The HEPD-02 trigger and PMT readout system for the CSES-Limadou mission

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Abstract

This contribution describes the trigger and PMT readout board (T&PMT) of the High-Energy Particle Detector, which will be placed onboard the second China Seismo-Electromagnetic Satellite for CSES-Limadou mission.
The ongoing work on the T&PMT board consists in the verification of its functionalities and its compliance with the HEPD design specifications and in the characterization of its components, next developments are the integration of the board with the other systems on the detector and the environmental testing of the whole system.

The HEPD-02 detector for the CSES-Limadou mission

The High-Energy Particle Detector for the CSES-Limadou mission [1] will detect **electrons** and **protons** in energetic ranges that go from 3 to 100 MeV for electrons and from 30 to 200 MeV for protons.

It will be composed by [2][3]:

- a **tracker** made of CMOS sensors, surrounded by two segmented planes of plastic scintillator used for **trigger** signals generation;
- a **calorimeter** composed by twelve planes of plastic scintillator and two segmented planes of an inorganic scintillator called LYSO;
- a **VETO** system realized with five scintillator planes that surround the detector.

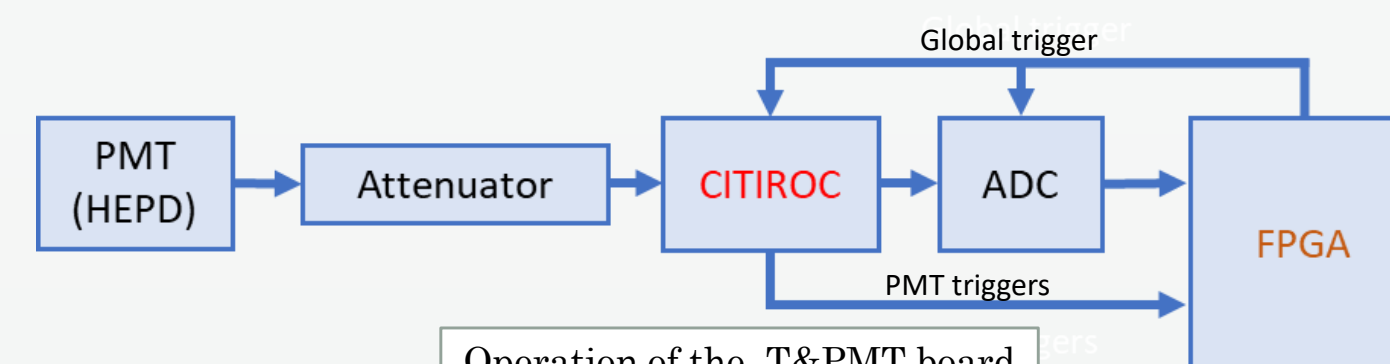Each scintillator is coupled with two PMTs.
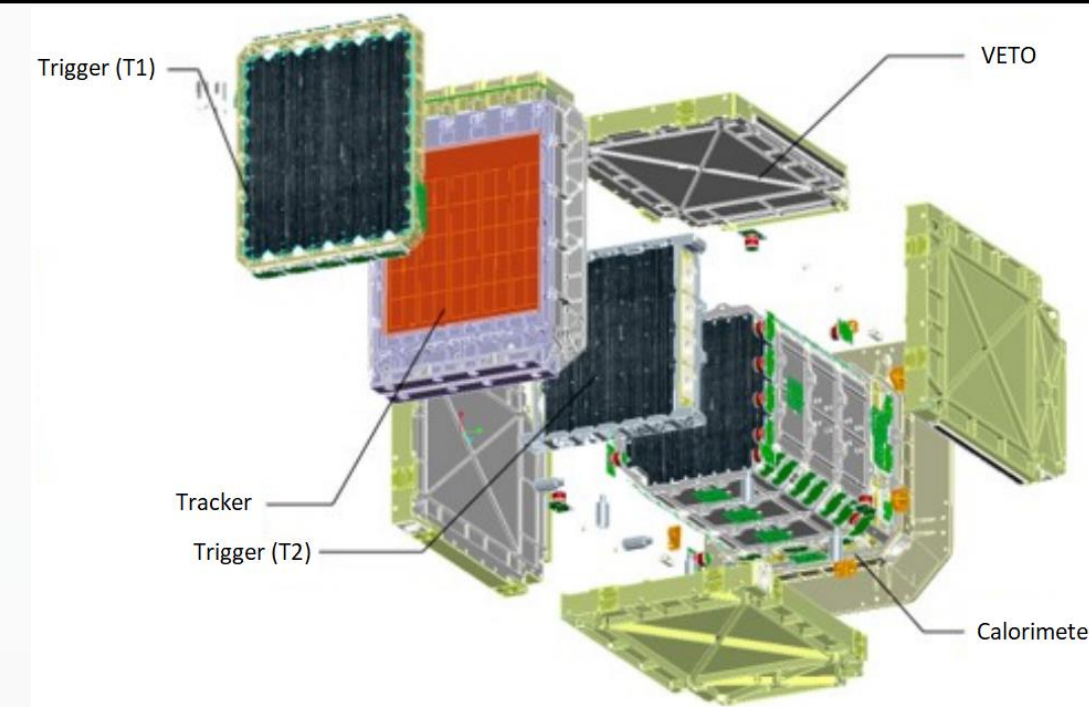
The HEPD-02 structure

The electronics of the detector is composed by four main boards:

- The data acquisition board (DAQ)
- The CPU board [4]
- The trigger and PMT readout board
- The telemetry/telecommand board

The trigger and PMT readout board

The T&PMT board


Operation of the T&PMT board

The 64 PMTs of the HEPD are acquired by an electronic board [5] based on **CITIROC read-out integrated circuits by Weeroc.**

CITIROCs are designed for the **amplification, shaping and sampling** of photomultiplier signals and produce the **triggers** for every PMT. Trigger signals produced by CITIROCs are acquired by an **FPGA** that implement various **trigger masks** to match different orbital zones and particles and produces the **global trigger** signal which enables CITIROCs outputs and starts the ADC conversion.

Characterization and measurements

The ongoing work consists in the characterization and optimization of the **Engineering Model** of the board in sight of the development of the **Qualification Model.** The following measurements are in progress:
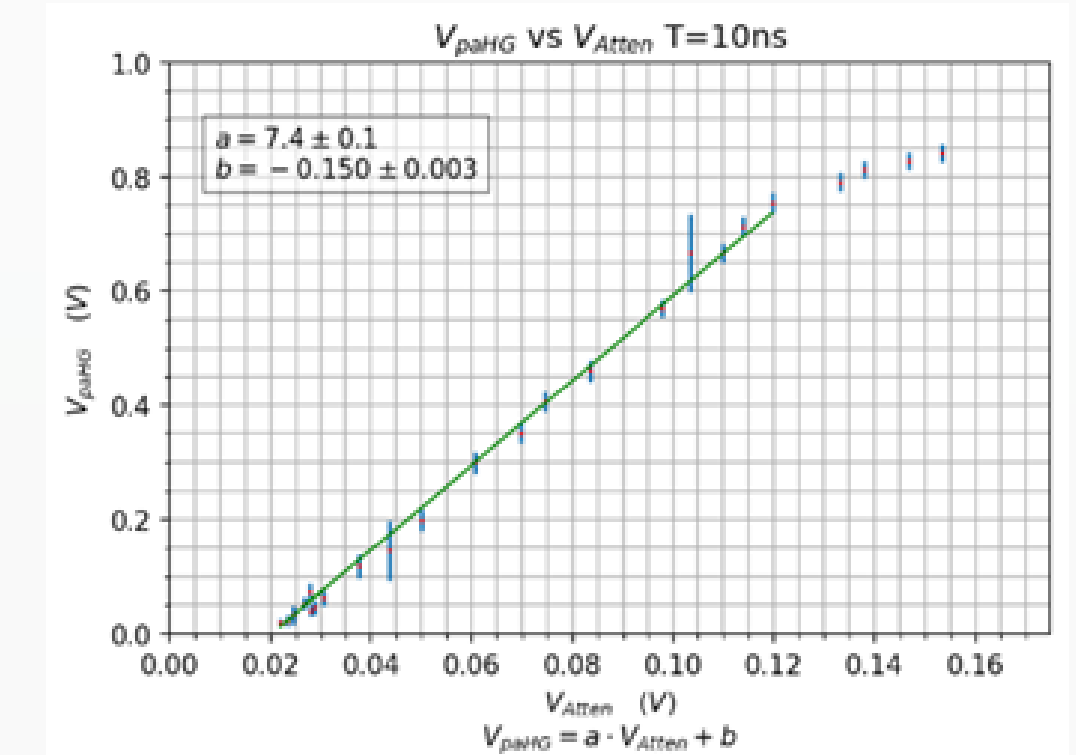
Threshold measurements

Treshold at ~5p.e. for a PMT with gain of $G = 6 \cdot 10^6$ and trigger efficiency of 90%
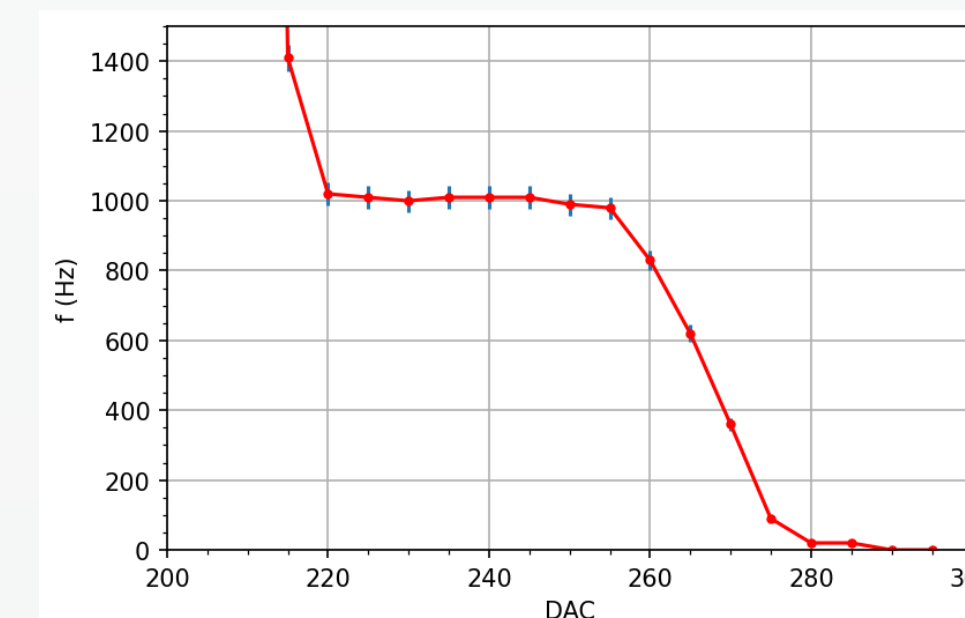
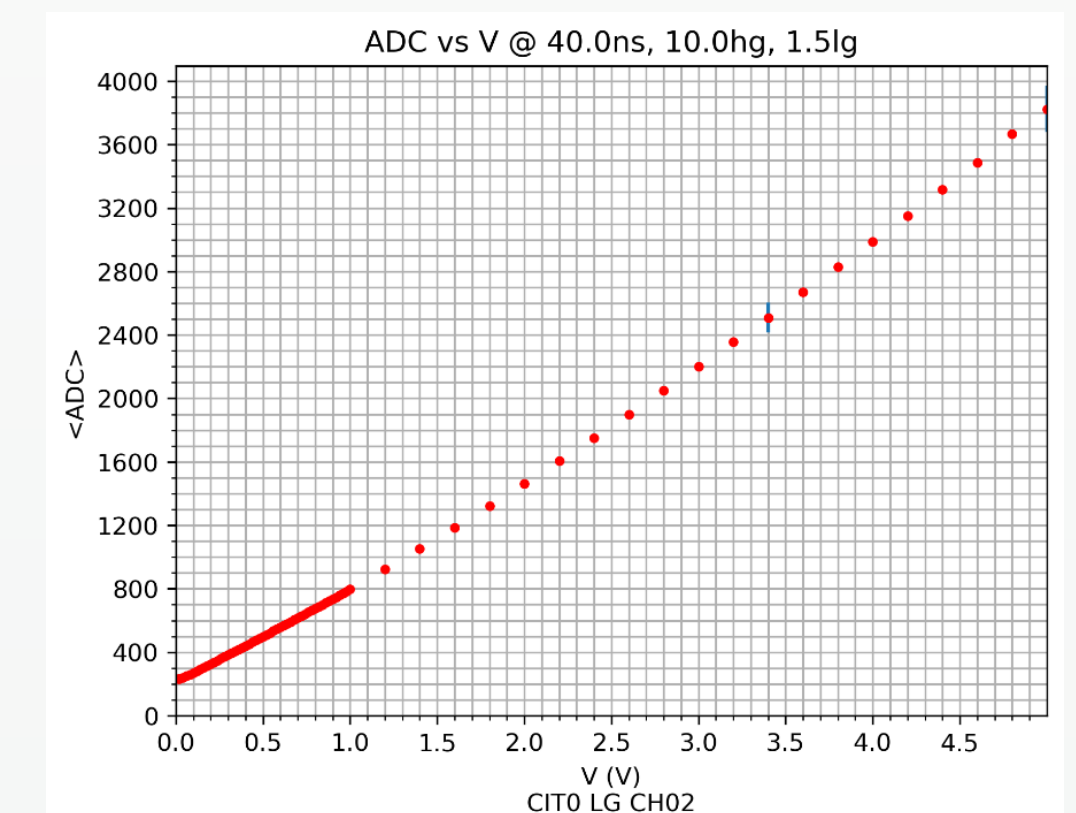
Trigger frequency vs DAC values for 30mV signals
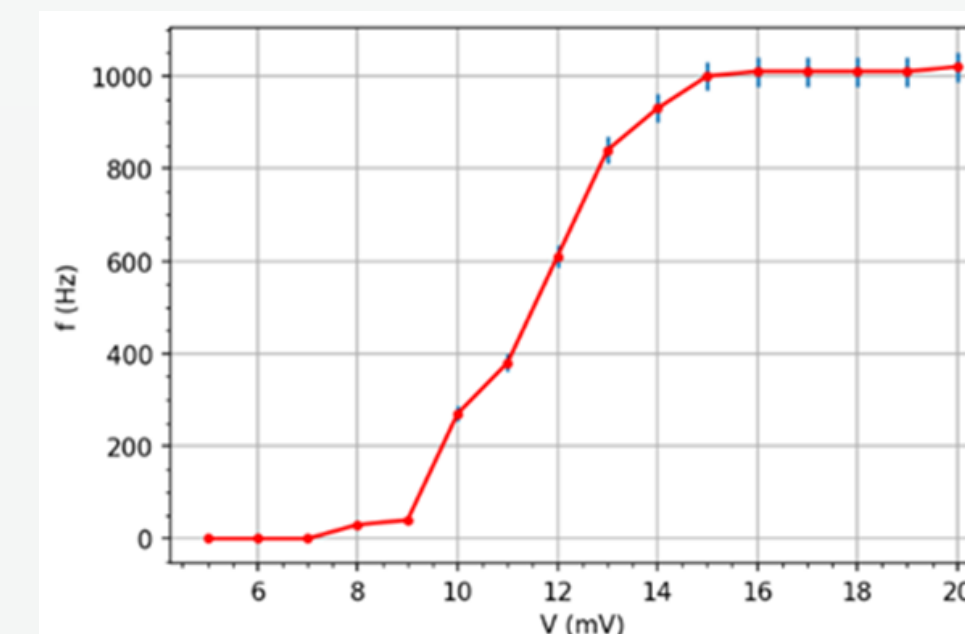
Trigger frequency vs signal amplitude @ DAC=225

Characterization of the signal conditioning circuit and calibration curves for CITIROCs

High Gain preamplifier calibration curve

ADC counts vs signal amplitude for 40ns pulses

References

[1] C. De Santis et al. 101873

[2] V. Scotti et al. IEEE (NSS/MIC) 9059936

[3] R. Iuppa et al. 101774

[4] G. Masciantonio et al. 101752

[5] V. Scotti et al. IEEE (NSS/MIC/RTSD) 8069878