

The LAGO (Large Aperture GRB Observatory) in Peru

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Abstract. The Large Aperture GRBs Observatory is a continental-wide observatory devised to detect high energy (around 100 GeV) component of Gamma Ray Bursts (GRBs), by using the single particle technique in arrays of Water Cherenkov Detectors (WCDs) at high mountain sites of Argentina, Bolivia, Colombia, Guatemala, Mexico, Venezuela and Peru. Details of the installation and operation of the detectors in Marcapomacocha in Peru at 4550 m.a.s.l. are given. The detector calibration method will also be shown.

Keywords. GRB, Gamma Rays.

1. Introduction

The LAGO (Large Aperture GRBs Observatory) international collaboration goal is to observe high energy component (around 100 GeV) of Gamma Ray Bursts (GRBs) through Water Cherenkov Detectors (WCDs) in high mountain sites, (Bertou 2008) using the single particle technique (Aglietta *et al.* 1996). When a GRB occurs, the atmosphere is impacted by a multitude of high energy gamma rays that produce decay showers. Together those showers are detectable at ground level as an instant excess in the flux measured by a detector. Gamma ray showers have a composition of 90 % photons, 9% electrons and < 1% muons, WCDs are sensitive to all those particles. These showers are absorbed high in the atmosphere, not being able to survive and reach the ground. In order to detect the greatest possible number of particles, the water Cherenkov tank must be placed at high altitude. Peru is in an initial phase. We have built two detectors, located at 4450 m.a.s.l. in Marcapomacocha-Huancayo, and a third one is under construction in the same location.

2. Experimental Setup

The LAGO project is using electronic acquisition and photomultiplier tubes (PMTs) from the engineering array of the Pierre Auger Observatory (PAO), (Pierre Auger Collaboration 2004). As data storage, we use an ARM computer which has a low power consumption (less than 1 watt) and resists extreme temperatures (-40 °C to 85 °C). At high altitude locations in Peru it is difficult to get stable power sources but the low consumption requirements of this system allows the use of solar panels and batteries. The WCD consists of a commercial cylindrical polyethylene tanks of 4m², with a large area PMT located in the central upper section. It has an internal cover of banner to ensure a good reflexivity and diffusivity and it is shielded from external light. The WCDs are filled with clear water up to 1.3m in order to ensure a high probability of photon conversion inside the tank. The water treatment must be done on the site. Filtered water is collected in a polyethylene tank and treated with aluminum sulfate, then is left to sediment

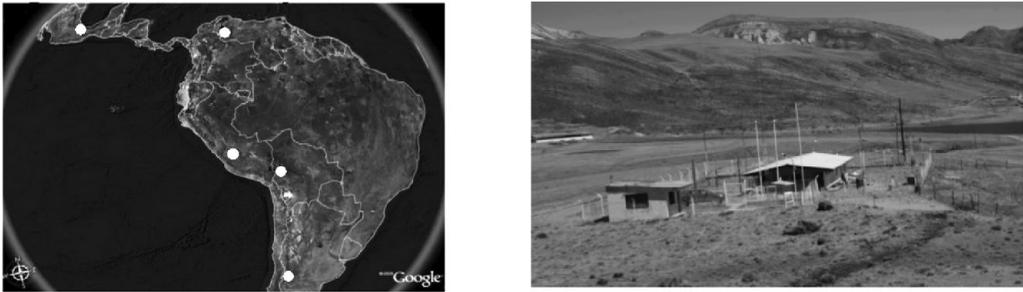


Figure 1. The left panel hand picture shows the stations of LAGO in Sierra Negra (Mexico), Pico Espejo (Venezuela), Marcapomacocha (Peru), Chacaltaya (Bolivia) and Bariloche (Argentina). The right panel hand picture shows a view of the Marcapomacocha site.

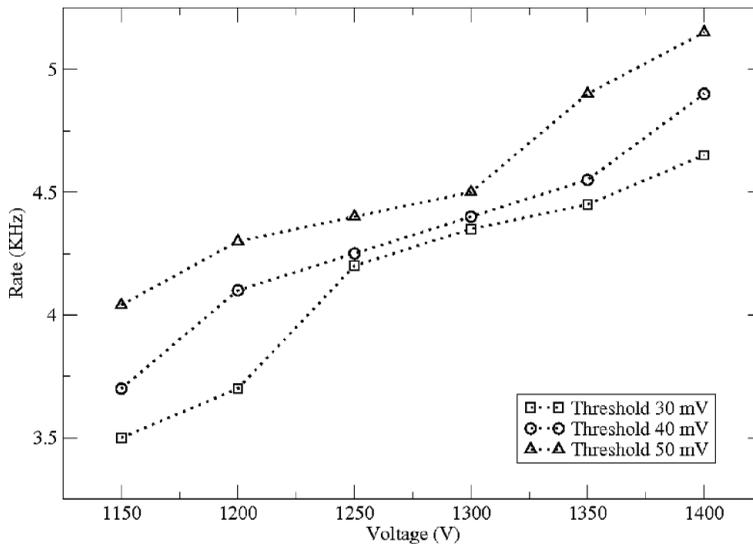


Figure 2. Total rate of charge pulses in one minute for thresholds 30, 40 and 50 mV.

for about a week. After that, the water pass to the WCDs through three filters of 20, 5 and 1 micra and 2 activated carbon filters, leaving behind the sediment, finally chlorination is made inside the WCD.

The signal from the PMT is digitalized by an adquisition board (Local Station, LS) of the engineering array of the PAO. It has six channels that sampled the data at 40 MHz. The content of four scalers per channel is read out every 5 ms. and it is send by serial line to an ARM computer.

3. Calibration of the Detectors

The FPGA(Field Programmable Gate Array) of the LS allows the read out of the distribution of the charge of the pulses generated in the WCD by secondary cosmic rays. We choose the high voltage applied to the PMT at 1250 V by the condition that the rate of cosmic rays is maintained linear in a range of $\pm 50V$ (See Fig.2). A secondary

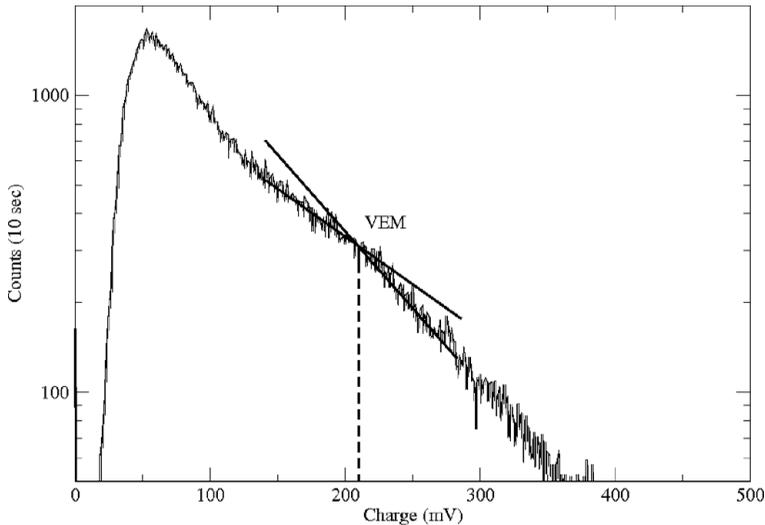


Figure 3. First calibration data: distributions of charge of the signal of the secondary cosmic rays traversing the WCD tank in 10 seconds, the VEM (Vertical Energetic Muon) position is extrapolated from the change in the slope of the charge plot).

peak in the distribution due to atmospheric vertical muons is expected at an energy of 260 MeV (muons deposit 200 MeV/cm when they cross water). Calibration points are obtained by finding a change in the slope of the distribution of charge (see Fig. 3).

4. Conclusions

A first WCD of 4m² has been installed in Peru at 4450 m.a.s.l. at Marcapomacocha site. The procedure for water treatment and calibration of the detectors has been developed.

Acknowledgements

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References

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