

ESA-CNES Final Presentation Days on Space Environments
and Radiation Effects on EEE Components

CNES ACTIVITIES ON RADIATION FACILITIES

Françoise BEZERRA

*Space environment and new components office
DSO/AQ/EC*

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- **QUALITY SURVEY OF STANDARD FACILITIES**



- **LOOK FOR NEW FACILITIES**

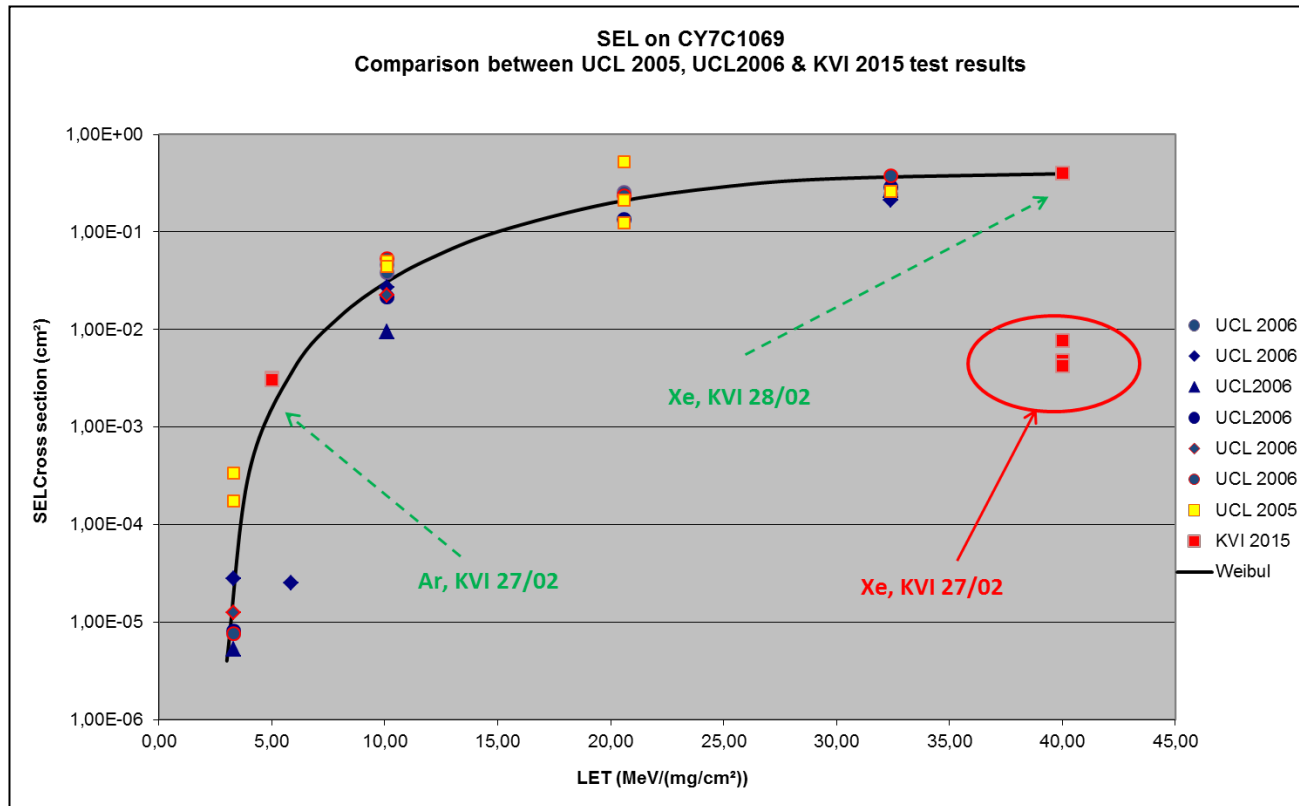
- ◆ New needs
- ◆ Closure of existing machines.



QUALITY SURVEY OF STANDARD FACILITIES

TILU2 SEL Test system: Set of widely characterized SEL sensitive devices as reference. (CY7C1069 / BS616LV16001 / 62LV4006 / 62LV8001)

- In early 2015 when CNES used the KVI heavy ion beam line for the first time => Revealed that the delivered beam was not the one expected.



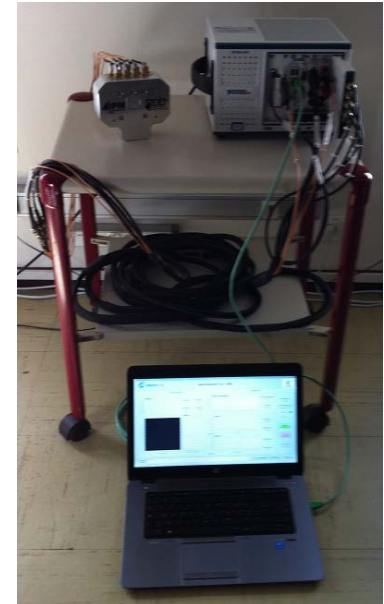
- We plan to use it systematically to check new beams or perform periodic beam quality control.

QUALITY SURVEY OF STANDARD FACILITIES

Measure the beam characteristics

- BET-C (Beam Evaluation Tool – CNES)
 - ◆ Energy
 - ◆ Spatial distribution
 - ◆ See presentation RFPD 2015
- Status:
 - ◆ Still under validation after pb with the diode high power bias.
 - ◆ Validation at IPN in Q2 2017
 - ◆ First operational campaign: New UCL cocktail asap .

Ion	M/Q	Energy on device [MeV]	Range on device [μm]	LET on device [MeV/(mg/cm ²)]
¹³ C ⁴⁺	3,25	131	269,3	1,3
²² Ne ⁷⁺	3,14	238	202	3,3
²⁷ Al ⁸⁺	3,37	250	131,2	5,7
⁴⁰ Ar ¹²⁺	3,33	379	120,5	10,0
⁵³ Cr ¹⁶⁺	3,31	513	107,6	16,0
⁵⁸ Ni ¹⁸⁺	3,22	582	100,5	20,4
⁸⁴ Kr ²⁵⁺	3,35	769	94,2	32,4
¹⁰³ Rh ³¹⁺	3,32	972	88,7	45,8
¹²⁴ Xe ³⁵⁺	3,54	995	73,1	62,5



LOOK FOR NEW FACILITIES

Necessary to cover new needs: **Electron beams**

● **CARCASSONNE HOSPITAL**

- ◆ CLINAC VARIAN 2100CD
- ◆ 6, 9, 12, 16 & 20 MeV
- ◆ 4 h slot (end of day)
- ◆ Currently working on ASN Agreement
- ◆ First test campaign planned Q2/2017 with TRAD (FPGA Test).



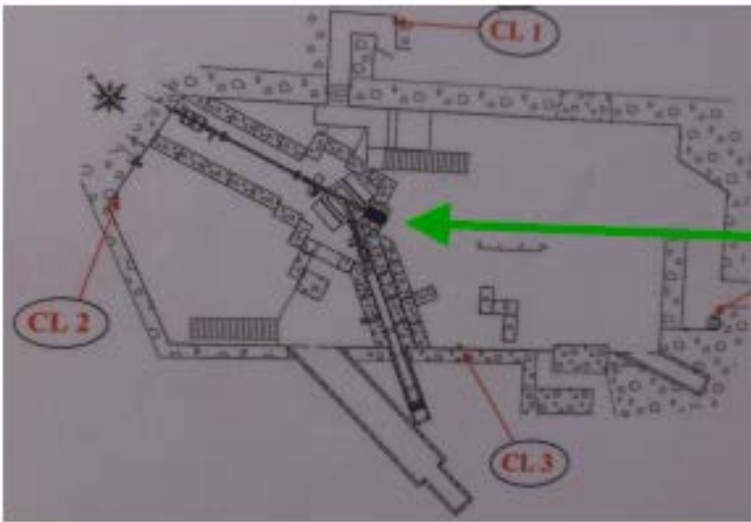
LOOK FOR NEW FACILITIES

Replacement of closed facility: QMN (Upsalaa, Sweden)

● QUASI MONOENERGETIC NEUTRON BEAM

- ◆ Svedberg Laboratory (TSL), Upsalaa University
- ◆ Up to 175MeV Mono energetic neutrons
- ◆ 80 cm diameter in air
- ◆ Used for fault injection (SEE) at component or system level.
- ◆ No TID

e.g.: Complete balloon platform

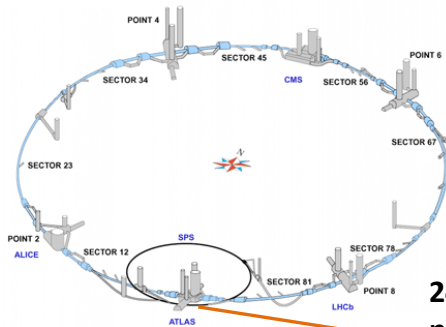


➤ **Closed since 2015 without equivalent beam in Europe.**

LOOK FOR NEW FACILITIES

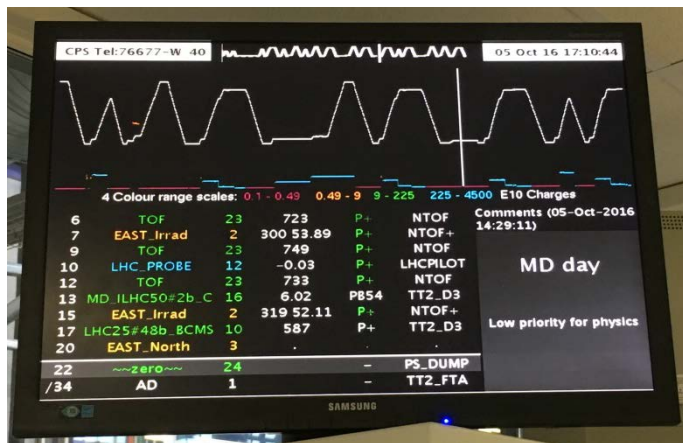
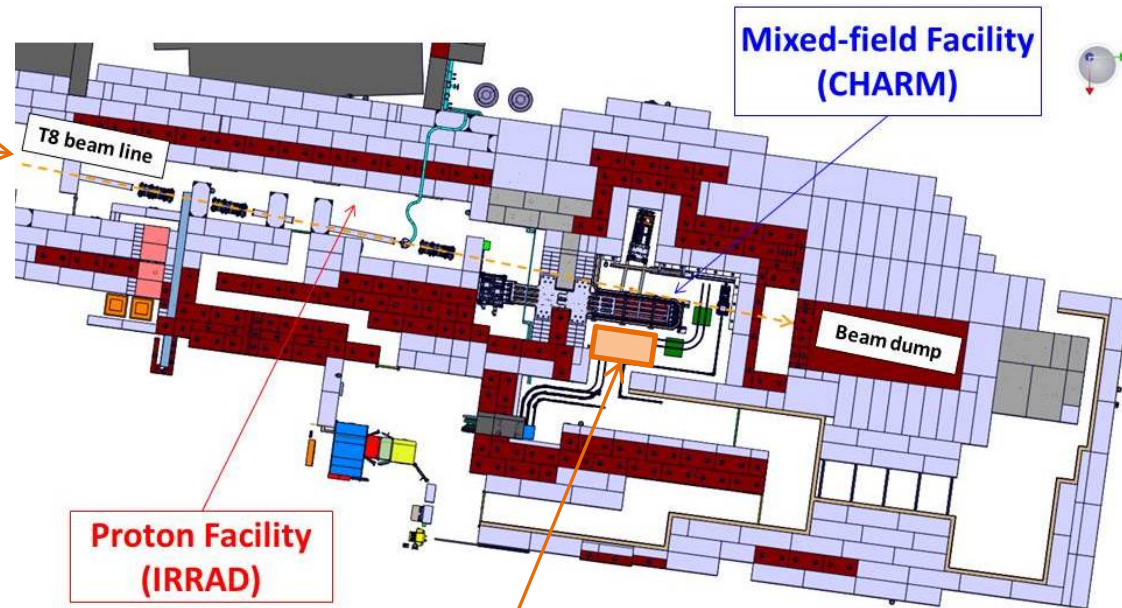
CERN/CHARM (Switzerland) as a replacement option?

● CHARM: CERN HIGH ENERGY ACCELERATOR MIXED FIELD FACILITY



24GeV
protons
from SPS

- ◆ Pulsed beam.
- ◆ Various irradiation positions
- ◆ Various shielding configurations

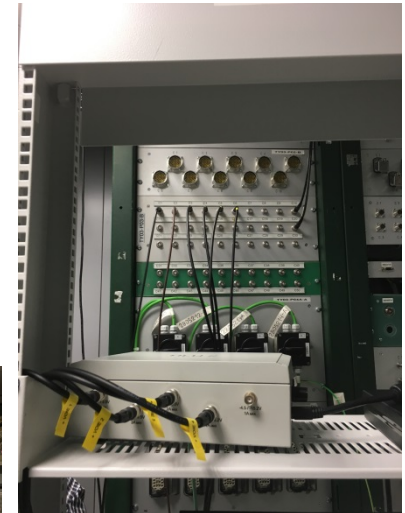


Area of interest for space spectra simulation

LOOK FOR NEW FACILITIES

CERN/CHARM as a replacement option?

- **CHARM: CERN HIGH ENERGY ACCELERATOR MIXED FIELD FACILITY**
 - ◆ Collaboration agreement CNES/CERN including access to CHARM facility
 - ◆ First test campaign October 2016
 - » Test of various SEL sensitive memories with TILU2 CNES latchup test system
 - » Injection of SEE induced faults in a complex OBC board.



LOOK FOR NEW FACILITIES

CERN/CHARM as a replacement option?

● LESSONS LEARNED FROM THE 1ST TEST CAMPAIGN

◆ Test preparation:

- » Administrative constraints (access and radiation safety)
- » Setup: Cable length 15m
- » Dry run the day before
- » Install the test boards in the facility using the conveyor

◆ Test management:

- » In situ control (from the control room upstairs) or web-control
- » 6 days long irradiation period
- » Main user (control of beam ON/OFF and shielding configuration)

◆ After the irradiation

- » Dismount the experiment
- » Irradiated boards and cables are put in radioactivity decrease for months!!!



LOOK FOR NEW FACILITIES

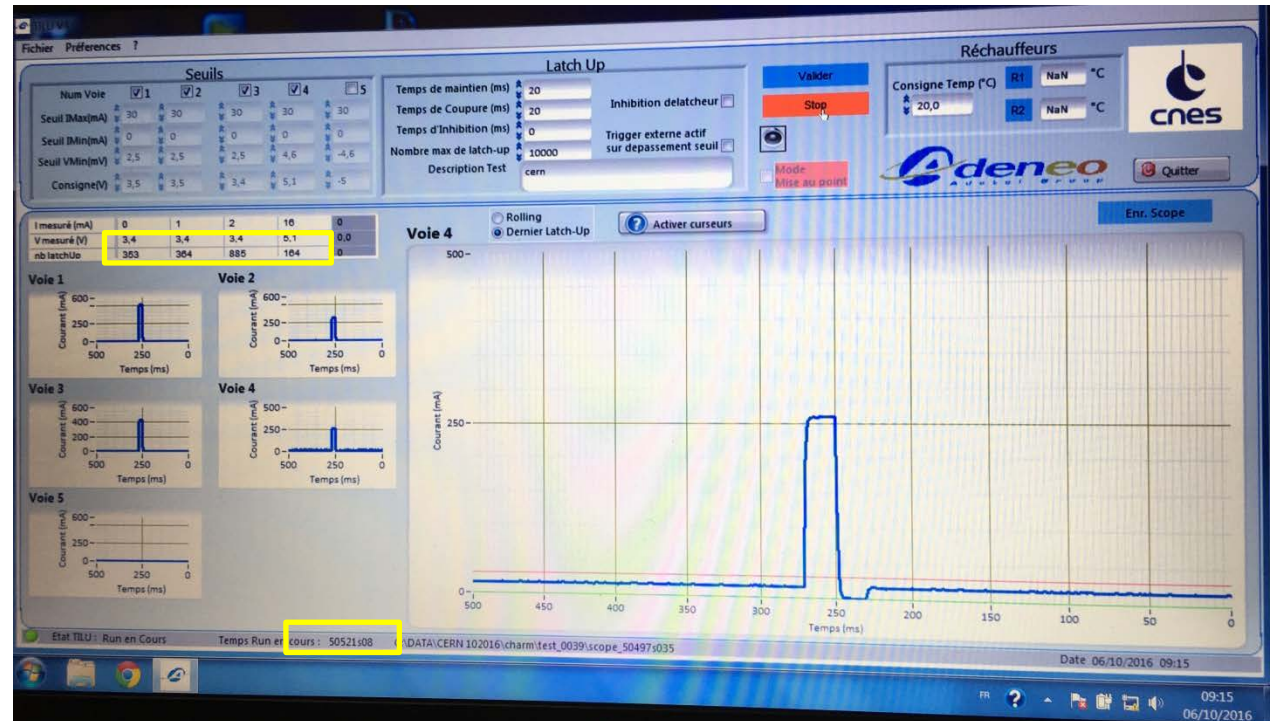
CERN/CHARM as a replacement option?

● RESULTS

- » TILU2: A lot of SEL collected on the 4 memories
=> comparison between devices is easily achievable as well as identification of sensitive devices.

SEL Number

RUN Duration



- » OBC: Various SEE induced error signatures at board level
=> RHA at system level validation tool.

CONCLUSION

It is necessary to get tools for beam quality check.

The status for radiation facilities is continuously moving (needs, availability) and requires constant attention.

At CNES, we do and encourage continuous day to day survey on this topic.