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Cu/Cu Repeater CHARM Radiation test Presentation

Radwg meeting
26 Nov. 2018

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1. Devices Under test
2. Description of the test setup
3. Experimental results
4. Conclusions

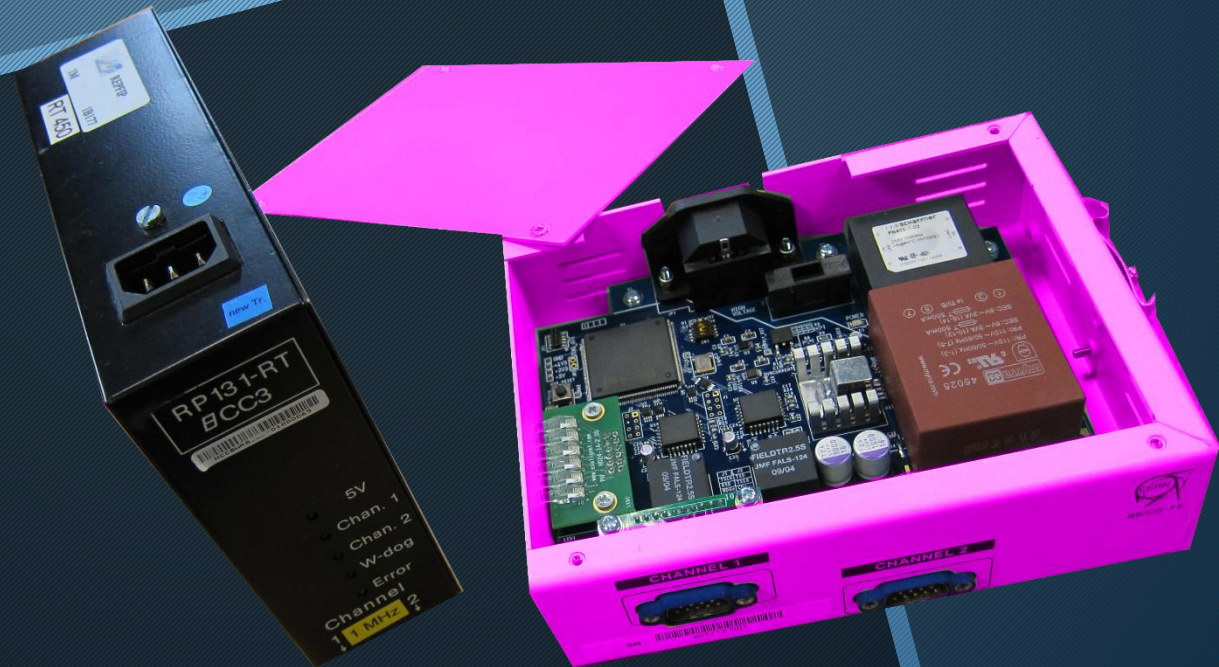
1 Devices Under Test

Currently there are ~300 Cu-Cu repeaters installed in the LHC, most of them under radiation.

Those repeaters were installed 10 years ago and they have been working reliably so far.

The goal of those tests is to validate a new design, that mainly replaces obsolete components with new ones from the RADWG database.

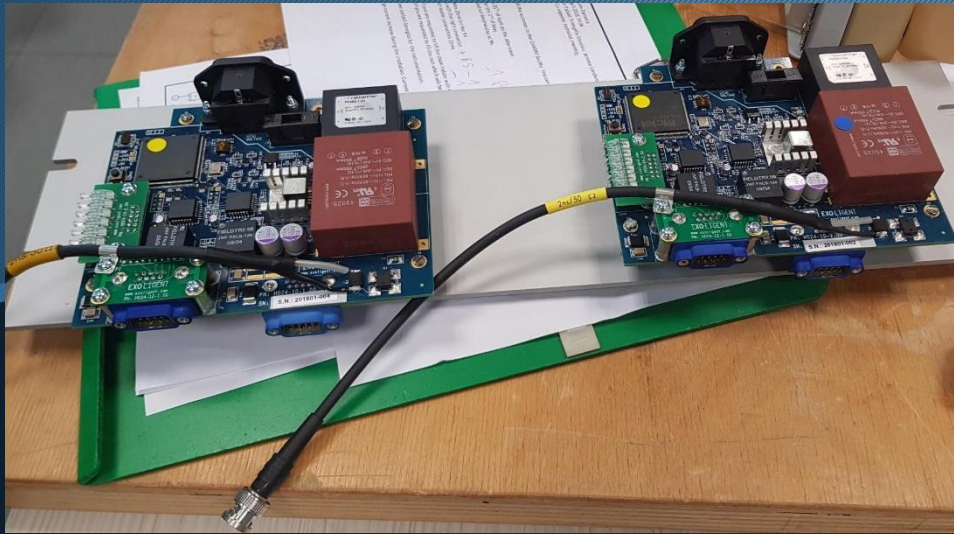
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1 Devices Under Test

RUN1: 2 Copper/Copper repeaters Rep-02 & Rep-04 3

- With original mosfet IRFR9220



- Version Prototype
- Manufacturer : EXoligent
- Current initial consumption : 110mA
- WFIP Speed : 2.5MHz
- Main components: FPGA ProAsic3, FieldDrive SSS-B231
- Anti-lachup mechanisms.
- Non-repetition timeout mechanism.

RUN2: 2 Copper/Copper repeaters Rep-01 & Rep-03

- Rep-01 With no mosfet (short circuit)
- Rep-03 With new mosfet SI3443

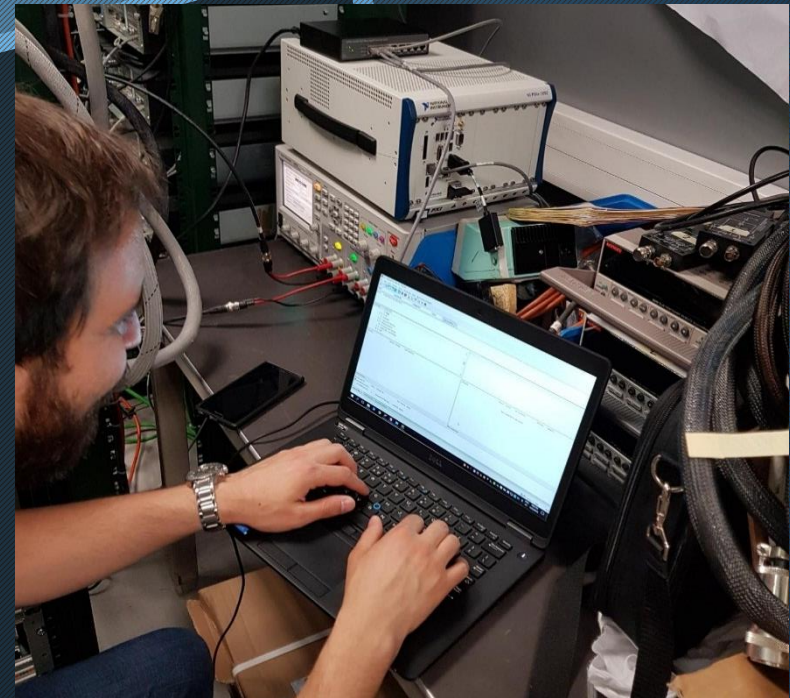
1 Devices Under Test

Other devices present in the setup :

- 2 FECs Manager in control room
- 2 FIPDiags in control room
- Georgios Current monitoring setup in control room

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Control room



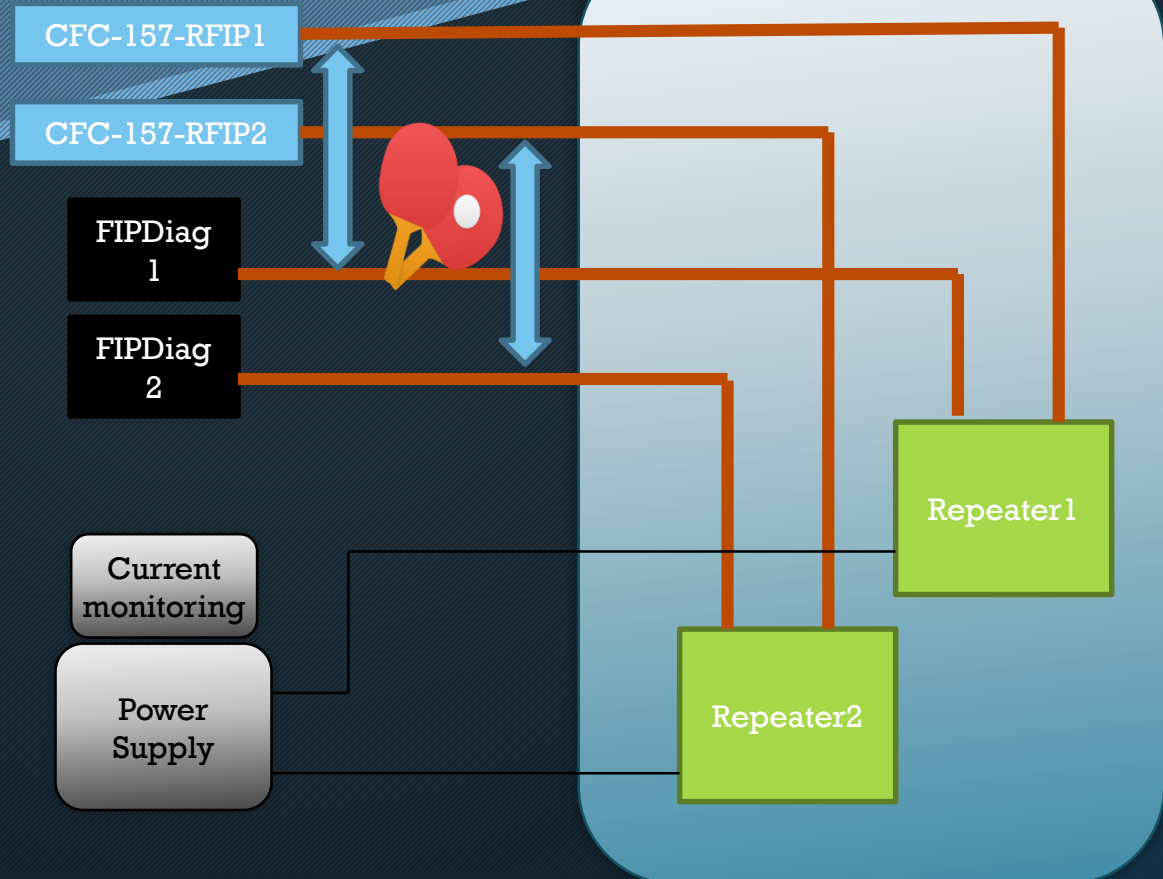
Current monitoring setup

2 Description of the test setup

Ping Pong mechanism :

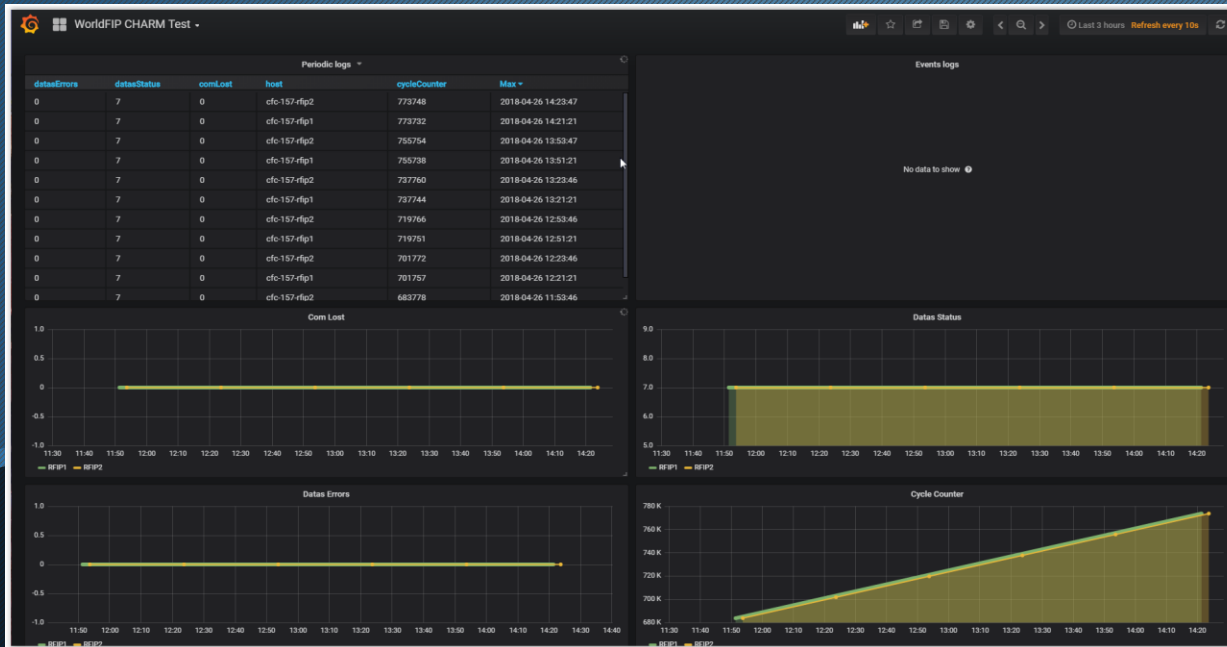
- The FEC manager send a data every cycle
- The repeater repeats the data in both ways
- The FIPDiag copy and return the value to the manager
- The FEC manager compares both datas and log errors

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2 Description of the test setup

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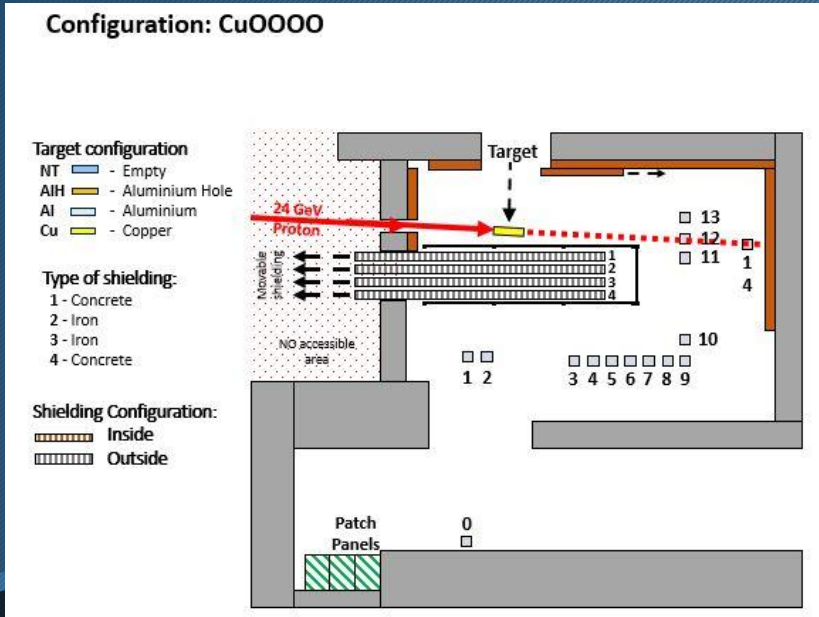


All errors counters are logged in database and could be retrieved thanks to a graphical interface

There is also a pc and a smart oscilloscope on the control room for power-supply and logging of the current consumption of the repeater.

2 Description of the test setup

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CHARM Configuration and run conditions

Configuration	Cu0000
Position	13 (R13U7)
Target Inside	2018-05-02 18:00:00
Target Outside	2018-05-23 09:00:00
H _{10%} [GeV]	3.34
H _{50%} [GeV]	0.70
Dose [Gy]	987Gy
1MeV eq. fluence [cm ²]	9.31 .10 ¹²
HEH fluence [cm ²]	3.74 .10 ¹²
Total POT	3.74 .10 ¹⁶

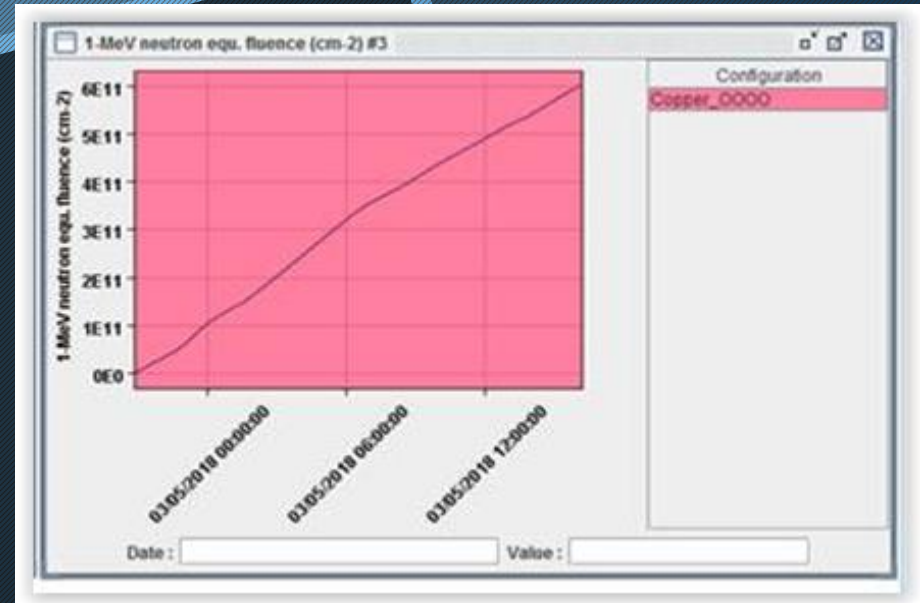
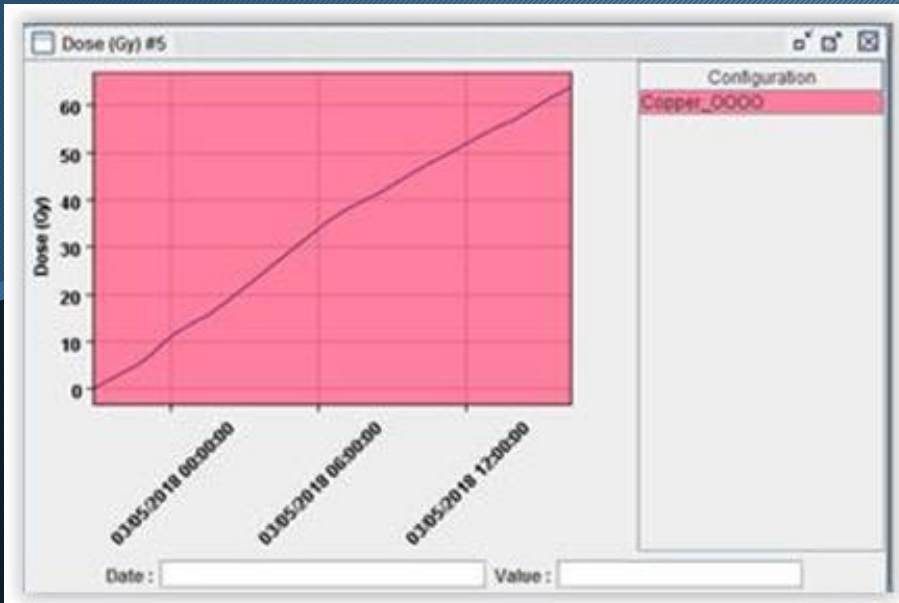
3 Experimental results

RUN 1: Rep02 & Rep04



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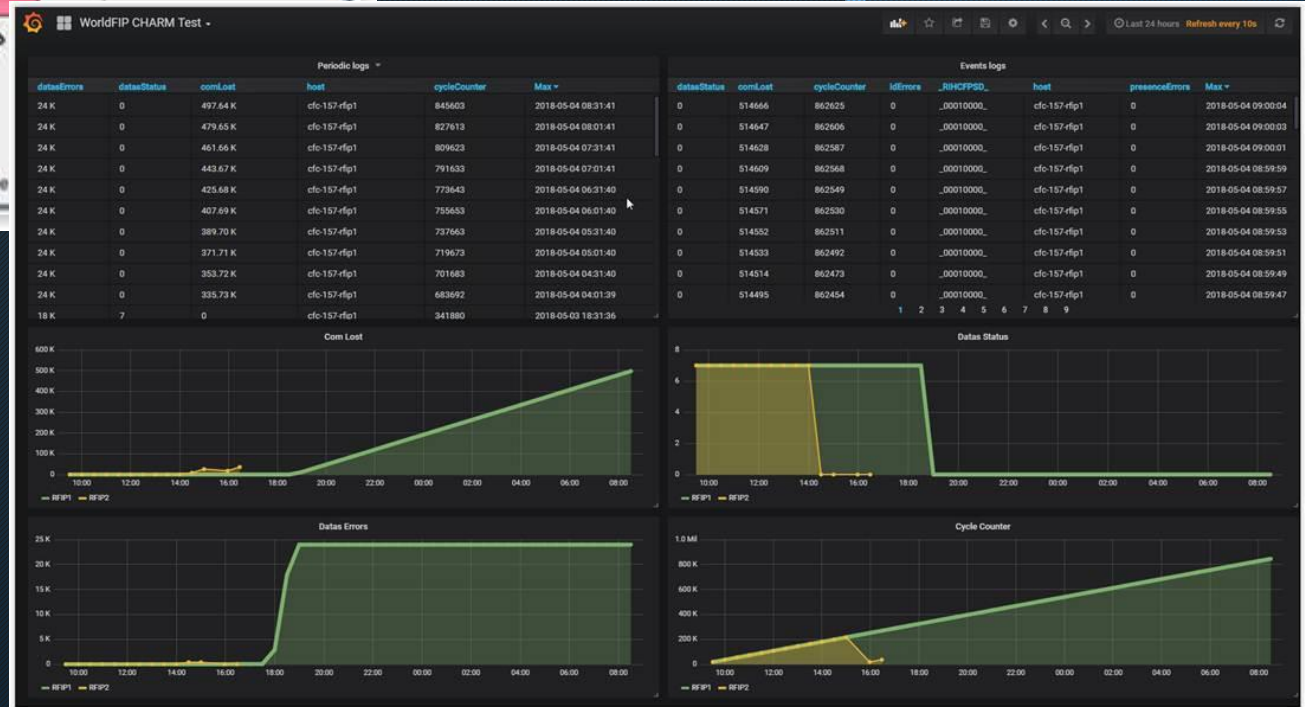
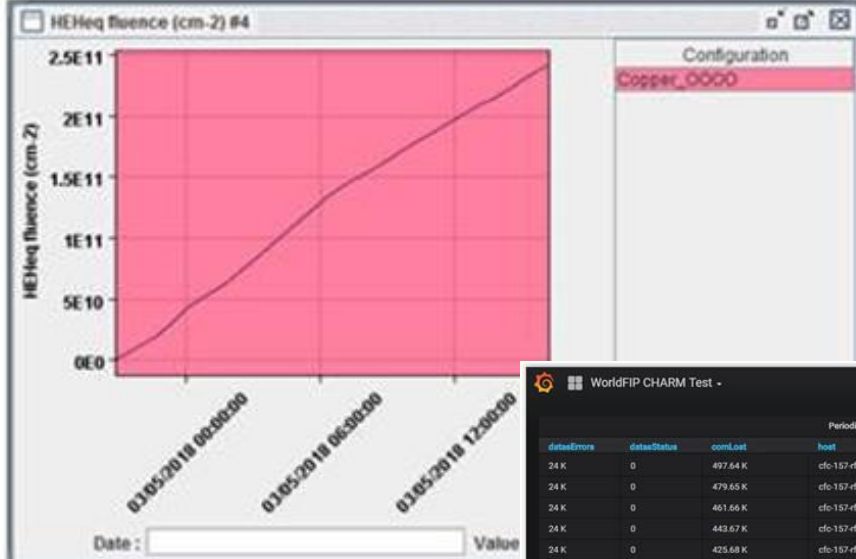
Both DUTs quickly died at 60Gy.



3 Experimental results

RUN 1: Rep02 & Rep04

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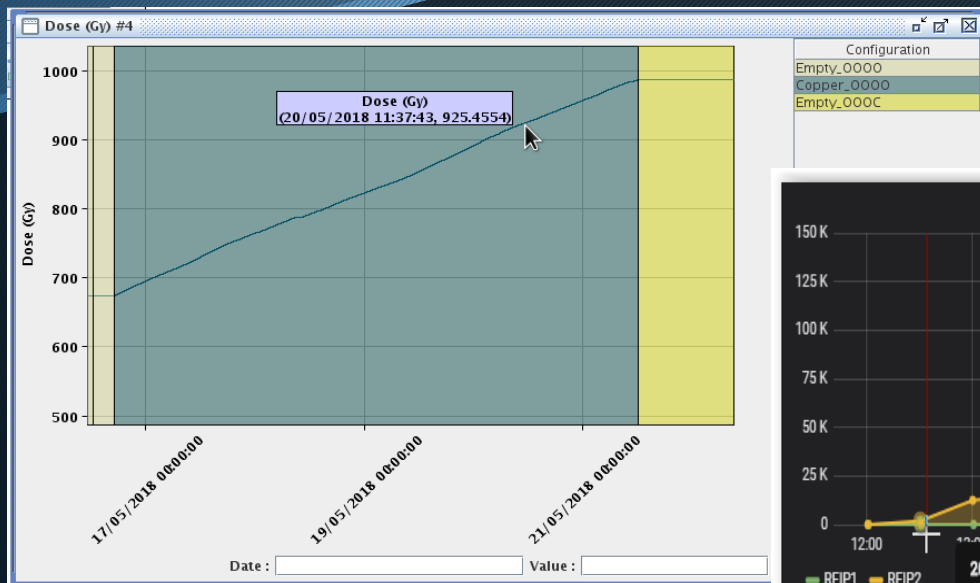


3 Experimental results

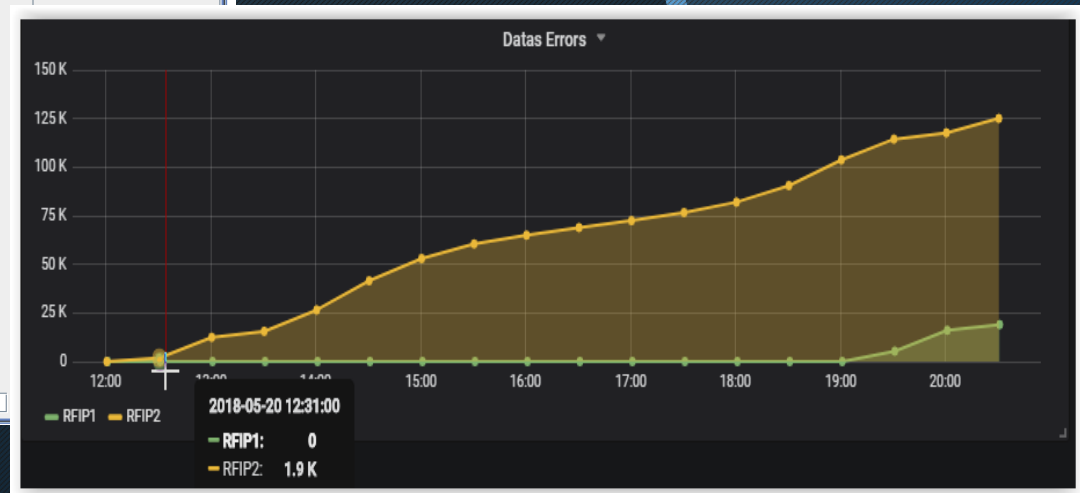
RUN 2: Rep01 & Rep03

- Suspecting the power mosfet IRFR9220 dealing with the anti-latchup, we shunted it on a repeater and replaced by the SI3443 on the second
 - Rep-01 With no mosfet (short circuit)
 - Rep-03 With new mosfet SI3443
- Both DUTs showed errors at 250Gy.

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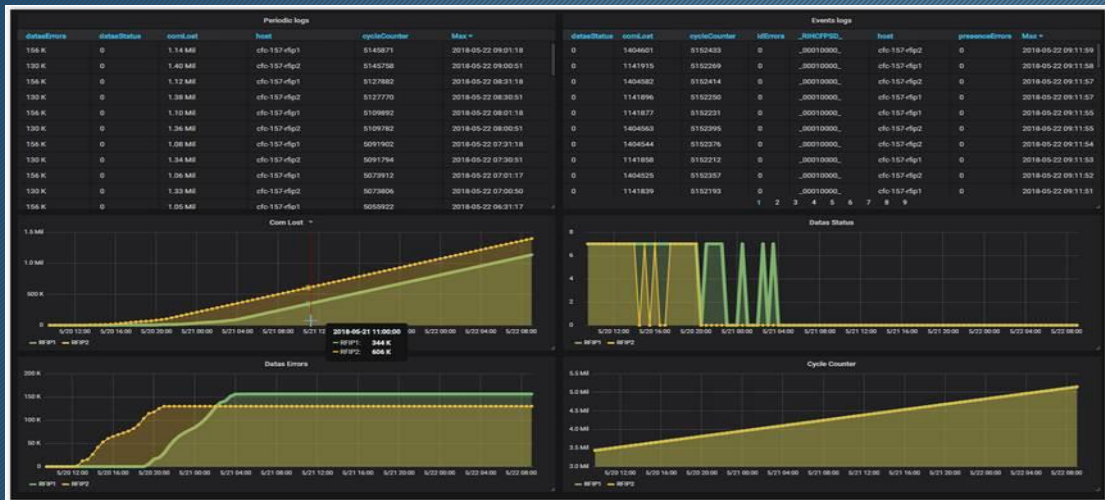


According to CHARM tool, it took $925 - 675 = 250$ Gy



3 Experimental results

RUN 2: Rep01 & Rep03

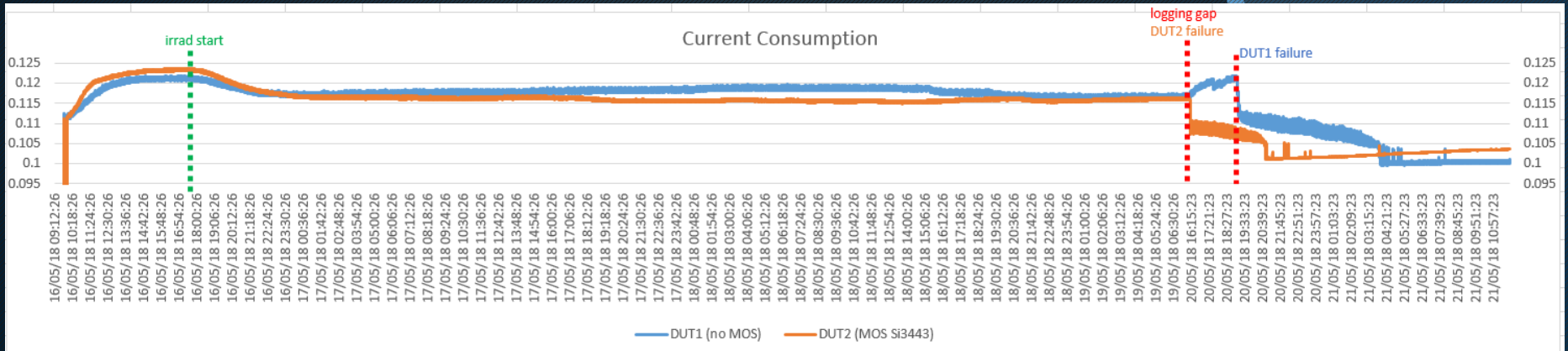


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20Gy after first errors, both repeaters did not respond anymore. Power reset did not help more



We are seeing a small current consumption increase exactly before the data failures and then a gradual decrease.



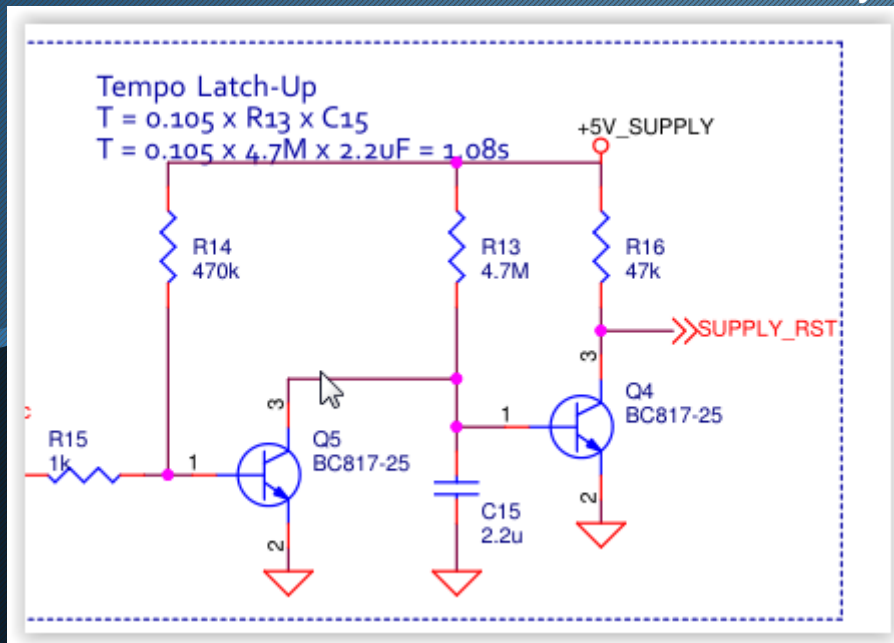
3 Experimental results

RUN 2: Rep01 & Rep03

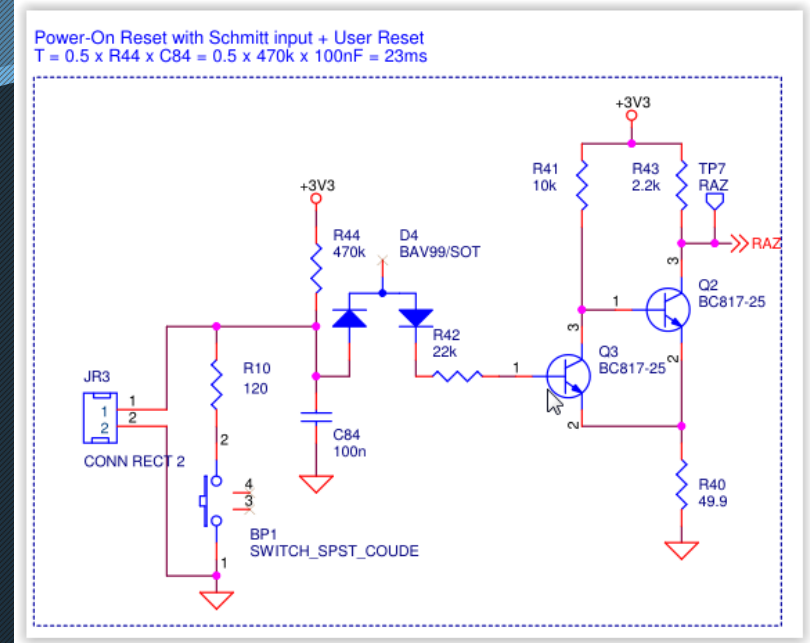
After looking at faulty repeaters in the 867 lab:

- We confirmed that IRFR9220 TID was very low 60 Gy
- We confirmed that Si3443 is a good replacement for IRFR9220
- We found that BC817 TID was 250 Gy and needs to be replaced

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SUPPLY_RST line in a wrong state



RAZ stuck low

So we order 5 prototypes with these modifications:

- Si3443 instead of IRFR9220
- FMMT419 instead of BC817

4 Conclusions

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The 2 first repeaters stopped working after only 60Gy with a Neutron 1MeVeq fluence of $5e11 \text{ cm}^{-2}$.

The 2 new repeaters without IRFR9220 stopped working at 250 Gy with a Neutron 1MeVeq fluence of $8.5e12 \text{ cm}^{-2}$.

2 components need to be replaced : IRFR9220 and BC817

Total dose seems to be the reason of the failures.

We are waiting 5 new prototypes with these modifications :

- Si3443 instead of IRFR9220
- FMMT419 instead of BC817

to be tested at CHARM the soonest possible.