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Readout electronics and data acquisition for gaseous tracking detectors

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A complete solution for collecting and processing data from gaseous tracking detectors has been developed. The readout chain consists of front-end modules (FEE) equipped with PASTTREC ASIC chips and Trigger Readout Board v3 (TRBv3) as readout platform, together with control and monitoring mechanisms and data quality assessment software.

PASTTREC chip is an 8-channel, fast amplifier and discriminator with Time-Over-Threshold (TOT). Highly configurable settings like gain (in a range between 1.8 and 10.5 mV/fC +- 25%), tail-cancellation, peaking time (10, 15, 20, 35 ns), individual baseline levels and common threshold allows for applications to various gaseous detector systems. Equivalent Noise Charge (ENC) remains in the range between 1000 and 1400 electrons even for the highest gain setting. The developed front-end modules have two PASTTREC chips installed and LVDS connection (slow-control and data channels) to the TRBv3 digitizing boards via dedicated adapters.

Trigger Readout Board v3 is an advanced platform for universal, configurable and scalable readout systems. Module consists of 5 FPGA devices, from which, one is the controller and four can be configured with various firmware as Time-to-Digital Converters (TDC), data concentrators or any other data processing units via dedicated mezzanine extension modules. Multiple TRBv3 modules can be interconnected in master-slave mode assuring high scalability with the use of optical fibers and HUB extension modules. Communication between modules is realized by custom TrbNet protocol, developed for this platform. It is characterized by three logical channels: trigger, readout data and slow control messages exchange. The logical trigger channel has a deterministic latency in message distribution. Measurement data exits the system via Gigabit Ethernet links under a form of UDP packets, sent through standard networks to PCs, therefore the solution is adaptable for various DAQ systems.

The PASTTREC as well as TRBv3 configuration is performed as register read/write messages exchange between PC and the master TRBv3 module, with a user-friendly, WEB based interface. Collected measurement data can be analyzed online by the Go4 framework or developed ROOT-based macros for in-depth data quality assessment, including track finder and visualization.

The entire system has been evaluated in the laboratory as well as in-beam experiments. The results show drift-time measurement as well as TOT precision of 1 ns and a high counting rate performance, reaching up to 1MHz per channel. Measured PASTTREC operation characteristics as well as TRBv3 platform used for readout allow to adapt and integrate the system under discussion to the existing HADES spectrometer and PANDA detector, an experiment under construction, both located at FAIR facility in Darmstadt.

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