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MARTA's DAQ system

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We successfully developed, built and tested a low power and stand alone DAQ system to be used with RPCs to measure the muonic component of air showers in the framework of MARTA. The MARTA system includes a front-end readout, high voltage, detector monitoring and a central unit to manage the different components of the system. The front-end is based on the MAROC ASIC coupled to an FPGA respecting the strict demands of field operations in Cosmic Ray experiments. Prototypes were produced and deployed, performing as expected. An engineering array will be installed at the Pierre Auger Observatory.

Summary

Muon Array with RPCs for Tagging Air showers (MARTA) was designed to measure the muonic component of the extensive air showers (EAS) that are created when a high energy cosmic ray interacts at the top of the atmosphere.
Extensive air showers can be detected using Cherenkov water tanks.
Light particles are absorbed in the tank while muons, which are deeply penetrating, cross the tank.
In a MARTA station, detector units are placed in a concrete structure below the water tank to detect the muonic content.
Each unit consists of a Resistive Plate Chamber (RPC) detector, HV, RPC monitoring and a front-end that are placed inside a aluminum box.
A central unit will be responsible for communications, trigger, data transfer and power distribution for the units of each station.
These detectors are expected to be deployed in the field where the environment is not favorable, with space and power limitations and harsh weather conditions.
Moreover, an engineering array as a proof of concept will be installed at Auger.

In this work, we will present the DAQ that was created and developed to read the fast RPC signals and sustain the adverse conditions presented in the field.
RPCs are mostly used in laboratory and only now are starting to be being tested in the field.
Other than be able to read the fast RPC pulses, this system also needs to be low power, compact, stable and reliable for low maintenance operation.
The center piece of the DAQ is the front-end.
Due to the space and power limitations it is based on a low power ASIC: MAROC3n developed by OMEGA.
The ASIC is able to perform a simple threshold measurement (hit) as well as measure the charge that is deposited by the avalanche in the detector.
An FPGA is responsible for the control of the ASIC.
It will also receive and store the ASICs digital outputs before they are sent out to the central unit.

After optimizing the ASIC's parameters to measure the RPC signals, validation tests were performed to both the hit and charge measurement.
The hit measurement results show a similar performance for different temperatures.
Efficiency measurements were obtained simultaneously using MARTA's front-end and an establish one with compatible results.
The charge measurement was studied for different ASIC's and RPC's configurations and several spectra acquired that are consistent with the spectra measured in the past for this kind of detectors.

The trigger used will be given by the water tank DAQ.
It is typically of the order of 100 MHz which is compatible with the dead times of the measurements.
The central unit is based on a FPGA with a dual-core ARM processor.
It is connected via LVDS to the front-ends for fast communication and I2C to the monitoring and HV.
It is also connected to a server via ethernet where data will be stored.

The first prototype station is expected to be installed in the next couple of months as production of the detectors, electronics and structures are already complete.

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