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Performances of the EUSO-Balloon electronics

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The 24th of August 2014, the EUSO-BALLOON instrument went for a night flight for several hours, 40 km above Timmins (Canada) balloon launching site, concretizing the hard work of an important part of the JEM-EUSO collaboration started 3 years before. This instrument consists of a telescope made of two lenses and a complex electronic chain divided in two mains sub-systems: the PDM (photo detector module) and the DP (data processing). Each of them is made of several innovative elements developed and tested in a short time. This paper presents their performances before, during and after the flight.

Summary

The satellite project JEM-EUSO aims to observe Extensive Air Shower produced in the atmosphere by high energetic extraterrestrial particles above 10^{19} eV, by detecting the released fluorescent UV photons; thanks to Multi-anode photomultipliers (MAPMT) arranged in 6x6 matrices inside Photo Detector Modules (PDM). In order to assess the concept and the technology foreseen, in conditions close to the ones prevailing in space, the EUSO-BALLOON project came to life in September 2011 with the support of CNES and the JEM-EUSO collaboration.

The EUSO-BALLOON instrument is composed by a set of 2 Fresnel lenses, a single PDM of 2304 pixels, a DP (data processing) system, a power pack (batteries) and an infra-red camera.
The lenses are meant to focus the photons on the PDM which can be compared to a UV camera taking pictures every 2.5 us (GTU). The different elements of the PDM are the following:

- 9 EC (elementary cell) units made of four MAPMTs and a set of 3 front end boards which are used to supply 14 different high voltages and to collect the analog signals of each MAPMT

- 6 EC_ASIC boards, each one welcoming six SPACIROC ASICs used to readout the MAPMT analog signals and detect the individual photons in each channel (photon counting)

- A High Voltage Power Supply providing the 14 voltages to each EC unit and including a switch system used to downgrade the gain of the MAPMTs The PDM board, interfacing with the EC-ASIC boards, the HVPS and boards from the DP. Its main component is a Virtex6 FPGA which contains the logic to manage the interfaces and handle the configuration and the data coming out of the 36 ASICs

The DP system is composed by a set of boards located in the same crate:

- The CPU which interfaces with the Cluster Control Board (commands and data), the data storage (DST), the House Keeping board (telemetry, commands, data) and the CNES SIREN unit (communication ground-balloon).

- The CCB collects, processes and classifies the data from the PDM board before transmitting them to the CPU

- The CLK board distributes the clock signals to all electronic devices and interfaces with the GPS receiver (position and absolute time for each event)

- The DST stores all the data and information collected

- The HK distributes tele-commands and collects telemetry from several sub-systems

- The Low Voltage Power Supplies provide all the different sub-systems with proper voltages and power

All these elements went through a prototype phase followed by the production and the tests of the flight models and finally the assembly and integration tests. This last phase ended in July 2014 with the green light from CNES to go for the August balloon campaign in Timmins (Canada). After less than two weeks of work, the instrument was ready and flew for several hours with success the 24th of August 2014.

This paper will present in detail the performances of the electronics before, during and after the flight.

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