FIPDiag PSI Radiation test Presentation

Radwg meeting
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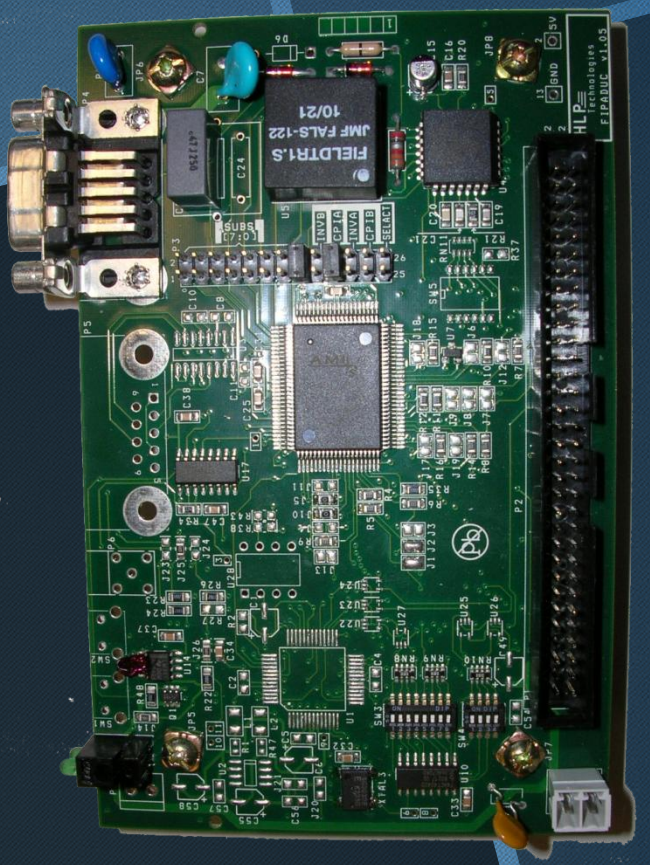
1. Devices Under test
2. Description of the test setup
3. Beam setup and results
4. Other observations
5. Conclusions

1 Devices Under Test

3 FIPdiags A, B & C

- Version 1.05
- Current initial consumption : 120mA
- Frequency : 1MHz
- Memory used : 2Bytes x 2
- Fuse : 500mA PTC
- Anti LatchUp set to 500mA during 1.6s (measured in lab)
- Mode standalone



1 Devices Under Test

Other devices present in the setup :

- Manager “FIPMOBILE” SLC5 (on surface)
- FIPWatcher (on surface)
- Labview acquisition system (on surface)

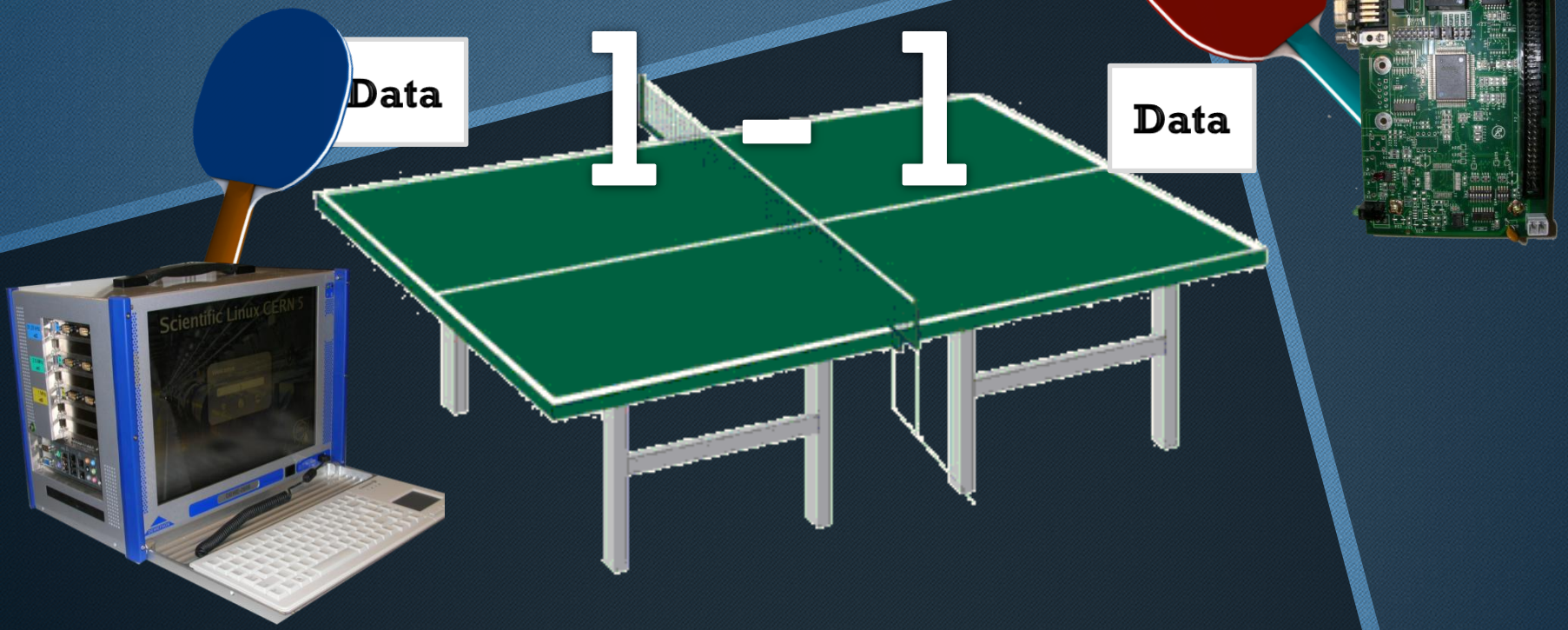
Control room

FIPMOBILE, BA manager

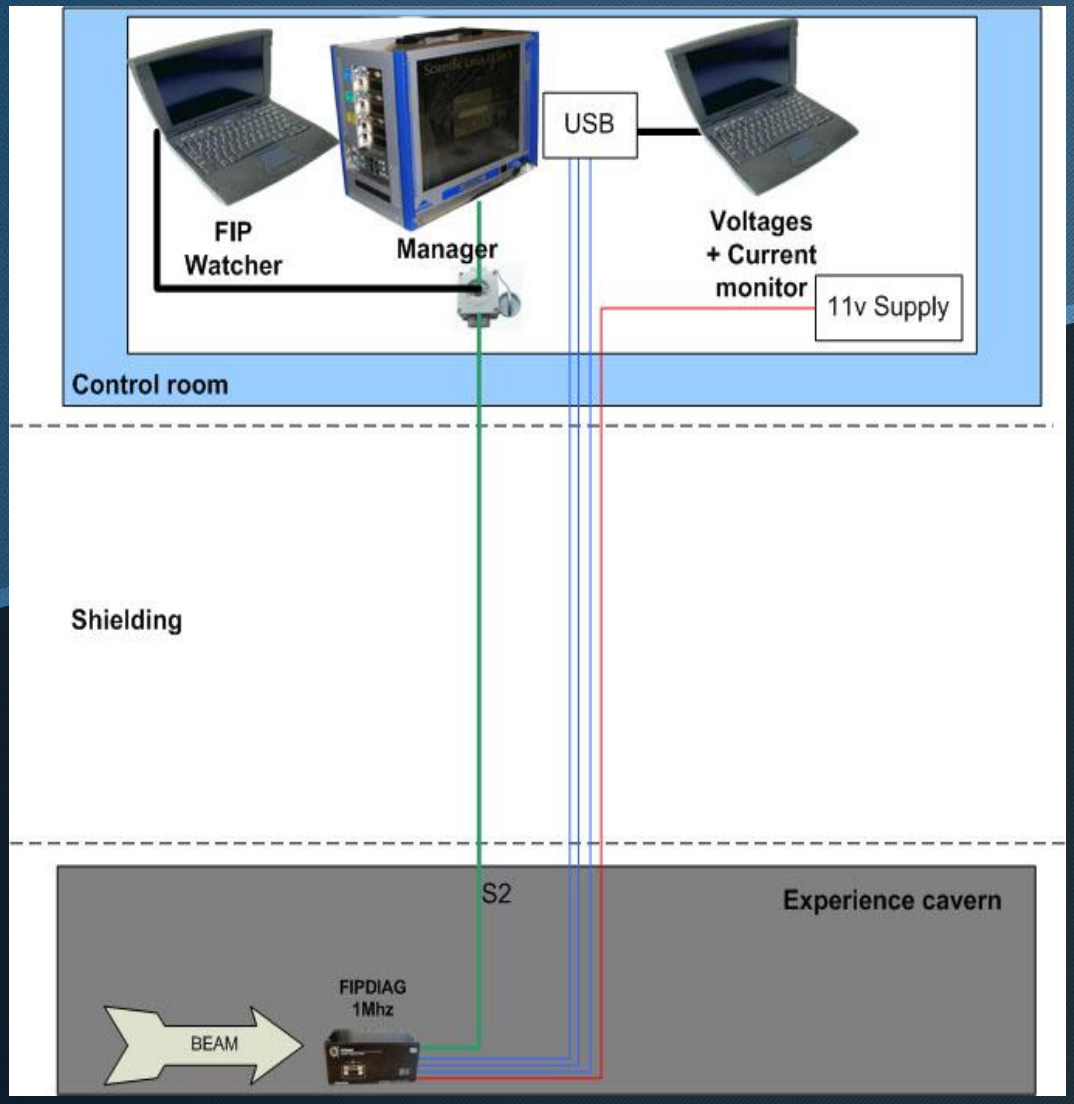
2 Description of the test setup

Ping Pong mechanism :

- The manager send a data every cycle
- The FIPDiag copy and return the value to the manager
- The manager compares both datas and log errors



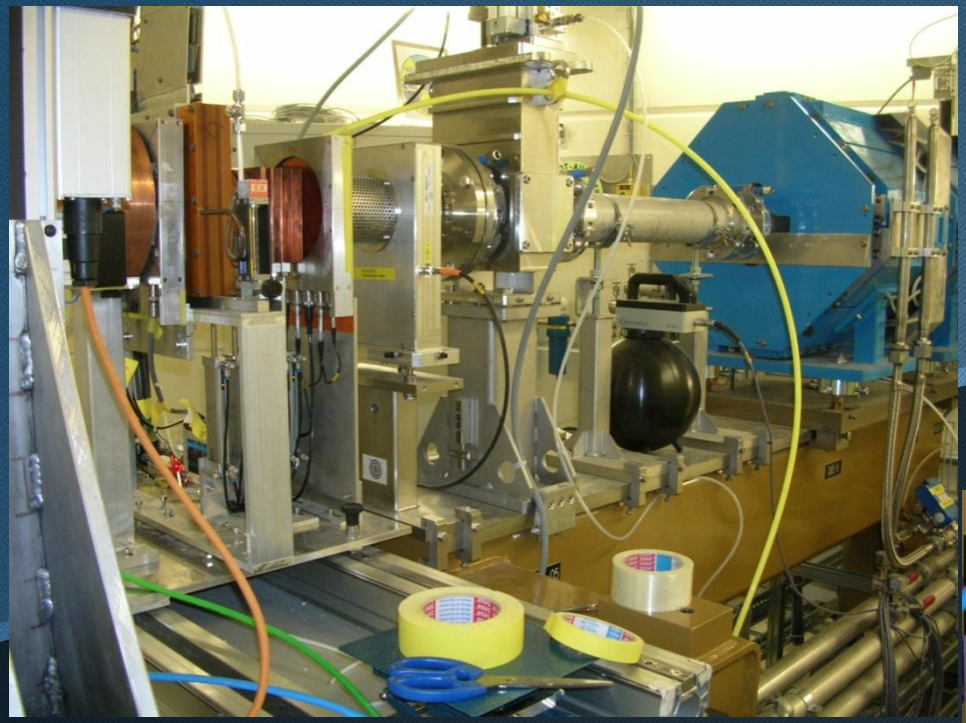
2 Description of the test setup



Mechanisms added :

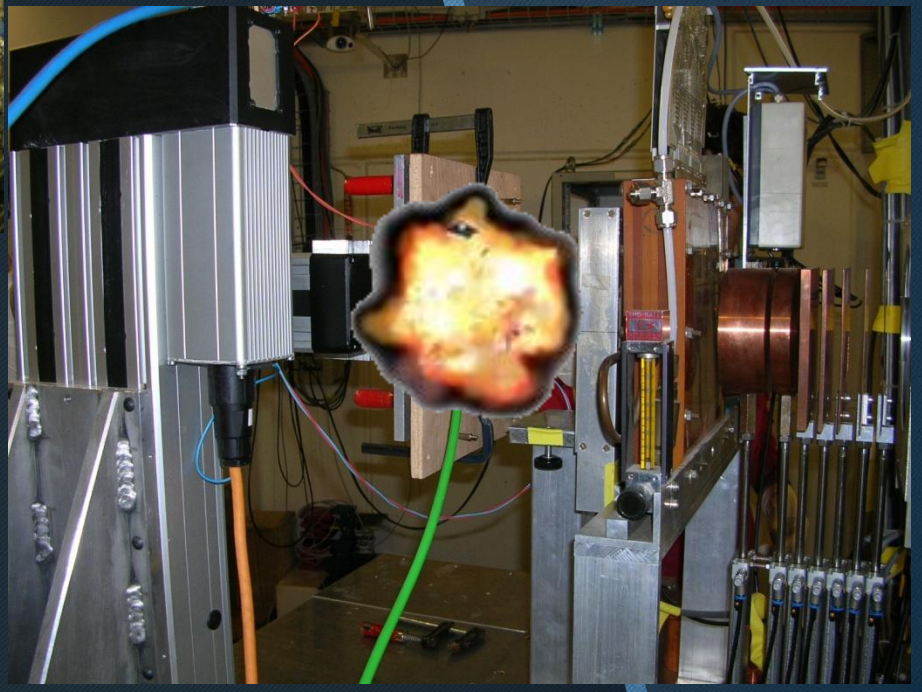
- Current measure + logging
- 5v Vcc measure + logging
- 5v Supply measure + logging
- Remote power cycle (11v Supply)
- Data control + logging
- Anti lachup reset (Vcc) onboard
- Soft reset (Vcc)

2 Description of the test setup



PSI, PIF Facility 230 MeV proton beam

FIPDiag under fire



3 Beam setup and results

First RUN : FIPDiag A

BEAM

Components irradiated :

- Q1 Si3443 canal P
- U13 74HCT32D Quad 2-inputs OR gate
- U17 74HCT123D Dual retriggerable monostable multivibrator with reset
- U6 MICROFIP
- U7 MAX809 Power on reset
- XTAL1 40MHz oscillator

Beam conditions :

- Start 7h22
- End 8h02
- Proton
- Energy : 230 MeV
- Flux 1.60E+08 $P/cm^{-2}/s$
- Dose rate : 8.6 rad/s (309 Gy/H)
- Collimator : none (=9cm)
- Macrocycle : 100ms

3 Beam setup and results

First RUN : FIPDiag A

Failures :
At 7h40

Current consumption goes up to 340mA, make the 5v voltage down to 3.5v.

No com

Beam dump

Soft reset

No com

Power cycle

Com OK

- **Fluence since last recovery [cm^{-2}] : 2E+11**
- **Total dose [Gy] : 108**

Seems like a SEL on a component.

3 Beam setup and results

First RUN : FIPDiag A

Failures :
At 8h02

Rise of the current

No com

Beam dump

Soft reset

No com

Power cycles

No recovery

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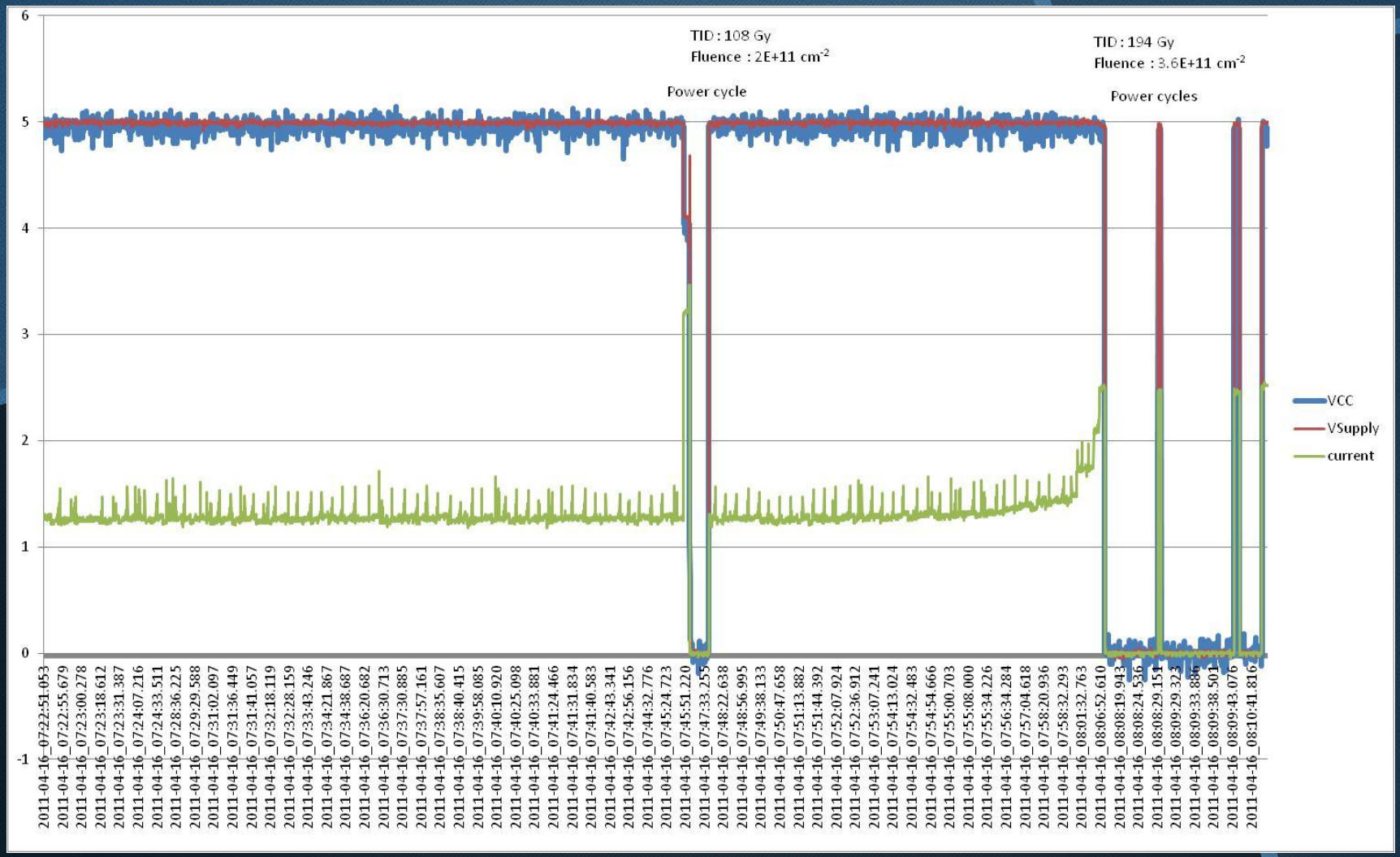
- **Fluence since last recovery [cm^{-2}] : 1.6E+11**
- **Total dose [Gy] : 194**

With a test with a multimeter, the U7 was blocked and delivered a permanent reset.

3 Beam setup and results

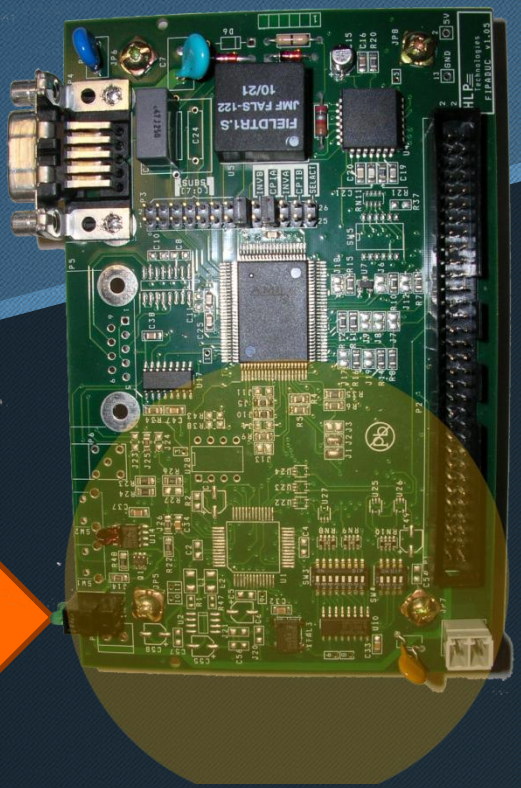
First RUN : FIPDiag A

Logging graph :



3 Beam setup and results

Second RUN : FIPDiag B



Components irradiated :

- Q1 Si3443 canal P
- U10 74HCT4040 12-stages counter
- U8, U11 74HC11D Triple 3-inputs AND
- U13 74HCT32D Quad 2-inputs OR gate
- U14 LM311D Voltage comparator
- U18 MC7805ABD2T Regulator+5V 1A
- XTAL3 32.768kHz oscillator

Beam conditions :

- Start 9h32
- End 10h35
- Proton
- Energy : 230 MeV
- Flux 1.60E+08 P/cm^{-2}/s
- Dose rate : 8.6 rad/s (309 Gy/H)
- Collimator : none (=9cm)
- Macrocycle : 100ms

3 Beam setup and results

Second RUN : FIPDiag B

Failures : NONE

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Com OK

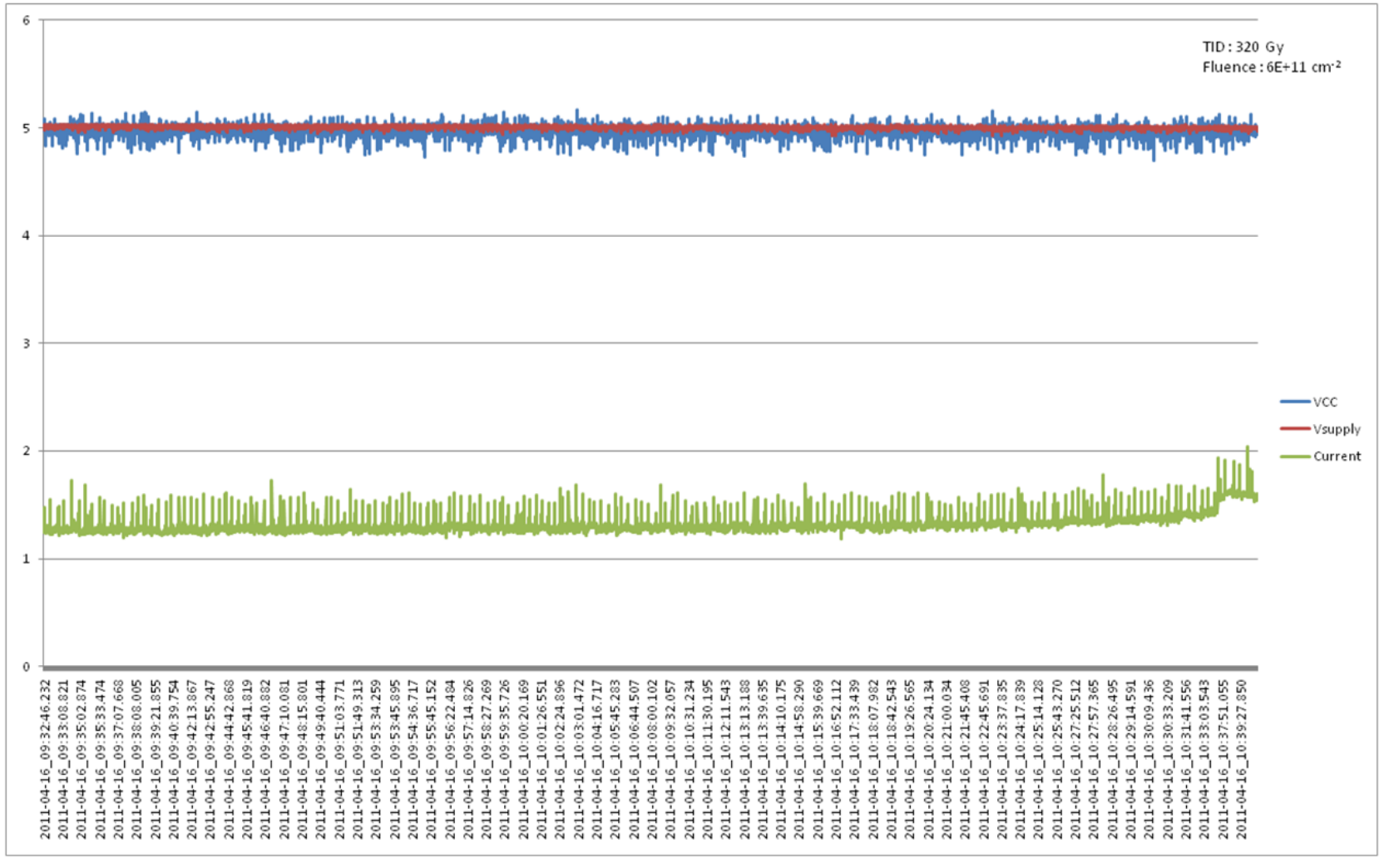
- **Fluence since last recovery [cm^{-2}] : 6E+11**
- **Total dose [Gy] : 320**

No error but the current has started to grow at the end

3 Beam setup and results

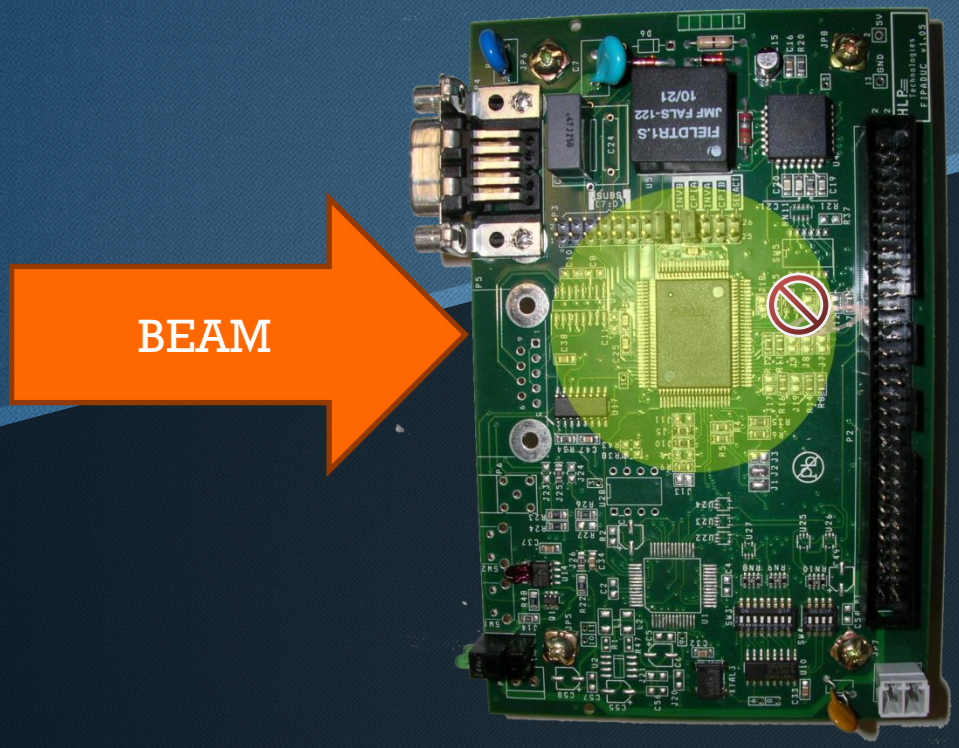
Second RUN : FIPDiag B

Logging graph :



3 Beam setup and results

Third RUN : FIPDiag C



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Components irradiated :

- U17 74HCT123D (not all)
  Dual retriggerable monostable multivibrator with reset
- U6 MICROFIP
- ~~U7 MAX809 Power on reset~~

NB : The monostable U7 has been disabled (Thanks to Paul's idea)

Beam conditions :

- Start 10h57
- End 11h51
- Proton
- Energy : 230 MeV
- Flux 1.60E+08 P/cm^{-2}/s
- Dose rate : 8.6 rad/s (309 Gy/H)
- Collimator : 5cm
- Macrocycle : 15ms

3 Beam setup and results

Third RUN : FIPDiag C

Failures :
At 11h20

Com lost during 101cycles (1.5sec)

No com

AntiLatchUp reset

Com OK

- **Fluence since last recovery [cm^{-2}] : 1.7E+11**
- **Total dose [Gy] : 95**

Seems like a SEL on the MicroFIP (or U17).
We do not see the current increase
but it must be due to the slow logging
acquisition (50Hz).
The time of the com lost (1.5sec)
match exactly with reset period,
and the Vsupply was on.

3 Beam setup and results

Third RUN : FIPDiag C

Failures :
At 11h51

A huge rise of the current drop down the voltage.

No com or data errors

Beam dump

Soft reset

No com

Power cycles

No recovery

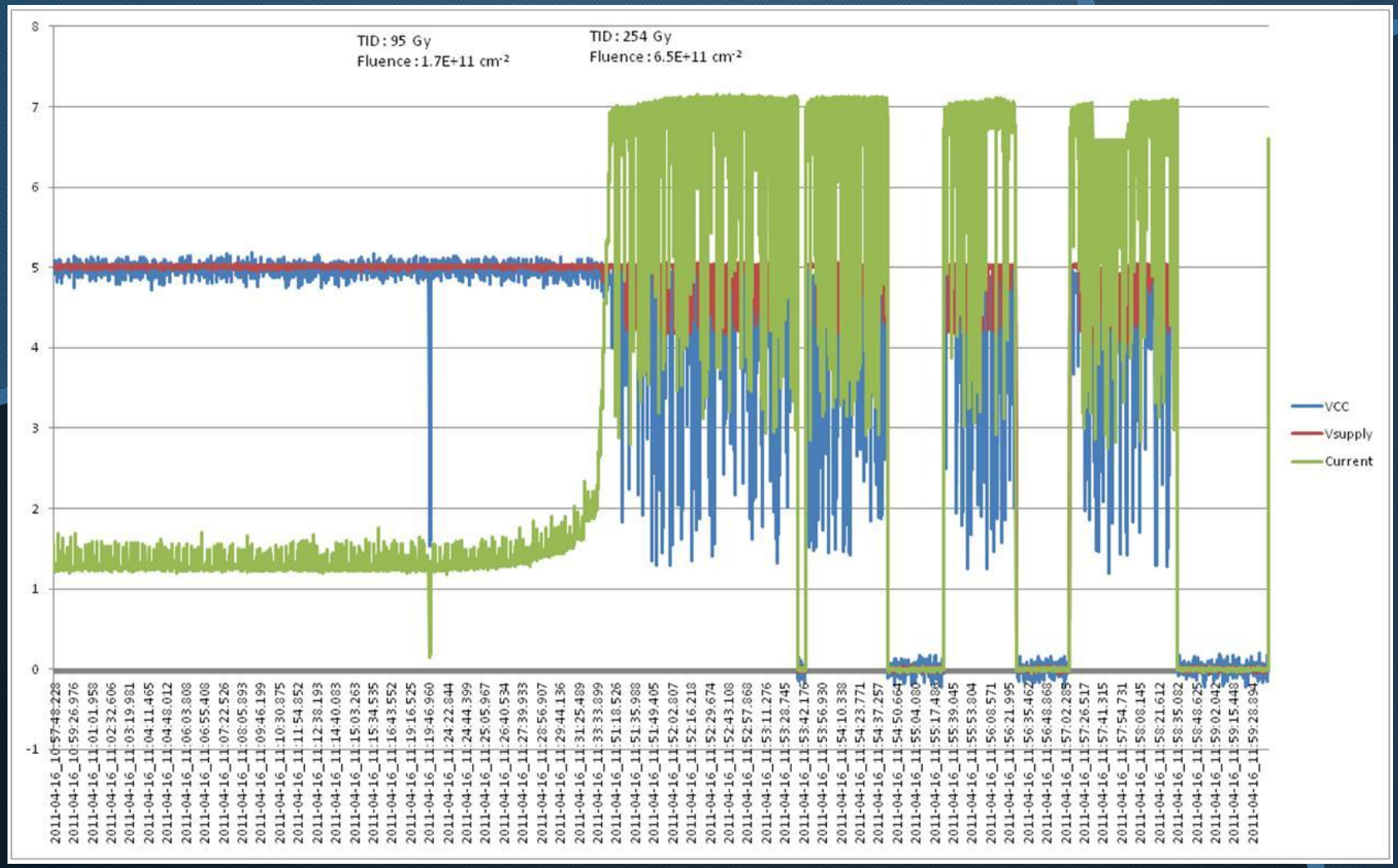
- **Fluence since last recovery [cm^{-2}] : 4.8E+11**
- **Total dose [Gy] : 254**

Looks like total dose effect.
We test it again after a long rest (MicroFIP + U17) and it works again .

3 Beam setup and results

Third RUN : FIPDiag C

Logging graph :



4 Other observations

To measure current, a resistance of 10 Ohm was on the surface.

This choice was not appropriate because of the unexpected transom, raise of the current observed, that causes drops in voltage too great and does not guarantee the proper functioning of the 5V regulator.

At the end of the third Run**,** we tried to compensate the drop of the voltage by increasing several times the 11v supply. Then a lot of data errors and com lost occurs with the current at 700mA.
At this time we think that the AntiLatchUp reset doesn't work anymore.

In other hand, maybe it prevent from a latchUp in the first run, by dropping the voltage when the current has raised

5 Conclusions

The purpose of these tests was to identify which components of the module FIPDiag benefit from being replaced for the new card NanoFIPDiag : FIPDiag with the chip NanoFIP in place of MicroFIP, now recognized as sensitive to radiation.

The results are quite good, a component U7 MAX809 has been identified as weak and will be replaced by passive components (see Amelioration fiabilite WorldFip wfdc001.pdf) in the next design NanoFIPDiag.

The MicroFIP held to about 1.7E+11 **cm^{-2}** fluence (95Gy) without perturbation, then after a power cycle fail at 254Gy (4.8E+11**cm^{-2}** fluence), mean score but not alarming for a diagnostic module. Recently we have tested the FIPDiags back from PSI and they are all working again.

However it worked in standalone mode, its mode of operation as simple and with less memory.
In addition, given the small number of observed events, it is difficult to evaluate a cross-section, further testing would be needed in microcontroller mode.

5 Big thanks

I would like to thanks Eva Gousiou, Paul Peronnard and Giovanni Spiezia for their help in these tests.