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Detector development and commissioning of TAMBO-4 pathfinder array

TAMBO-4 is a compact array developed as an initial prototype for the Tau Air-Shower Mountain-Based Observatory (TAMBO), a future experiment designed to detect Earth-skimming astrophysical tau neutrinos through extensive air showers in the Colca Valley, Arequipa, Peru. The detection of tau neutrinos in the PeV energy range with TAMBO is essential for multimessenger astrophysics, flavor physics, and searches for physics beyond the Standard Model. The TAMBO-4 prototype consists of four plastic scintillator detector panels, each with an active area of approximately 1.5 m^2 formed by 16 scintillator bars coupled to a SiPM photosensor through wavelength-shifting optical fibers. The detectors are arranged in a triangular geometry and deployed at the campus of the Pontificia Universidad Católica del Perú. TAMBO-4 is optimized for the detection of atmospheric air showers initiated by primary cosmic rays in the 10–100 TeV energy range and serves as a testbed for detector instrumentation, calibration procedures, timing synchronization, and event reconstruction techniques. The detector readout and acquisition systems were developed using Red Pitaya-based and micro-DAQ solutions, together with a dedicated synchronization system aimed at achieving precise timing measurements for air-shower reconstruction. We report on the current status of the detector development and commissioning of TAMBO-4, including scintillator panel construction, DAQ implementation, noise reduction studies and detector calibration using vertical muons MIP measurements and radioactive source mapping. In parallel, detailed simulations based on CORSIKA and GEANT4 are being used to characterize detector performance, optimize the array geometry, and study the expected angular reconstruction capabilities. Preliminary performance studies and first commissioning results demonstrate the potential of TAMBO-4 as a platform for validating detector technologies and reconstruction methods for the future TAMBO deployment.

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