CENTRE NATIONAL D'ÉTUDES SPATIALES

Measurements of SETs in Space CARMEN2/MEX

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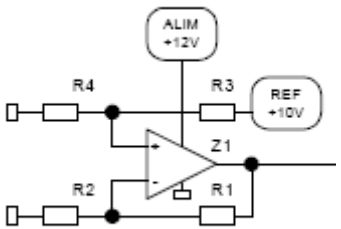
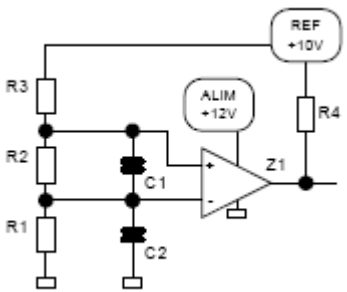
Outlines:

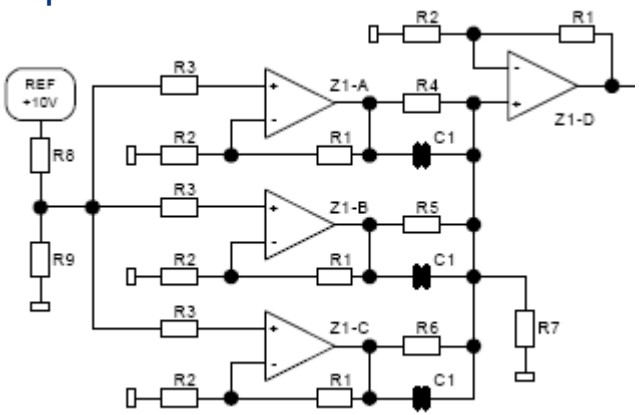
- The implemented test
- Experimental results on accelerators
- How to predict?
- In flight result & discussion

The implemented tests

- Based on ground testing results, 3 candidates have been selected:
  - LM124 Texas Instruments – Low Power Quad Op Amp
  - LM139 National Semiconductors – Low Power Low Offset Quad Voltage Comparator
  - OP470 Analog devices – Very Low Noise Quad Op Amp







LM124

R1=R2=15kΩ
R3=30.1k Ω
R4=10k Ω

LM139

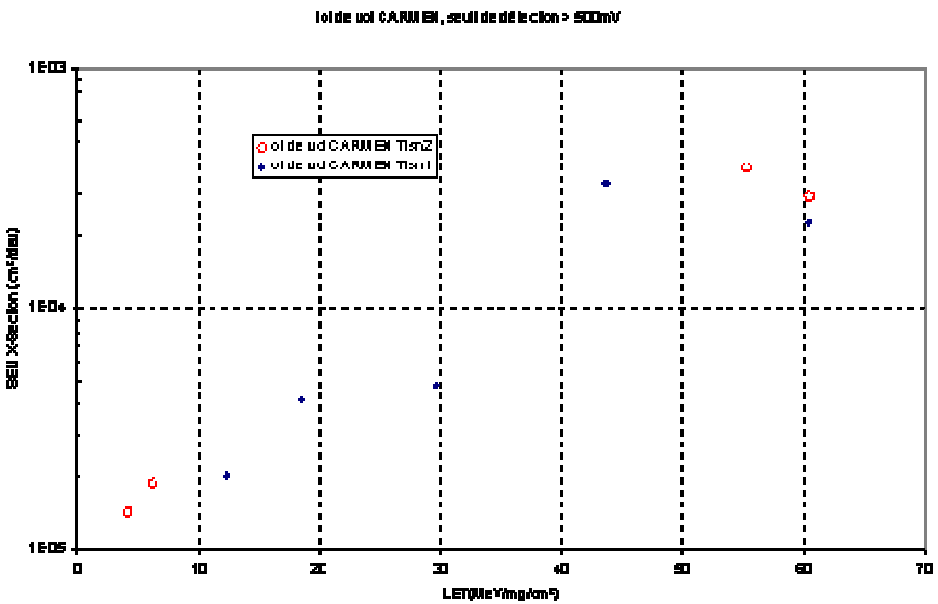
R1=R3=24.9kΩ
R2=200k Ω
R4=20k Ω
R5=30.1k Ω

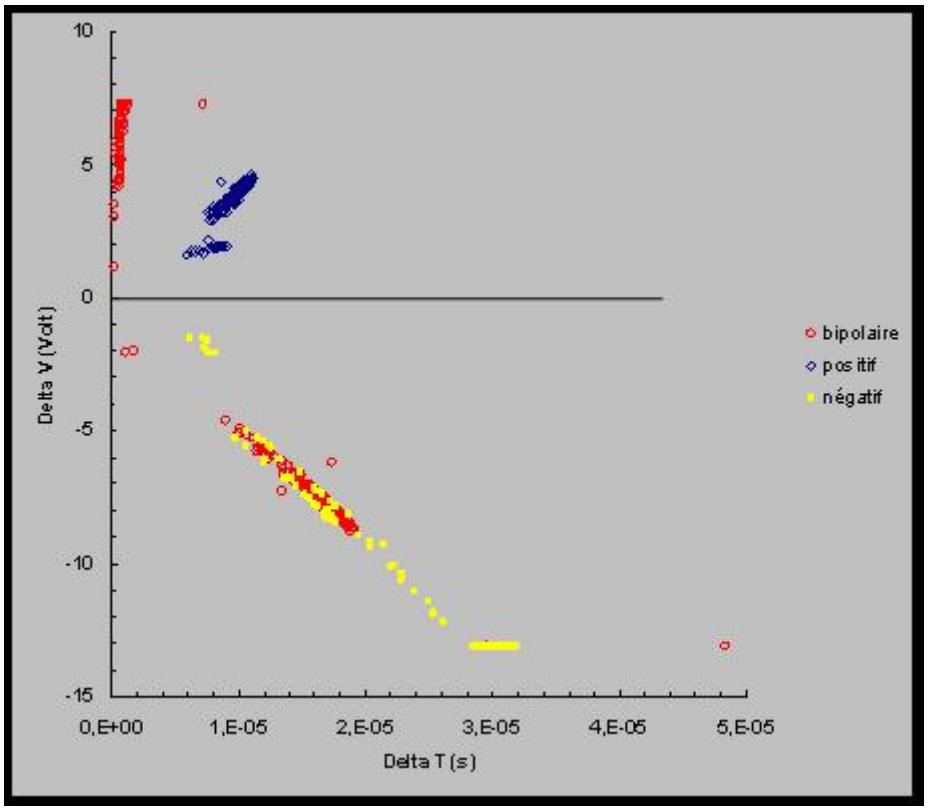
OP470

R1=8.87kΩ R2=R7=1k Ω
R3=10 Ω R4=63.4k Ω
R5=31.6k Ω R6=15.8k Ω
R8=90.9k Ω R9=10k Ω

Experimental results on accelerators (LM124)

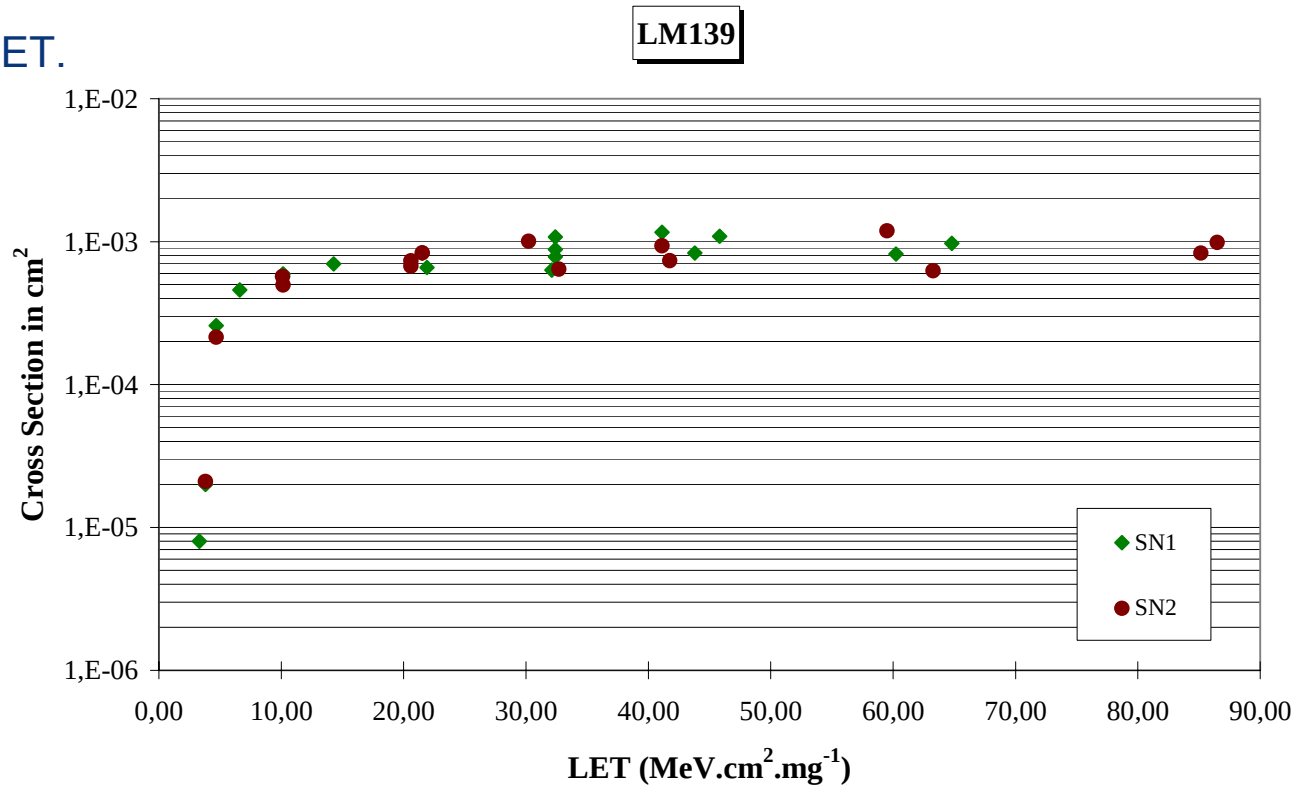
- Flight lot tested at GANIL and IPN with the in flight biasing conditions:
  - LETth~5MeV/(mg/cm²)
  - SIGMA Sat~4E-4cm²
  - Positive, Negative and Bipolar SET.





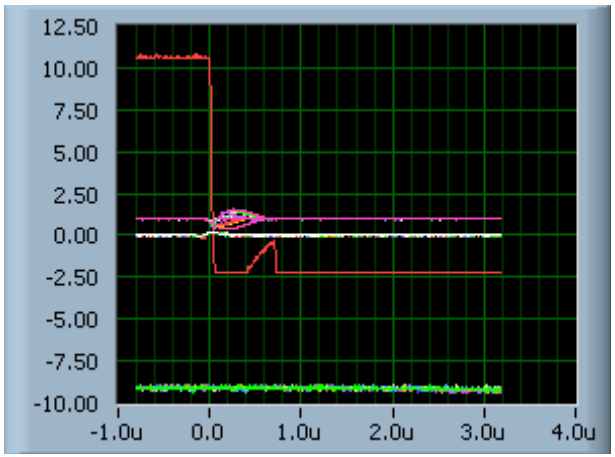
Experimental results on accelerators (LM139)

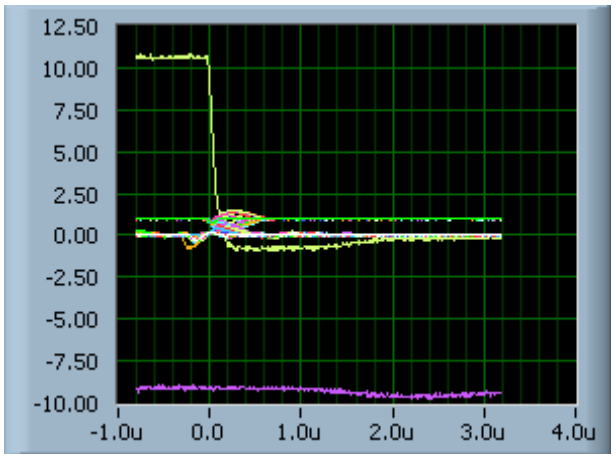
- No test performed on the flight lot itself but a lot of previous data collected at UCL and GANIL with similar biasing conditions:
  - LETth~3MeV/(mg/cm²)
  - SIGMA Sat~1E-3cm²
  - Positive and Negative SET.



Experimental results on accelerators (OP470)

- Tests performed on the flight lot by ASTRIUM at GANIL.
- When placed in a given biasing state, OP470 is SET sensitive and shows sensitivity to a destructive phenomena (SEDR) leading Vout degradation down to 0V<Vout<-Vcc and Icc increase.





- The experiment built on CARMEN2/MEX aims to verify if this event may occur in space. By the same way, SET are also checked.

How to predict?

- Problem with sensitive volume definition:
  - Several SV in one device with various location
  - Some located close to the surface, others are deeper in the device (10 to 100µm).

- Can we use heavy ions to predict protons as it is admitted for SEU?
  - When regarding low LETth measured for SET phenomena, devices should be sensitive to protons.

⇨ While using the “classical SEU approach” (estimation of sensitivity under protons from sensitivity under heavy ions and sensitive volume depth=2µm), we predict very high SET rates due to protons on CARMEN2/MEX (several in a month).

In flight Data:

- After 7 months in a severe proton environment (JASON2: 1340km, 66°)
- The 3 devices are functional (Vout is read every 2 hours)
- Even after reducing to 0.3V the SET detection threshold (positive and negative)
- **No event observed up to now!**
  - We know the detection system is functional because 1 parasitic SET is measured when experiment is powered ON (threshold crossing).
  - We are currently playing additional tests on the EM to ensure that the detection system is OK.

We are probably overestimating the SET rates when using Heavy ions data to predict protons rates => proton tests will be done in S1/2009.

Other probable problem comes from “c” sensitive volume depth parameter selection.

Acknowledgements:

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- EREMS for helping us in our current investigations.