TWEPP 2021 Topical Workshop on Electronics for Particle Physics

Contribution ID: **146** Type: **Poster**

A modular and flexible data acquisition system for a cosmic rays detector network

Tuesday 21 September 2021 17:56 (2 minutes)

We describe a modular data acquisition system developed as the foundation of a cosmic ray detector network. Each detector setup is composed of an independent hardware device that can be controlled and read out through the Internet. This device is designed to acquire and process the signal of up to eight different detector planes. Each of these detector planes uses plastic scintillator slabs that are optically coupled to silicon photomultipliers (SiPM). The main readout is based on a programmable system-on-a-chip (PSoC), a flexible and re-configurable commodity hardware that is used to implement the trigger and timing logic.

Summary (500 words)

The detection of cosmic rays using simple apparatuses for quantitative data-taking has been explored over the years by several initiatives around the world for outreach and experimental High Energy Physics instrumentation teaching. The possibility to connect geographically dispersed stations synchronized by a GPS timing signal allows for a larger detection area suitable for the identification of high-energy cosmic rays showers. In order for such a system to be deployed in a high school or science museum environment (hence for outreach purposes), it must be safe (no flammable gases or high voltages) and ideally low cost, so the network can comprise as many stations as possible. The use of plastic scintillators, SiPMs, and commodity electronic hardware allows the project to fulfill this objective. The readout, timing, and trigger implementation supports a variety of geometries and even other cosmic rays detection methods (Cerenkov) that can be easily deployed in the system by a simple reconfiguration of the hardware. This enables a variety of experiments to be performed with a single design, thus reducing the complexity and costs of the system construction and operation.

Each station is an autonomous hardware (and firmware) unity that detects cosmic ray events and transmits the raw data to the software stack through the Internet. These stations are composed of up to four Frontend modules, in which the scintillators, SiPMs, and the analog section of the electronics are located in separate boards and a Backend module aggregating the trigger, timing, data acquisition, event building, and network communication functions.

The current system uses 4mm x 4mm SiPMs sensors that can be installed as an array of up to four sensors mounted on dedicated PCBs. The SiPMs are attached to a plastic scintillator slab using optical grease. The current design is able to use scintillator slabs as thick as 20mm. An EEPROM device installed in each detection board allows for matching the inventory of built boards with the boards deployed in a given site. The system is sealed in a light-proof aluminum container and the connection to the readout electronics made by a flat cable. Two LEDs can be pulsed in order to provide a light signal for debugging and calibration.

Each Frontend holds a two-channel voltage amplifier followed by a discriminator circuit. Each channel can sum up the signal from two SiPMs or be ganged together to sum the signal from four sensors when a thicker scintillator slab is used. A minimum detection system can comprise only one Frontend module with two separate channels, and detect the passage of cosmic rays by requiring the coincidence of the two signals.

The Backend module is a single board responsible for the trigger, timing, and data acquisition. The power for all the station and network connectivity is also provided through the Backend. Up to four Frontend modules can be connected to a single Backend module through a commodity HDMI cable in which the four differential lanes are used to carry two digitized SiPM and two LED calibration signals.

Primary authors: SAITO, Guilherme Tomio (Universidade de Sao Paulo (BR)); LISBOA LEITE, Marco (Universidade de Sao Paulo (BR)); Mr MENEGASSO, Ricardo (Universidade de Sao Paulo (BR)); ESTEVAM DE PAULA, Rodrigo (Universidade de Sao Paulo (BR)); GAMEIRO MUNHOZ, Marcelo (Universidade de Sao Paulo (BR)); KURIYAMA, Marcel Keiji (Universidade de Sao Paulo (BR))

Presenter: SAITO, Guilherme Tomio (Universidade de Sao Paulo (BR))

Session Classification: Posters Systems, Planning, Installation, Commissioning and Running Experience

Track Classification: Systems, Planning, Installation, Commissioning and Running Experience