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High-Fidelity Simulations of the Full Askaryan Radio Array and its Sensitivity to Ultra-High Energy Neutrinos

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The Askaryan Radio Array (ARA) is a five-station, in-ice radio detector located at the South Pole searching for particle cascades from cosmogenic and astrophysical neutrinos with >1e17 eV of energy. Cascades in this energy regime emit radio-wavelength Askaryan radiation that can be observed by one or more ARA stations. With the recent Km3Net observation of an approximately 2e17 eV neutrino, there is renewed, urgent interest in further unlocking the ultra-high energy (UHE) neutrino sky. This work delivers updated calculations of ARA's array-wide effective volume, sensitivity, and expected event rates for UHE neutrino-induced cascades. Notably, results now account for the contributions of secondary particles from neutrino interactions (such as muon tracks) and multi-station detections within a detailed detector simulation framework. Previous work has shown these secondary interactions and multi-station coincidences compose 25% and 8% of the detector's effective area, respectively. We intend to extend these results towards a novel analysis estimating the degree to which secondary cascades and multi-station observations are detectable in a real neutrino search. This will inform future UHE neutrino searches as it will characterize the feasibility of detecting such events.

Collaboration(s)

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