Preliminary setup of FERS on the miniSPD facility

Romakhov Sergey
A member of Straw-tracker team
Laboratory of High Energy Physics, JINR
romakhov@jinr.ru

Abstract

The poster delves into the intricate process of the preliminary setup and configuration of the Front-End Readout System (FERS) within the mini-SPD system, a pivotal component of the forthcoming primary detector for the NICA experiment. Developed by CAEN, the FERS DT5202 undergoes comprehensive testing to optimize its functionality, adapting to the unique conditions of the mini-SPD stand. This presentation outlines the essential results of equipment preparation, configuration, and initialization, emphasizing the critical aspects of adjustment, adaptation, and verification under the testing conditions of the mini-SPD stand. The focus extends beyond the setup process to include detailed investigations into cosmic ray phenomena. The research involves measuring the output of the DT5202 running in Spectroscopy and ToT mode, providing a nuanced understanding of the detector's behavior and response characteristics. Detailed analyses of multiphoton peaks, energy spectra, and staircase plots contribute to a comprehensive evaluation of the system.

Results

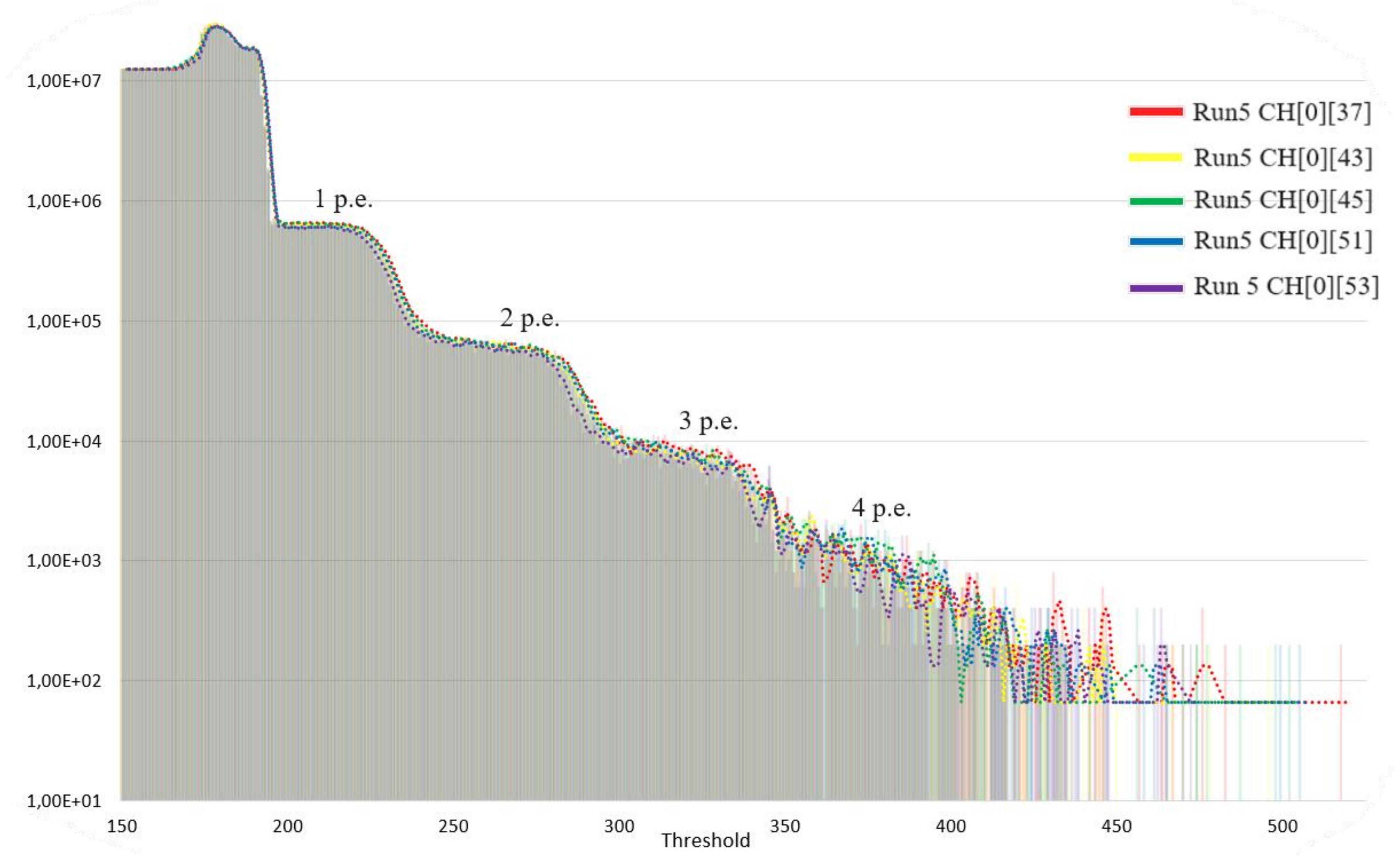

Fig. 3. Counts vs Threshold (Staircase) from the OR of the SiPM matrix pixels connected to high-gain channel of the DT5202.

The Staircase spectrum (fig. 3) is a plot illustrating the relationship between the threshold level set for triggering events and the corresponding counts observed in the detector.

- **Threshold Optimization:** The Staircase spectrum helps optimize the trigger threshold by identifying the level at which the detector starts registering valid events. It allows fine-tuning to capture signals of interest while minimizing noise.
- **Noise Characterization:** The spectrum provides insights into the noise characteristics of the system. Sudden jumps or variations in counts can indicate the presence of noise or spurious signals.
- **Photonic Peaks** (e.g., 1 p.e., 2 p.e., etc.) represents the detection of a specific number of photoelectrons (p.e.). As the threshold is lowered, the detector starts capturing individual photons, leading to distinguishable peaks in the spectrum.
- **Shape Variations:** The shape variations in the Staircase spectrum are indicative of the detector's response to different energy levels. Features such as the width of the peaks and the smoothness of the steps provide information about the energy resolution and noise characteristics of the system.

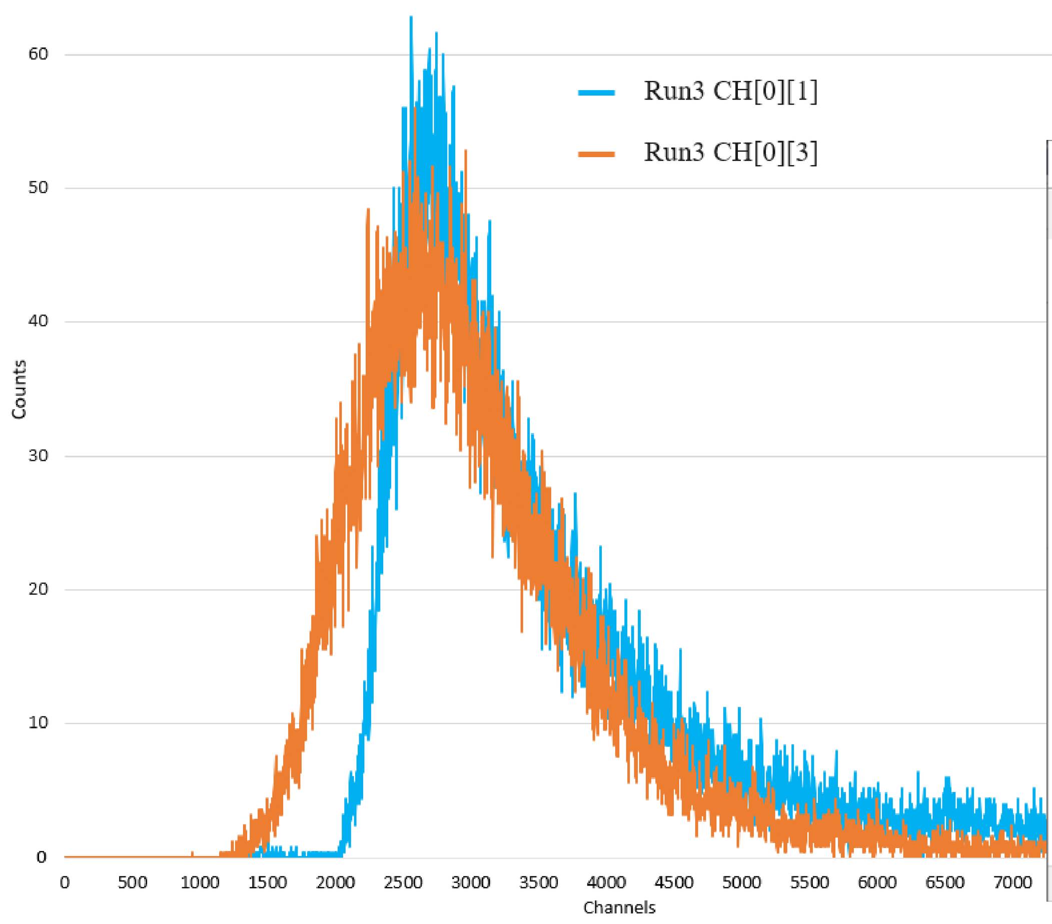

Fig. 5. Landau distribution of Cosmic Rays

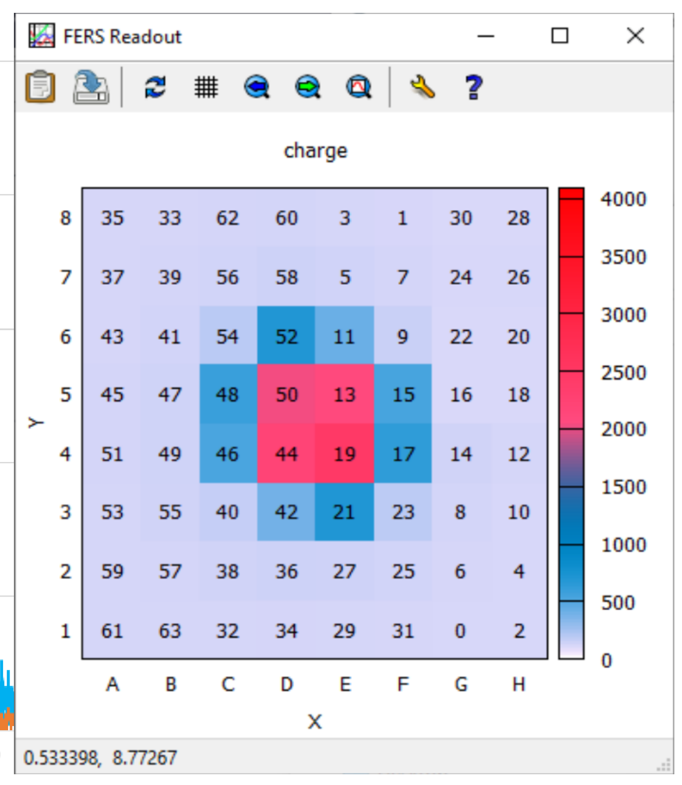

Fig. 6. 8x8 Charge-Trigger Matrix

The Landau Spectrum (fig. 5) illustrates the loss of energy distribution for relativistic muons, providing valuable insights into the energy dissipation characteristics of these cosmic particles. The peak represents the most probable energy loss, while the tail signifies rare events with higher energy dissipation.

Figure 6 presents a 8x8 matrix illustrating charge-trigger events in response to cosmic radiation. Each cell in the matrix corresponds to a specific position in the SiPM array, providing a visual representation of the spatial distribution of charge-trigger events.

MiniSPD and FERS-5200 System

MiniSPD is a facility for space muon testing of all types of detectors that will be used in the SPD facility. It includes a trigger system, straw, silicon and GEM trackers, electromagnetic calorimeter modules and a lead filter to remove the soft component of cosmic rays. The stand will be used to measure such important parameters as spatial and temporal resolution, efficiency, drift characteristics, gain, etc. The installation is also intended for testing the data collection system, slow control and online monitoring.

Fig. 1. General view of the 64-channel FERS unit for SiPM readout.

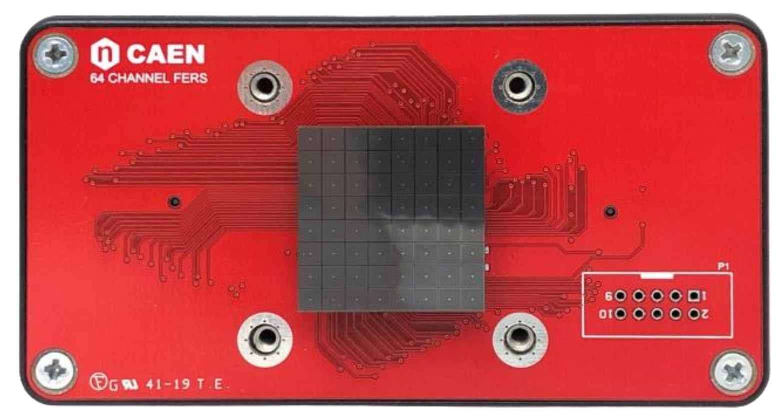

Fig. 2. General view of MPPS header adapter with Hamamatsu S13361 SiPM matrix.

FERS-5200[1] represents a distributed and easily scalable system, where each Front-End unit functions as a versatile card capable of various roles, including a traditional analog spectroscopy chain, a digital front-end (TDC or trigger logic board), or a switched capacitor array. The initial unit, DT5202 (fig. 1), utilizes the CITIROC 1A chip by Weeroc SaS[2] for SiPM readout. The data collection involves a specialized Hamamatsu S13361[3] series 64-channel SiPM matrix (fig. 2), providing high channel density and cost-effective integration into small-sized and low-power modules.

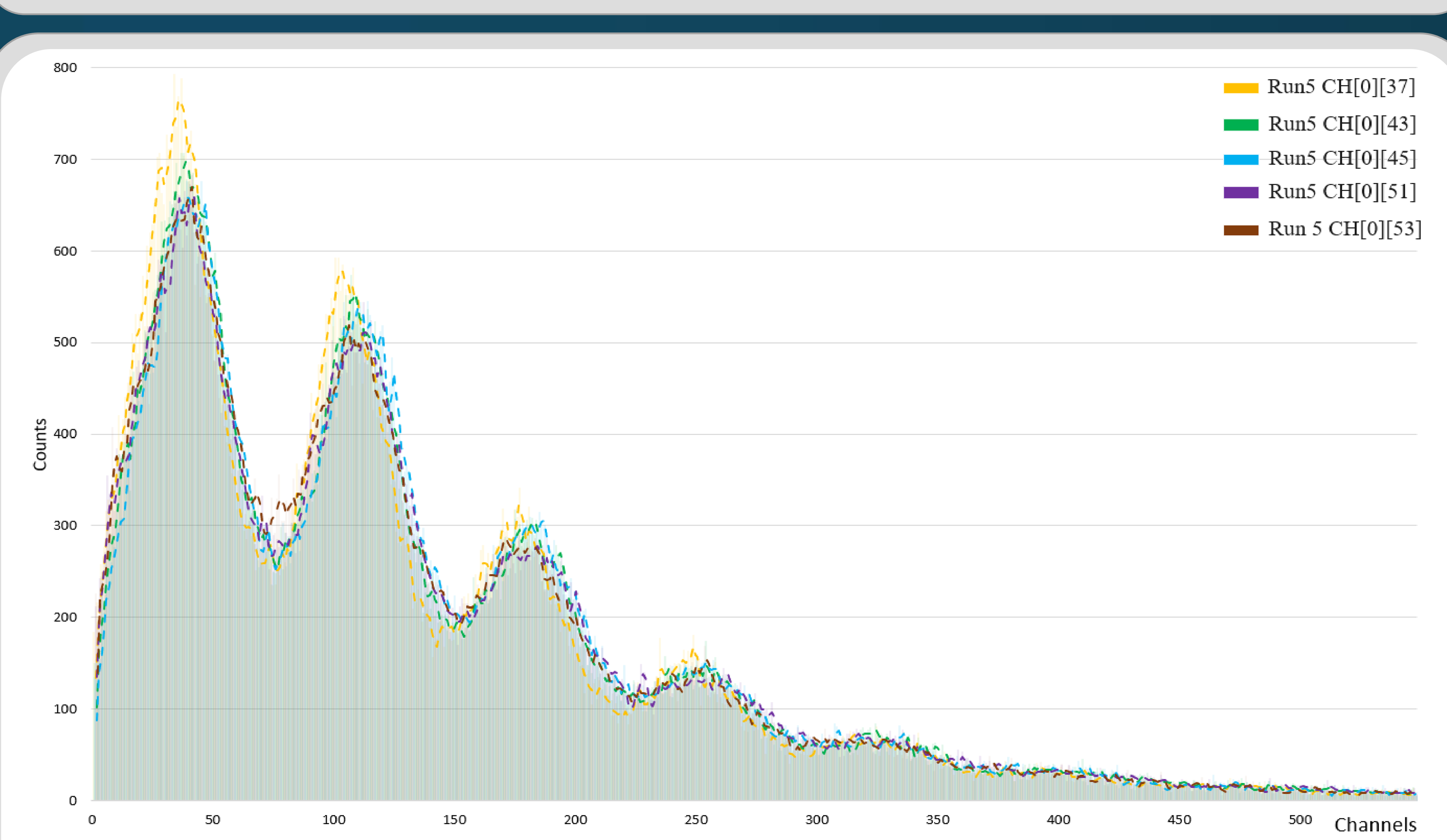

Fig. 4. Energy spectrum from high-gain channels of the DT5202,

The Multiphoton Spectrum (fig. 4) is a graphical representation illustrating the response of the DT5202 detector channels when the Hamamatsu S13361 matrix is illuminated with the LED driver.

- **Energy Characterization:** The Multiphoton Spectrum aids in characterizing the energy levels detected by the DT5202 channel when exposed to the illuminated Hamamatsu S13361 matrix.
- **Clearly Visible Peaks:** The spectrum exhibits distinct multiphoton peaks, each indicating the detection of a specific number of photons. These peaks provide insights into the discrete energy levels at which the DT5202 channel responds.
- **Energy peak calibration:** The clarity of these peaks indicates the accuracy of the detector in quantifying the energy levels of incoming photons. They also demonstrate the need to perform gain calibrations on each channel.

Conclusion

In conclusion, the provided data offers valuable insights into the continuous assessments of FERS-5200's performance. The system's adaptability, coupled with ongoing calibration processes, establishes it as a highly suitable candidate for seamless integration into diverse experiments with evolving requirements. Additionally, MiniSPD is specifically configured for cosmic muon tests, utilizing detectors and readout electronics from the NA64 experiment as its primary testing components.

Looking ahead, planned enhancements to the MiniSPD setup involve the exploration and integration of FERS, aligning with the broader goal of advancing experimental capabilities and understanding within the field of particle physics.

References

1. CAEN SpA, Italy [Online]. Available: https://www.caen.it/subfamilies/fers5200/, Accessed on: Oct. 20, 2020
2. Weeroc SaS, France, "CITIROC-1A Datasheet vers. 2.5". [Online]. Available: https://www.weeroc.com/my-weeroc/download-center/citiroc1a/16-citiroc1a-datasheet-v2-5. Accessed on: October 20, 2020.
3. Hamamatsu S13361 datasheet. Available: https://www.hamamatsu.com/eu/en/product/optical-sensors/mppc/mppc_mppc-array/S13361-3050AE-08.html.