

Readout system for high resolution resistive plate chambers

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We describe our apparatus built to track cosmic muons using Resistive Plate Chambers (RPC). The system consists of 12 RPCs (50 cm X 50 cm) each one coupled with 330 strips (1.5 mm pitch) and readout by means of MAROC multiplexing chips. We also present the current version of the system, where the readout is implemented using ASICs. The new system is characterized by high modularity and uses the IPBus protocol for configuration of the boards and data readout. Each RPC module is a self triggering unit and all the communications with the central DAQ are performed over Ethernet.

Summary

We have built and tested a muon tracker prototype based on 12 Resistive Plate Chambers (RPC) to perform Muon Scattering Tomography. This technique relies on a very accurate reconstruction of the muon traversing the detector to identify regions where the track is subject to large scattering angles (typically 20-30 millirads) due to interactions with high-Z materials.

The detectors (50 cm x 50 cm) are coupled with a total of ~ 4000 strips (1.5 mm pitch) and paired in six vertically stacked cassettes, each cassette providing X-Y information on the muon track. The charge induced on individual pickup strips is readout, digitized and saved to disk to be analyzed. In this way we can reconstruct the hit position of the muon on each layer with a resolution of ~1 mm, efficiency above 99% and purity above 95%. To cope with the large number of electronic channels we used multiplexing chips widely adopted in high energy physics experiment. This solution allowed us to greatly reduce the number of readout lines and digital convertes: currently only 12 ADC channels are required, one per RPC.

We are now in the process of upgrading the system with new readout boards designed in Bristol and carrying five MAROC chips developed at Laboratoire de l'Accelérateur Lineaire.

The readout boards communicate with Spartan-6 FPGA development kits which interface with the rest of the DAQ using the IPBus protocol. A pc running LabVIEW is in charge of board configuration and data reading; all the communications are performed over Ethernet.

The new readout system increases the modularity of the setup since the cassettes no longer need an external ADC to digitize the samples and the digital data can be transferred to any pc connected to a local area network. The MAROC built-in ADC converters can work with an external trigger or self-trigger whenever the signal strip exceeds a threshold value. In this way each cassette becomes a trigger unit with two RPCs.

When a trigger occurs a time stamp is associated to it and saved in a circular FIFO to be read from the DAQ pc.

The preliminary studies on a single MAROC board have been successful and we are now deploying the new readout on the full system.

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