

MSD Status

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Detector noise

Detector noise characterization with pedestal macro

Channel pedestal: base - line in the absence of a signal

$$\text{ped}_i = \frac{1}{N} \sum_i^{N_j} (\text{ADC}_{ij})$$

Common mode noise subtraction: subtraction of the collective signal variation for every event due to the pickup of the external electromagnetic noise

Gaussian distribution, with fit width is ≈ 3 ADC counts, corresponding to 20 - 25% predicted MIP signal

$$\text{CN}_j = \frac{1}{N_j} \sum_i^{N_j} (\text{ADC}_{ij} - \text{ped}_i)$$

Pedestal and common noise subtraction. Channel reduced value:

$$r_{ij} = \text{ADC}_{ij} - \text{ped}_i - \text{CN}_j$$

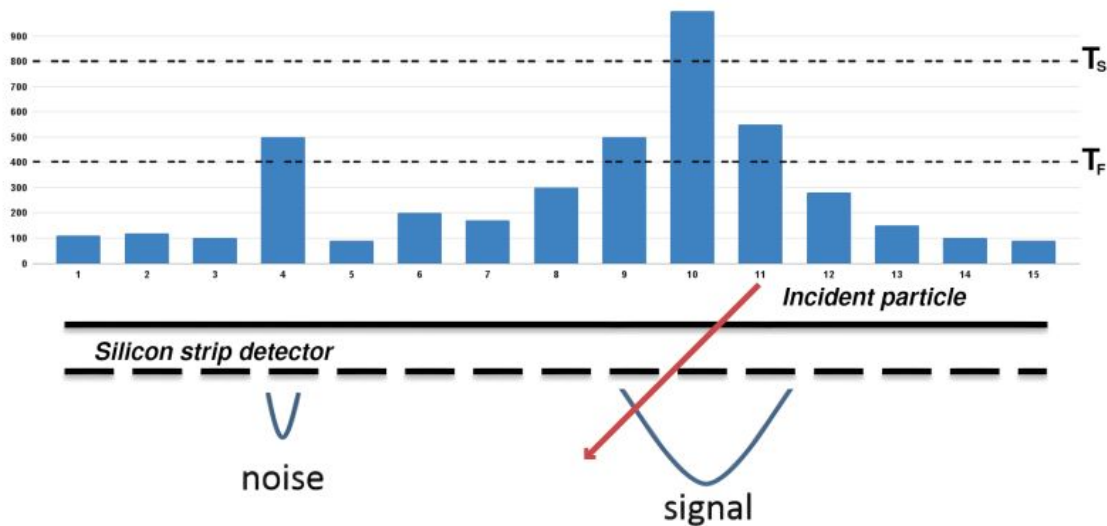
Sigma of each channel to discriminate signal from noise

$$\sigma_i = \sqrt{\frac{1}{N} \sum_{j=1}^N (\text{ADC}_{ij} - \text{ped}_i - \text{CN}_j)^2}$$

if $\sigma < 1.8$ → Dead strip

if $\sigma > 5$ → Noisy strip

Clustering Algorithm

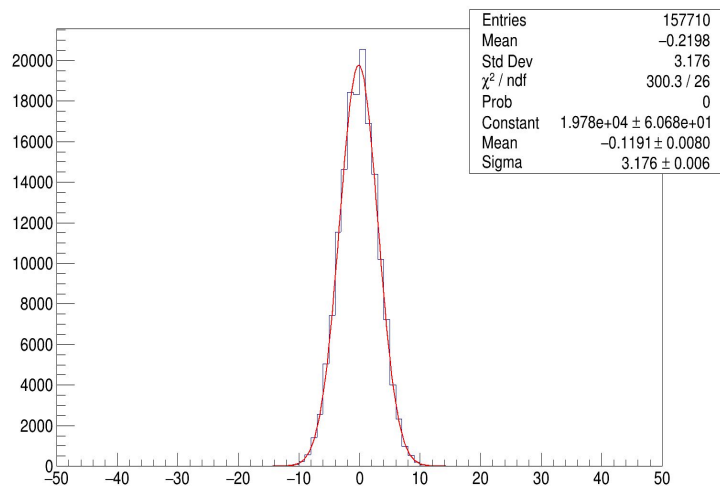


- Hypothesis: single channel noise is mostly thermal (i.e. gaussian)
- “Seed” signal is defined for a channel reduced value $> 3.5\sigma$
 - Lower threshold for neighboring only if “seed” is present
- If all “noisy” strips are correctly masked we should only expect clusters with particles

This is not always the case!

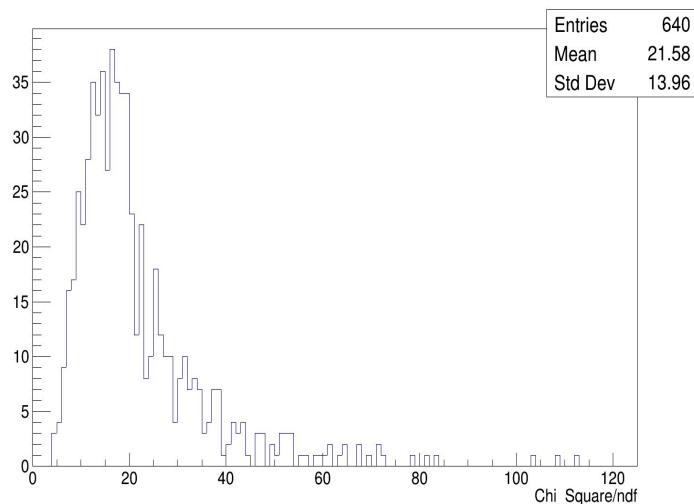
Gaussian hypothesis

Histogram plotting of each channel and gaussian fit application



Channel 306, sensor 0, run 4268, GSI 2021

Chi_Square/ndf plot



Sensor 0 Chi_Square/ndf distribution, run 4268, GSI 2021

From the Chi_Square distribution we see that the channels are not perfectly gaussian: we use distro RMS instead of gaussian fit sigma in the pedestal macro, and we should study why the channels are not gaussian

Pedestal Stability Study

Hypothesis: pedestals are metastable

At a certain time there could be an

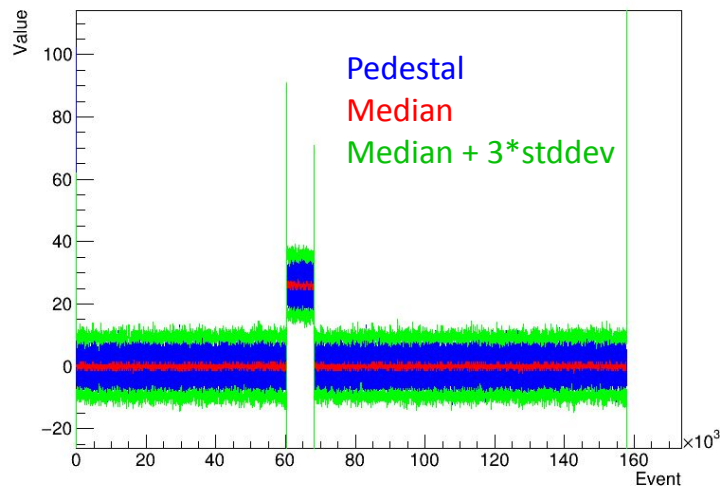
upward shift in the pedestal baseline

Implementation of a moving median
algorithm to find the shift



Monte Carlo data generation to
generate the upward shift and validate
the algorithm starting from real
pedestal data: run 4268 sensor 0 of GSI
2021 campaign.

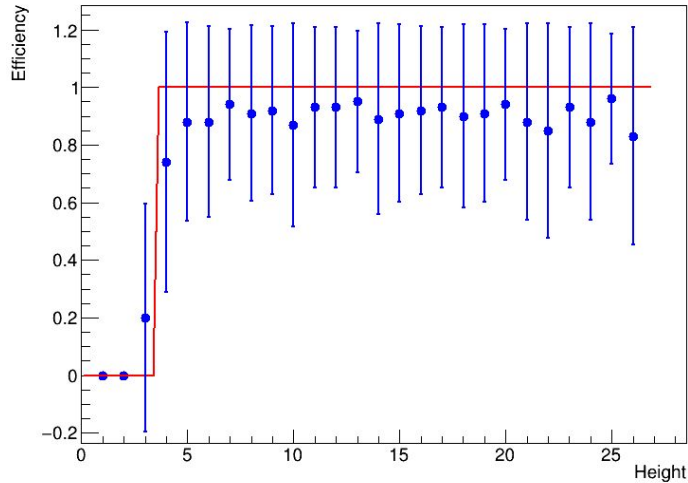
The jump width is fixed, the height is
variable.



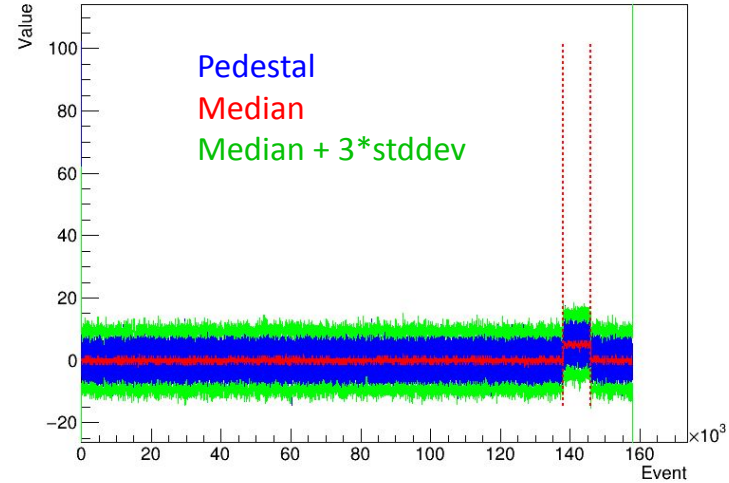
Monte Carlo data generated from run 4268 sensor 0 GSI
2021

Pedestal Stability Study

Study of the algorithm efficiency as a function of the jump height



Efficiency as a function of jump height with a fixed width

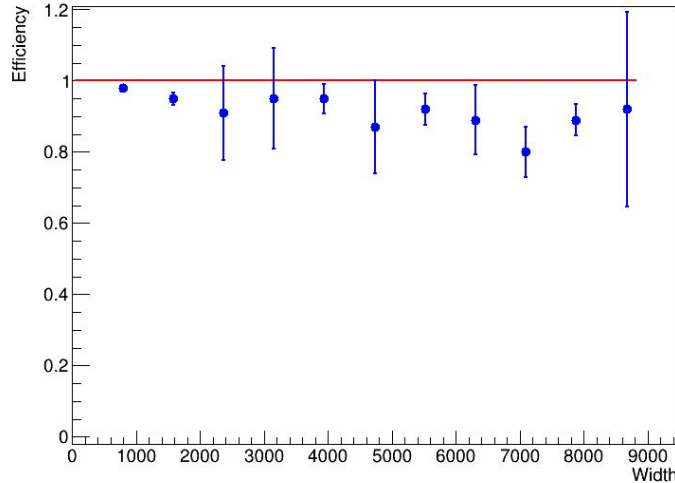


Monte Carlo data generated from run 4268 sensor 0 GSI 2021 with a jump of 5 ADC

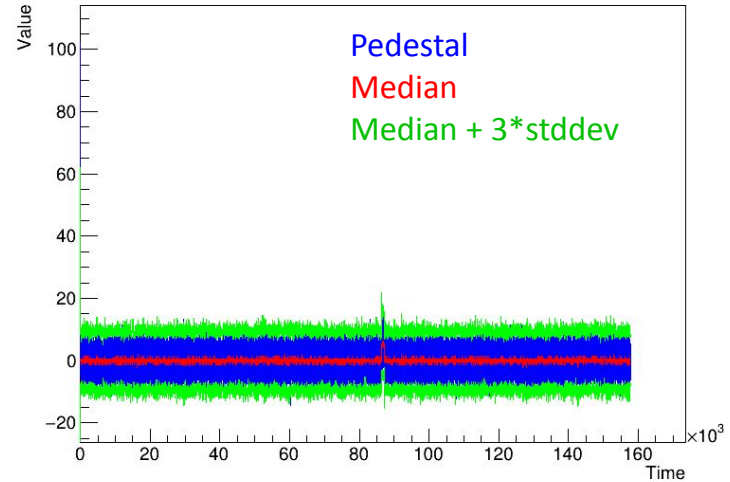
Good efficiency achieved from a jump of at least 5 ADC

Pedestal Stability Study

Generation of Monte Carlo data with jump height fixed at 5 ADC and the width is varying. Study of the algorithm efficiency as a function of the jump width with a fixed height of 5 ADC.



Efficiency as a function of jump width with a jump height of 5 ADC



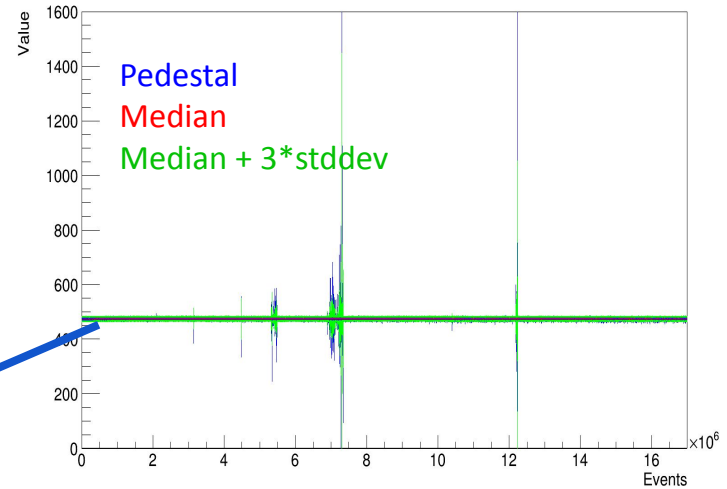
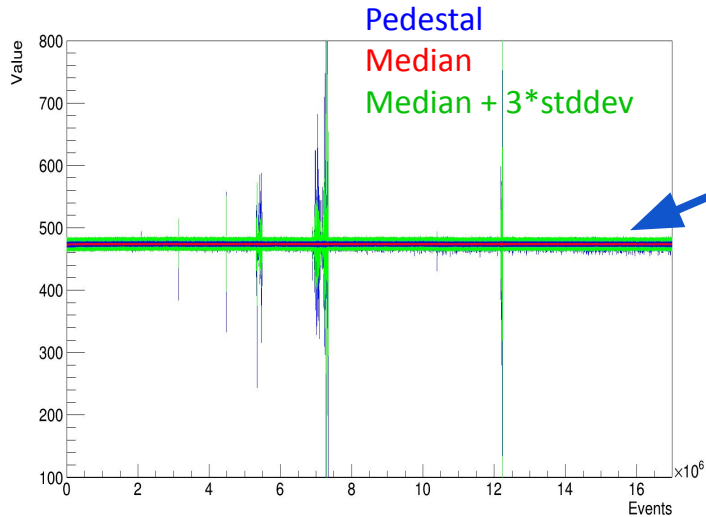
Monte Carlo data generated from run 4268 sensor 0 GSI 2021 with a jump of 5 ADC and a width of 788 events

Good efficiency achieved for a jump of 5 ADC on all range with a minimum of ≈ 800 events

Research of the Effect on Laboratory Data

Long run: acquisition for about 5 days taken in Perugia laboratory. The spikes are noise due to the system that was not guarded (e.g. switching lights on/off).

Data taken for 5 days in Perugia laboratory

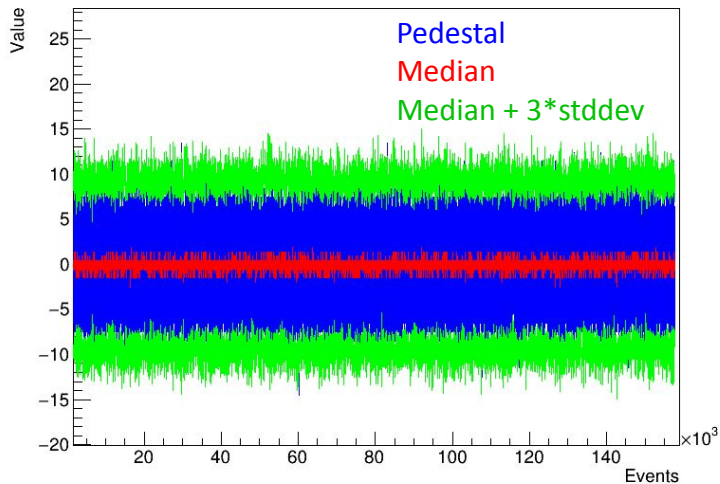


Data taken for 5 days in Perugia laboratory

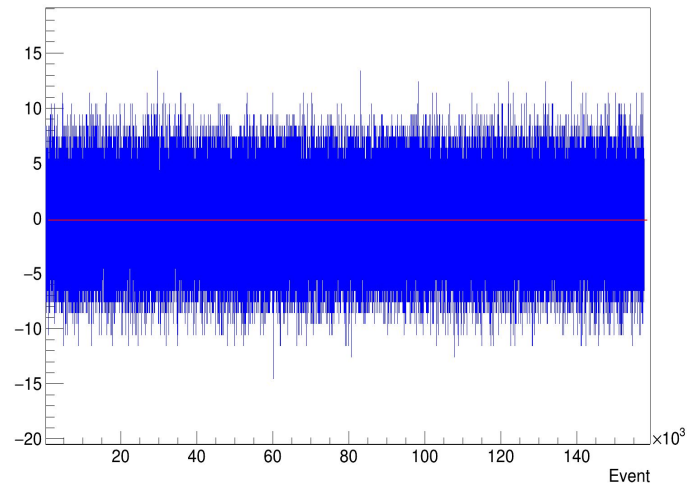
No significant effect detected

Research of the Effect on Run 4268

Run 4268 of GSI 2021 campaign, sensor 0, pedestal data



Pedestal as function of event number run 4268, sensor 0, GSI 2021, with moving median algorithm applied

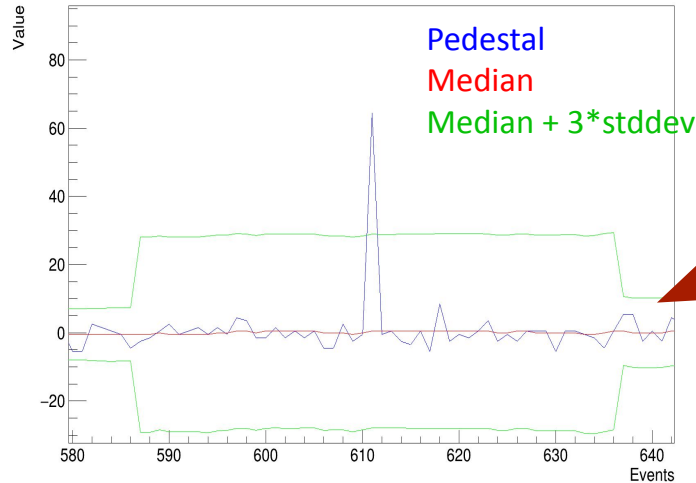


Pedestal as function of event number run 4268, sensor 0, GSI 2021

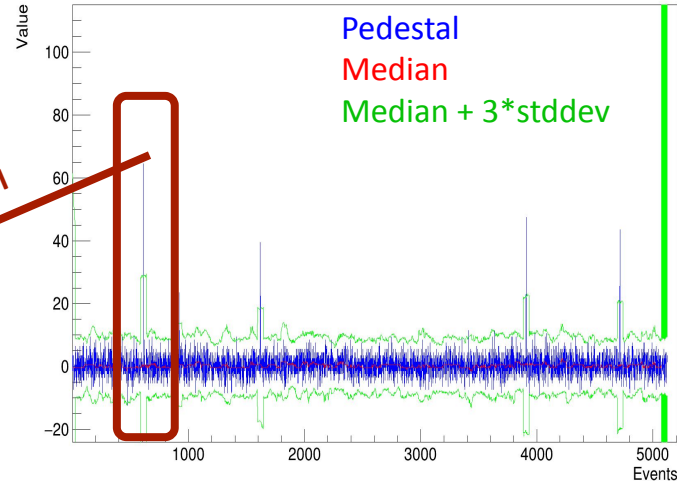
No significant effect detected

Research of the Effect on Data Run 4270

Beam data run 4270 sensor 0 of GSI 2021 campaign: does this algorithm kill the strips that have signal?



Beam data as a function of event number run 4270, sensor 0, GSI 2021



Beam data as a function of event number run 4270, sensor 0, GSI 2021

No significant effect detected

The algorithm does not kill the strips with signals because jump duration of the signal is too short

Conclusions

- The Gaussian hypothesis has been verified and since the channels are not perfectly Gaussian according to the Chi_Square distribution, the RMS of the histogram is used instead of the standard deviation of the fit
- It was assumed that the pedestals were metastable, but the effect of an upward shift in their baseline was not YET found.
- The minimum jump height recognized by the algorithm implemented is 5 ADC, corresponding to 25% of a MIP and slightly higher than background noise (about 3 ADC)

Next steps

Sensor 0 Run 4268

```
Step rise start: 3419 at 0  
Step rise end: 3420 at 1  
Step fall start: 19828 at 1  
Step fall end: 19831 at 4  
Step jump width = 16412
```

Jump detected from 3419 to 19831 for channel 1

- Apply the algorithm on all channels and all campaigns
- If the shift is found, define how to correct it

UNDER INVESTIGATION





Thanks for your attention

