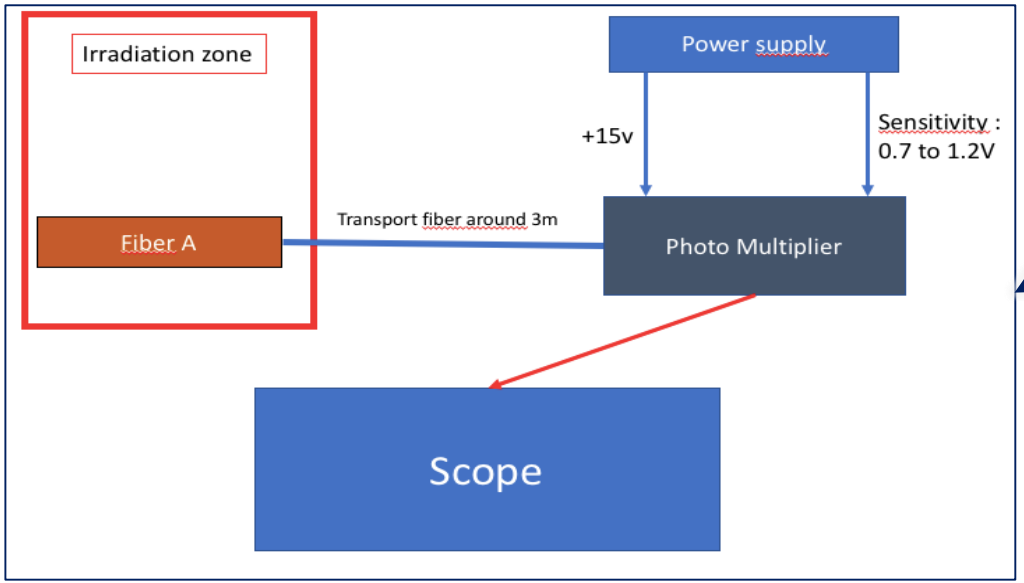
CNES needs mainly driven by low dose rate measurement whereas CERN needs are meanly driven by a high Dose range measurement ability.
Overlap between the CERN/CNES needs.

Technology actually identified and under investigation:

Radiation Induced luminescence (RIL) : Light is emitted by the fiber itself under irradiation and guided towards a detector. The power of the light is proportional to the dose rate.

➔ technology already used (medicine) and with recent breakthrough in material design

➔ Allows simple & miniaturized setup (one detector) with low energy consumption



Schematic of the current setup

✓ Very simple setup in terms of complexity

Optical sensing – Status of the project

Work carried out :

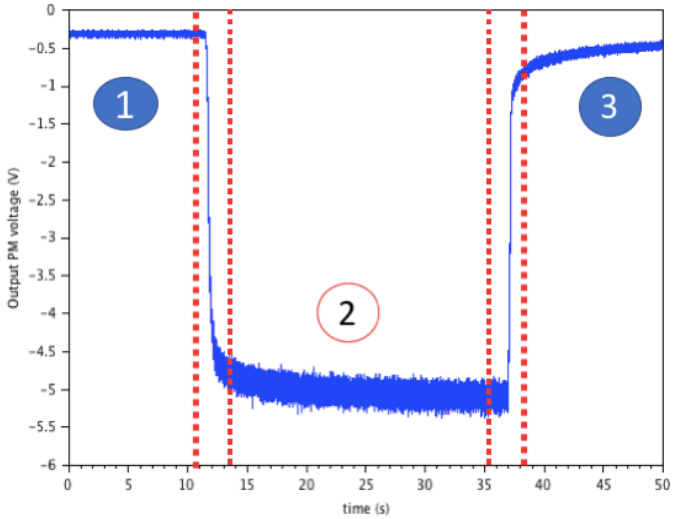
- Definition of an experimental setup
- Experiment campaigns in several facilities :
  - Saint-Etienne, X-rays (Jan 2018)
  - ChipIR (Oxford,UK), High Energy Neutrons (March 2018)
  - Grenoble ILL, Low energy neutrons, (March 2018)
  - CERN, Cobalt 60 gamma (May 2018)
  - TRIUMF, Protons, Vancouver, Canada (April 2018)

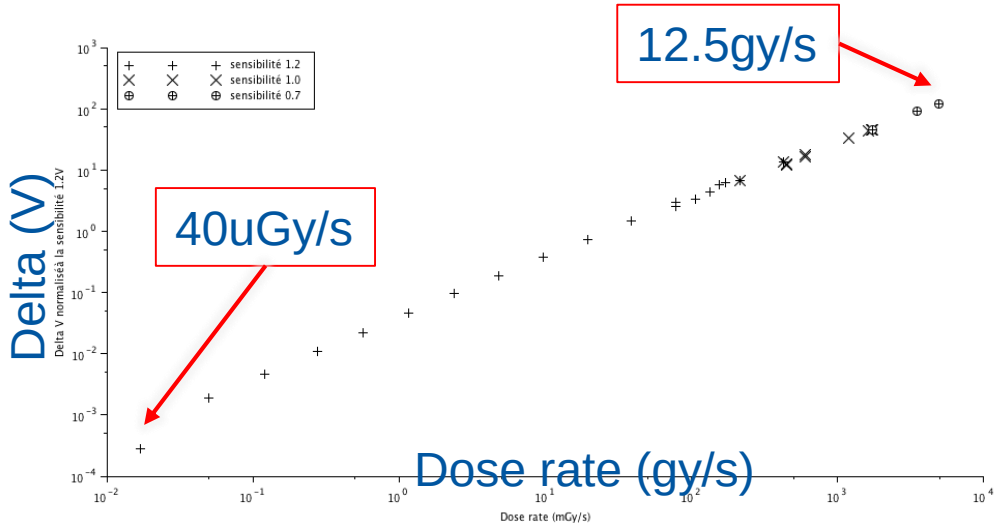
Results :

- Very simple and low-cost setup
- Good sensitivity and linearity of the tested new materials (nitrogen,cerium,copper... Etc)
- Low dose rate measurement promising (40uGy/s under X-rays ➔ limited by the irradiation facility)
- Still big margins (material, detector, signal processing) to improve the performance

Optical sensing – performance

Typical results (X-rays, room temperature)
Accessible time resolution: ~ 1ms (limited by the lifetime of the luminescence)
Knowing the time duration ➔ dose can be easily deduced too through RIL





Conclusion and Outlooks

- CNES and CERN needs are overlapping
- CNES R&T on-going with Lab Hubert Curien
- Promising results already fulfilling the high dose rate requirements, and getting close to the low dose rate ones.

Outlooks:

- Improvement to be carried out on the RIL setup (noise, optical looses, etc…)
- Large Investigation to be carried out on other availables technologies potentially meeting the requirements.
- On-going investigations on RIL setup and additionnal characterization of differents samples potentially interesting for this application.

Thanks for your attention !


CERN