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Radio Detection of Ultra High Energy Neutrinos with Askaryan Radio Array

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The Askaryan Radio Array (ARA) is an in-ice ultra high energy (UHE, >10 PeV) neutrino experiment at the South Pole that aims to detect UHE-neutrino induced radio emission in ice. ARA consists of five independent stations each consisting of a cubical lattice of in-ice antenna clusters with side length of ˜10 m buried at about 200 m below the ice surface. All five independent ARA stations have collectively accumulated about 310 TB of data over the last decade. The fifth station of ARA (A5) is special as this station has an additional central string, the phased array (PA), which provides an interferometric trigger that enables ARA to trigger on weak signals that are otherwise buried in noise. Leveraging the low threshold phased array trigger, ARA was the first radio neutrino experiment to demonstrate significant improvement in sensitivity to weak signals. In this talk, I will present initial results from a neutrino search on A5 combining information from both the traditional station antennas and the phased array antennas. We will show the improved vertex reconstruction achieved with this approach, and leveraging this improvement, we expect to enhance the analysis efficiency beyond what has been achieved previously by ARA. This analysis is the paradigmatic representation of future neutrino searches with the next generation of in-ice neutrino experiments. I will also present the current state of the first array-wide diffuse neutrino search using data from all five independent stations of ARA. We anticipate that this analysis will result in the first UHE neutrino observation or world-leading limits from a radio neutrino detector below 100 EeV. Additionally, this analysis will demonstrate the feasibility for multi-station in-ice radio arrays to successfully conduct an array-wide neutrino search, paving the way for future, large detector arrays such as RNO-G and IceCube-Gen2 Radio.

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