Calibration of the gain and measurement of the noise for the apv25 electronics

K. Gnanvo, N. Liyanage, C.Gu, K. Saenboonruang

From INFN Italy: E. Cisbani, P. Musico

Experimental setup put in place at UVa to

- Measure the gain of two apv25 based readout electronics: Scalable Readout System (CERN, RD51) and MPD (INFN Italy for SBS)

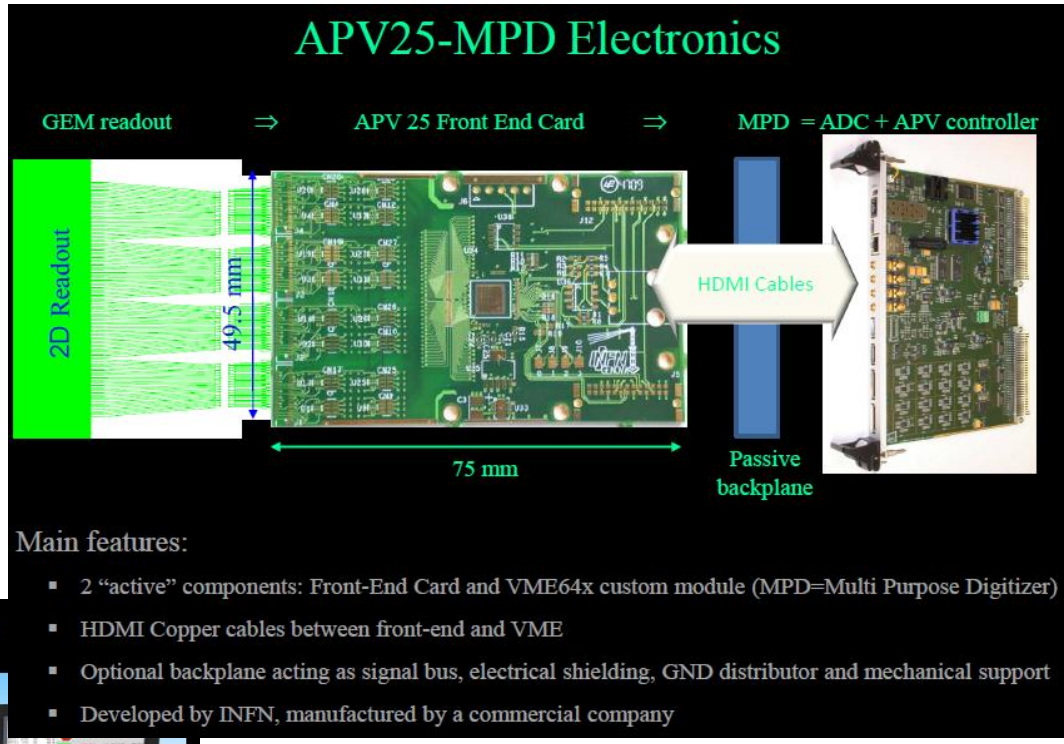
- Measure the apv channels rms noise and estimation of the ENC from the apv gain measurement

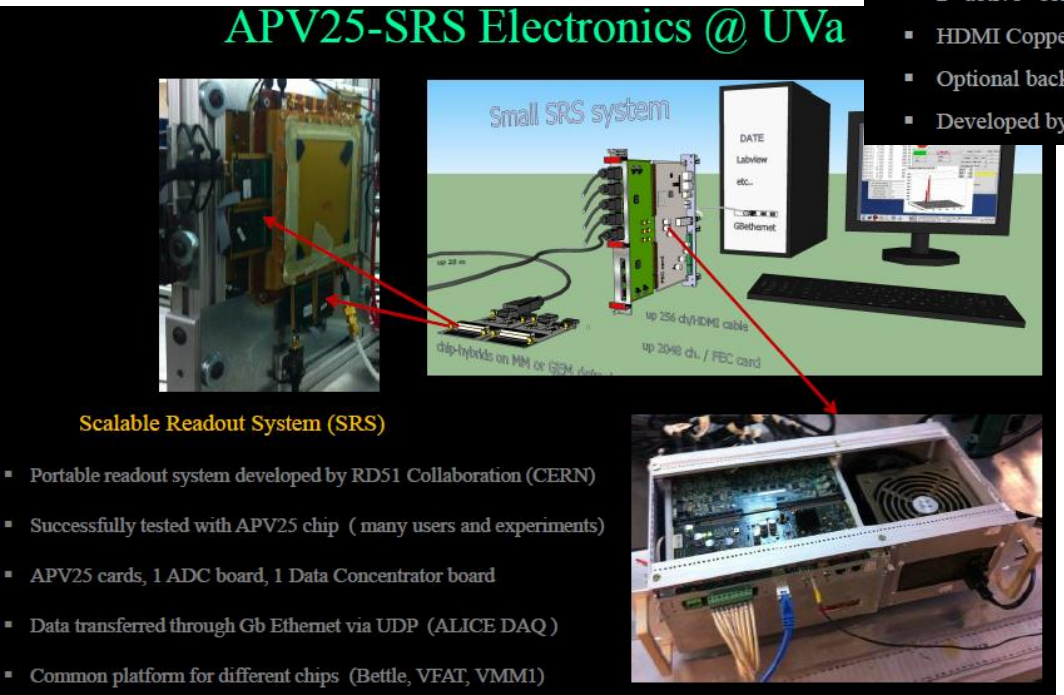
- Comparison of the performances of the two systems

APV25 MPD and SRS system

Multi Purpose Digitizer (MPD)

- P. Musico, INFN Italy
- More than 2.5K Channels at UVa

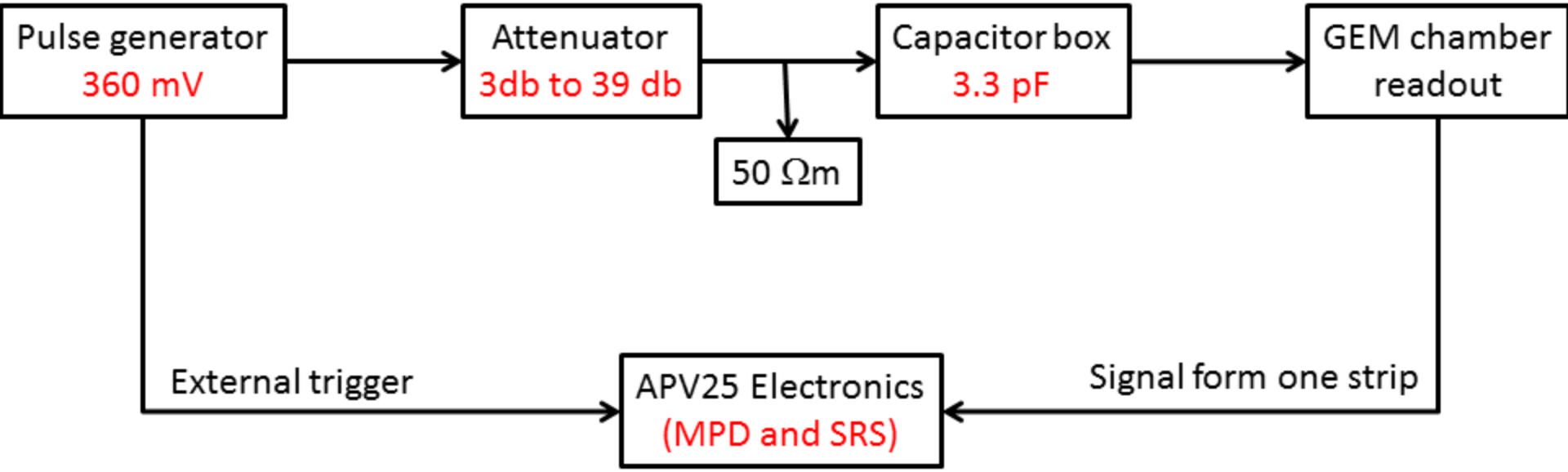




Scalable Readout System (SRS)

- H. Muller, CERN, RD51
- 2048 channels at Uva

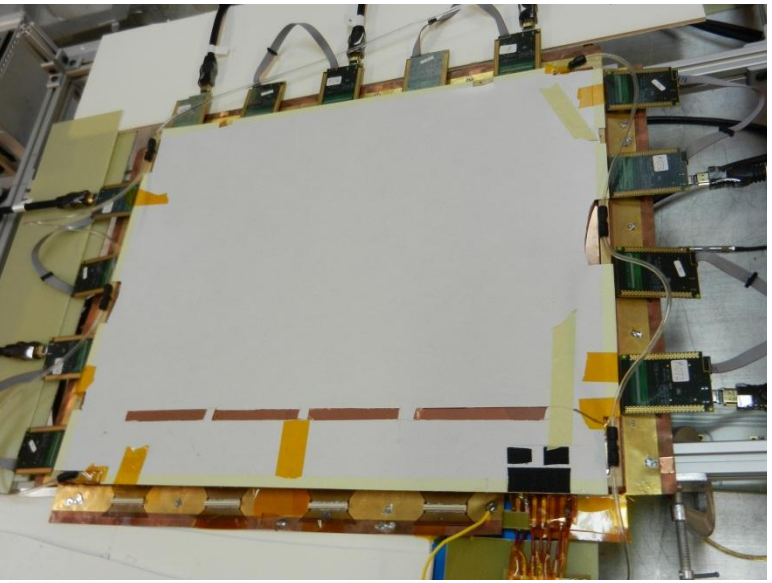
APV25 Gain calibration setup



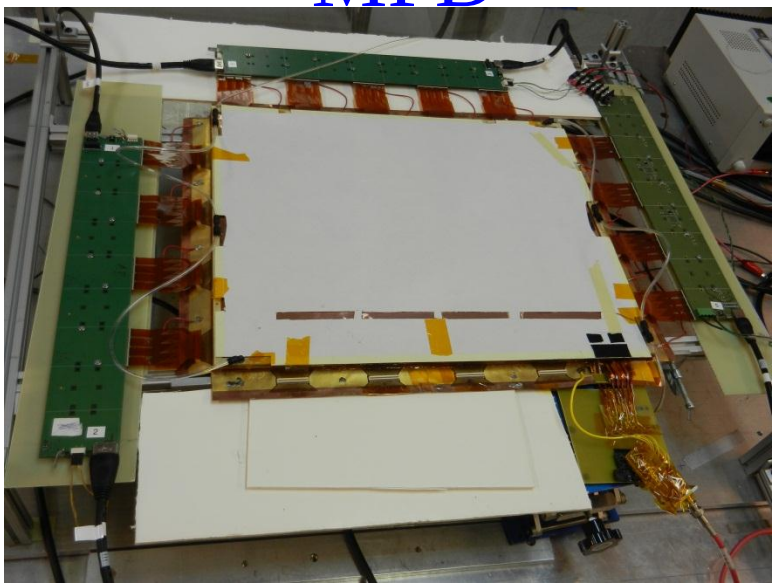
- Test pulse = 360 mV, Capacitor = 3.3 pF ➔ Equivalent charges = 7.2 Million e-
- Injected charges = Equivalent charges / Attenuator ➔ attenuation 3dB to 39 db

APV2 on SBS GEM prototype

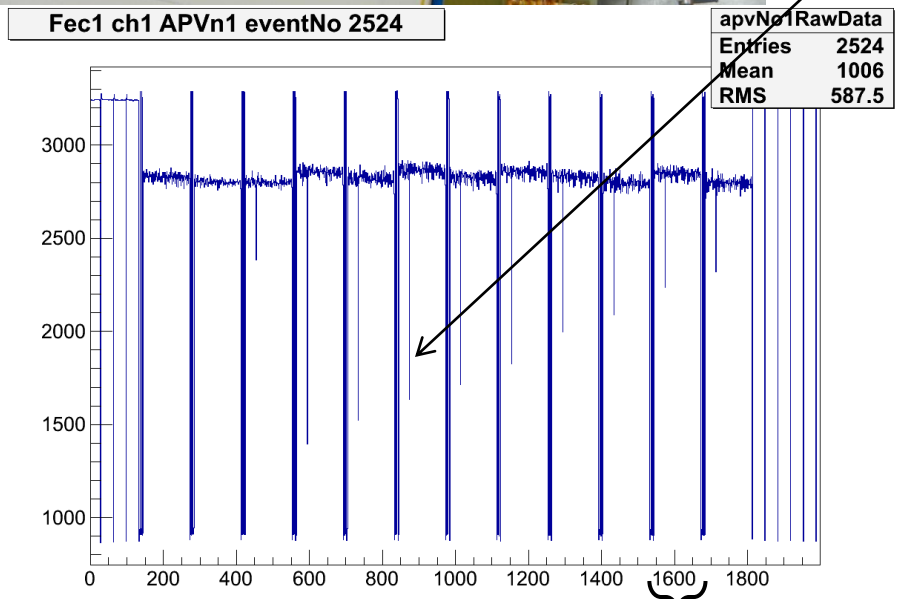
SRS

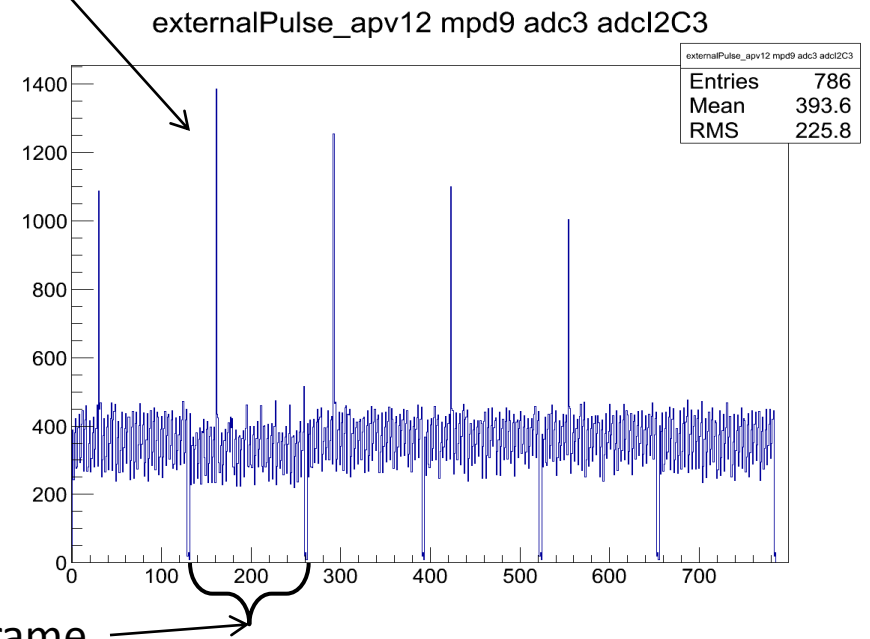


MPD



Analog signal

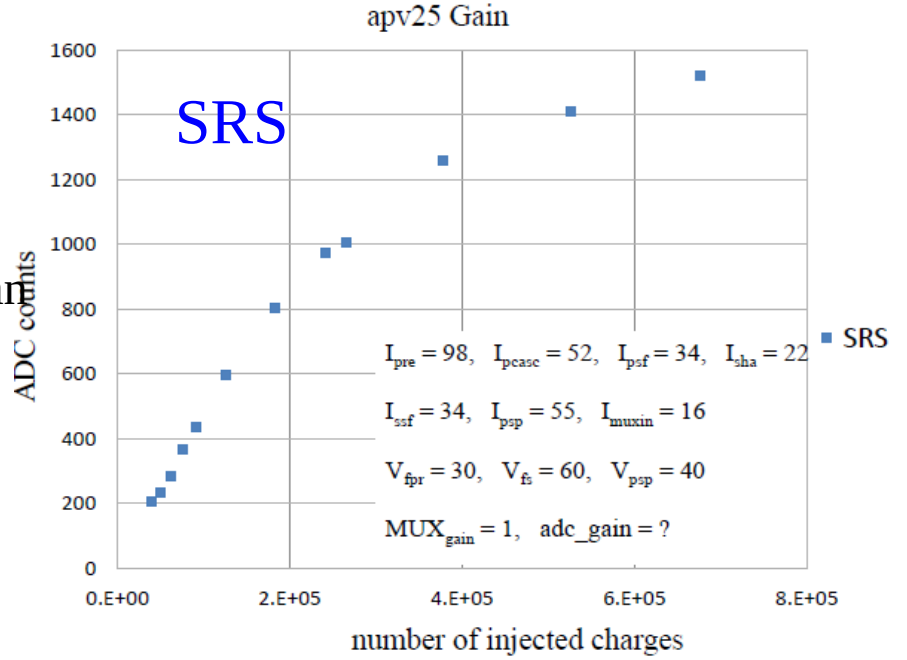


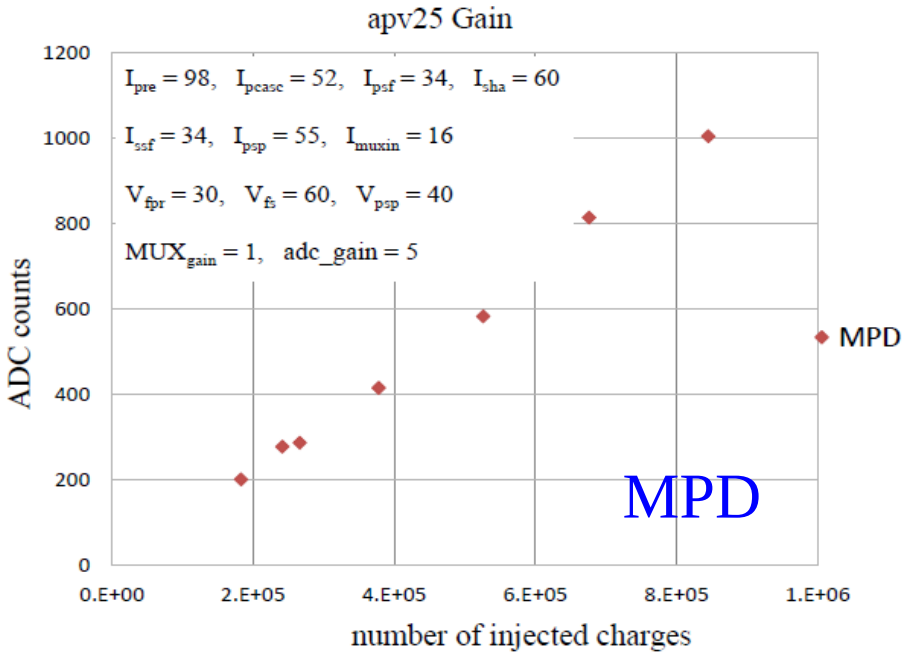


25 ns time frame

APV25 and ADC configuration for MPD and SRS systems

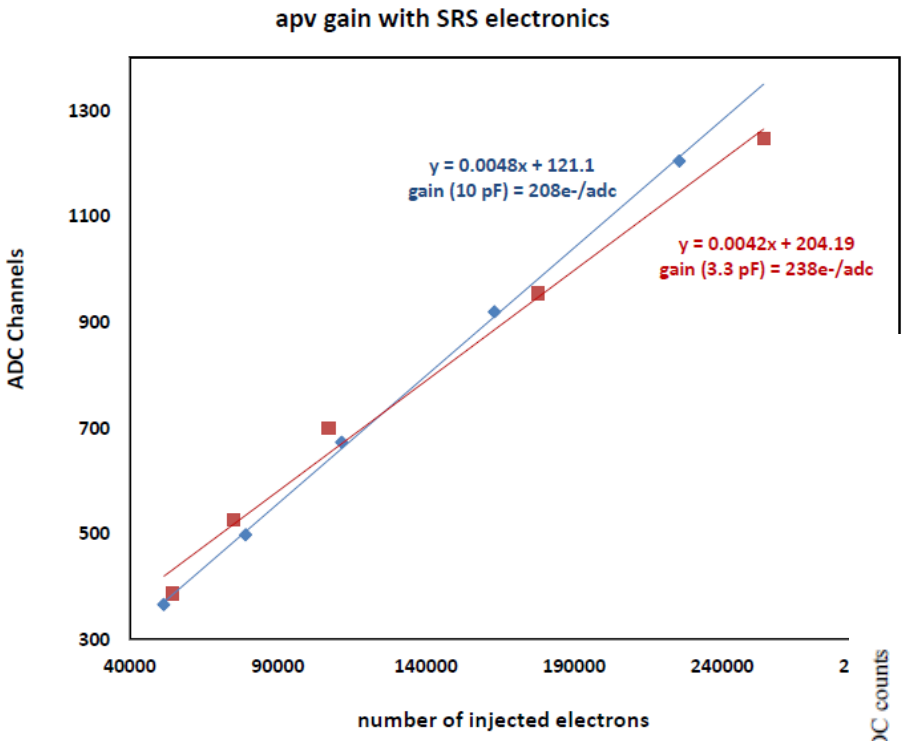
- We have almost the same configuration parameters for the two systems
- Different performances of the two electronics can be related to some differences in hardware that Paolo has identified:
  - protecting diode in the VCC line of the INFN card
  - input capacitance 47 pF vs. 1 pF in SRS
  - 1 MΩ resistor to ground in the SRS input lines
  - external biasing in INFN card vs. internal biasing in SRS (this affect the values of the APV parameters for the optimal working point)



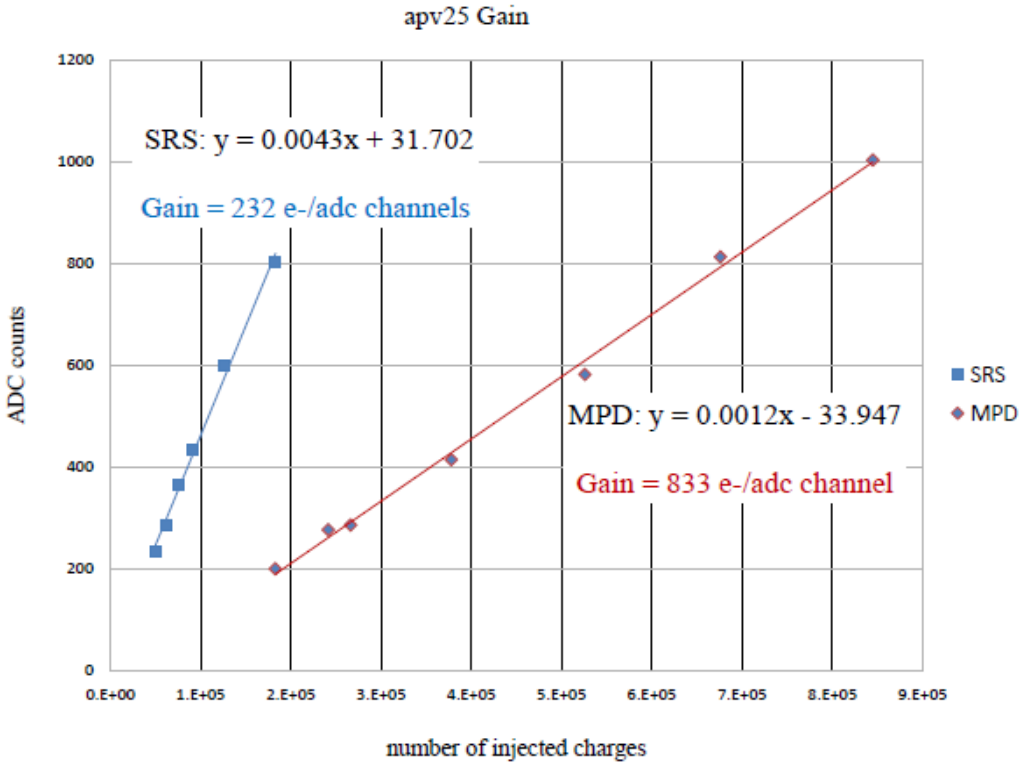


Apv25 Gain: MPD vs SRS

Gain calibration with 3.3pF and 10pF

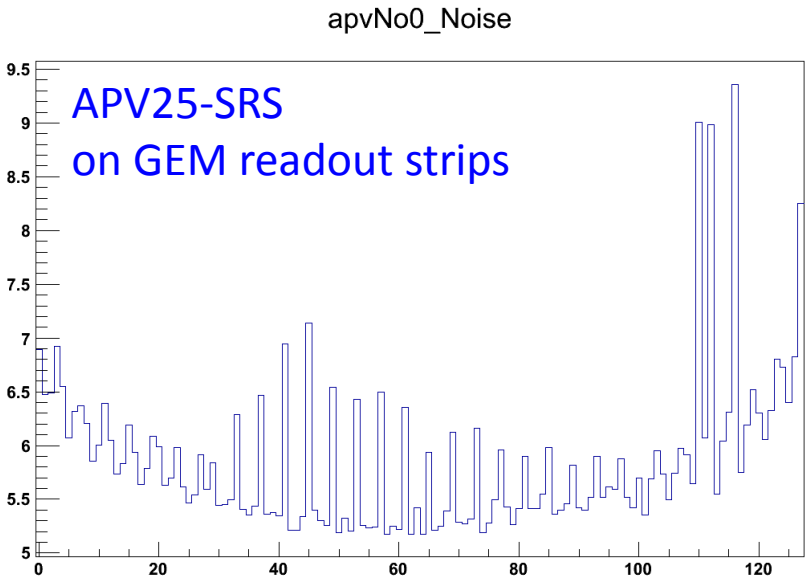


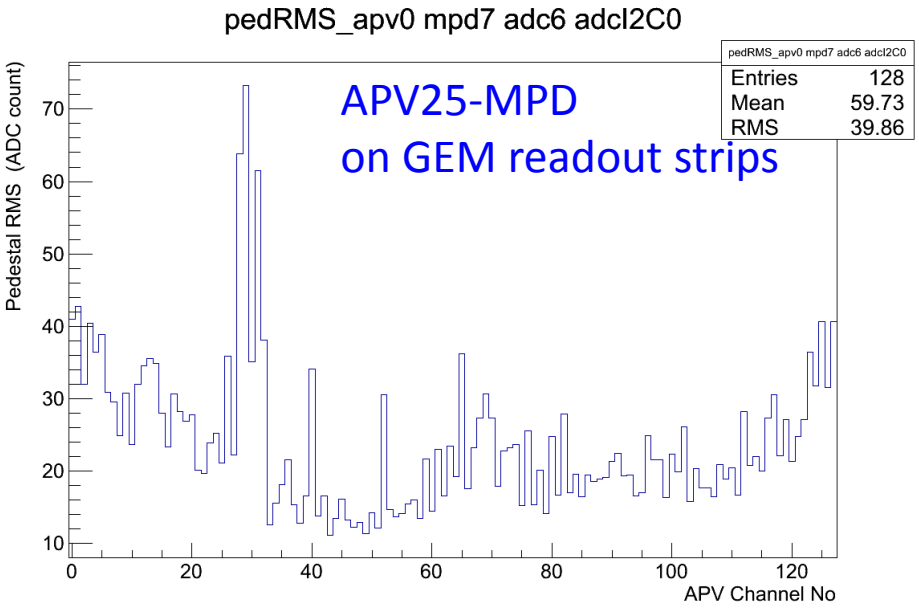
Gain calibration for SRS and MPD



Study of the noise (rms of the apv25 channels)

- Typical rms for each of the 128 channels of a given APV cards from a pedestal run and for both MPD and SRS
- This rms is obtained after common mode correction of the baseline
- The common mode correction reduce the rms by
  - a factor 2 for apv25-MPD (basically from ~ 40 adc counts to ~ 20)
  - A few adc counts for apv25-SRS (from ~8 adc counts to 6.5-7)
-

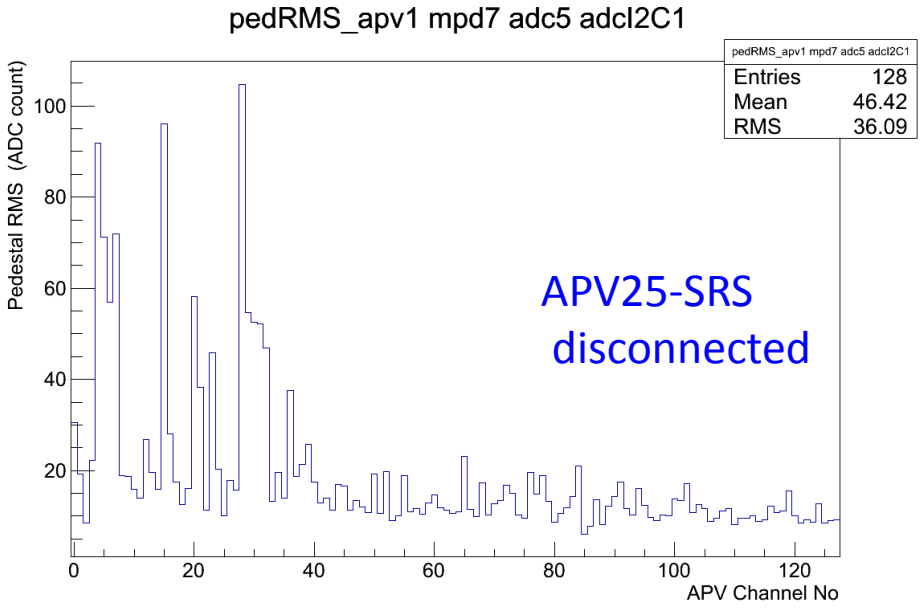


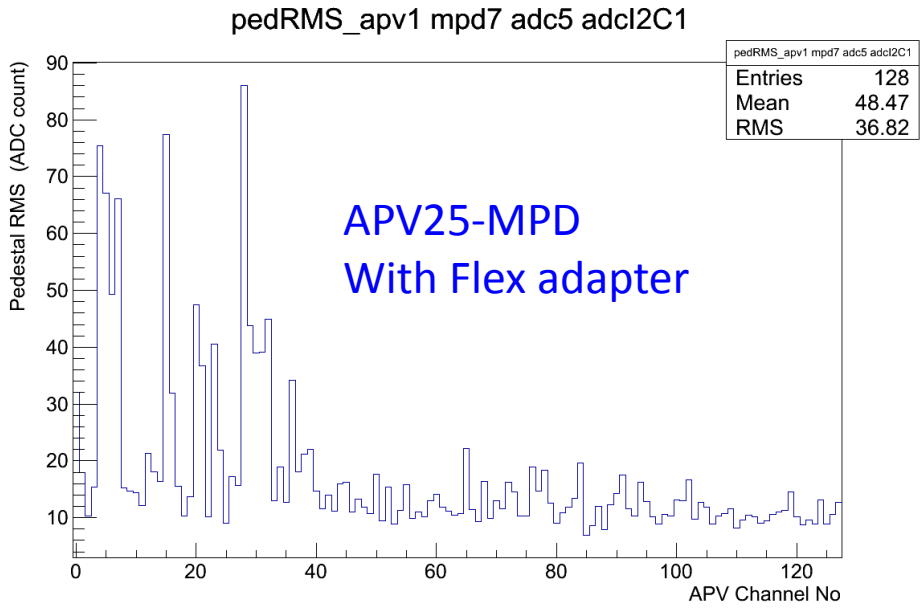


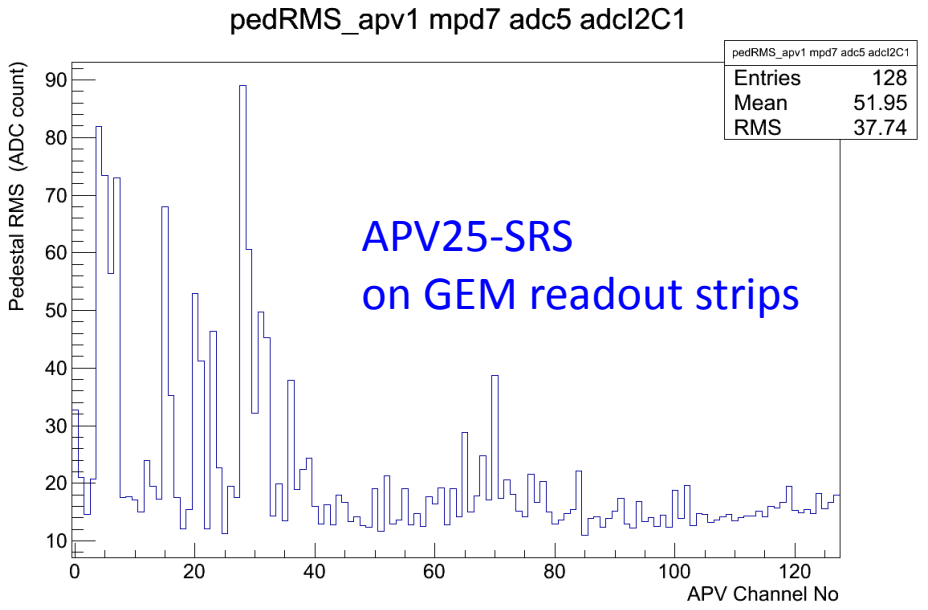
Where do the hot channels come from for apv25-MPD electronics

Hot channels appears in some of the apv cards

- Sometimes come from the noisy strips or bad connection with the adapter
- Not always from the GEM strips nor is it alway coming from the flex adapter
- We are still studyin this effect

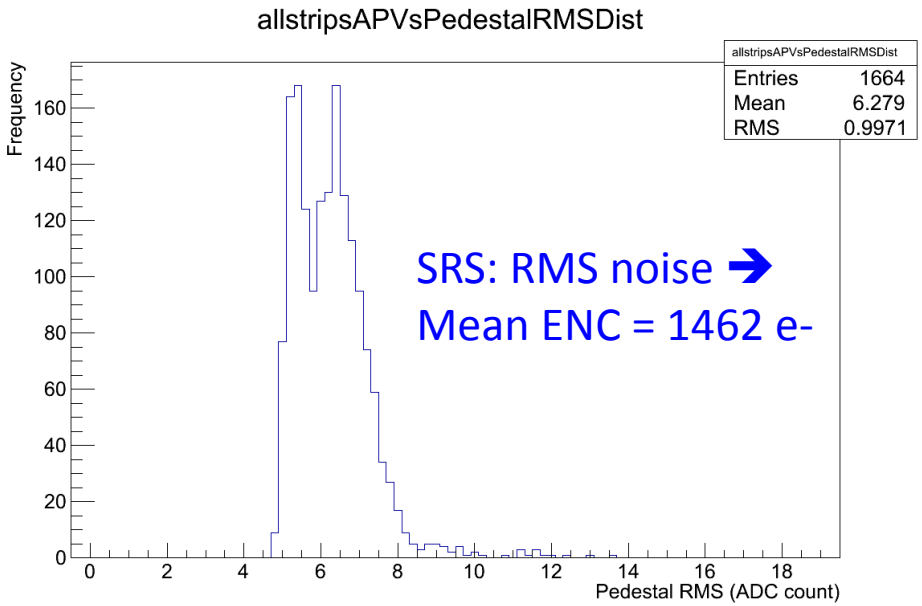


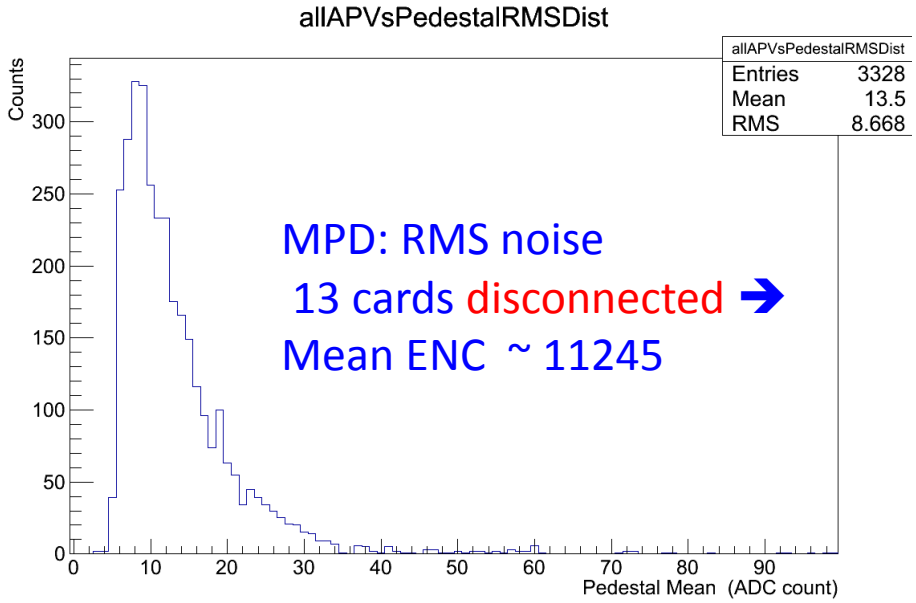


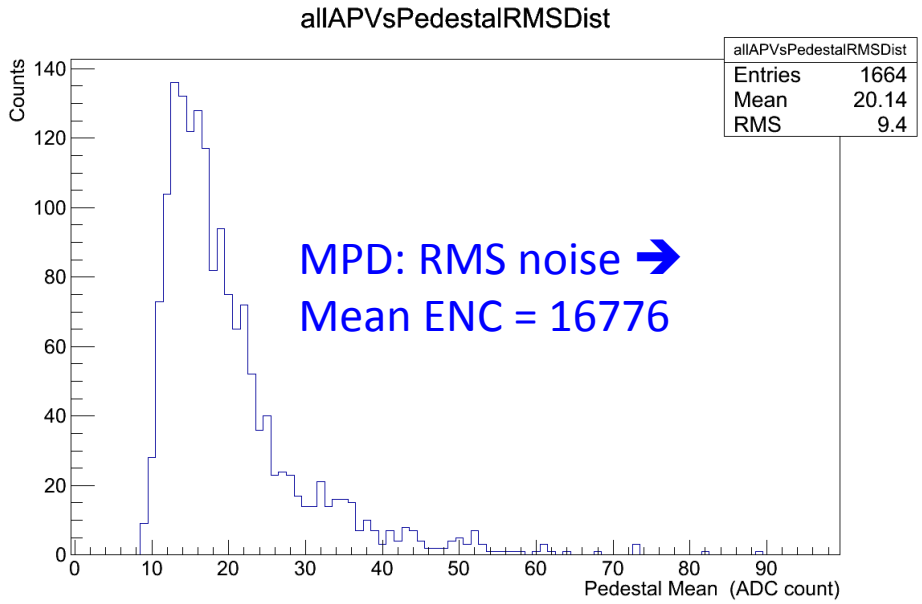


RMS noise and Equivalent Noise Charges for the 13 apv25 FE cards

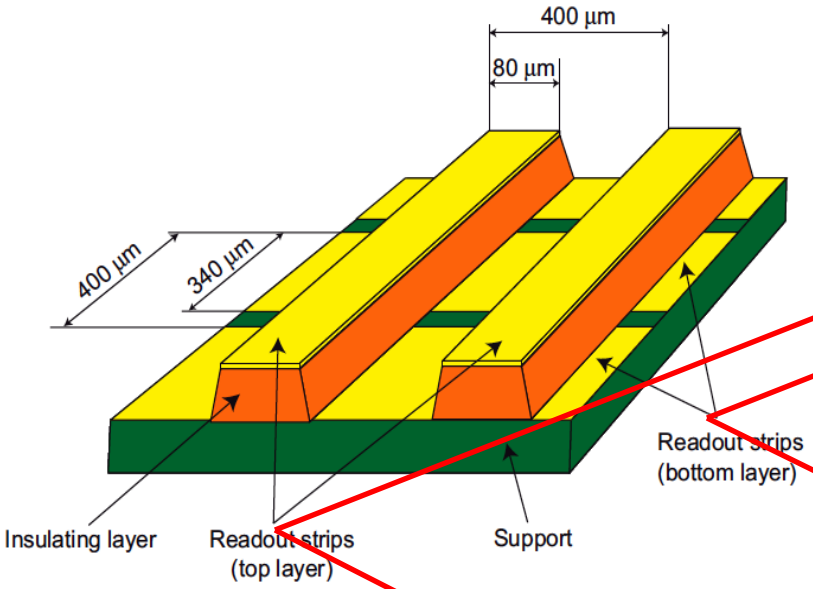
- Noise in ADC counts is 3 × bigger for MPD (~20 ADC channels) than SRS (~7 ADC channels)
- When translated into ENC, it becomes a factor ~10 because MPD has a gain 3 to 4 times higher than SRS

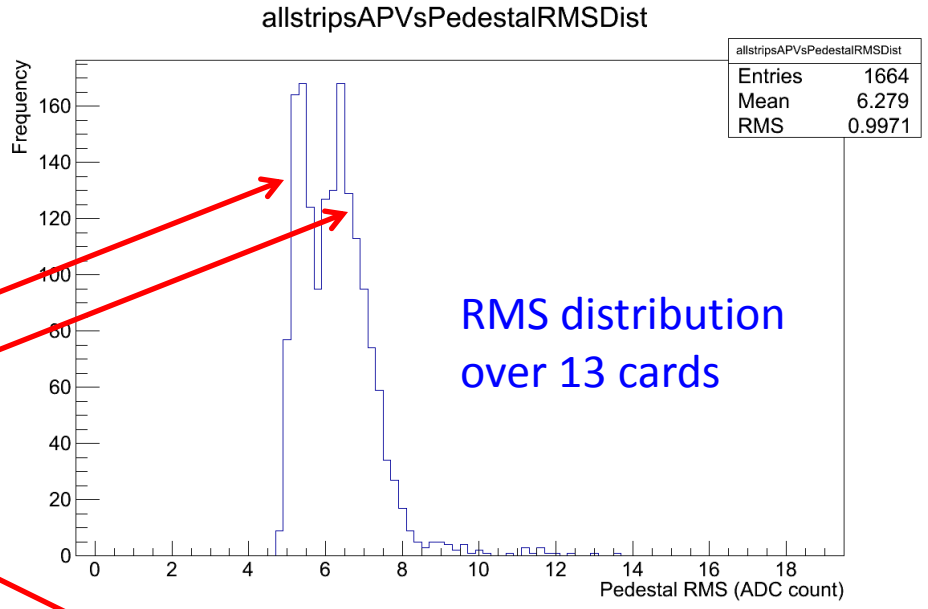


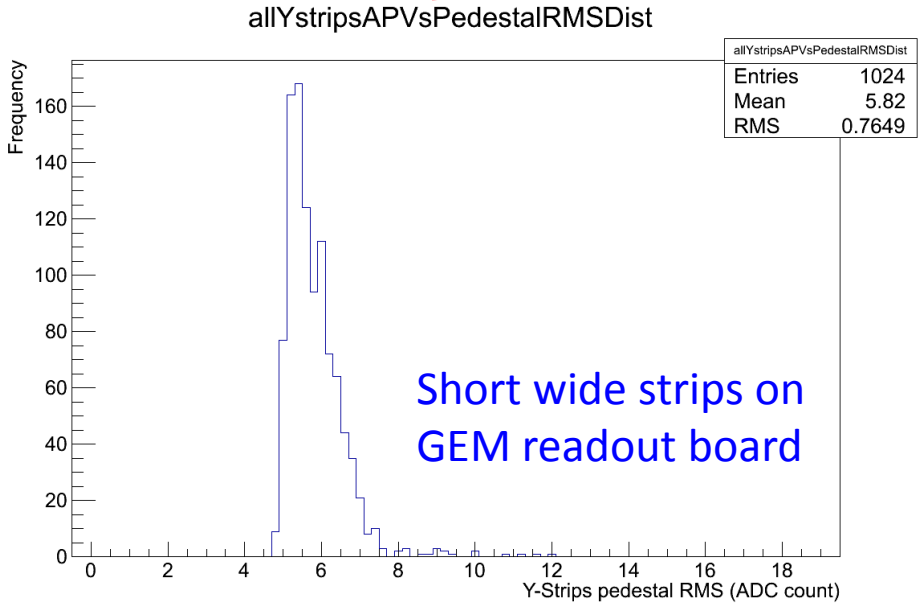


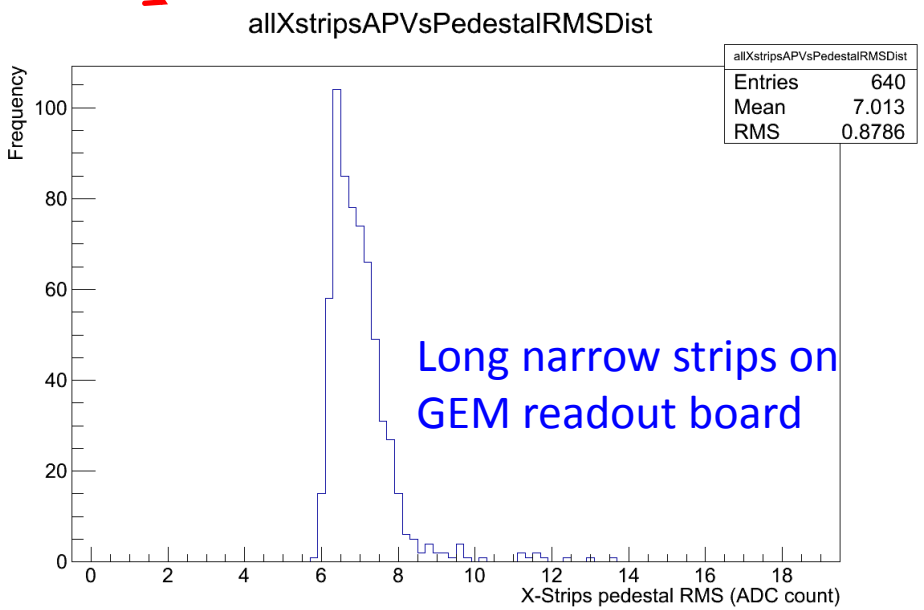


SRS: GEM Readout strip Capacitance effect on the noise

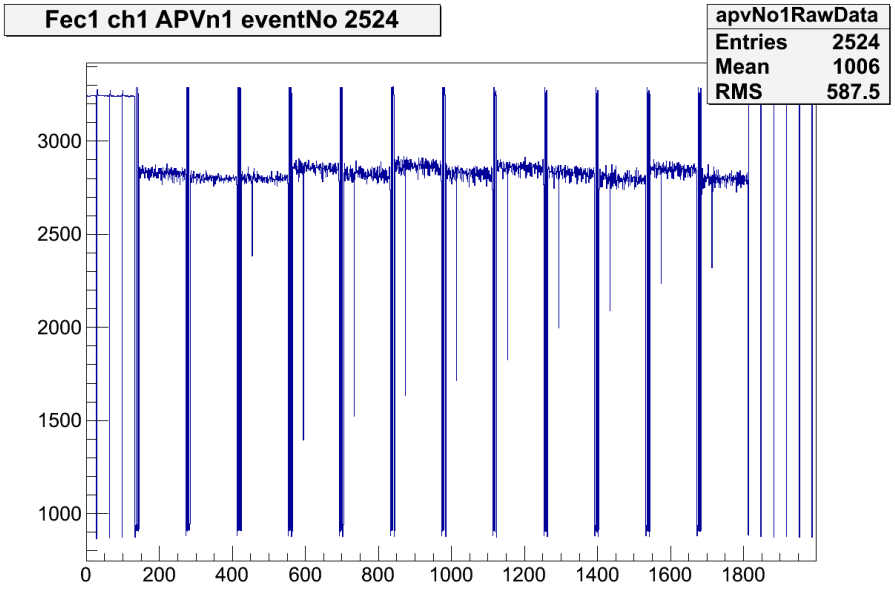


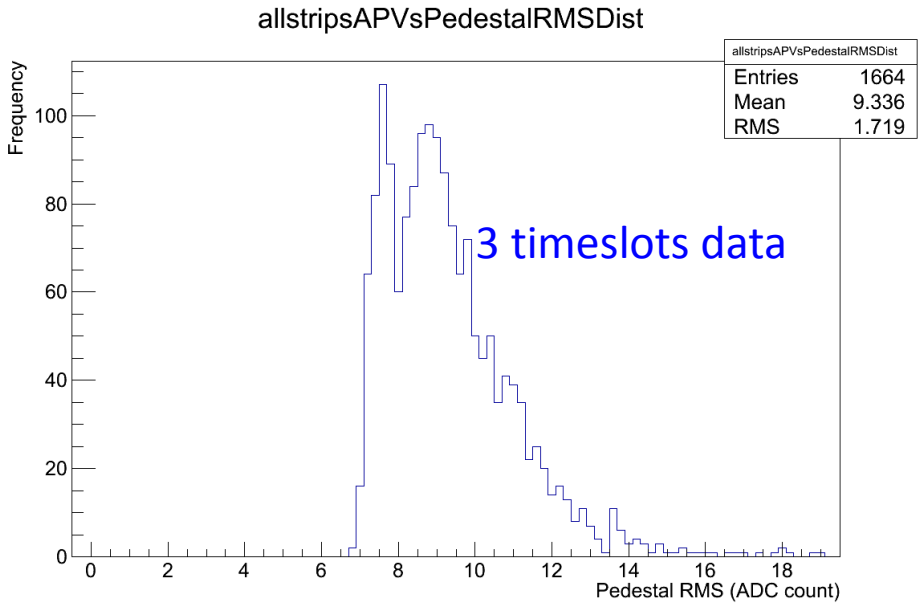


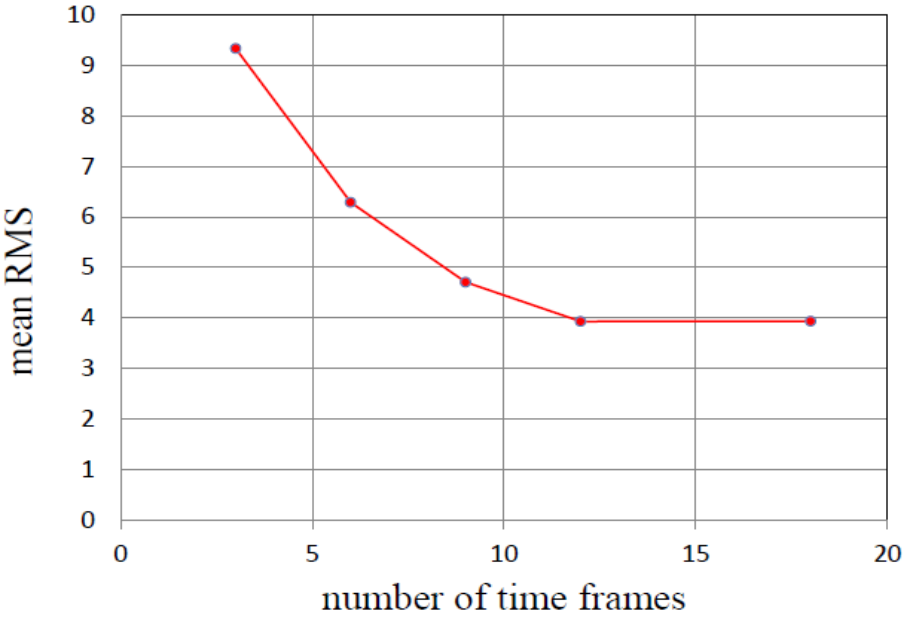


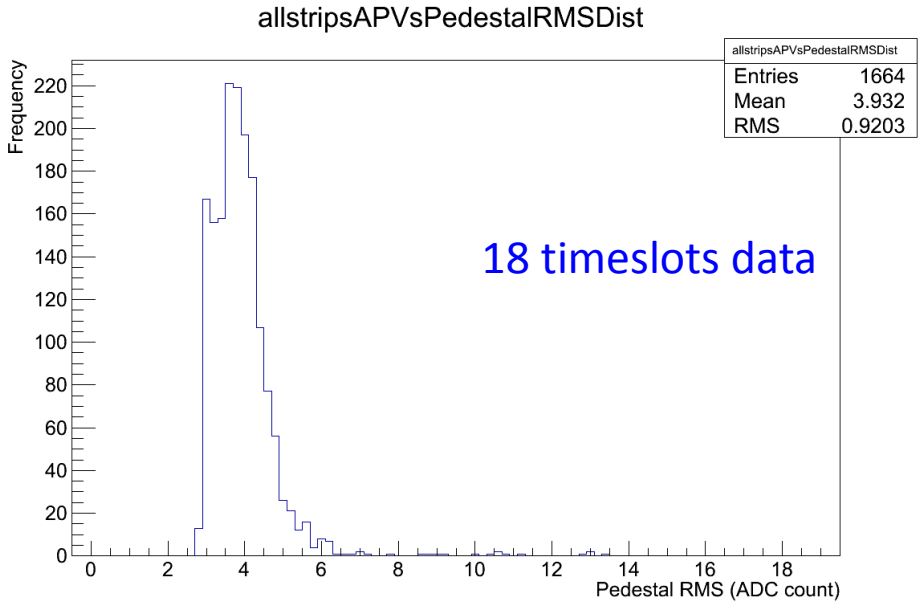


SRS: Effect of the number of apv25 time frames on the noise









Backup slides

APV25 Readout time

Buffer length 192 samples : 4.8 us Look back 160 samples

32 samples reserved for event readout

➔ Look back 160 samples ➔ 4 us

APV readout time :

t_APV = 141 x number_of_sample / 40 MHz

t_APV (1 sample) = 3.7 us.

Max rate APV front end :

270 KHz in 1 sample mode

90 KHz in 3 samples mode

Will be triggered by coincidence trigger around 50 KHz