ACORDE a Cosmic Ray Detector for ALICE

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ACORDE is one of the ALICE detectors, presently under construction at CERN. It consists of an array of plastic scintillator counters placed on the three upper faces of the ALICE magnet. It will act as a cosmic ray trigger, and, together with other ALICE sub-detectors, will provide precise information on cosmic rays with primary energies around $10^{15} \div 10^{17}$ eV. Here we describe the design of ACORDE along with the present status and integration into ALICE.

1. Introduction

At CERN, the use of large underground high-energy physics experiments, for comic ray studies, has an important tradition [1]. ALICE is an experiment mainly designed to study the products of nucleus-nucleus collisions at CERN Large Hadron Collider (LHC) [2]. The underground location of the ALICE detector, with 30 m of overburden composed of subalpine molasse, is an ideal place for muon based underground experiments. Using this facilities, we plan to observe muon bundles generated by cosmic ray primary particles with energies around the knee region $10^{15} \div 10^{17}$eV [3]. ACORDE (the ALICE COsmic Ray DEtector) is an array of scintillator modules that will act as a cosmic ray trigger for ALICE calibration, as well as, multiple muon trigger to study high energy cosmic rays.

2. The ACORDE Detector

ACORDE is an array of plastic scintillator modules (60 at the present) placed on the top sides of the central ALICE magnet, as shown in Figure 1. More modules, to achieve a better angular coverage and acceptance, will be added later. Each module, see Figure 2, consists of two plastic scintillator paddles with 188×20 cm^2 effective area, arranged in a doublet configuration. Each doublet consists of two superimposed scintillator counters, with their corresponding photomultipliers active faces, looking back to back. A coincidence signal, in a time window of 40 ns, from the two scintillator paddles gives, for each module, the trigger hit. A PCI BUS electronics card have been developed in order to measure plateau and efficiency of the module counters [4]. The signal of each ACORDE scintillator channel is applied to a leading edge discriminator. After the conversion of each PMT negative signal in a digital hit, a single or a multi-coincidence trigger signal is generated. In both cases we will use a tracking system to identify which ACORDE modules were hit. Afterwards, these module hit information will be stored in a FIFO memory before being sent to the DAQ system through the Detectors Data Link (DDL).

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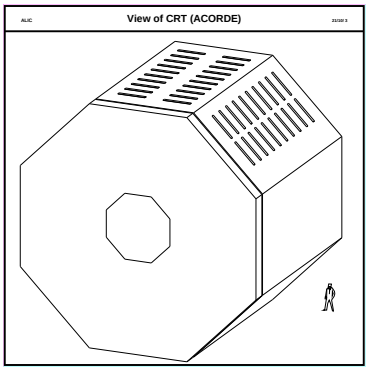

Figure 1. The ALICE Cosmic Ray Detector. The scintillator array is on top of the ALICE magnet.

Figure 2. An ACORDE module; the scintillator modules consist of two superimposed scintillator counters.

3. The ALICE Cosmic Ray Trigger

The cosmic ray trigger system (CRT) will provide a fast level-zero trigger signal to the central trigger processor, when atmospheric muons impinge upon the ALICE detector. The signal will be useful for calibration, alignment and performance of several ALICE tracking detectors, mainly the ALICE Time Projection Chamber (TPC), the ALICE Transition Radiation Detector (TRD) and the ALICE Inner Tracking System (ITS). The typical rate for single atmospheric muons crossing the ALICE cavern will be less than Hz/m^2. The expected rate for multi-muon events will be around or less than 0.04 Hz/m^2. Atmospheric muons will need an energy of at least 17 GeV to reach the ALICE hall, while the upper energy limit for reconstructed muons in the TPC will be less than 2 TeV, depending on the ALICE magnetic field intensity (up to 0.5 T). We have designed and implemented the necessary electronics to do the following tasks: LHC clock synchronization, send single and multi-muon trigger signal to the Central Trigger processor, send a wake-up signal to ALICE-TRD and communicate with the DAQ through a DAQ Source Interface card(SIU). Also, we complete the ACORDE Detector Control System, to monitor the performance of the scintillator counter array.

At the present, we have 20 ACORDE modules already installed and the related electronics working. The ALICE-TPC above ground commissioning is proceeding based on ACORDE trigger using 10 modules placed on the top and 10 underneath the ALICE TPC (see [5]).

4. Summary

We have implemented a dedicated cosmic ray trigger for ALICE which in conjunction with other ALICE detectors provides a powerful tool for the study of muon bundles properties.

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