OPTIMISATION OF NOISE-FILTERING SYSTEM FOR DATA REDUCTION UNDER HIGH BACKGROUND.

In SND@LHC Experiment

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Abstract

The SND experiment focuses on the detection of neutrinos from particle collisions produced at the LHC, in a currently unexplored pseudo-rapidity range. colisions produced at the LHC, in a currently unexplored pseudo-rapidity range. The goal of this work is to eliminate most of the electronic noise maximize the efficiency. Currently SND is detecting only 100 neutrinos per year, therefore, any minimal change in the noise filtering or in the general conditions of the experiment, can achieve an increase in neutrino detection and therefore a greater achievement in the goal of the experiment.

SND@LHC Experiment

The SND@LHC experiment has been operational underground since 2022. It is located 450 meters away from the ATLAS experiments where protons collide. The experiment aims to collect information from all neutrinos, primarily emanating from charm decays, which will eventually strike the massive target at SND.

The experiment utilizes nuclear emulsion plates in the target to identify the vertex where the neutrinos interact with the nucleus. Additionally, information from the recoil charged particles is read out by the electronic detector, which includes A Veto stystem in the first part to detect charge particles, SciFi trackers, and an upstream part made of iron slabs and plastic scintillators to measure electromagnetic and hadronic showers, respectively.

With the current increase in muon background in the cavern due to changes in the accelerator, the system is recording more information than needed. This is primarily because it was designed to collect a low number of muon events during collisions; however, this number has now increased by a factor of three relative to the design and by a factor of two compared to last year's measurements.

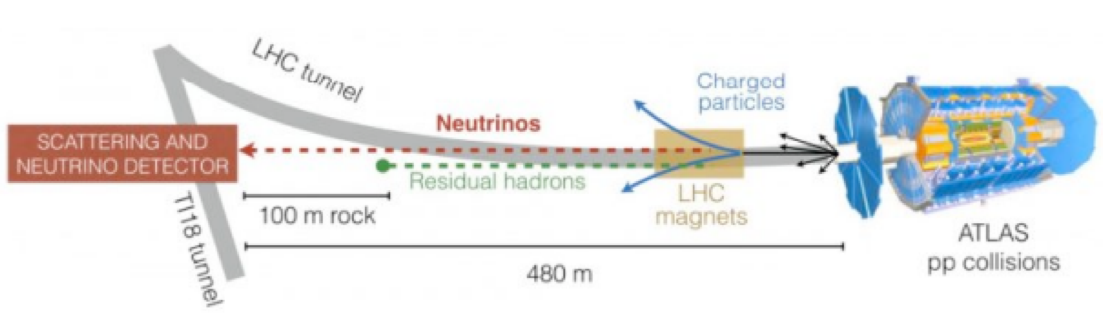

Figure 1: SND location in LHC tunnel

For this reason, the purpose of the project is to evaluate the noise associated with the measurements of the years 2022, 2023 and 2024 in order to estimate a trigger rate and thus in the future identify possible mitigations to reduce the number of non-relevant events in the Muons detectors at SND@LHC.

The electronics fornt-end used in the experiment is the "TOFPET2-ASIC" made by PETSYS, which has 64 channels and it used for all the subdetectors. the Chip is in charge of integrating the charge of the SIPM coupled to the either scintillating fibres or scintillating bars. The chip allows individual channel treshold adjuntments, wich can be based on the dark current rate (DCR) of the SiPMs In addition to this, the chip has an adjustable range of treshold, Load, T1 and T2.

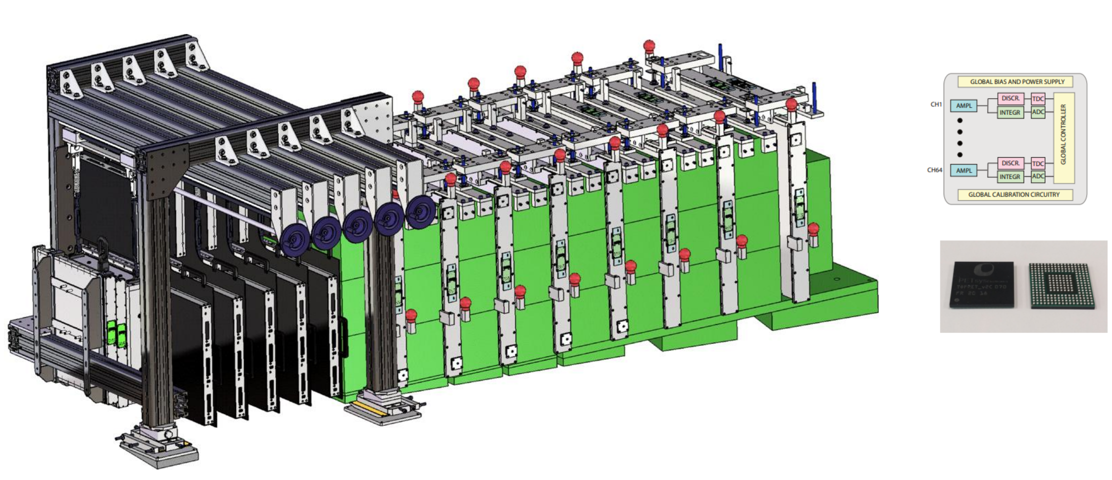

Figure 2: SND Profile : Detector and Electronics

Project Purpose

The Main Goal

Detection of neutrinos is extremely difficult due to their minimal interaction with matter. To identify neutrino signals in detectors, it is essential to have advanced noise filtering systems. These systems eliminate irrelevant signals generated by other particles or unrelated phenomena, helping to distinguish real neutrino interactions from false positives.

Currently, the SND@LHC experiment Without a good filtering system , detectors can accumulate a lot of background noise, making data interpretation difficult. Effective filtering is therefore crucial to obtain accurate and reliable measurements of neutrinos, ensuring that the results adequately reflect interaction events with these elusive particles.

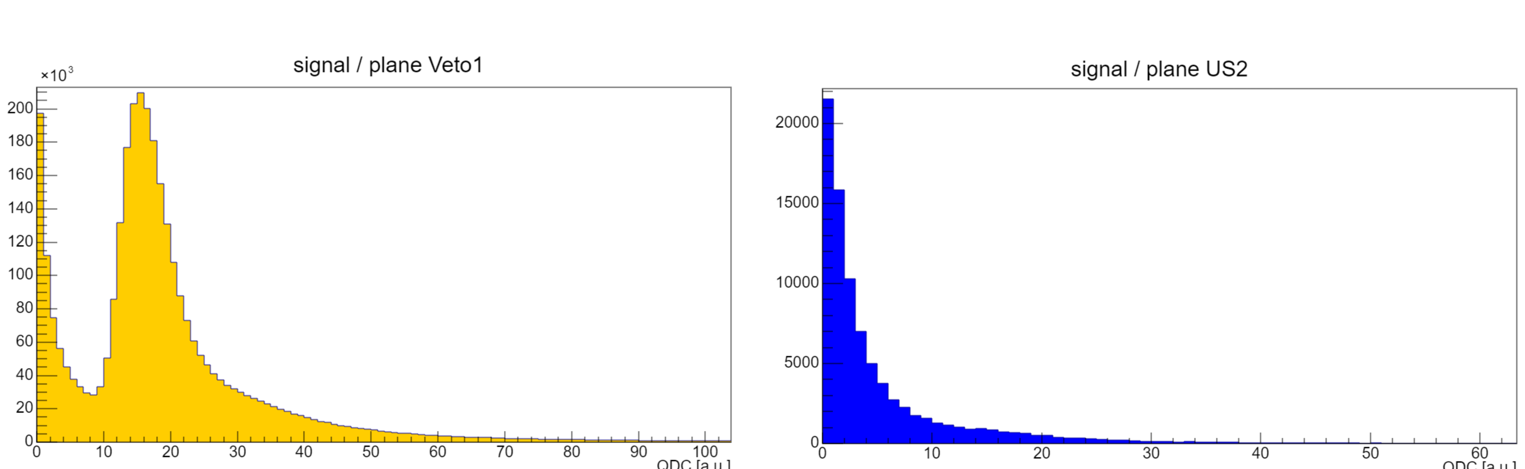

Figure 3: Histogram of Muons signal with noise

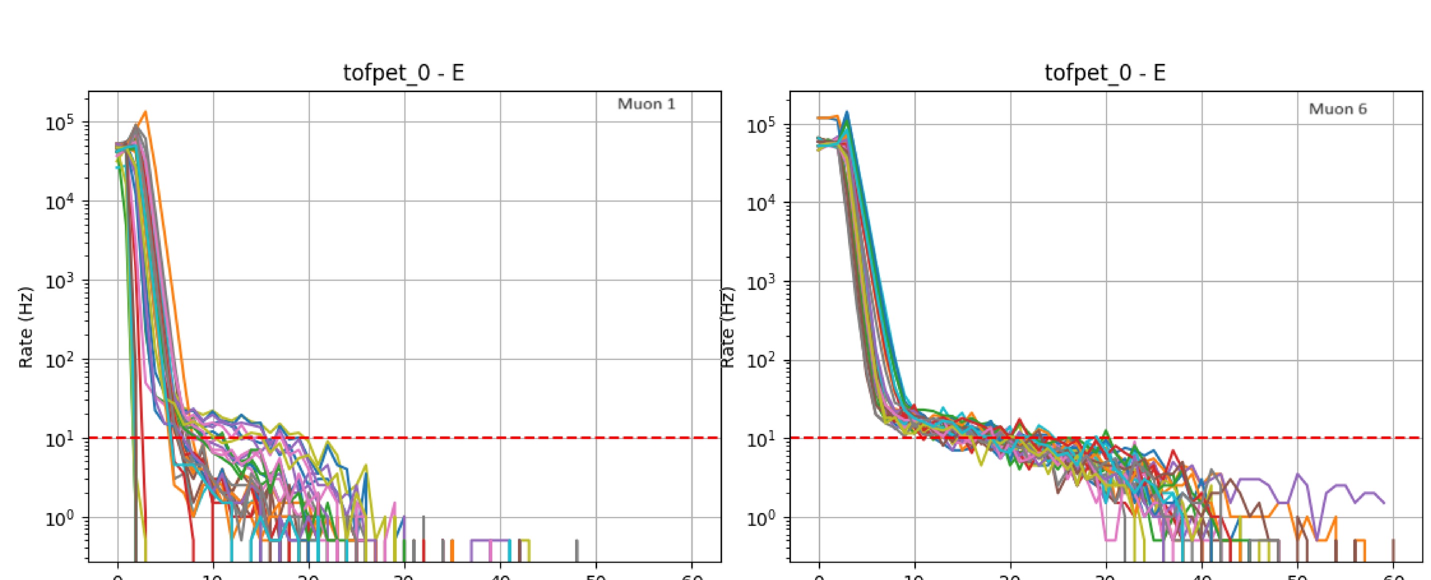

Figure 4: Dark Count Rates vs Treshold for one TOFPET

The plots shown above are based on different data acquisitions useful for the optimization of the noise system, as they give us a lot of information about the SND data. As for figure 3, these histograms are muon detections in which the associated noise can be appreciated. In Figure 4, we have for each tofpet the noise count frequency and its respective treshold. With this data, we can now start working and get results!

Method

To optimize the noise filtering system, it was planned to work in the following way.

- Data was obtained for each channel by varying the treshhold and evaluating the frequency of counts.
- A maximum frequency of 10 Hz was arbitrarily chosen for each treshold.
- A threshold associated with the count rate chosen for each tofpet was found.
- A treshold for each tofpet was obtained by averaging the threshold per channel.

In addition to this, in parallel, work was done with the load histograms. Following the following methodology.

- Using data from the years 2022, 2023, 2024. Charge histograms with notable noise were studied.
- The noise and signal were identified. Obtaining the maximum of both and their minimum.
- For Estimate level of noise inside signal level.

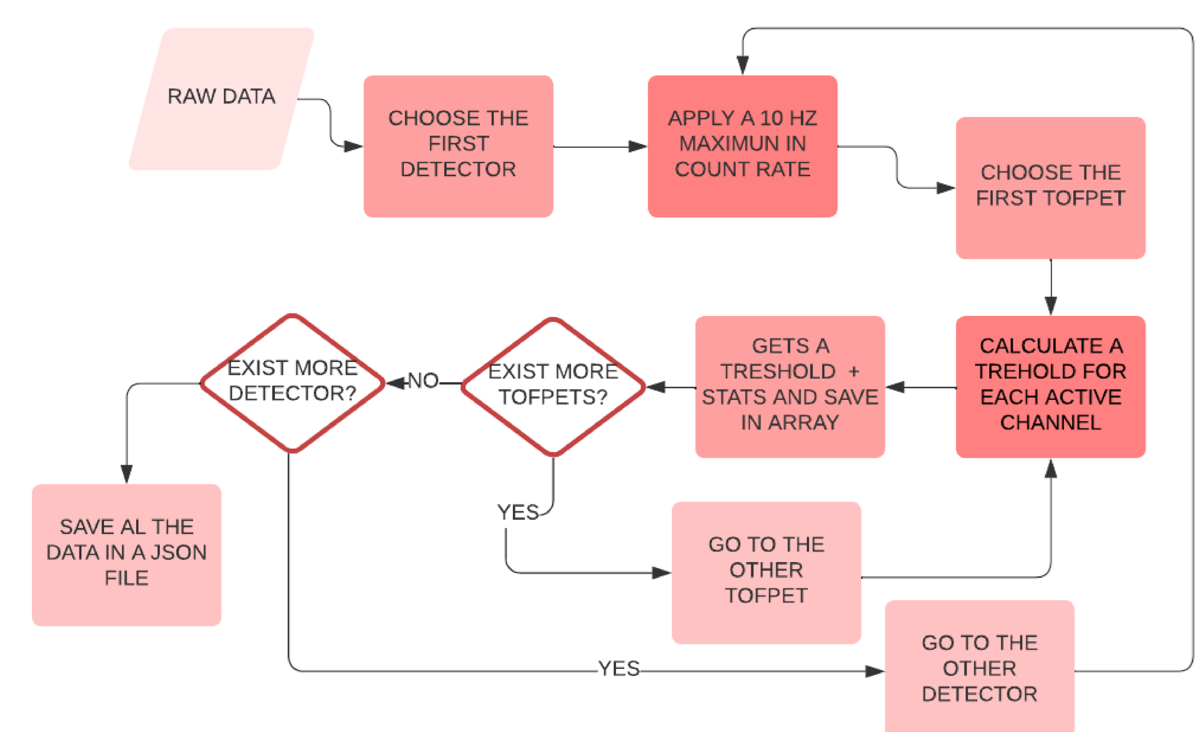

Figure 5: Method in a diagram.

Preliminary Results

First, we obtained the optimal thresholds for each tofpet of each detector, exemplified in the following plots

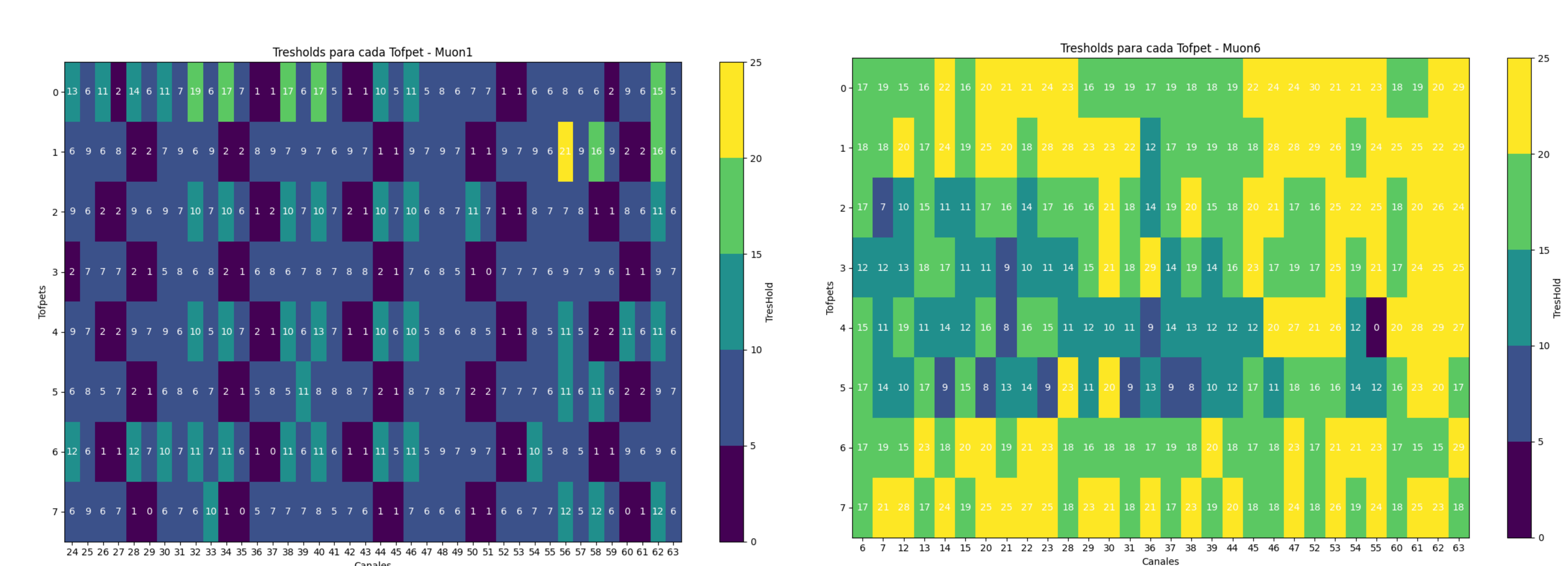

Figure 6: Heat map, TOFPET Vs Channel with color change for Treshold value .

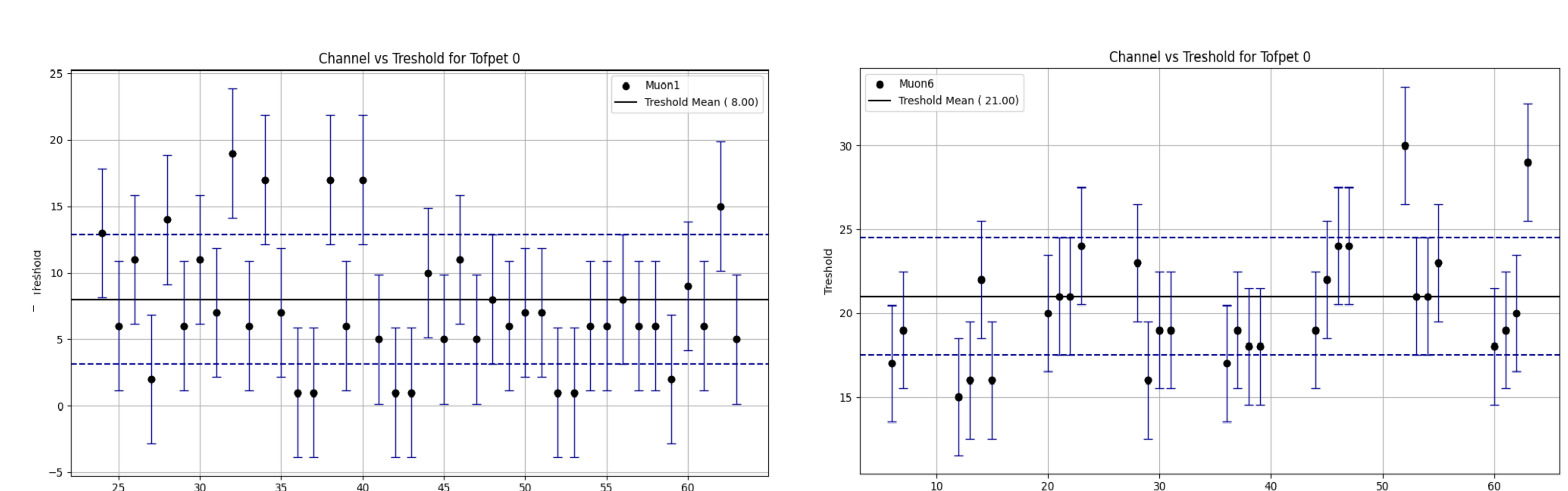

Figure 7: optimal Treshold + Stats per channel in one tofpet.

Conclusions and Future Work!

Although it is still too early to draw definitive conclusions, we can analyze the work done during these weeks. First of all, we have evaluated whether there is any noise that could interfere with the measurements. This assessment is crucial, as noise can significantly affect the accuracy of the data obtained. From this evaluation, we have defined a threshold to filter out as much of this noise as possible, thus improving the quality of the measurements.

- we have observed that each detector studied requires a different threshold.
- the digitizer chips and circuits are nominally the same, each exhibits relatively different behaviors.
- the mean treshold is around 8 - 13 but for some detectors like muon 6 the mean is incredibly bigger .

As for what remains to be done, there are still several measurements and tests to be made and these results are to be compared with the previous ones. In addition to this, we will continue to work on the load histograms and estimate the noise level of each signal. We still have 1 month of work to do !!!!