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A cosmic ray muons imaging system based on bar plastic scintillator detectors

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Muons are mainly produced by the decay of pions created by the interaction between high-energy protons in space and the Earth's atmosphere. Among cosmic ray-charged particles, muons are the largest number of particles reaching sea level. Muons have penetrating solid ability and can pass through materials hundreds of meters to several kilometers thick. In this paper, the Cosmic Ray Muon Imaging Systems (CORMIS) consists of three main components: the mechanical structure, the detector, and the readout electronics. The detector consists of two large and two small bar plastic scintillators coupled to a silicon photomultiplier (SiPM). In the structure, a small bar-shaped plastic scintillator is placed close to a large one, symmetrically with the other two plastic scintillators. The smaller plastic scintillator is closer to the symmetry center, and the four plastic scintillators can be rotated around the symmetry axis at a rotation rate of 1 cycle/s to monitor the spatial muon distribution in real-time. Readout Electronics mainly consists of GPS circuits, attitude sensor circuits, WIFI circuits, high voltage circuits, FPGA circuits, analog conditioning circuits, and some peripheral circuits. During the operation, the FPGA controls the high-voltage circuit to generate the SiPM bias voltage. The charge pulse signal output from the SiPM is fed to an analog conditioning circuit for IV conversion, filtering, and shaping and then sent to a high-speed comparator. The result of the comparison is fed back to the FPGA. The GPS and attitude sensor circuits provide absolute time and space angles. The FPGA packages the matched information, sends it to the WIFI circuit, and communicates with the back-end host computer through WIFI. The expected results are: (1) To realize reliable and efficient muon detection, capable of accurately monitoring muon distribution and obtaining data related to environmental changes. (2) To establish a correlation model between muon distribution and environmental changes and to predict some environmental changes (e.g., earthquakes, volcanic eruptions, landslides) by monitoring changes in muon distribution. At present, CORMIS has been designed and is undergoing laboratory testing. The test results are promising. The next step is to conduct tests in different environments. We will display the test results during the conference.

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