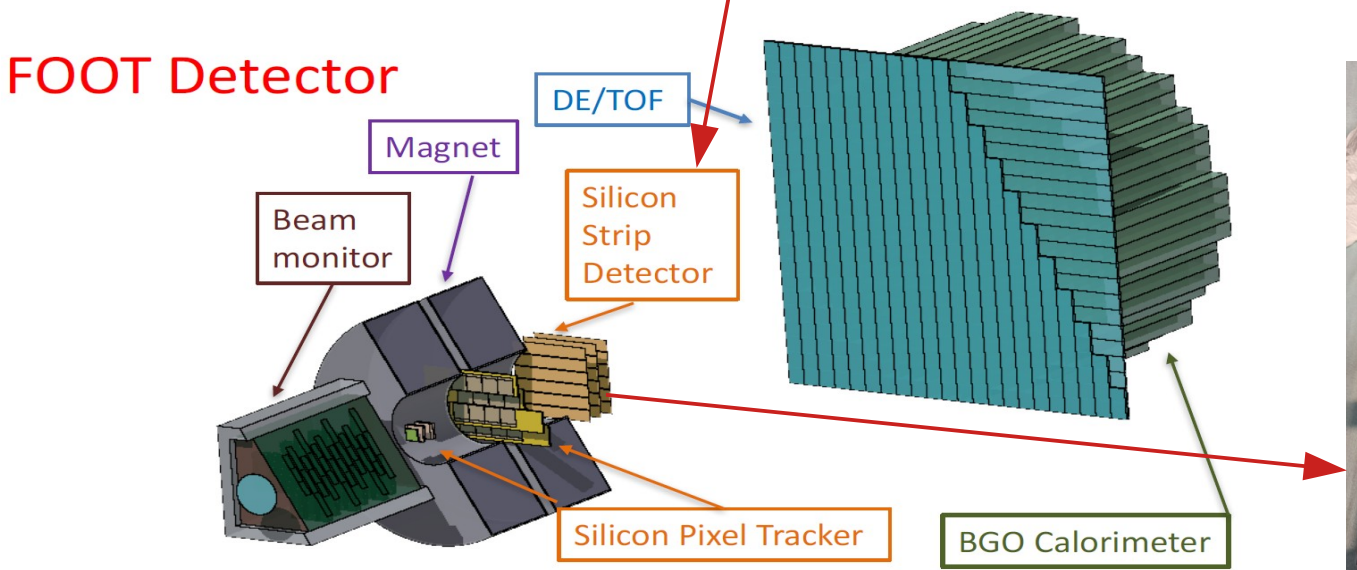
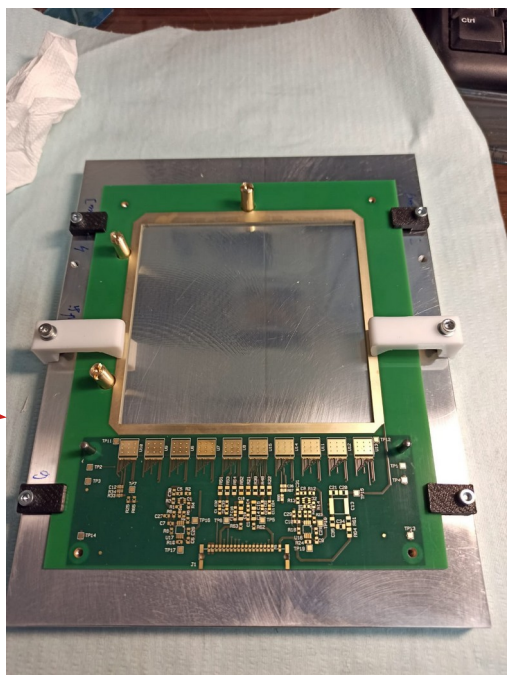
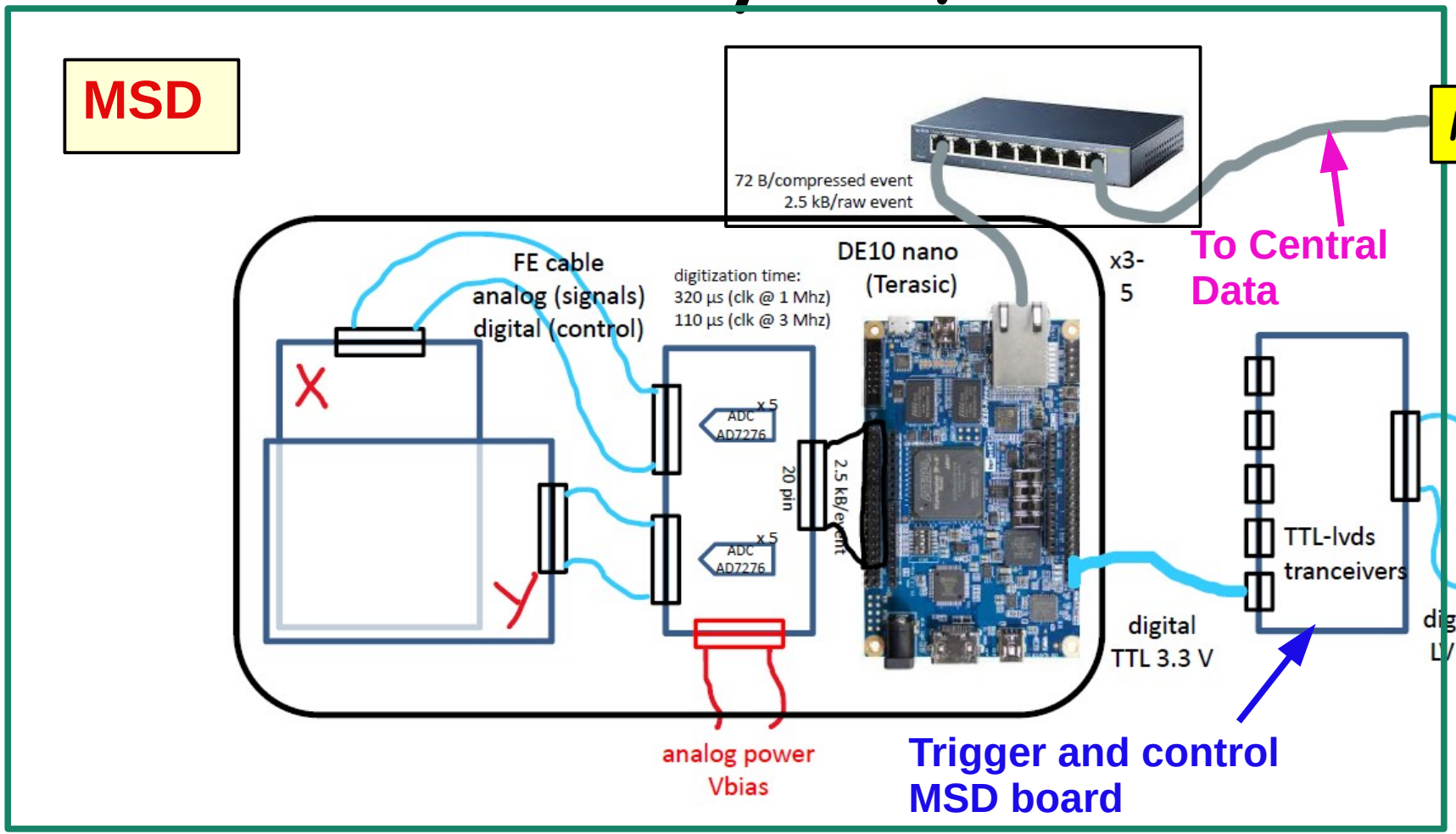
L. Servoli, G. Ambrosi,
K. Kanxheri, G. Silvestre,
M. Movileanu-Ionica,
M. Caprai, M. Barbanera,
F. Peverini

Status of MSD subsystem





Hardware: Hybrid, ADC and DAQ



Procurement: Sensor + DAQ chain

→ Sensors: arrived.

→ Readout Chip (VA1140): arrived.

→ Hybrid for chip bonding: arrived

→ ADC board: order placed; design approved; produced; should arrive today.

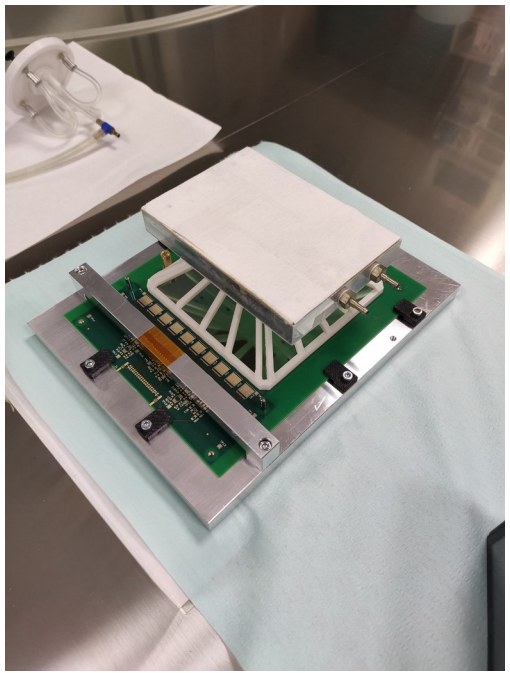
→ Trigger distribution board: order placed; design under finalization;

→ DAQ De10-nano boards: arrived

→ bias sensor CAEN A7585DU (SiPM power supply chip);
→ power supply DAQ chain: arrived (1+1 spare);
→ ethernet switch: arrived;
→ PC for DAQ standalone with clone of official FOOT DAQ ready.

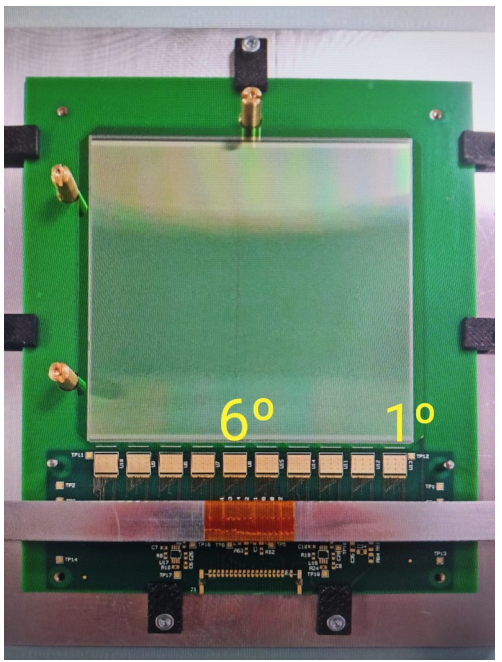
Module Construction

First mechanical assembly test with dummy modules to develop procedure (begin july - begin august):



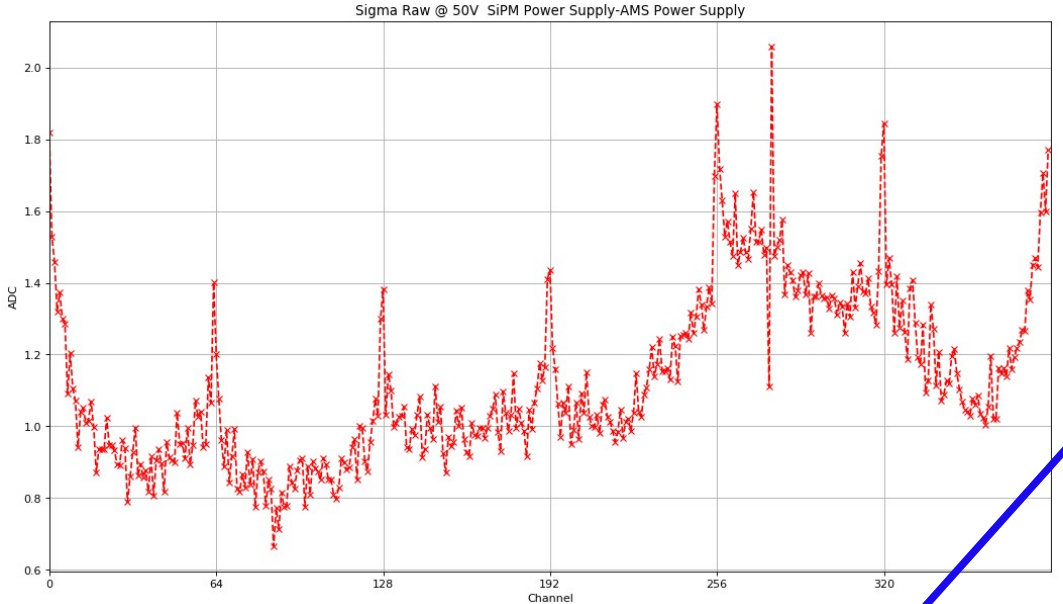
First electrical module (good 150 μm thick Hamamatsu sensor + new hybrid + 2 VA1140 chips to test electrical functionality.

(today VA1140 glueing and bonding)

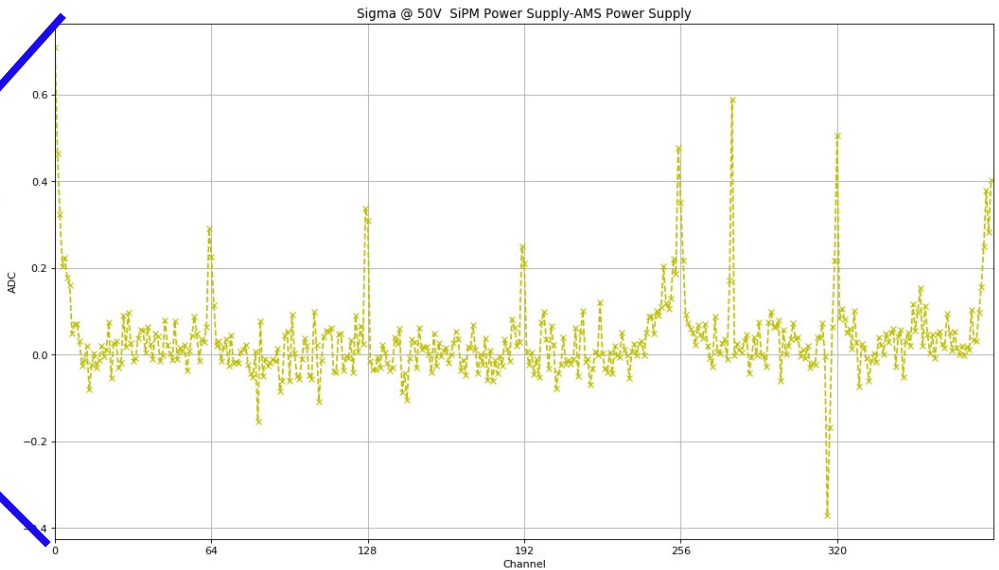


Next week: start tests also with lab sources. Using old DAQ chain from DAMPE experiment (only 2 ADC on the ADC board)

Hardware: Power Supply



Raw Noise: difference within 2 ADC



Strip Noise: difference < 1 ADC

CAEN A7585DU has been chosen

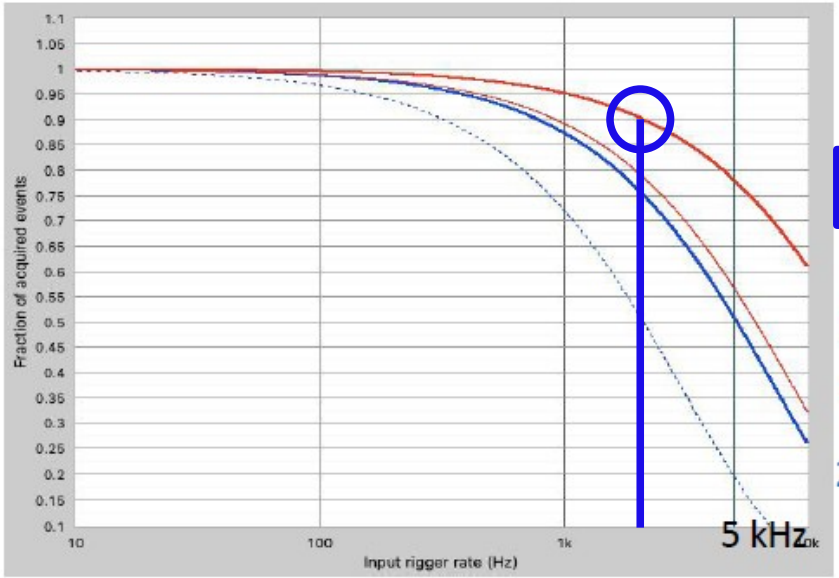
Up to 16 CAEN chips could be controlled in daisy chain (Arduino)

Hardware: new ADC board

We have modified the layout to gain some more margin in acquisition rate.

Old ADC board: 1 ADC to read out 5 VA1140 chips.

Now we have 1 ADC to readout 5 VA1140 chips.
→ ~2 kHz @ 90%



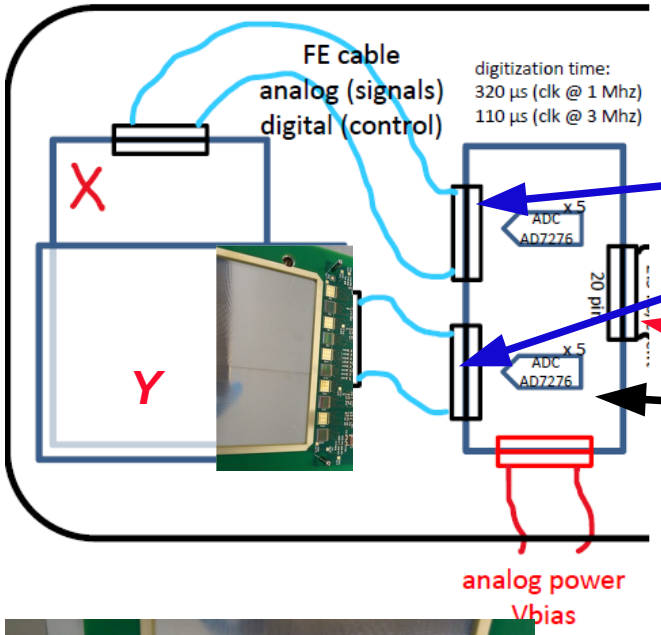
5 ADC @ 3 Mhz, T = 50 µs

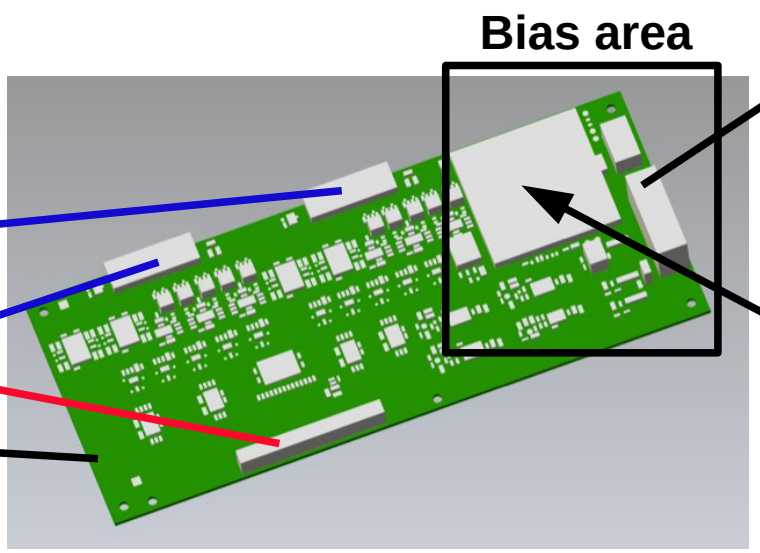
2 ADC @ 3 MHz, T = 114 µs

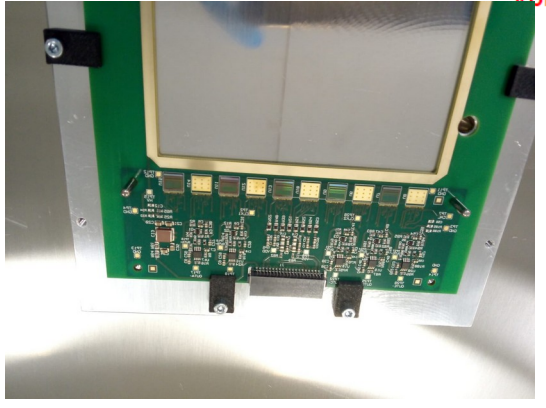
5 ADC @ 1 MHz, T = 135 µs

2 ADC @ 1 MHz, T = 327 µs

Hardware: ADC board with sensor bias







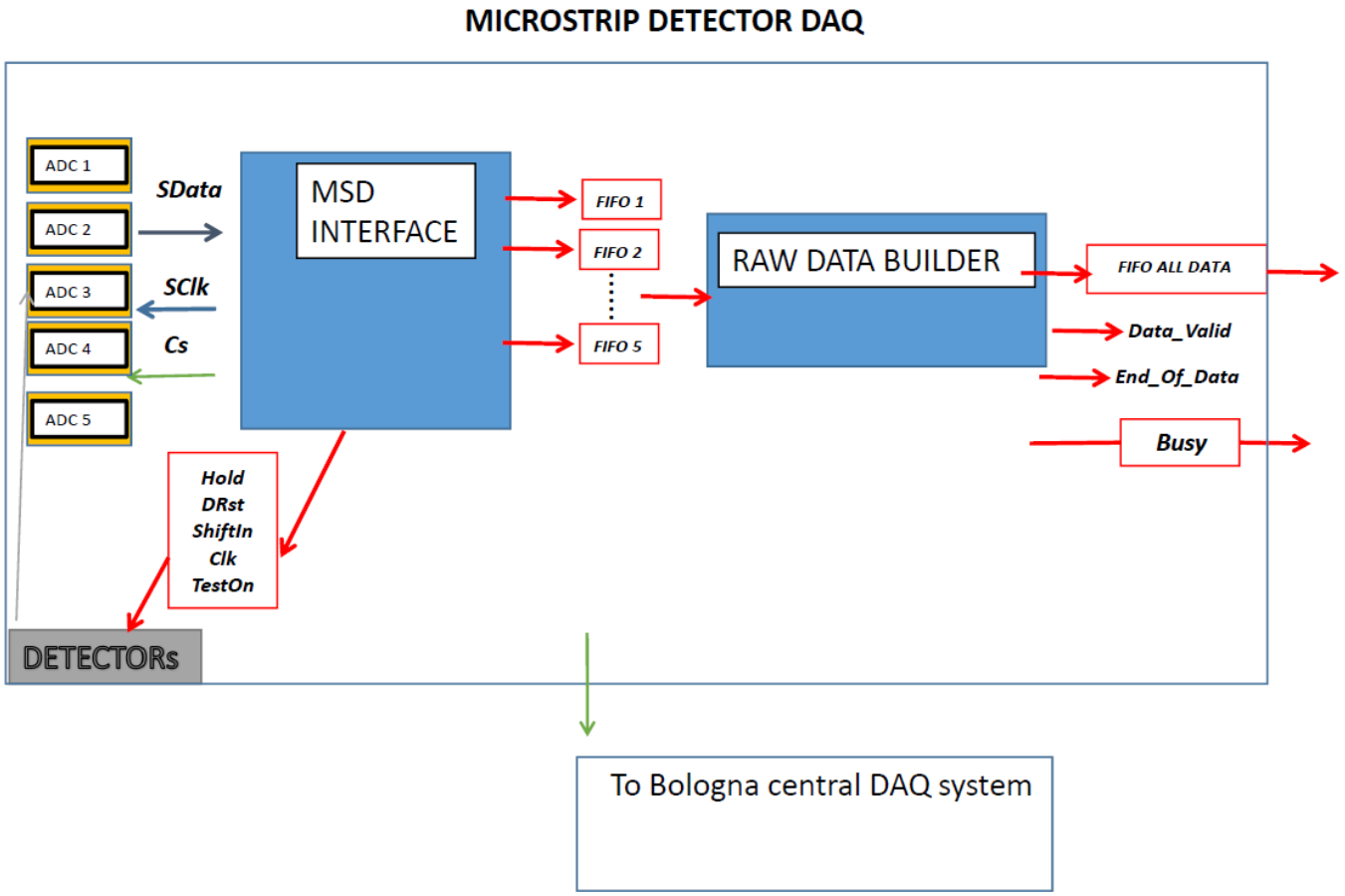
Connectors to hybrid with VA1140 and sensors

Connector to DE10-nano

Connector for daisy-chain of bias control

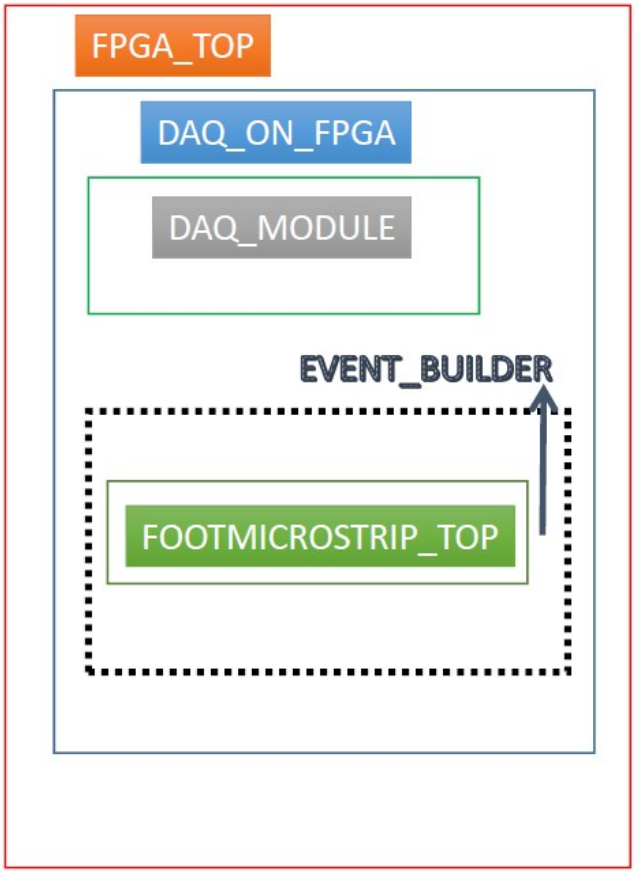
DAQ Status:

Just a reminder of the general scheme of the MSD DAQ project and the connection with the general DAQ FOOT

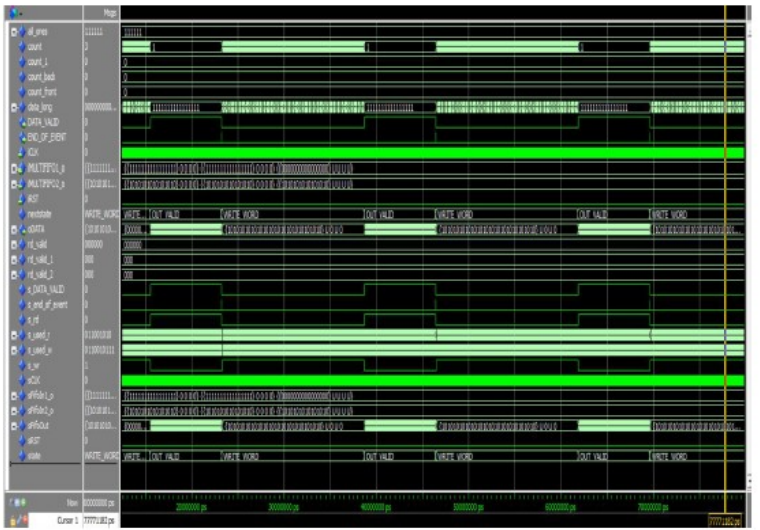


DAQ Status: Merging two systems

Connections between MSD part developed by Perugia and preexisting Bologna framework have been established and tested at simulation level.

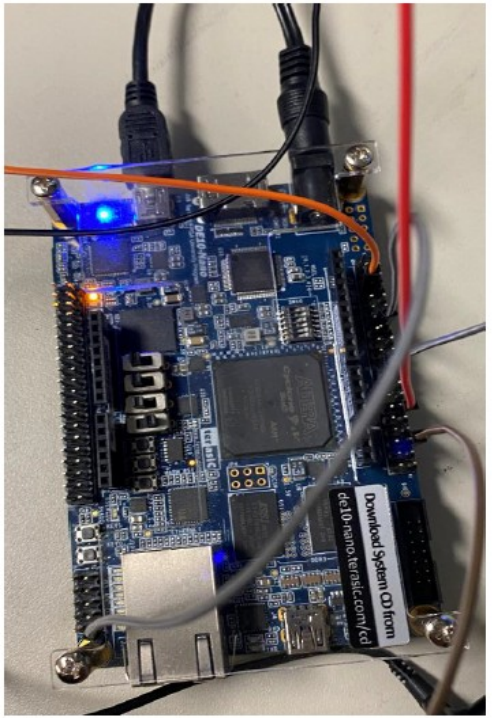


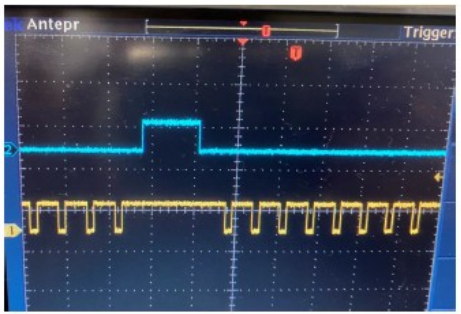
MSD CONTROL INTERFACE AND DATA TRASMISSION SIMULATIONS

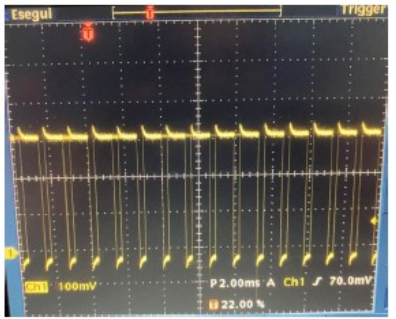


DAQ Status:

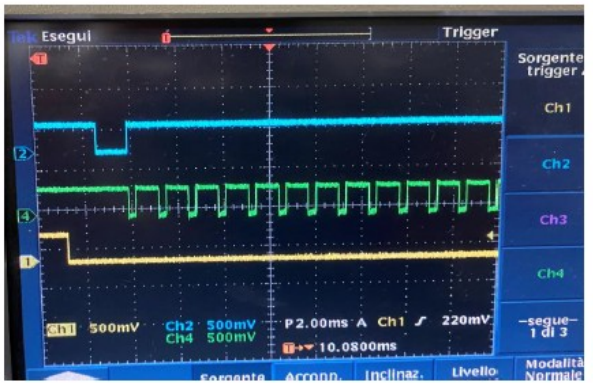
MSD Control Signals







All control signal arrive where they should….



….WAITING FOR THE ADC BOARD TO TEST THE ENTIRE SYSTEM!!

Hardware: Mechanical support structure

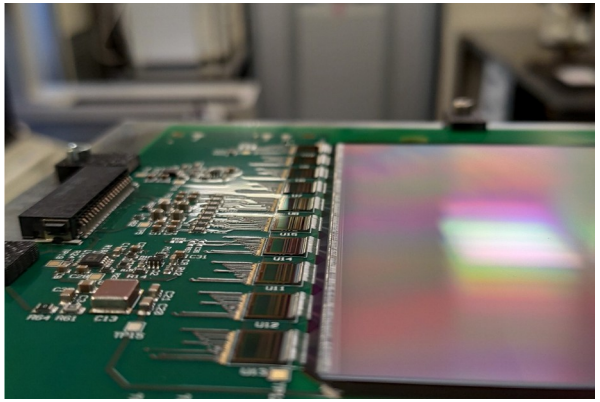
We are working to have a one-piece MSD system including:

→ Support for x-y planes (3 to 5 possible) (sensors + hybrids);
→ Support for ADC boards;
→ Support for trigger and Control board;
→ Support for Ethernet switch;
→ Support for sensor Analog Bias power supply.

In principle only: 1 ethernet cable, 1 flat cable (digital LVDS), 1 power cable will get out from MSD subsystem.

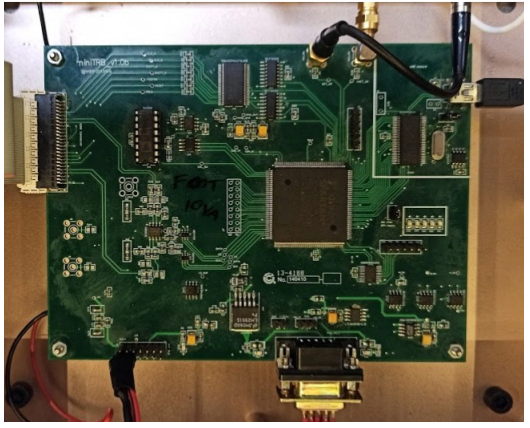
Coordination with general mechanical FOOT system slowed down by COVID.

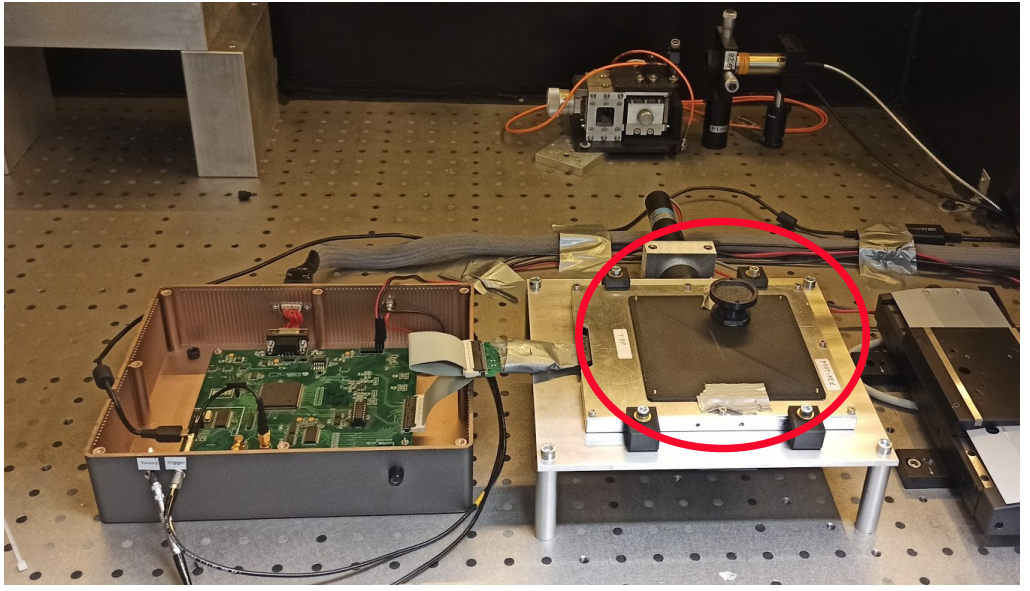
Hardware: Test of PE01 prototype



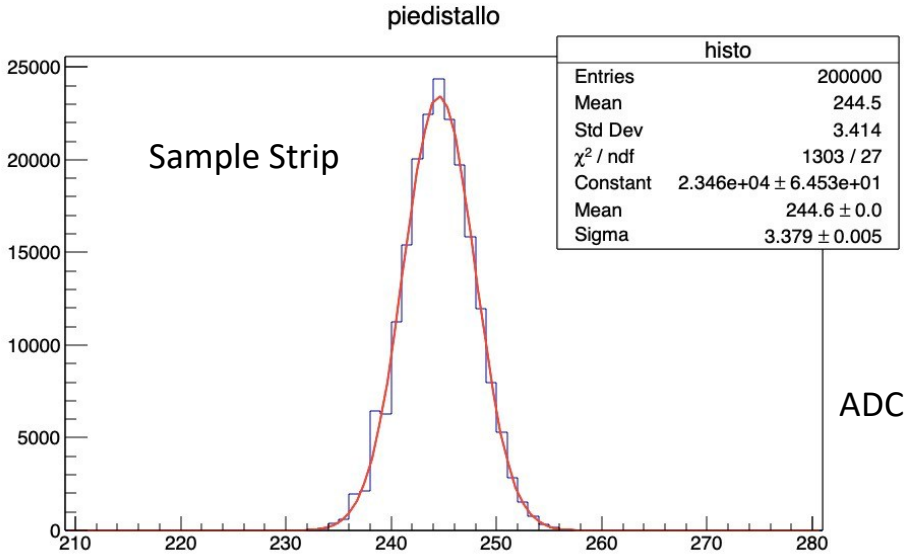
Sensor 150 mm thick, 10 VA1140 chip, 2 ADC channels

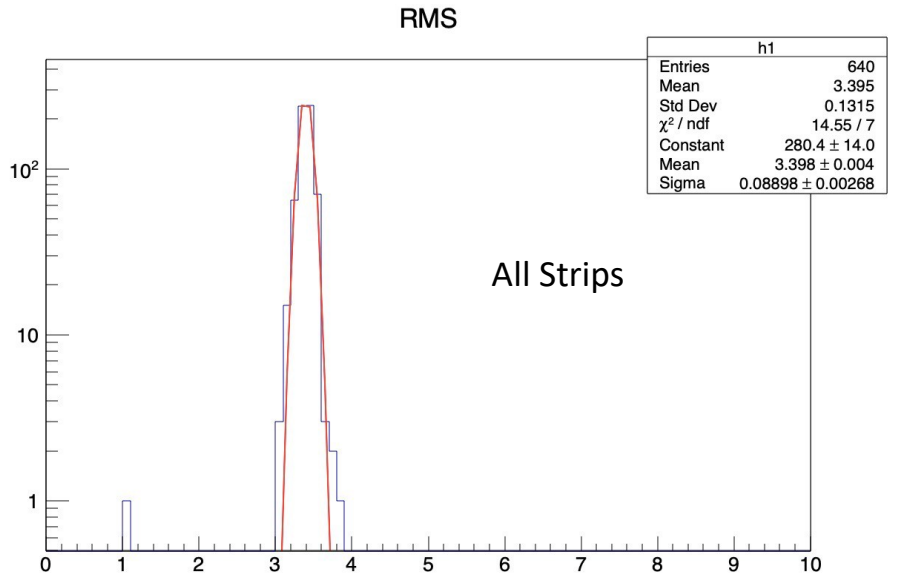
Old DAMPE DAQ board with FPGA to read 2 ADC





Hardware: Test of PE01 prototype

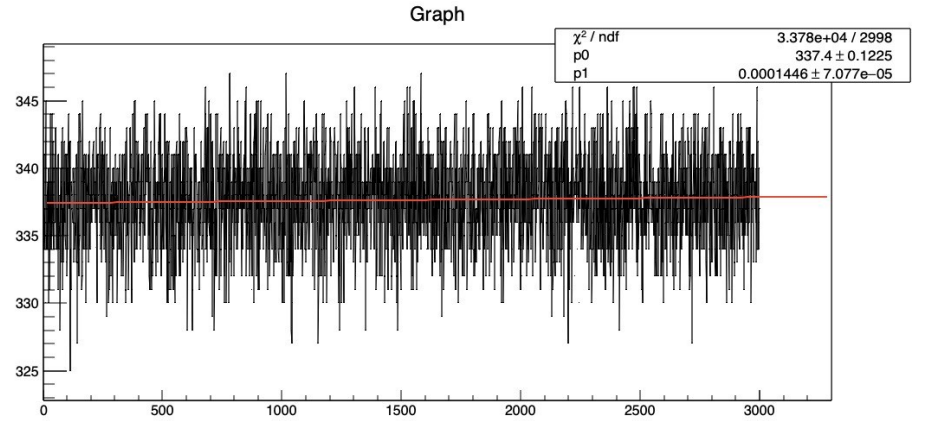


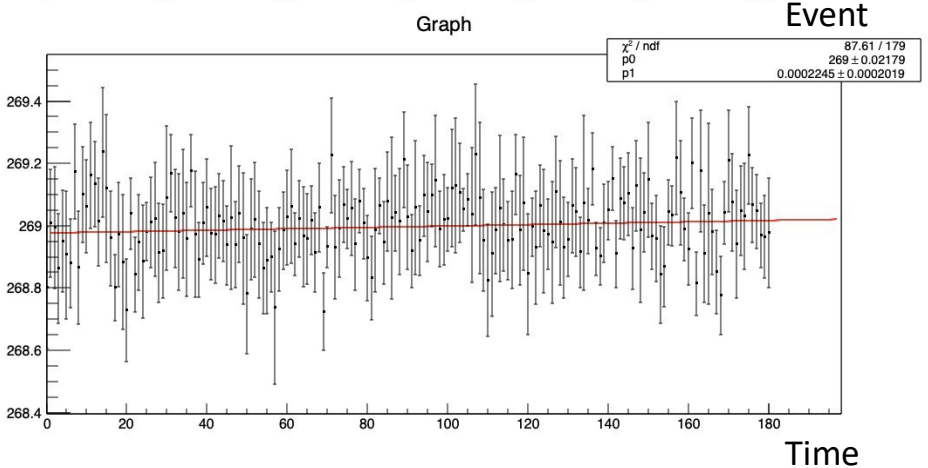


- Mean pedestals value of readout electronics ≈ 270 ADC counts
- Typical channel noise after sensor gluing between 2 and 3 ADC (depending on conditions)
- Leakage current @80V: around 400nA
- Leakage current stability tested over several days of continuous operation

Hardware: Test of PE01 prototype

Typical Noise of the detector



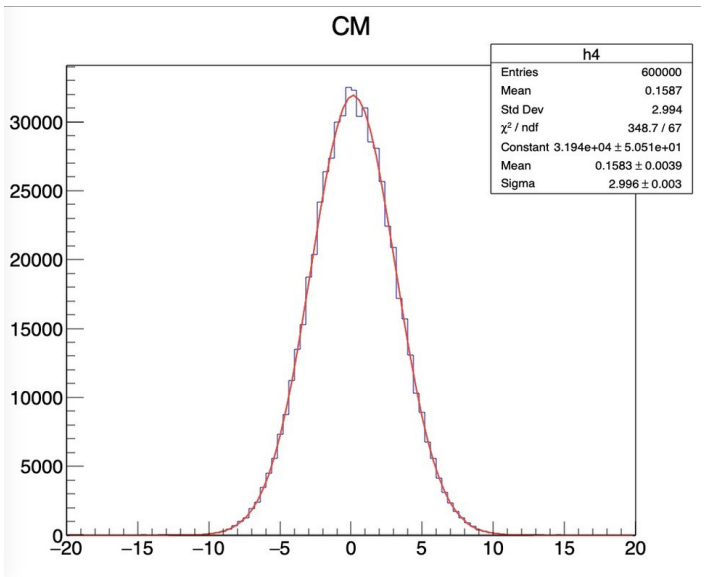


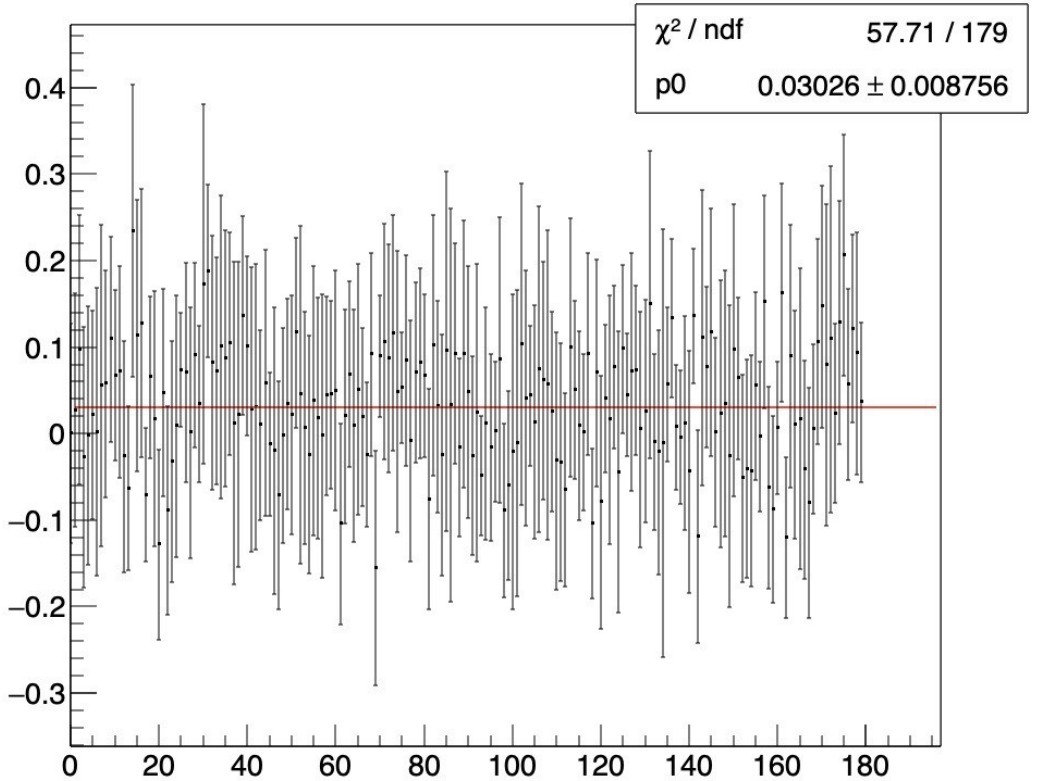
- Data acquisition at constant 50Hz rate
- Pedestal value of the channels as a function of the event number
- Fit with pol1

- Data acquisition at constant 50Hz rate
- Mean over 3000 events as a function of "time
- Fit with pol1

Hardware: Test of PE01 prototype

Average common mode noise time profile over 3 hours. Very stable





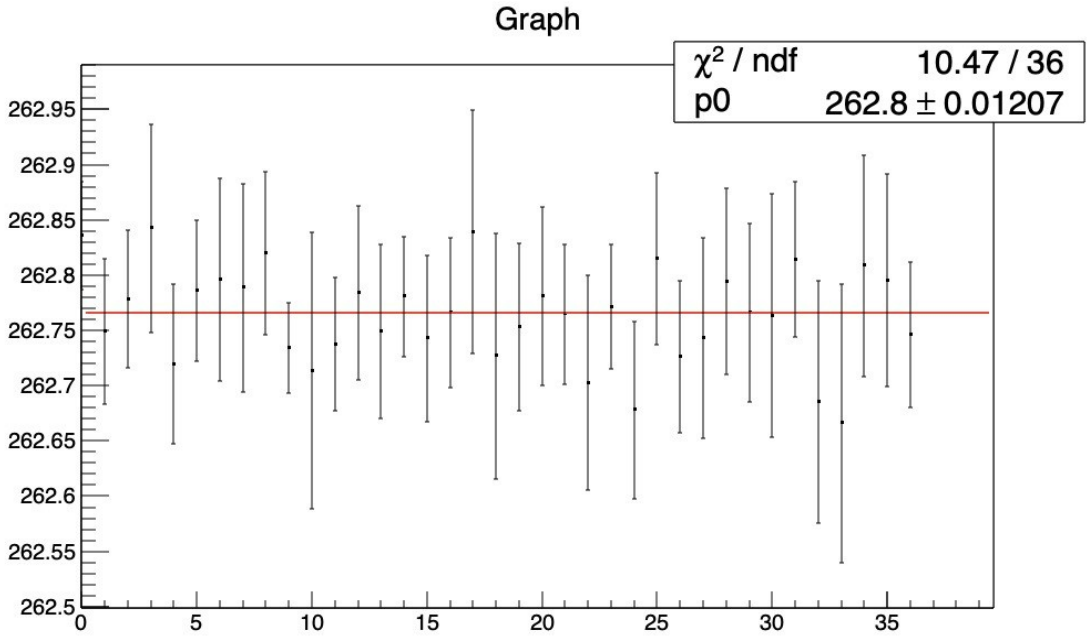
Fluctuation ~ 3 ADC

Hardware: Test of PE01 prototype

Pedestal stability in time:

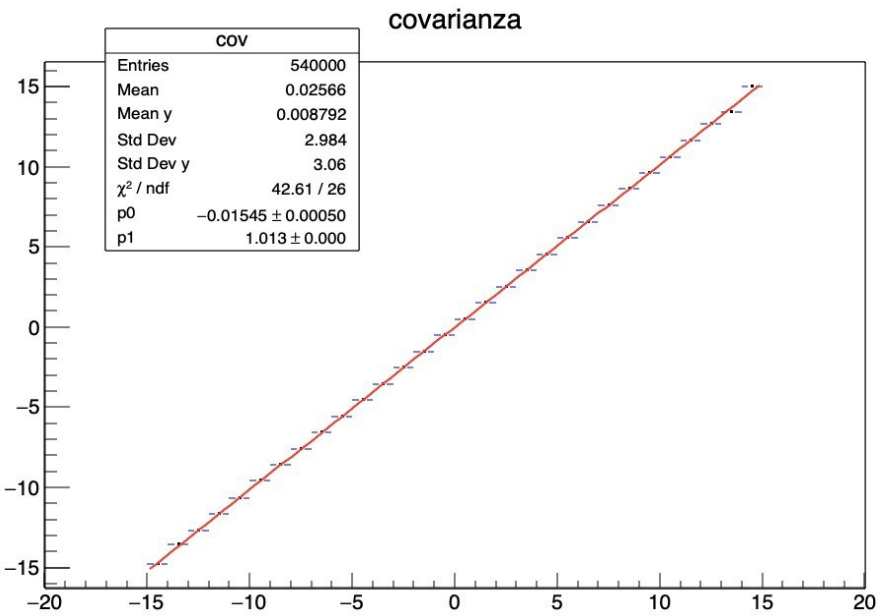
Over 3 hours no modification

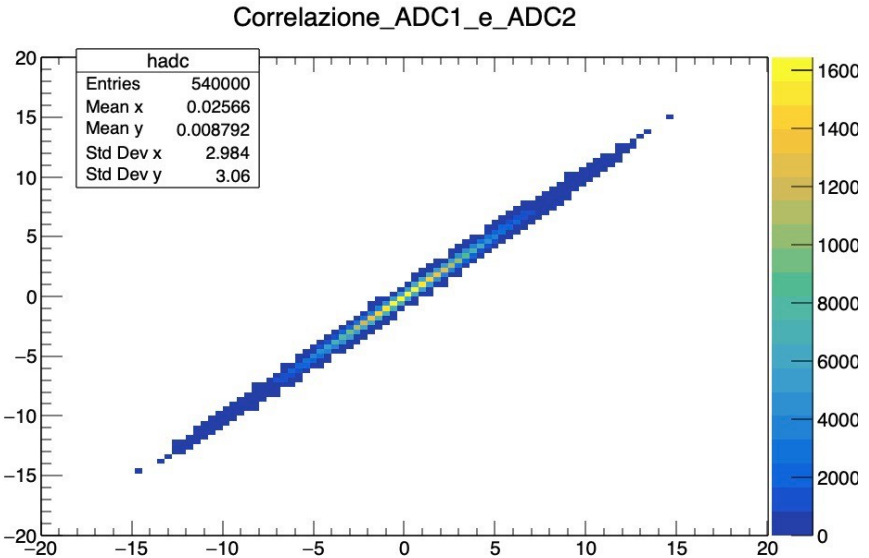
→ *we can live with the same calibration over a reasonable amount of time.*
(to be confirmed on a real data taking environment)



Hardware: Test of PE01 prototype

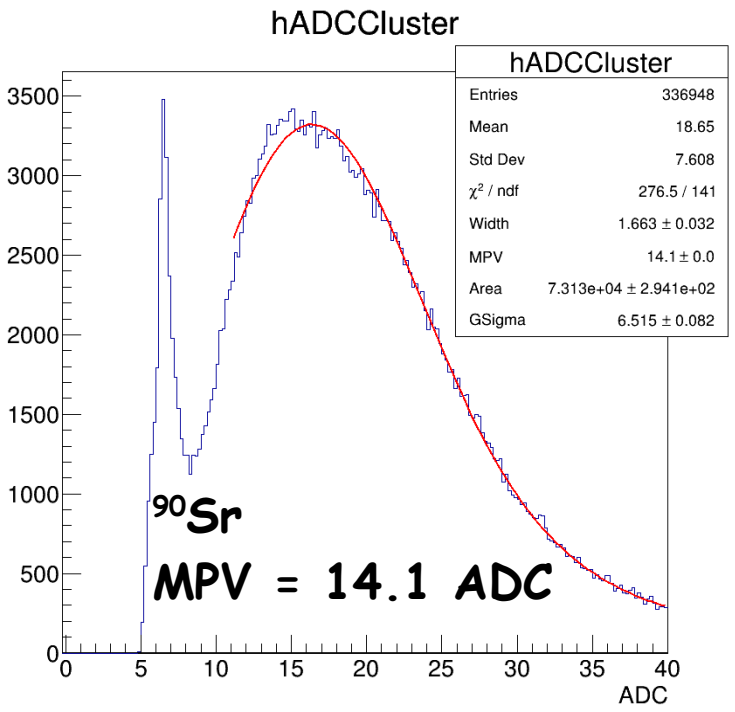
Difference between ADC channels using Common mode fluctuation:

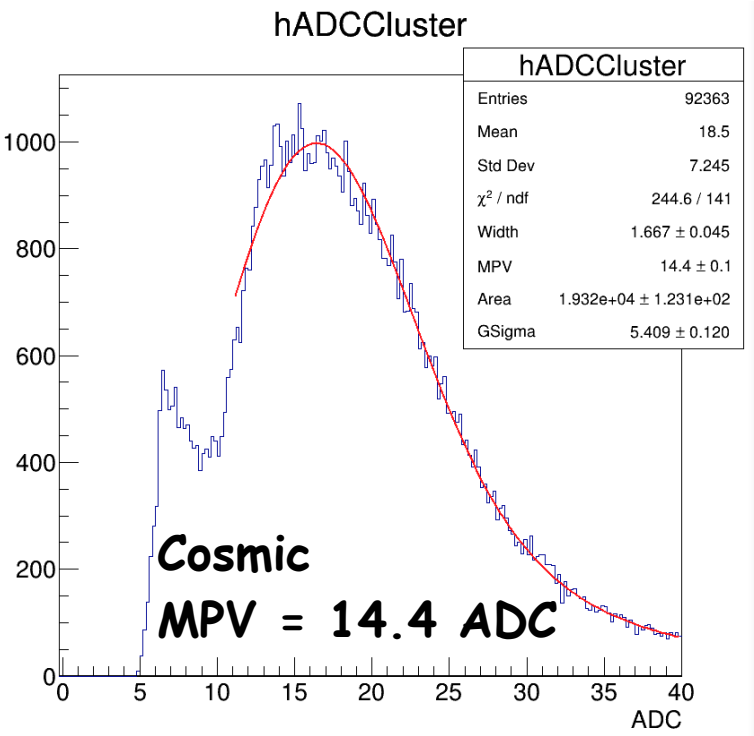




Correlation close to 1.
No need for correction up to now. We are working on possible differences using cosmic.

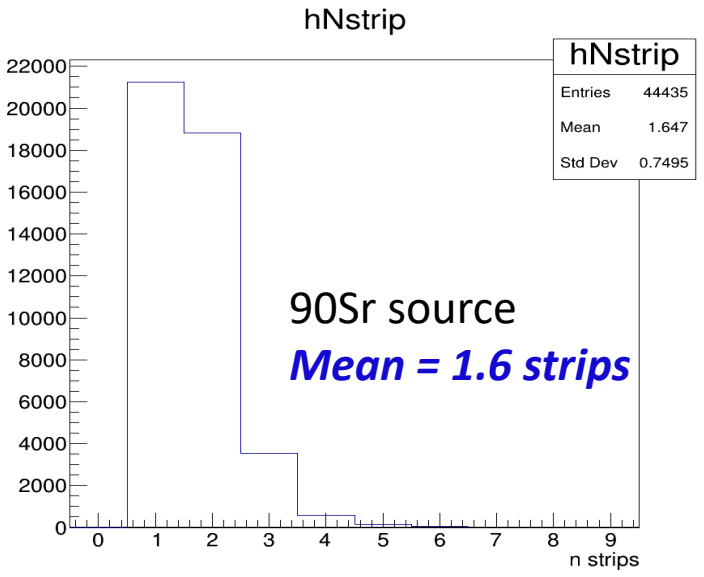
Hardware: Test of PE01 prototype

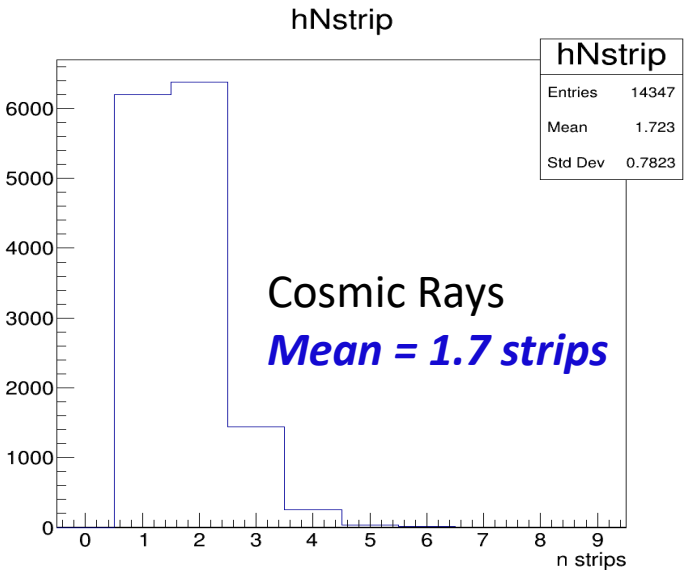




- Signals from Cosmic Rays and 90SR radioactive source
- Most Probable Value compatible with the estimates obtained from 300um thick sensors
- Small quantitative differences due to slightly different conditions during acquisition

Hardware: Test of PE01 prototype

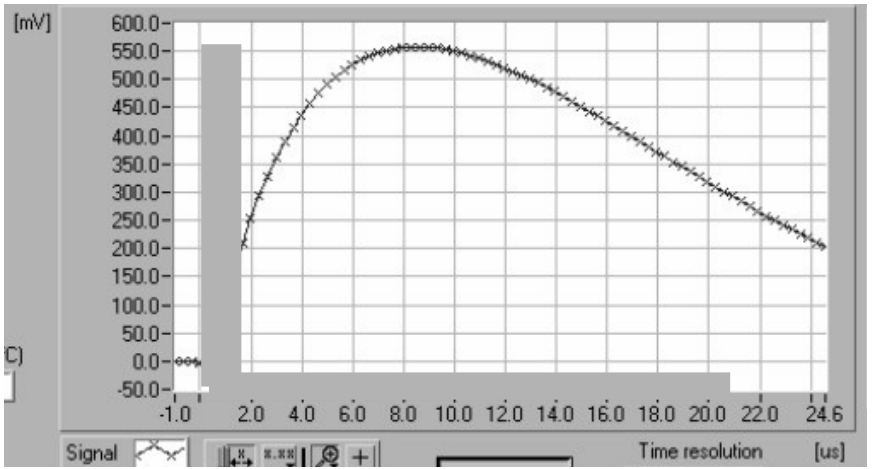




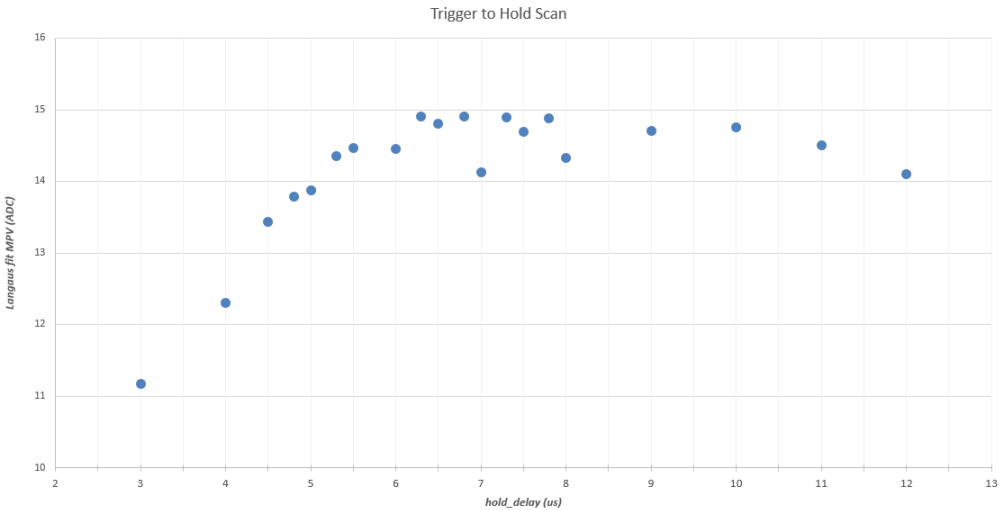
- ***Cluster width reasonable given the readout pitch (150um)***
- Distributions dependent on cluster algorithm thresholds
- Still preliminary

Hardware: Test of PE01 prototype

VA1140 shaping function from IDEAs



VA1140 shaping function from our data

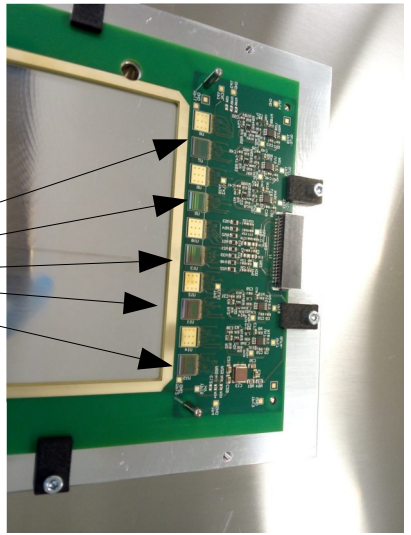


- Test with data from 90Sr radioactive source
- MPV from Langaus fit for various Trigger to hold values
- Range 3us to 12us limited by the DAQ system
- Qualitatively comparable with data from IDEAs
- ***To be retested with the new DAQ system***

Started writing a general paper on these tests.

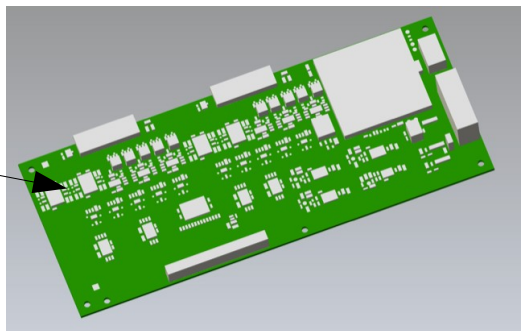
2020 Workplan for construction and commissioning

→ We should finish the 3 x-y plane + 2 spares in two working weeks from the final positive functionality test with the DE10-nano board.
(We have the hybrid with *5 analog out with half VA1140* mounted waiting to be electrically tested)



→ There could be some limited follow-up next year if we found problems with laboratory / beam tests (ADC board and/or mechanical setup).

→ MSD DAQ full chain: waiting for ADC board to do test with final hardware.



→ Development of mechanical support for all the MSD system and interface with general experiment frame.

2021 Workplan for commissioning and data taking

- → There could be some limited follow-up next year if we found problems with laboratory / beam tests with ADC board.
- → Finalization of mechanical support for all the MSD system and interface with general experiment frame.
- → Dedicated test beam for defining the detector response to ion and to define the eta-function for spatial resolution.
- → DAQ development for zero-suppression algorithm.