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Measurement of cosmic-ray air-shower radio emission with an IceCube Surface Array station

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The surface array of the IceCube Neutrino Observatory currently consists of 162 ice Cherenkov tanks and is used both as a veto for the in-ice neutrino observations and as a capable cosmic-ray detector. In order to further enhance the science case of the IceCube surface array, the existing detectors will be complemented by an array of scintillation panels and radio antennas. The scintillation detectors will lower the energy threshold and the radio antennas will significantly improve the energy and Xmax reconstruction performance, especially for inclined showers at higher energies. The radio-quiet environment at the South Pole and the design of the radio antennas allows to measure air-shower radio emission in the novel higher frequency band between 70-350 MHz. The utilisation of this higher frequency band will give us a higher signal-to-noise ratio and a lower shower detection threshold compared to traditional sparse cosmic-ray radio arrays which mostly utilise the 30-80 MHz frequency range. A prototype station consisting of 8 scintillation panels and 3 radio antennas has been deployed at the South Pole in January 2020 and has been collecting data since then. Detection and successful reconstruction of air showers using this single station has proven the viability of the hardware and informs further optimizations of the detector design and shower analysis techniques that will be applied to the full array when deployed in a few years. It has also been confirmed that we can indeed measure the radio emission from air showers with energies of a few 10s PeV. Due to the successful validation of this surface station design, it builds the baseline for the layout of the future IceCube-Gen2 surface array. In this talk, I will introduce the IceCube Surface Array Enhancement with the focus on the air shower detection with the radio antennas.

Collaboration

IceCube

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