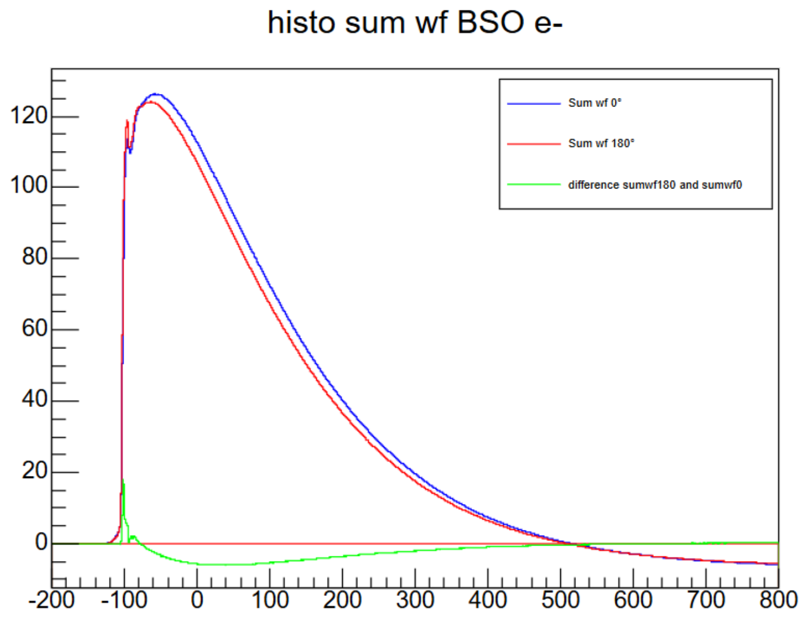
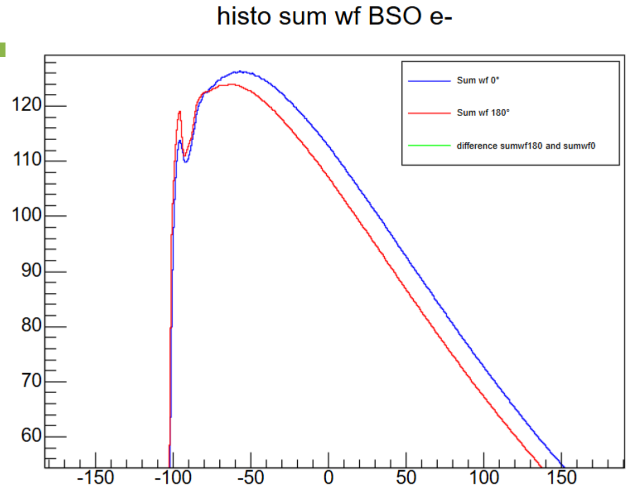
Update 04/12/2024

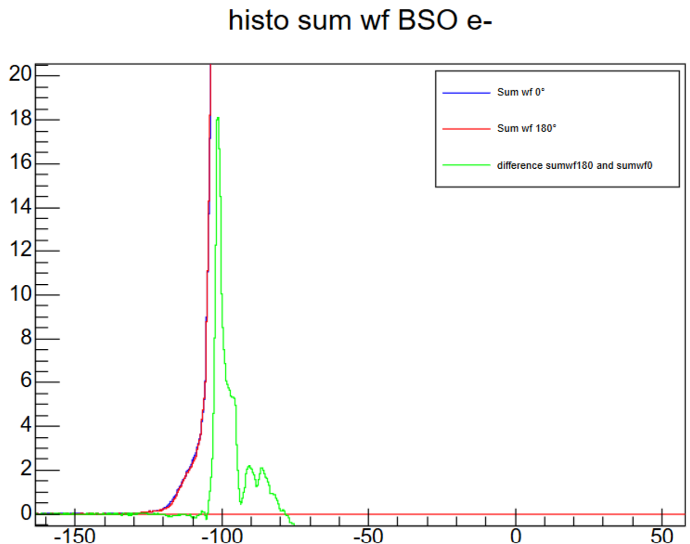
FCC Naples

Work of:
Lucrezia Borriello (Istituto Nazionale di Fisica Nucleare Napoli)

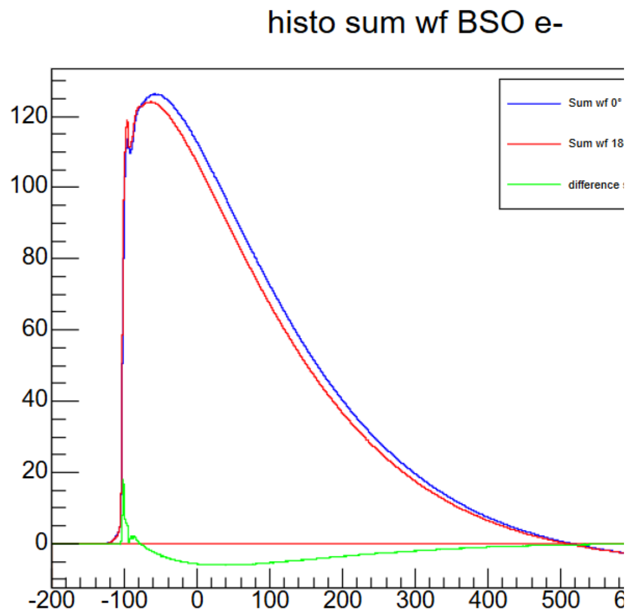
Waveform study for the BSO with e+10GeV

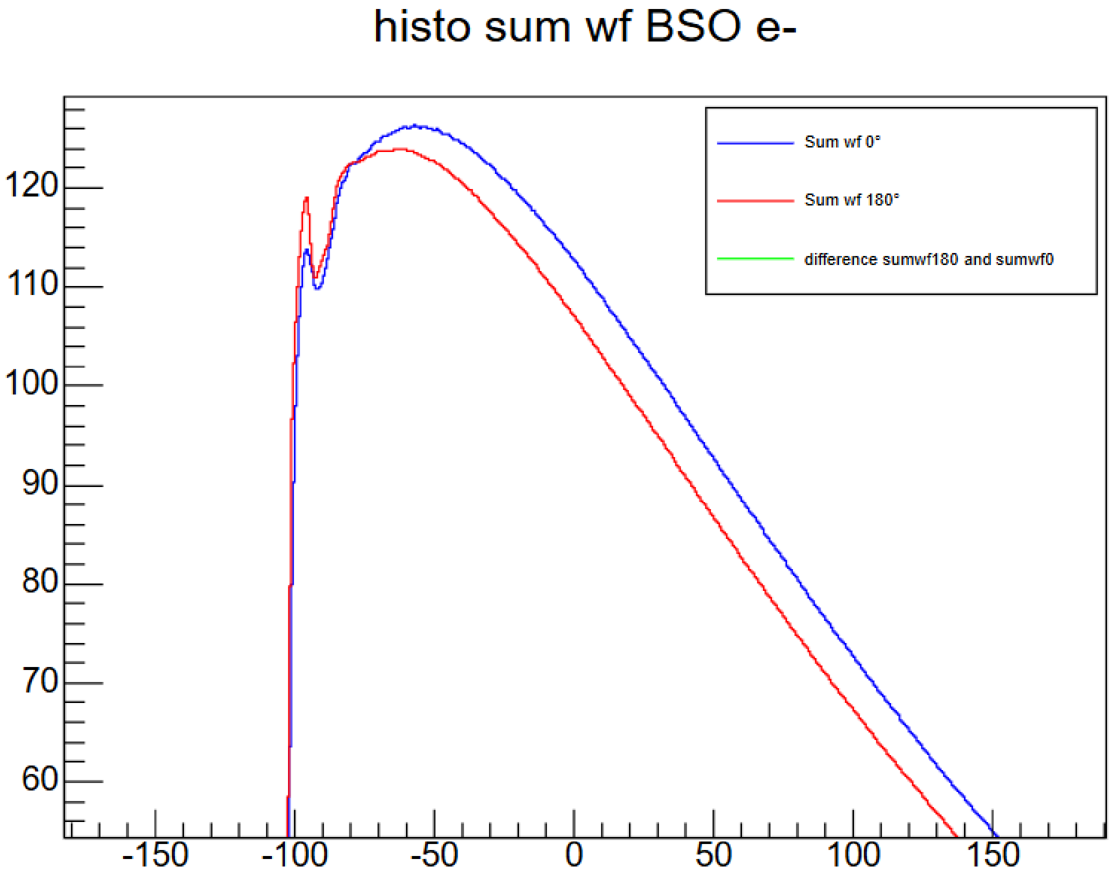


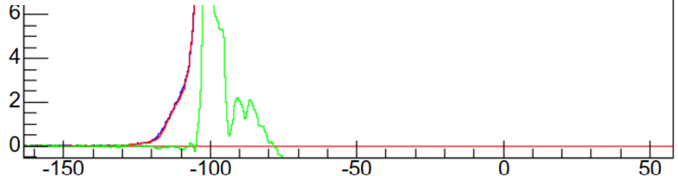




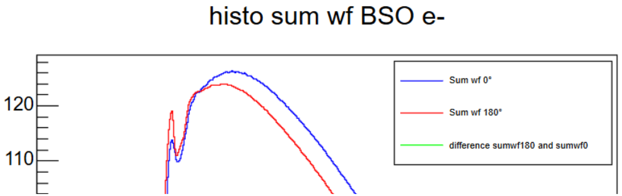
Waveform study for the B

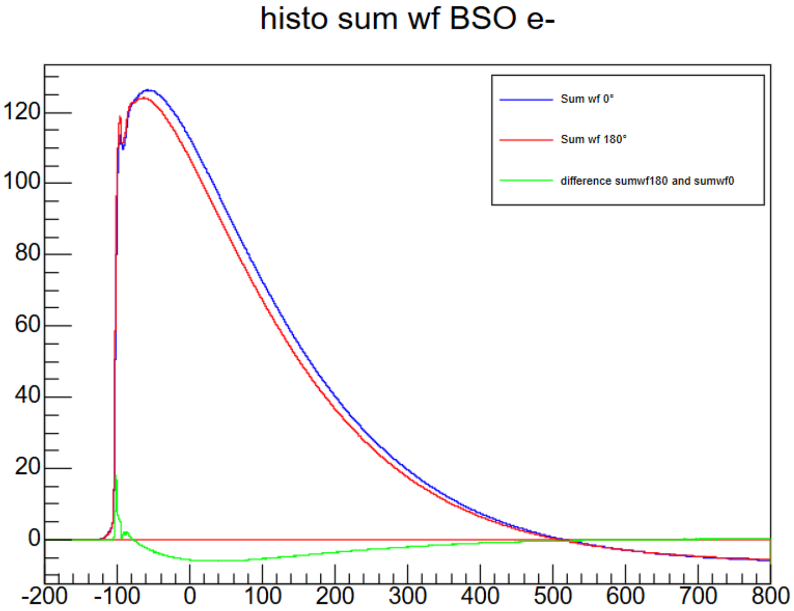


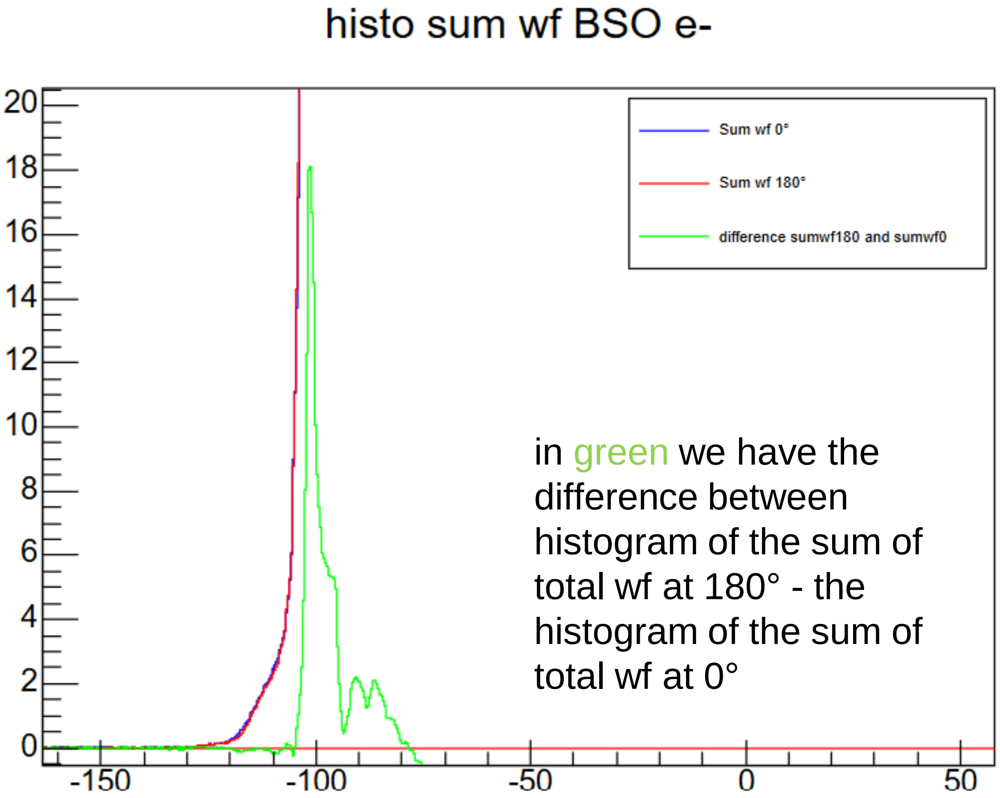




Waveform study for the BSO with e+10GeV

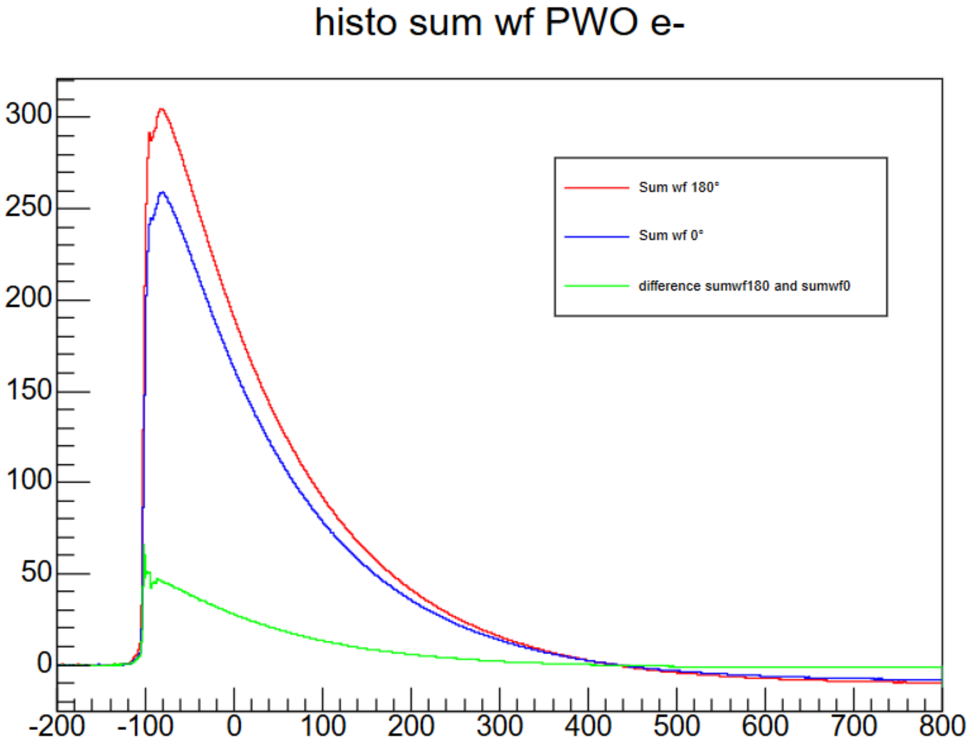


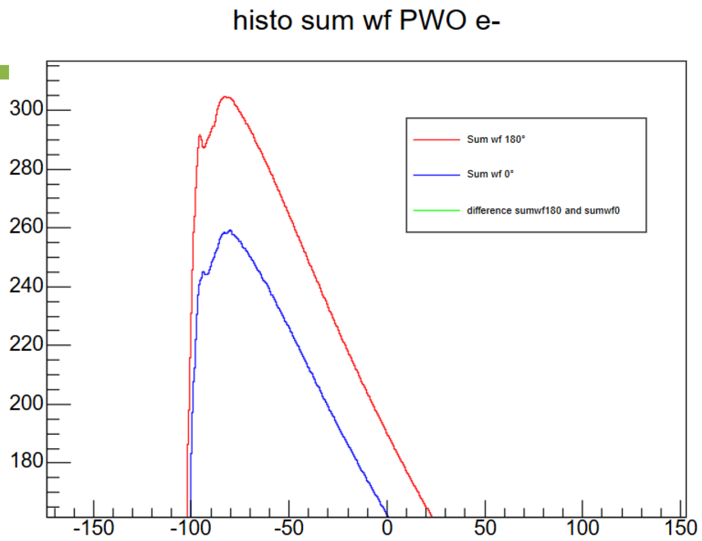


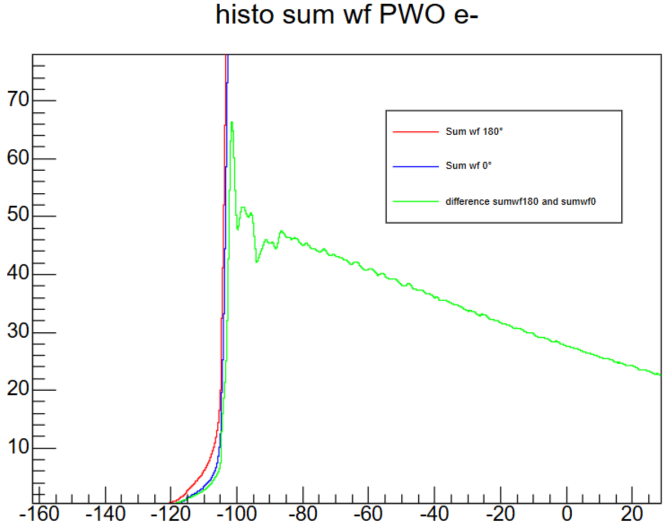


in green we have the difference between histogram of the sum of total wf at 180° - the histogram of the sum of total wf at 0°

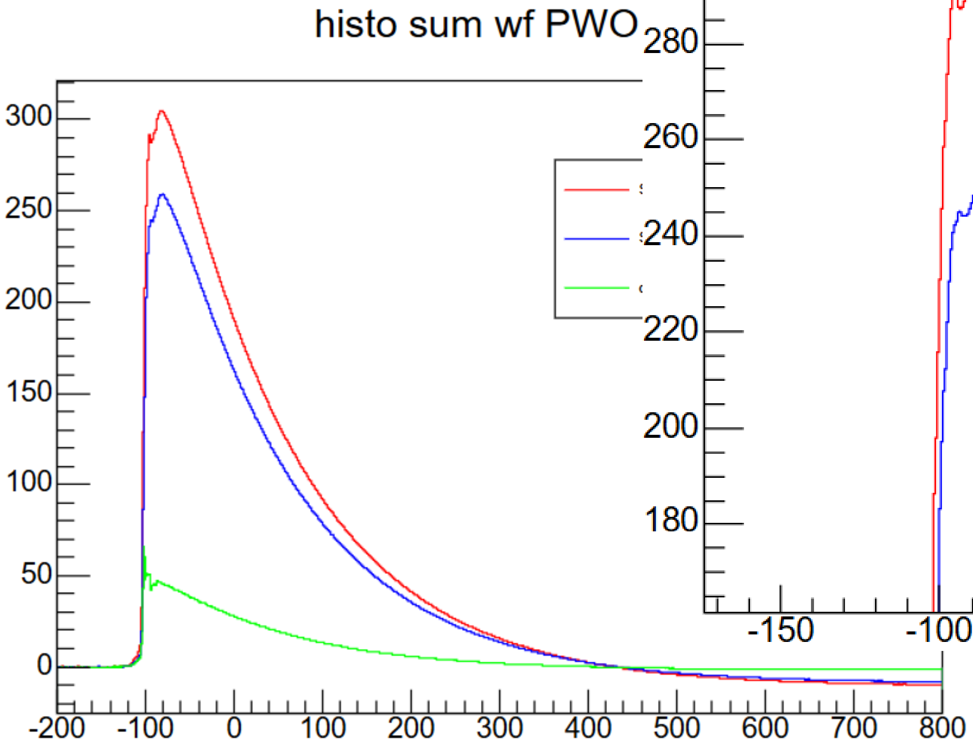
Waveform study for the PWO with e+10GeV

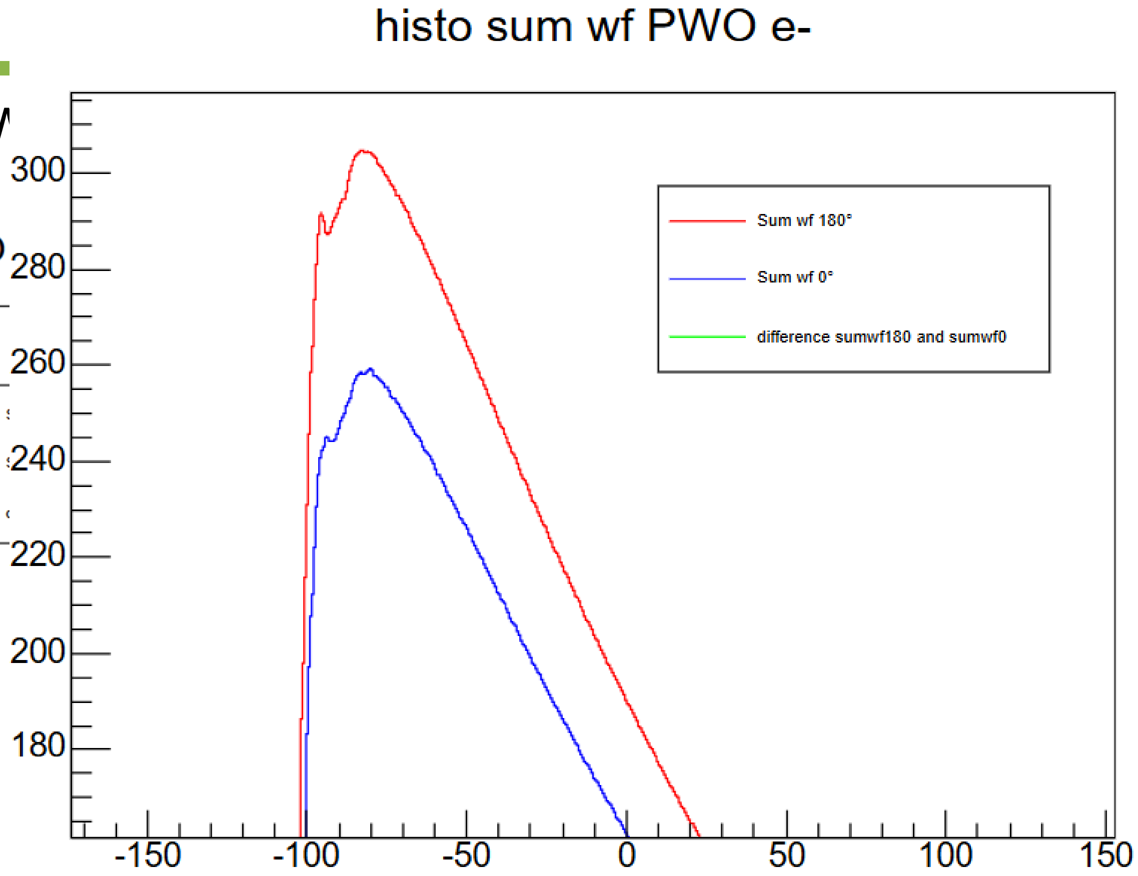


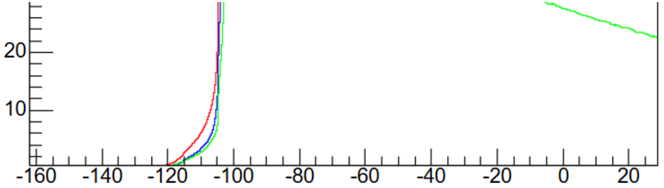




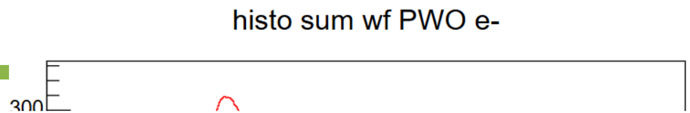
Waveform study for the PV

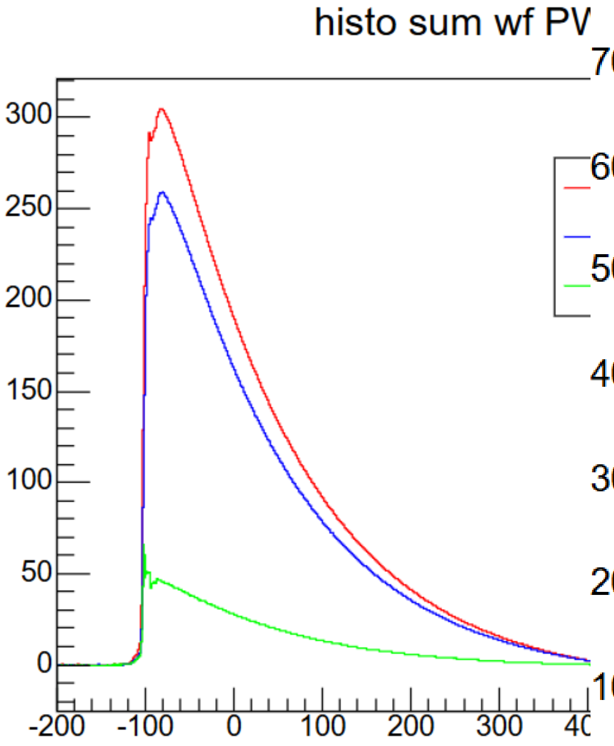


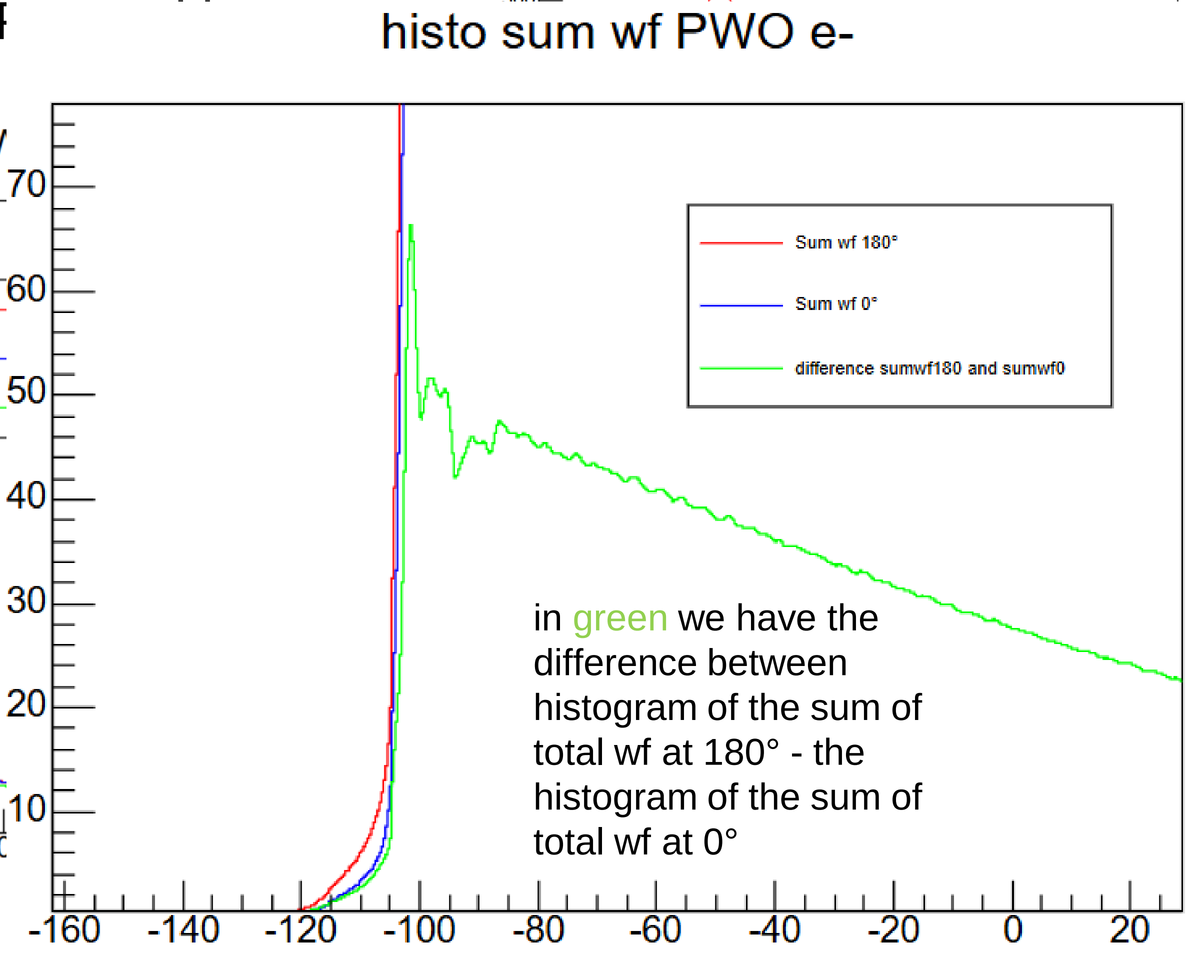




Waveform study for the F







in green we have the difference between histogram of the sum of total wf at 180° - the histogram of the sum of total wf at 0°

Evidence of single-photon resolution studies

- I made dark measurements of the SiPM specifically, study the shape of the single photon.

Why these studies?

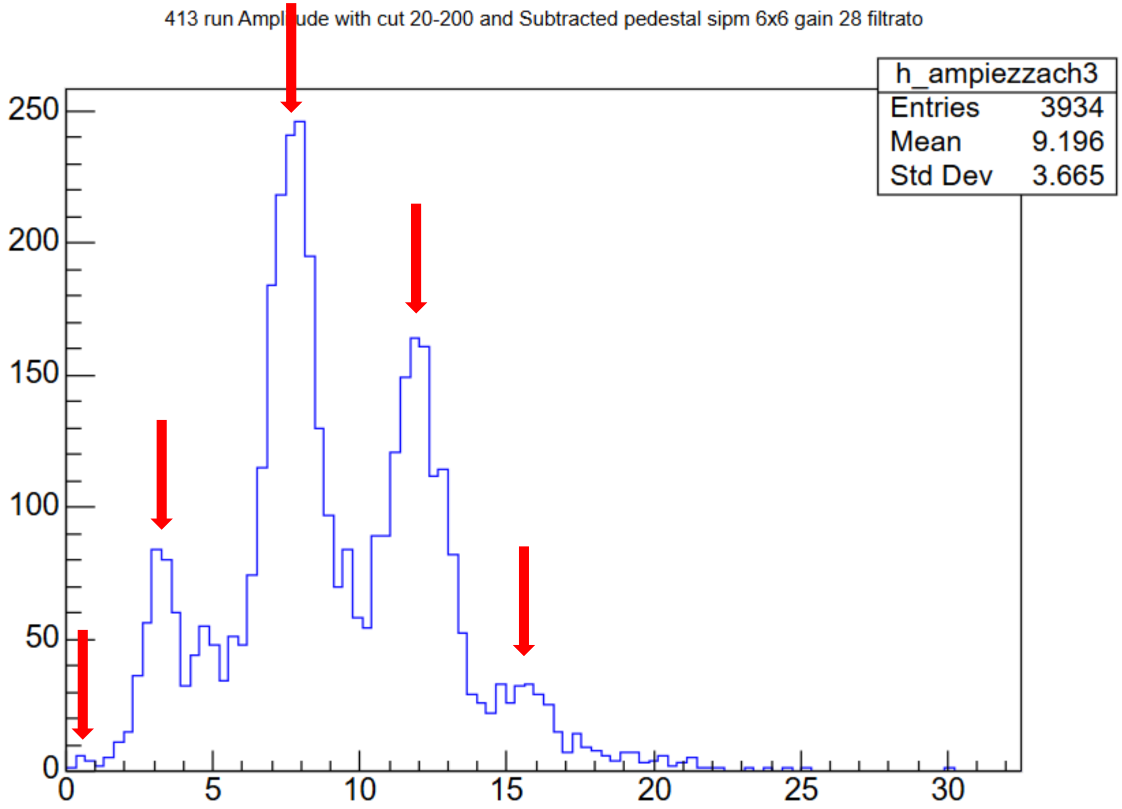
- because we could use the single photon shape as a template to fit individual wf

- Specifically, it could help to fit the first peak of the wf

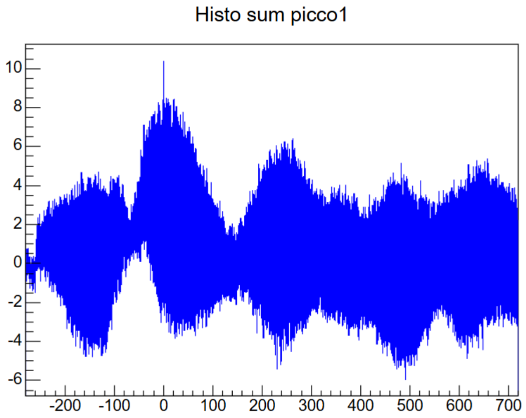
dark measurements for single-photon resolution studies

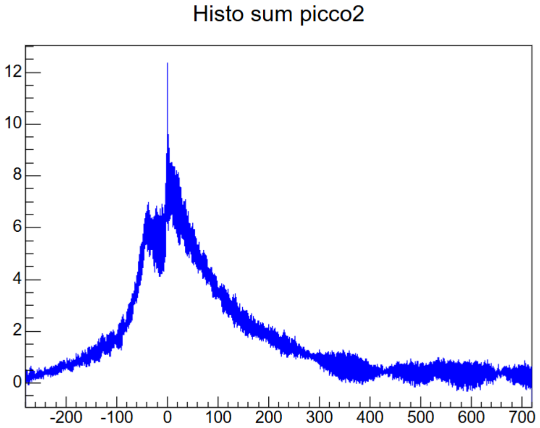
I have studied the amplitudes of the wf, what is observed is the presence of five distinct peaks.

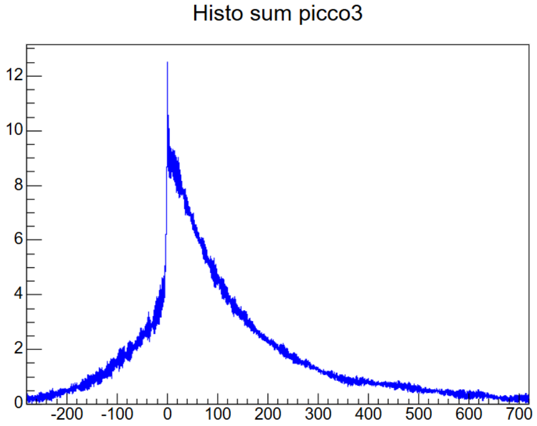
Then what I did was to study the wf corresponding to these 5 peaks and I made the average wf for each peak

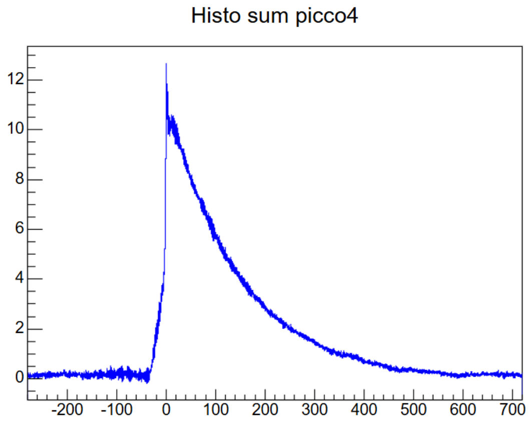


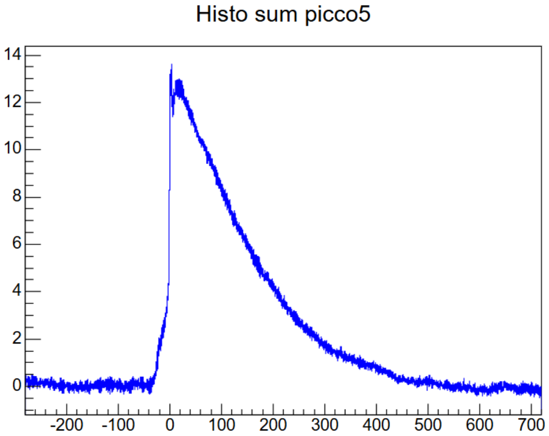
dark measurements for single-photon resolution studies



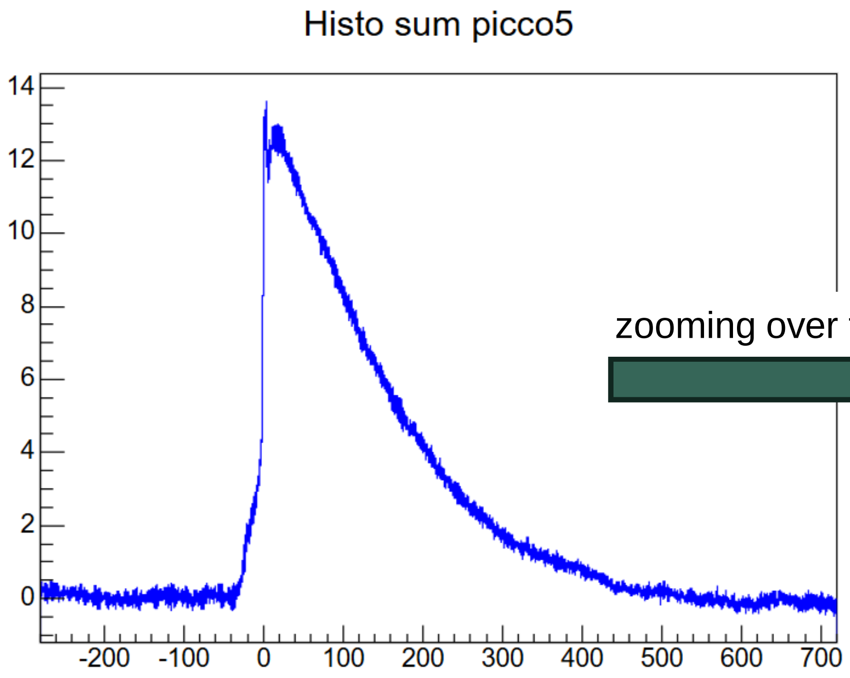




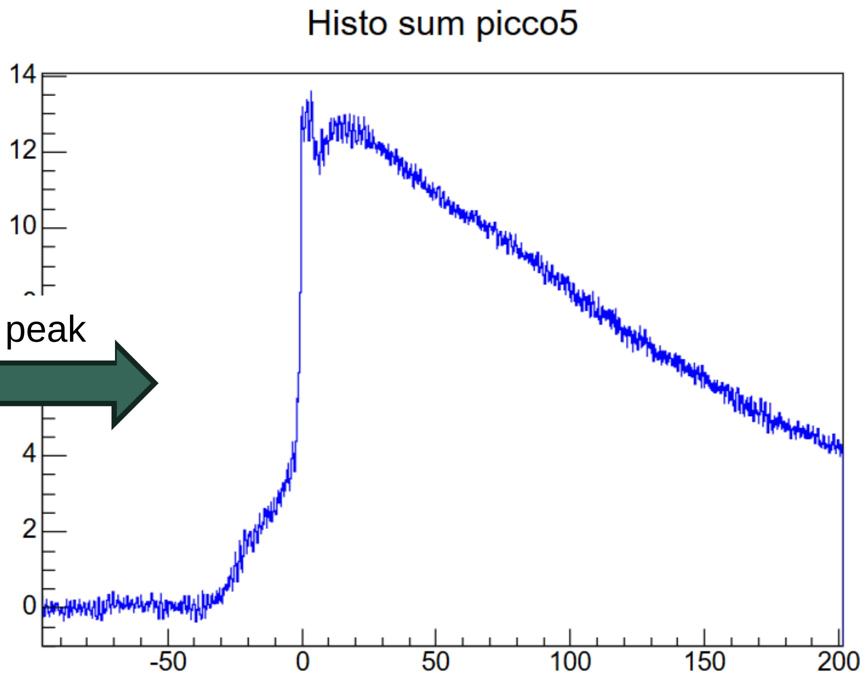




dark measurements for single-photon resolution studies

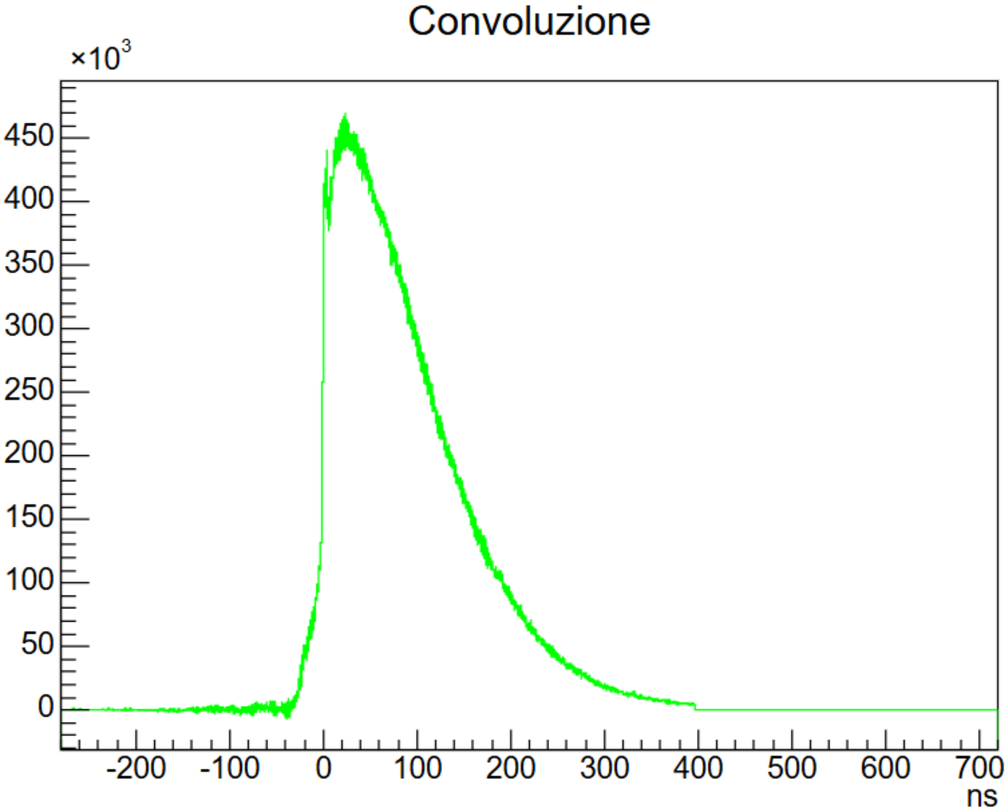


zooming over the peak



Convolution

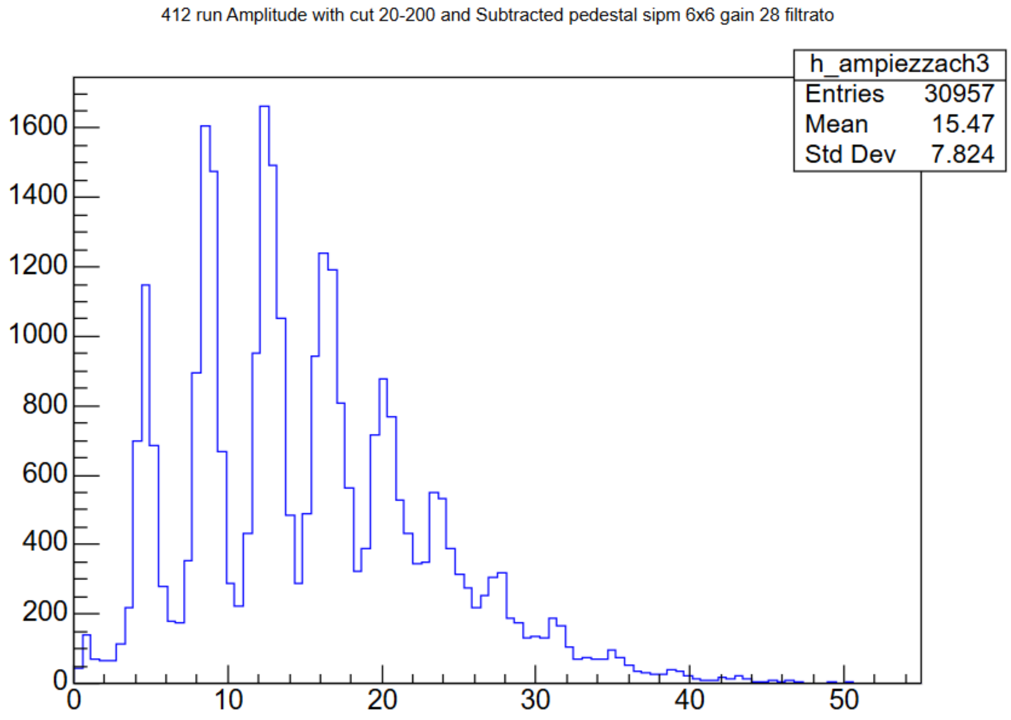
I used for the convolution the shape of the average wf for peak 5 of the dark measurements + an exponential



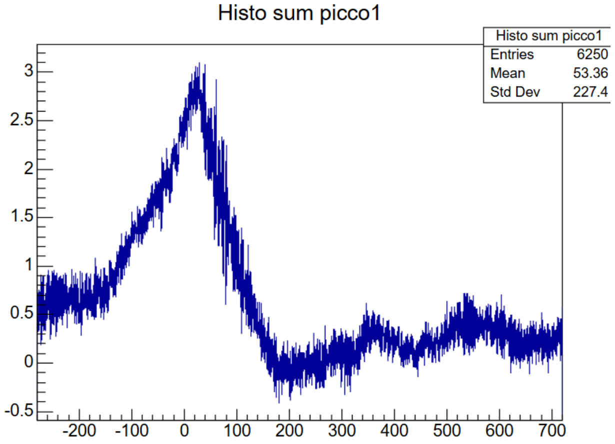
Measurements with frequency led 6

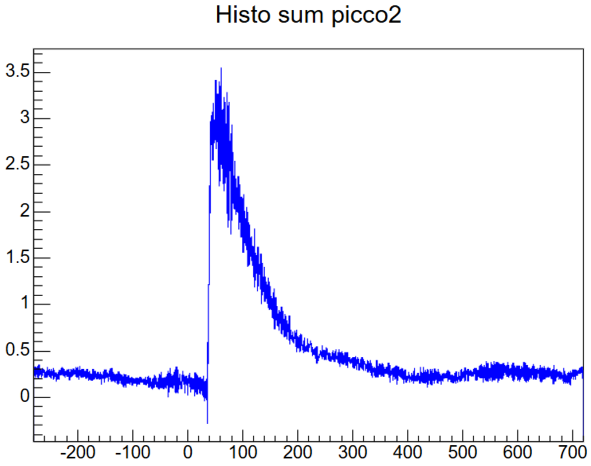
I have studied the amplitudes of the wf, what is observed is the presence of 10 distinct peaks.

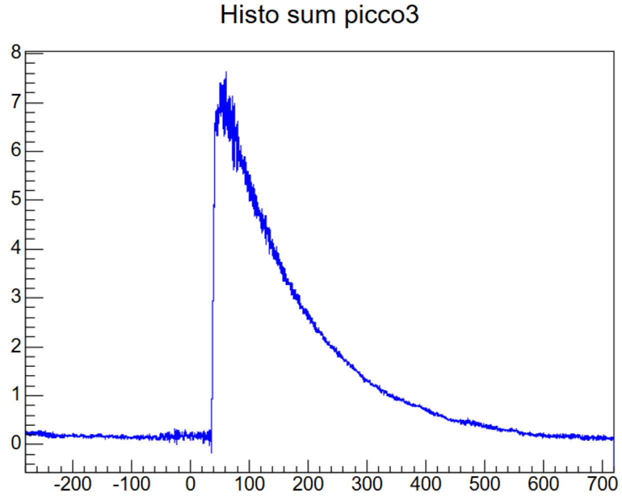
Then what I did was to study the wf corresponding to these 10 peaks and I made the average wf for each peak



Measurements with frequency led 6

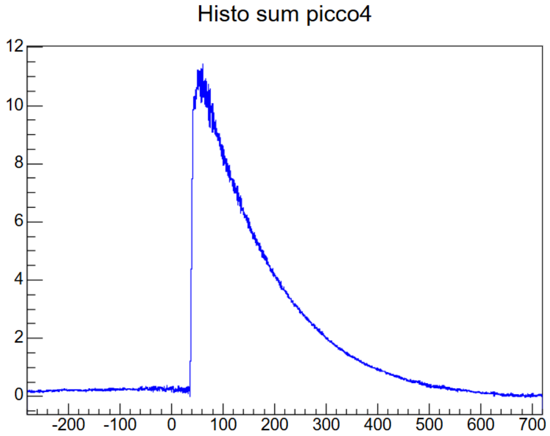


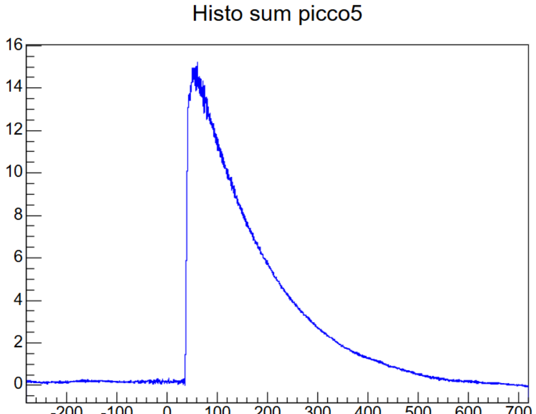




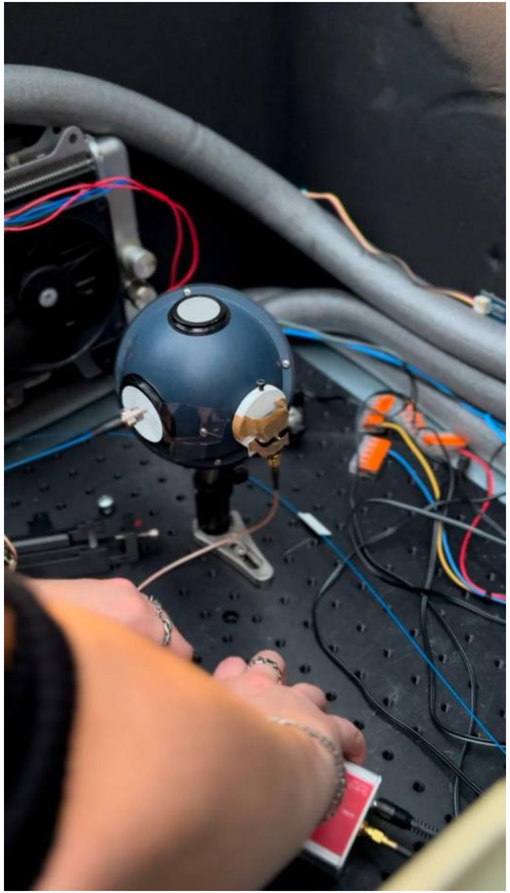
In this case we see that there is no presence, as in the case of the dark, of the initial peak.

This may be due to the led





Attenuation sphere



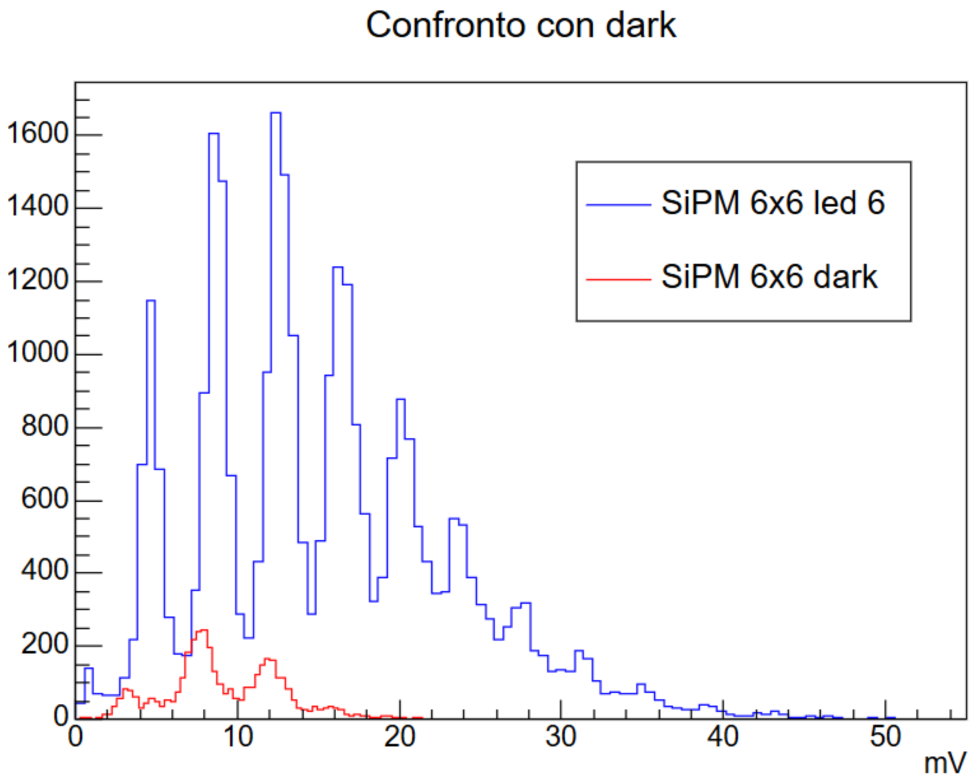
I tried to reduce the LED light with an attenuating sphere

but unfortunately I had problems with the trigger

Working in progress

Backup Slides

Amplitude comparison with led and dark



Summary SiPM 6x6 Calibration

SiPM	Gain	Gain amplitude conversion	Method	$p_0 + error$	$p_1 + error$ [mV/n_{pe}]	$\tau(ns)$	conversion factor charge $\tau(1-0{,}0497)$
6x6	28	25,12	A	0,4±0,1	3,46±0,02	132,26	125,7
6x6	28		B	15±1	3,49±0,006		
6x6	18	7,94	A	1,31±0,06	1,161±0,005	120,72	114,7
6x6	18		B	3,0±0,4	1,156±0,003		
6x6	24	15,85	A	0,20±0,05	2,27±0,01	149,72	142,3
6x6	24		B	17,5±0,7	2,169±0,003		

Summary SiPM 3x3 Calibration

SiPM	Gain	**Gain amplitude conversion**	Method	$p_0 + error$	$p_1 + error$ [mV/n_{pe}]	$\tau + error(ns)$	conversion factor charge $\tau(1-0{,}0497)$
3x3	28	25,12	B	-1,4±0,4	1,236±0,002	46,9±0,2	44,61
3x3	24	15,85	B	-0,9±0,2	0,785±0,002	45,2±0,2	42,93
3x3	18	7,94	B	-0,3±0,1	0,401±0,002	46,3±0,6	44,02
3x3	Passive Preamp	-	B	0,064±0,005	0,0425±0,0009	18,3±0,3	17,41

Gain conversion factor at various temperatures

$$V_{OV}(26°C) = V_{OP}(25°C) - V_{BD}$$

$$V_{BD}(T°) = V_{BD}(25°) + 0{,}034\frac{V}{°C}\,\delta T$$ ➡ This is in case of temperature increase from 25°C, or in case of temperature decrease ➡ $$V_{BD}(T°) = V_{BD}(25°) - 0{,}034\frac{V}{°C}\,\delta T$$

$$G(26°C) = \alpha V_{OV}(26°C) = calculated \rightarrow \alpha = \frac{G(26°C)}{V_{OV}(26°C)}$$

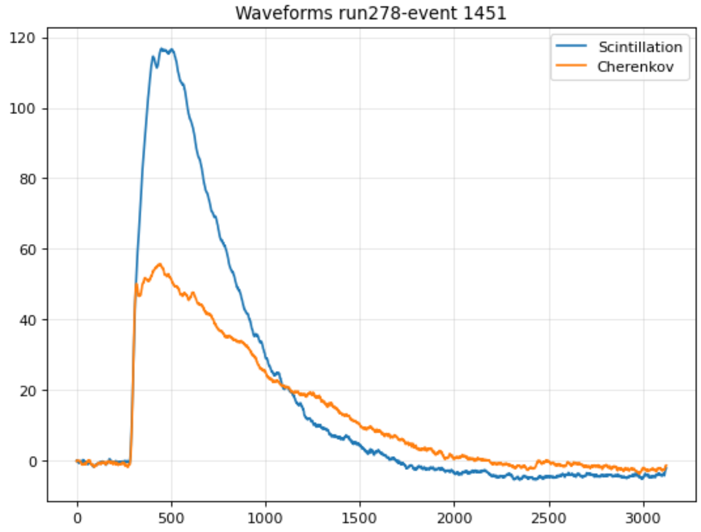
$$G(23°C) = \alpha V_{OV}(23°C)$$

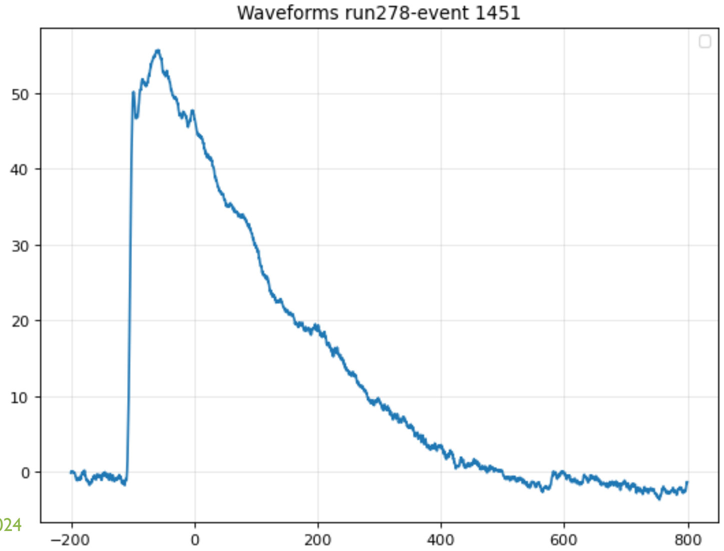
We then have the 26°C gain and we want to know how much is the gain at 23°C:

SiPM	$V_{OP}(V)$ tabulated 25°C	$V_{BD}(V)$ tabulated 25°C	V_{OV}(26°)	G(26°C)	α	V_{OV}(23°)	V_{BD}(23°)	G(23°C)
6x6	40,7	38	2,67	3,461	1,30	2,77	37,93	3,59
3x3	44	39	4,97	1,236	0,25	5,07	38,93	1,26

Analysis of the 264-278 BSO angular scan with e+ 10GeV

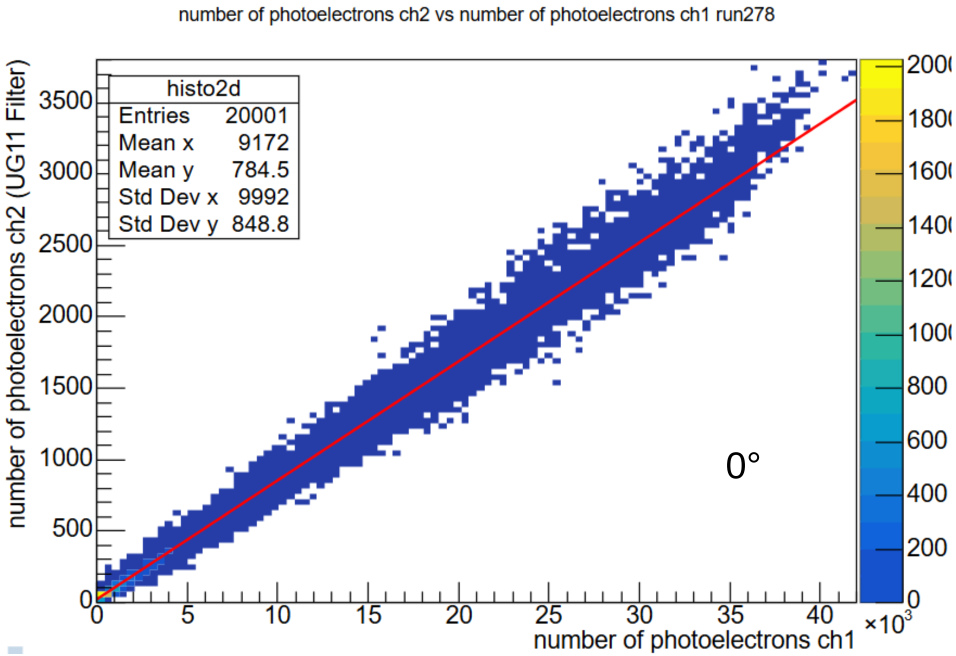
- Ch1 CAEN amp 18
- CH2 CAEN amp 18 e Filtro UG11
- CH3 LYSO
- CH4 MPC
- CH5 Plastico 1x1x1 cm3
- CH6 Trigger signal (from MIB plastic)

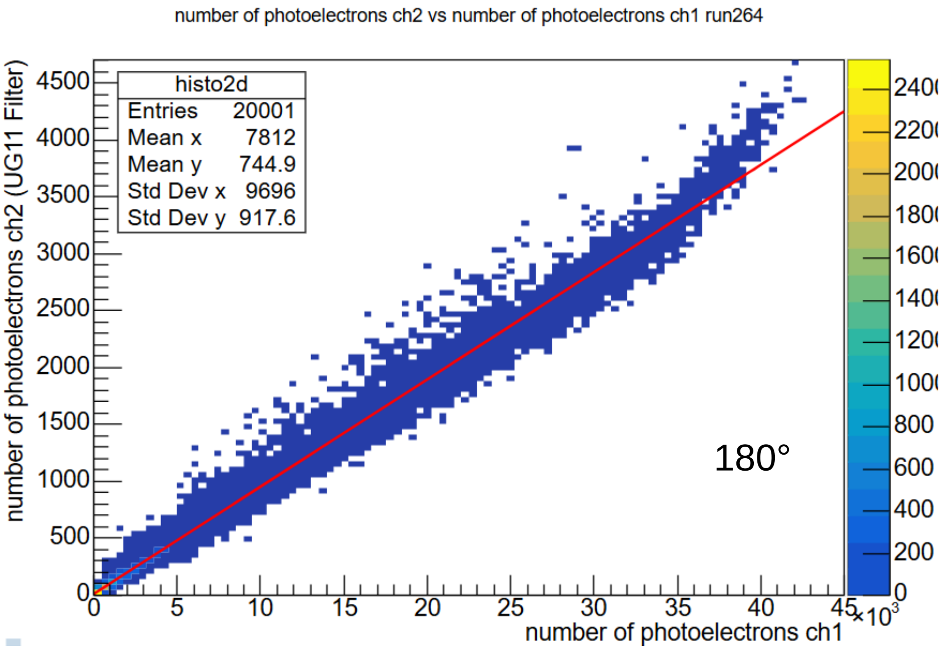




2D Histogram and fit for BSO e+10GeV

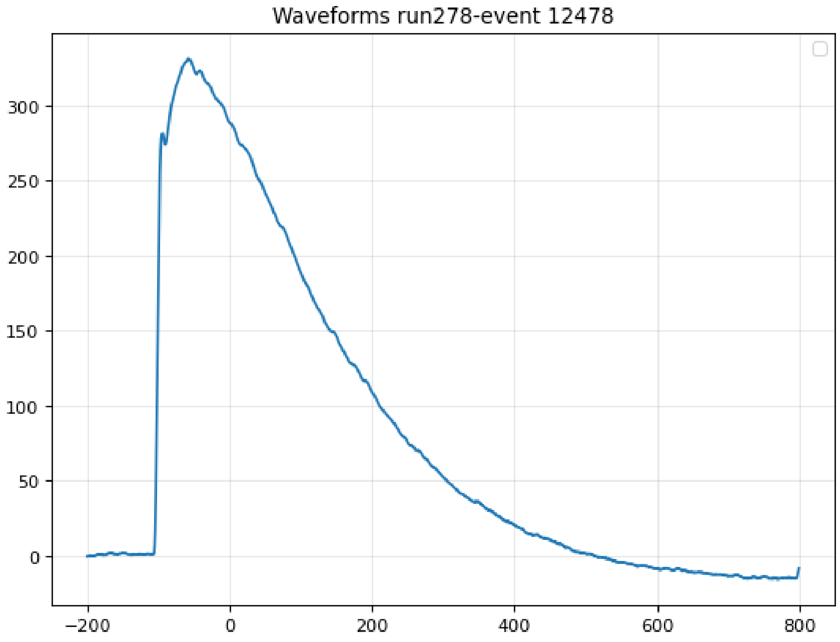
```python
# Calcolo l'integrale delle waveforms
integral_ch1 = np.sum(np.abs(wf_channel1))
integral_ch2 = np.sum(np.abs(wf_channel2))

a=integral_ch1/(44.02*0.401)
b=integral_ch2/(114.7*1.16)
```

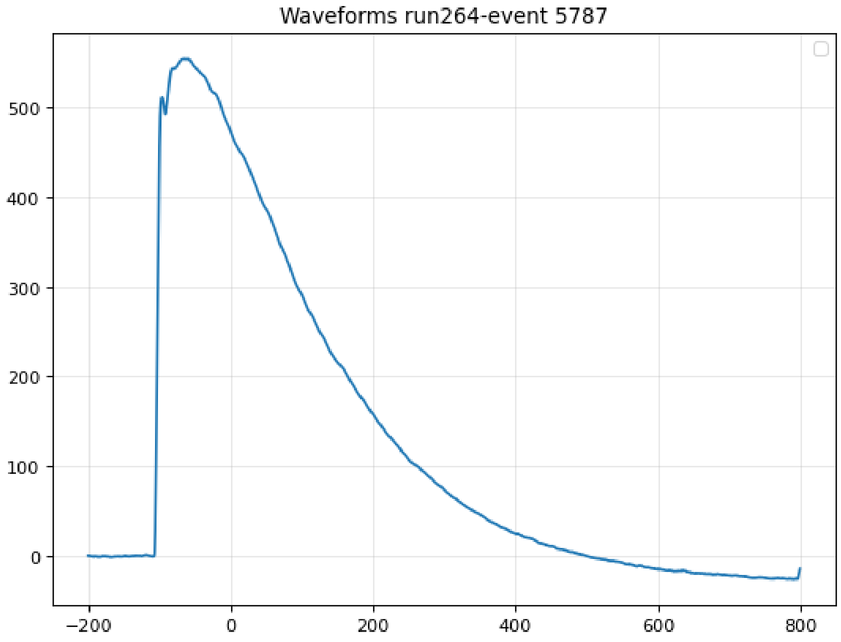




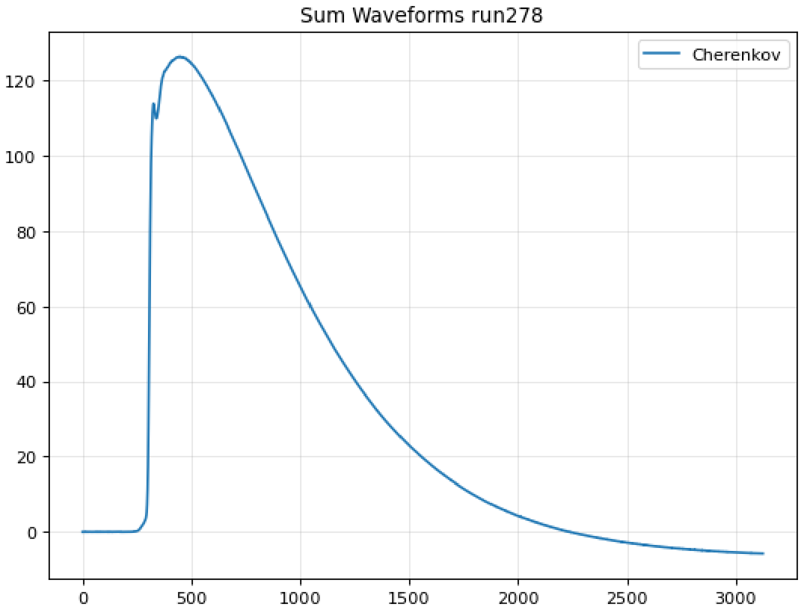
- If there were only scintillation the slope would always be equal depending on the angle

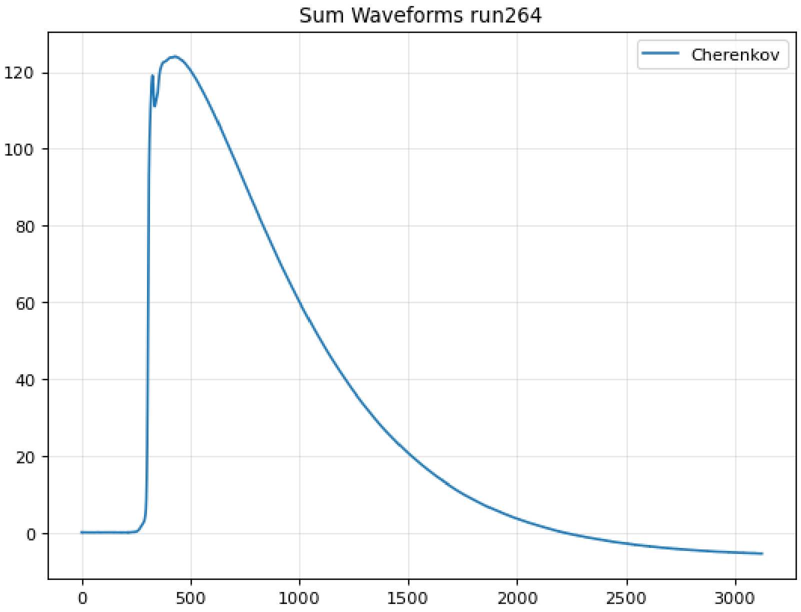
Wf for BSO e+10GeV





Wf for BSO e+10GeV





Calibration procedure

We want to calibrate the Silicon Photomultiplier (SiPM) that we used at the test beam: 2 SiPM of different sizes and using a variable-gain preamplifier that allows us to have various gains.

Procedure:

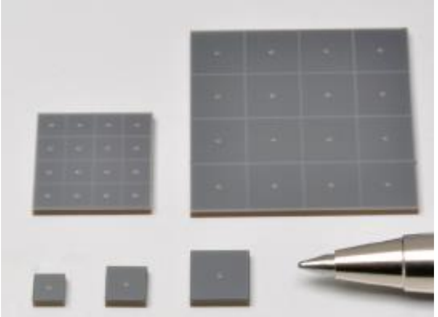
- Reproduce the SiPM - Preamplifier - Oscilloscope chain in the Naples lab
- Use a led drive that to generate light for our sipm in a controlled way
- Acquire our signal with the oscilloscope
- Calibrate the SiPM response to derive the number of incoming photons.

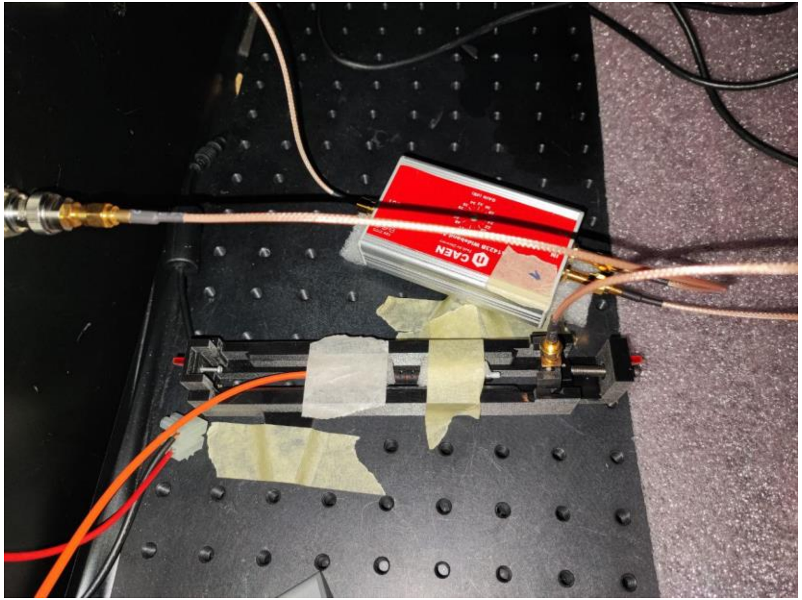
Two different methods have been used (to be described in the next slides):

A) Waveform integral measurement from the amplitude (Peak id)
B) Photoelectrons counting (PE Count)

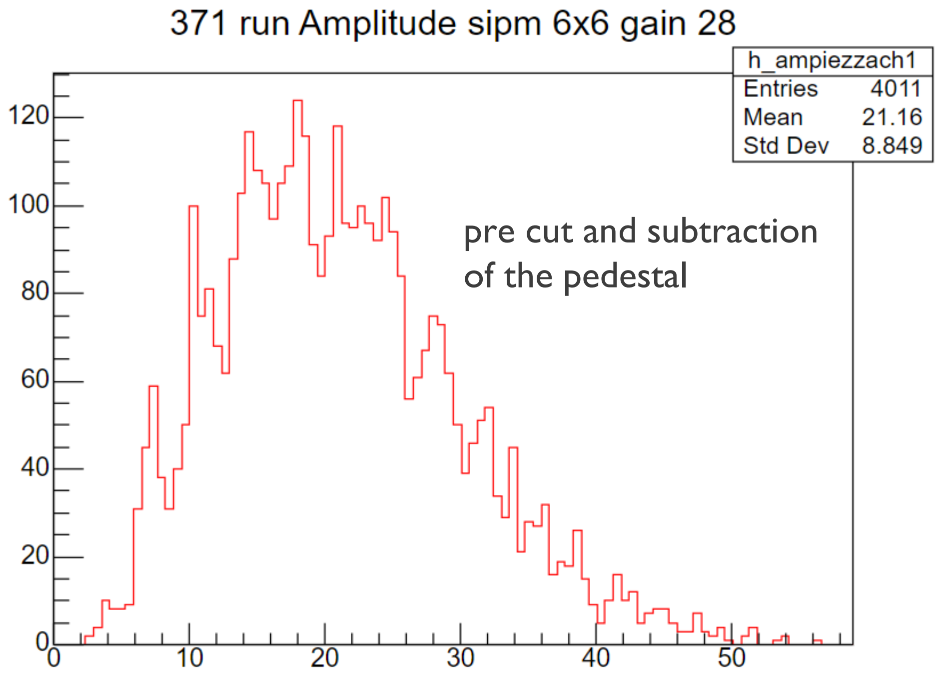
Setup:

- SiPM Hamamtsu S14160-6050HS:
  - -photosensitive area 6x6 mm^2
  - -number of pixels= 14331
- SiPM Hamamatsu S14160-3010PS:
  - - photosensitive area 3x3 mm^2
  - - number of pixels= 89984
- Preamplifier CAEN serie A1423B:
  - -Gain range from +18dB to +54dB
- CAEN Led Driver SP5601
- CAEN NIM HV Power supply module N1419ET
  - - 4 Ch Reversible 500 V/200 µA
- Tektronix Oscilloscope MSO66B:
  - - 1,5 GHz Bandwidth
  - - 6 Analog channels

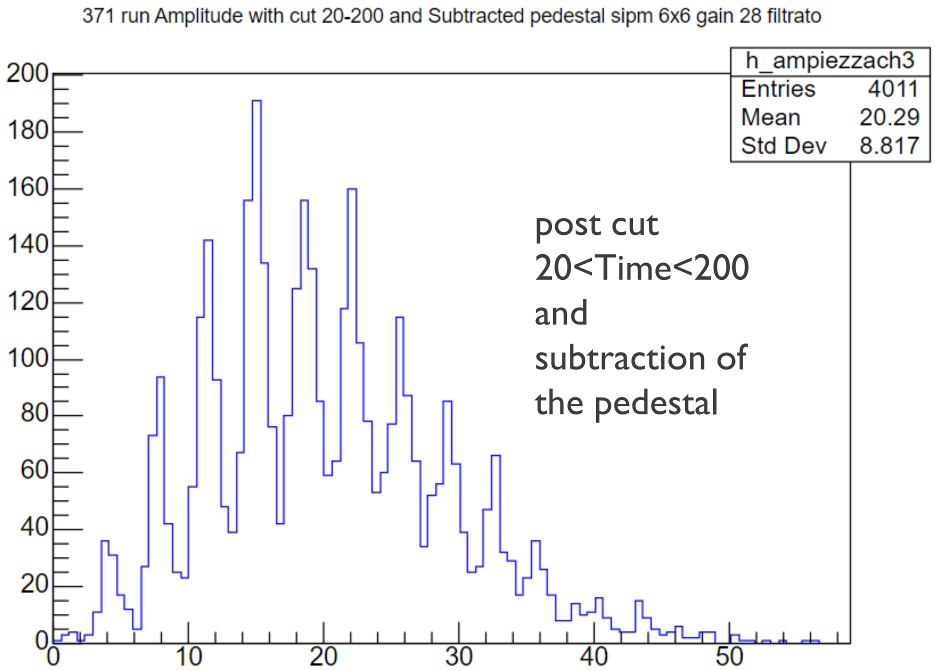




SiPM 6x6 at Gain 28 Calibration

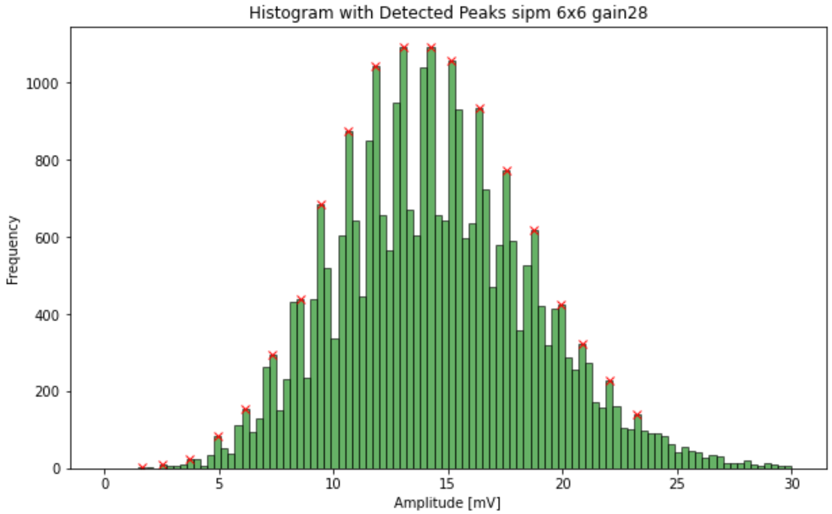


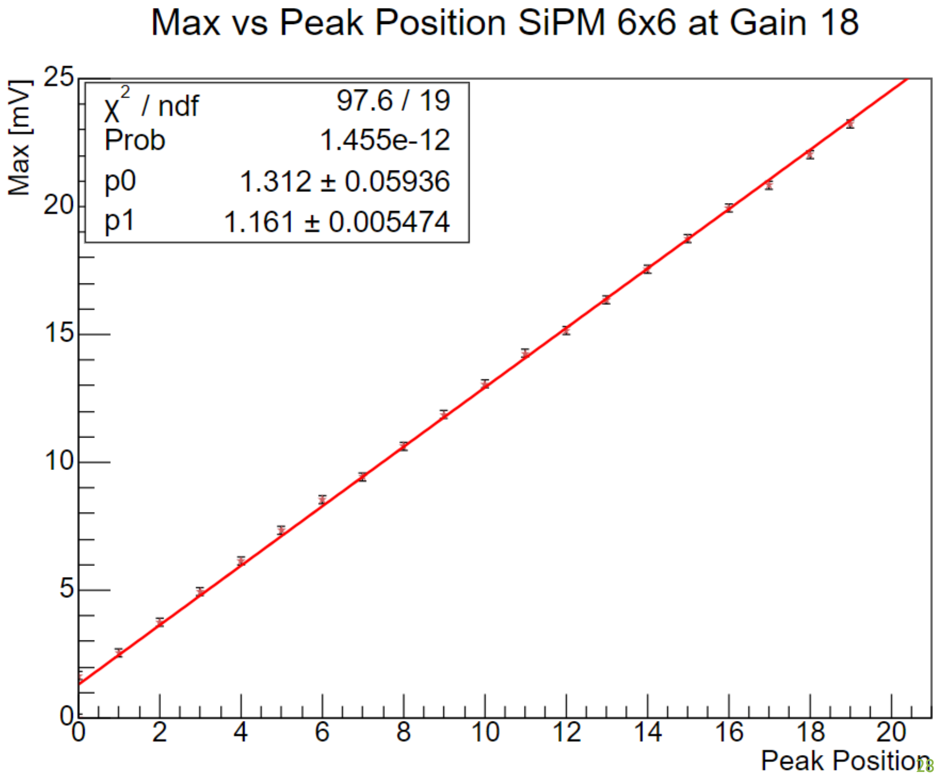
pre cut and subtraction of the pedestal



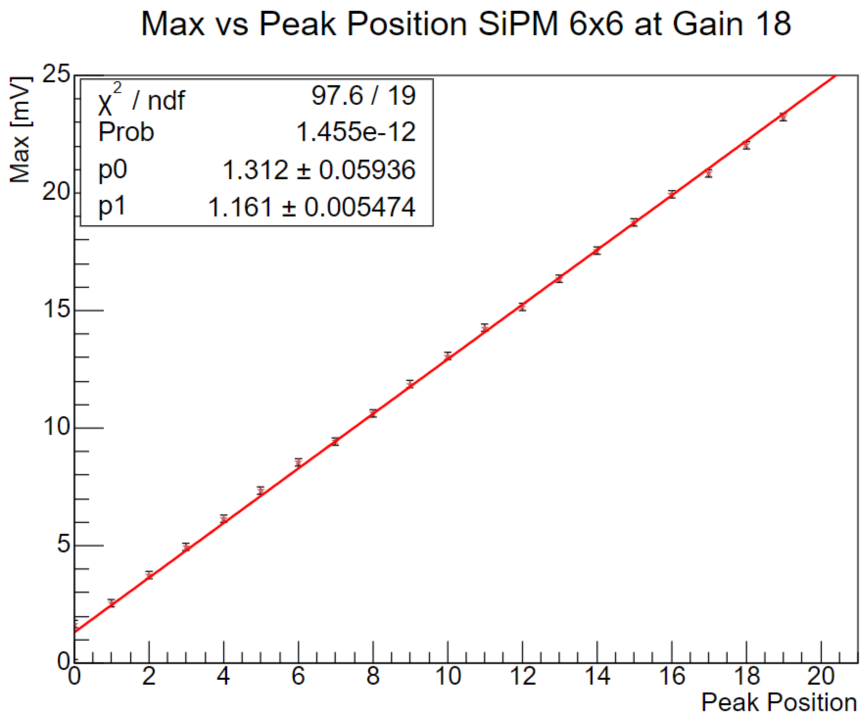
post cut 20<Time<200 and subtraction of the pedestal

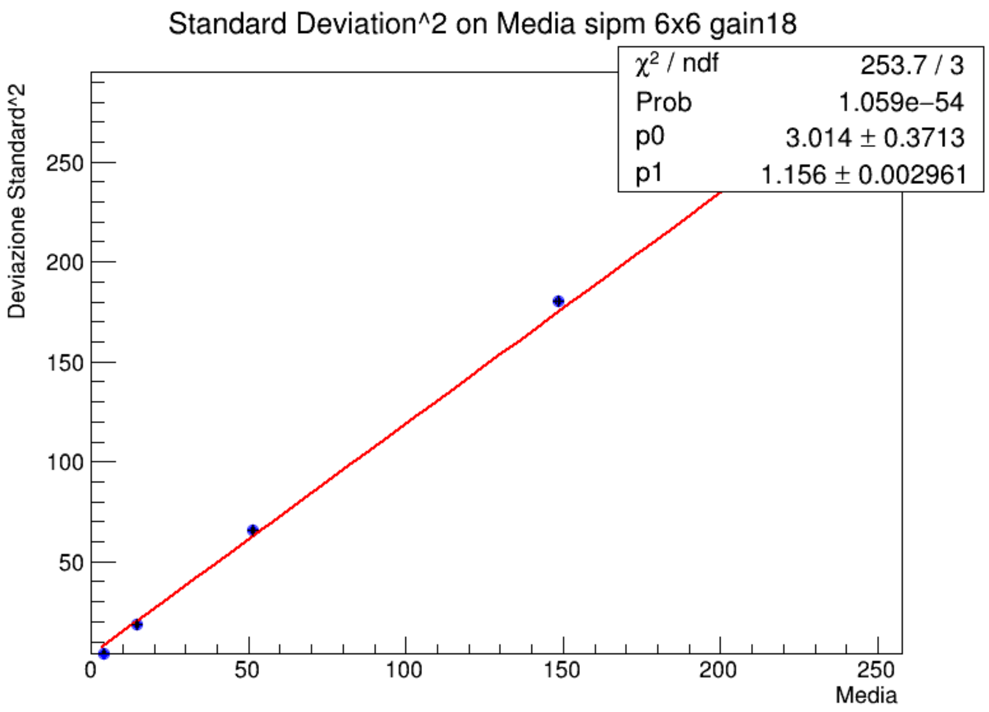
SiPM 6x6 at Gain 18 Calibration



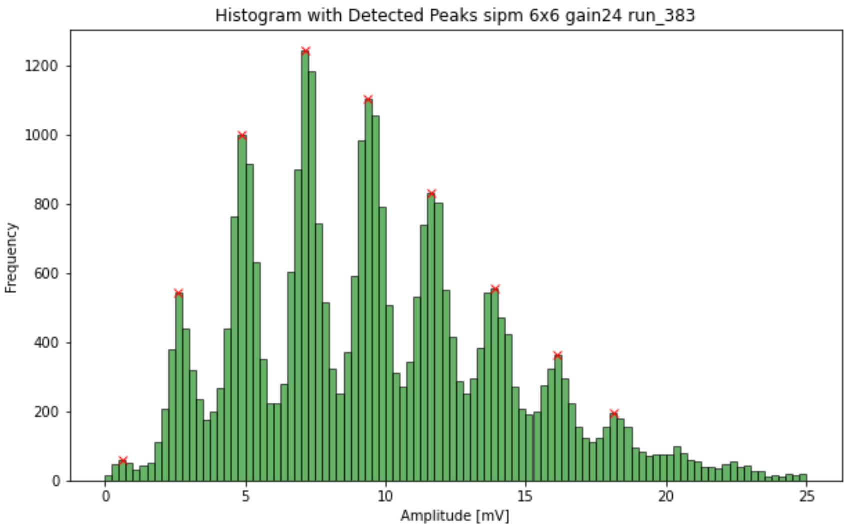


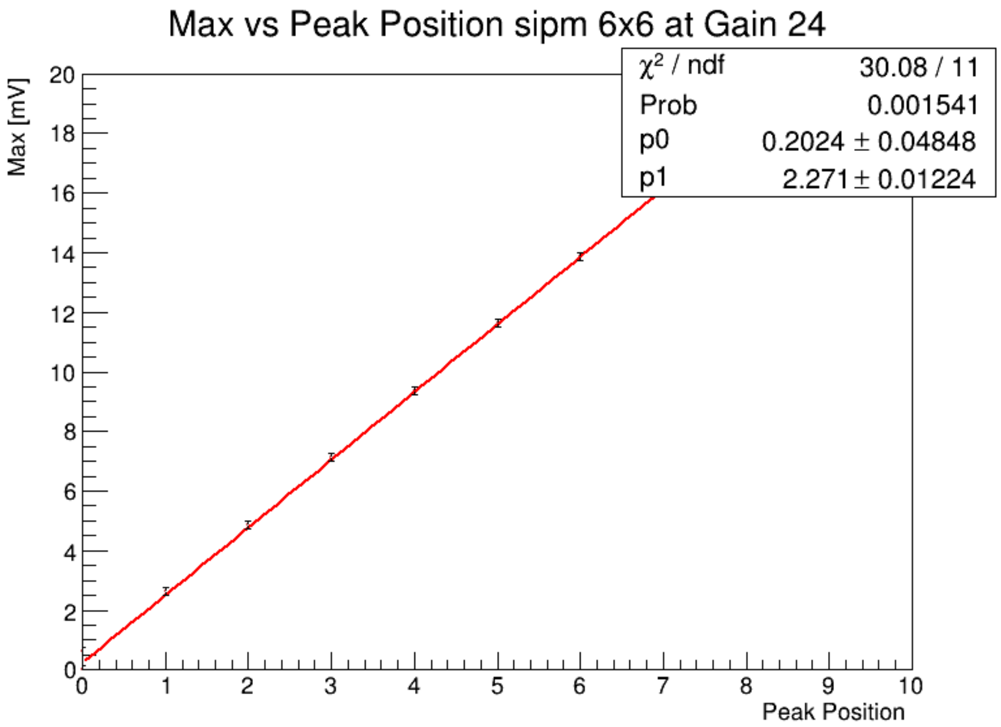
Calibrations SiPM 6x6 Gain 18 with other method and Comparison 2 methods



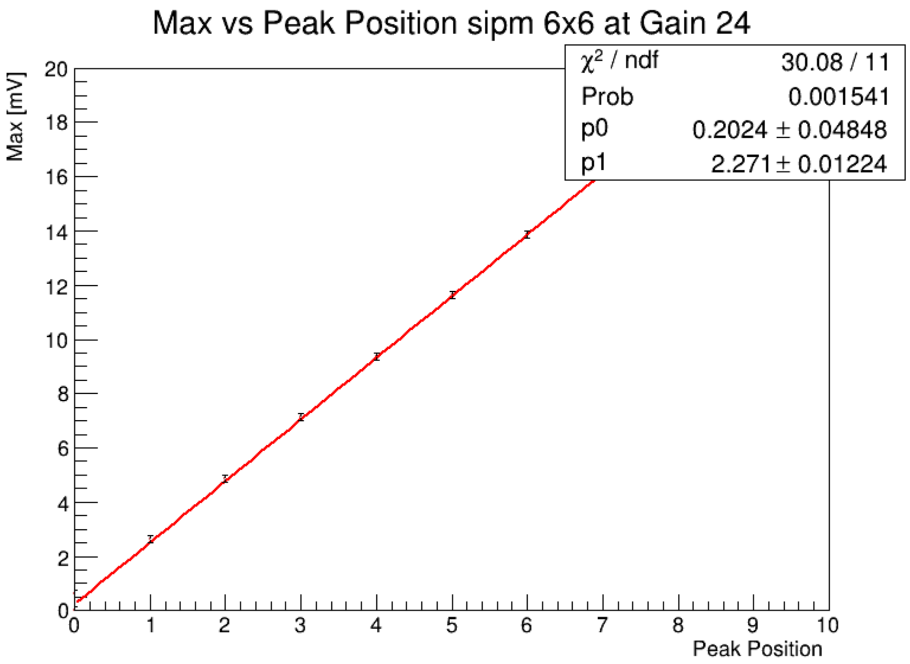


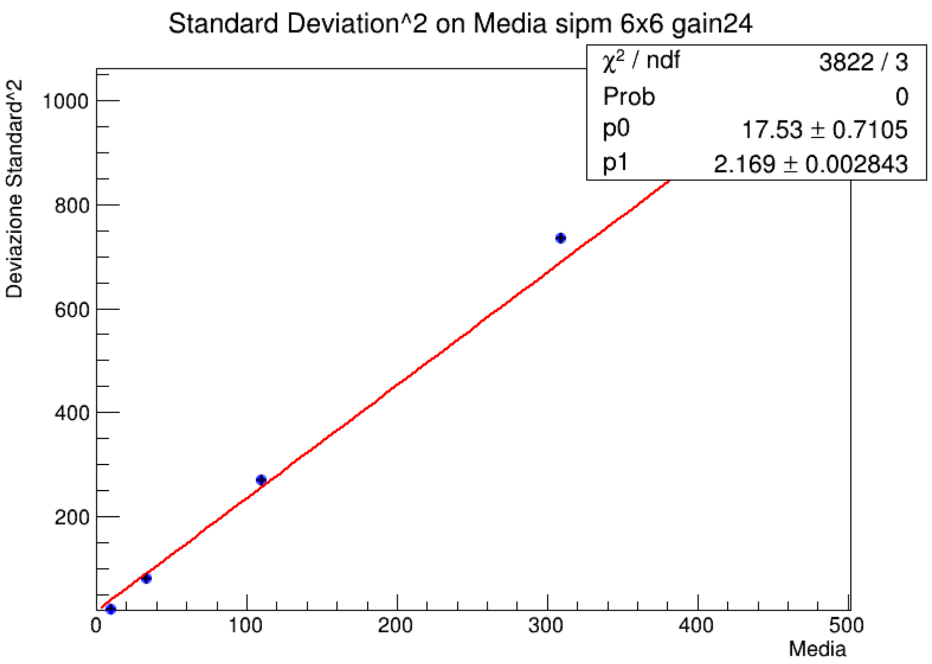
SiPM 6x6 at Gain 24 Calibration





Calibrations SiPM 6x6 Gain 24 with other method and Comparison 2 methods



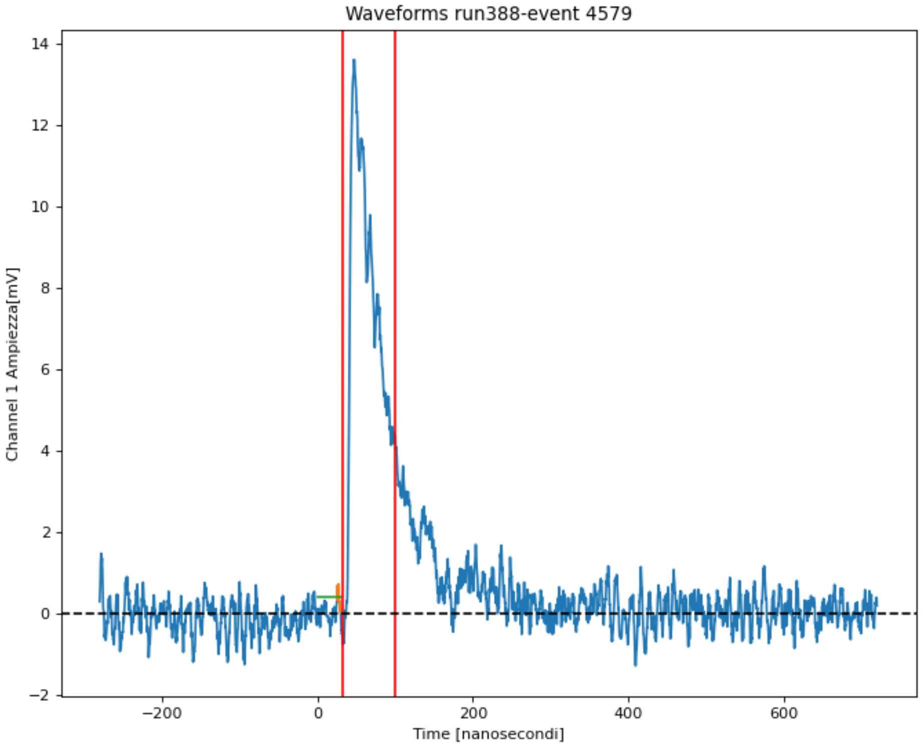


Calibrazioni sipm 3x3 Gain 28

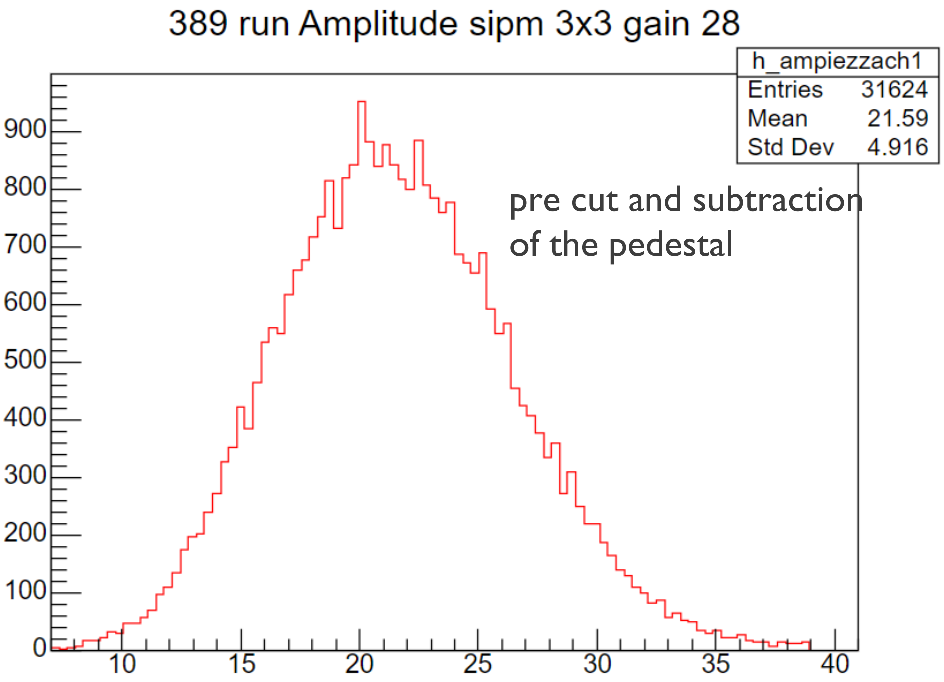
- Power suply 44V
- CAEN Preamplifier at gain 28

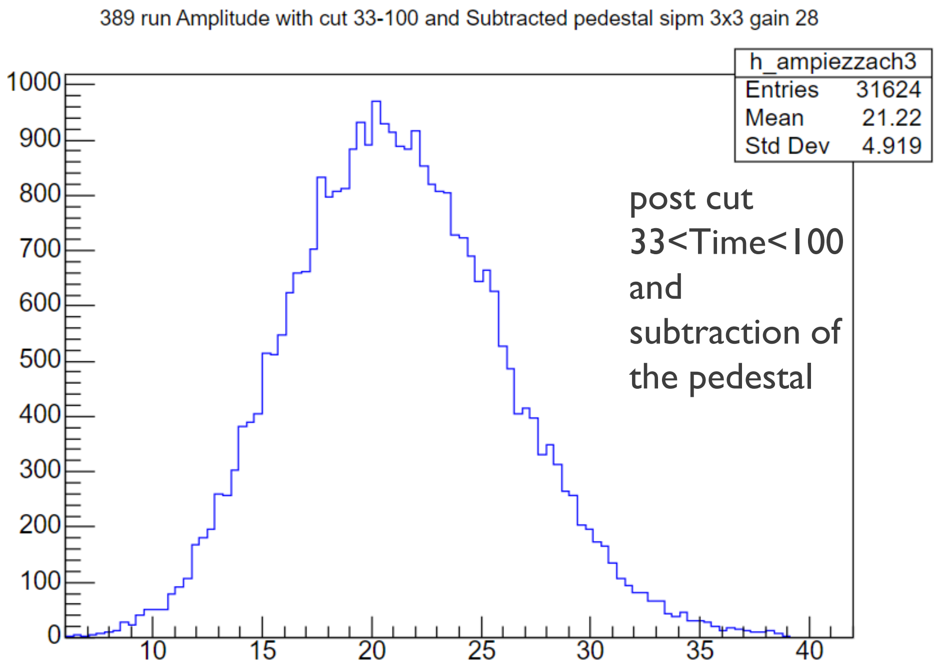
- In red= cut on waveform at 33<Time<100

- In orange= pedestal to subtract

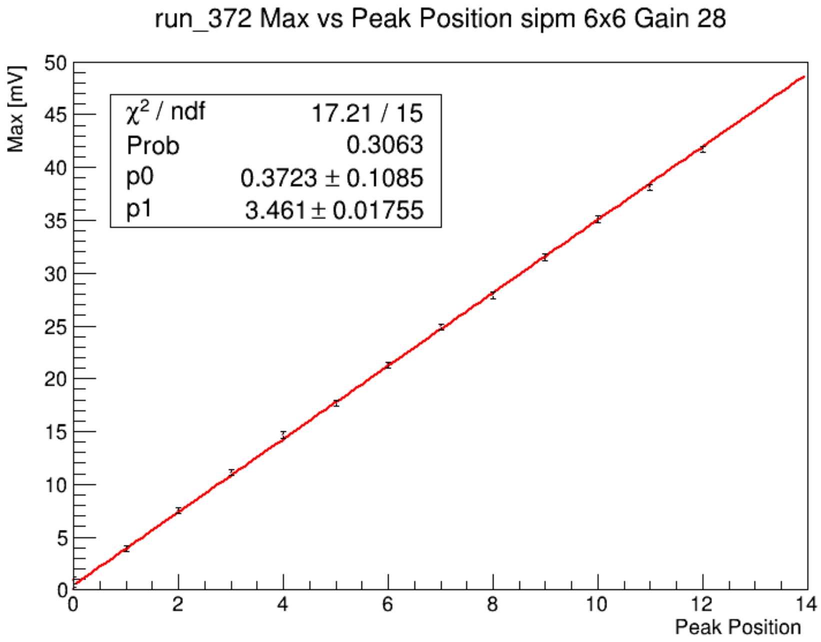


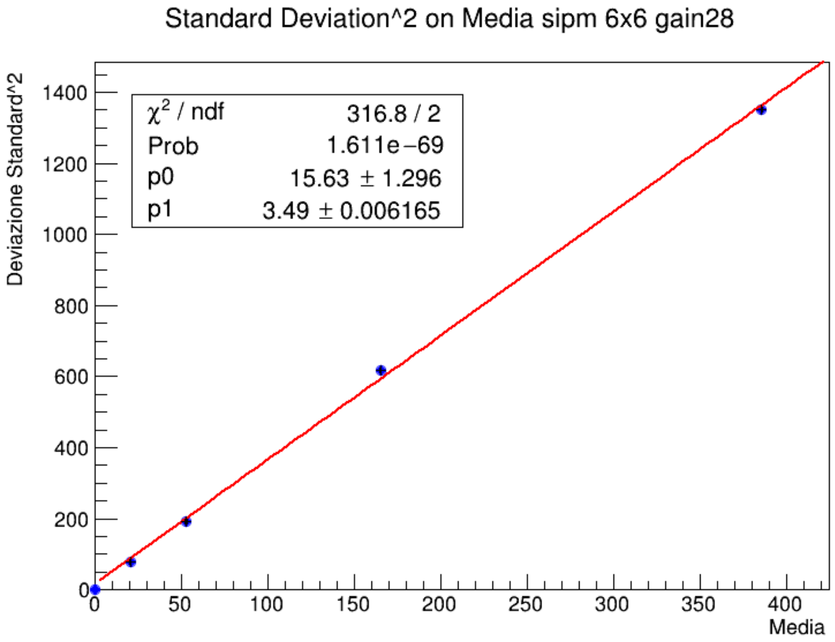
Calibrazioni sipm 3x3 Gain 28



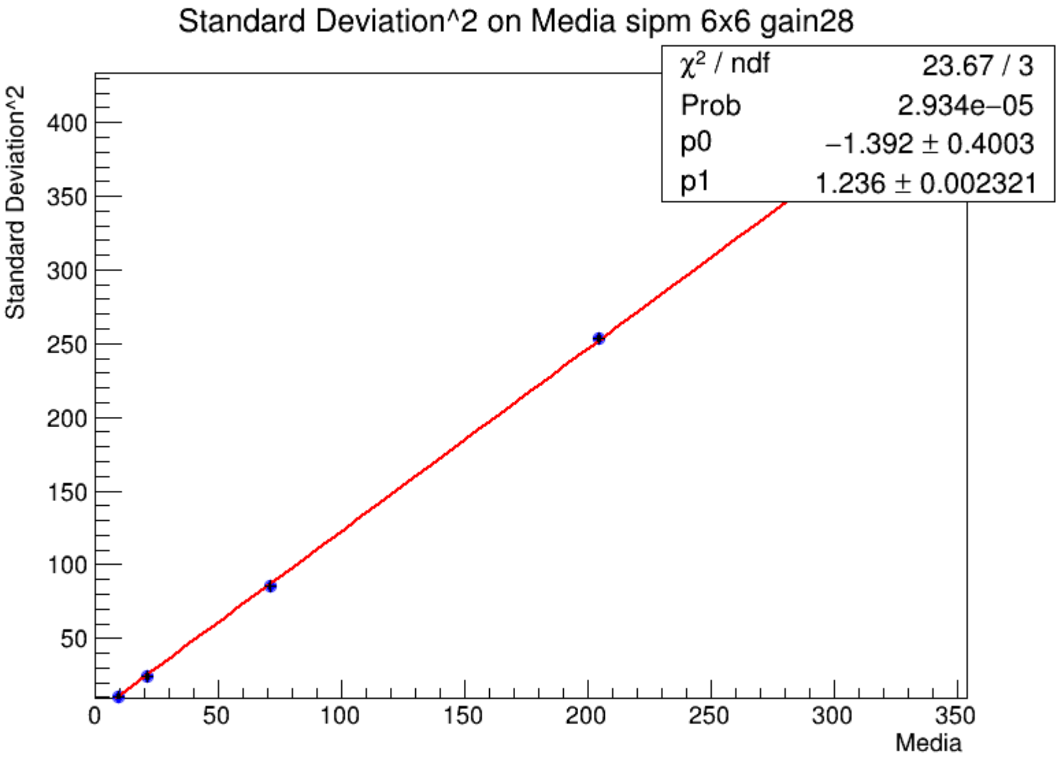


Comparison 2 methods

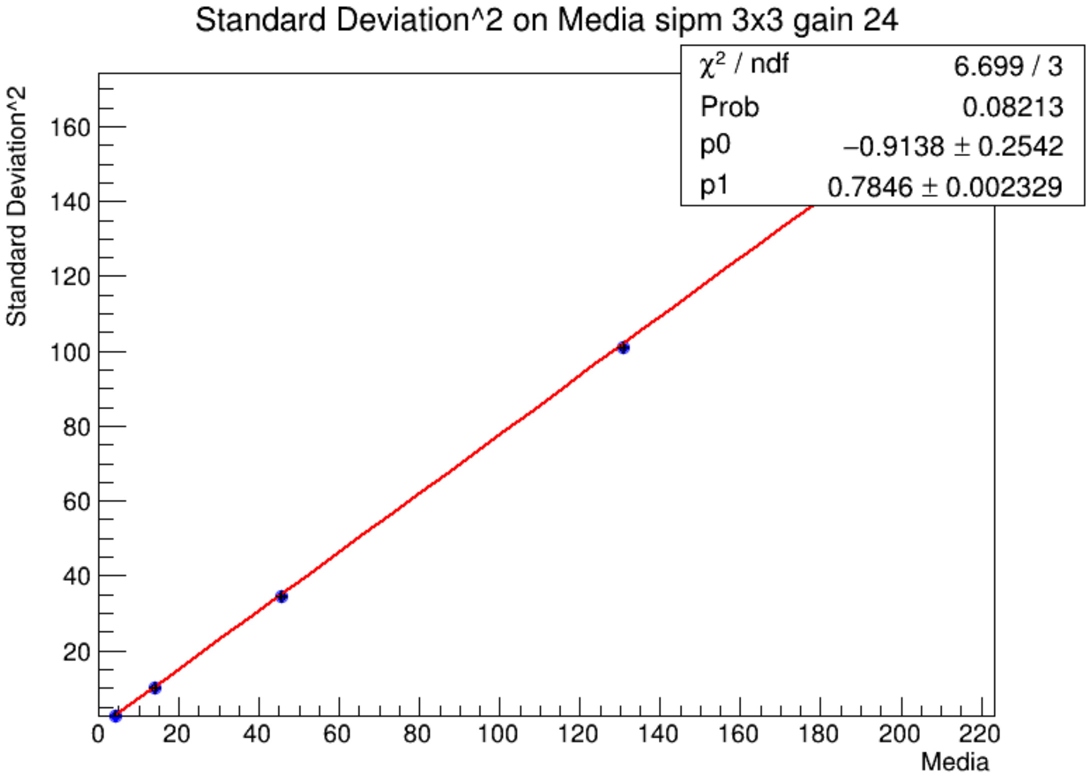




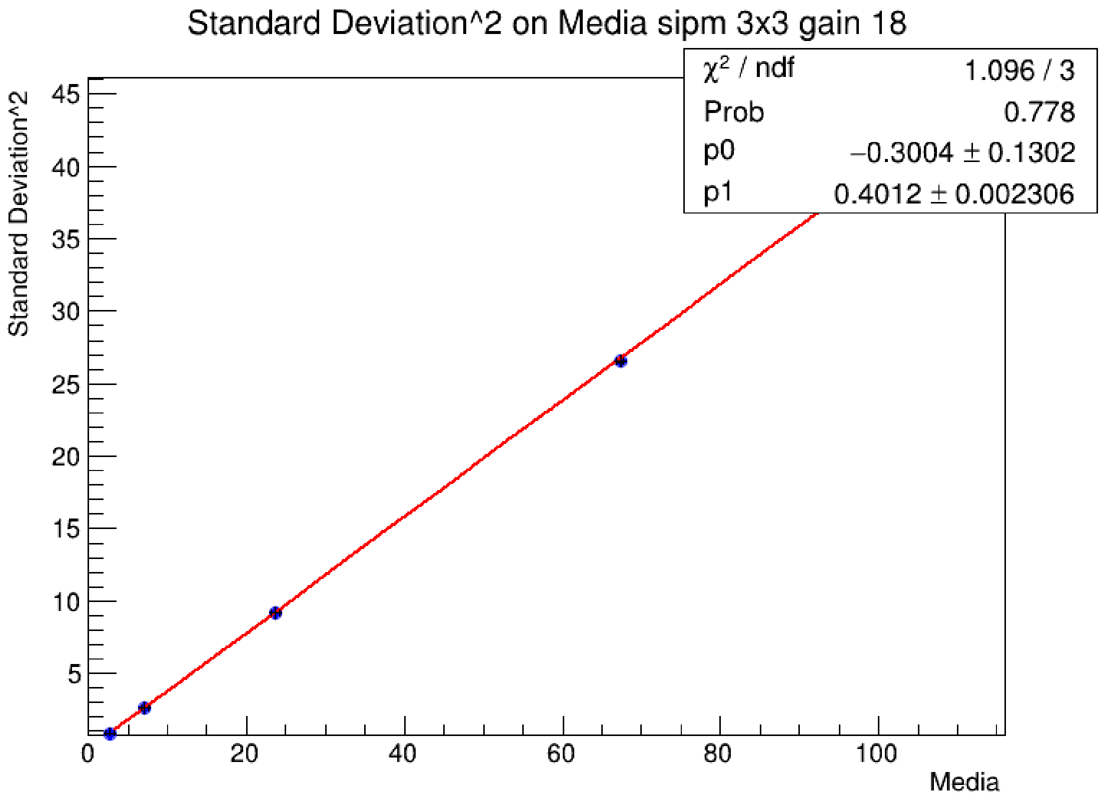
Calibrations SiPM 3x3 Gain 28 with other method



Calibrations SiPM 3x3 Gain 24 with other method



Calibrations SiPM 3x3 Gain 18 with other method



Calibrations SiPM 3x3 with passive preamp with other method