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The readout electronic of EUSO-Balloon experiment

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A complex readout electronic chain has been designed for the EUSO-Balloon project. It contains two elements: the EC units (9 of them) and the EC-ASIC boards (6). The EC unit includes 64-channel Multi-Anode Photomultipliers and a set of pcbs used to supply the 14 different high voltages needed by the MAPMTs and to read out the analog output signals. These signals are transmitted to the EC-ASIC boards which contain 6 SPACIROC ASICs each. During the year 2012, prototypes of each board were produced and tested successfully, leading to the production of the flight model pcbs.

Summary

EUSO-Balloon experiment is a pathfinder for the satellite mission JEM-EUSO [1] which goal will be to observe Extensive Air Shower produced in the atmosphere by the passage of the high energetic extraterrestrial particles above 10^19 eV. Both instruments (balloon and satellite) will detect fluorescent UV photons released by the EAS thanks to Multi-anode photomultipliers (MAPMT) arranged in 6x6 matrices inside Photo Detector Modules. A set of lenses is used to focus the photons on the PDM which can be compared to a UV camera taking pictures every 2.5 ⊠s period (GTU).

The aim of the experiment is to launch a balloon, at 40 km of altitude, equipped with complete Photo Detector Module (PDM) and Data Processing systems. This project, supported by CNES, involves the whole JEM-EUSO collaboration and is meant to prove that constructing such an instrument is technologically possible and that the performances are satisfying. Moreover, complex trigger algorithms will be assessed and the main back ground (night glow) will be studied.

The readout electronic of the PDM can be divided in two parts:
• 9 EC (elementary cell) units
• 6 EC_ASIC boards, each one welcoming six SPACIROC ASICs

The EC units consist in four MAPMTs, arranged in a matrix of 2x2, and a set of 3 different boards (EC_dynode, EC_anode and EC_HV) which are used to supply 14 different high voltages (ranging from 20 V to 1000 V) and to collect the analog signals of the 64 channels of each MAPMT.
These analog signals are sent to the EC_ASIC boards, which are complex pcbs welcoming six SPACIROC ASICs [2]. This microelectronic chip has two main measuring modes running in parallel: the photon counting mode for each input and the charge-to-time conversion for groups of 8 channels, respectively allowing counting the number of photons detected in each pixel of the PDM and estimating the charge generated by the photons. The design was done using AMS SiGe 0.35µm process. The final chip dimensions are 4.6 mm x 4.1 mm (19 mm^2).

The main specifications of this readout electronic are the following:
• Individual photon counting with a trigger efficiency of 100% for charger greater than 50 fC (1/3 of photoelectron for a gain of 10^6)
• Low power consumption (e.g. 1 mW/channel for the ASIC)
• Compactness of the boards to fit in the restricted volume available in the mechanic of the PDM
• Potting of the parts involving high voltage to avoid destructive sparking due to the low pressure (3 mbar) at 40 km of altitude

The tests carried out on the prototypes built during the year 2012, showed that the strategy taken was appropriate and that these specifications were satisfied thoroughly. During 2013, the flight model instrument will be integrated and tested before being launched in 2014.

This paper will present in detail the design of the EC unit and EC_ASIC as well as the tests performed on the prototypes.

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