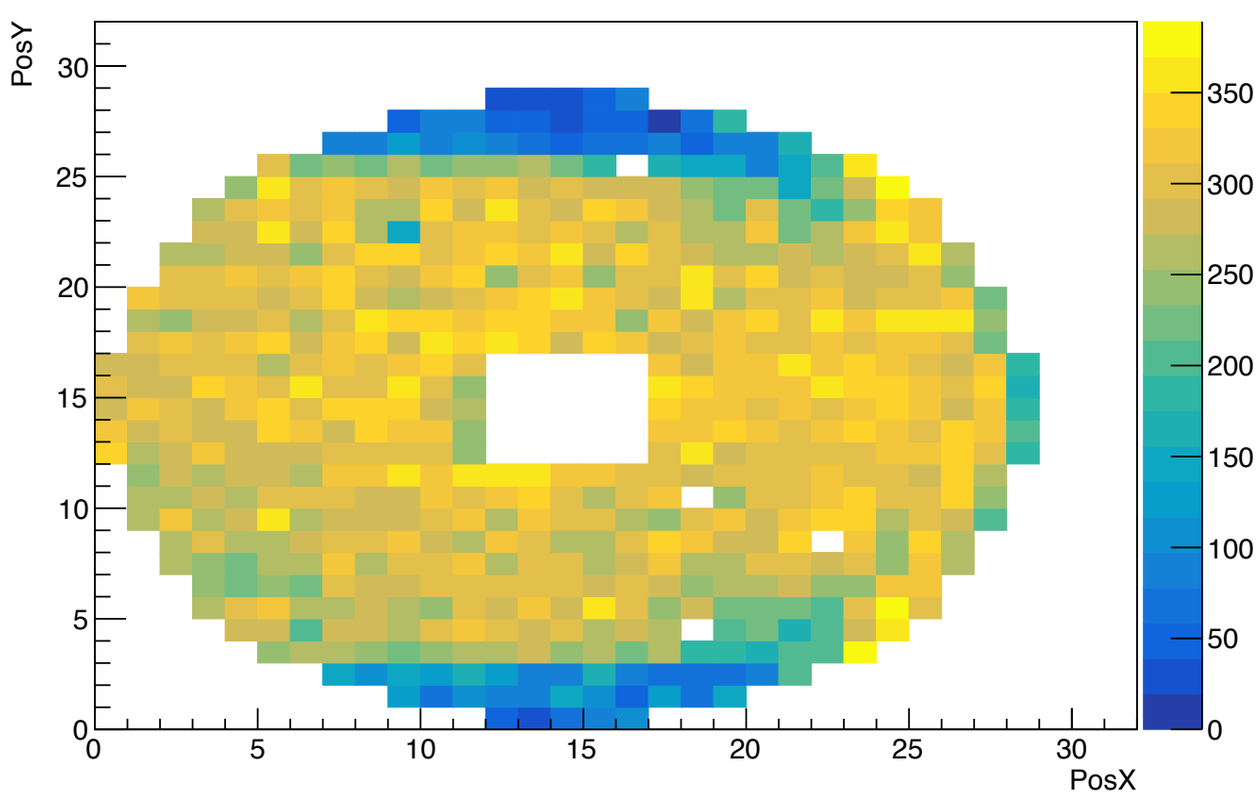
Istituto Nazionale di Fisica Nucleare

ECAL status

Gabriele Piperno (thanks to Alessandro, André, Danilo, Fabio and Ivano for the work and the updated information)



Hardware

ECal positioning

Alessandro has already the drawings for the ECal target holders, that can be sent to the workshop (he discussed w/ Marco Paris only the holder shape, but not the alignment method): there are 3 targets wrt which it is possible to position all the ECal elements and then align it.

The steps for the positioning are:

- position the ECal w/ crystals frontal face parallel to vacuum chamber flange
- measure ECal position wrt the absolute reference
- adjust on X and Y (horizontal) w/ table screws
- adjust on Z (vertical) w/ calorimeter feet

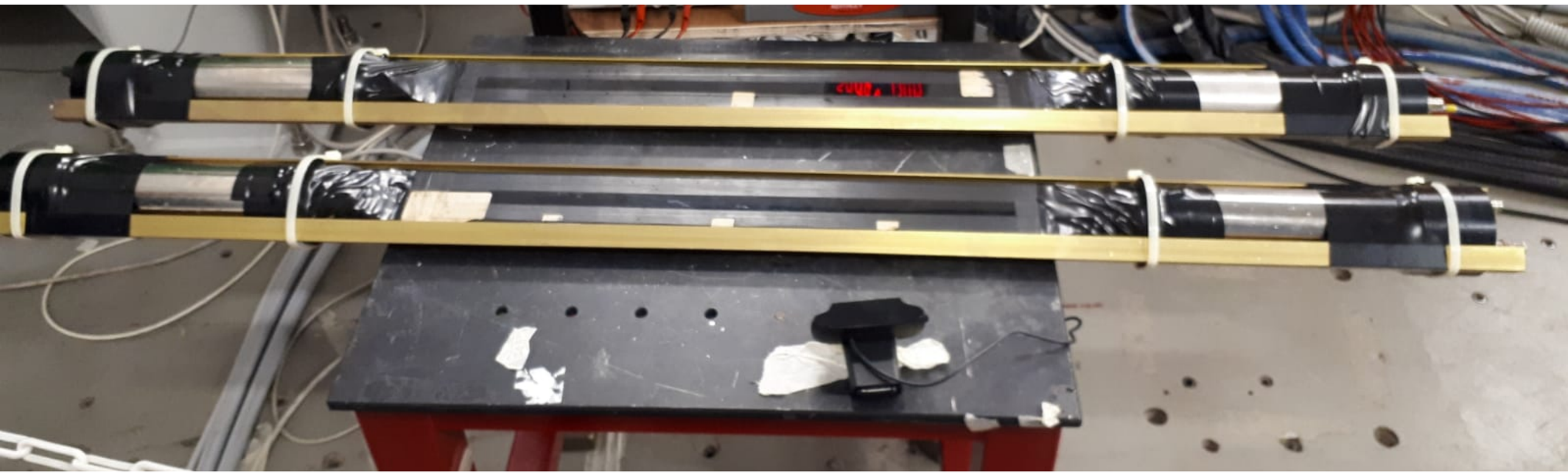
Once the pieces have been done, the alignment service must be contacted to do the job, probably together w/ Emilio for the X, Y and Z adjustment. This should take 1 week after the piece production.

New cosmic rays trigger

Originally there were 2 paddles on the bottom of ECal, then other 2 have been added on top.

W/ these new paddles the rate dropped to zero.

Removing the paddles to fix them, we found that in one light guide and the PMT were detached. Ivano and Danilo repaired both and now are doing tests.



HV problems

Up to the beginning of December we had very few trips (<5). Then we started to have many HV failure, mainly concentrated on boards 8 and 9.

Update from Fabio's December 18th presentation:

ECAL trips saga

We've been running VERY quietly with ECAL HV since the beginning of the experiment, BUT since 11/12 we had several trips recorded

Slot 0	Slot 2	Slot 5	Slot 7	Slot 8	Slot 9	Slot 11
Ch 34 - 1	Ch 22 - 1	Ch 19 - 1	Ch 6 - 1	Ch 0 - 2	Ch 5 - 1	Ch 24 -1
Ch 44 - 1	Ch 34 - 1		Ch 8 - 1	Ch 5 - 1	Ch 10 - 3	
	Ch 47 - 1		Ch 9 - 1	Ch 10 - 1	Ch 13 - 2	
			Ch 12 - 1	Ch 15 -2	Ch 15 - 2	
			Ch 17 - 1	Ch 18 - 1	Ch 18 - 3	
				Ch 23 - 4	Ch 20 - 2	
					Ch 37 - 1	
					Ch 39 - 1	

+ 1 "generalized" trip of slot 10,11,12,13,14 on 2018-12-13 10:15:59 (maybe SY4527 problems – not seeing some slots)

Till 15/12 only slots 8 and 9 tripped , but after also slots 0,2,5,7,11
Now trips are recovered automatically, BUT not good anyhow !
Still inquiring ….
N.B. : NO TRIPS from SAC/Cosmics in this period

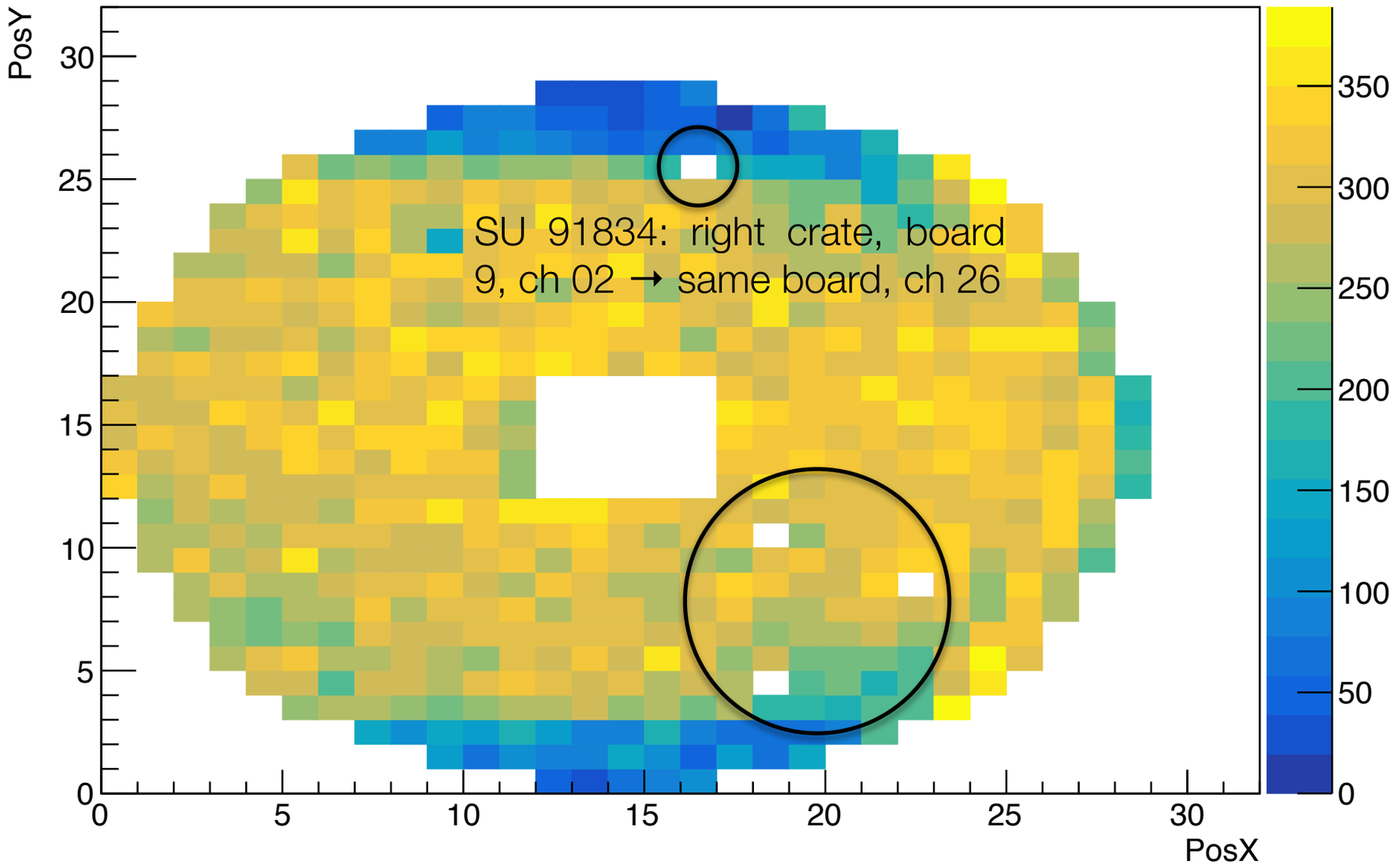
- PMT's life decay time (no problems w/ SAC and many tripping channel)?
- Position effect (only ECal lower half)?
- HV boards?
- HV crate?

Not working channels

There are 4 non working channels:

- 3 give no signals at all
- 1 is always 0-suppressed, but gives appreciable signals at the oscilloscope: it has now been moved to another channel on the board to see if it works now →

setup full201901

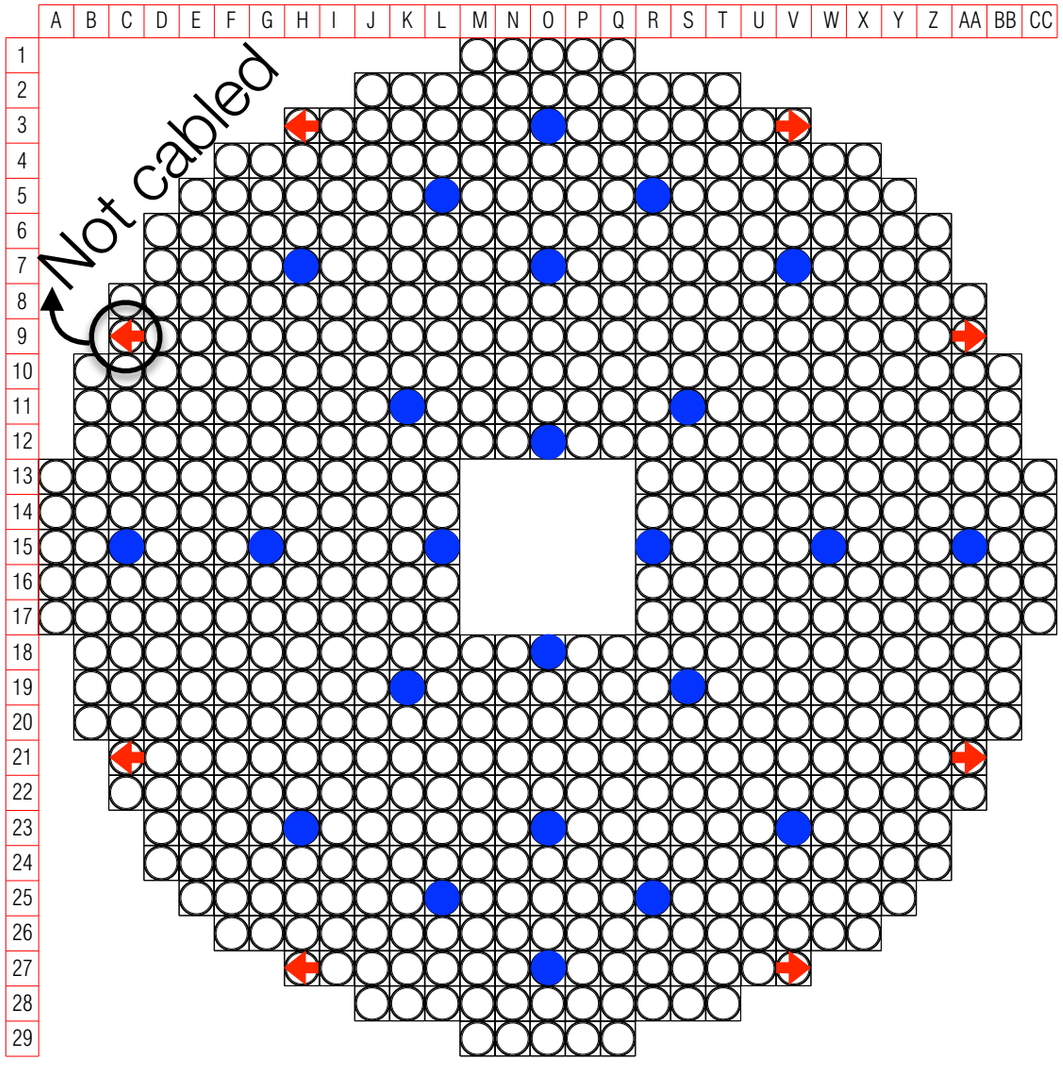


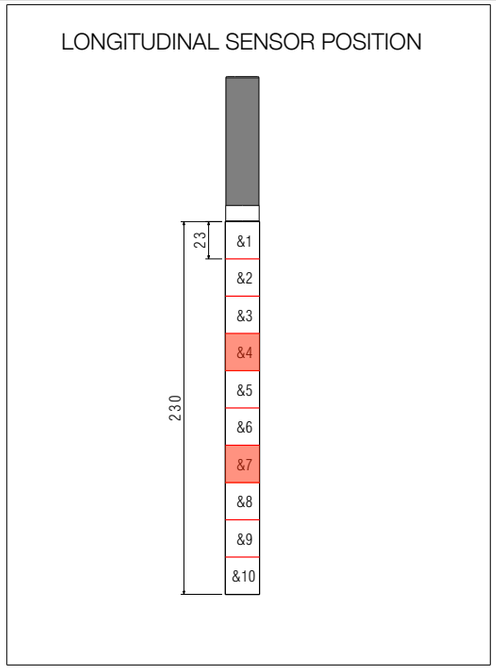
BGO thermometers

Positions (back view):

Back

Side (2 thermometers)

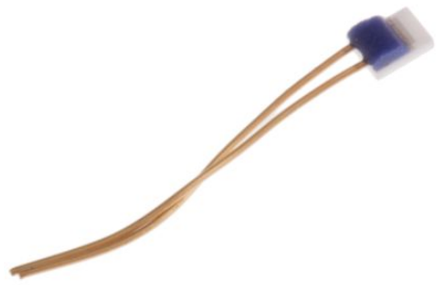




Position along side

24 + 16 thermometers:

- Pt100 (100 Ohms @ 0°C)
- thin film, 10mm tails
- dimensions: 1.2×1.6 mm²
- temperature range: (-50, 500°C)
- self-heating:< 0.5 °C/mW
- thermal response: 0.1 s
- stability: ±0.05%

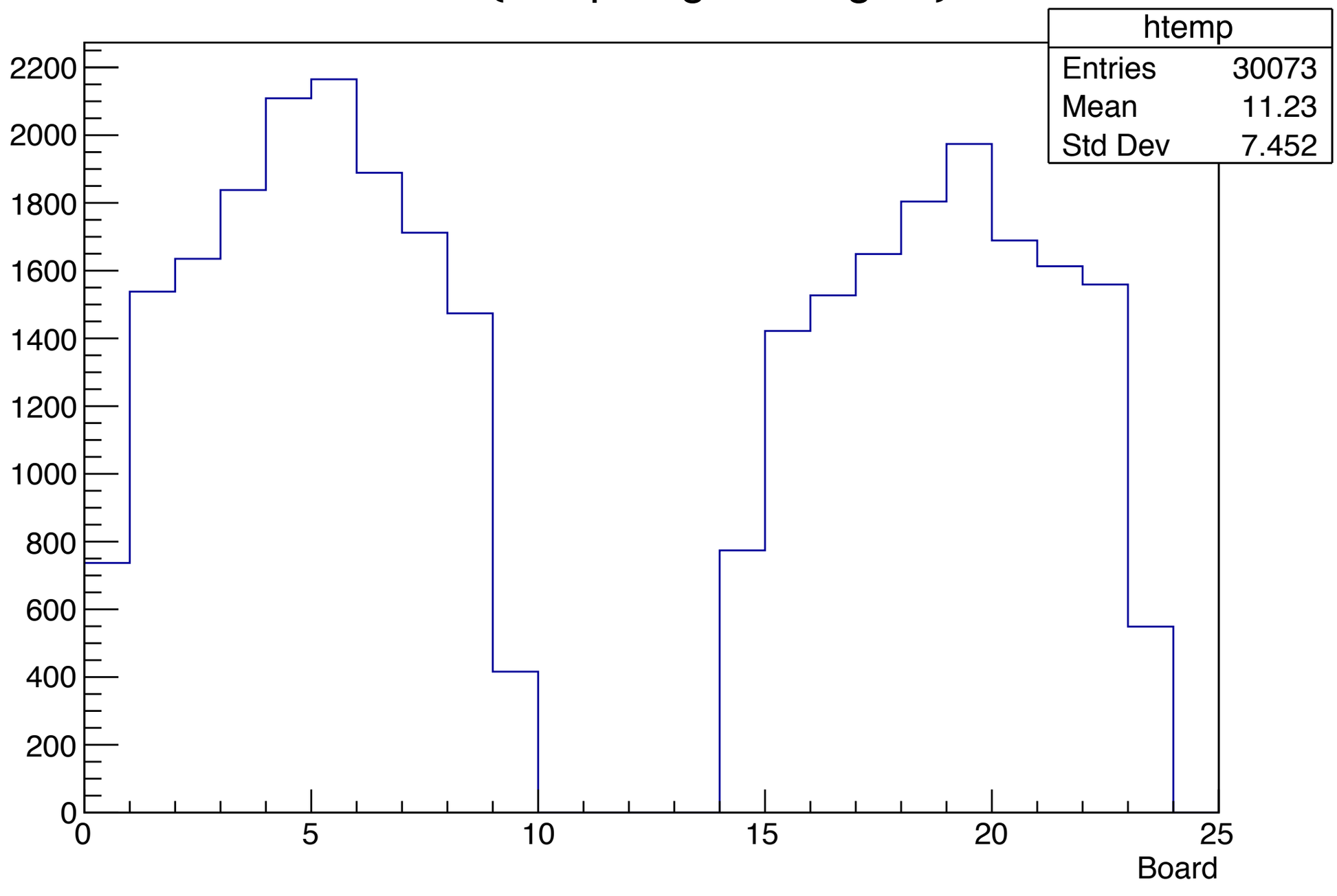


Currently thermometers are not read during data taking because their ADC induces noise on boards

Software

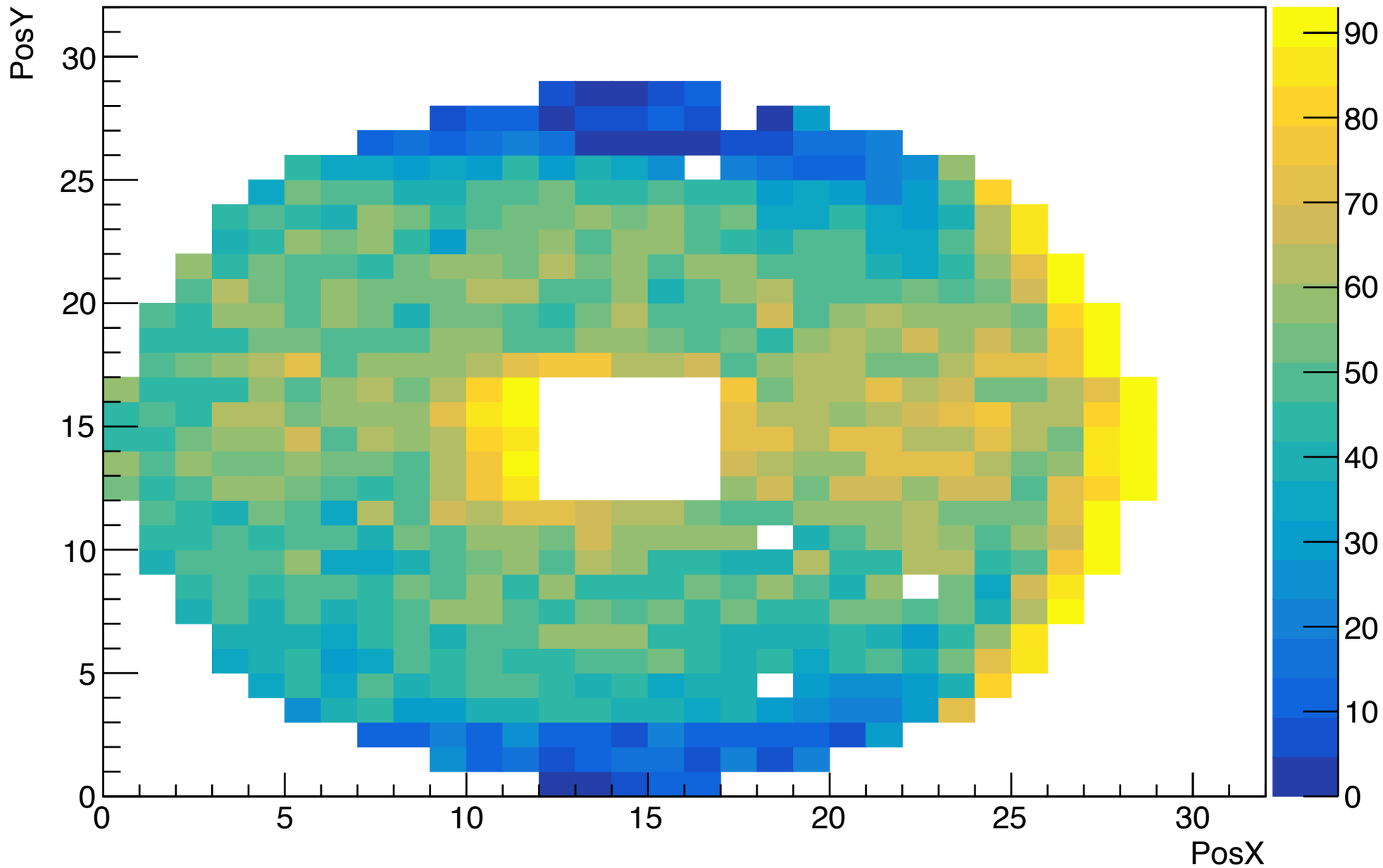
Zero suppression on ECAL boards

Number of events per board that pass the 0-suppression cut (1000 trigger).

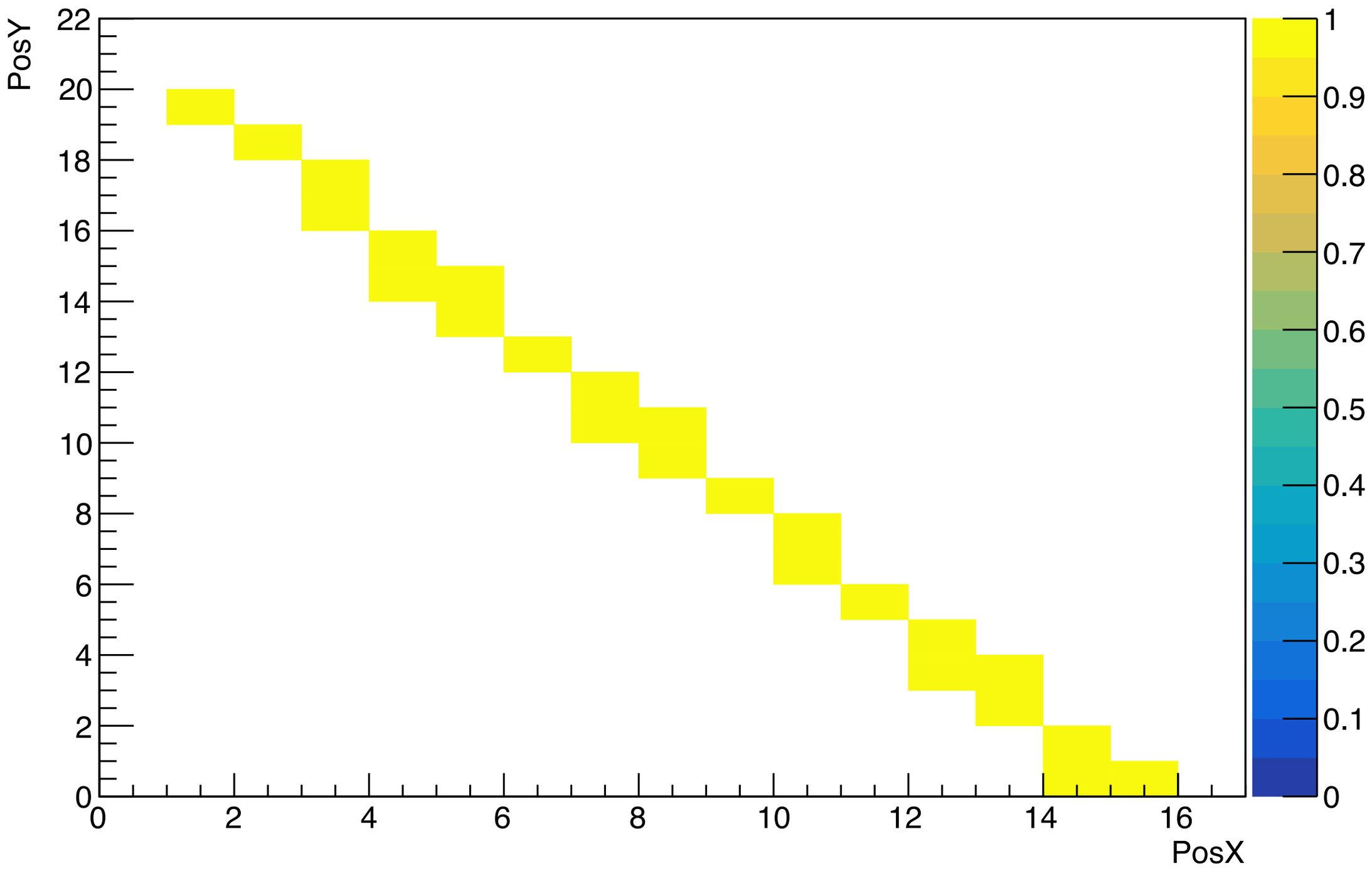


Zero suppression on ECal channels

Distribution of events per ECal channel that pass the 0-suppression cut (1000 trigger).

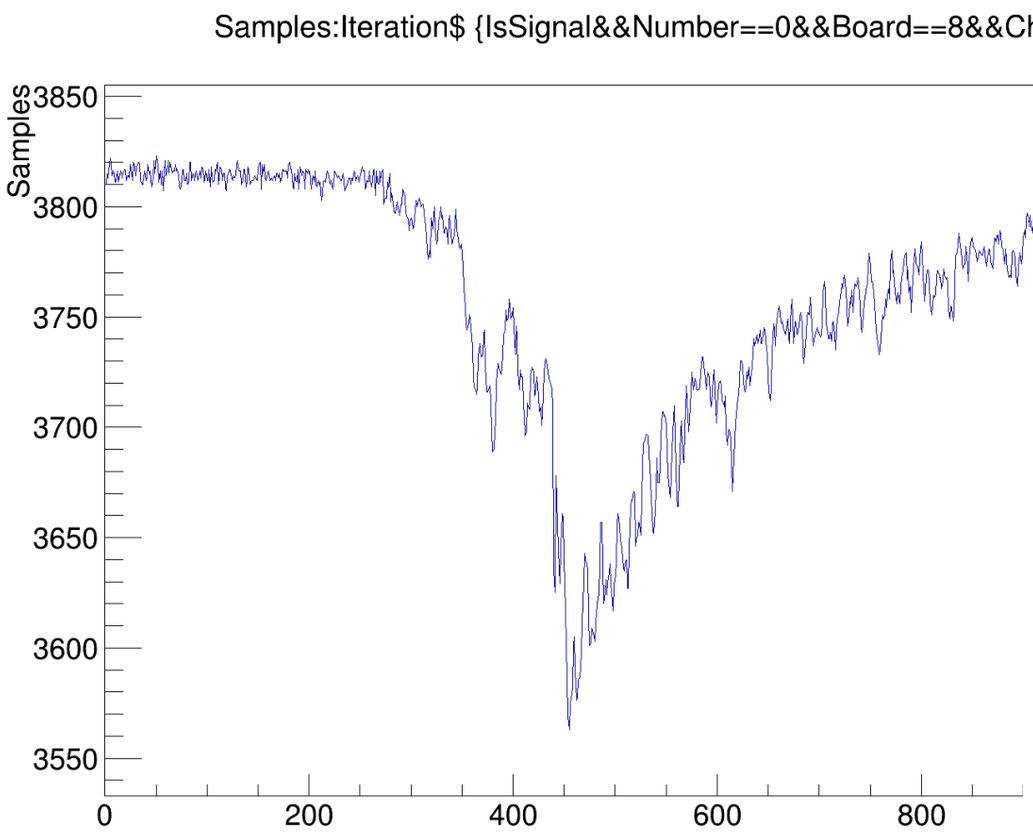


Cosmic ray passing through ECal



Pulse shape problem

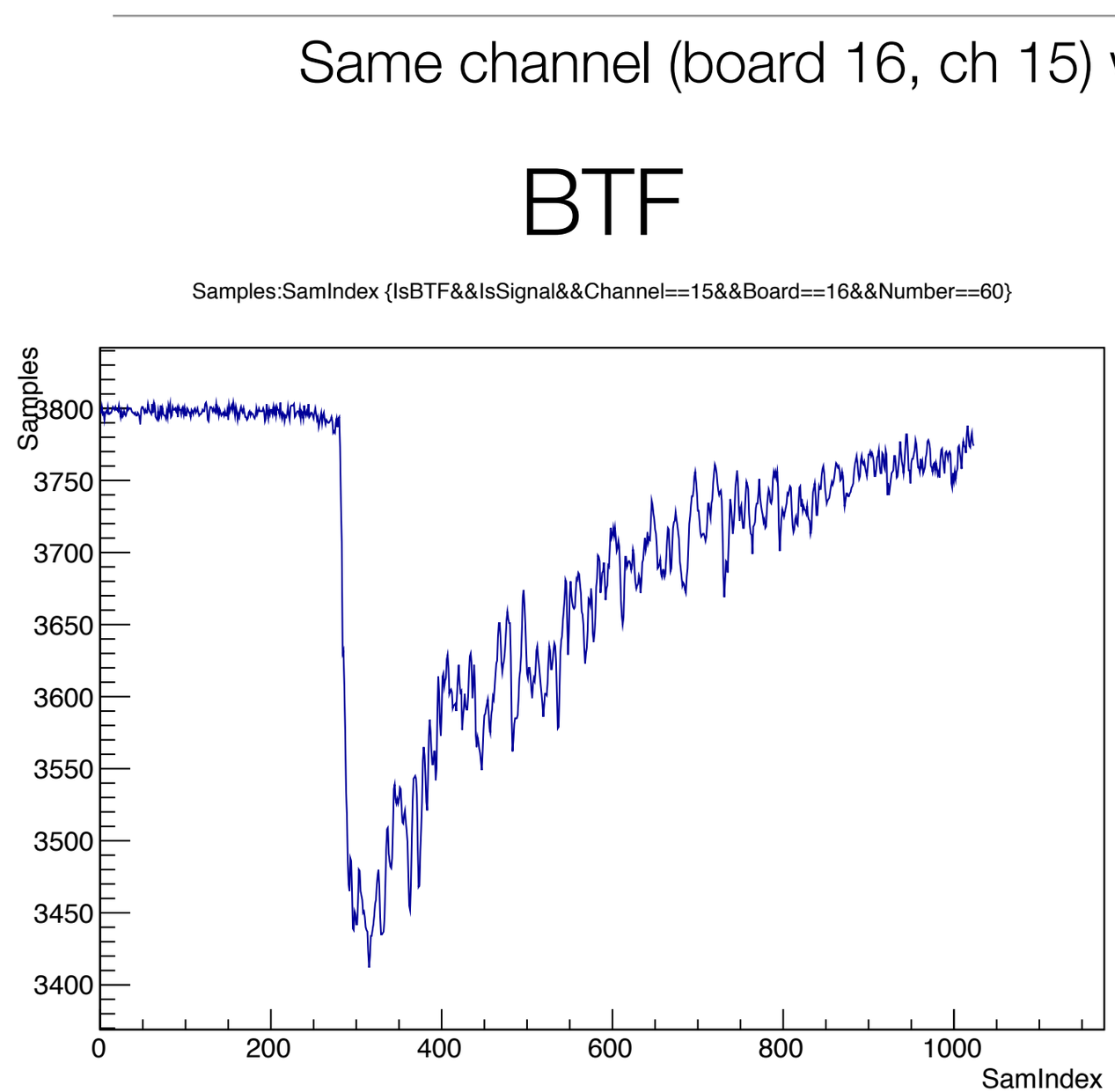
Pulse shape seems not to be always very beautiful…



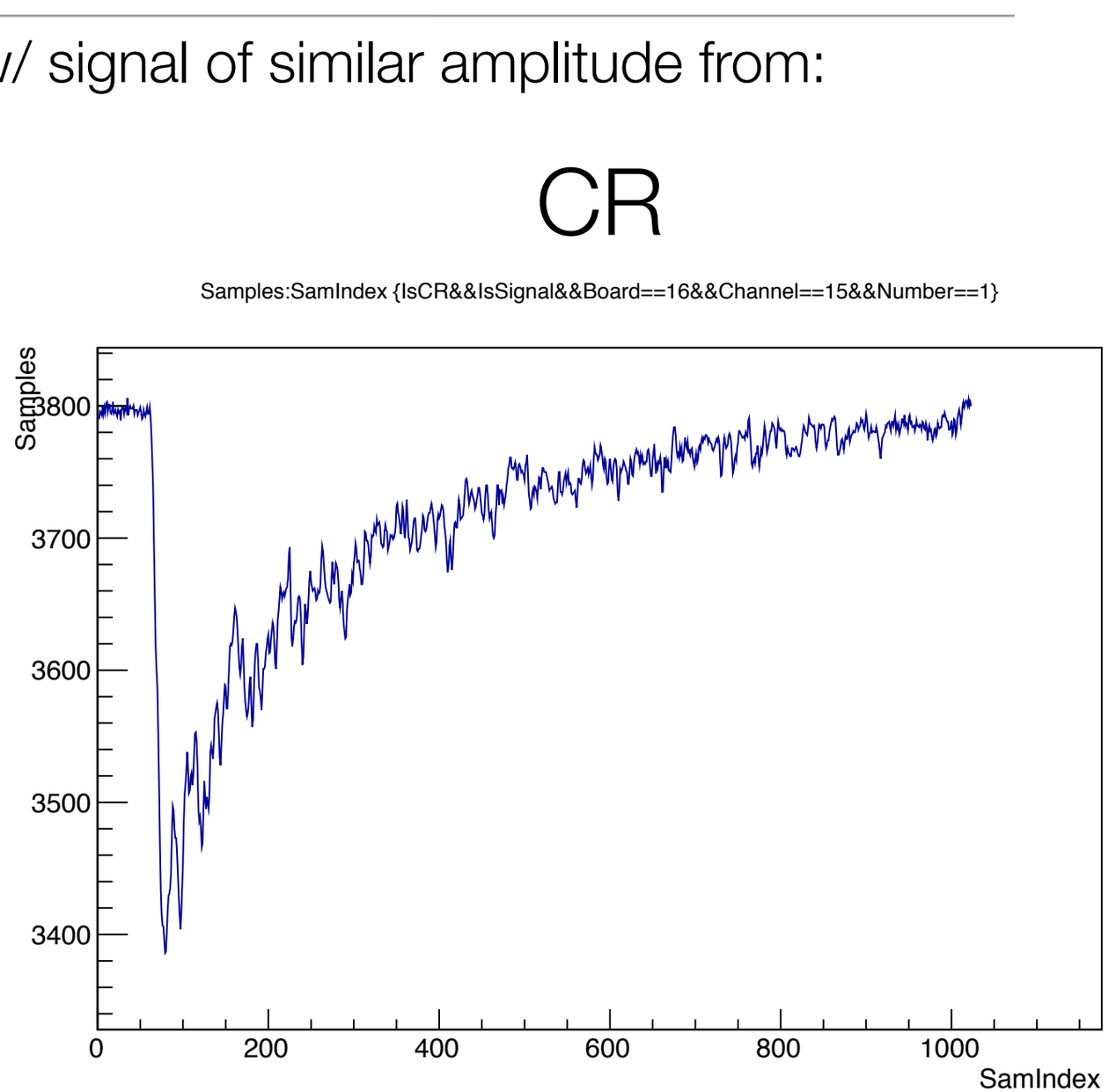
BTF VS CR pulse

Same channel (board 16, ch 15) w/ signal of similar amplitude from:

BTF



CR

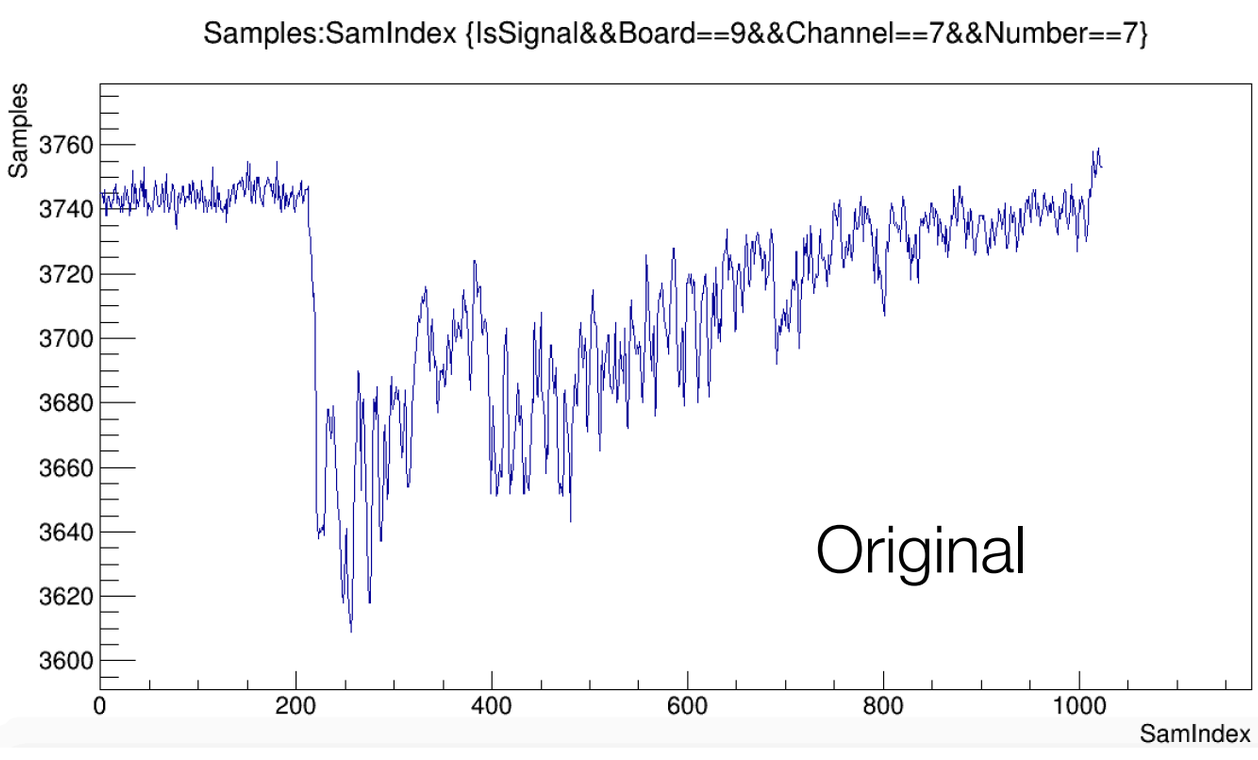


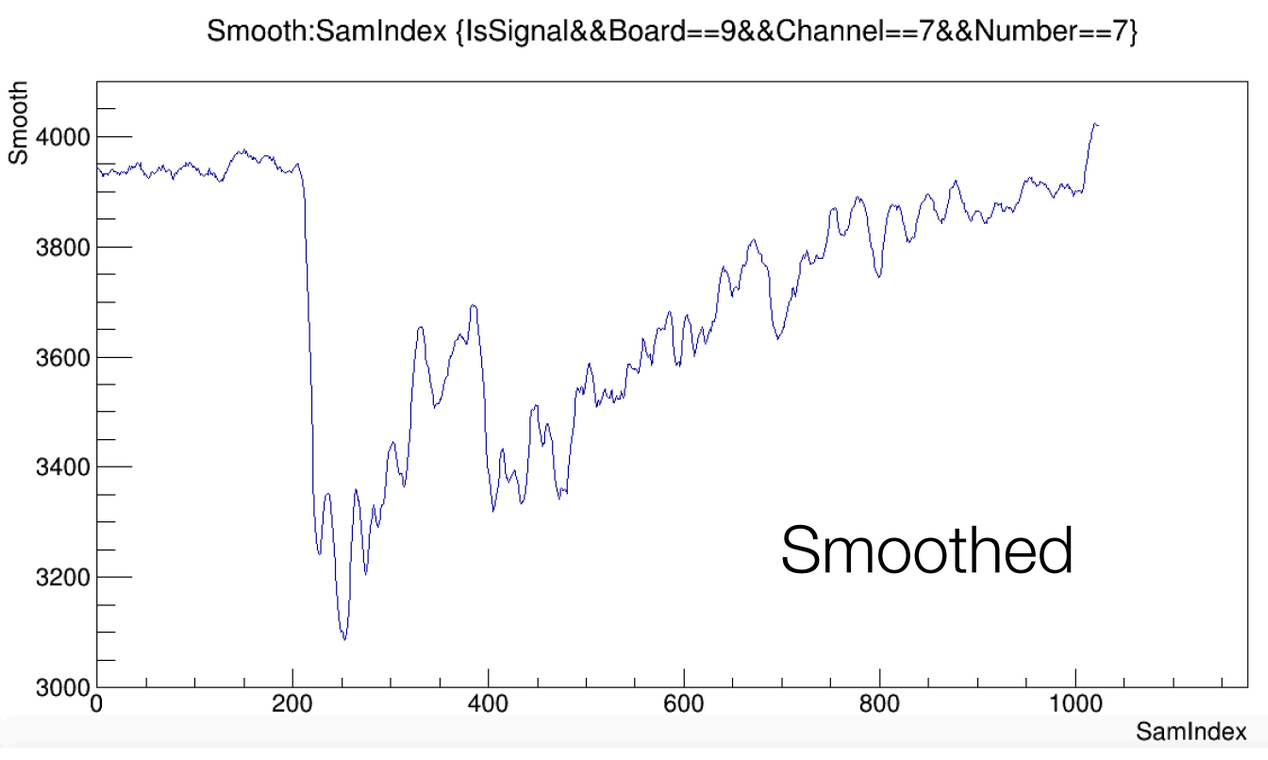
BTF seems to be more noisy→something arrives together w/ the beam

Pulse smoothing

To try to reduce the shape problem I use a one-dimensional Markov spectrum smoothing function.

This function calculates smoothed spectrum from source spectrum based on Markov chain method.

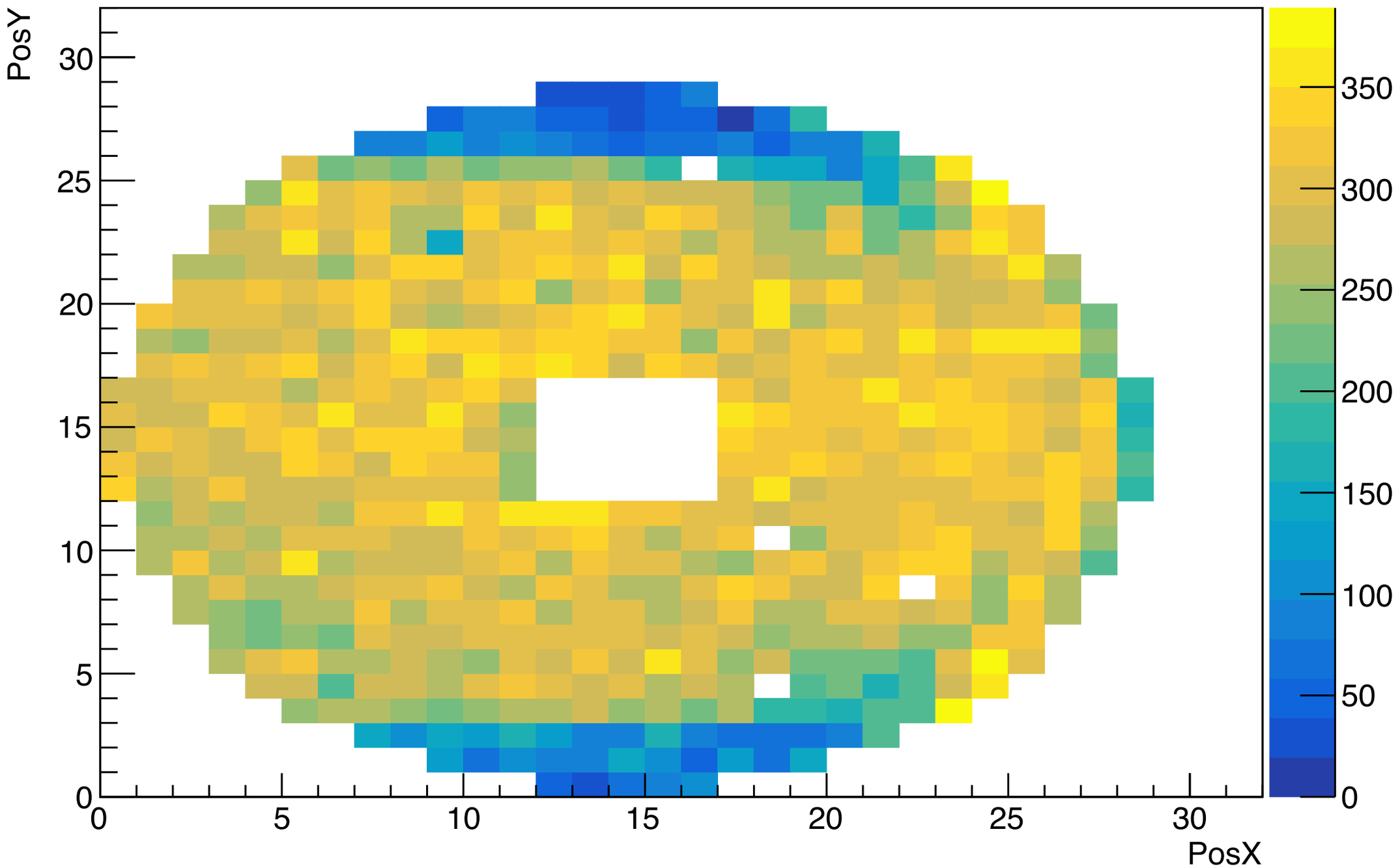




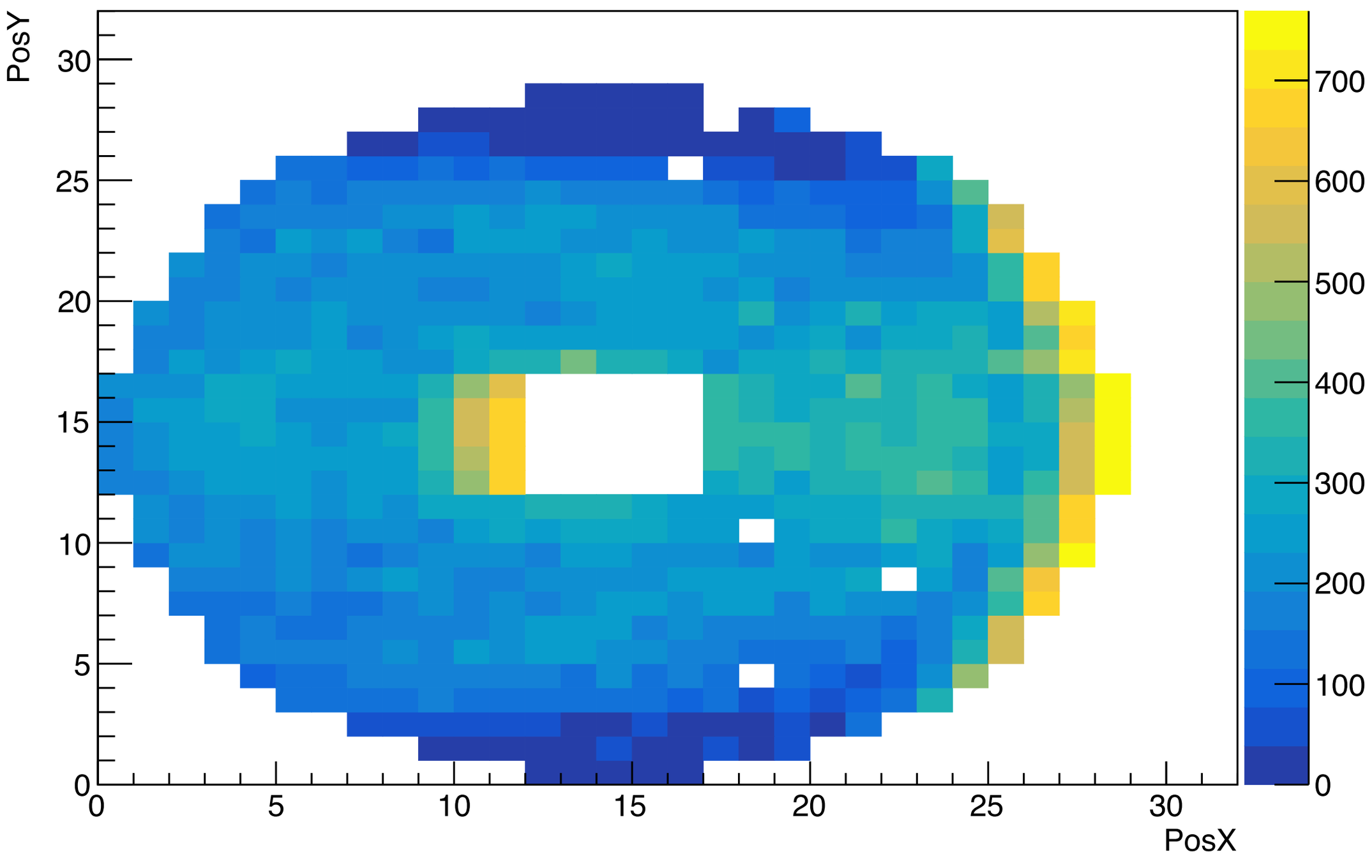
charge from the original pulse

pulse identification and counting from smoothed window

Multiplicity =1 distribution



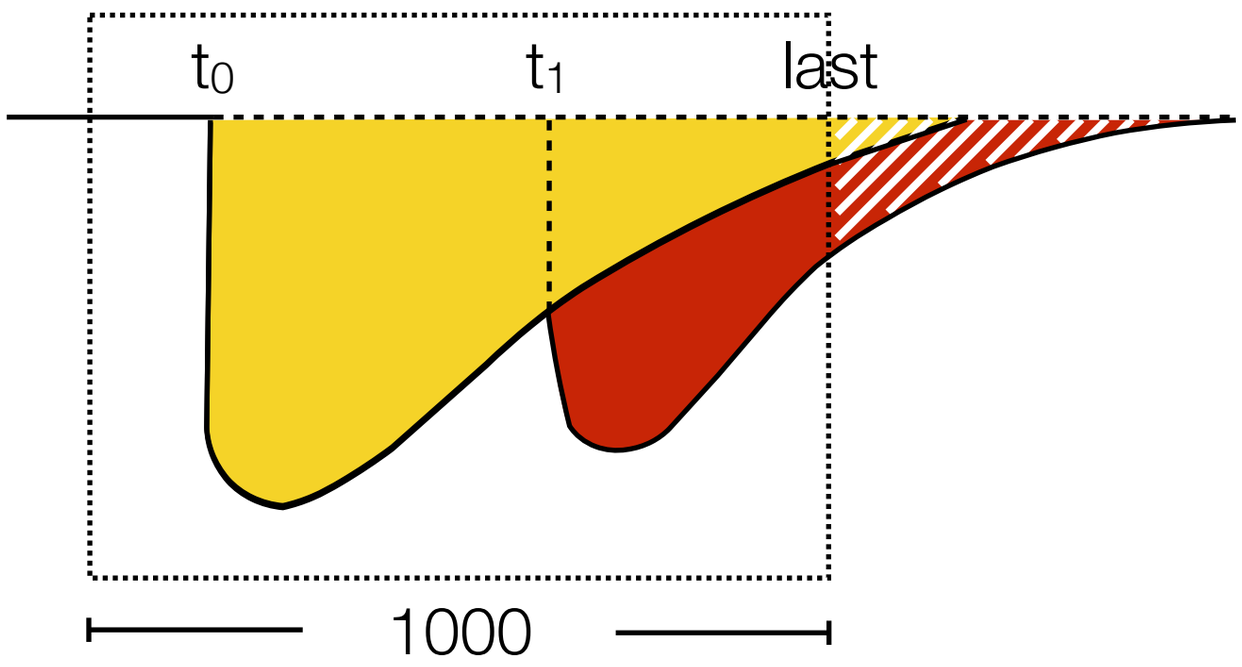
Multiplicity >1 distribution



Pulse charge evaluation

Three different kind of charge:

- Qtot: $t_0 \rightarrow 1000$ integral
- Qpulse[i]: pulse charge = $t_i \rightarrow t_{i+1}$ (1000 for last pulse) integral, corrected w/
  - subtraction of previous pulses charge
  - its fraction in window w/ exponentially decaying function, no rise time
- QpulseW[i]: same of Qpulse[i], but only the part contained within the window is considered (last sample: 1000)

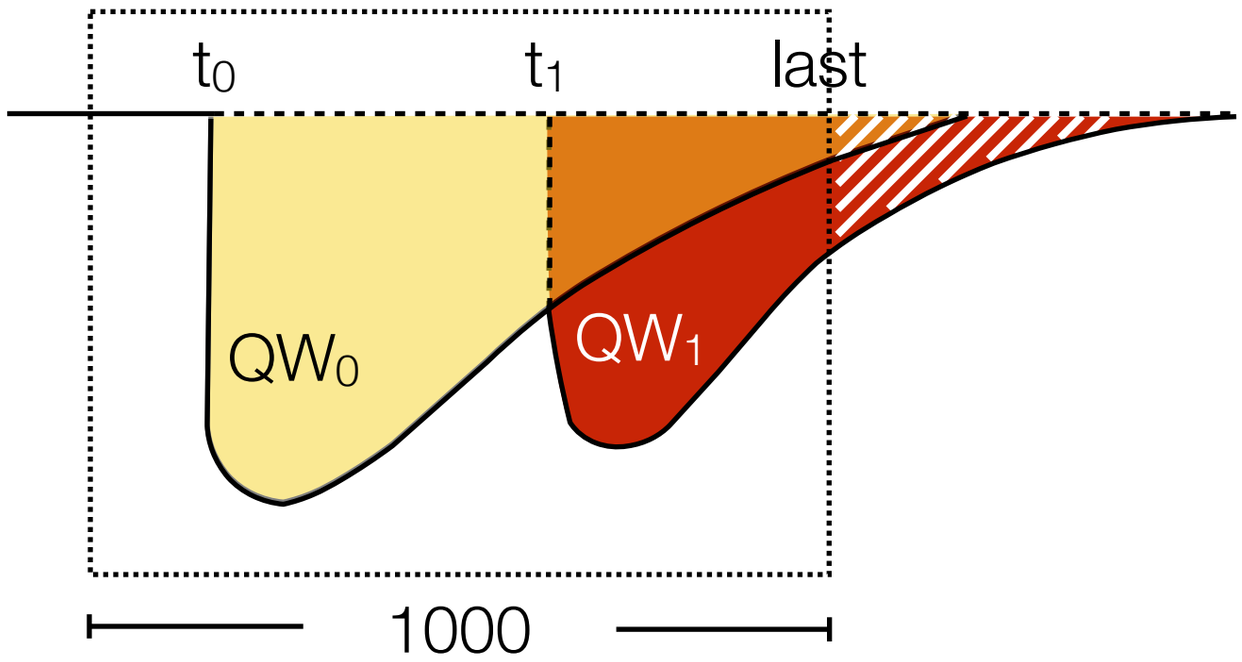


Qtot: integral
Qpulse[0]: extrapolation
Qpulse[1]: extrapolation
QpulseW[0]: extrapolation
QpulseW[1]: extrapolation

QpulseW[i] problem

With this definition of charge it results:

$\sum_i$QpulseW[i] ≃ Qtot

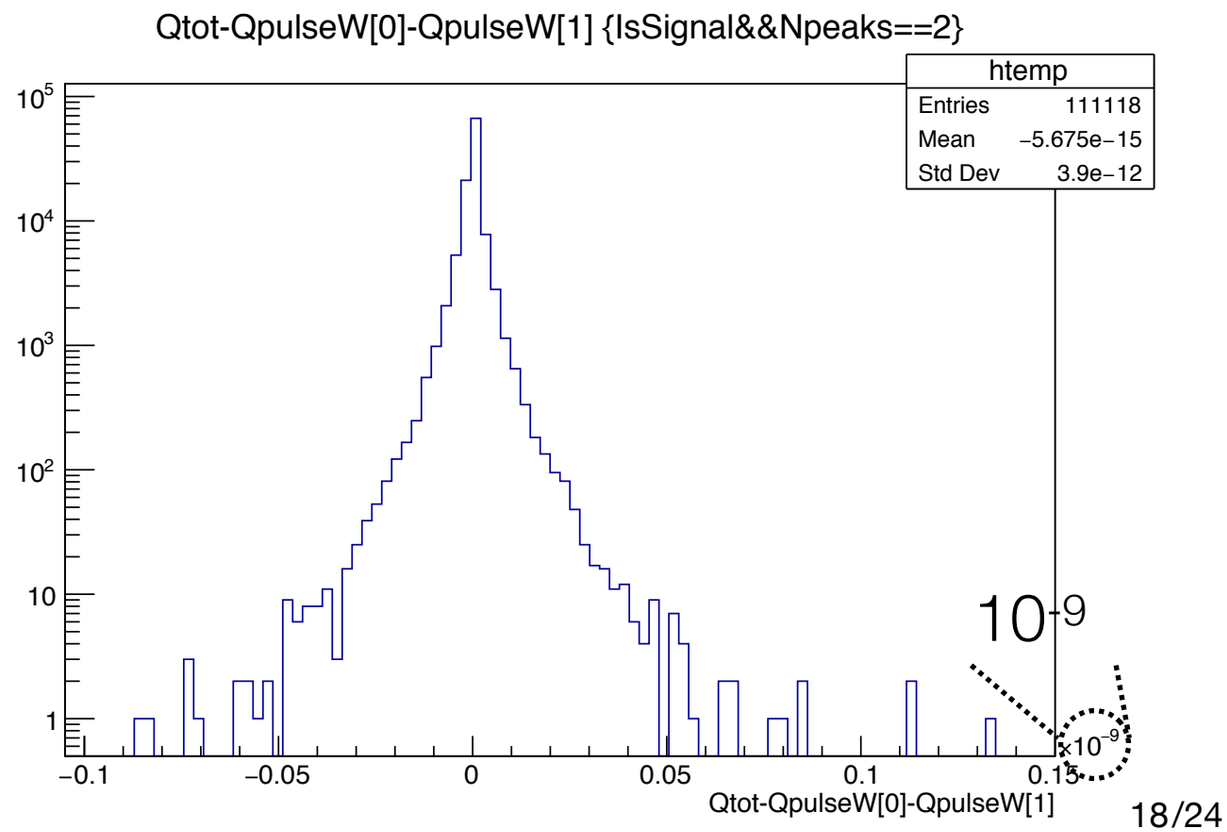


2 pulses example:
orange region once is summed (QpulseW[0]), once is subtracted (QpulseW[1]) → when summed QpulseW[0] to QpulseW[1] gives Qtot

Hence

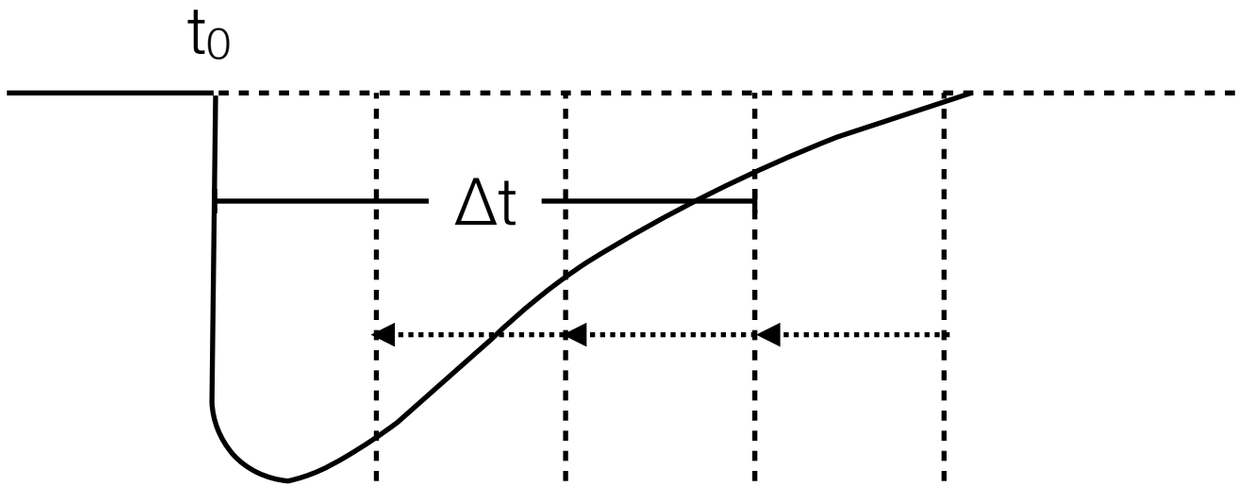
Qtot-QpulseW[0]-QpulseW[1]

is not a good number to test the goodness of the method



Extrapolation goodness

I started to cut the CR pulses and to extrapolate the charge w/ the exponentially decaying function in 12 different integration intervals Δt, to compare Qtot w/ Qpulse[0] and to evaluate the goodness of the method.



Only a part is integrated, the rest is extrapolated

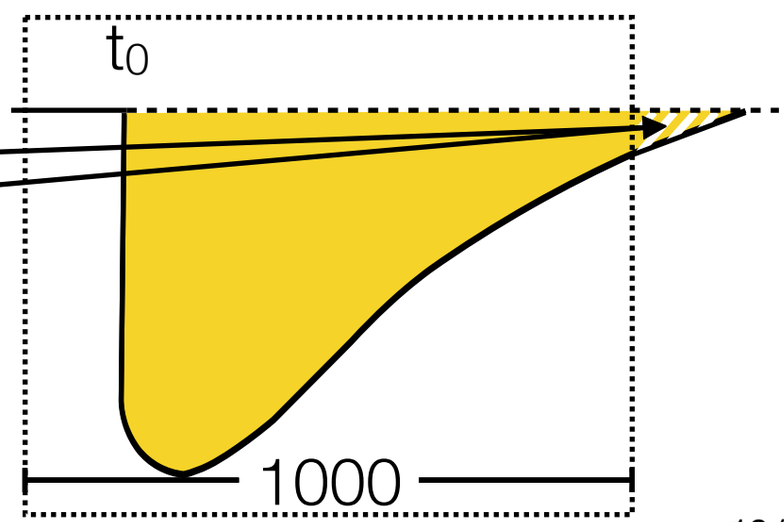
int. interval Δt [ns]

25	50	75
100	200	300
400	500	600
700	800	900

I consider the 2 variables:

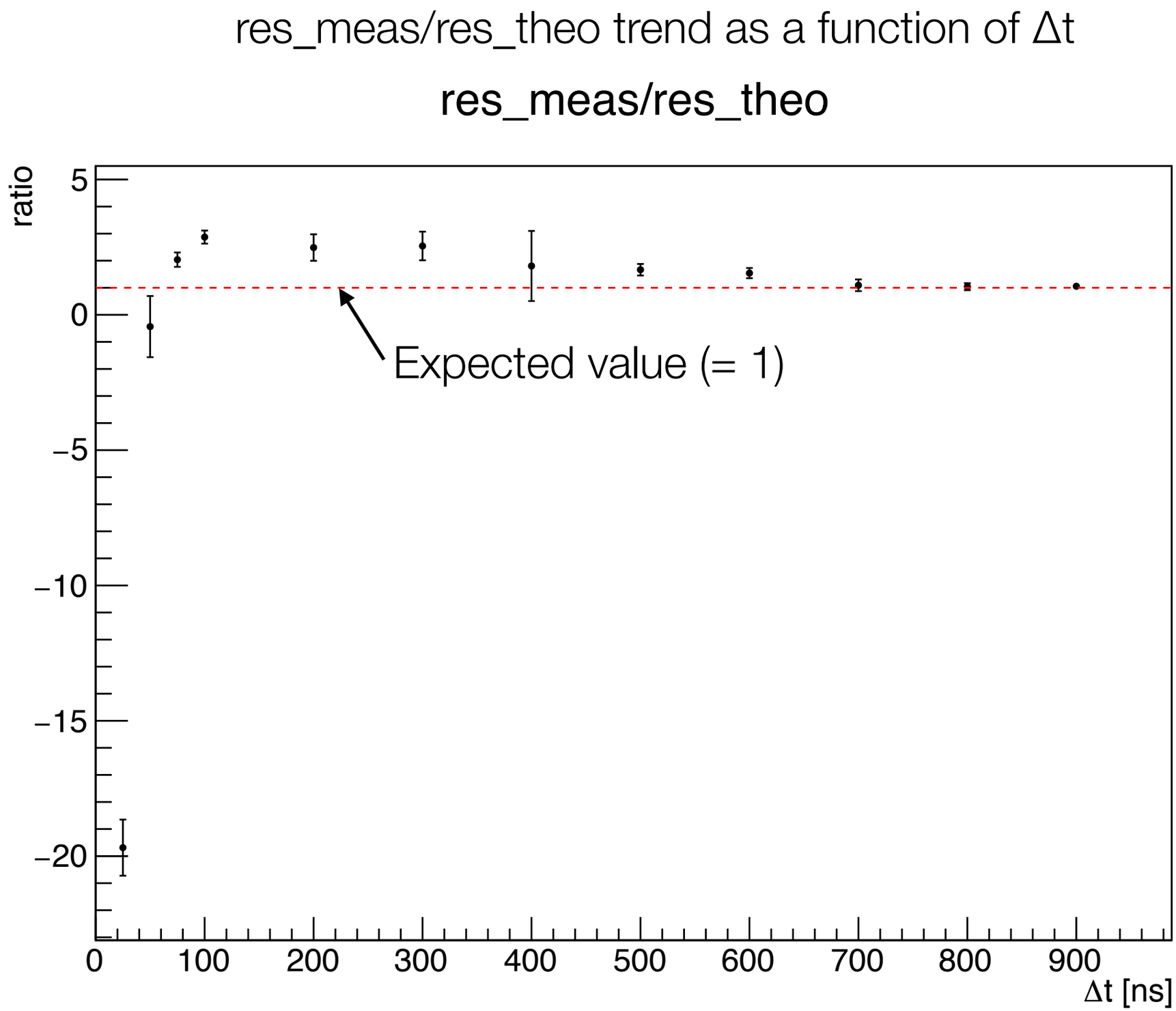
res_meas = (Qpulse[0]-Qtot)/Qpulse[0]

res_theo = Exp((t_0-1000)/300)



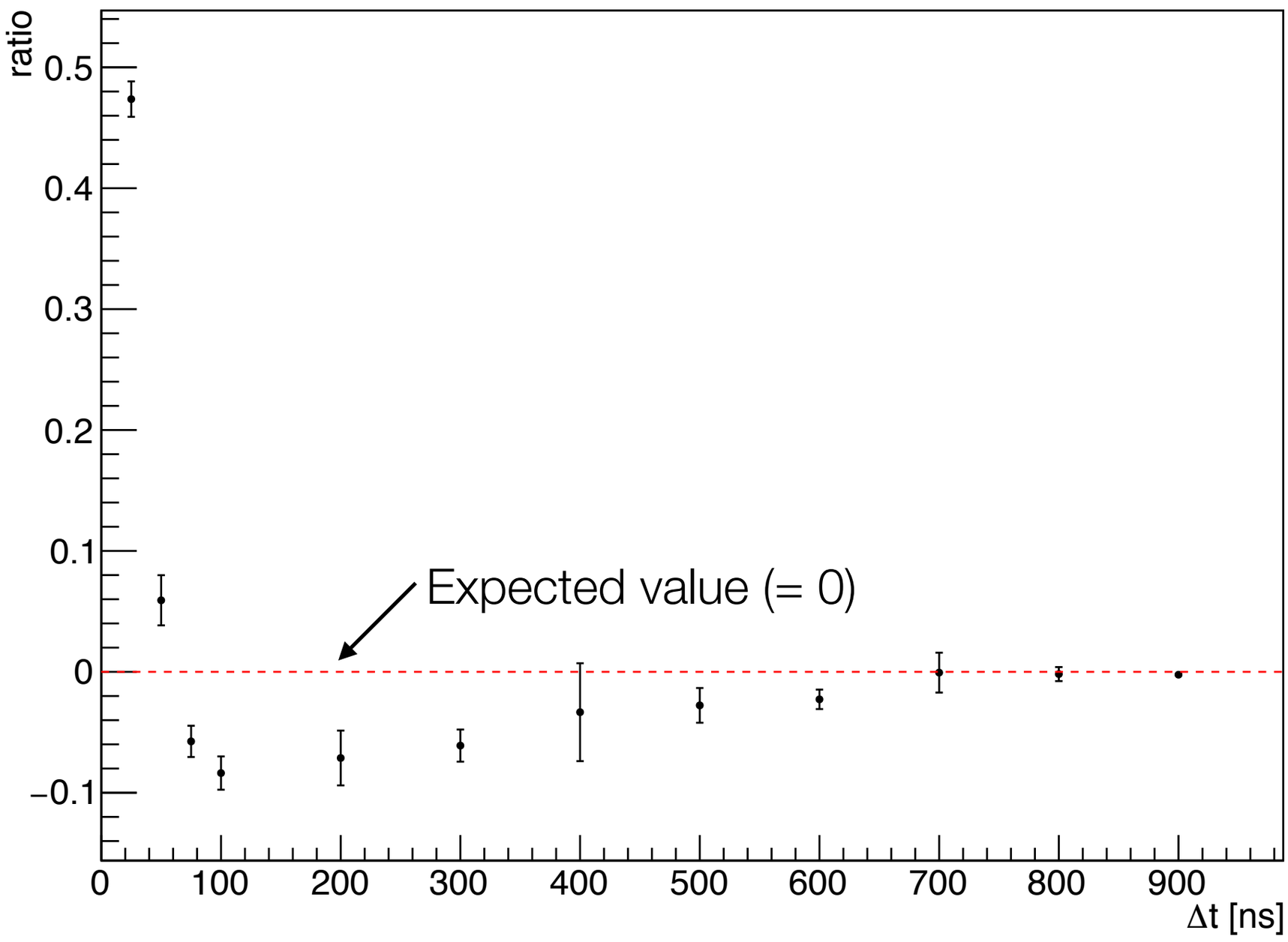
The choice of this strange variables is to try to account for the t_0 straggling (15-20 ns)

Ratio trend


res_meas/res_theo trend as a function of Δt
res_meas/res_theo
ratio
5
0
−5
−10
−15
−20
Expected value (= 1)
0
100
200
300
400
500
600
700
800
900
Δt [ns]

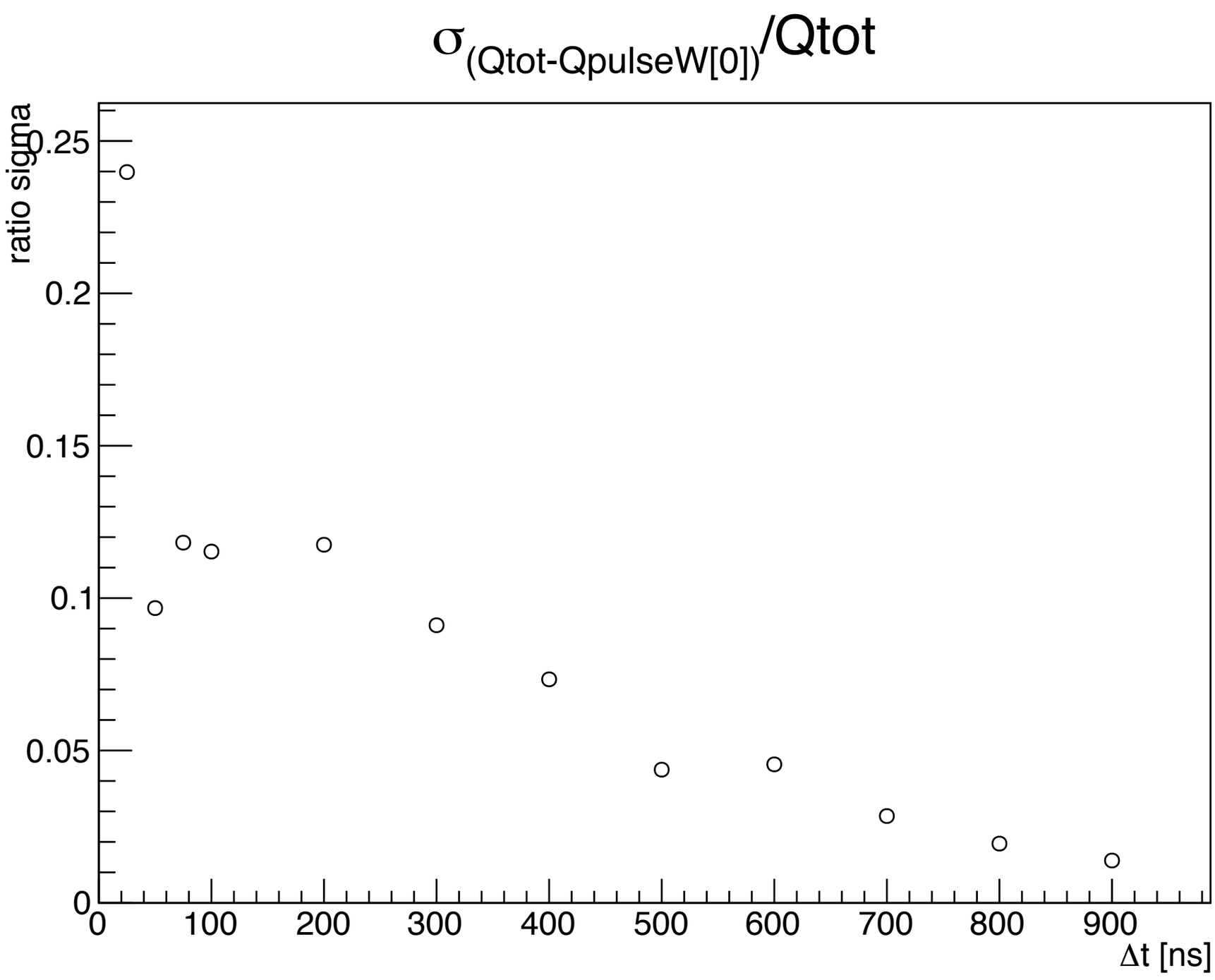
Difference trend

(Qtot-QpulseW[0])/Qtot trend as a function of Δt



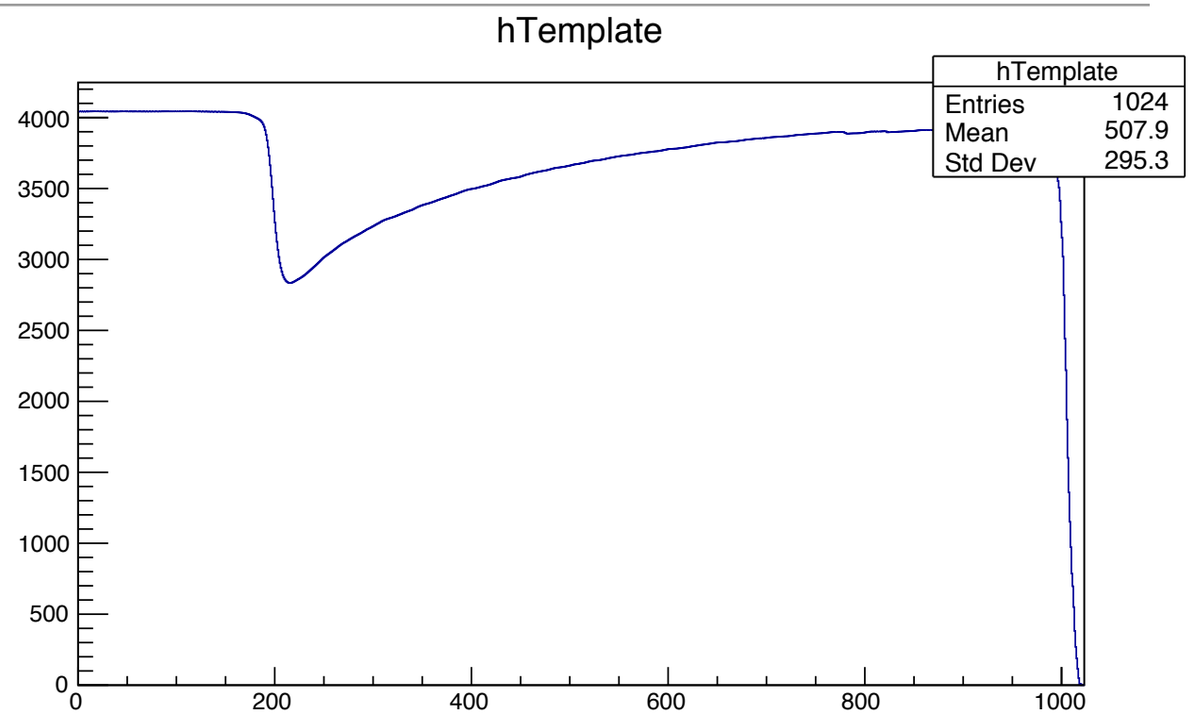
Relative sigma trend

$\sigma_{(Qtot-QpulseW[0])}/Qtot$ trend as a function of Δt (σ: gaussian fit sigma, not the error)



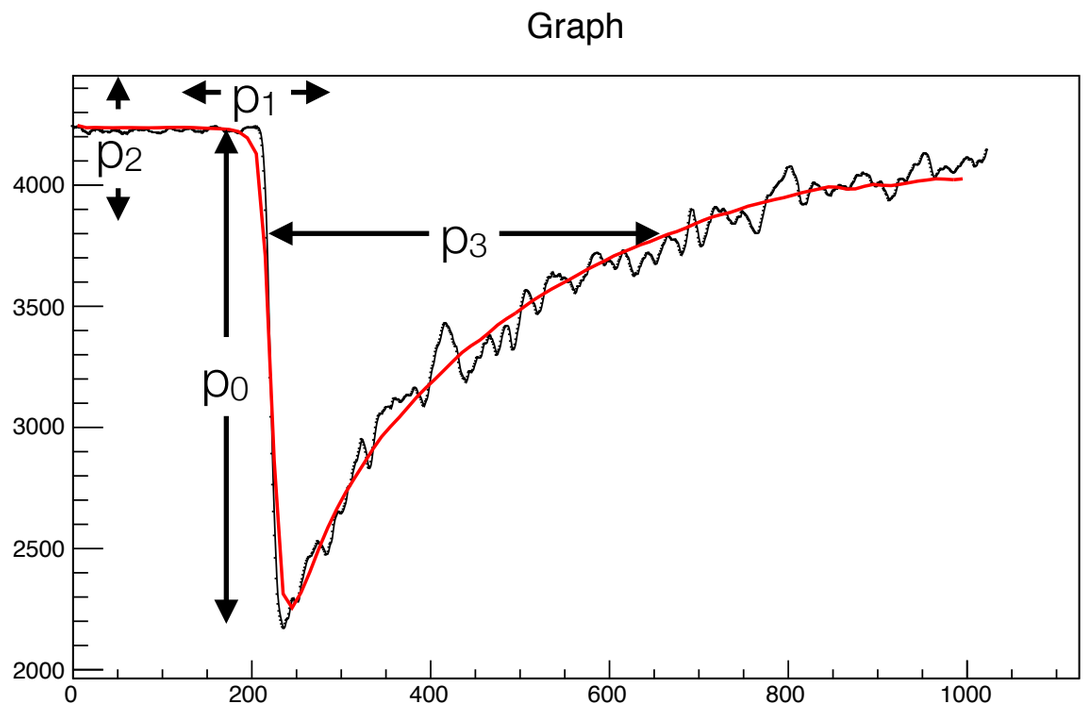
André's template function approach

- Build a template function T(t) averaging many pulses together



- Using 4 parameters, mold the template to each pulse:

$$f(t) = p_0 \cdot T[(t - p_1)/p_3] + p_2$$



Currently it works well on single pulses; perhaps using a template for each ch it will fit also more pulses in a single window

Conclusions and a question

- To place ECal in its final position we need to make already designed small tools and to find a day in which the alignment service and Emilio can do the job
- ECal temperature is currently about 10 °C, do we want to turn on PMTs and heat them (operational temperature is about 30 - 40 °C)?
- CR trigger paddles have been fixed
- We should carefully monitor the HV behaviour
- At the moment it is not possible to read thermometers during data acquisition
- Pulse shape is not very beautiful and presents large oscillation on the decay also for high energy evts; noise seems to be (partially) correlated to the beam
- Currently there are 2 methods to count pulses and evaluate their energy: smoothing and fit; we can try to get the best from the two, e.g. count pulses w/ smoothing and evaluate charge w/ fit

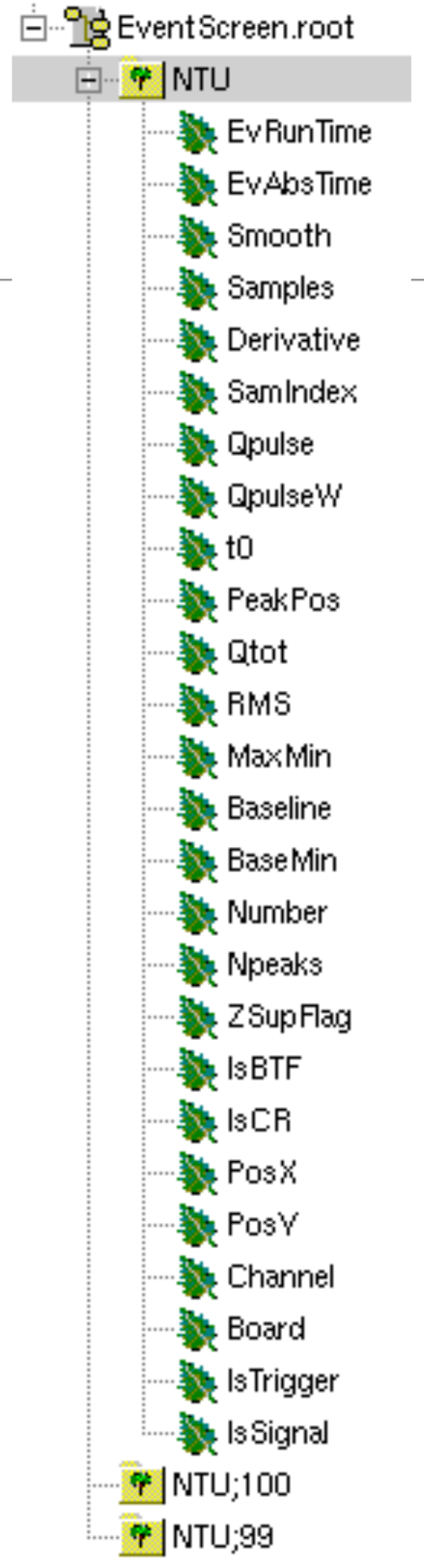
Backup

Tree structure

Currently I'm working on an algorithm that identifies the pulses, their "starting moment" (the t_0), evaluates their charge. These, together with other quantities and info from the DAQ (channel, board, samples, BTF or CR trigger, …), are stored inside a TTree.

One entry per trigger fire, board and channel.

This code works on level1 root files.



TSpectrum::SmoothMarkov

One-dimensional markov spectrum smoothing function.

This function calculates smoothed spectrum from source spectrum based on Markov chain method.

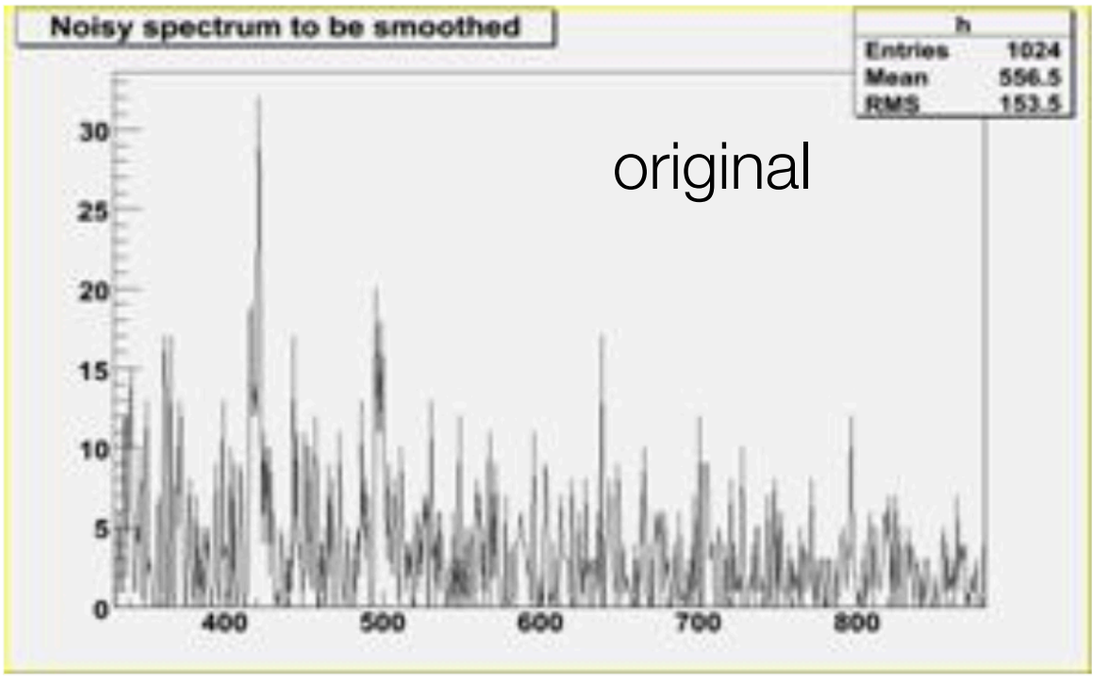
```
const char * TSpectrum::SmoothMarkov(
Double_t * source,
Int_t ssize,
Int_t averWindow
)
```

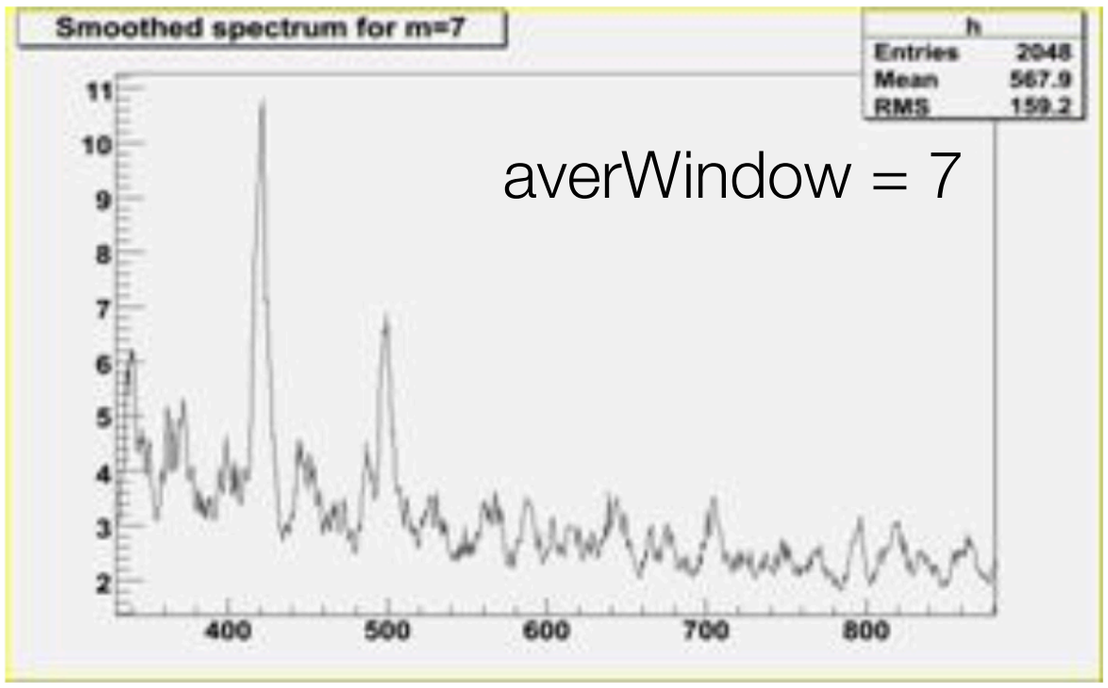
Parameters:

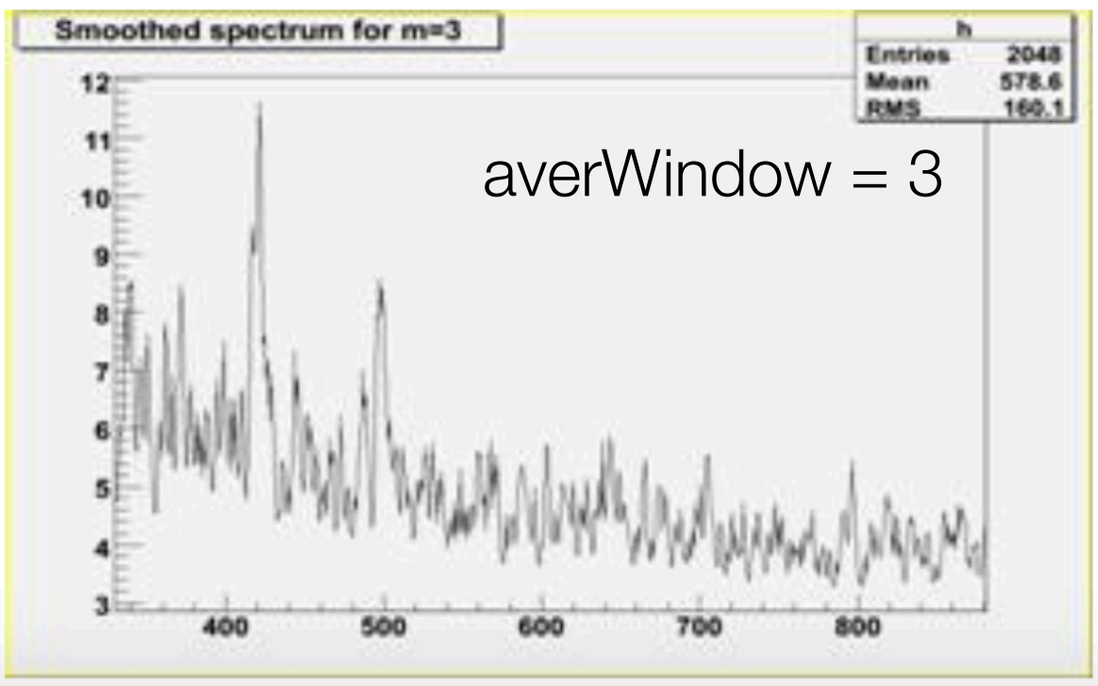
- source: pointer to the array of source spectrum
- ssize: length of source array
- averWindow: width of averaging smoothing window

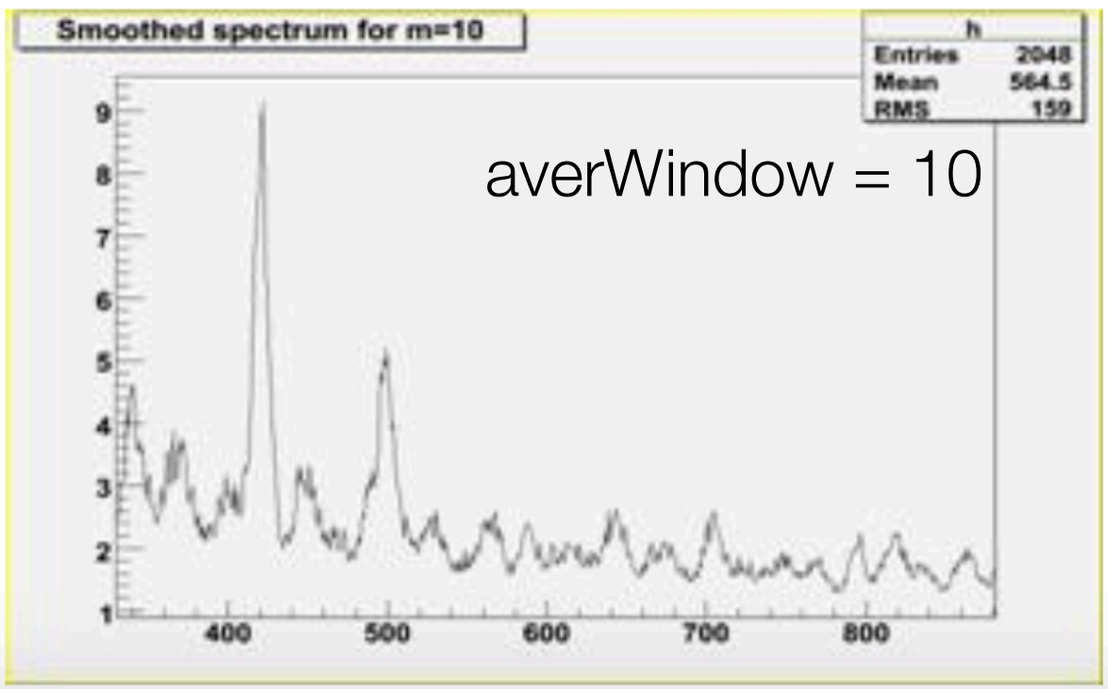
Smoothed spectra

The larger averWindow, the smoother the spectrum



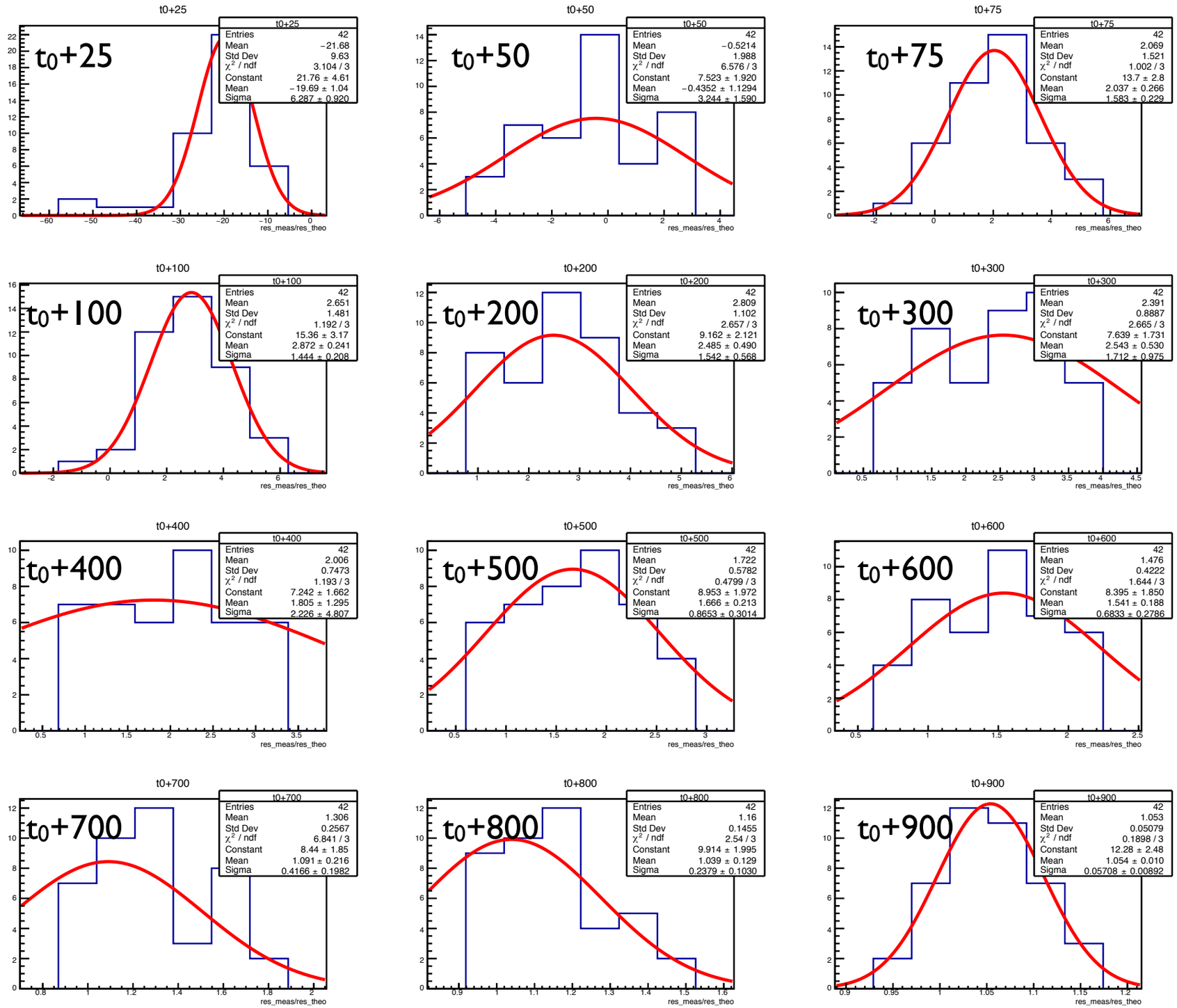






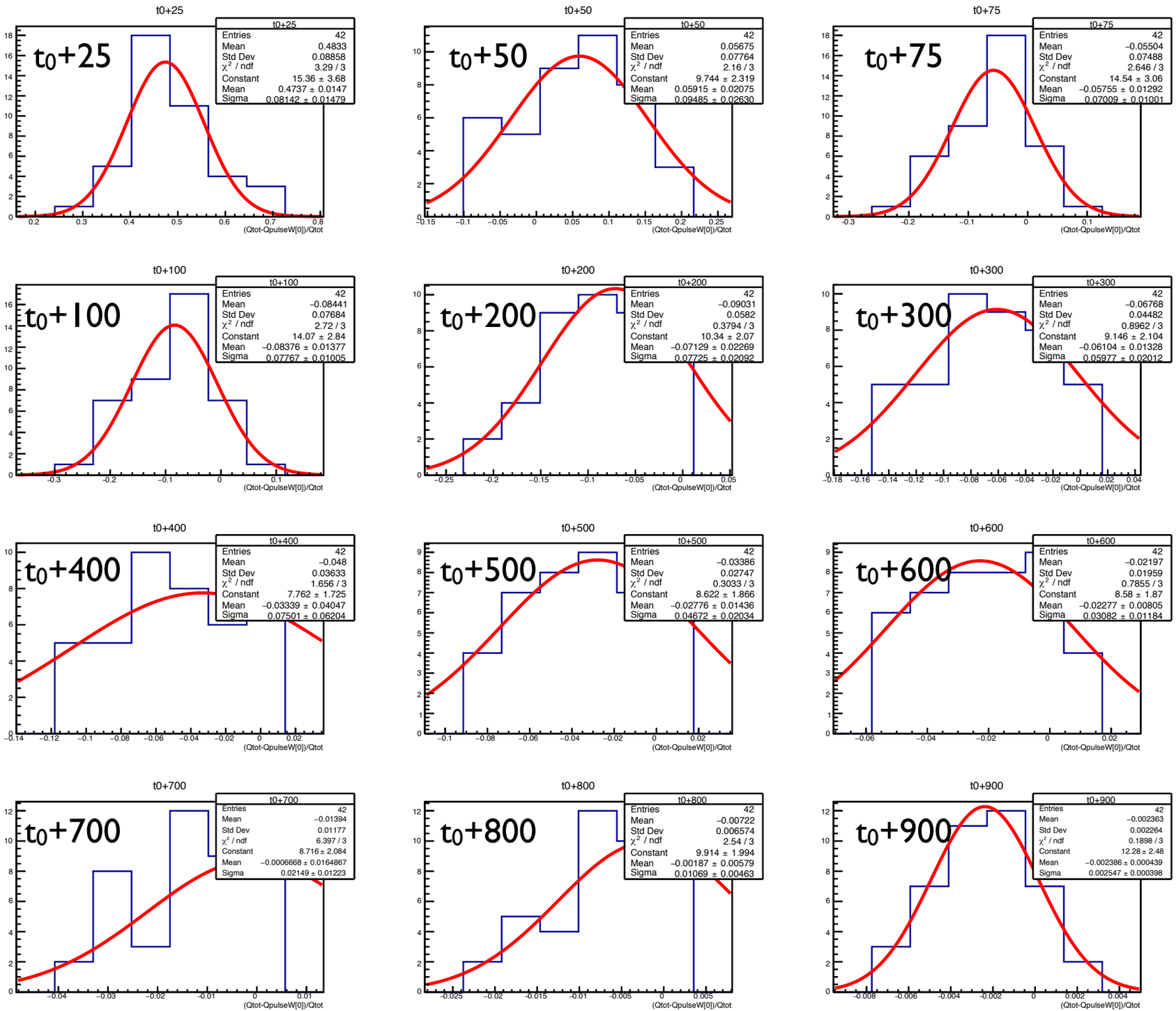
Ratio distributions

res_meas/res_theo distributions for different Δt



TSpectrum::SmoothMarkov

(Qtot-QpulseW[0])/Qtot distributions for different Δt



Difference sigma trend

(Qtot-QpulseW[0])/Qtot sigma trend as a function of Δt