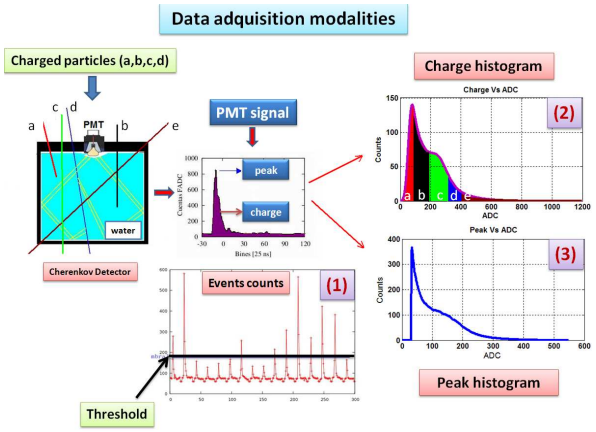

Fig. 2. High energy charged particles (a, b, c, d, e) produce Cherenkov Radiation in the water. The Cherenkov ligth fills the entire volume of water due to diffuse reflection on the tyvek. A light portion is collected by the PMT. The signal can be acdquiered as single events (1), charge (2) or peak histogram (3).

• at the Centro Atómico Bariloche in Argentina, a prototype is used for calibration and software tests since 2006;

• in Caracas and Mérida, Venezuela, Bucaramanga, Colombia, Lima and Cuzco, Perú, prototypes are taking data at the universities;

• at Pico Espejo, in Mérida, Venezuela, three 4 m^2 WCD have been installed at 4750 m.a.s.l. Unfortunately, the Mérida cablecar which allowed to reach the detectors had a failure and was shut down in 2008.

In the future, new detectors are expected in the north of Chile and Argentina, in Brazil and Guatemala. Many high altitude sites are available in Peru and are being surveyed. Whenever the Mérida cable car reopens, the Pico Espejo site will be instrumented.

2.2. *Experimental Setup*

All WCD share similar characteristics (see Figure 2). They are filled with high quality purified water up to a level of 1.2 to 1.5 m, ensuring a full efficiency for photon detection through pair production in the water volume. The water is contained in a reflective and diffusive bag, made either of Tyvek or Banner, to achieve optimal uniformity of the detector response, independently on the direction and entry point of the particle in the detector. The water volume is overlooked by a single photomultiplier tube, usually of 8″. The signal is digitized and readout by prototype electronics from the Engineering phase of the Pierre Auger Observatory, with custom made programming both of the DAQ CPU and of the low level FPGA trigger. New electronics is being developed for LAGO and the complete replacement of the currently used electronics is foreseen for 2011. The FPGA have been programmed to provide every 5 ms 4 scalers per channel. The thresholds are set depending on the PMTs characteristics (gain and noise). At Sierra Negra, they are set to about 15, 150 and 600 MeV deposited in the WCD, while a special scaler counts undershoots. At Chacaltaya, where higher gain phototubes are available, they are set to 1/2, 5 and 20 photoelectrons (about 2, 25 and 100 MeV deposited), with the same undershoot counter. The undershoot counter allows detecting High Frequency noise pick up on the cables. This is necessary to discriminate HF noise produced in electric storms from bursts of particles.

Monitoring and calibrating a WCD at high altitude is a more complex task than at sea level. The characteristic hump left by muons in a WCD (such as the one used for calibrating the Pierre Auger Observatory WCDs, see (Bertou et al. 2006) is smeared by the large background of electrons, positrons and photons. While the muon hump is almost indistinguishable on a pulse amplitude histogram, a characteristic shoulder can be seen on a charge histogram, shown on Figure 2. One can therefore use this break point to intercalibrate detectors. The rate obtained for values above the break point (about 600 Hz m^{-2}) in Sierra Negra for example) is compatible with a muonic origin. It is important to note that as we are going to work in amplitude (scalers), we need to correct for different charge to amplitude ratio from different detectors. We therefore determine the average charge to peak ratio for each detector at the level of the break, and use this ratio to fix a threshold in amplitude equivalent to one muon for each WCD.

3. ONGOING RESEARCH

3.1. *GRB Data analysis*

A first way to find the high energy component of GRB using ground based WCD is to look at their signal when a GRB is reported by a satellite. A search for signal within 100 seconds of a GRB reported by a satellite was performed on data taken from early 2007 to April 2009. The Gamma-Ray Burst Online Index (GRBOX) was used to extract bursts data and those happening for each site with an apparent zenith angle lower than 60 degrees were selected. A site is requested to have at least 2 detectors in operation at that moment, removing noisy detectors. 21 bursts for Chacaltaya and 20 for Sierra Negra passed these criteria, with one burst occurring in the field