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The simulation chain for the Terzina Cherenkov telescope on board the NUSES space mission

The Terzina telescope is designed to detect ultra-high energy cosmic rays (UHECRs) and Earth-skimming neutrinos from a 550 km low-Earth orbit (LEO) by observing Cherenkov light emitted by Extensive Air Showers (EAS) in the Earth's atmosphere pointing towards the telescope and in the field of view. In this contribution, a simulation chain for the Terzina telescope onboard the NUSES mission will be presented. The chain encompasses all stages of the detection process, from event generation and EAS modelling with CORSIKA and EASCherSim to Geant4-based simulations of the telescope's geometry and optics, followed by modelling of the trigger system and silicon photomultiplier (SiPM) response. The Geant4 module includes the real CAD model of the telescope structure and optical components, with manually implemented aspherical lenses to ensure accurate representation of the optical efficiency and point spread function in Geant4. The expected background for this experiment was evaluated in detail using the data from the DMSP satellite for city lights contributions, the Lunar Irradiance Model of the European Space Agency (LIME) for the Moonlight, the effect of auroral emissions, as well as radiation sources responsible for dose deposition in the telescope components. Radiation tolerance was assessed by simulating the dose from charged particles using SPENVIS particle flux predictions. SiPM characterisation was used to simulate the SiPM response within the simulation, as well as the realistic signal shape from the preamplifier and conditioning electronics chain. This comprehensive pipeline, developed using modular C++ code and Python tools for event analysis and reconstruction, produces detailed performance assessments of a telescope operating in a LEO mission but can be adapted for any high altitude Cherenkov telescope, making it a versatile tool for future observatory designs. The possibility of modeling balloons in the atmosphere has also been developed.

Collaboration(s)

on behalf of the NUSES Collaboration

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