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TASET
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Foreword

Dear Participants,

We welcome you to 5th International Science and Technology Conference. We accepts Scientific papers of Oral, Poster and Video Presentation in all scientific areas of social and natural sciences. We organizes scientific and technological conference in popular places of the World. Many participants all around the World participate in the conference from U.S.A. to South Africa.

Almost 5 years ago we started to organise the International Science and Technology conferences in Turkish Republic of Northern Cyprus with about 200 papers submitted all around the World. In present conference, more than 400 papers were accepted from various countries Algeria to Poland. Some selected papers presented in the conference will be published in The Online Journal of Science and Technology.

Our goal is to rewiev and accept all kinds of scientific research paper. We are approaching to 5th ISTEC 2014 conference held in Doha, Qatar between 18-20 December 2014. We are welcome all attendees coming and joining the conference.

I will thank to the participants all around the World for supports by sending their valuable scientific works to present in the conference.

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Barış BORU

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Information Acquisition System and sensitive position detector for atmospheric muon prospecting

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Abstract. When subatomic particles pass through a material, their flux is reduced by the interactions with the atoms of the medium. This attenuation is directly related to the density and composition of the material. Measuring the absorption of particles passing through a volcano, a density distribution of the interior can be derived, e.g., allowing to know the internal channels of the structure (Tanaka 2003, 2005, 2007). In order to implement these measures, a detector sensitive to its position, as well as a robust Information Acquisition System (IAS) is required. It needs low power consumption and the possibility of remote monitoring, because the IAS will be placed too far and with non-optimal environmental conditions for this type of electronic equipment. Currently, commercial electronics that allow us to implement such systems exist, able to operate under standard CAMAC (Computer Automated Mesurament And Control) or VME (Vesa Module Europe). This paper presents the IAS as a prototype detector used to detect muons. An IAS-detector similar but larger could be used later to observe the volcano Citlaltepetl, Puebla, Mexico.

Keywords: Instrumentation Technologies: CAMAC -- VME; Particle Physics: Muons; Information Adquisition Systems: Photomultiplier Tubes -- C/C++ -- CAEN – LECROY – ROOT.

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Introduction

Due to the interaction of cosmic rays with the Earth's atmosphere, a shower of subatomic particles called muons occurs. This rain is nearly constant, with an approximate flux (at sea level) of one muon per square centimeter per minute, with no preference in its direction of arrival. In addition, a muon of high energy (> 100 GeV) can travel several hundred feet through solid matter before losing all its energy (Marteau 2012; Nagamine 1995). In general, it will lose energy at a rate of 2MeV/cm medium density (Stefaan 2010). These muons have proved to be useful for prospective studies in monumental structures. Tanaka and colleagues (Tanaka 2003, 2005, 2007) have demonstrated the possibility of using an X-ray muon type technique using quasi-horizontal muons to study the internal structure of volcanoes. Developing this technology in Mexico is important because it is a country with large mountain chains, with volcanoes that have different forms of activity and are relatively close to urban centers.

Therefore, the first part of this article explains the design, construction and operation of a prototype detector of atmospheric muons, as well as the necessary instrumentation to monitor Mexican volcanoes. This prototype can be the basis for a larger sensor that can be installed on the slopes of Citlaltépetl or Pico de Orizaba volcano, since the infrastructure (electricity, fiber optics) generated by the observatory HAWC is already in place, and would facilitate operating the detector and learn about potential problems that could arise when operating a remote sensor on the slopes of a volcano, as shown in Figure 1.

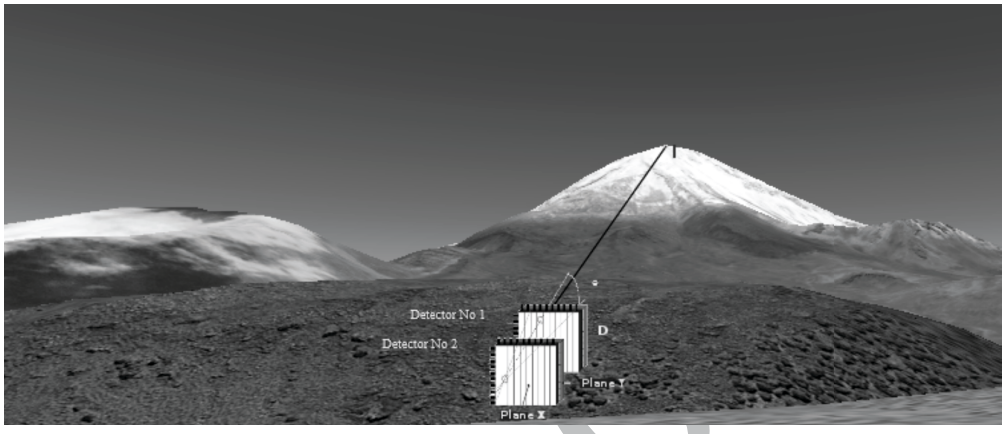

Figure 1: Experimental setup of the detectors at the observing site.

It continues with a description of the equipment that was used and the basis of the programming for the acquisition system of the prototype, which was developed in C and C ++ with the protocol CAMAC, originally developed in the 1960´s for the nuclear research industry (CERN). It is followed by a brief explanation of the possible use of the protocol VME, European Version Modules for its acronym in English, and the basic similarities of the electronic interconnection systems between modules.

Muon Detector

The detection system will comprise two counters (detectors), placed as shown in the example in Figure 1. Each counter is composed of two planes of scintillator plastic, aligned and spaced 1.6m. Each scintillator plane will consist of 20 bars of 45 x 4.5 cm and 1.5 cm thick, 10 vertically positioned (x´s plane) and 10 placed horizontally (y´s plane), whose intersections form a matrix of 10x10 (100) pixels with 4.5 x 4.5 cm^2 of sensitive area each. A photomultiplier will be placed in each scintillator bar, taking 40 electronic channels in total for two counters. A muon passing through both detectors will generate two nearly simultaneous signals, a signal in a pixel of the first counter and a second signal in a pixel of the second counter, so that the muon path could be reconstructed and therefore its direction can be traced.

The detector will be placed where the HAWC Gamma Ray Observatory is located, at 5327m of the volcano, which has the necessary infrastructure for its operation already in place. The Pico de Orizaba volcano is within the territorial limits of the states of Puebla and Veracruz, has an altitude of 5715m above sea level. Its crater is elliptical with major axis of 478m and minor axis of 410m, and depth of 300m. See Figure 2.

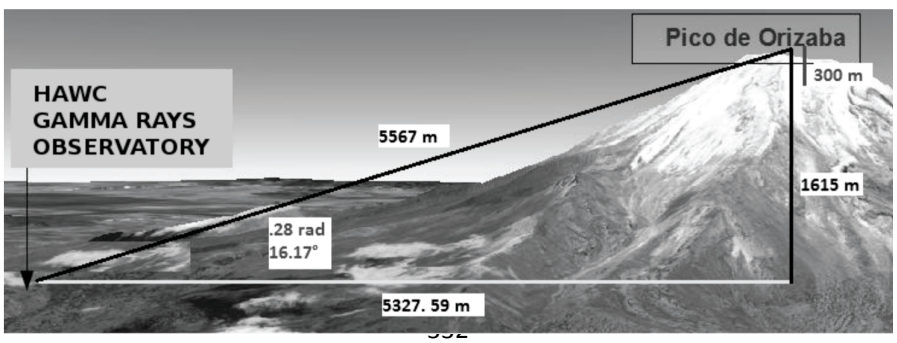

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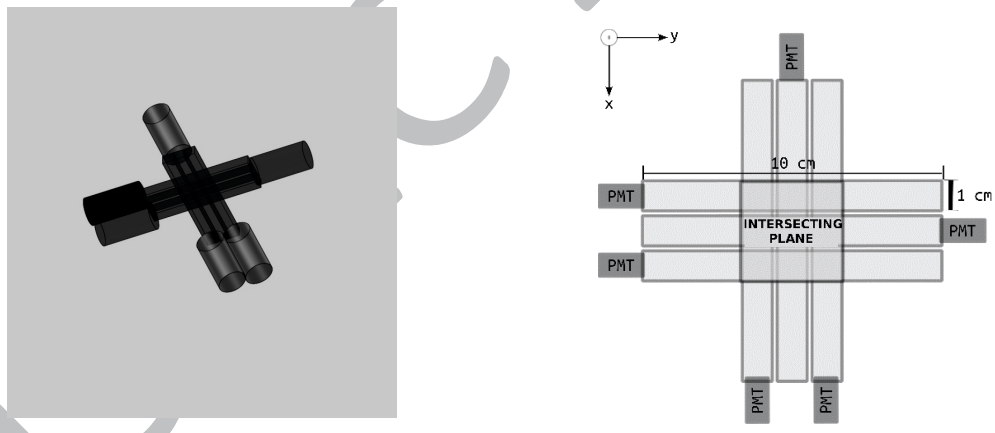
Figure 2: Dimensions of the volcano and separation distance between the observation point and the observed object.

The detector is inspired by the work of Tanaka et. (2003), in which the internal structure of Mt. Asama volcano, located on the island of Honshu Japan, was studied, and intends to compare their results with ours, since they are expected to be very similar.

Prototype

To begin the testing in the lab, six plastic scintillator bars Eljen, EJ-208 of (10 x 1 x 1) cm^3 each, were used. The bars were covered with teflon tape, which acts as a reflector and with black electrical tape to keep out the light. At the end of each bar a photomultiplier tube Photonis XP3112 / 03 (PMT) was coupled. Reading and information processing is done independently for each photomultiplier, so this first prototype has 6 channels, although all the developments of electronic and data acquisition system should be able to be scaled to at least 20 channels to be used in the final version of the detector. Figure 3 shows the detection system used, a 3D model (a) and the coordinate system with dimensions (b)



(a) (b)

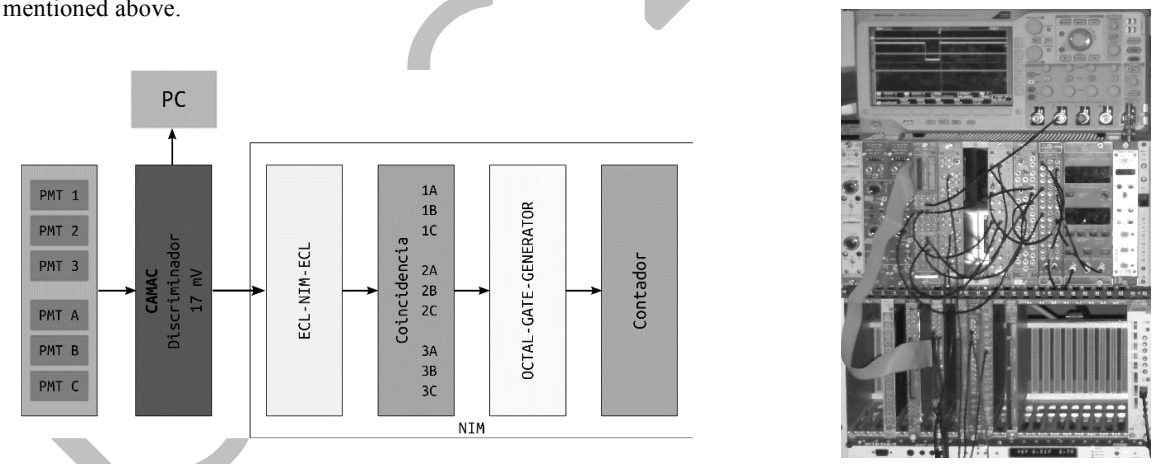
Figure 3: Muon Detector. (a) muon detector in three dimensions, (b) coordinate system and dimensions of scintillating bars.

Three of the scintillating bars were placed and oriented in the X direction and three were directed in the direction Y, forming a plane with 9 intersections of (1 x 1) cm^2 sensitive area. Cells or pixels were appointed to the nine areas of intersection of the detector. The 3 PMT´s rods positioned in the X direction, were assigned the numbers 1, 2 and 3; the three PMT´s of the positioned bars in Y direction were assigned the letters A, B and C. To determine the operating voltage of the PMT´s, each plateau´s curve and gain were measured. For this first phase of measures, reading and data acquisition electronics the standard NIM (Nuclear Instrument Measurements) was used, in particular the units to 4-FOLD GATE

LOGIC LRS model 364AL, LED CAEN N841, 662 LRS COINCIDENCE, QUAD ORTEC COUNTER model 772, DUAL HV CANBERRA 3125 SUPPLY, POWER SUPPLY CAEN Mod. N471, QUAD COUNTER / TIMER ORTEC 872 see Figure 4. In a second step, a system for information reading acquisition was developed, which will lead us quickly to digital stages and could be controlled by a computer, with the data stored into a computer.

Information acquisition system and analysis

In a second step, the standard protocol CAMAC (Knoll 2010) that communicates with the computer through a USB-II cable and two drives discrimination LECROY 4413 and CAEN C257, were used and tested. The controller used was WIENER CC-USB and the access and communication with the computer were made using the library of programs provided by the manufacturer to control his units, but can also be used to control other brands like Lecroy. For graphical interfaces ROOT-Cern libraries was used. This libraries provide us with graphic and mathematical skills to acquire and process the data. The purpose of this information acquisition system is to minimize the amount of electronics necessary in order to perform the measurements. In this particular case, the PMT is connected directly to the discrimination unit (making it unnecessary to use NIM units) and the rest of the processing can be performed by software. The first tests were conducted using a CAMAC system and to evaluate the efficiency of this system (it must be capable of processing similar rate counts to those registered with the NIM electronics of the first stage). The counts recorded on the computer were compared to counts obtained by NIM units, as in the first part. This was possible, because the CAEN C257 unit has a mode of operation that allows it to function as a NIM discriminator. However, given that it performs a digitization process and ECL standard is most commonly used, it was necessary to add a level adapter to ECL-NIM. In Figure 4 (a) diagram of how these measures are carried out is shown. The communication software and information processing control was implemented by using libraries provided by the manufacturer in C language, as mentioned above.



(a) (b)

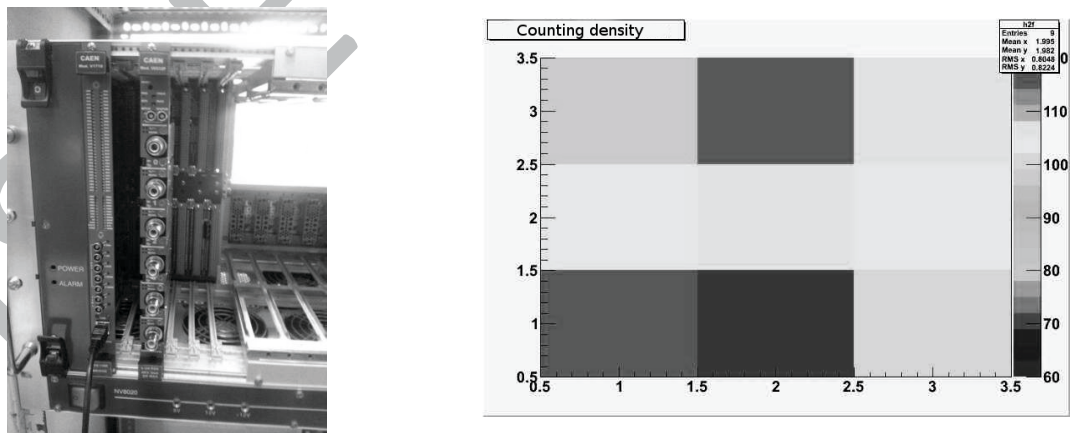
Figure 4: (a) Logical diagram of the system, (b) CAMAC, standard NIM and complete electronic system used.

Although this system worked well (we can reproduce the measurements made with the NIM system) it has the disadvantage that the rack or crate which was implemented and shown in Figure 4 (b) requires a high energy consumption and, in case of diagnosing a possible malfunction, a NIM crate with NIM available units would be required. One solution to this problem has been to migrate the system to the VME standard.

This was decided on the basis that CAEN recently fabricated a hybrid rack, NIM VME-low power consumption. With a maximum power of 350 Watts, the CAEN Create NV8020A allows us to have up to seven units VME. In the VME standard it is possible to manipulate the devices with functions of standard low-level, for example in the case of a high voltage source, after locating the base address the device can be opened through memory addresses. Another advantage is that it has an asynchronous signaling scheme, which means that the transfer of information is independent from the timing synchronization on the transmission lines. This makes handling and transmitting of information better than CAMAC. Figure 5 shows the implementation that has initialized with the VME standard sample. In this case both the high voltage and the level of discriminators can be controlled remotely from the computer. This is important because the entire operation and monitoring can be done remotely, while having the possibility of diagnosing problems on site with NIM electronics.

Prototype operation and data acquisition system.

After determining the operating voltage of the PMT´s, the output signal of each PMT was sent to the discriminator scheduled to have a threshold of 17mV. The count data was recorded individually in each bar, forming a flat bar X and a flat bar Y (see Figure 3 (b)). Every time there was a signal in a bar (X or Y), all were read, which was called an "event". The signals produced in events stemmed from muons and background radiation (electrons and low energy atmospheric range), making it necessary to perform an event identification derived exclusively from muons. To identify muons from background radiation it was taken into consideration that, by having high energy levels and close to lightning speed, muons are the most likely particles to leave signals in both the X and Y bars for the same pixel within 20 nsec time window. Therefore, it was determined that, for the same event, signals had to appear in both bars forming the plane X and Y. In fact, the intersecting plane forms a 3x3 matrix with 9 pixels and an active area of 1cm^2 per pixel, that matrix by itself already represents a screen or image of the arrival of the muon detector. Depending on the muon energy and the kind of materials passing through before reaching the detector, the events measured in each pixel can be interpreted as a map of uniform densities (Figure 5 (b)) (as long as the changes have sufficiently contrasting density, as in the case of an image taken with X-rays).



(a) (b)

Figure 5: (a) Hybrid rack, NIM VME-low power consumption, (b) muon rate as function position.

Discussion

Although this prototype is small when compared to the final size of the detector, it has been used to start developments that can be scalable, such as data acquisition system and control. About data acquisition system performance, test runs were performed with the help of a function generator. In order

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to do this, the electrical signal produced by the PMT was simulated and the frequency was gradually increased, ensuring that the number of registered events coincided with the frequency of the simulated generator. Up to 10 KHz, no appreciable difference between the pulse generator and the data acquisition system was found. Based on the flux of muons at sea level and making a height correction, it was estimated that, for a $1m^2$ detector, the counting of muons (without restricting the angle of incidence) would be around 1 kHz, meaning that the implemented acquisition system and information could be used in the final size detector. As for monitoring and control, the high voltage power supply can be controlled, programmed and monitored via computer. The system for transmission and monitoring of information, although it can be improved, is a true basis for the implementation of the detector. It is missing stability tests of voltage or potential communication failures between computer and VME. The graphical interface using ROOT-CERN has also proven its feasibility, building and deploying C ++ code that controls the VME with respective ROOT libraries and, finally, a GUI easy to operate could be implemented. As far as the prototype is concerned, in the 10 % of pixels the same registration event was found. This 10% of uncertainty may stem from the fact that, in this case, there was no restriction on the direction angle of arrival of the muon detector, so that a muon with an angle> 45 ° (relative to the normal of the detector plane), may leave a signal in two or more pixels, which can cause confusion. This can be improved by placing a detector background separated by a distance D (Figure 1). The muon incident angle and the solid angle subtended by each pixel depends on the distance D. For 1.6m it will be approximately 16 degrees (relative to the normal of the detector plane).

The number of muons incidents in the detector combined with the ability to capture, analyze and display it with a format suitable for experts in various fields (astrophysics, geophysics, high energy physics, etc.), provides of important and useful information that helps to reveal the internal structure of a volcano by using cosmic rays. Information that is not only interesting in the field of science but also in social areas, because it also helps to assess risks and impact of a possible eruption especially when the volcano is close to a urban center as in the case of several volcanoes in Mexico.

Conclusions

A information acquisition system and analysis, which can control and monitor a position sensitive detector was implemented. This arrangement can detect atmospheric muons and give us information about the position and number of incident muons. This arrangement is the basis for building a large scale development, which can be used as a survey tool to provide information on the study of mountains and volcanoes, relevant studies in Mexico due to the large number of volcanoes, particularly those located close of urban centers.

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