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ALICE SAMPA-ASIC Second-Prototype Qualification Studies for LHC Run 3 and Beyond

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The ALICE experiment at the LHC plans an upgrade of its TPC, due to the expected high Pb-Pb collision-rate after the shutdown of LHC in 2018. In the upgraded TPC, Gas Electron Multiplier (GEM) chambers and continuous readout system will replace MWPC chambers and conventional triggered readout, respectively. In the continuous readout, GEM signals will be processed using 32 channels of SAMPA ASIC (preamplifier and ADC). The SAMPA second-prototype was delivered in 2016 and the production of the final version is in progress. During the presentation, test results of the SAMPA coupled with GEM detector prototype will be presented.

Summary

During Run3 the interaction rate of lead ions at the ALICE experiment at the LHC is expected to be 50 kHz. Due to these high collision rates, the Multi-Wire Proportional Chambers of the present ALICE TPC will be replaced by readout chambers featuring Gas Electron Multiplier (GEM) foils. A continuous readout system will replace the existing triggered readout.

In the upgraded TPC readout, the current signals from the GEM detector pads will be readout by Front-End Cards (FECs) via custom-made SAMPA ASICs. The SAMPA contains a charge-sensitive preamplifier, a shaper, a 10 bit 10 MHz digitizer and a digital filter, processing and data compression chain. In the FECs, the output of the SAMPA will be multiplexed and transmitted using GigaBit Transceivers (GBTx) via optical links to a Common Readout Unit (CRU). The CRU is an interface to the on-line computer farm, trigger and detector control system. The upgraded readout system will utilize 3400 FECs, each containing 5 SAMPA ASICs (32 channels each), and in total of about 500k channels. The data rate from SAMPA to CRU via GBTx will be 1 TBytes/s.

This presentation will be focused on the qualification studies of the second prototype of the SAMPA ASIC. These studies are done using waveform generator and GEM detector prototype. The tests performed using waveform generator showed an excellent pulse shape stability and gain linearity at various input charges (5 fC to 110 fC). A significant improvement is observed in the noise and cross-talk performance of the present SAMPA as compared to its older version.

The SAMPA prototype performance is also studied by coupling it to the GEM detector prototype which consists of a stack of four 10 x10 mm^2 GEM foils with S-LP-LP-S configuration. Here S and LP refer to standard and large pitch, respectively, while pitch defines the distance between GEM holes. The GEM foil configuration is optimized to keep ion back-flow below 1%. The survival studies of the SAMPA input-protection from the GEM discharges will also be reported. The GEM discharges are created using two different alpha sources: firstly a standard Am-241 source followed by a gaseous Rn220 alpha source. The first source produced more localized sparks while the other source irradiates the detector volume more uniformly. The results obtained from these tests meet the ALICE TPC requirement and helped to finalize the SAMPA ASIC design. This work is relevant to the workshop topic Highly Integrated Detector and Electronics.

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