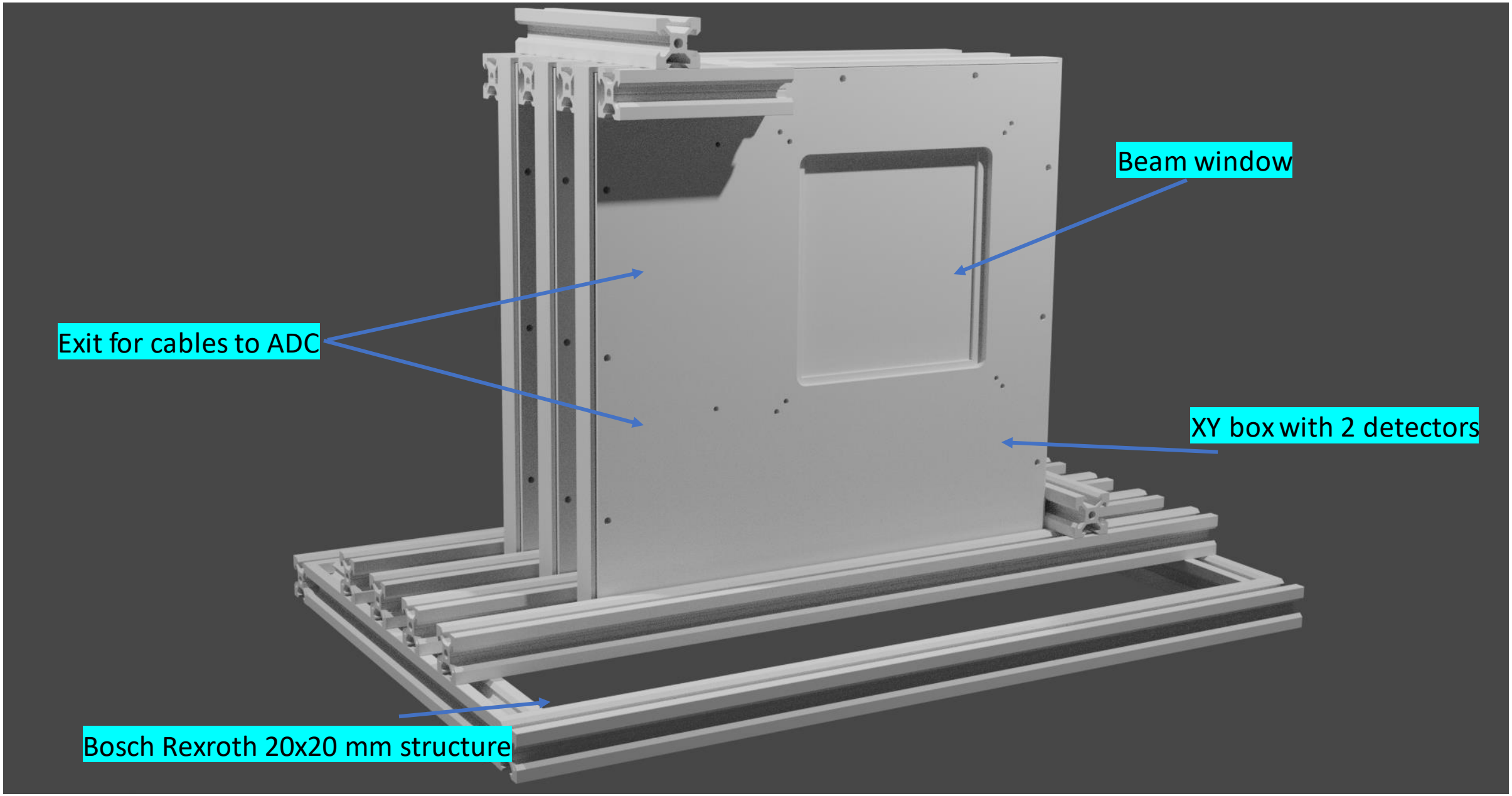
# MSD Status Report after GSI 2021

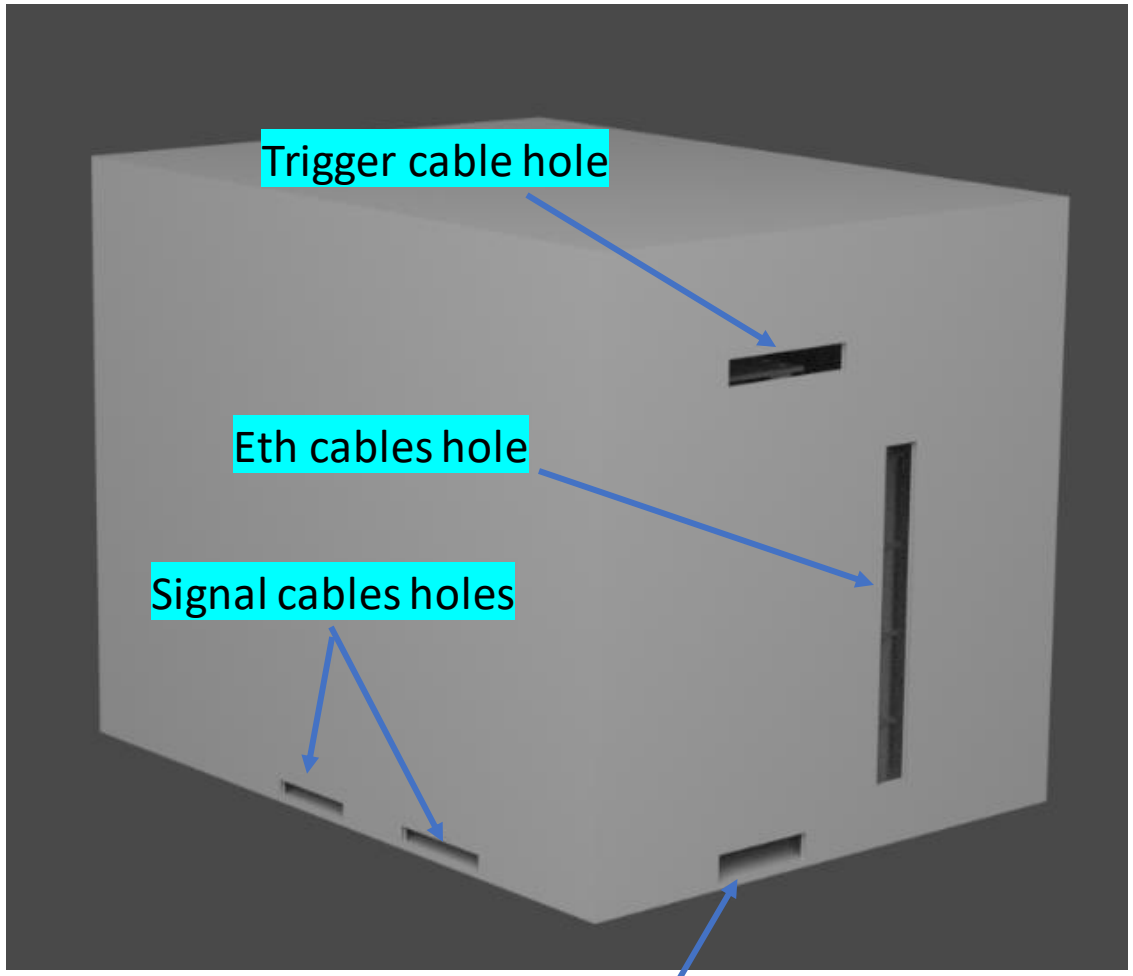
*Gianluigi Silvestre on behalf of the MSD Group at Perugia*

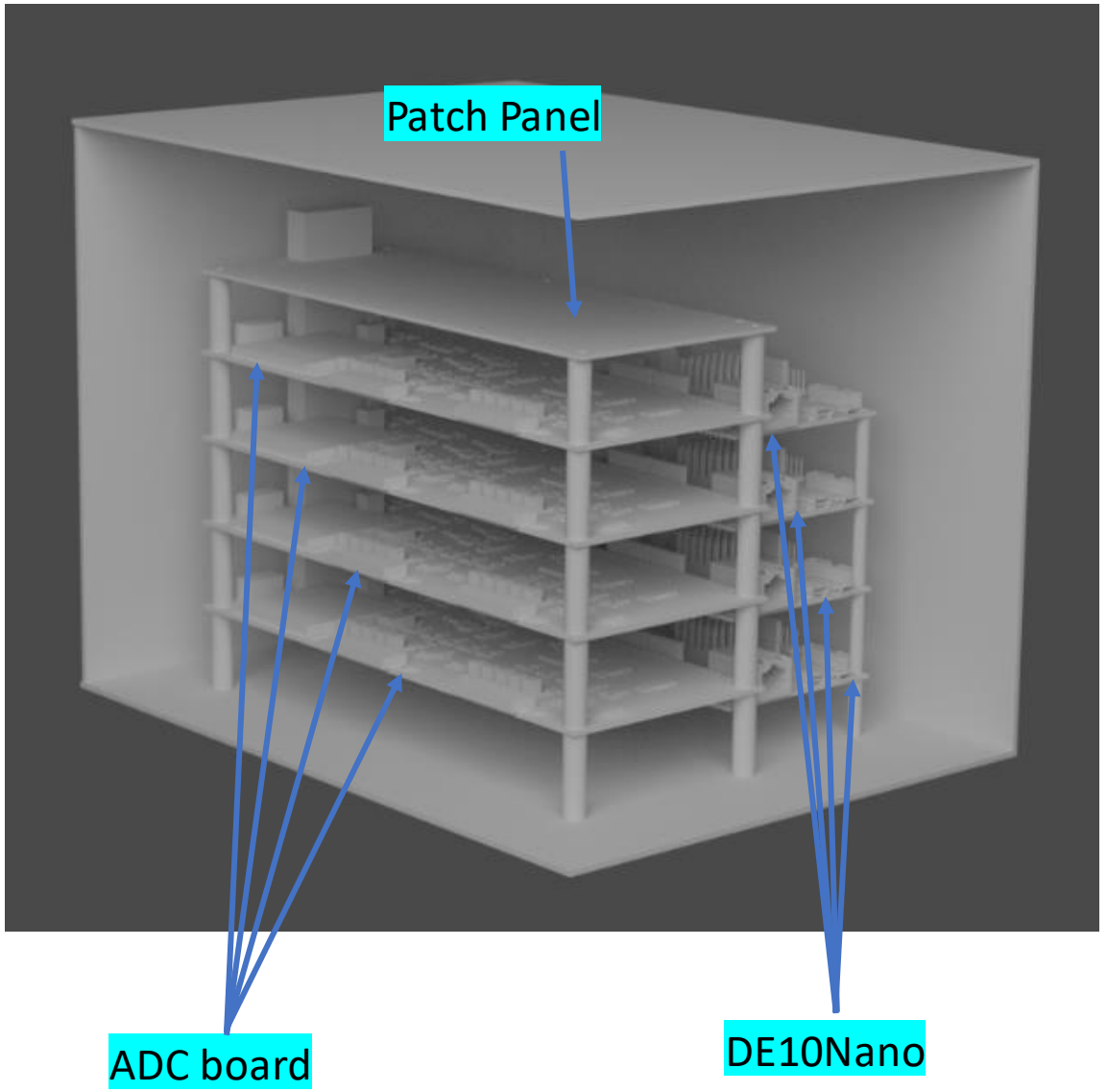
08 September 2021

# GSI 2021 MSD Setup



# GSI 2021 MSD Setup

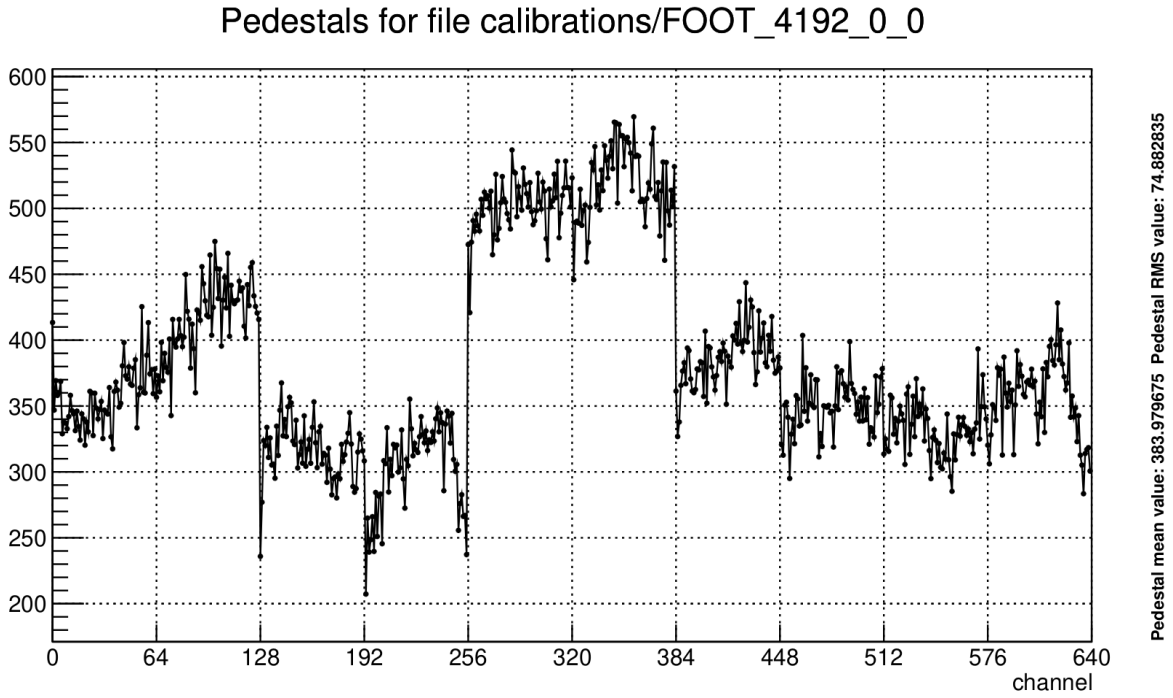


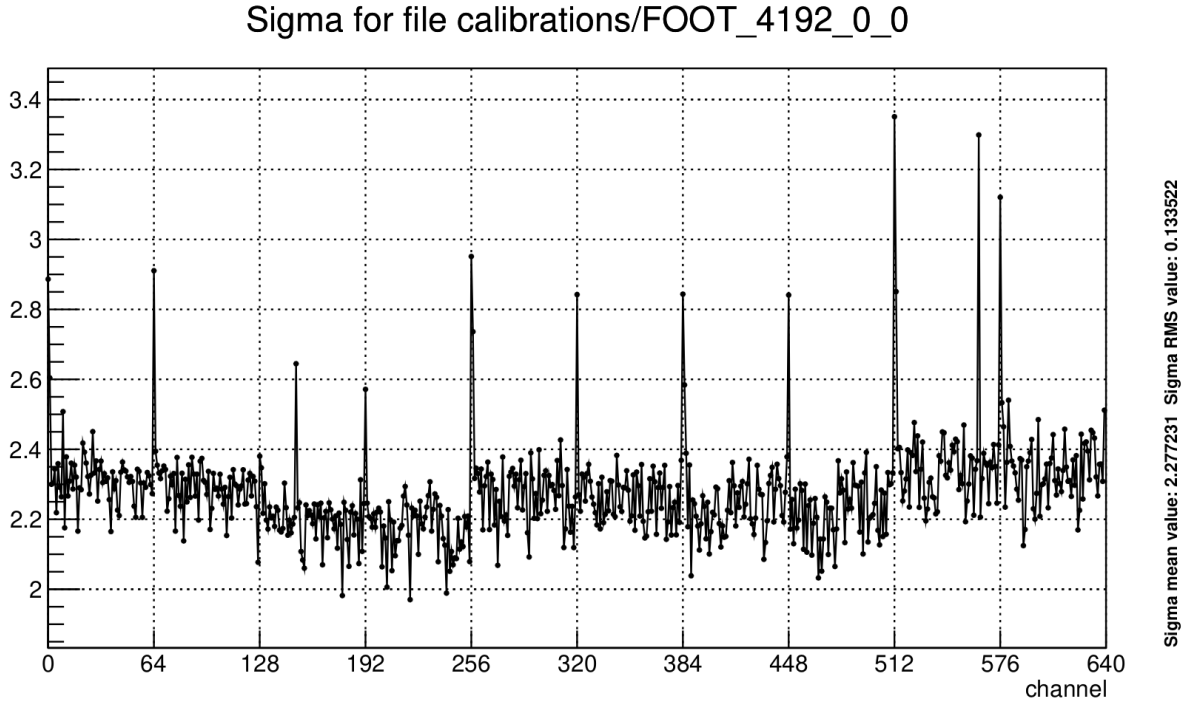



# GSI 2021 MSD Setup

- Aluminium enclosure box
  - 3 XY detector pairs with dedicated ADC board + DE10Nano
  - 1 ADC + DE10Nano spare pair in the electronic stack
    - The spare pair was used after a ≈20 minutes work in the cave
    - Investigation on Pair 3 malfunction is ongoing
  - XY pair can be replaced if necessary (just remove the box from the structure)
    - No need to replace it during data taking arised
- Holes on the box closed by aluminium tape
- Shielded ETH cables
- Signal cables shielded with aluminum tape

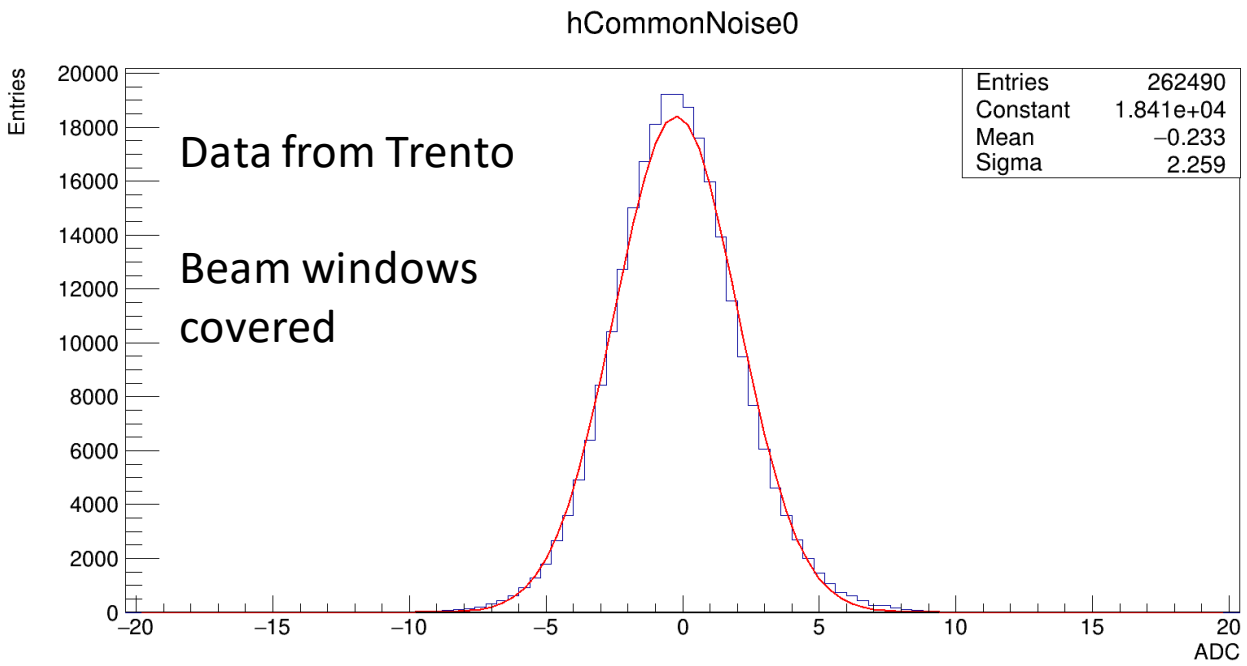
# GSI 2021 MSD Noise Performance

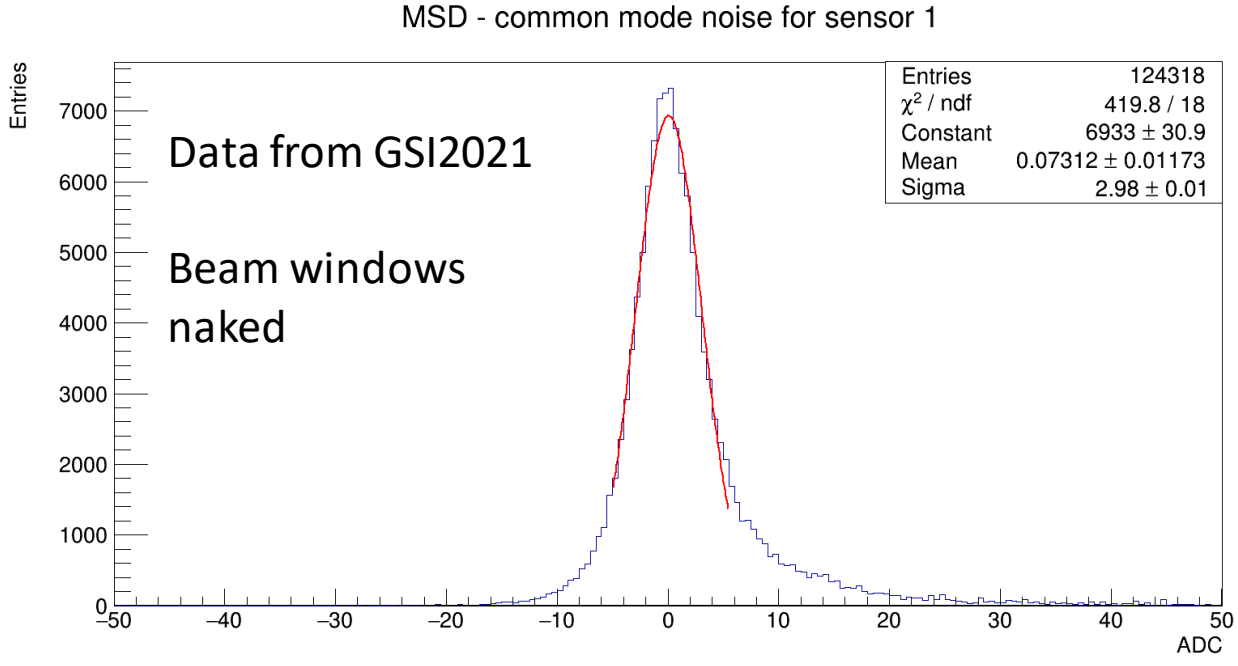



- Pedestals and mean sigma values comparable with measurements in the lab @ PG
- Mean pedestal value set to around 350 to maximize dynamic range
  - Values were chosen with a predicted signal value ≈ 1500 ADC
- Strips at the border of a readout ASIC are a bit noisier
  - Problem observed also with Protons @ Trento
  - Investigation ongoing on the impact on S/N

# GSI 2021 MSD Noise Performance



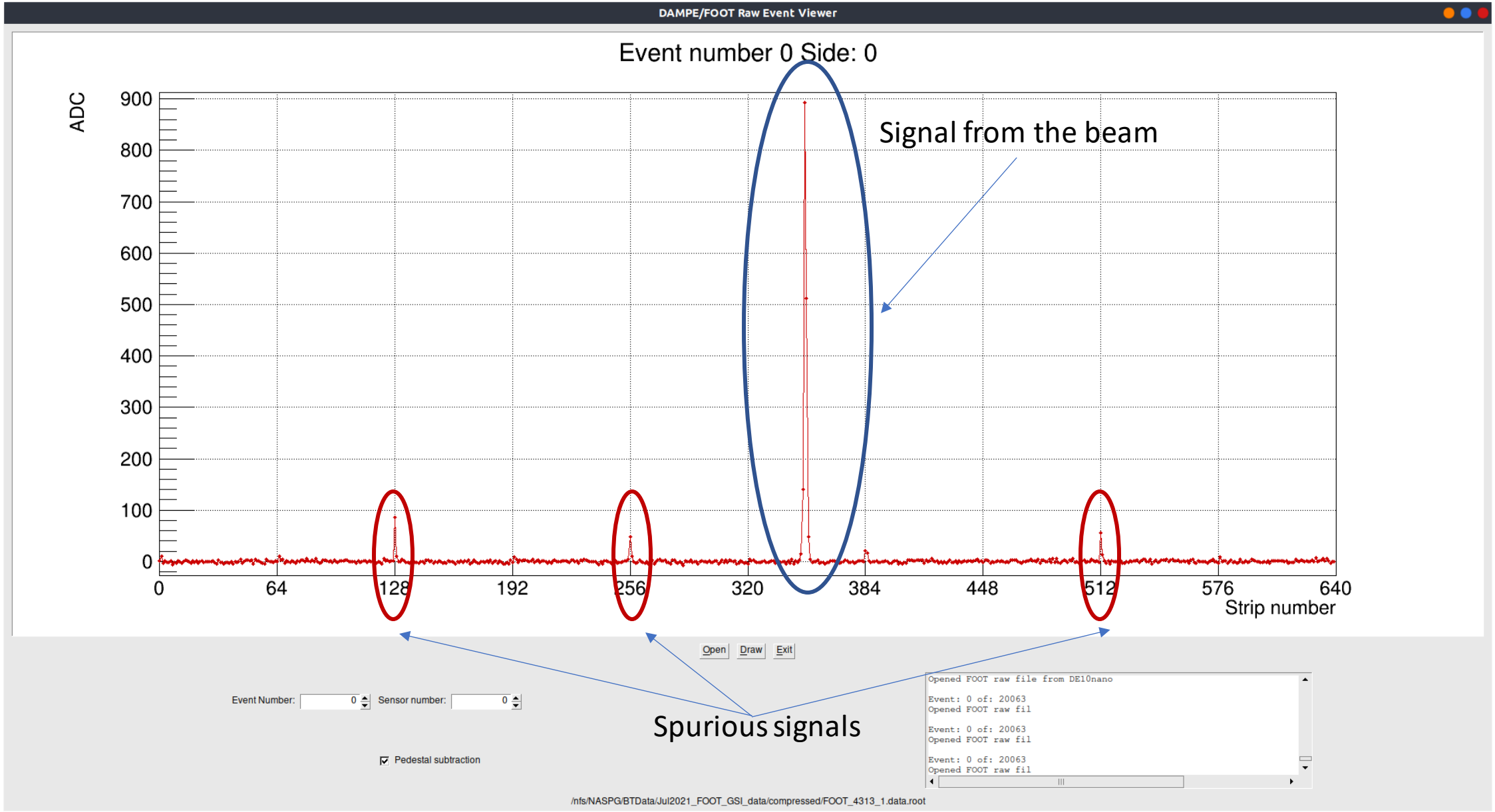




$$CN = \sum_{i=0}^{63} \frac{ch_i}{N} \quad \text{if} \quad (\,\overline{\text{ch}} - 2 * \text{RMS}_{\text{ch}}\,) < ch_i < (\,\overline{\text{ch}} + 2 * \text{RMS}_{\text{ch}}\,)$$

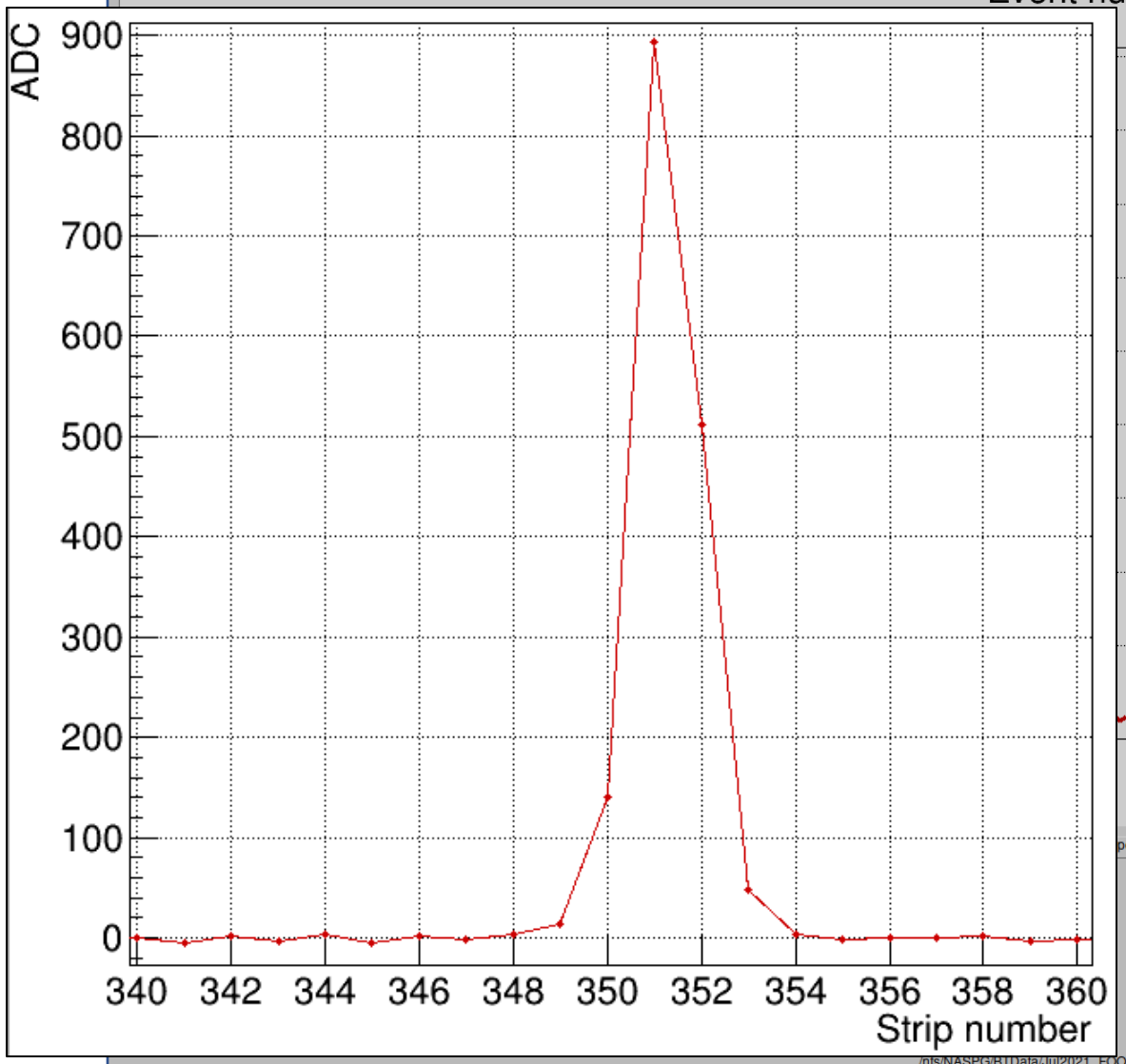
where $\overline{\text{ch}}$ is the ASIC mean channel value and $\text{RMS}_{\text{ch}}$ is its channel RMS value

- Common Mode noise of readout ASICS
  - Values comparable with Trento data
  - The metallization of the back of the sensor is a good enough shielding from light
  - Parameters (and type) of common mode computation algorithm need to be tweaked

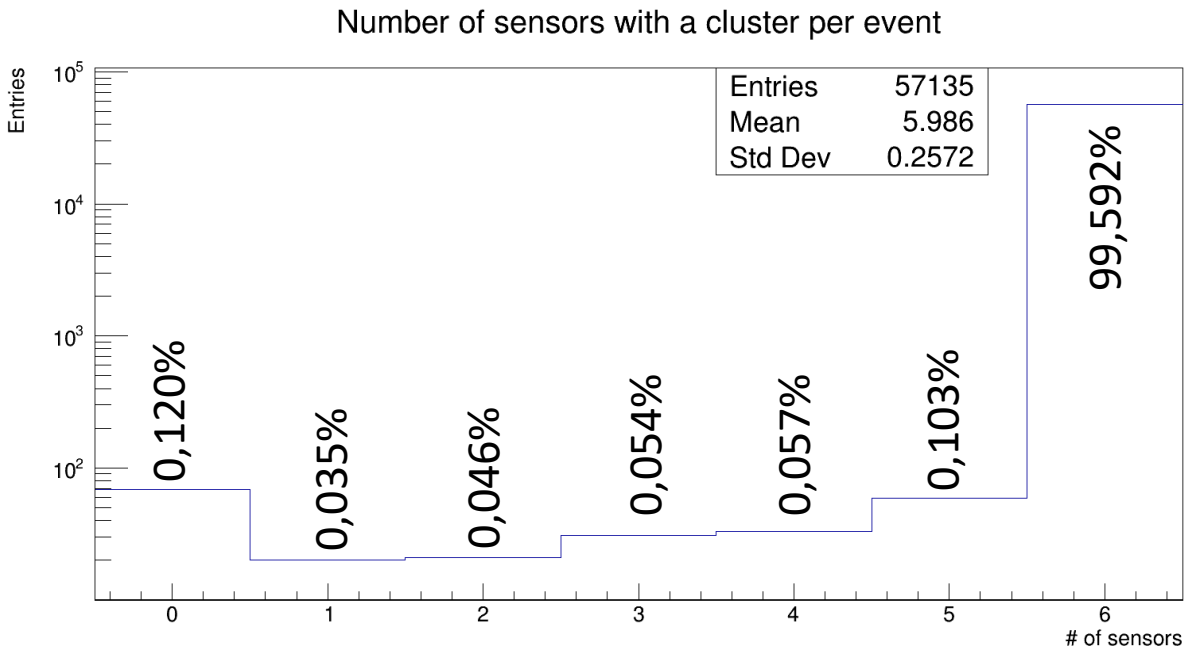
# GSI 2021 MSD Event Display

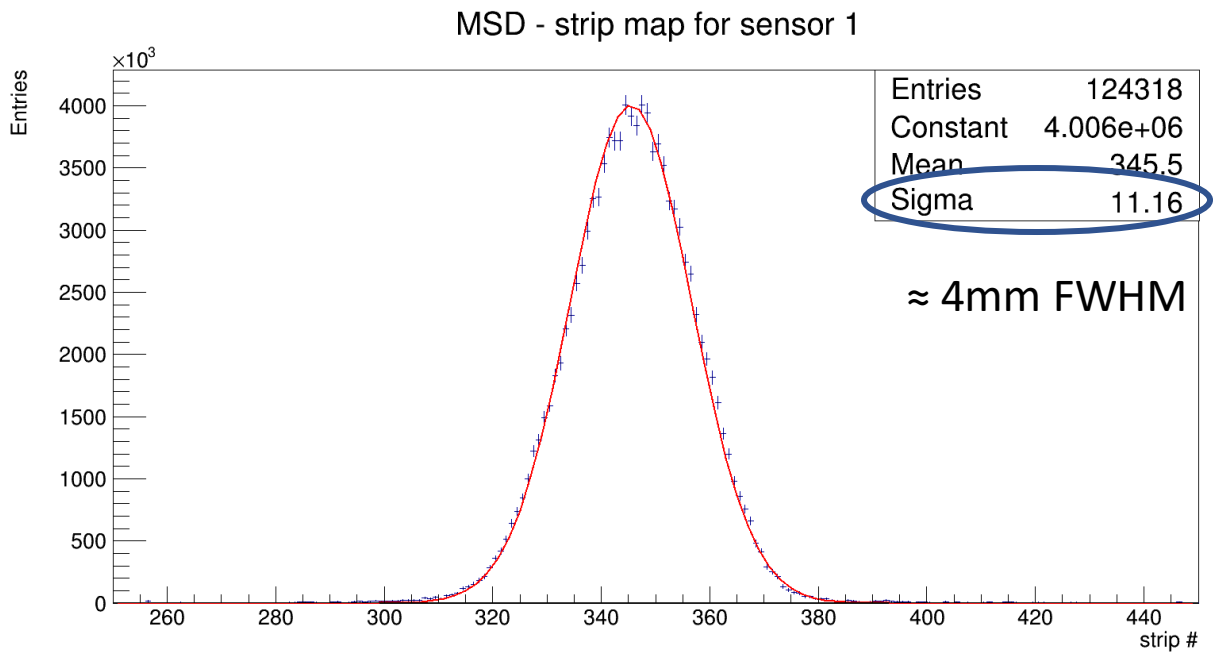


# GSI 2021 MSD Event Display



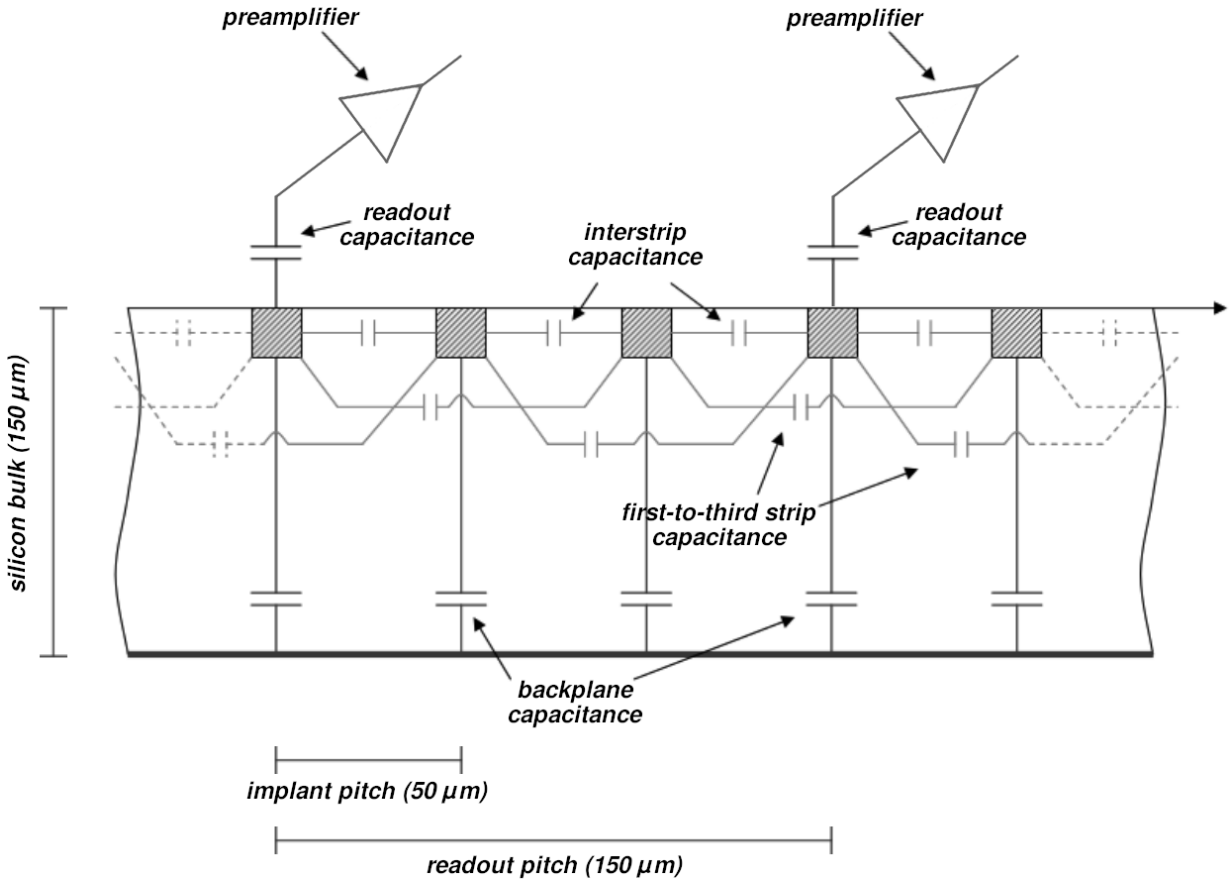
# GSI 2021 MSD Signal



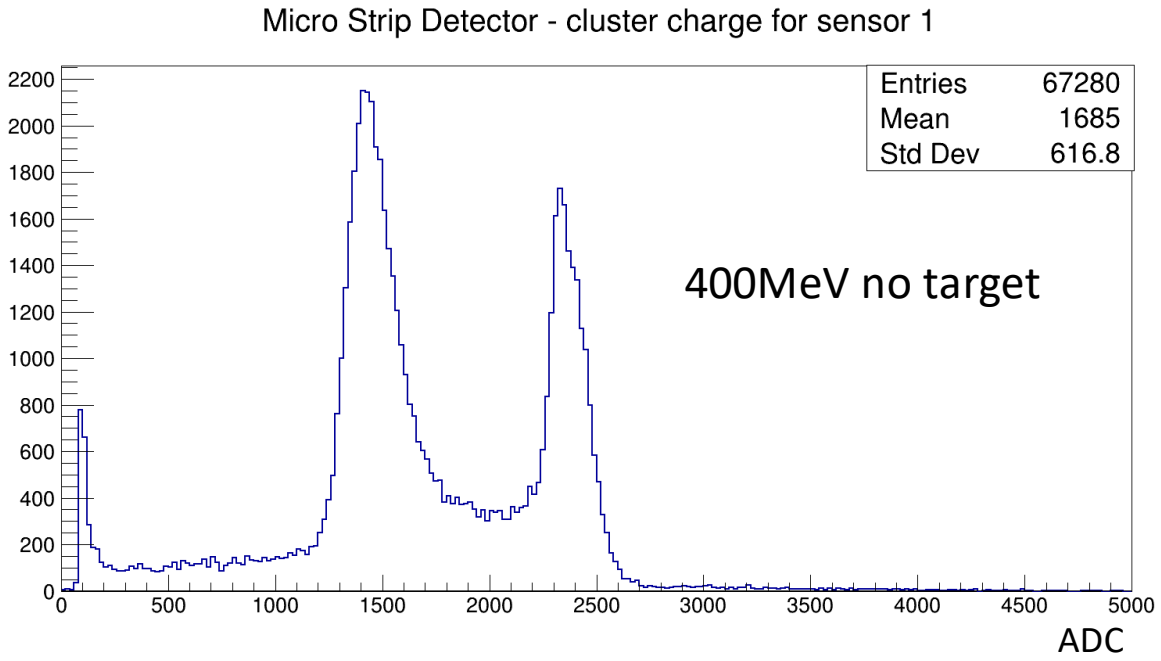

- Preliminary results with high thresholds for cluster reconstruction (around 5 MIPs)
  - Most of the times all the detectors have a cluster
  - It is possible to correctly reconstruct the beam profile (example: 400MeV with no target)

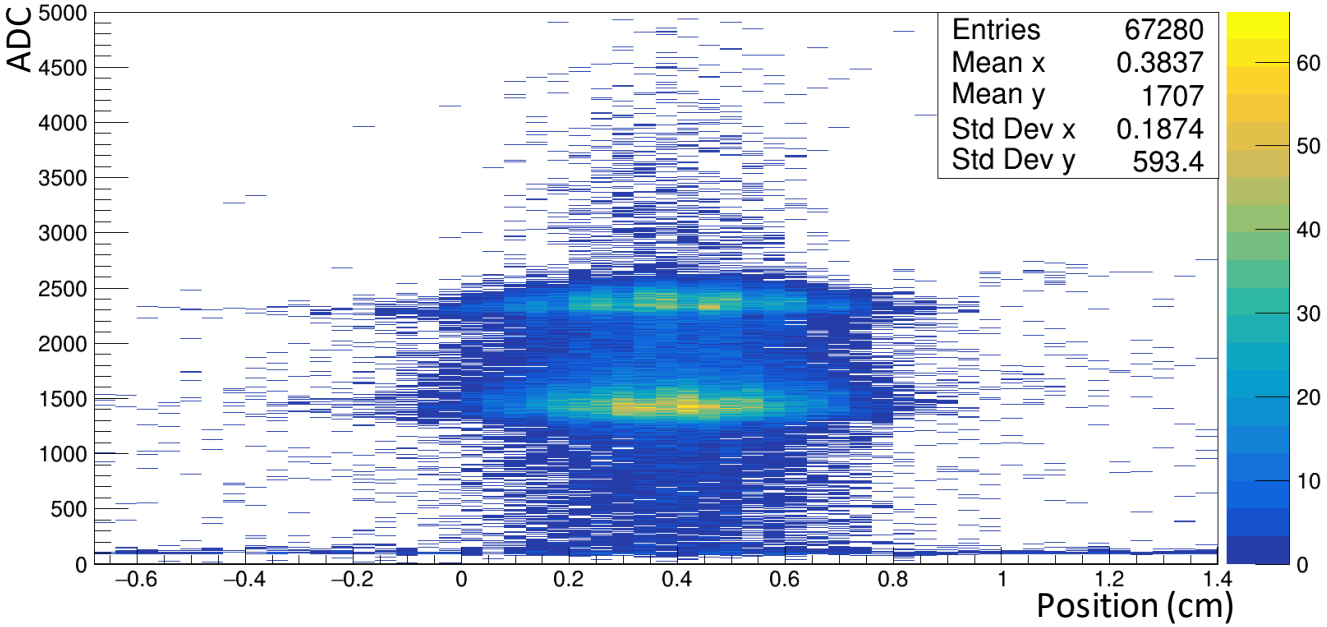
# GSI 2021 MSD Readout Strategy




- AC-coupled silicon microstrip sensor read-out by ASIC chips
- Active area segmented in 1920 strips with a 50µm implantation pitch
- Readout pitch: 150µm, with 2 "floating strips"
- Total number of readout strips: 640
- Floating strips help with charge collection between readout strips
- Charge collection efficiency expected to be non linear between two readout strips

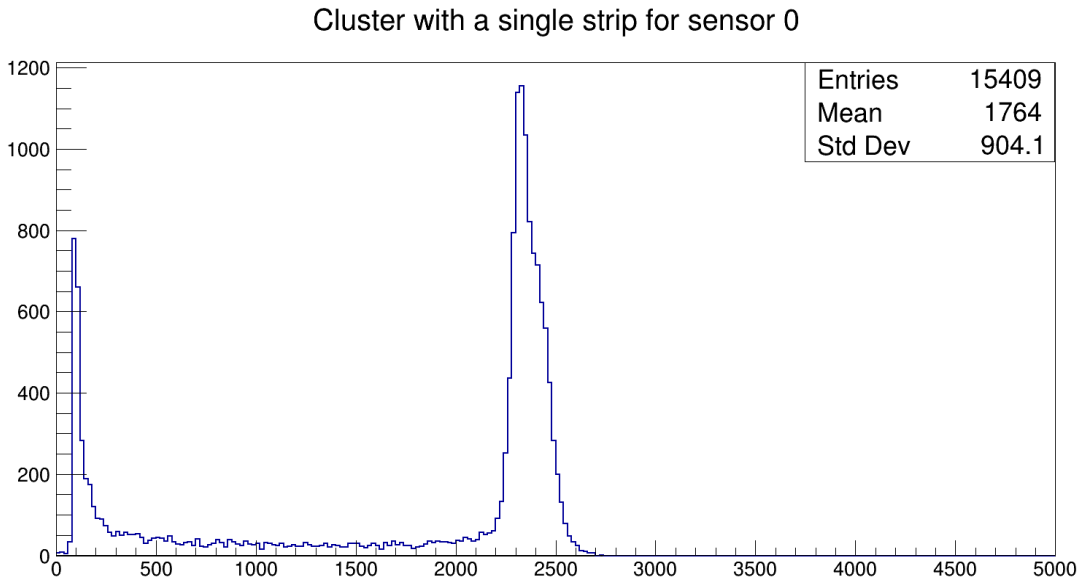
# GSI 2021 MSD Signal

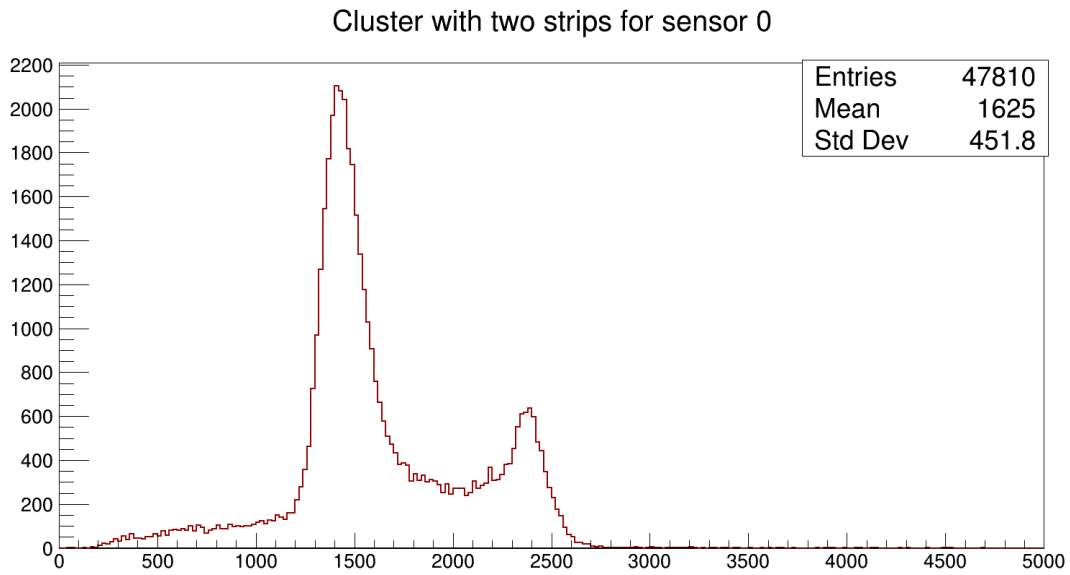


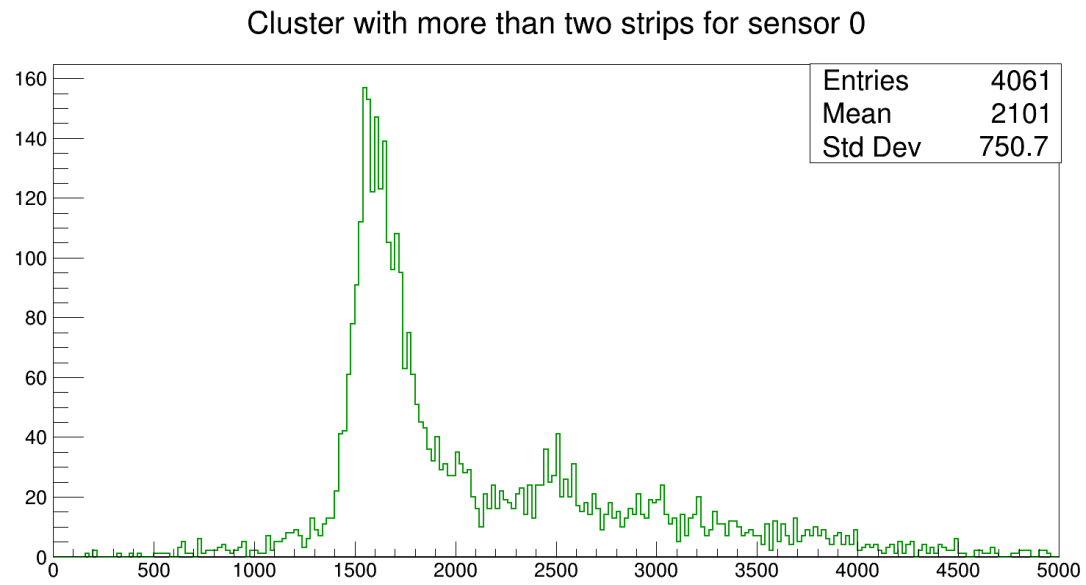




- Double peak structure for cluster ADC distribution
- Charge collection efficiency depends on the impact position with respect to readout strips
- Variation due to different ASICS is negligible (pic on the right: signal mostly contained in 2 chips)

# GSI 2021 MSD Signal

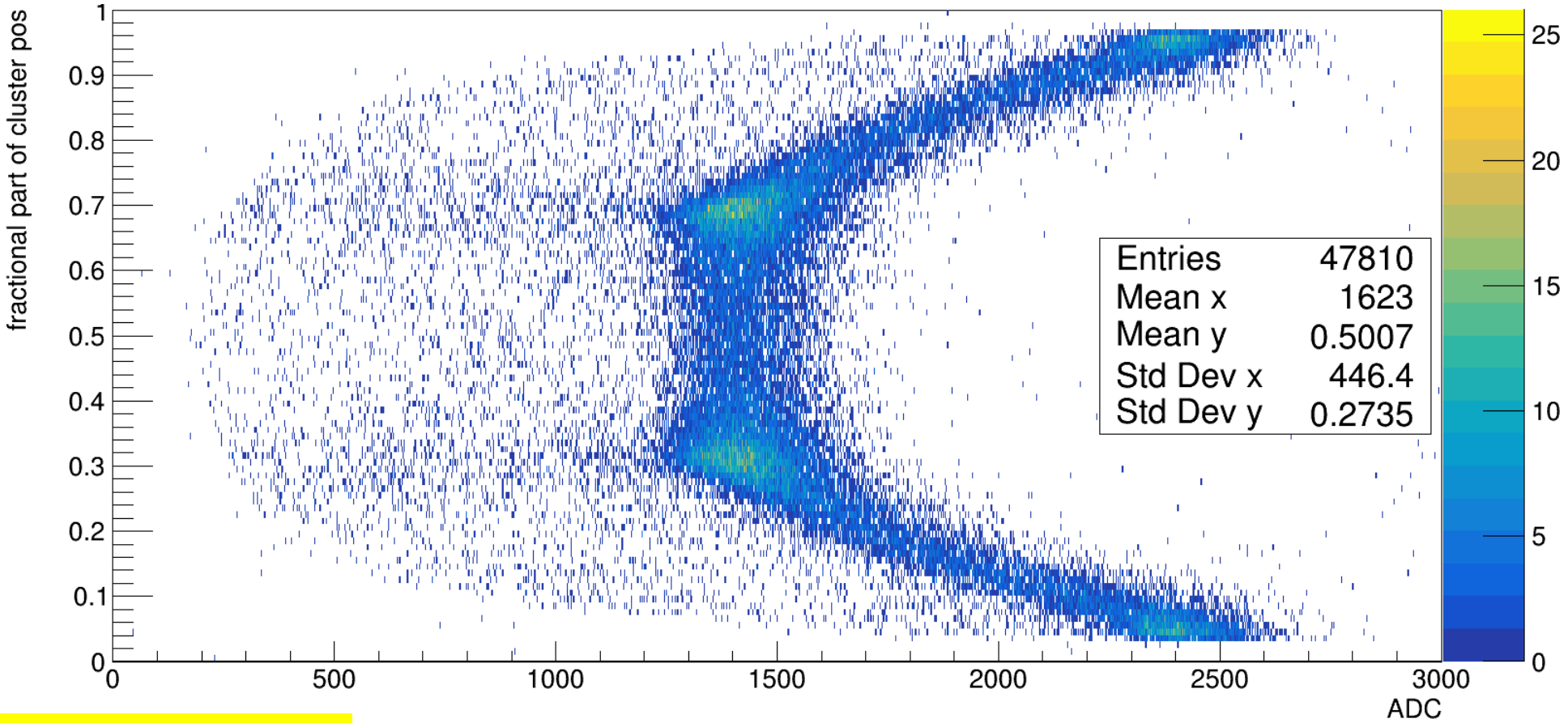



- Charge collection efficiency depends on the impact position with respect to readout strips
  - Higher signal peak mostly from single strip clusters
  - Lower peak mostly from larger clusters
- Spurious noise strips mainly add to the single strip clusters

# GSI 2021 MSD Signal

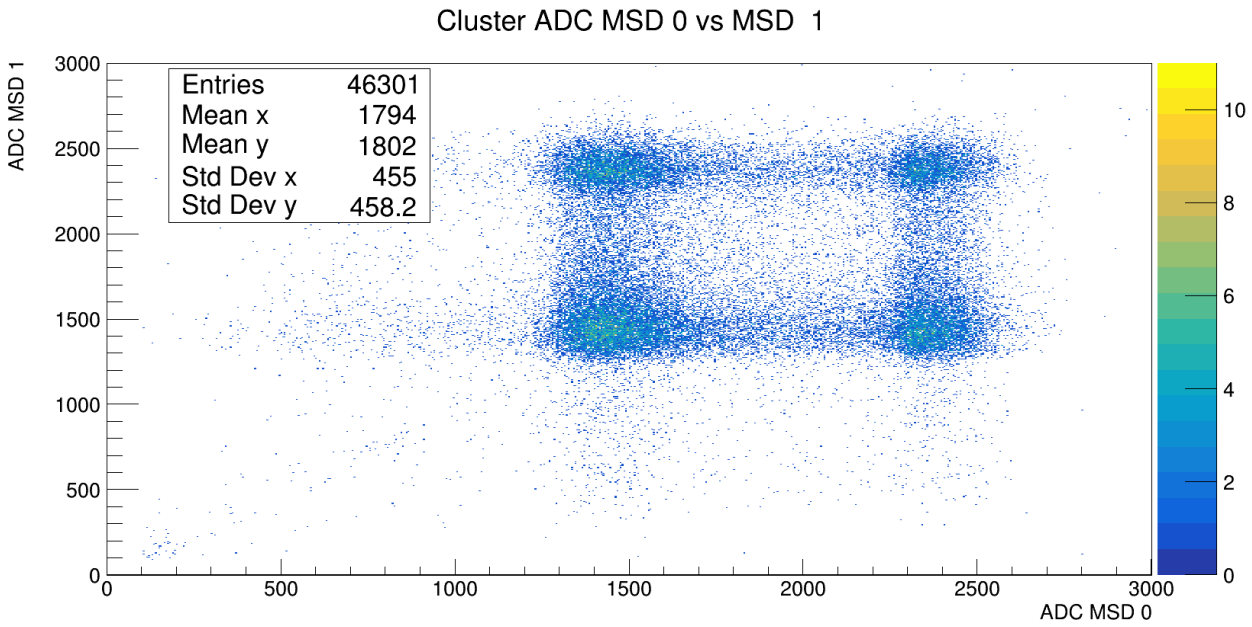


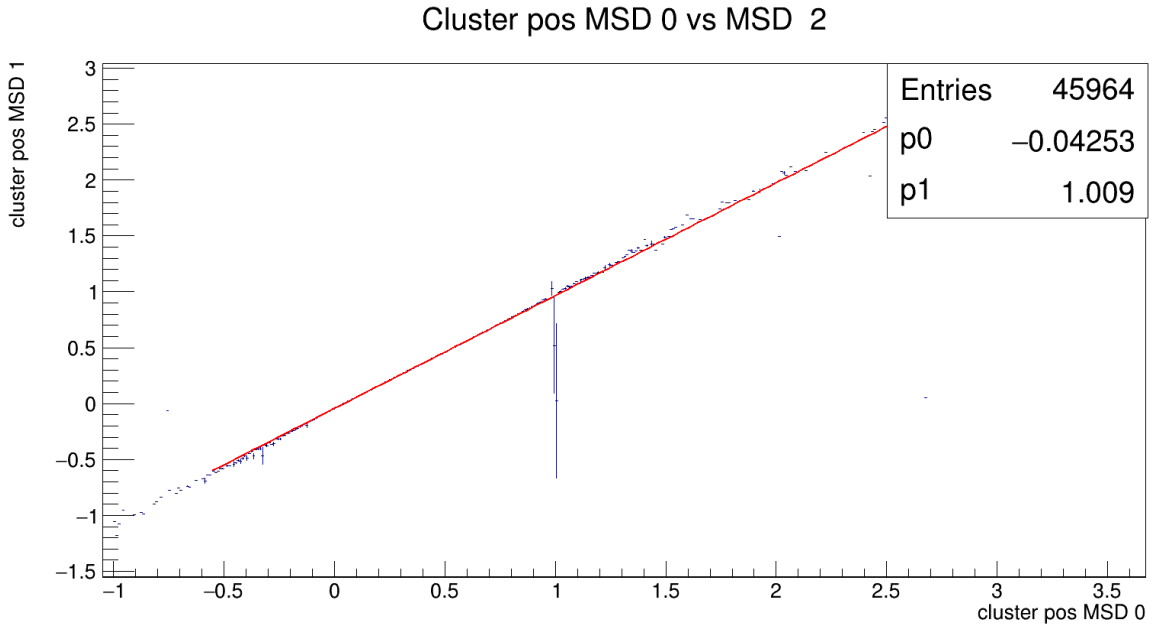

Subsample: clusters with 2 strips

- Family of clusters where the position non-linearity is mostly evident
- Fractional part of the cluster center of gravity as an indicator of impact position
- Correction needed with 'eta' function
  - Real eta function needs an external reference
  - Hopefully soon to be measured at a future beam test (probably CERN SPS)

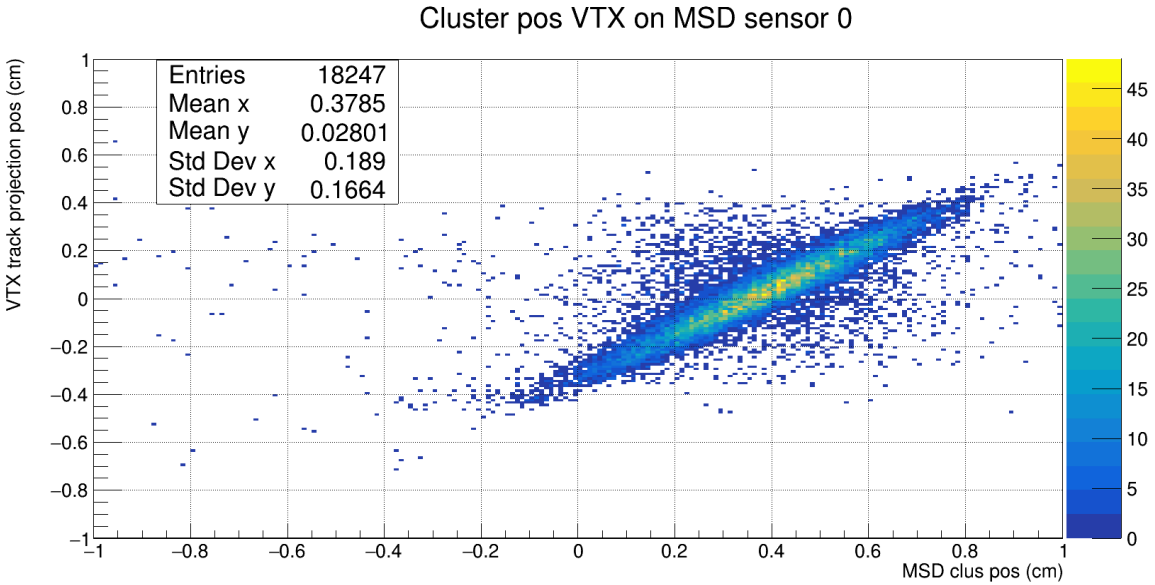
$$pos = \frac{ADC_1 * Strip_1 + ADC_2 * Strip_2}{ADC_1 + ADC_2}$$

# GSI 2021 MSD: some correlation plots




- Charge correlation affected by the eta non-linearity
  - Results as expected in 4 point accumulation points
- Spatial correlation ok with SHOE alignment parameters
  - MSD 0 and MSD 2 read the same coordinate
- Position correlation is present with VTX detector



# GSI 2021 MSD:ToDo list

- Analysis of all the different configs at GSI 2021
- Correlation with other detectors (TW, Calo etc.)

- Eta function measurement at CERN

- Implement a stronger clustering algorithm in SHOE
- Implement tracking in SHOE
- Start work on MSD MC with SHOE
- Calculate parameters for clustering and Common Noise mode

- Solve the noisy strips problem for next data takings
- Fix the problem with the faulty ADC board