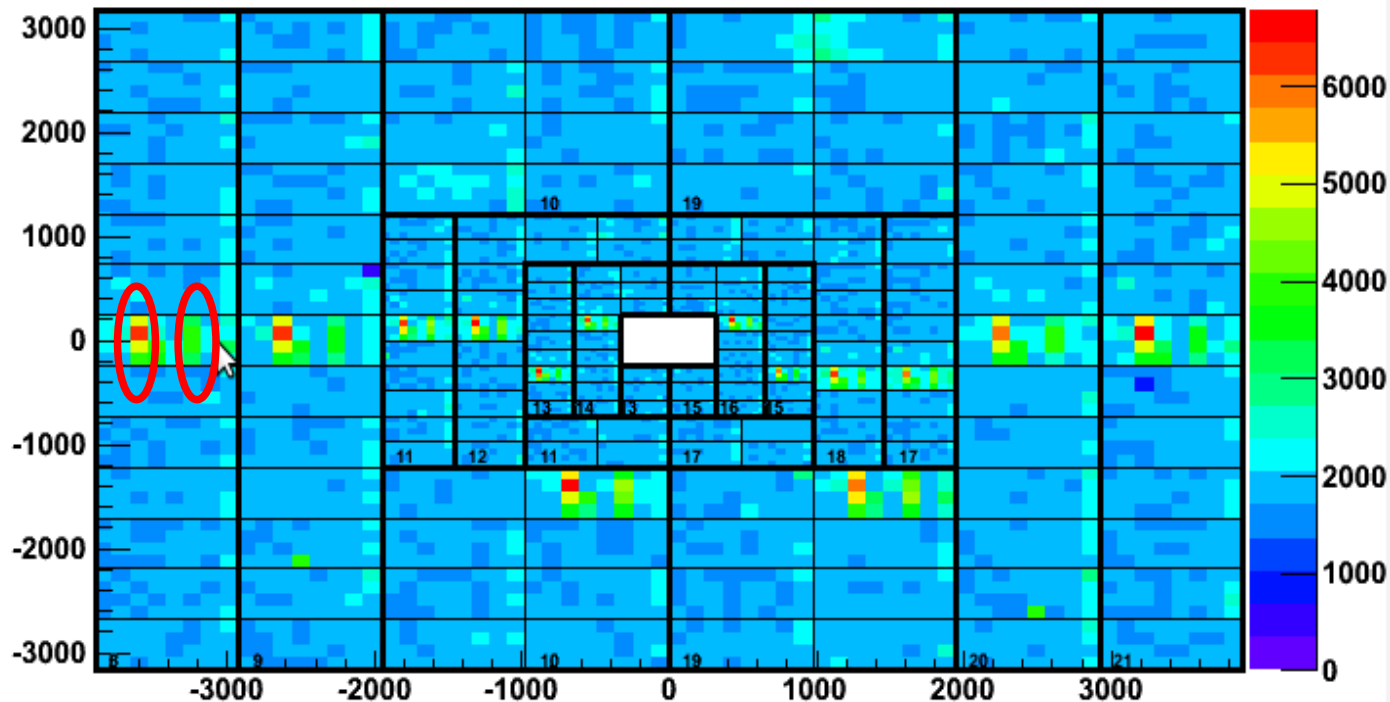# Calorimeter ReadOut Card Shielding

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Noise observed at 1MHz


- During the 1MHz tests performed in June, some extra noise was observed systematically on a single FEB of each crate

- The FEB is located on the left of the CROC board. Two regions of the FEB looked more affected.

- The RMS of the noise of the worst channels reached up to 3 and 4 ADC in the two concerned regions (to be compared to 1.2)

Identifying the origin of the noise (I)

- On the worst channel, a structure appears

- A first test was performed at 1MHz

  - CROC configured to disable half a crate → one of the two noisy regions disappeared

  - Noise was linked to the data transfer between the CROC and the optical emitter

- Optical emitter looked as a good culprit

  - The metallic cover of the emitter is not connected to the ground...

  - The two regions would correspond to the two emitters of the CROC

  - The emitter are not exactly but almost facing the delay line of the FEB (delay line = good antenna ?)

adcT0Ref {(feb%16)==7&&febchannel==18}

es	14000
Mean	1.563
RMS	4.282
Underflow	0
Overflow	0
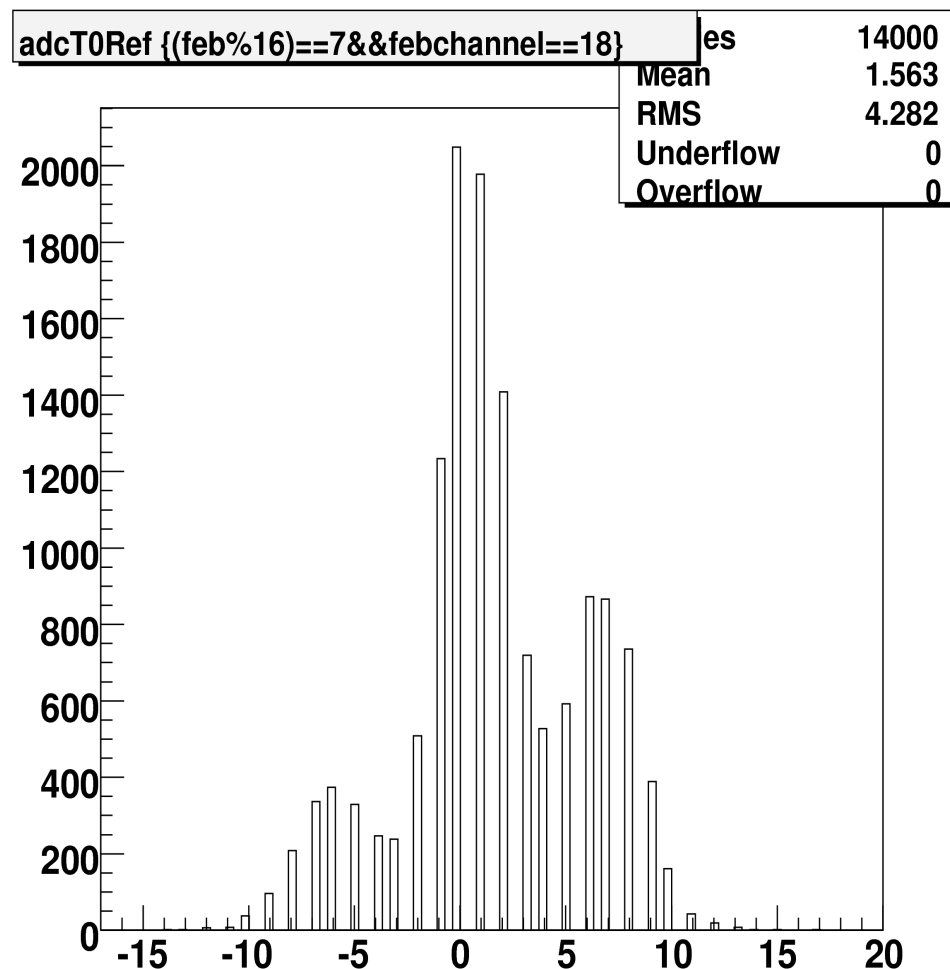
Identifying the origin of the noise (II)

- But then, we should be able to "see" the noise with an oscilloscope looking at the signal input of the FEB (one of the two "ends" of the delay line)

- We tried to configure the test bench in a way such that we could reproduce the noise observed at the pit
  - We have never been able to do so
  - We had to work at the pit and launch 1MHz runs

- Finally even by averaging the oscilloscope signal over a large number of samples, nothing relevant appeared

- Optical emitters were too good culprits : we had to look for something else

- Jacques imagined that RC circuits on the FEB could be a good antennas
  - Circuit is outside the ASIC, on the signal path, between the buffer and the integrator
  - We have some lines at the surface of the CROC to feed GOLs facing those RC
    - 2 groups of such lines

- We made a crude shielding with a double sided scotch and a layer of copper

- Noise disappeared on the Calo event display (1MHz runs)

Shielding and intervention
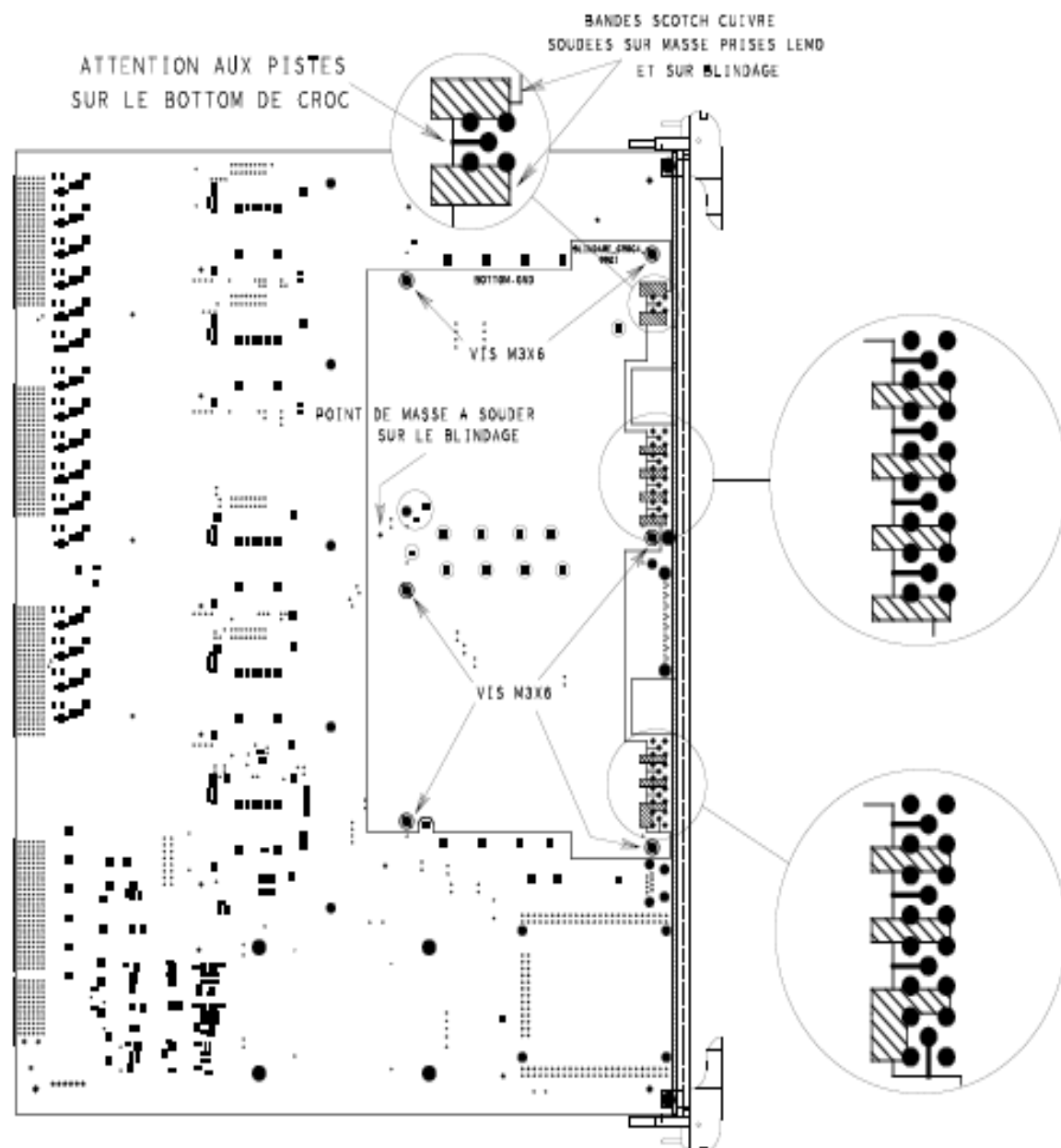
- Shielding designed at LAL

- A PCB layer (P. Rusquart)

  - 0.3mm thickness

  - 35µ Cu on external surf.

  - Thin layer of silver (polishing)

  - Use the optical mezzanine plastic screws (x6)

  - Soldered to the ground of the LEMO connectors of the CROC

- 32 Layers bought

  - Made in a month

  - Received on Sept. 2nd, 09

- First test on Sept. 3rd at the pit

  - Noise disappears

- Shielding of ALL the CROC on Sept. 4th, 09

Conclusions

- The CROC have been shielded

  - No problem after re-installation of the boards

    - Configuration of ECAL/HCAL/SPD-PS crates
    - 1MHz test with ECAL/HCAL → noise has fully disappeared
    - Stéphane / Daniel started to control SPD-PS → looks ok

- The operation took a bit more than one day

- The CROC have been put in their original crates → no effect for the user

- We used this access to correct problems on some FEB

  - 1 board to debug (ADC bit stuck at 128) and replaced → crate 9 / slot 3
  - 1 board fixed (transistor ripped off) straight away → crate 9 / slot 11
  - About ten cables/connectors fixed