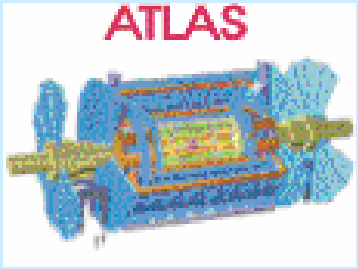
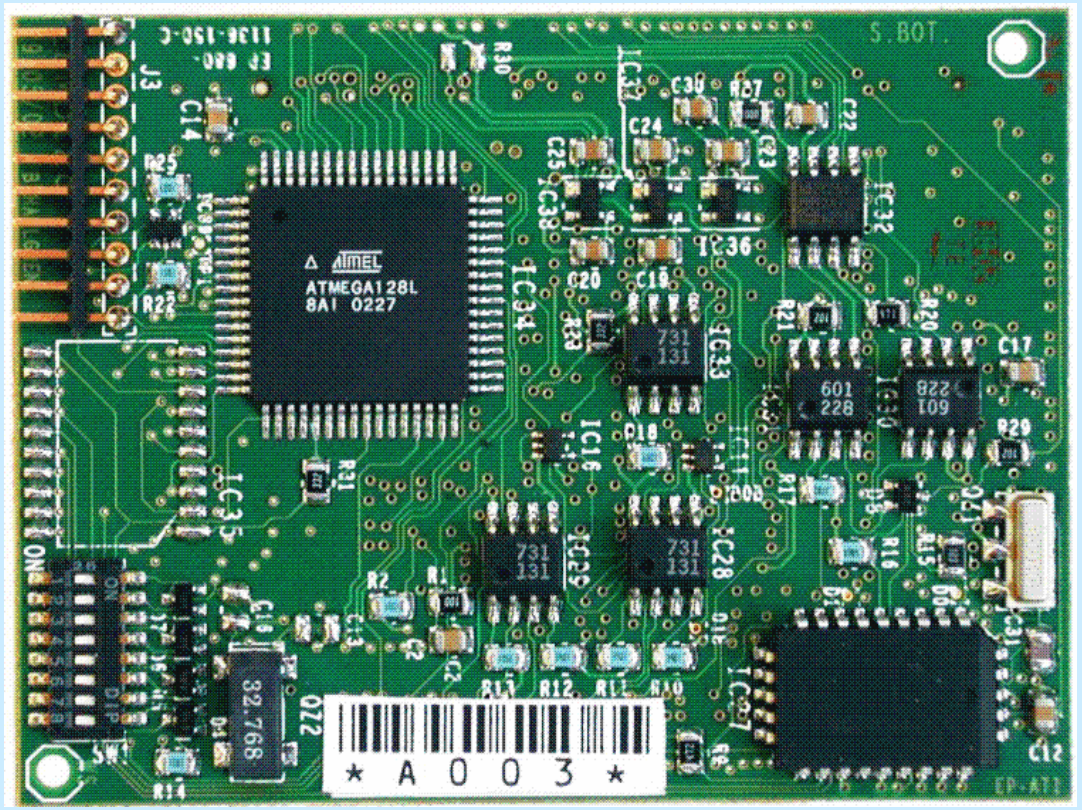


Results of the ELMB TCC2-02 tests

B. Hallgren
ATLAS Detector Controls

Embedded Local Monitor Board
ELMB(128)



50 mm

Fieldbus CAN

ATMEL processor 128 kbytes flash memory

ELMB back side

Low power consumption - 45mA

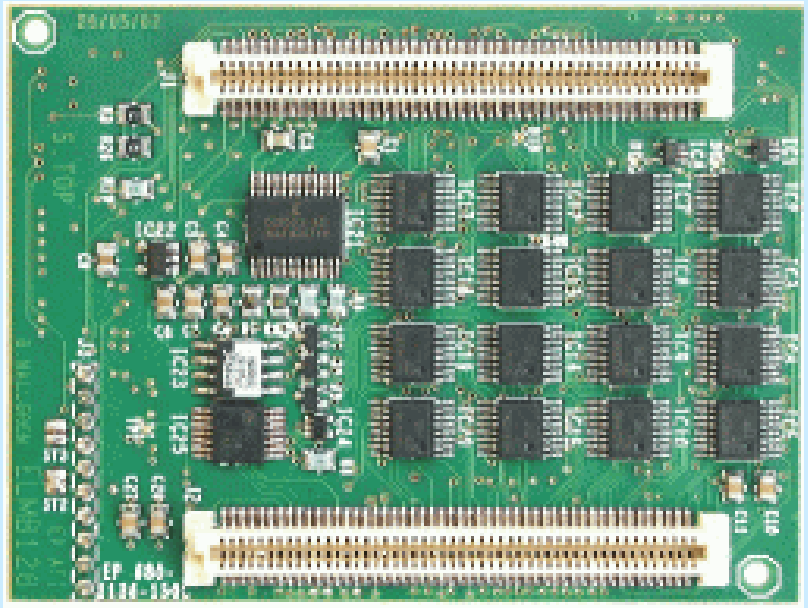
May be remotely powered

ADC 16 bits + 7 bit gain

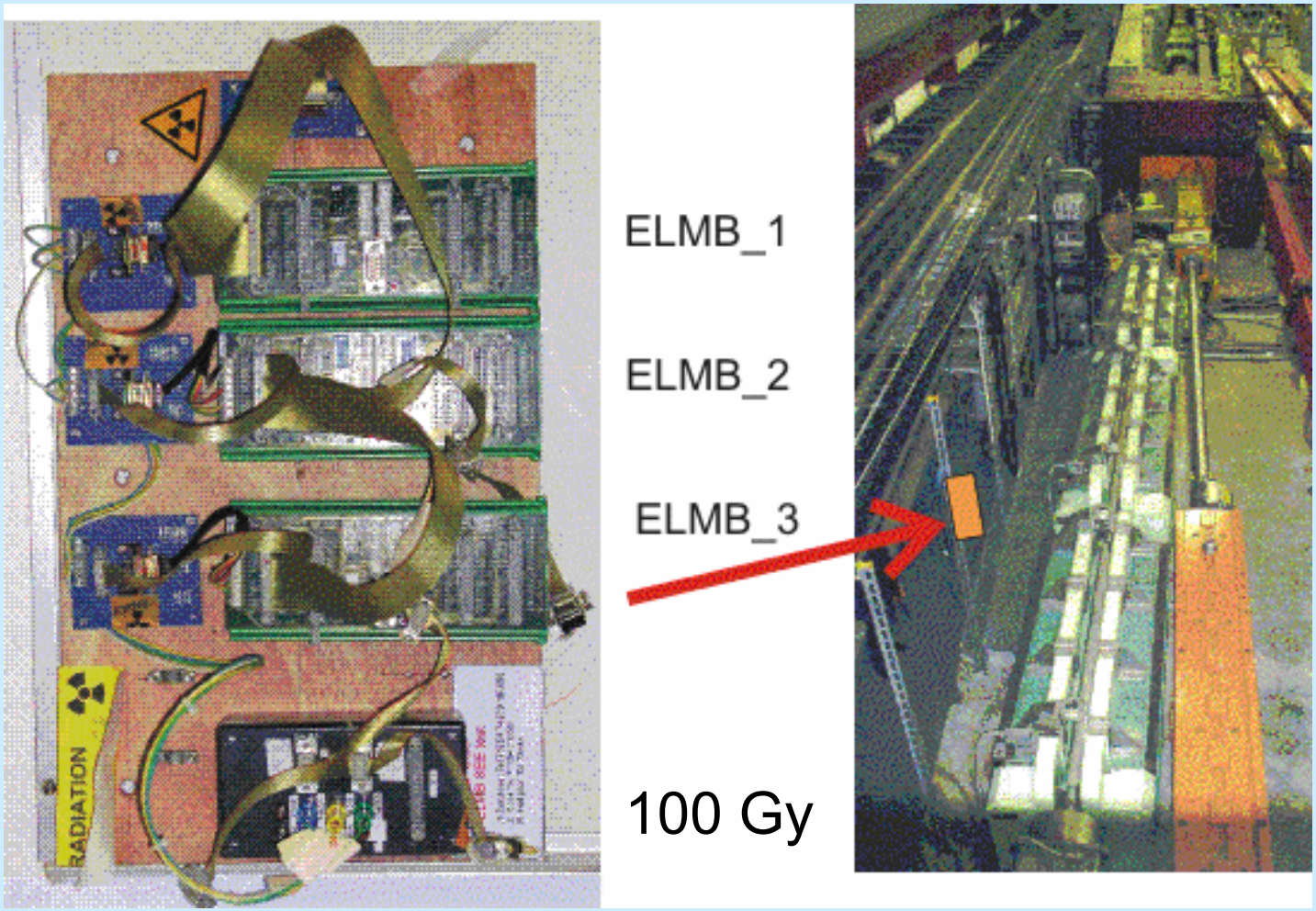
64 channel differential multiplexer

1000 pieces produced by industry

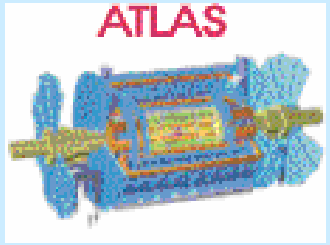
Cost < 150 CHF



TCC2 2002 ELMB Position



ELMB Test Setup



PC
PVSS

ELMB for
Power
monitoring
and cycling

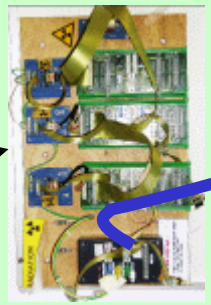
CAN
and
power
cable

+12V

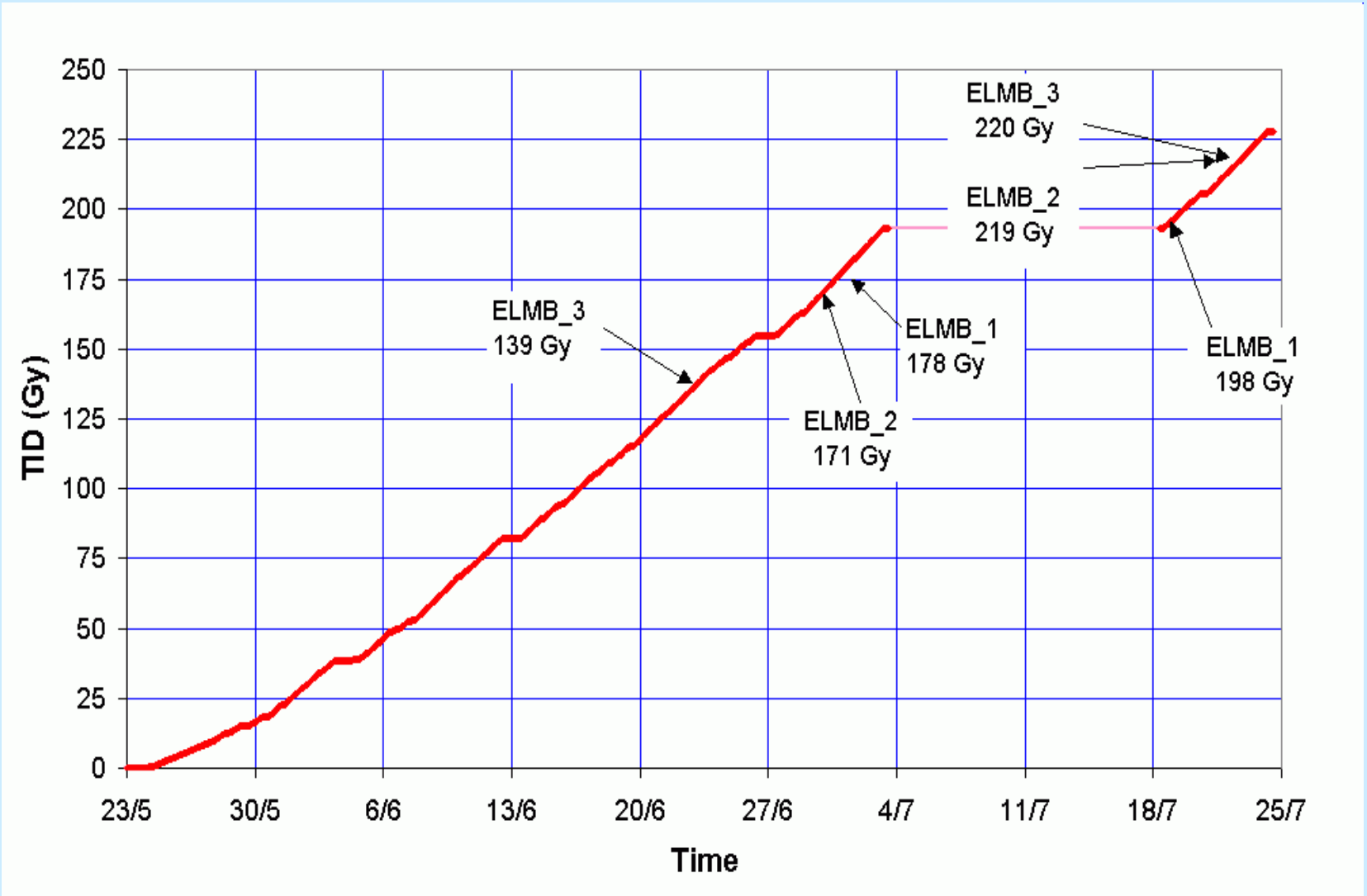
150 m

TCC2 AREA

3 x ELMB



Daily variation of the dose and the dose when each ELMB stopped



Result of ELMB "functional" SEE test

Table 5: Result for ELMB_1 and ELMB_2 together (ATmega128L 0.35 µm)

Recovery	Number of SEEs detected	Average fluence per error
Hard resets	4 for $5.9*10^{11}$ particles/cm^2	$1.5*10^{11}$ particles/cm^2
Soft resets	4 for $5.9*10^{11}$ particles/cm^2	$1.5*10^{11}$ particles/cm^2

Table 6: Result for ELMB_3 (ATmega103L 0.5 µm)

Recovery	Number of SEEs detected	Average fluence per error
Hard resets	4 for $2.2*10^{11}$ particles/cm^2	$5.5*10^{10}$ particles/cm^2
Soft resets	3 for $2.2*10^{11}$ particles/cm^2	$7.3*10^{10}$ particles/cm^2

Hard = power cycling; Soft = software CAN command

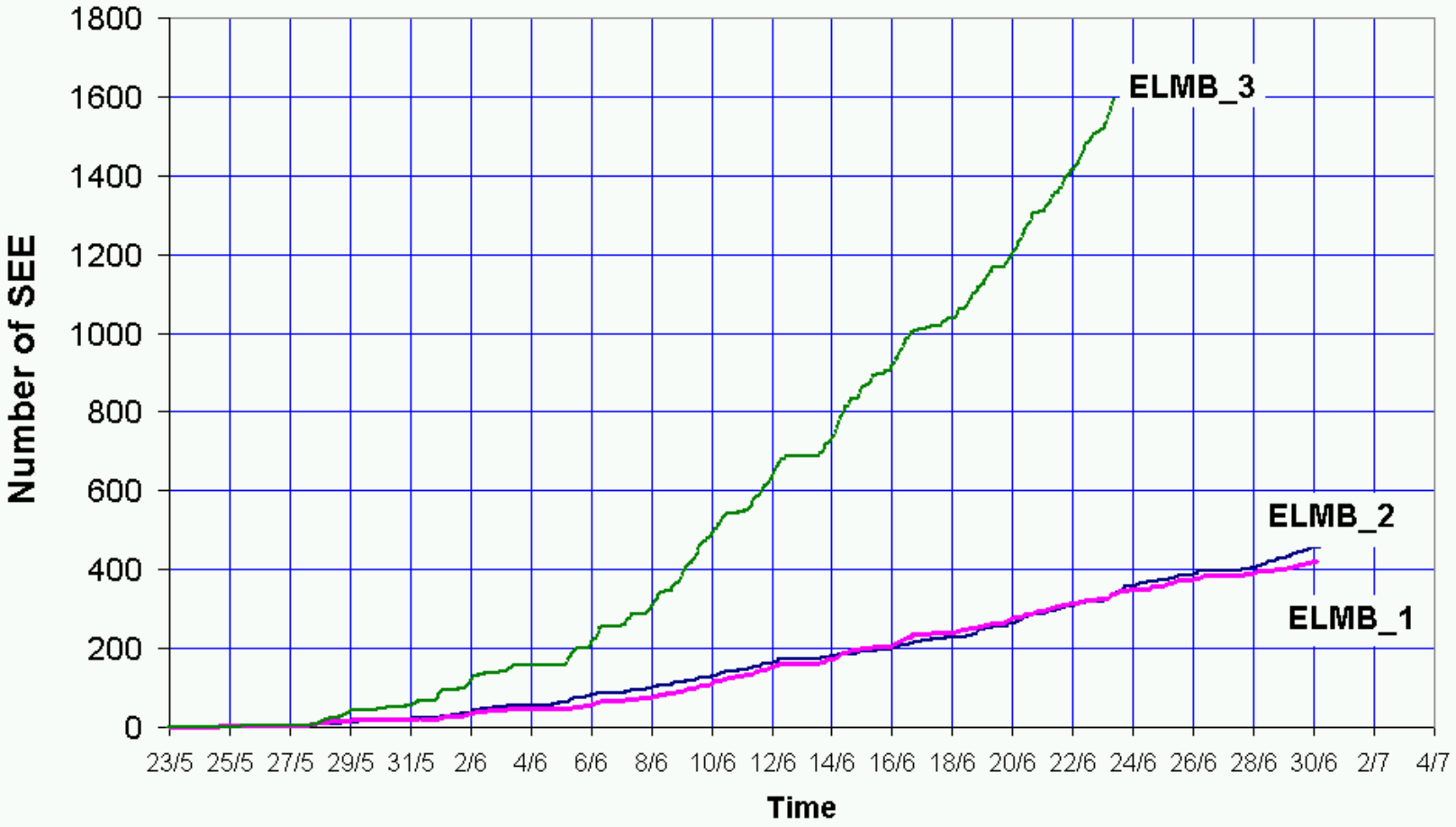
Example of ATLAS performance

- ATLAS MDT Barrel 2

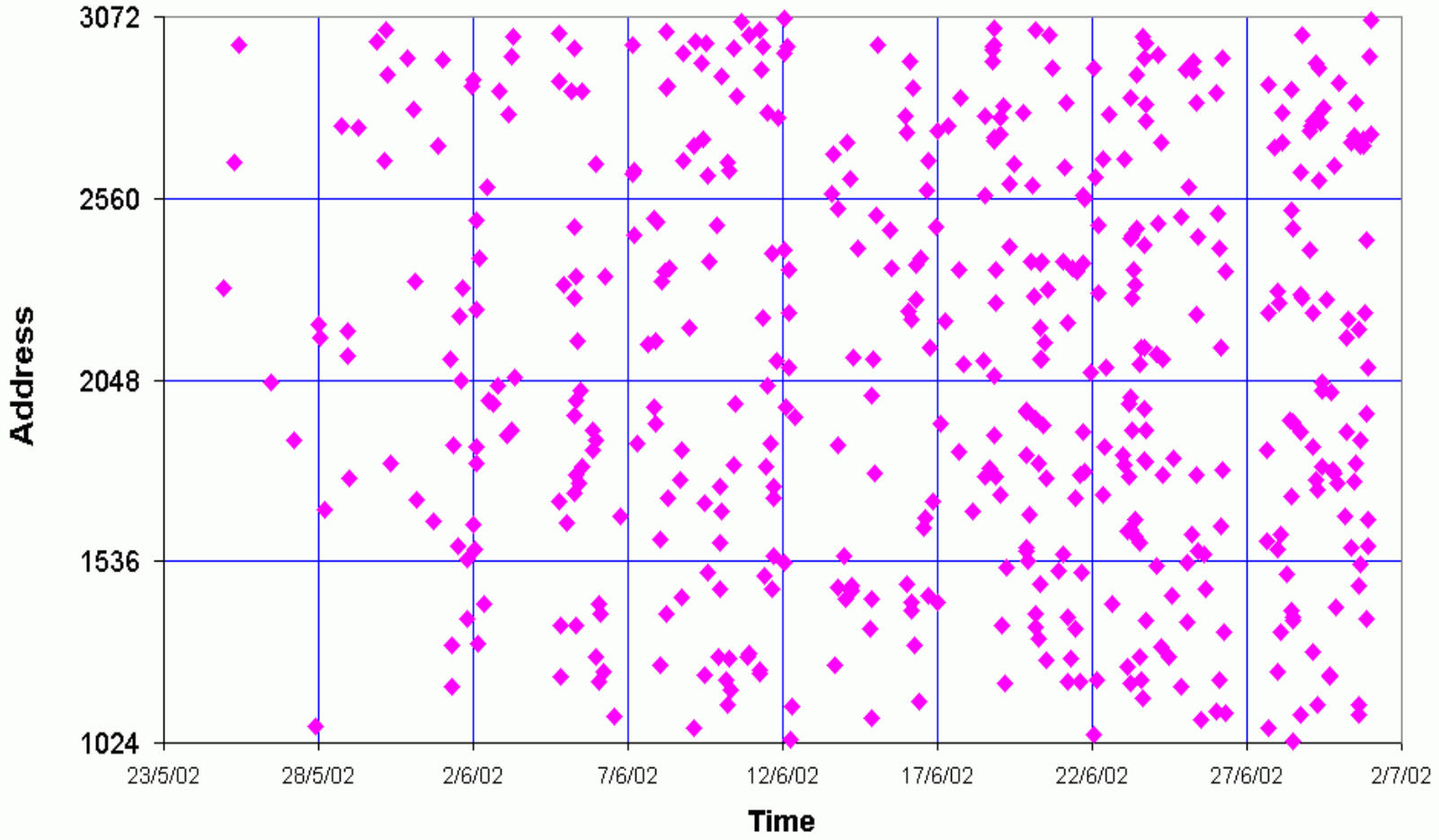
  Simulation $6*10^9$ h * cm^2 in 10 years

  Safety factor of 20 gives $1.2*10^{11}$ h * cm^2
- About one soft reset and hard reset per ELMB in 10 years - but 1200 ELMBs in this detector
- **CANopen Node guarding feature together with Automatic power cycling needed.**

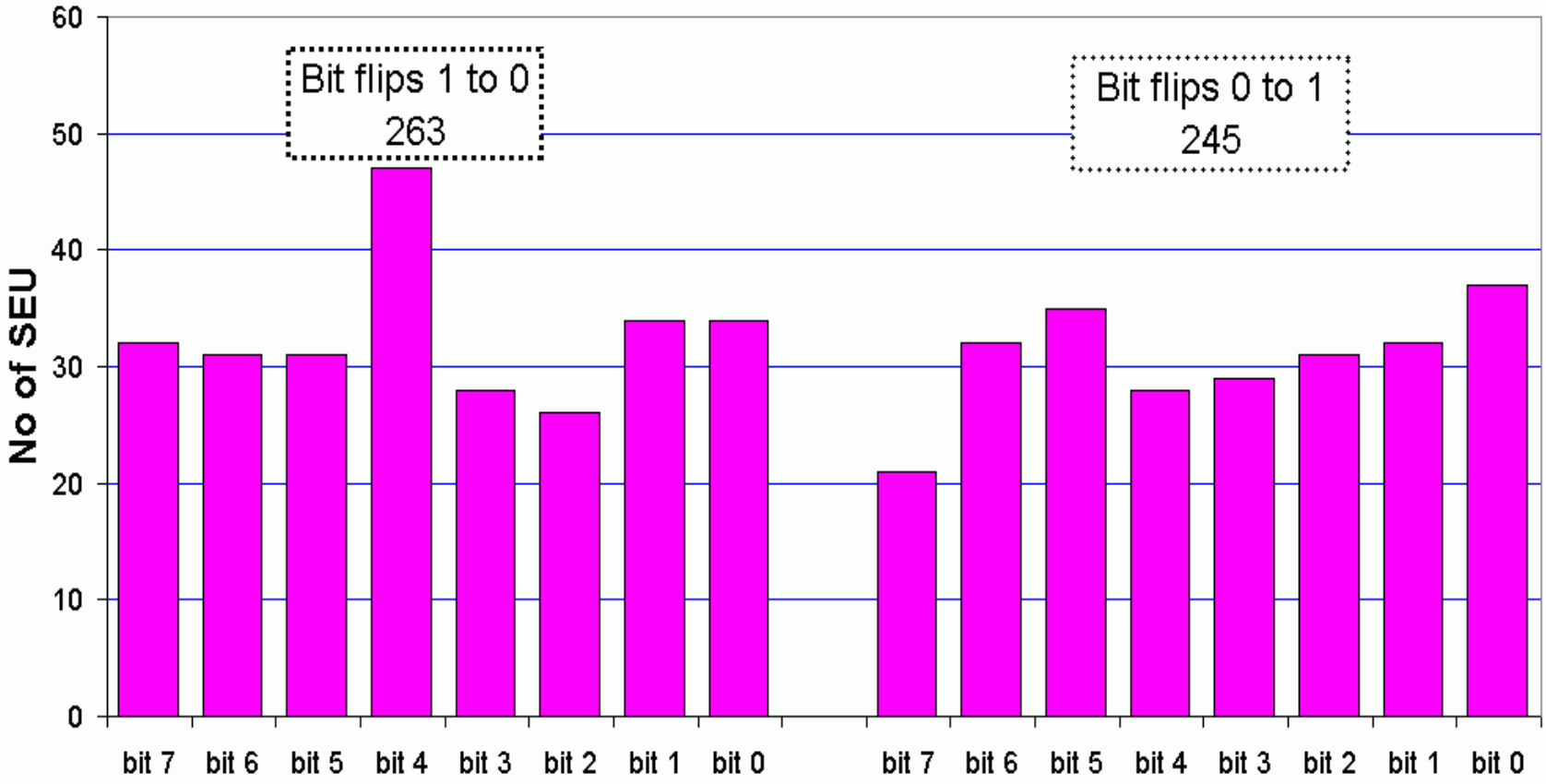
The number of SEE in SRAM (2kbytes)



SRAM SEE versus address for the ELMB_1 TCC2-02



ELMB_1 SRAM Bit errors



Results of systematic SEE study

Device under test	Number of bits tested	Number of errors	Estimated fluency hadrons/cm^2 (1)	Cross-section cm^2/bit
SRAM 0.5 µm	16384	1593	$2.2*10^{11}$	$4.4*10^{-13}$
SRAM 0.35 µm	16384 x 2	904	$5.9*10^{11}$	$9.4*10^{-14}$
EEPROM	28762	<1	$8.1*10^{11}$	$< 4.3*10^{-17}$
FLASH	524288	<1	$8.1*10^{11}$	$< 2.4*10^{-18}$
CAN register	320	65	$8.1*10^{11}$	$1.0*10^{-13}$
ADC register	264	54	$8.1*10^{11}$	$2.5*10^{-13}$

(1) The fluency is estimated from the known cross-section of the SRAM 0.5 µm as measured with 60 MeV protons.

Example of ATLAS

- For a fluence of $1.2 * 10^{11}$ h / cm^2 10 years

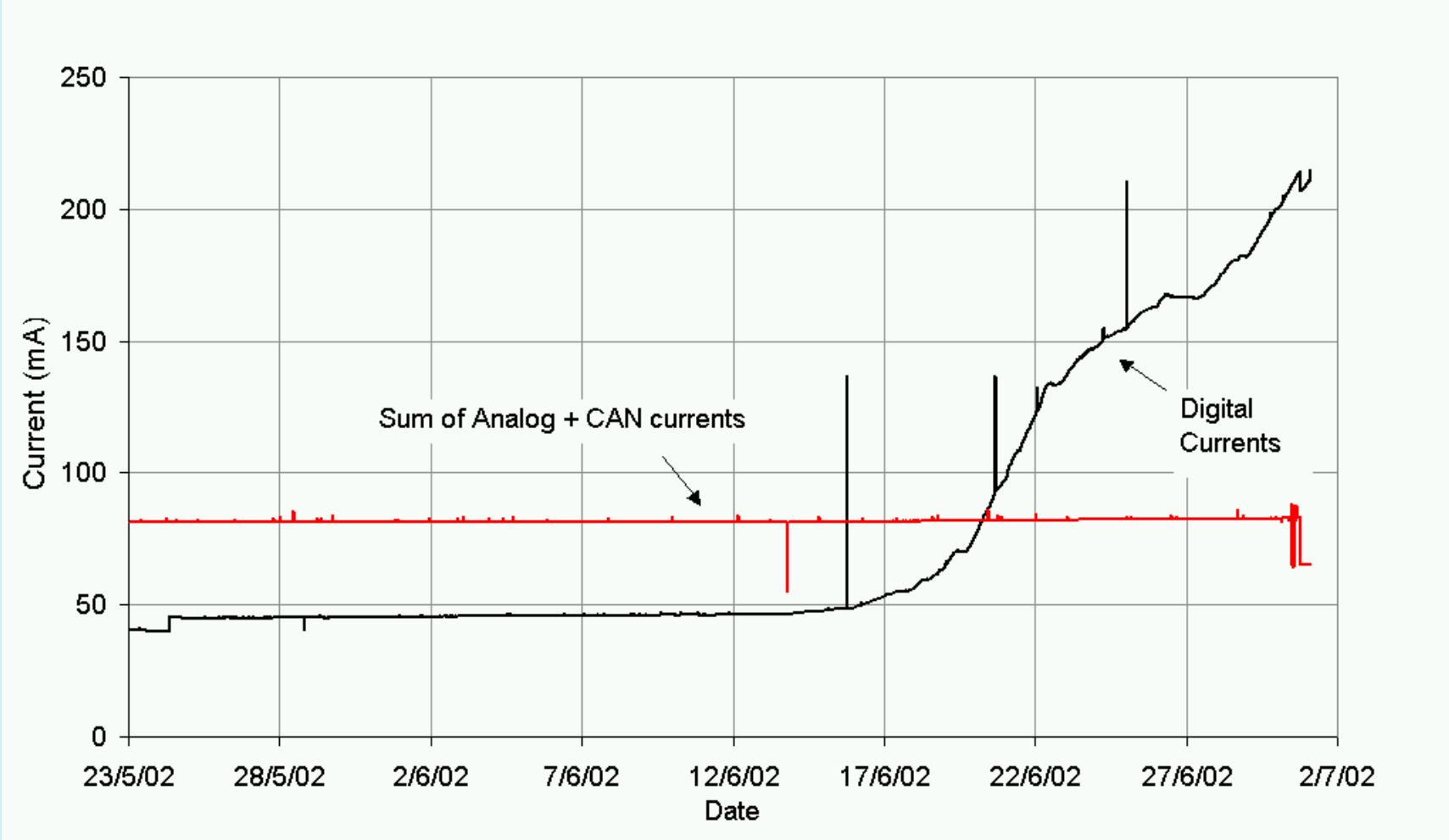
A technology with a cross-section of $1 * 10^{-13}$ cm^2 / bit would mean that:

A 8 bit register would receive 1 SEE / 100 years

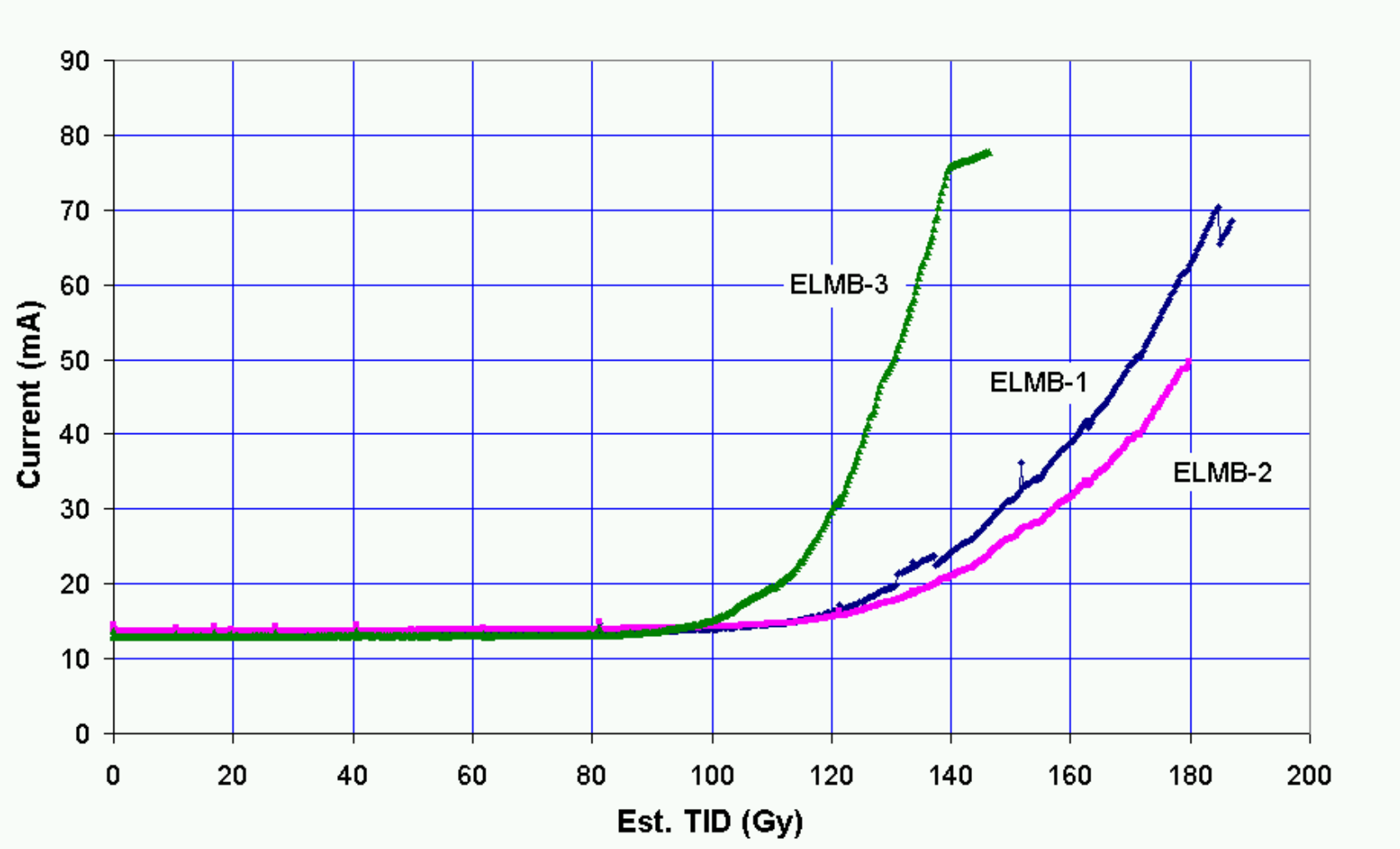
The application will decide if this is OK or NOT

TID effects

Measured currents during the first part of the irradiation



ELMB Digital Current



Conclusions

- More details in the report

http://atlas.web.cern.ch/Atlas/GROUPS/DAQTRIG/DCS/ELMB/DOC/TCC2_2002_report.pdf

- TCC2 is very useful for long term studies and functional system tests
- Next year test “wish”

10^{13} particles/cm^2 and 100 Gy