List of open problems

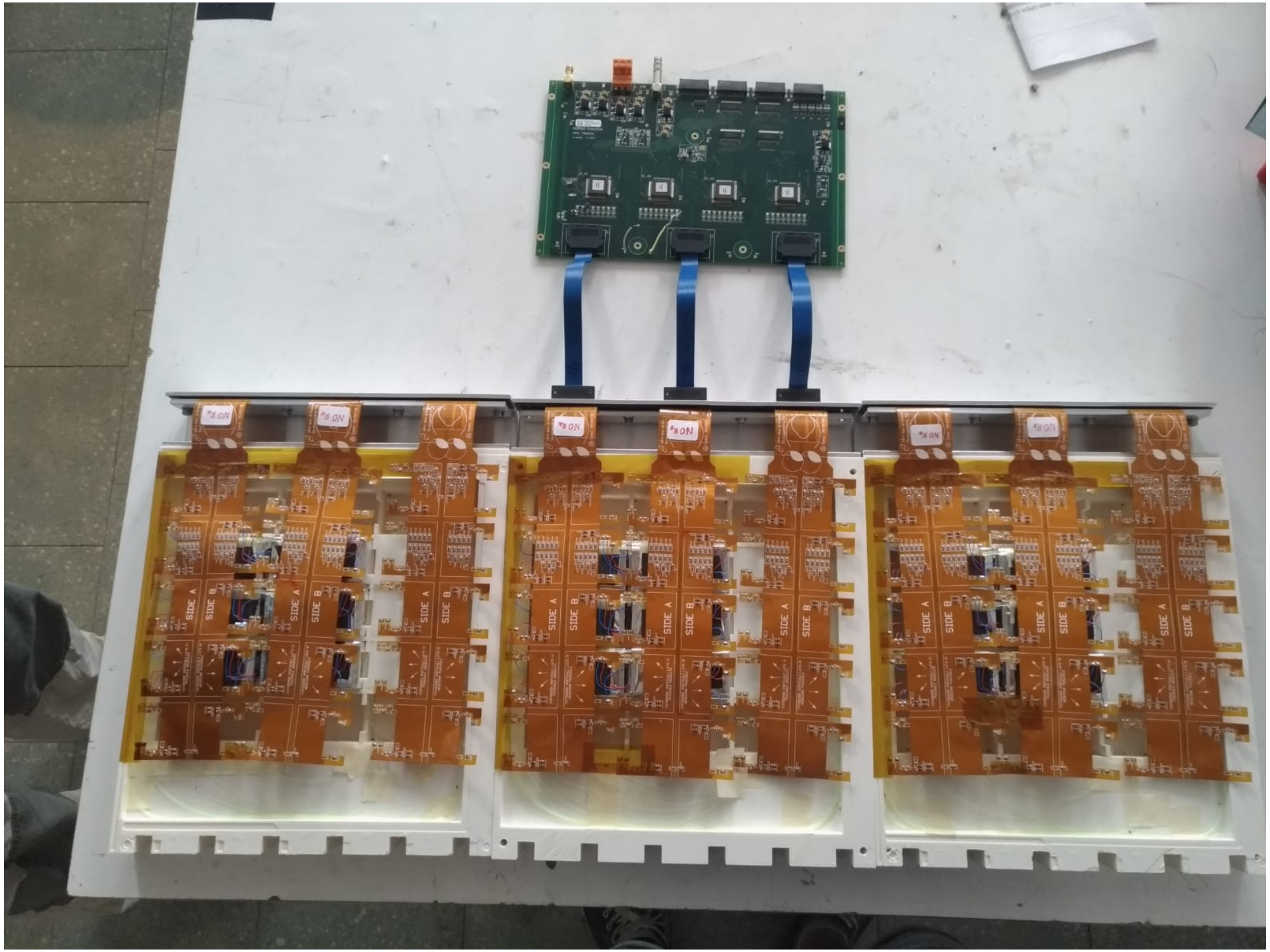
- Dynamic range: with the new PD, and by attenuating the small PD by a factor of ~70 is expected to be ~ 250 TeV (slides 2, 3, 4).
- Trigger efficiency: new PD MIP ~ 70 ADC, noise ~ 25, what is the correct value of the trigger threshold?
- Pedestal drift after big signal (slides 5, 6, 7, 8):
  - can be completely removed by using the PD in DC but dark current will increase the pedestal, the self trigger can not work...
  - can be attenuated by decreasing the input capacitance and resistor but we will create a increase of the singal with respect the casisTime
  - Can be removed by placing a transistor in parallel to the Rp, it will increase the noise (30% with a first test).
- Saturation of a channels affects other channels: when a small PD will saturate can we use the nearby small PDs?
- Signal vs casisTime dependence: depends on PD, LED, electronics??
- Samtec blue cable increase the noise of the system (about 20%): why?

List of open problems

- Calibration: the procedure works, we need to check all the channels of all the boards.
- Self trigger: sometime the information is missing (due to C++ code, firmware?)
- Chip 2 gain: always low gain.
- Chip 3 broken on a board, fixed ~33000 ADC channels.
- Additional board?
- Need to define the SiPM – fiber coupling (Maybe we can start on Monday)
- ....

Prototype status

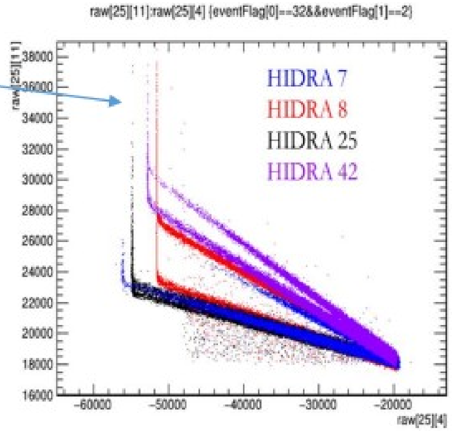
- Old L PD and S PD are already connected (excluding the first layer with one cube which is used for other tests).

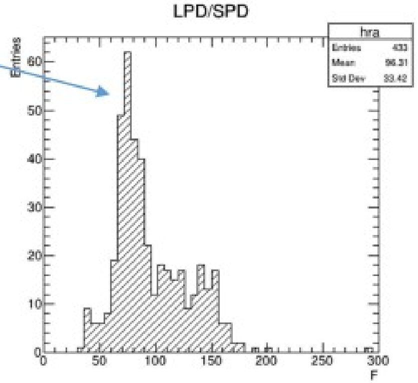


Based on VTH2090

HERD dynamic range

- MIP (CsI(Tl) 3.6 cm) → ~ 21.6 MeV → 553 ADC-ch
- MIP (LYSO 3 cm) → ~ 28 MeV → ~ 56% · 553 ADC-ch ~ 310 ADC ch
  - (takes into account crystal dimensions, LYSO light yield and VTH2090 QE)
- HIDRA LG range:
  - ~ [20 × (55000-18000) - 2000] ADC-ch ~ 738000 ADC-ch (±10%)
- LPD range
  - CsI(Tl) → 738000 ADC-ch × 22 MeV / 553 ADC-ch ~ 29 GeV
  - LYSO → 738000 ADC-ch × 28MeV / 310 ADC-ch ~ 67 GeV
- SPD range ~ 75 × LPD range
  - CsI(Tl) → 2.2 TeV
  - LYSO → 5.0 TeV





Possible extension of the range

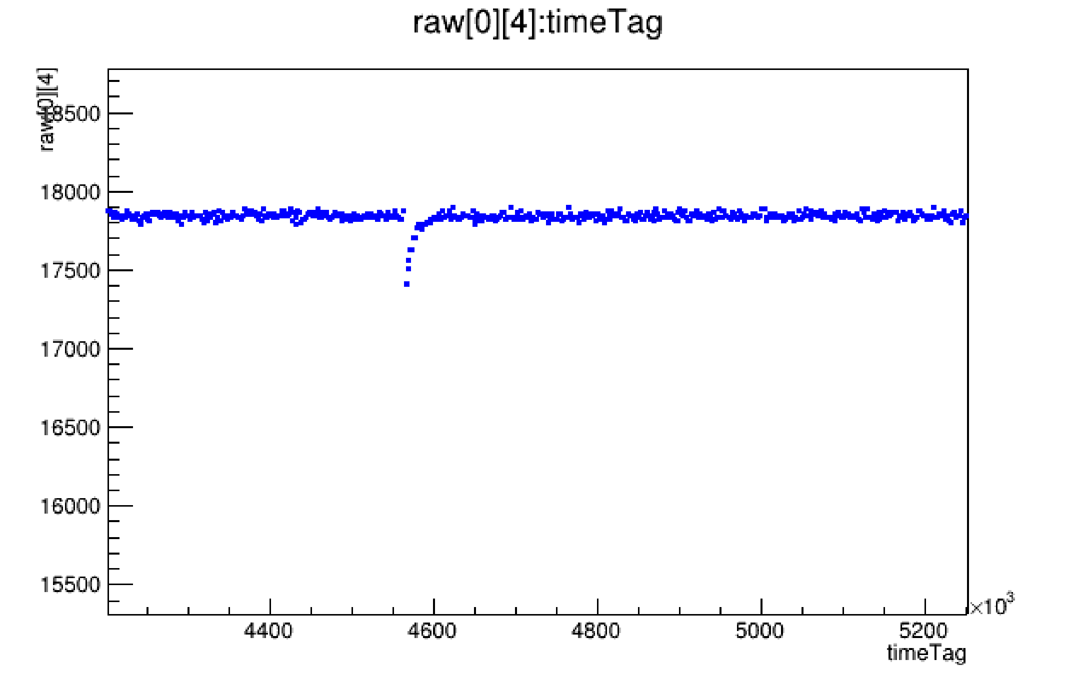
- Typical noise : 25 ADC (1 MIP with Large PD in High Gain $\sim$ 300 ADC).
- Max signal with Large PD, low gain: 2380 MIP.
- MIP for Large PD in Low Gain: 15 ADC.
- MIP for Small PD in High Gain: 4 ADC.
- MIP for Small PD in Low Gain: 0.2 ADC.
- Saturation of Large PD corresponds to a Small PD (High Gain) signal of: 9520 ADC.
- Can we **decrease the Small PD signal of a factor of 20?**
  - In this case the the saturation of Large PD corresponds to a Small PD signal $=$ 475 (S/N $<$ 10)
  - It is not possible to attenuate the Large PD with a attenuation factor $>\sim$20 (**5TeV*20** $\sim$ **100 TeV**)
  - Attenuation of 20 creates a very small range for the relative calibration of SPD with LPD.

New diode, expected dynamic range

- Old PD MIP $\sim$ 320 ADC.
- New PD MIP $\sim$ 70 ADC (by a single measurement using HIDRA, to be confirmed)
- Dynamic range:
  - The saturation of the new PD (low gain) will be ~4.5 higher than the one of the old large PD
  - We can attenuate the small PD with an additional factor of 3 (at least) moving the dynamic range from **100 TeV to 300 TeV** (250 TeV is required, see this presentation)

    https://agenda.infn.it/event/23275/contributions/116818/attachments/73484/93061/Saturation.pdf
- Problem: minimum self trigger threshold $\sim$ 70 ADC: the MIP signal will triggered with small efficiency with the new PD.
  - Is it possible to decrease the trigger thresholds?
  - Other ideas?

TEST WITH LED



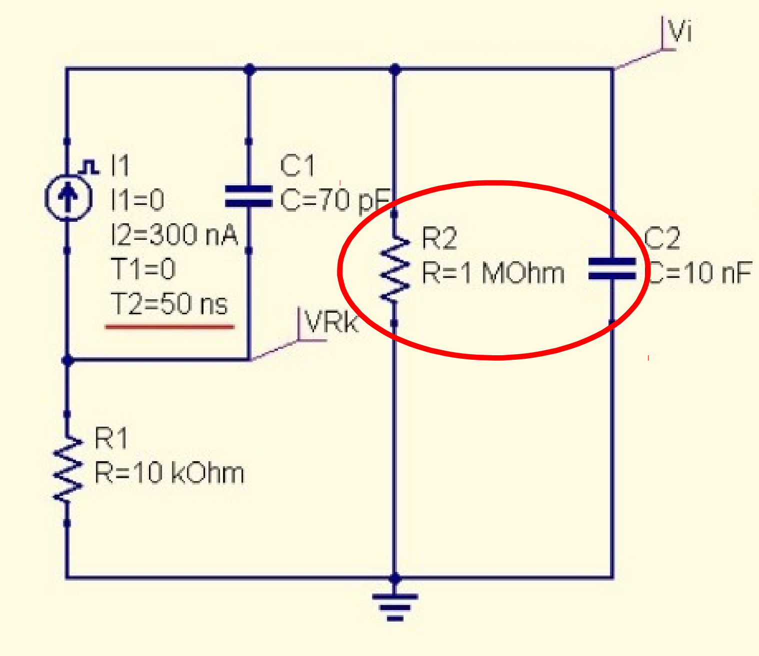
- An acquisition with two shots of large amplitude physical signal
- Point distance is 3,8 ms
- Falling time ~ 40 ms

TEST WITH LED

This behavior creates serious problem for calorimeter performance:

- Pedestal shift can reach ~ 3000 ADC or ~ 9 MIP
- Pedestal shift is time depended and varies strongly in the case of random trigger
- All measurements are compromised during ~ 40 ms after high energy events.
- Low level signals (MIP) are completely unusable.
- Very hard correction during analysis

CIRCUIT STUDIES AND SIMULATIONS



- Circuit analysis and simulations show that AC coupling circuit can cause this problem
- Input capacitor accumulates charge from large physical events and releases it.

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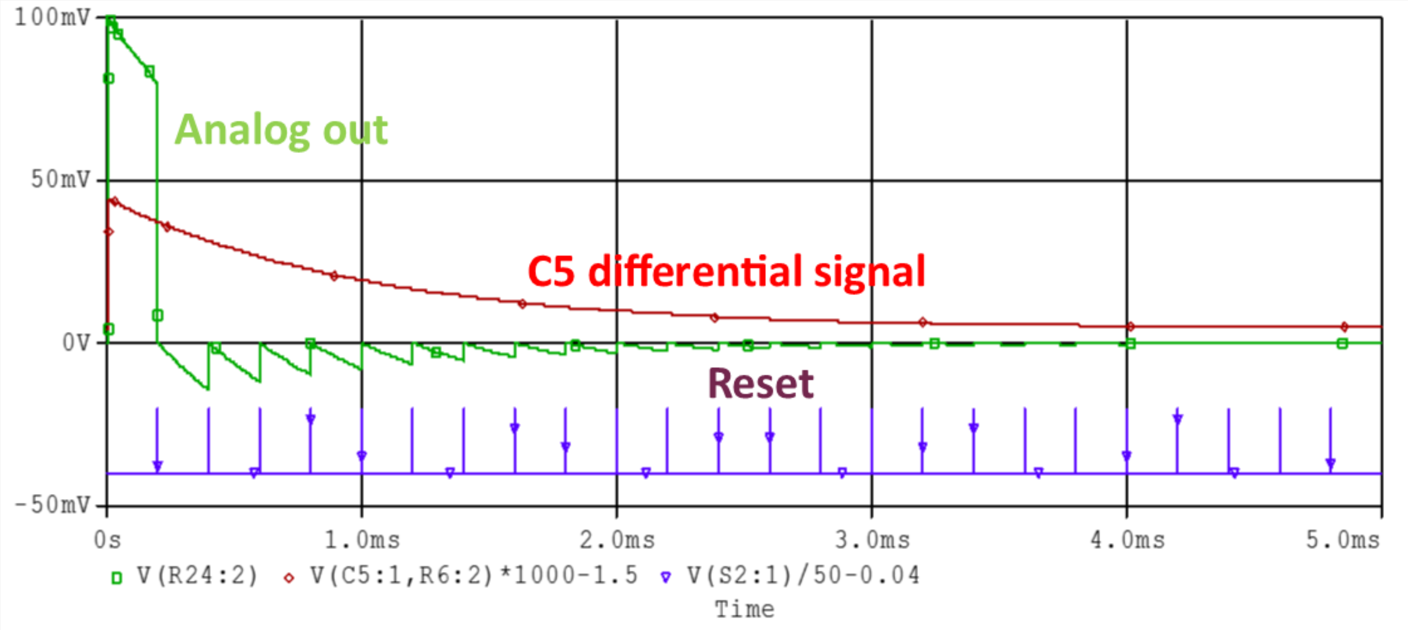

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