CONDOR - A New Observatory for Gamma Rays and Cosmic Rays

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Resumen

CONDOR is a proposed observatory for gamma ray and cosmic ray measurements at high altitude. It is planned to be constructed on Cerro Toco in the Atacama Astronomical Park at an altitude of 5300 meters, which would make it the highest observatory of its kind in the world. A scientific and technical team at the Center for Science and Technology of Valparaiso (CCTVal) is contributing to its planned construction by developing a precise timing network capability. This capability is needed for estimation of the angle of incidence of the shower of particles produced in the atmosphere by the primary gamma ray or cosmic ray. To achieve the timing precision needed, the network will use the White Rabbit technology developed at CERN and now in use around the world for many types of applications.

The lead institution of this project, U. California Riverside, has made the technology proposal for the design of the observatory[1]. The CONDOR observatory will consist of an array of detector modules that span an area of 113 meters x 122 meters. The showers will be more densely sampled in the middle of this area and more sparsely sampled near the perimeter. Each detector module contains 12 plastic scintillator strips 5 cm wide, 2 cm thick, and 1.6 m in length. Each strip has a wavelength shifting fiber inside that absorbs the blue light made by the scintillator when a charged particle passes through it. The wavelength shifting fiber absorbs the blue light and re-emits green light that is transported down the fiber to the light detector at the end. The silicon photomultiplier emits electrical pulses that can be analyzed to determine the time of the hit. In the event of a shower that is sampled by multiple strips, the timing information can be used to identify which hits come from the same shower, and can be used to estimate the incidence angle of the shower. However, the timing information comes from detectors as far apart as more than 100 meters, while the level of precision needed is at the nanosecond level. This level of precision cannot be achieved by typical ethernet networks, especially over such large distances, which can span timing differences exceeding 500 nanoseconds. For this reason we are using the White Rabbit (WR) technology developed at CERN[2]. CERN, the largest accelerator lab in the world, developed it to upgrade their accelerator timing systems to manage precise timing of many time-critical systems and processes distributed over tens of kilometers. They developed it as an open hardware, open firmware, and open software product. We have purchased a commercially available WR switch with two nodes in order to prototype a precise timing network. The other ingredients in the system are the electronic cards that convert the light from the fiber to digital information that is then sent through a fan-in/out card to the WR switch. We plan to use the uDAQ card which was developed by the IceCube Neutrino Observatory[3] for measurements in Antarctica. The electronics branch of CCTVal[4] will fabricate these cards, which are WR-compatible, to be used in tests of the precise-timing network. We intend to set up a first on-site test in the north of Chile at the end of 2022.

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Referencias

[1] https://condorobservatory.ucr.edu/
[2] https://white-rabbit.web.cern.ch/
[3] https://icecube.wisc.edu/
[4] https://cctval.usm.cl