The New Trigger/GPS Module for the EEE Project

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The Extreme Energy Events (EEE) Project

The EEE Project [1] [2] is an experiment devoted to the study of the Extensive Atmospheric Showers (EAS). This is accomplished through a network of muon telescopes based on position-sensitive Multigap Resistive Plate Chambers (MRPCs). The telescopes are located inside Italian High Schools so young students are directly involved in assembling and monitoring telescopes, with the aim to introduce them to the methods and results of High Energy Physics. The EEE muon telescope network has been extended since 2008, reaching at present 57 MRPCs telescopes, spread across a very large area of 3 x 10^5 km²

The detection of an EAS is achieved by measuring the coincidences in time recorded at different sites of the EEE Telescopes Array [3]. Coincidences between stations at Savona, ~1.2 km apart, are perfectly compatible with the precision timing requirement of the EEE telescopes. The difference between the signals from the reference module 1PPSr and from the other modules 1PPSr was measured with an oscilloscope.

The Global Time Stamping resolution of the cosmic ray event σGPS should be the sum of:

- σGPSr, which depends on the signals from MRPCs [5] and on TDC resolution (100 ps)
- σGPS, time resolution for 1PPS

σGPS = σGPSr + σGPS

The EEE Data acquisition System

The DAQ of the EEE system is based on VME standard.

Each telescope is equipped with a trigger unit and a GPS receiver to record the universal time of each event.

- EE Telescope at Liceo L.B Alberti, Cagliari

The new Trigger/GPS Module for the EEE telescopes was developed, including an embedded GPS engine for timing application. That allows extracting the event time stamping at level of the trigger unit, avoiding time drifts.

The Trigger Unit

- A 6-fold coincidence (within a 500 ns window) of the OR-signals from both FRONT-END cards of the 3 MRPCs, generates the data acquisition Trigger
- The trigger unit performs the count values of the triple (Trigger) chambers coincidences, the 3 doubles, the 3 single, and 6-FRONT-END outputs for testing purpose (efficiency measurements)

The GPS Interface

- The GPS unit feeds both the TDCs with its clock disciplined to the one pulse per second signal (1PPS) to synchronize the TDCs internal counters
- At each 1PPS pulse the TDCs internal counters are reset
- Every time an event trigger occurs, the module feeds into each TDC a signal and the TDC stamps its time. The absolute time of an event is built as the TDCs event time plus the GPS timestamp for each 1PPS
- The LaView DMM system directly sorts out and puts the data from the two TDCs into single events, reads out the module at appropriate times and inserts the GPS time values within the data stream at the correct record.

Summary

The Trigger/GPS Modules have been produced and tested. Time resolution measurements for 1PPS between different boards and the mean distribution exhibit adequate stability in time. Time Stamp jitter measurements are perfectly compatible with the precision timing requirement of the EEE telescopes.

References

[1] Centro Fermi web site: http://www.centrofermi.it/docs