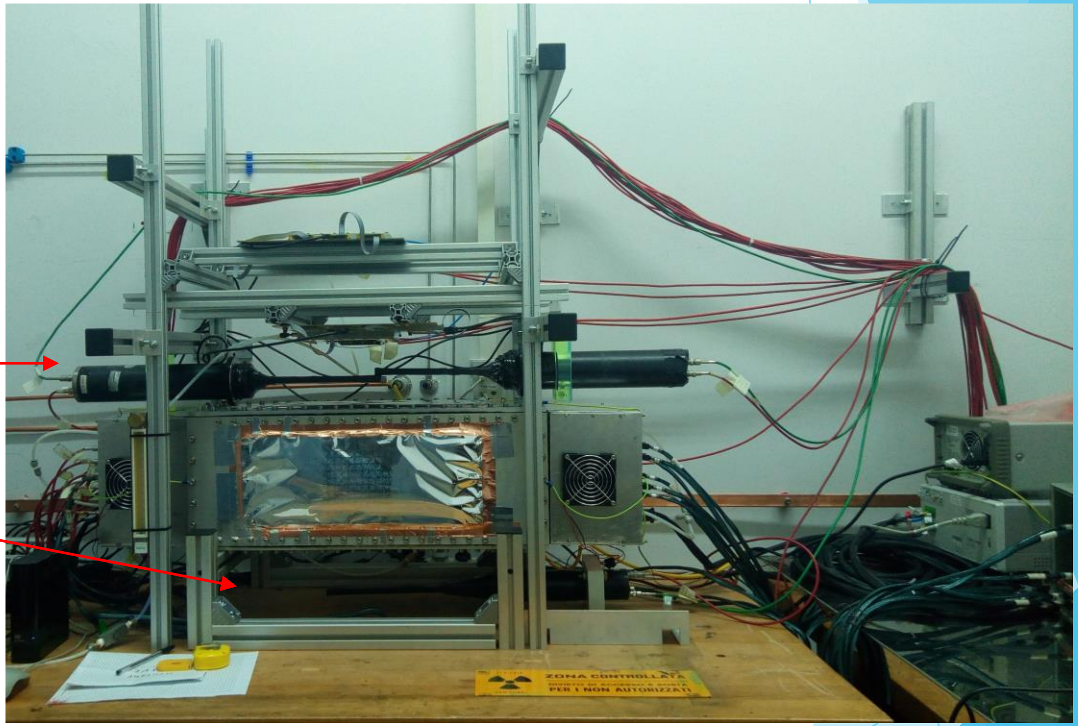
# Drift chamber prototype for cosmic data

During the last month, we took cosmic data with drift chamber prototype with the aim to understand and correct the signal «patologies» observed during the test beam.

The chamber is a ultra-light drift chamber, presented as a new efficient tracking detector.

As you can seen, trigger system is made of 3 scintillators: two up the chamber, one below.



Mixture consists on He-iC4H10. HV was varying from 1510-1540 V with mixture of 90%He-10%iC4H10 and from 1650-1710 V for 85%He-15%iC4H10.

We are reading just 9 channel of the chamber with high bandwidth oscilloscope (LeCroy HDO4096).
To study the noise, we are tooking signal waveform applying an HV under the gas amplification range (200 V).
To study chamber properties, we are acquiring cosmic data.

# NOISE FILTERING

We will analyze the two kind of waveform:

- Signal waveform: run 33, layer 2-3-4, mixture 85%-15%, HV=1710 V
- Noise waveform: run 28, layer 2-3-4,mixture 85%-15%, fictitious HV=200 V

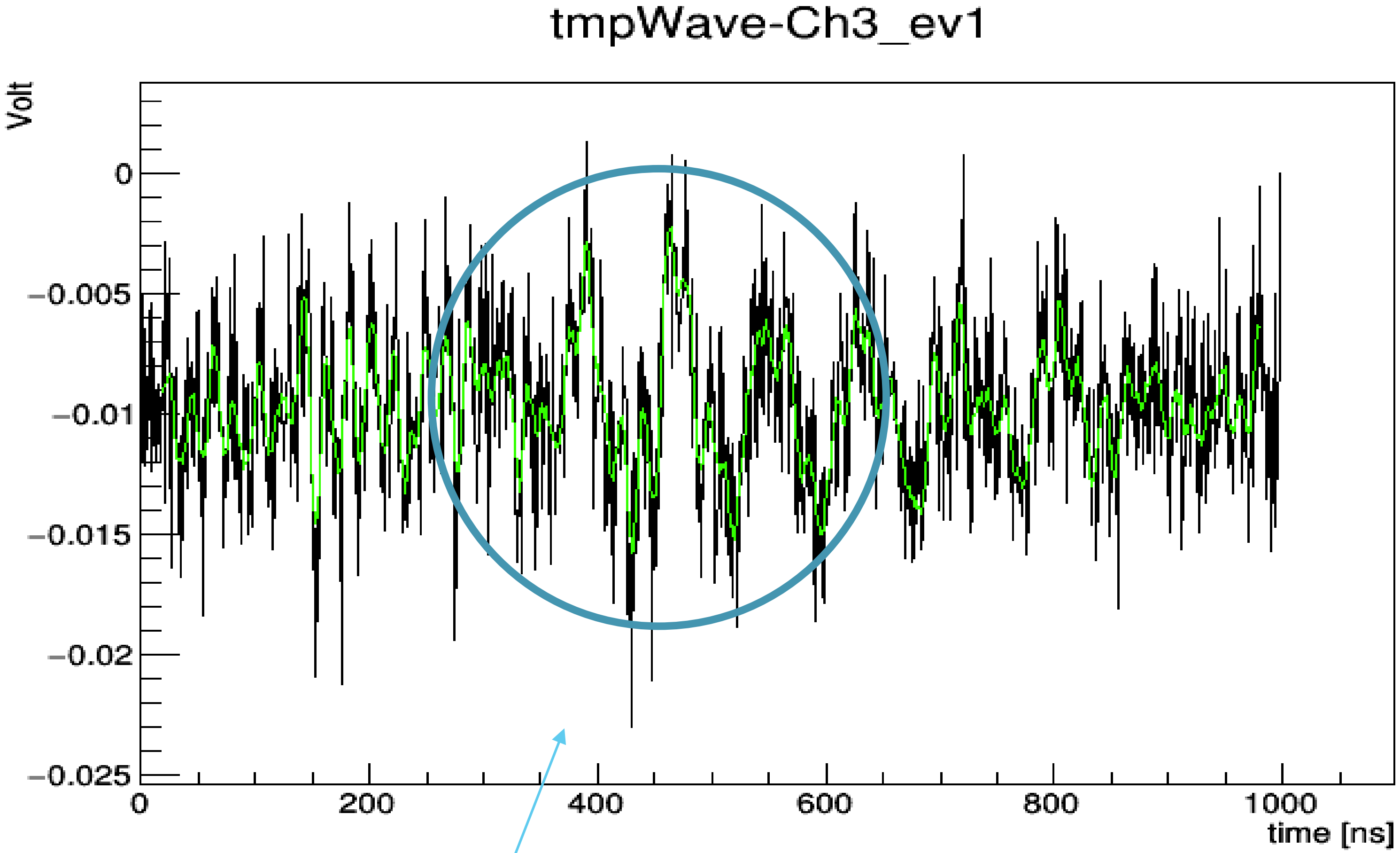
Used methods for noise treatment:

- Smoothing (running average and Savitzky-Golay filter)
- Analysis of frequency spectrum
- Implementation of filters: Notch filter, RC filter, subtraction of beat function

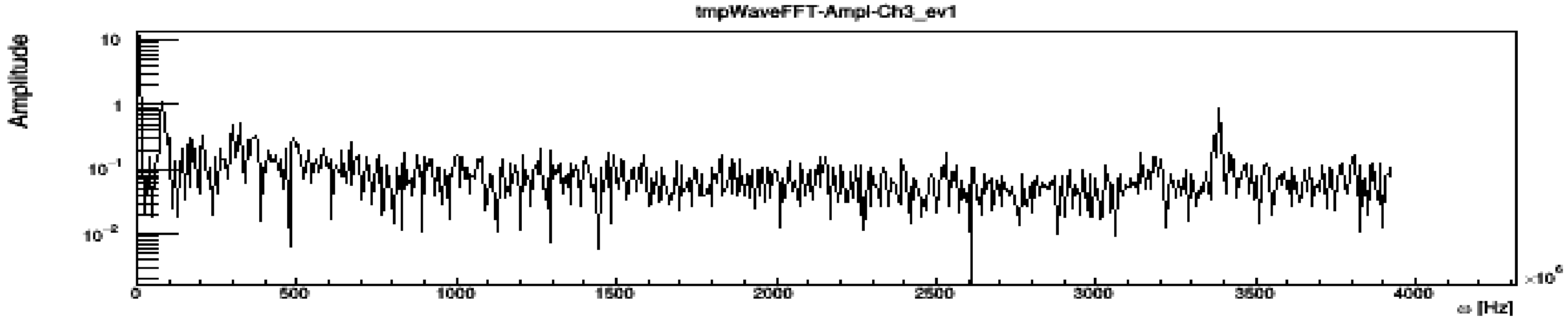
Step for the current noise treatment:

1. analysis of frequency spectrum
2. analysis of noise peaks, searching for distribution of their positions
3. Notch filters
4. analysis of «difficult» noise components
5. fitting noise with beat function
6. (eventual) RC filter

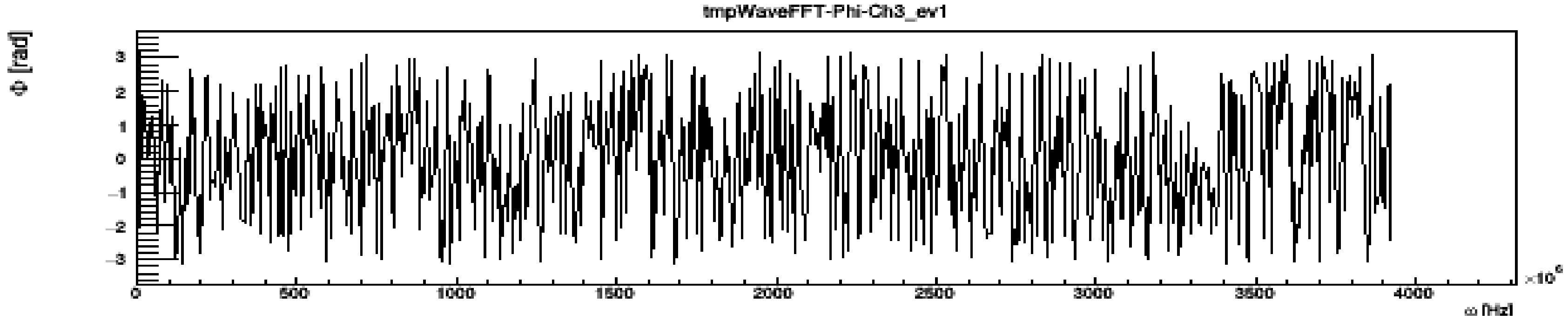
This is an example of noise waveform

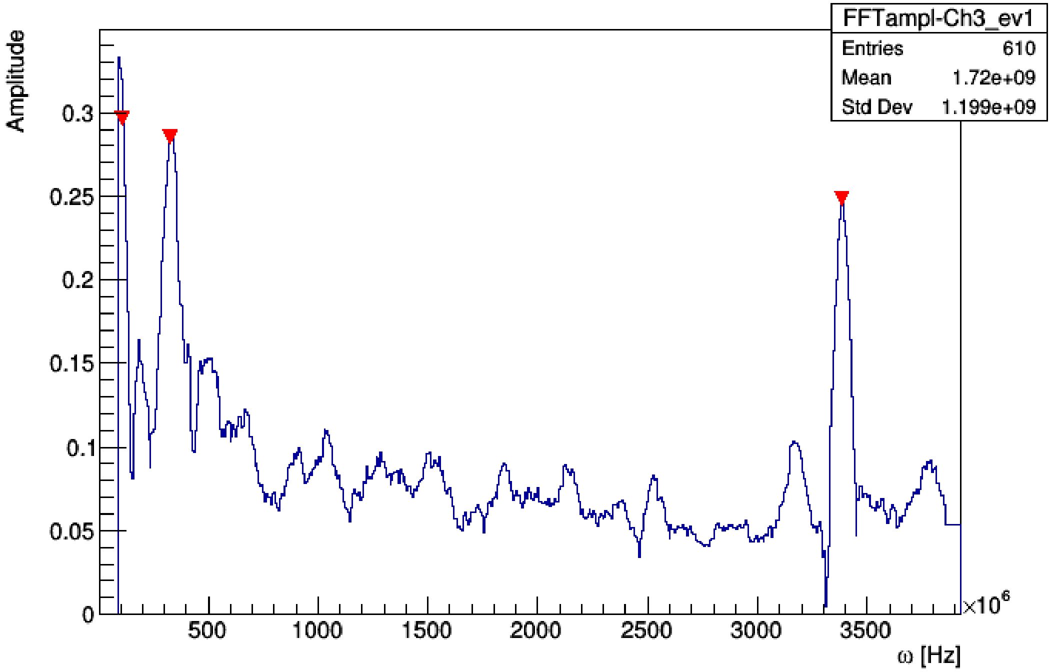



We can observe an oscillation




Spectrum of the noise wave

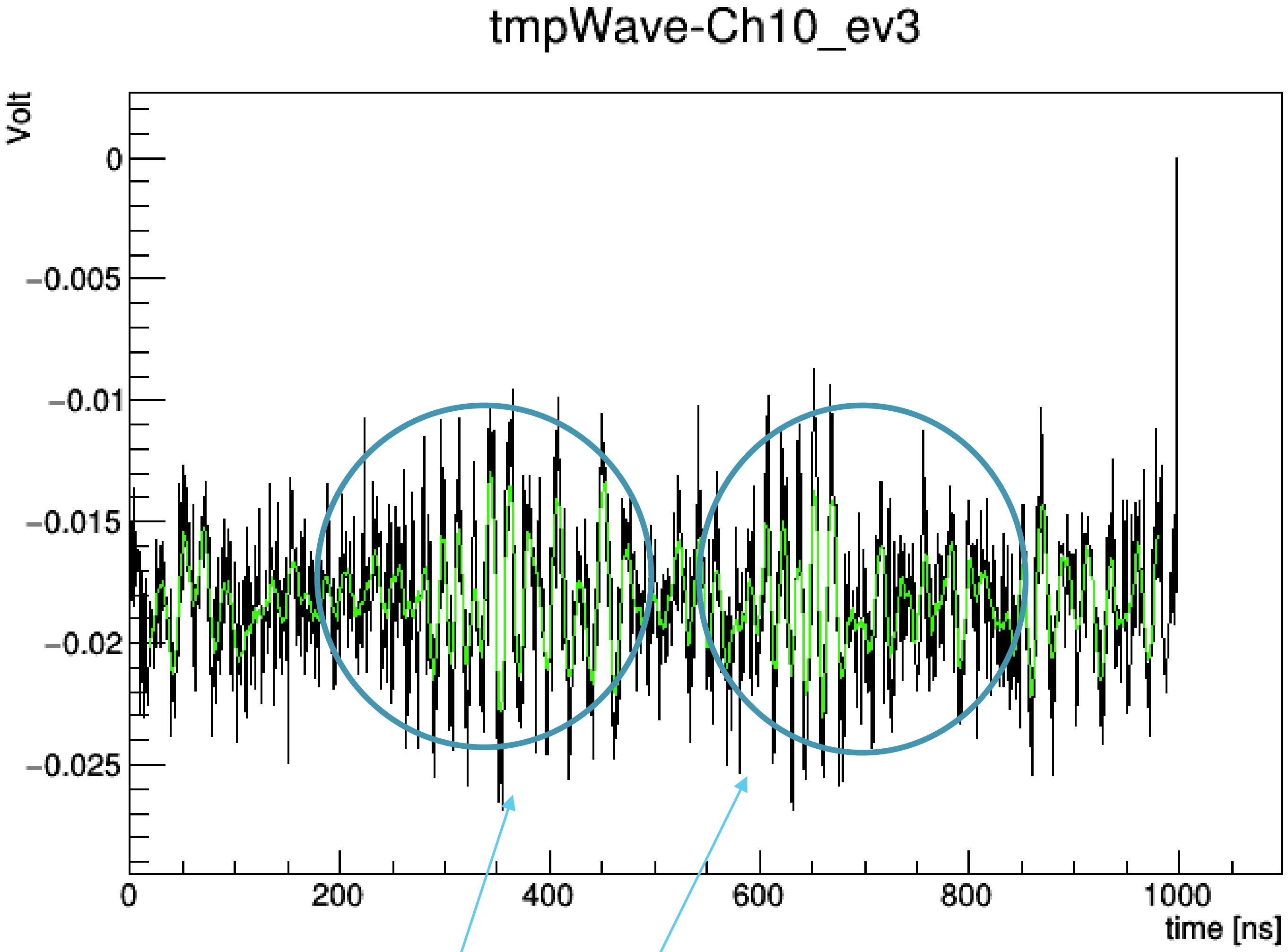


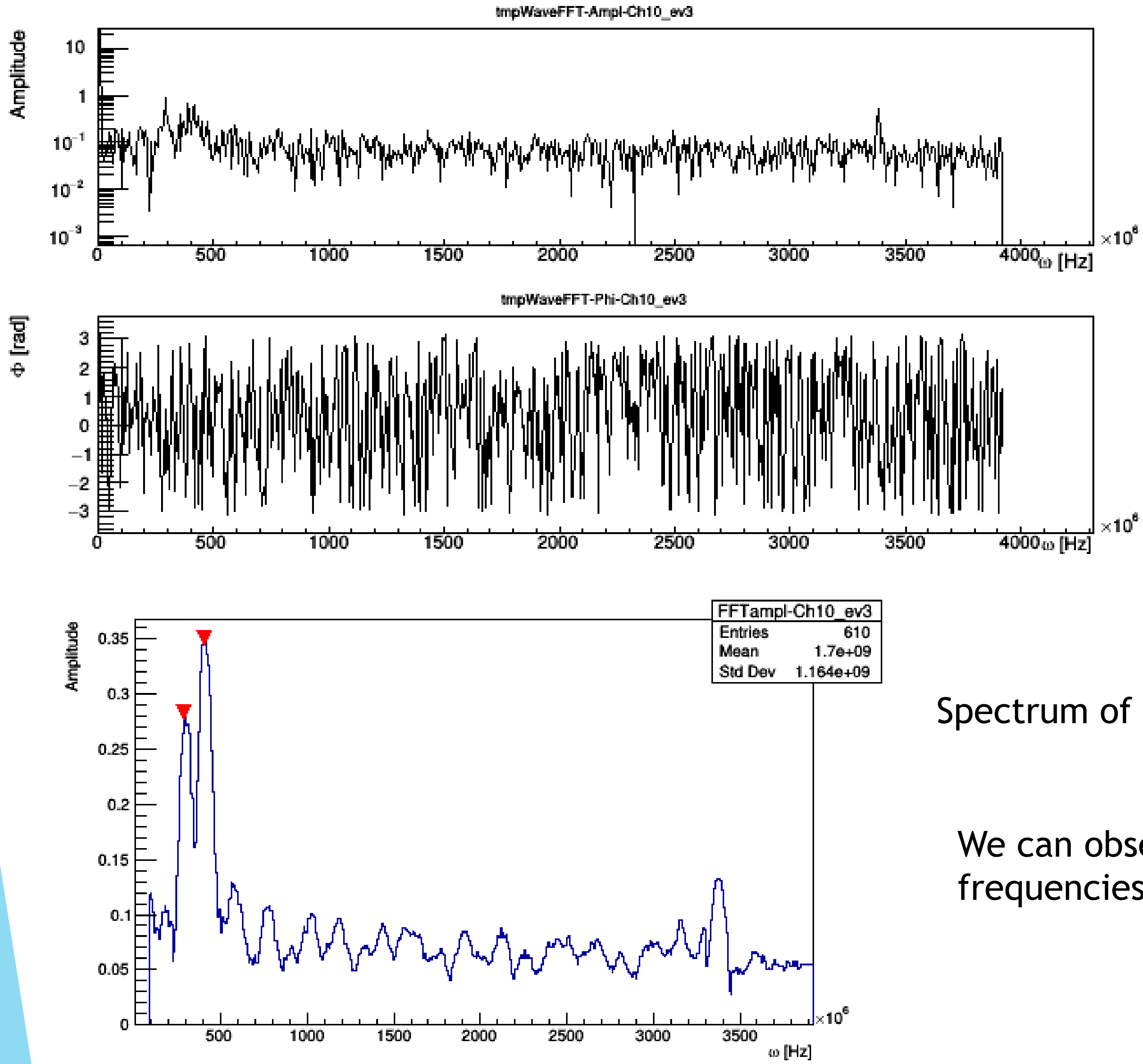

Spectrum of the smoothed noise wave

We can observe three main frequencies: 10,66,538 MHz

Another example of noise waveform




Here, we can observe a more tight
oscillation, similar to the first wave shown

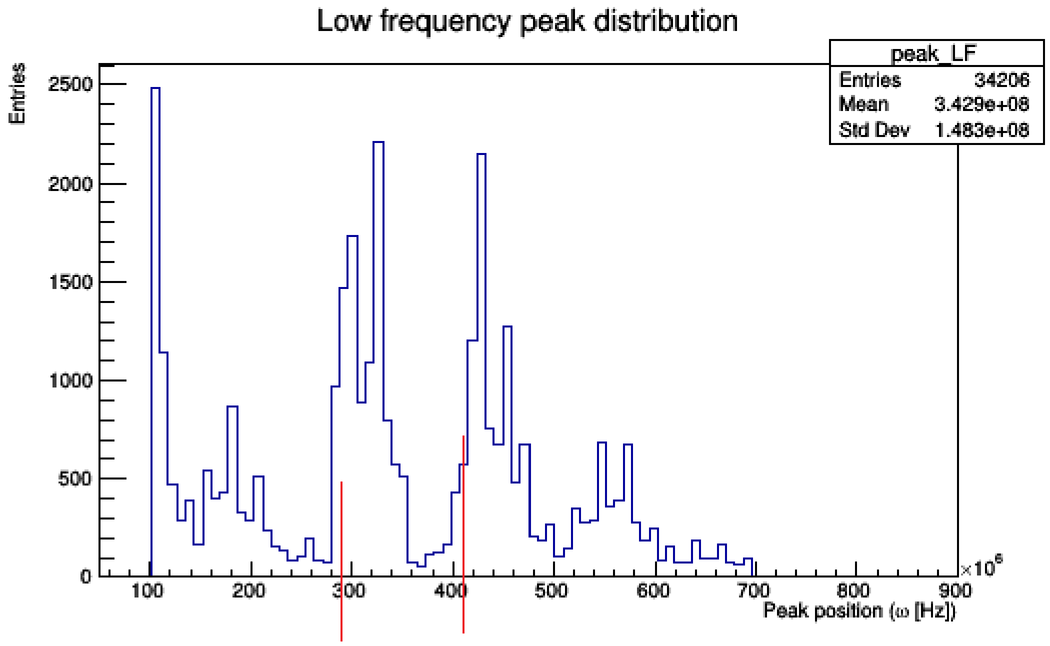



Spectrum of the noise wave

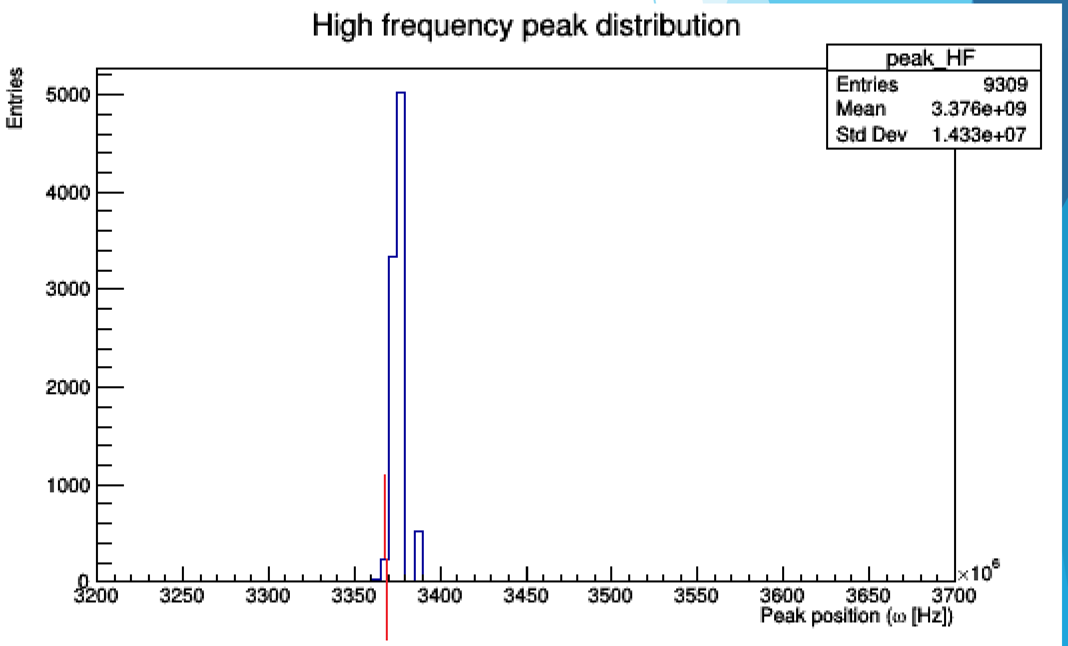
Spectrum of the smoothed noise wave

We can observe three main frequencies: 46,66,538 MHz

Peak distribution for all events in the noise run




At high frequency, the distribution is more thigt than the distribution al low frequency.

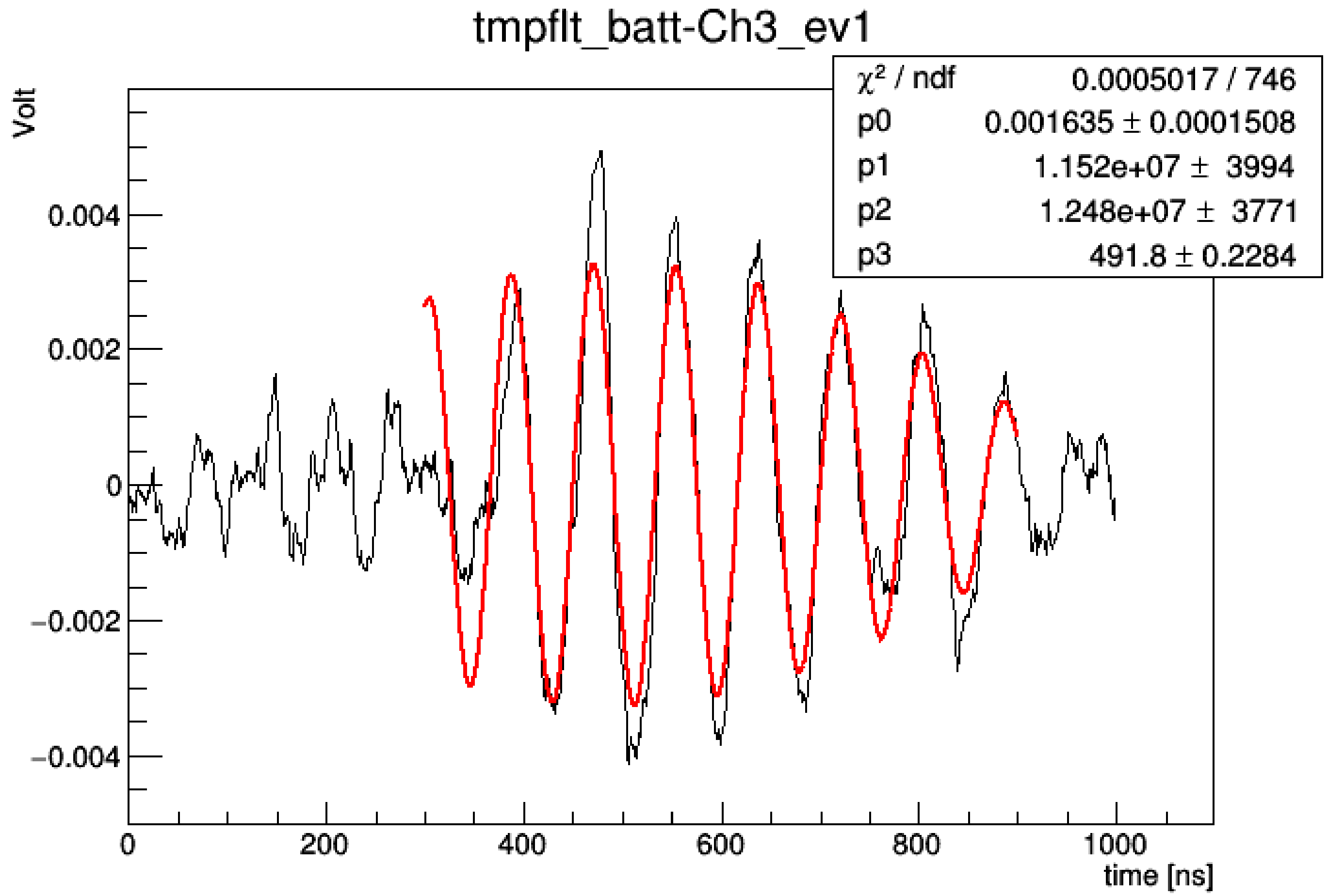



To cut the two central peak in low frequency distribution and to cut the single peak in high frequency distribution, we chose the cut-off value of:

46 MHz
66 MHz
538 MHz

All those components are filtered very well with Noch filter, without any evident distortion for signal shape

but…for the oscillation in the first wave of noise illustrated, it is necessary to change the method of filter, because cutting only this frequency distorts signal shape.
We fit the shape of the wave with a beat function (red curve), then remove this shape from the original wave.

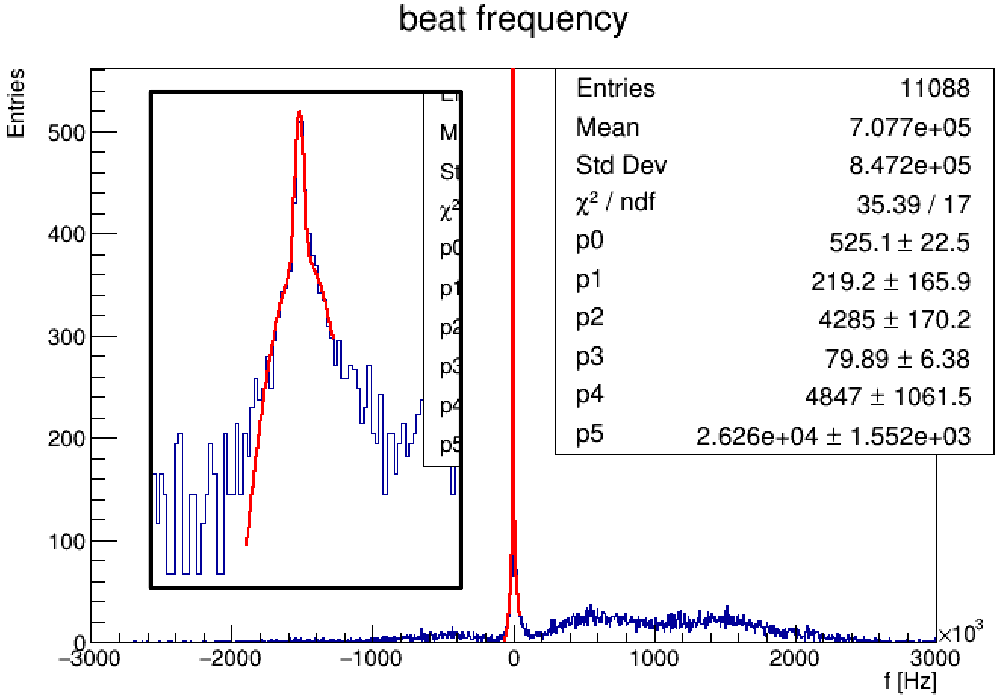



With a band pass filter, we selected the noise frequency and then fit the wave with beat function

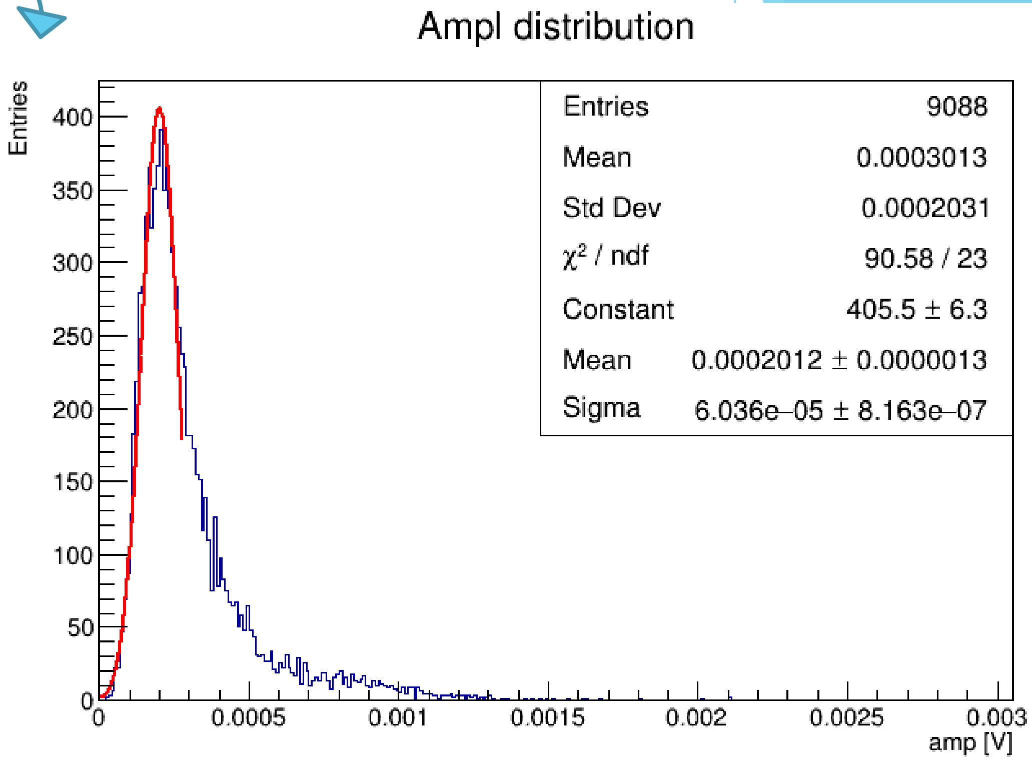
$$y_{tot} = 2A\cos 2\pi\left(\frac{f_1 - f_2}{2}\right)t \cdot sen\, 2\pi\left(\frac{f_1 + f_2}{2}\right)t$$

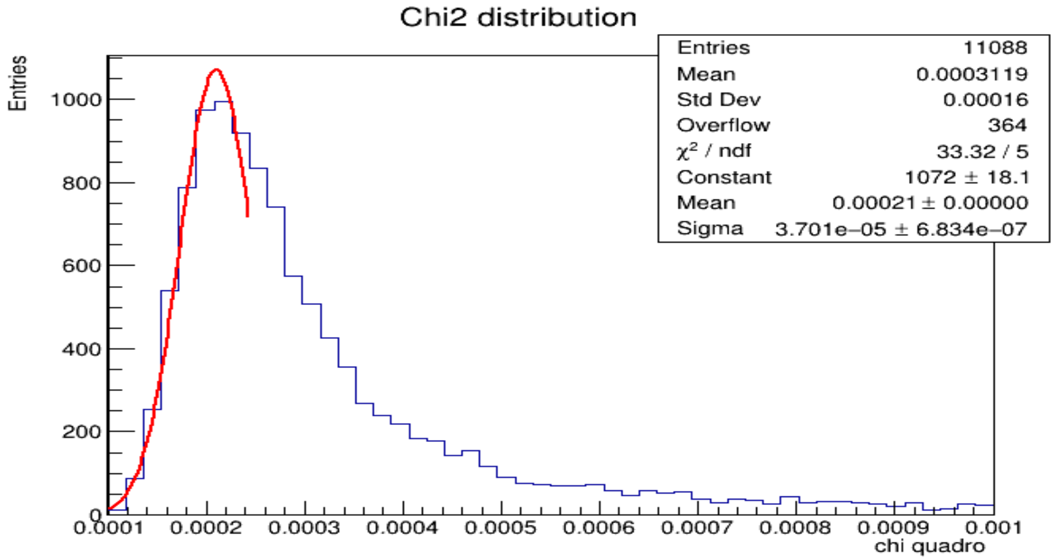
This subtraction is made just for the wave with this kind of noise . For example, the second wave noise illustrated does not have this particular noise.

We made the distributions of difference between the two frequencies of the beat function .




Cutting the mean value of the gaussian fit, we studied the distribution of amplitude

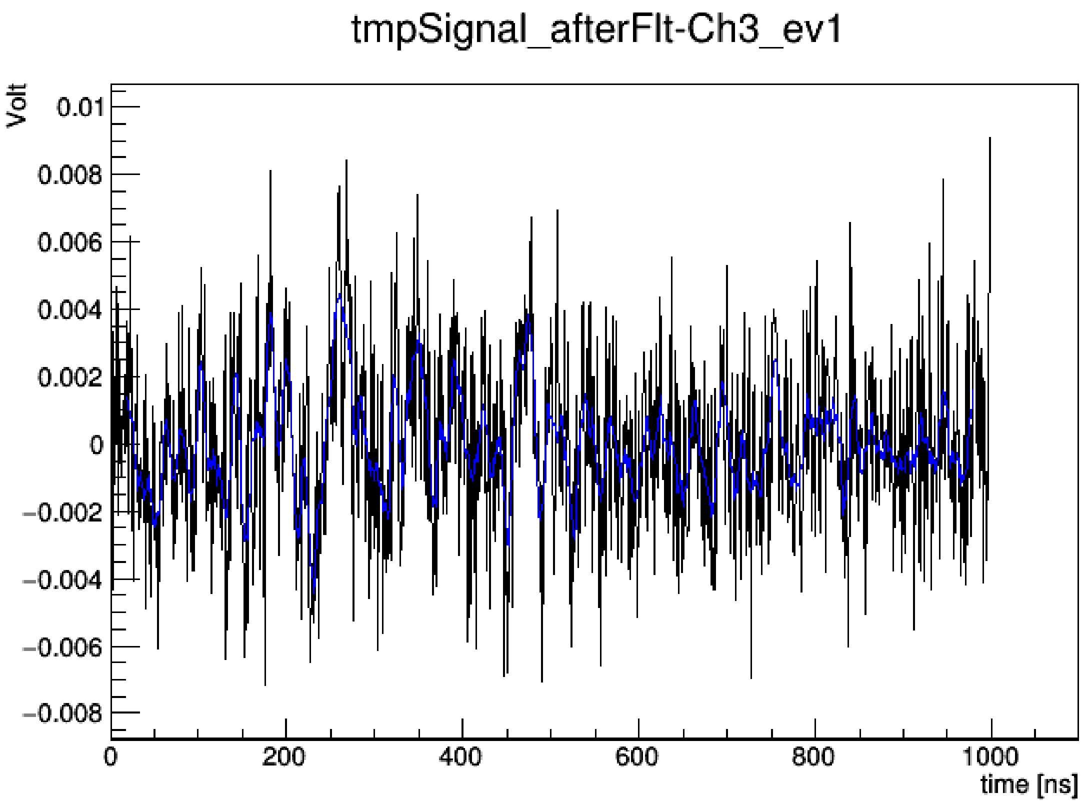


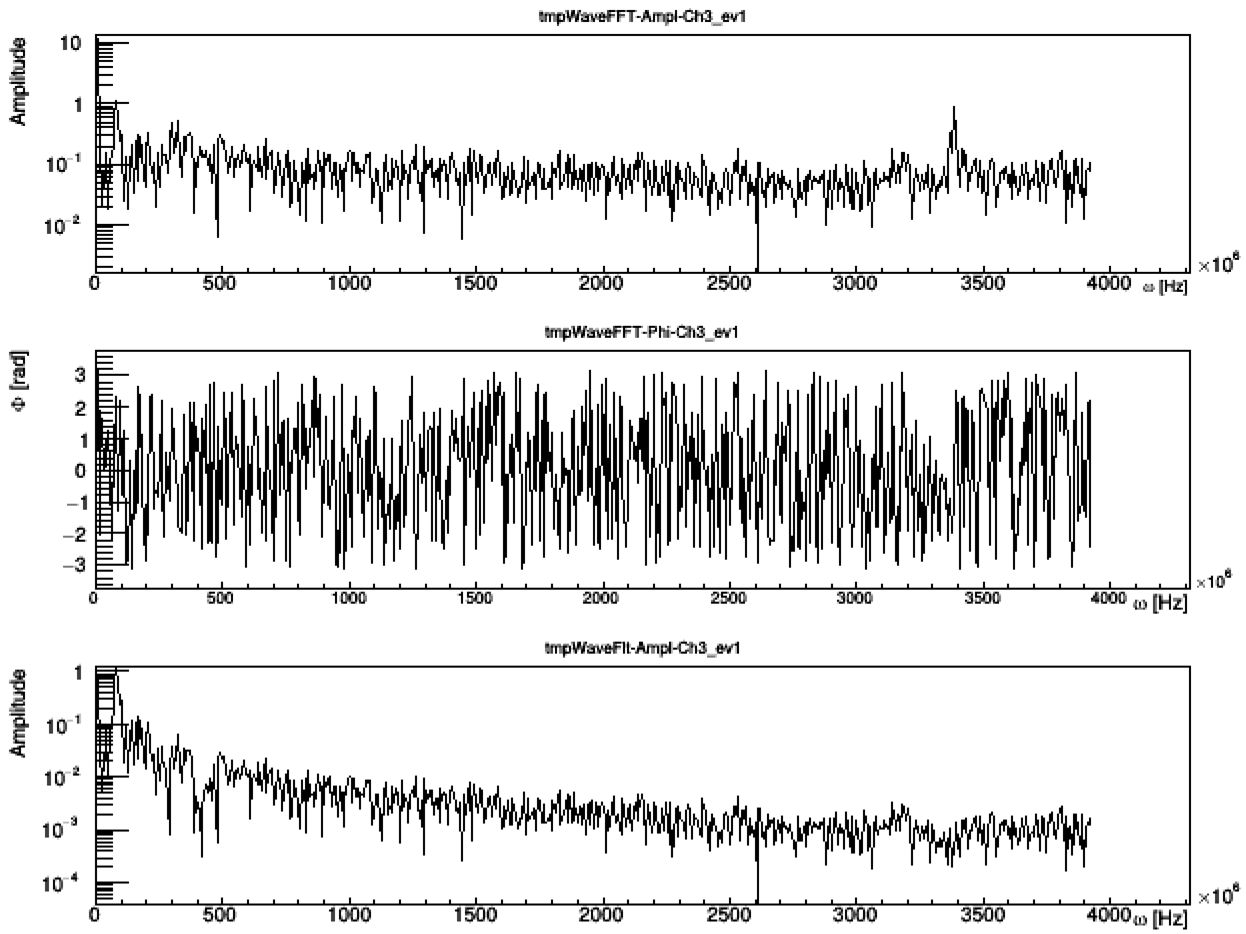



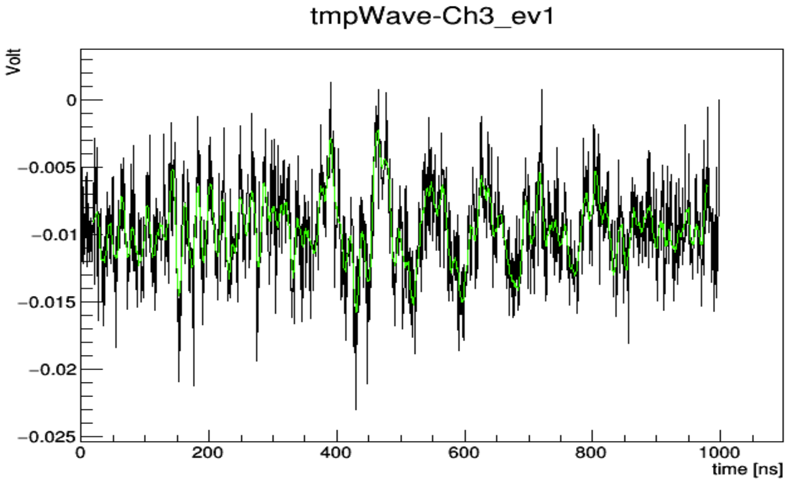

And then, we plotted the distribution of Chi2

In this way, we can select a threshold to apply the filter

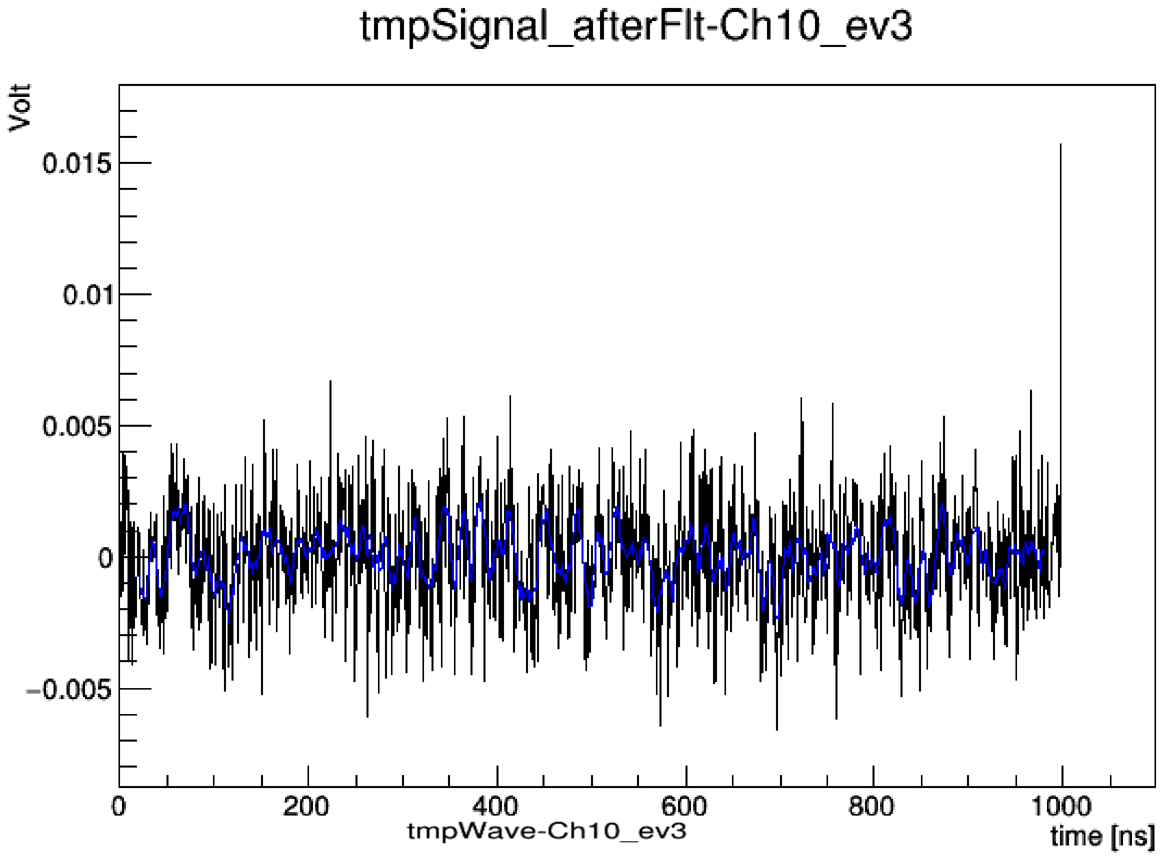
The result on the first wave is:

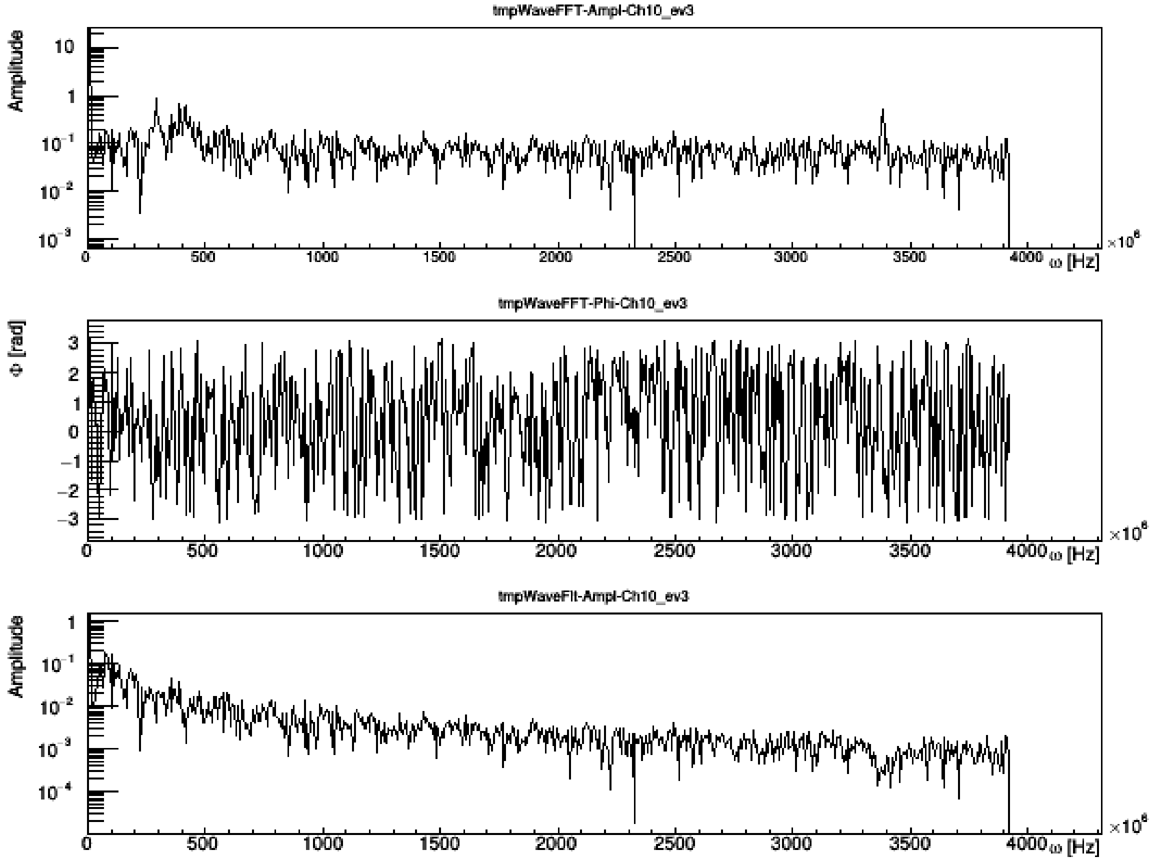


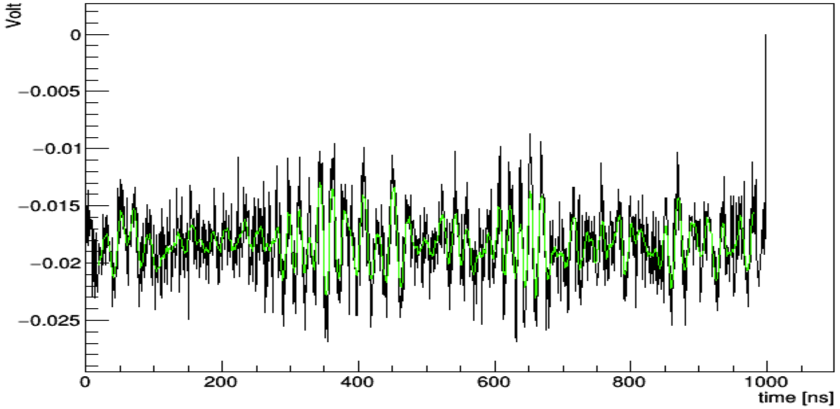



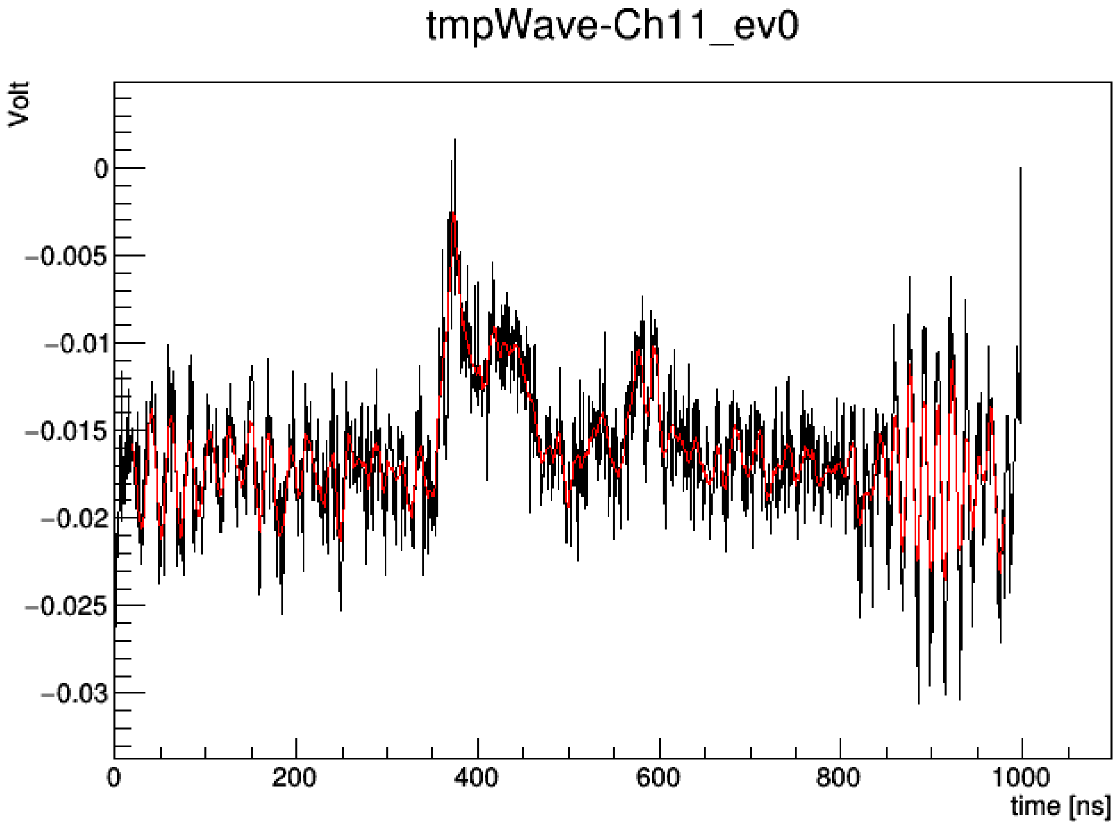
The result for the second wave is:

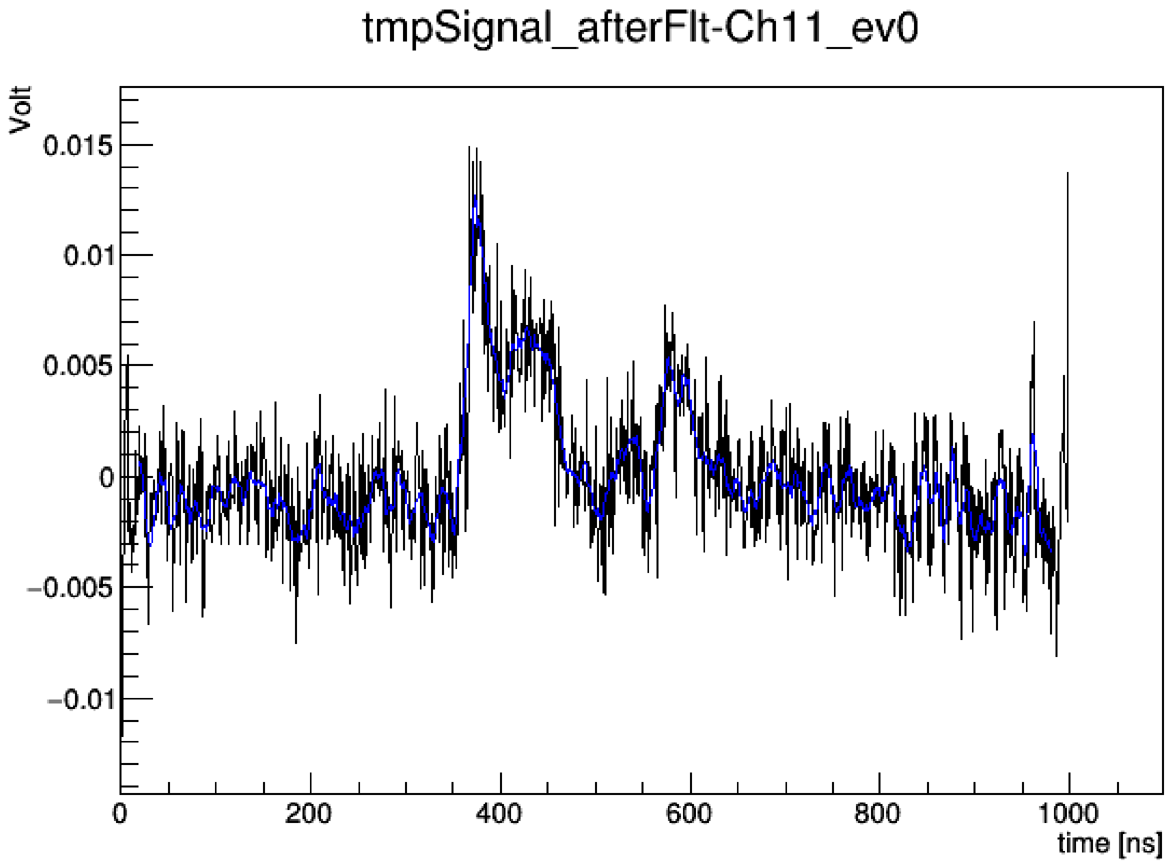


Example of signal waveform.
Risults of signal processing

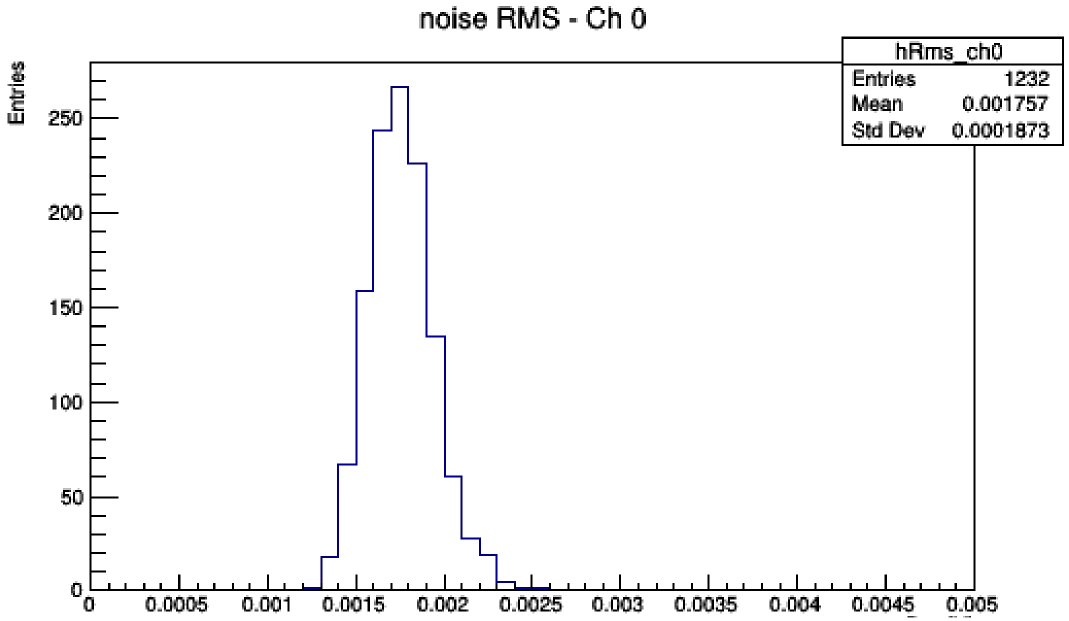


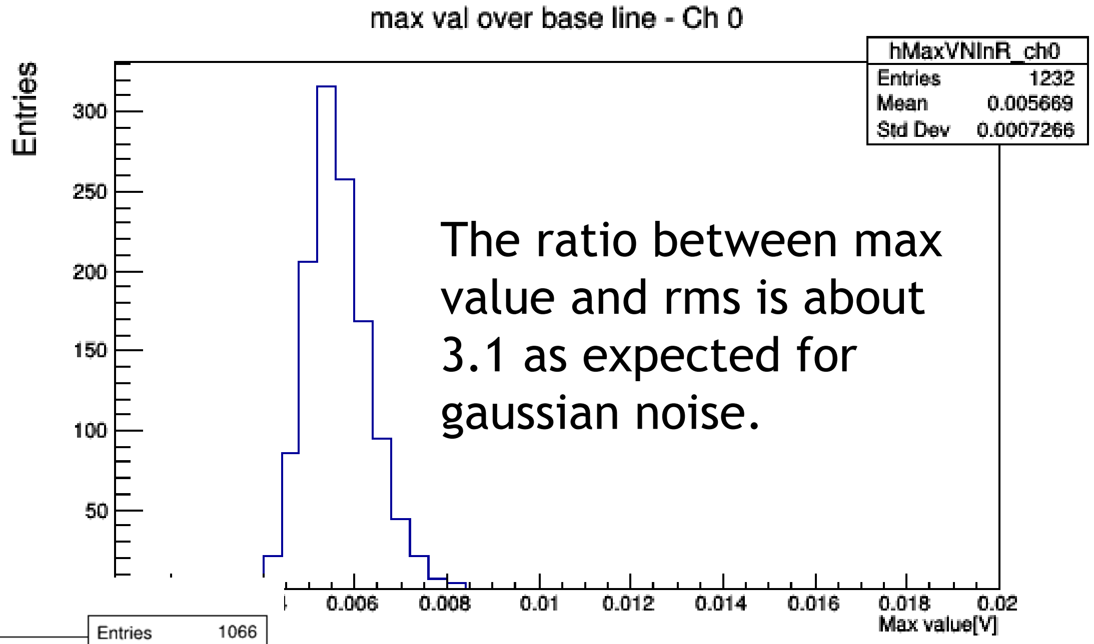




As you see, the noise components are efficiently remove.

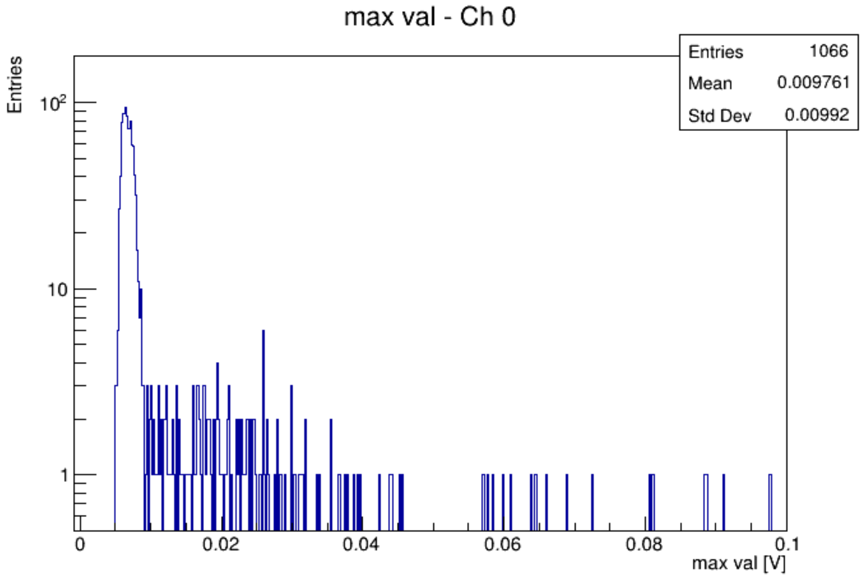
Check of the noise removal procedure

For each electronic channel, we plotted the histograms for rms and max value, for noise waveform, as example:




The ratio between max value and rms is about 3.1 as expected for gaussian noise.



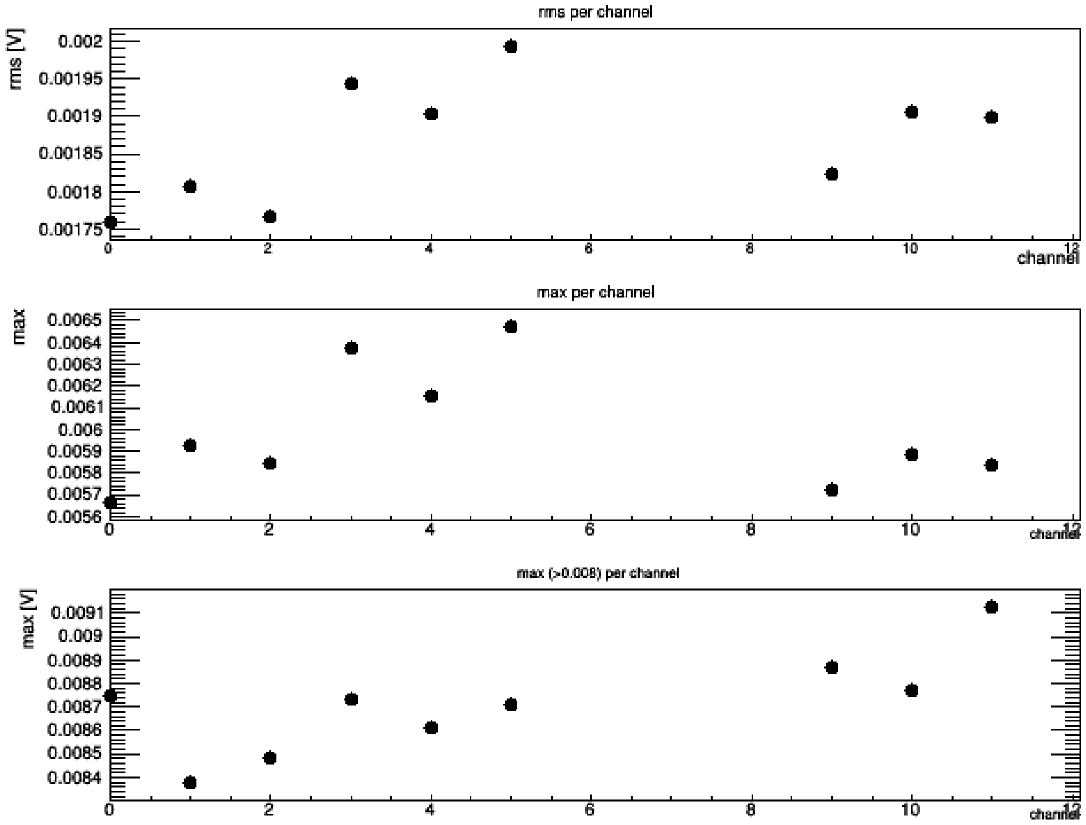
Another important component of noise is the white noise. We tried to filter this noise with RC filter.

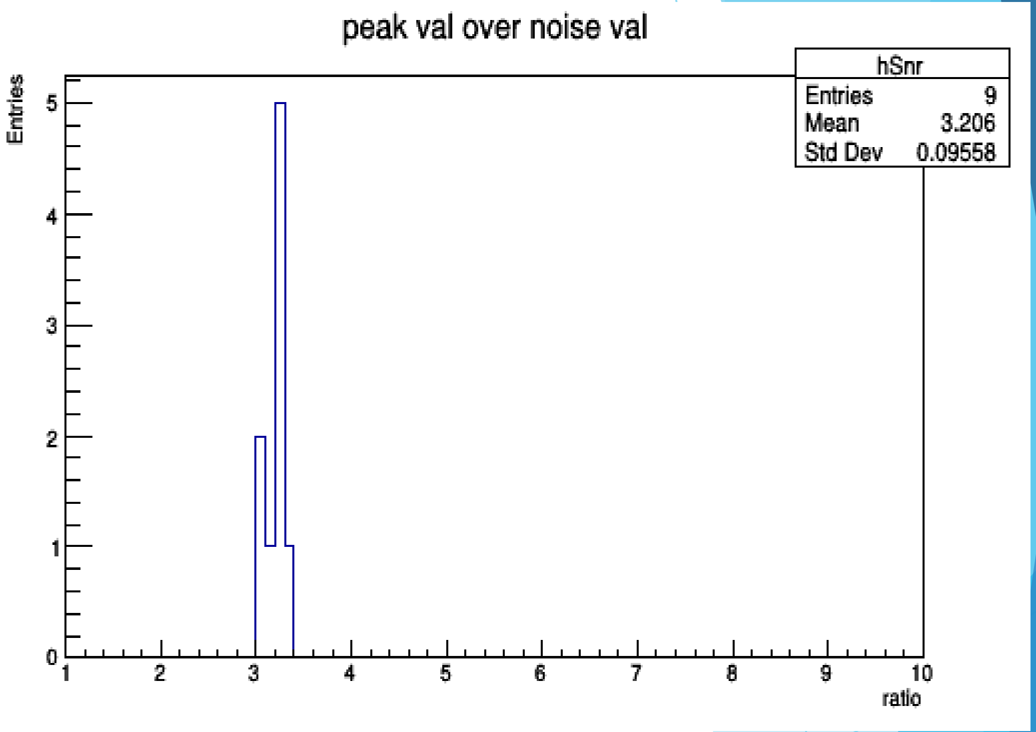
The cut-off frequencies are varying :

300 MHz
500 MHz
700 MHz
900 MHz

We studied the distribution of rms and max value varying the cut off frequency of RC filter and the distribution of their ratio.

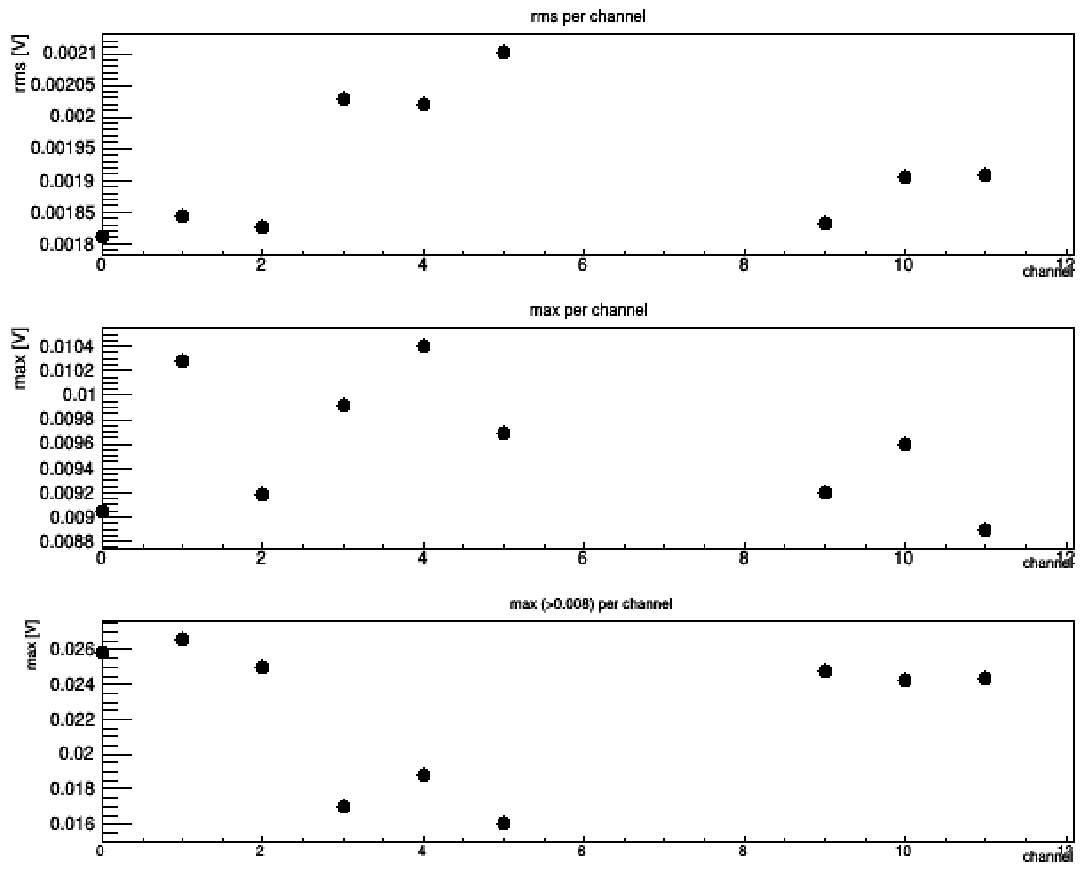
f=300MHz

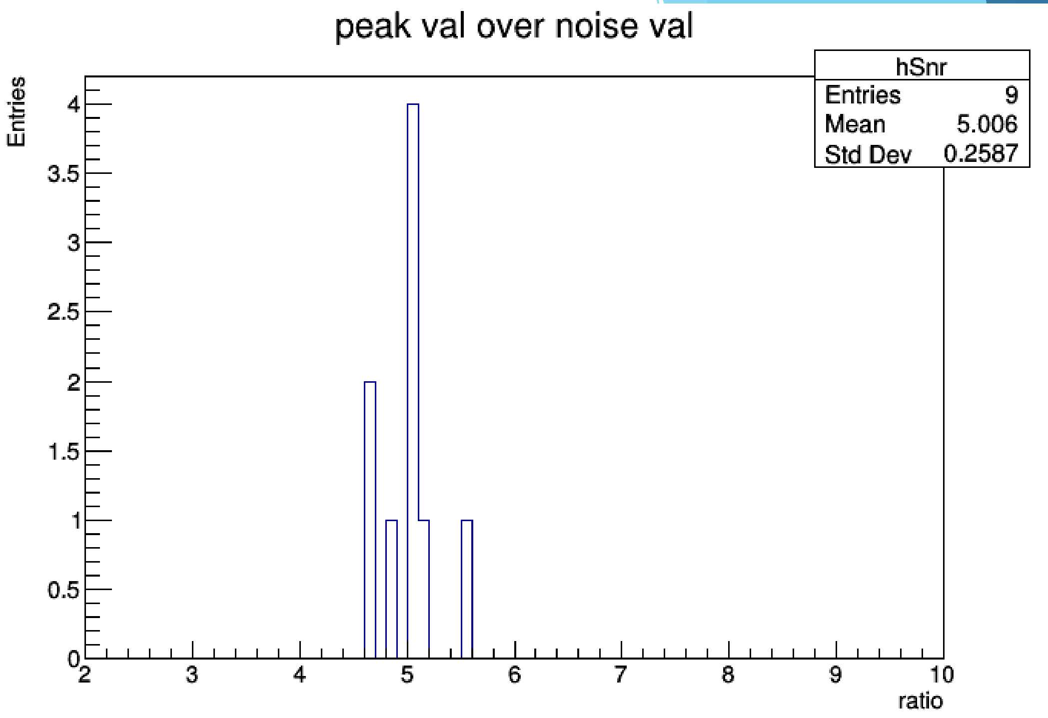


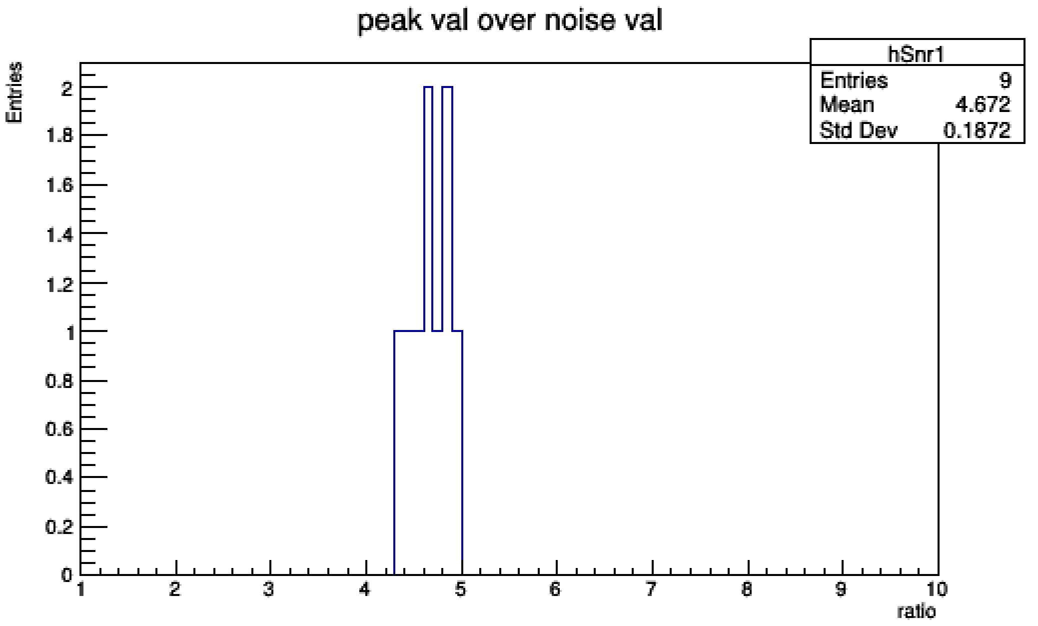
Here the distribution of distribution of rms and max value and the distriburion of their ratio for the signal waveform

f=300MHz



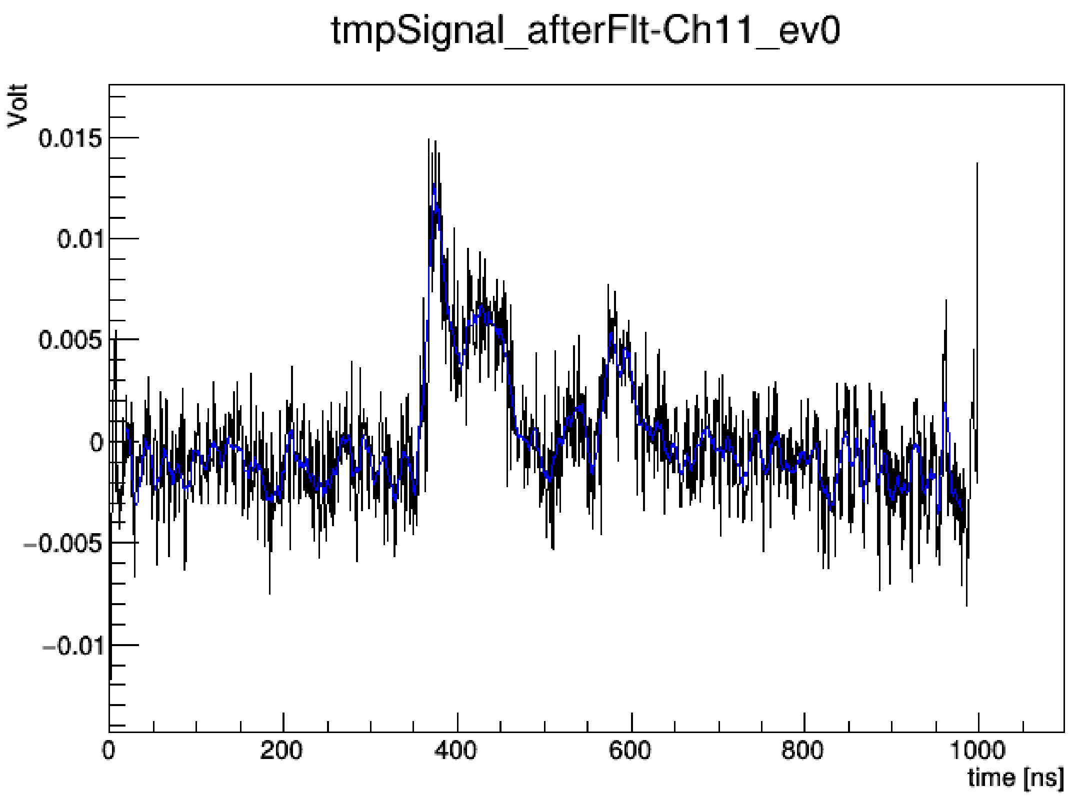




Ratio for max value evaluated with threeshold

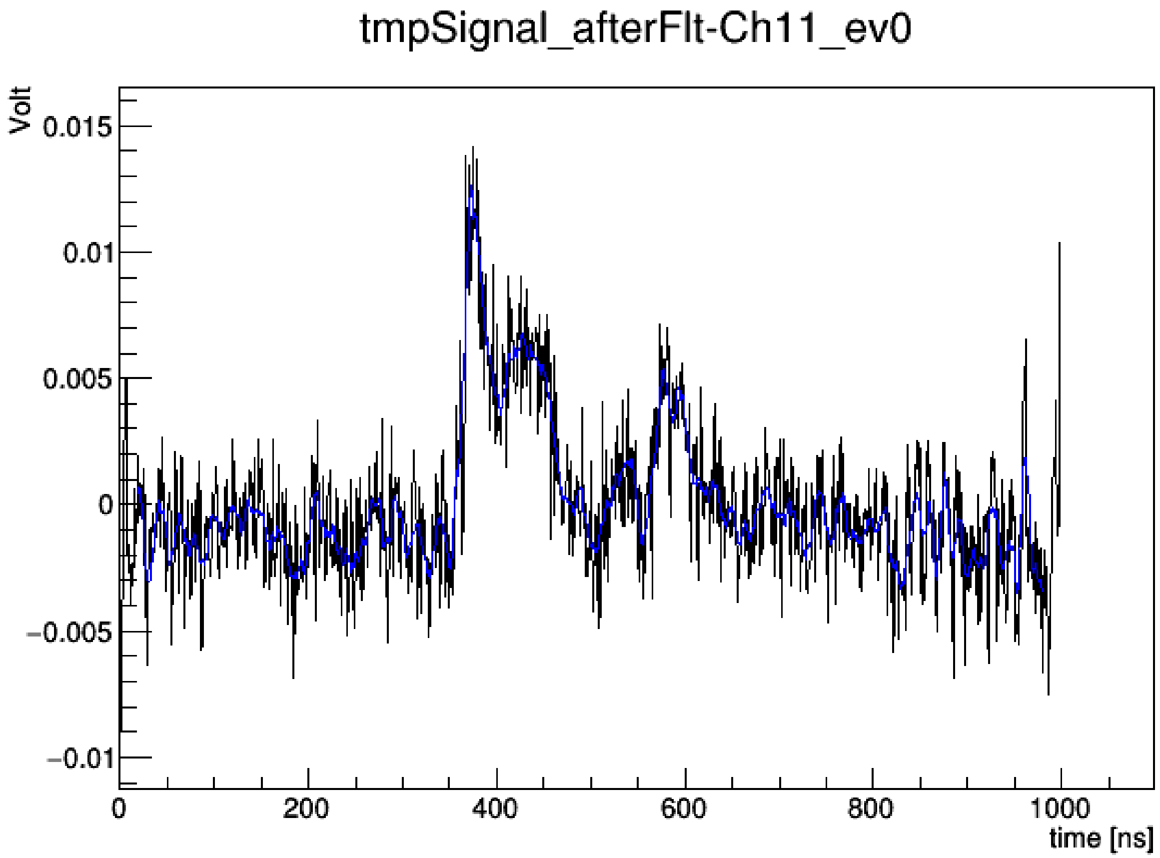


# Introducing the RC filter

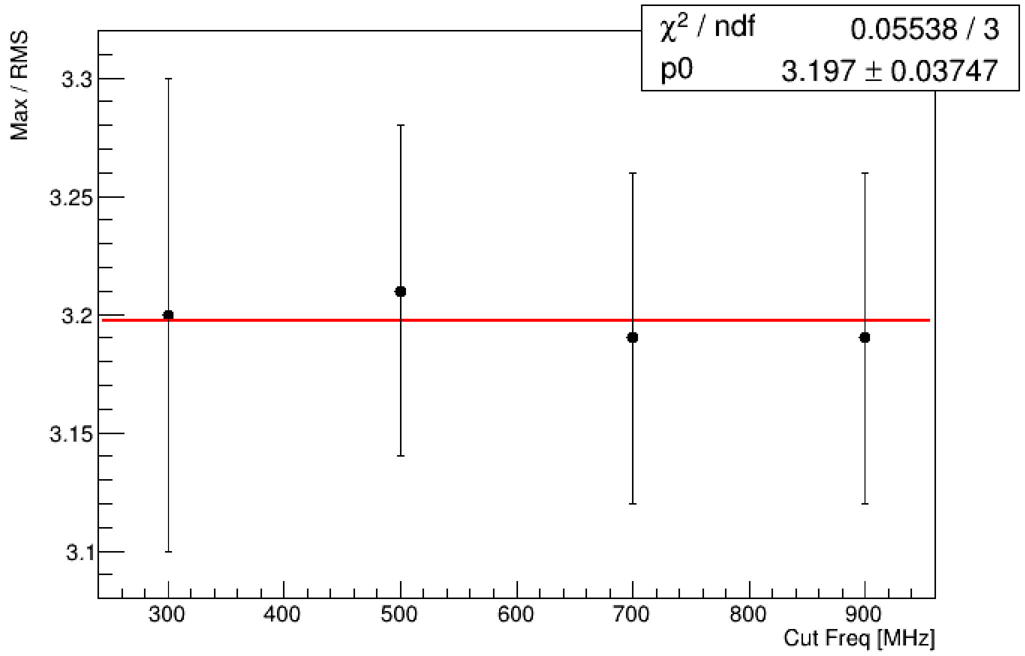
f=300 MHz

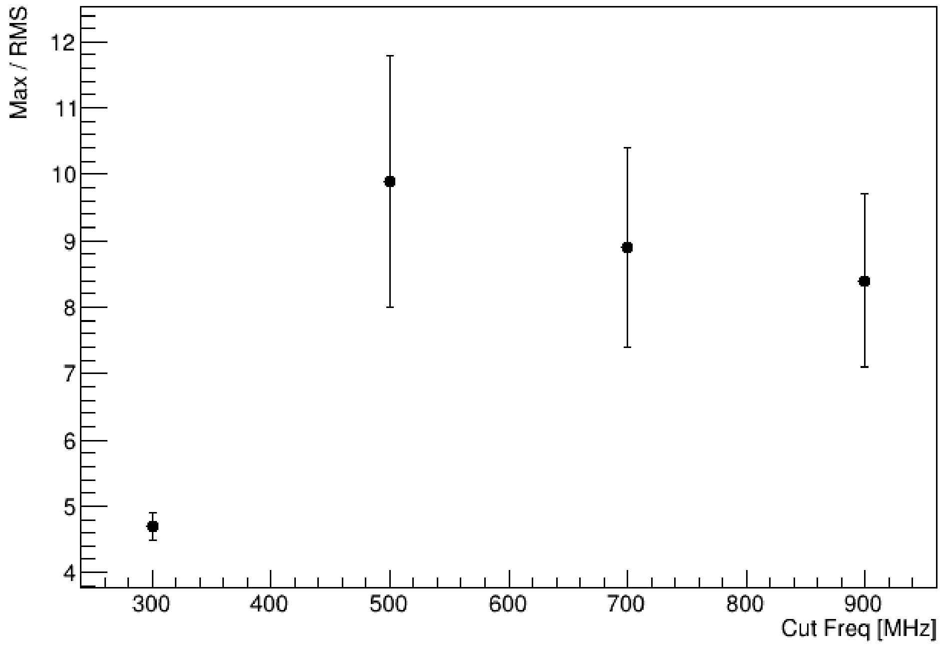



f=500 MHz



Trend of ratio vs frequency cut for noise waveform and signal waveform



# CONCLUSIONS

The treatment of noise with beat function need to be tested again.

The next step will be the implementation of the zero pole cancellation to reduce the decay time of signals.

All the noise removal procedure will be apply on the test beam data.