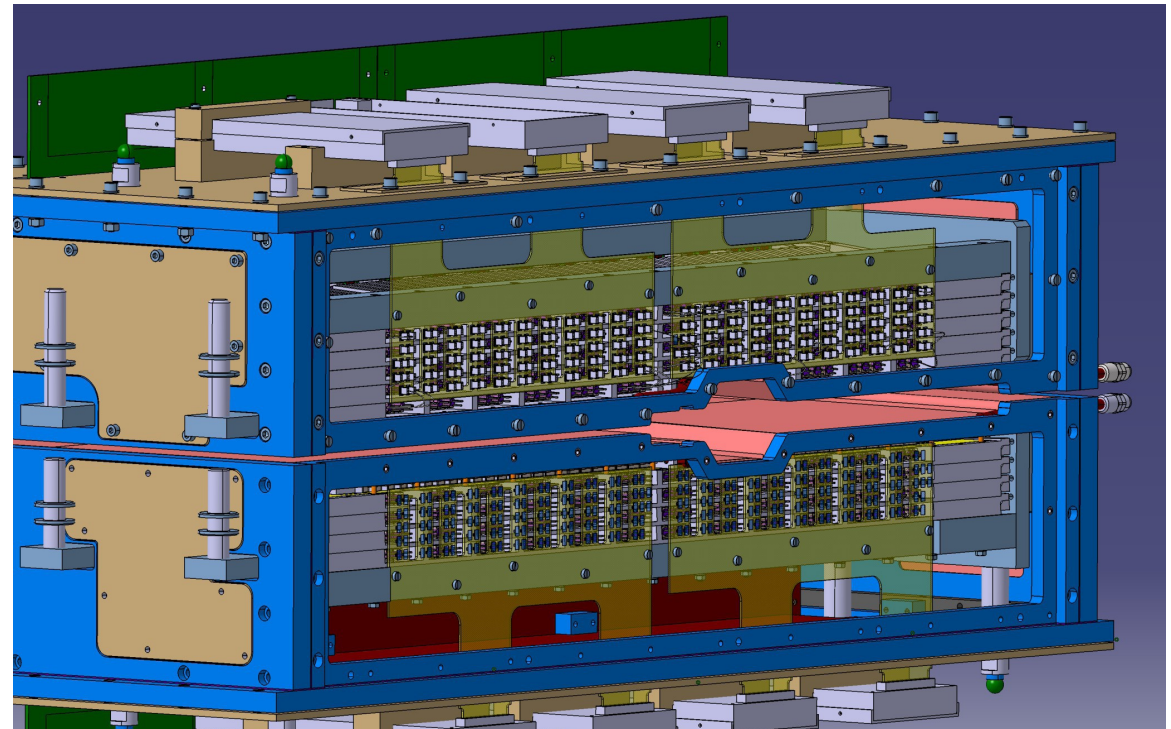


ECAL LED system status

ECAL LMS status

HPS-ECal LED monitoring system is currently installed in the experiment, fully working

- A specific DAQ configuration exists to acquire data with it
- The associated slow control system has been developed and installed, both Epics driver and GUI



Commissioning tasks summary

From the 2014/09/08 ECal meeting discussion, these were the tasks that were supposed to be performed during ECal commissioning, **before** tests with cosmic rays / beam

Task	Status	Done
1: Cabling test	Done	100%
2: LEDs working point determination	Done	100%
3: Cross-talk evaluation	Data on tape, analysis not performed	10%
4: Timing	NOT DONE	0%
5: DC effects	NOT DONE	0%
6: Stability	Some runs have been taken, and a (not so user-friendly) analysis driver has been developed	70%

In my opinion, at this stage it is better to focus only on stability measurements, and on the study of DC effects.

DC effects: is there any change in channels response if the LED system is used in DC-mode to recover radiation damage via light-annealing?

LED runs currently on tape

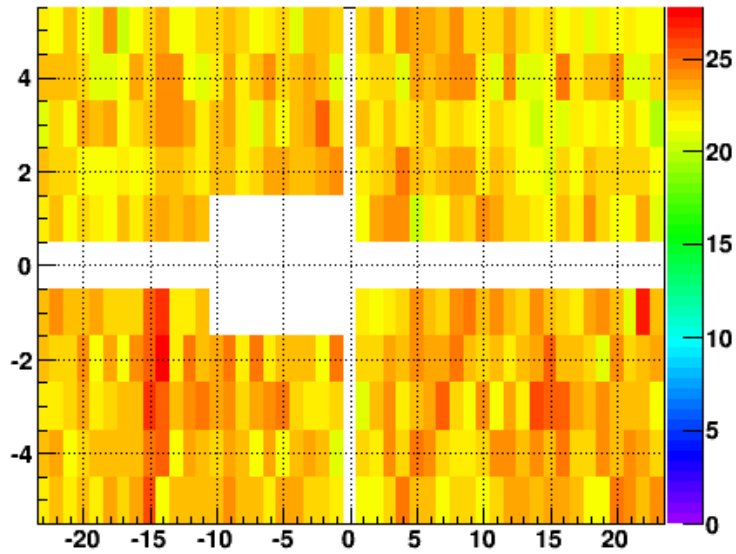
Run	Date	Color
4195 , 4196	11 March 2015	Blue
5113	28 April 2015	Blue
5114	28 April 2015	Red
5358	4 May 2015	Red
5359	4 May 2015	Blue
5804	18 May 2015	Red
5807	18 May 2015	Blue
5810,5811,5813	19 May 2015	Blue
5809,5812	19 May 2015	Red

LED system: measurement reproducibility

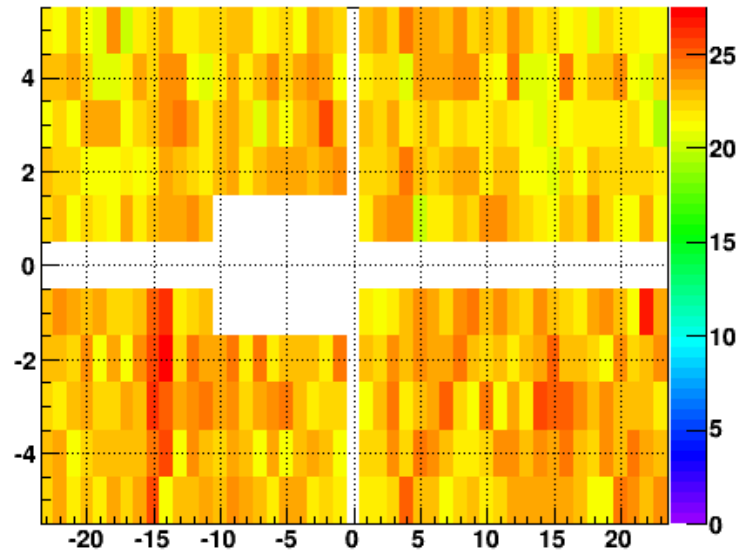
Observable: average charge (cal. constants not included).

BLUE: HPS start (4195 vs 4196)

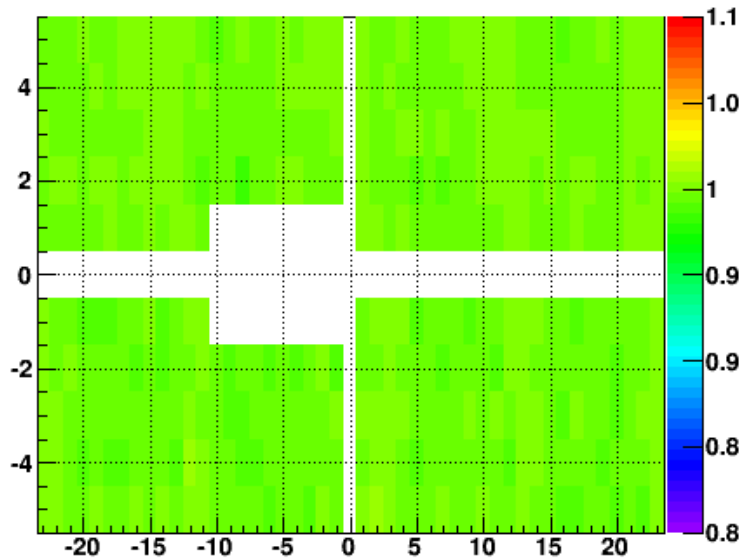
Blue Before



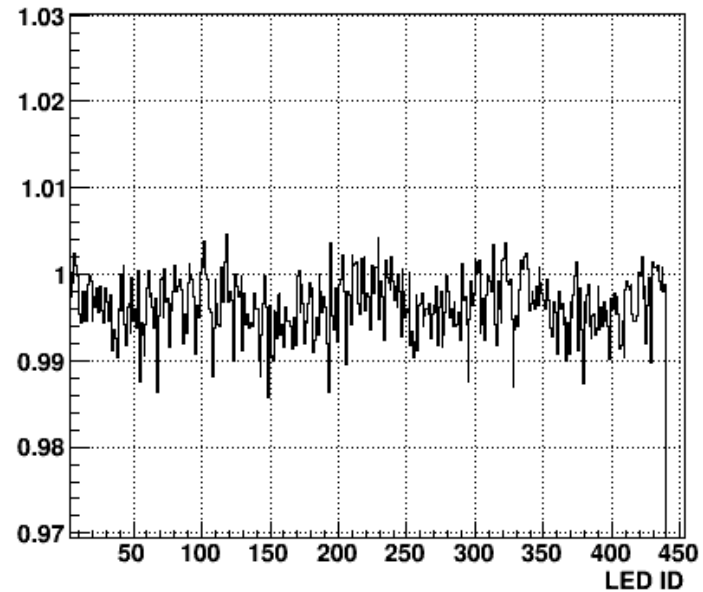
Blue After



Ratio AFTER : BEFORE



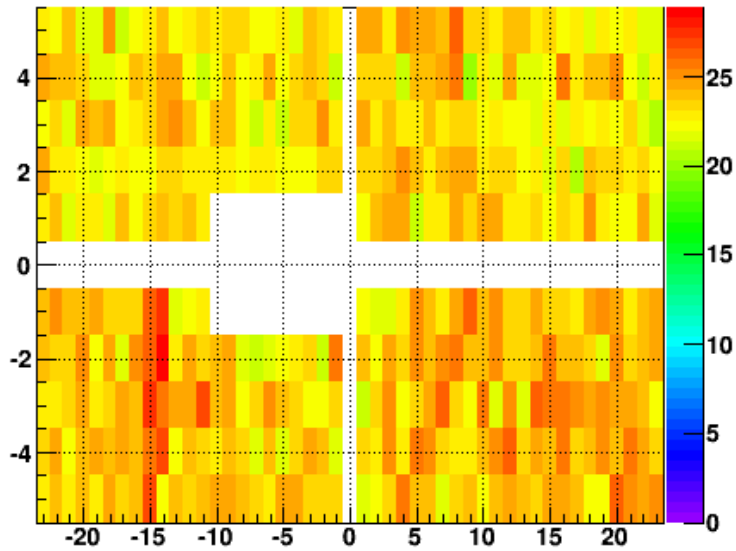
Ratio AFTER : BEFORE



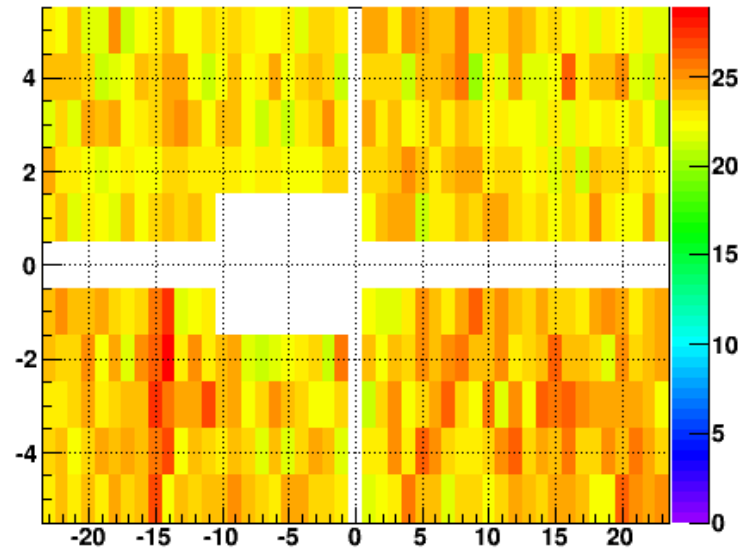
LED system: measurement reproducibility

BLUE: HPS end (5811 vs 5813)

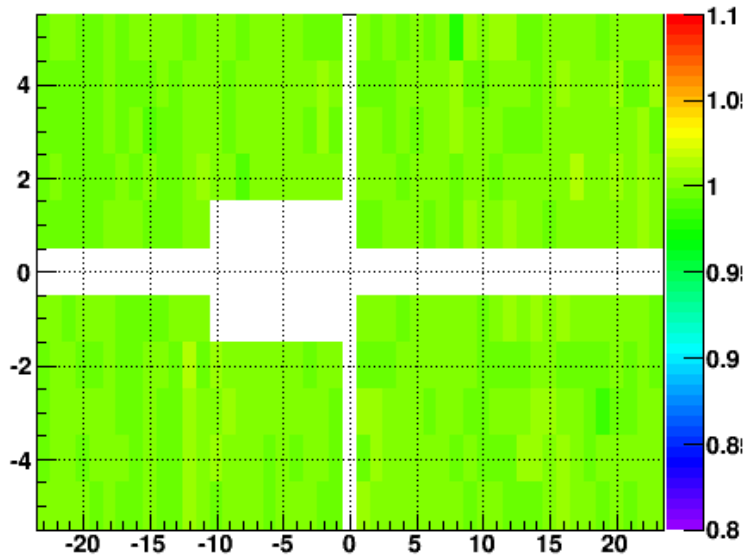
Blue Before



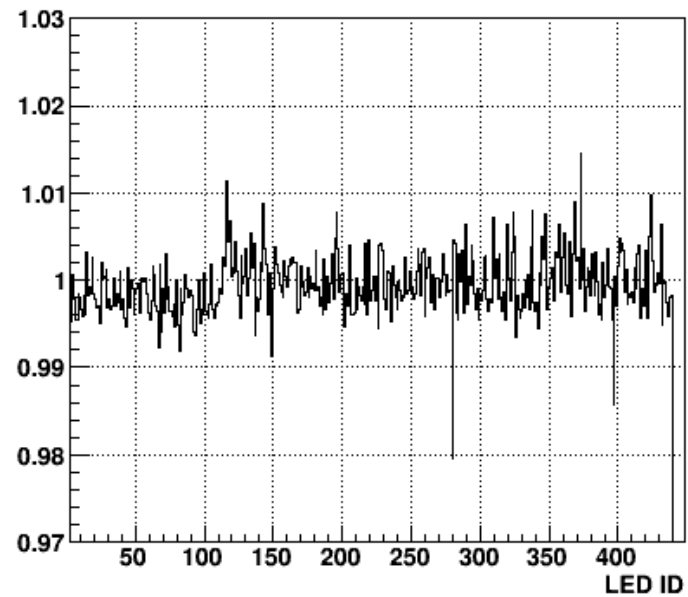
Blue After



Ratio AFTER : BEFORE



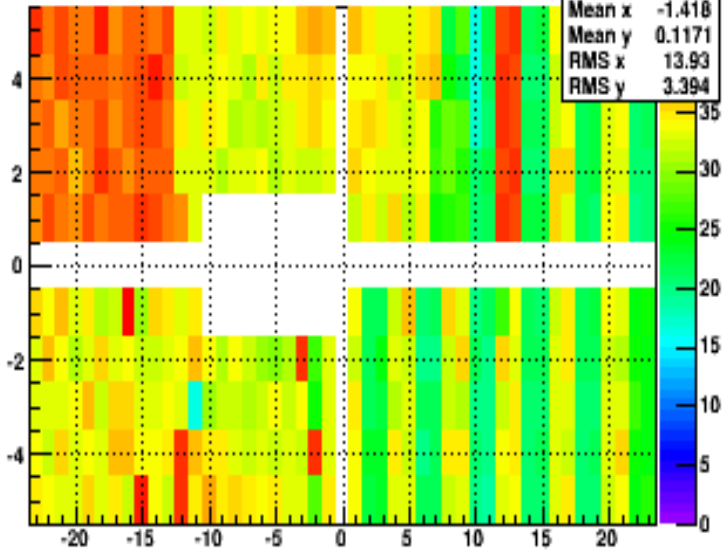
Ratio AFTER : BEFORE



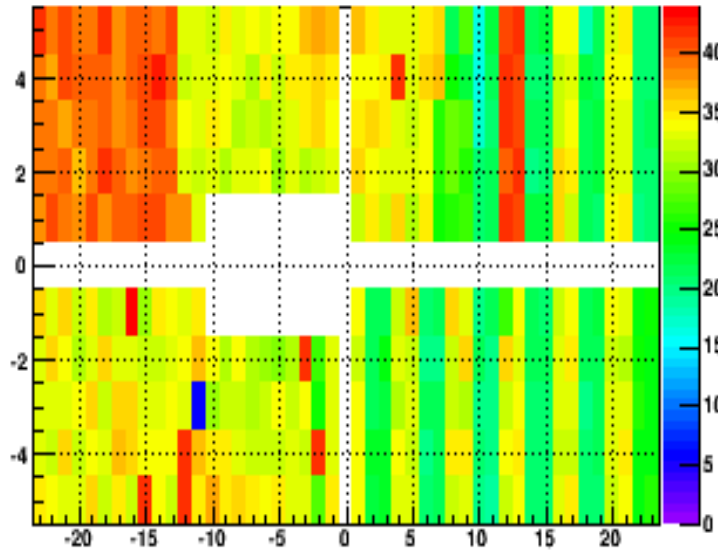
LED system: measurement reproducibility

RED: HPS end (5809 vs 5812)

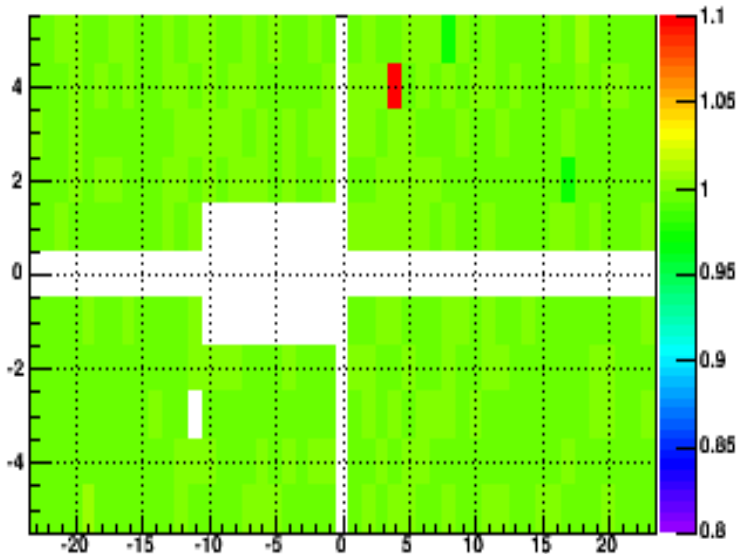
Red Before



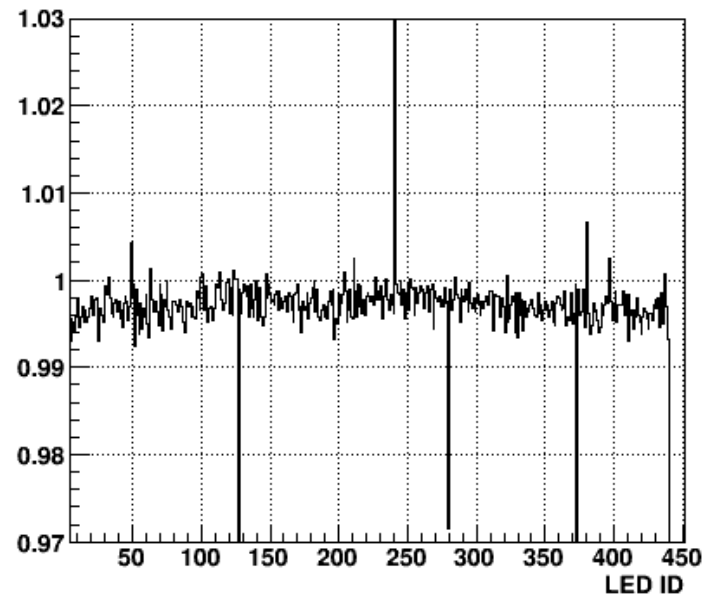
Red After



Ratio AFTER : BEFORE



Ratio AFTER : BEFORE



LEDs radiation damage

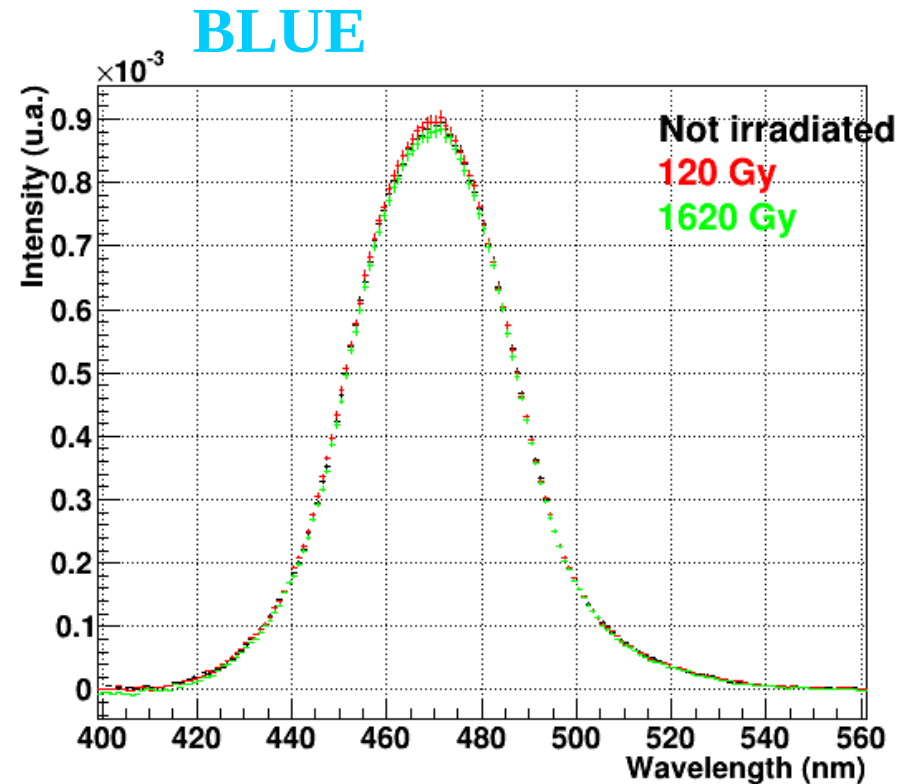
EM radiation:

- LED radiation hardness was evaluated by exposing LEDs to a known EM dose (^{60}Co source).
- Emission spectrum measured before and after irradiation.
- Control LEDs (not-irradiated) showed no variation during different measurements.

Expected radiation dose in Ecal: \sim rad/hour

- 120 Gy: 100 days (with 5 rad/hour)
- 1620 Gy: 3.7 years (with 5 rad/hour)

No damage was seen at 1% (system accuracy)



LEDs radiation damage

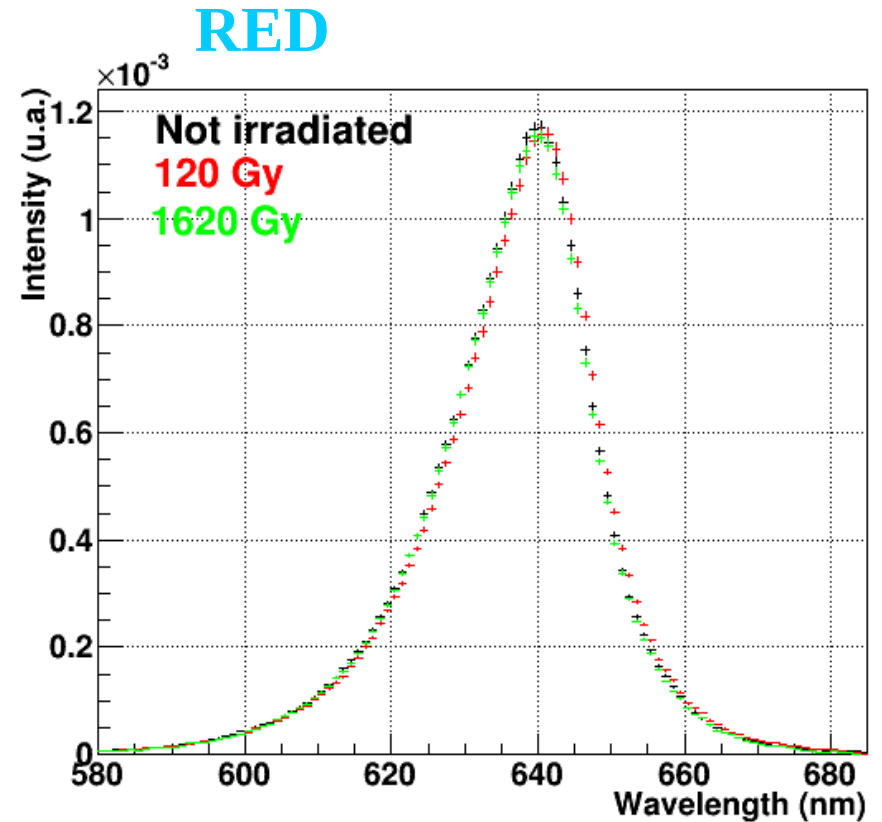
EM radiation:

- LED radiation hardness was evaluated by exposing LEDs to a known EM dose (^{60}Co source).
- Emission spectrum measured before and after irradiation.
- Control LEDs (not-irradiated) showed no variation during different measurements.

Expected radiation dose in Ecal: \sim rad/hour

- 120 Gy: 100 days (with 5 rad/hour)
- 1620 Gy: 3.7 years (with 5 rad/hour)

No damage was seen at 1% (system accuracy)



LEDs radiation damage

EM radiation:

- LED radiation hardness was evaluated by exposing LEDs to a known EM dose (^{60}Co source).
- Emission spectrum measured before and after irradiation.
- Control LEDs (not-irradiated) showed no variation during different measurements.

Expected radiation dose in Ecal: \sim rad/hour

- 120 Gy: 100 days (with 5 rad/hour)
- 1620 Gy: 3.7 years (with 5 rad/hour)

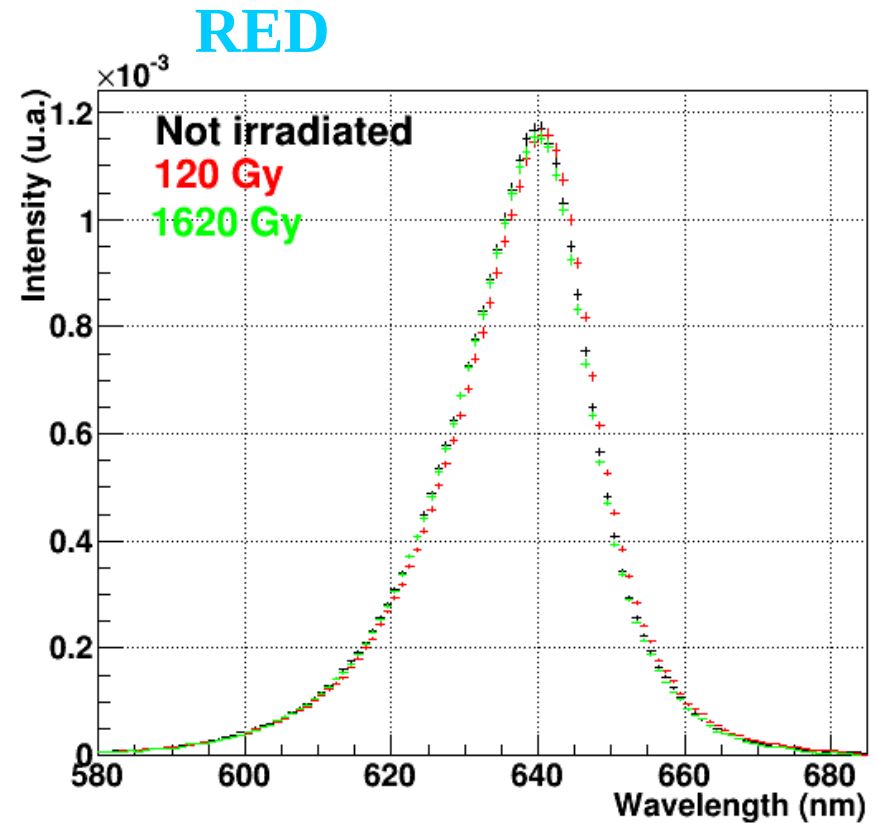
No damage was seen at 1% (system accuracy)

Neutrons:

- LEDs exposed to neutron flux $\sim 4 \cdot 10^{11}$ n/cm² @ 14 MeV
- Expected neutron flux in ECal: ?

No damage was seen. System accuracy not better than 15% (normalization)

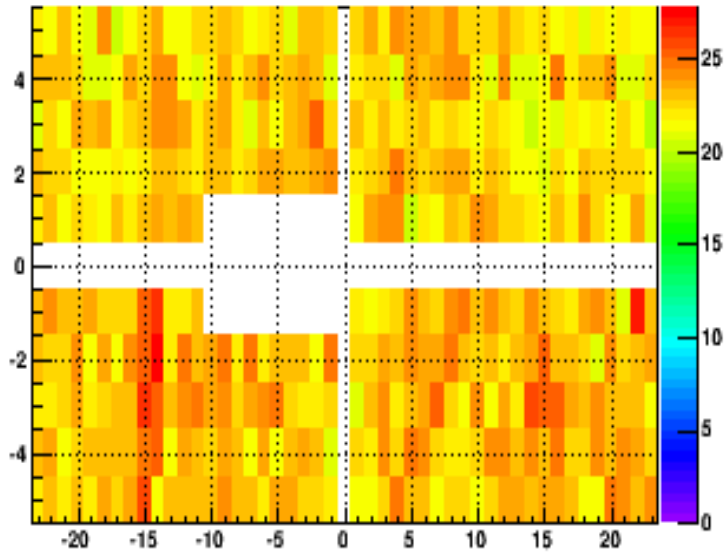
—► **Further studies are required.**



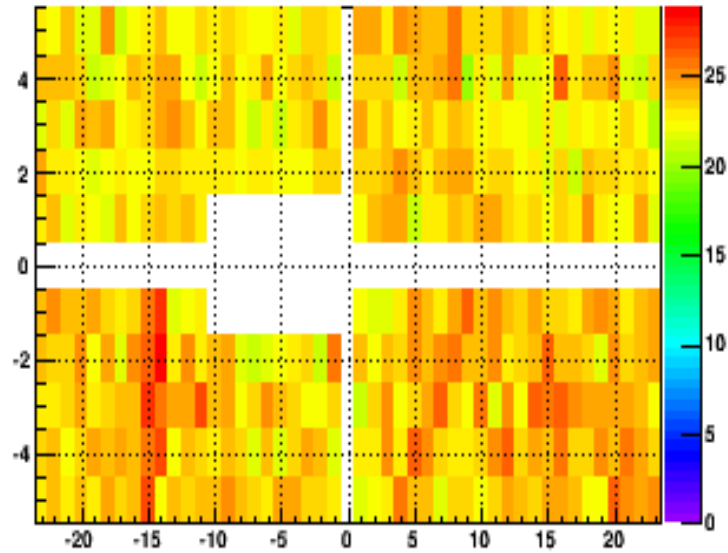
LED system: stability

BLUE: HPS start (4195) vs HPS end (5811)

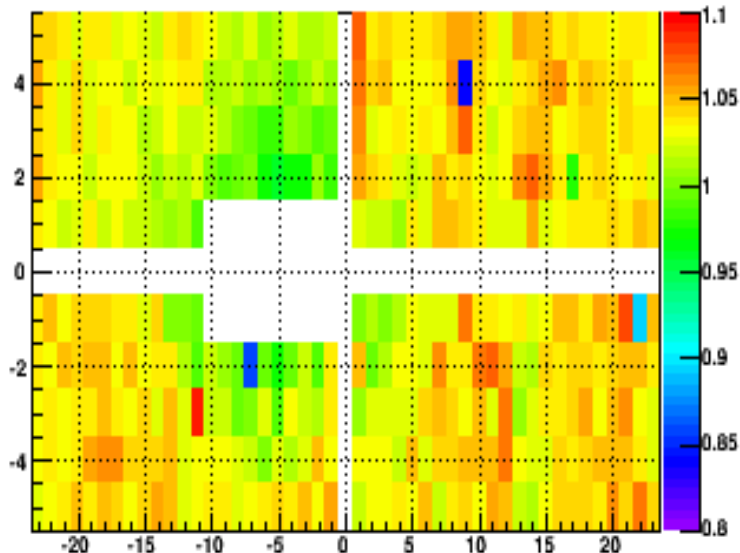
Blue Before



Blue After



Ratio AFTER : BEFORE



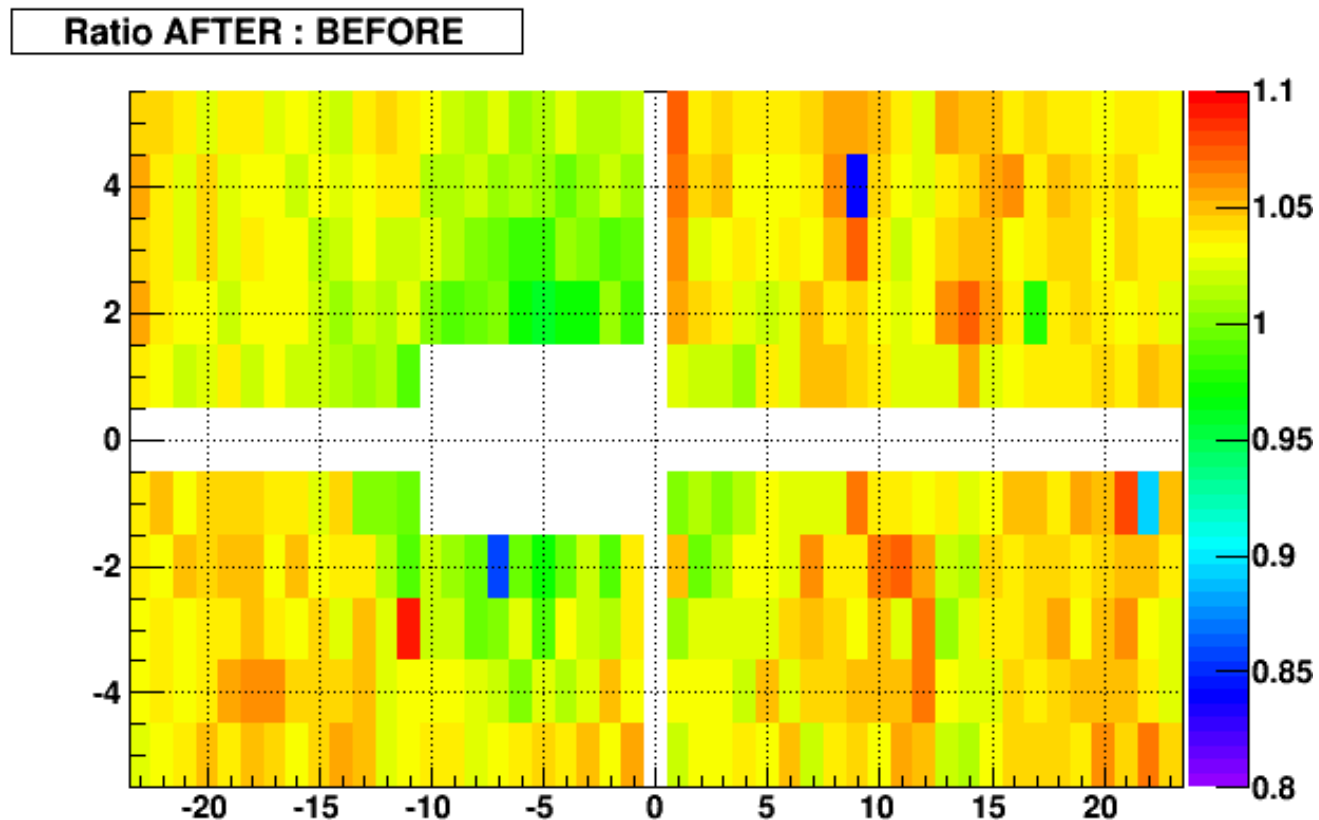
“Bad” channels

- $X = -7$, $Y = -2$ has a real shift also with cosmics
- $X = 9$, $Y = 4$ had a bad LEMO cable, replaced
- $X = -11$, $Y = -3$?
- $X = 22$, $Y = -1$?
- $X = 17$, $Y = 2$?

LED system: stability

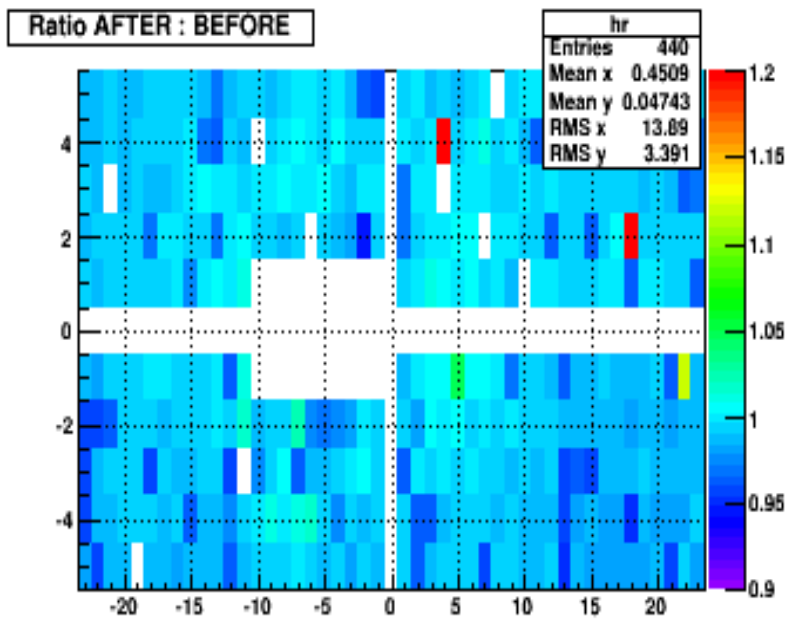
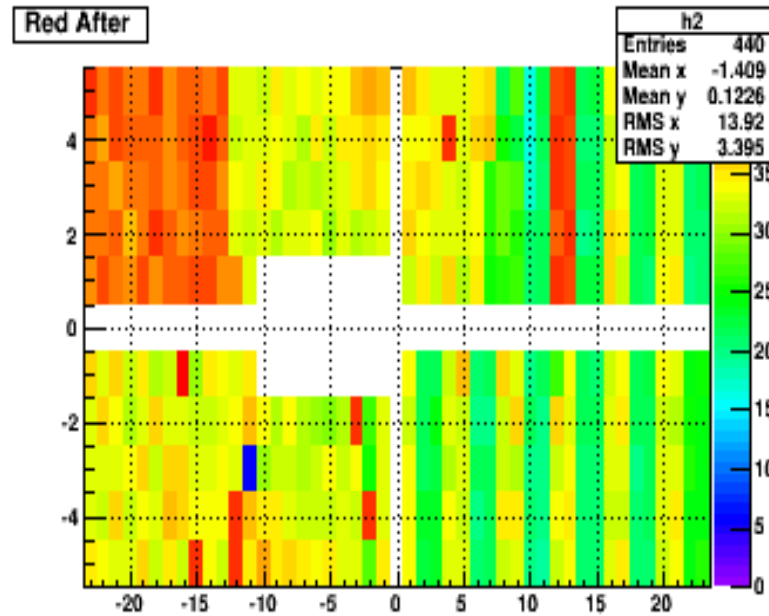
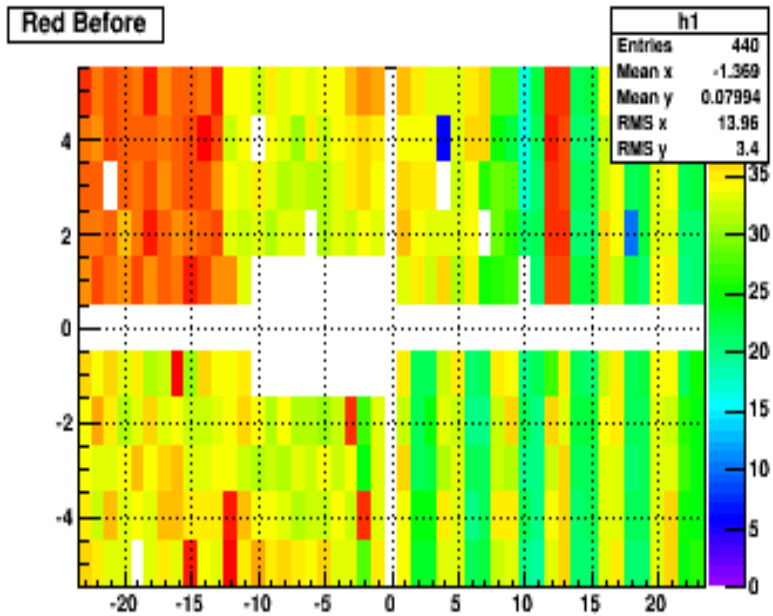
BLUE: HPS start (4195) vs HPS end (5811)

- There's an overall INCREASE (~5%) in the average channels response. Possibly due to an higher APD gain after removal of the stickers on the pre-amplifiers?
- The increase is NOT uniform, channels near the beam hole have less increase: radiation effect / LED (neutron) damage?



LED system: stability

RED: HPS middle (5114, 28 April) vs HPS end (5812, 19 May)

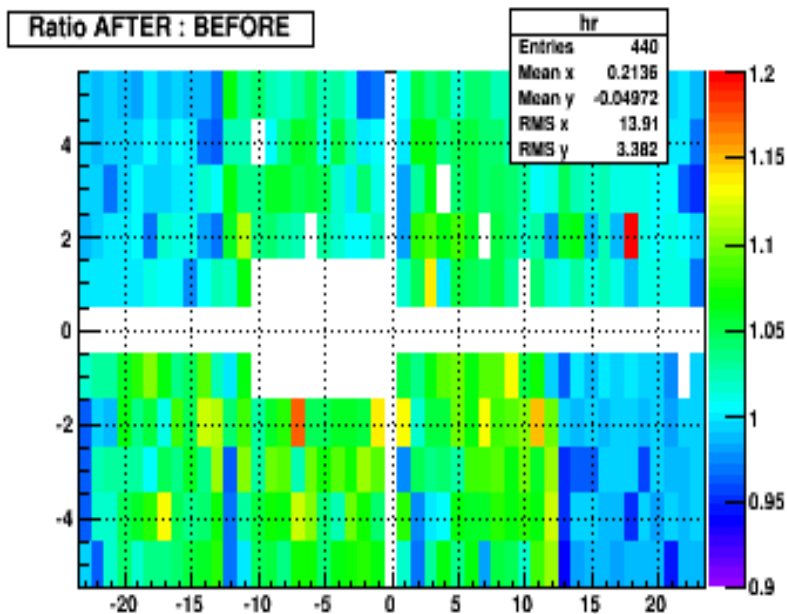
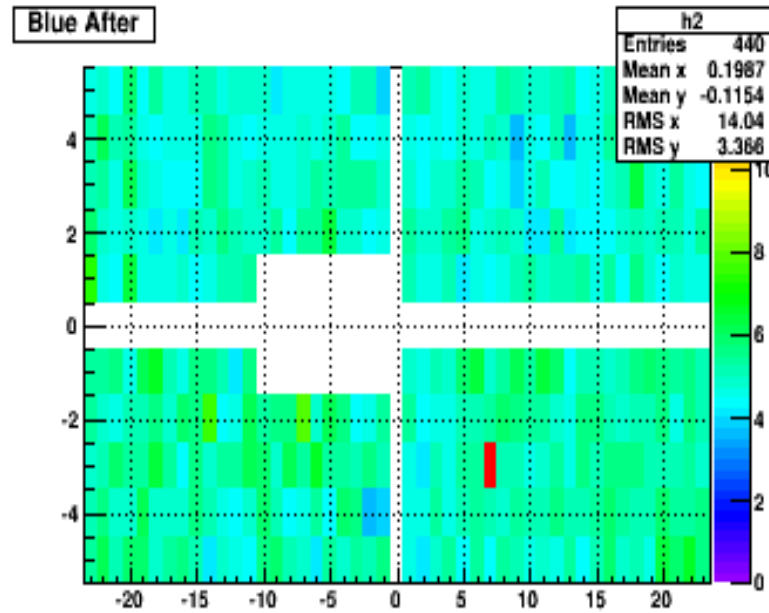
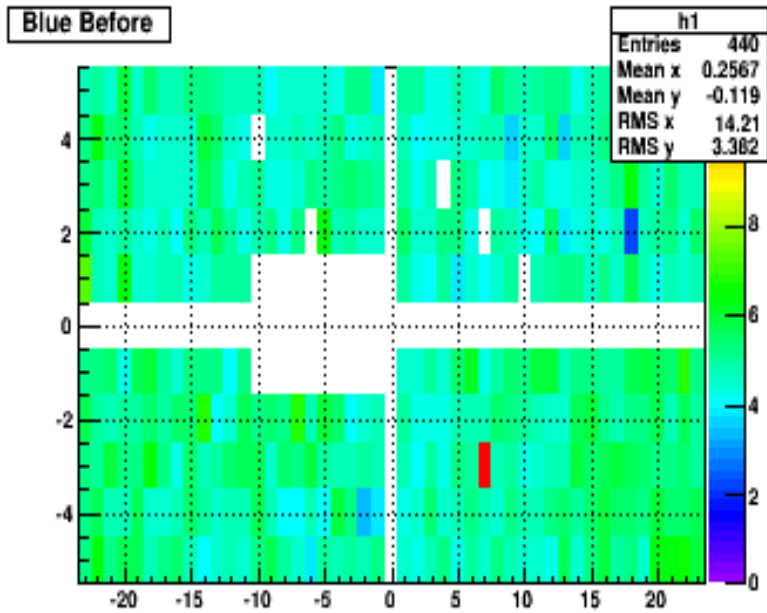


There are more “bad” channels than in the previous case: these have to be investigated.

There's no evidence for a global shift, neither for a correlation with the beam-hole.
However, here “before” refers to a different date

LED system: stability

BLUE: HPS middle (5113, 28 April) vs HPS end (5813, 19 May)



This case can be compared 1-to-1 with the previous case.

Here, AFTER > BEFORE, with a non-uniform behavior, opposite to what was shown before.

LED system: work-plan

- Re-check individually all the LEDs, both colors, and eventually refurbish those not working.
- Compare the apparent blue-LED variation with physical gains (cosmics / FEE) to understand if there was a real damage to the crystals or to the LEDs.
- Complete software development for LED sequences, in a more user-friendly way (including interface with conditions DB)
- Perform the “DC-mode” study.