Progress Towards Measuring the Ultra-High Energy Neutrino Flux with the Askaryan Radio Array

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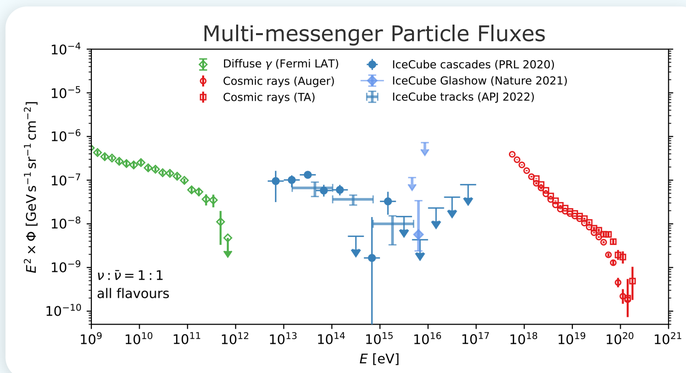
We aim to discover cosmic neutrinos with energy >10^{17} eV using a decade of data from the Askaryan Radio Array

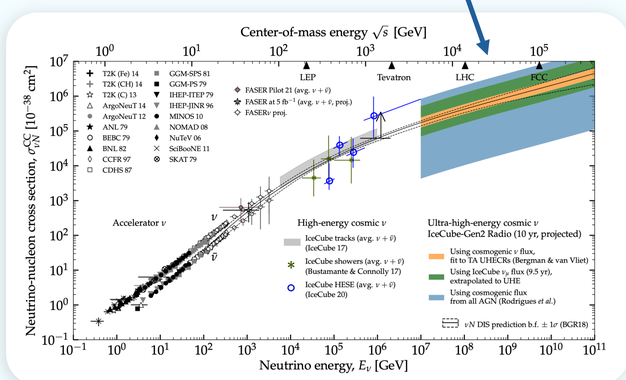
More information on arXiv:

1. Science Goal

We're looking for ultra-high energy (UHE, E >10^{17} eV) cosmic neutrinos- they haven't been observed yet [1]



The observations may help constrain the neutrino-nucleon cross section at ultra-high neutrino energies [1]

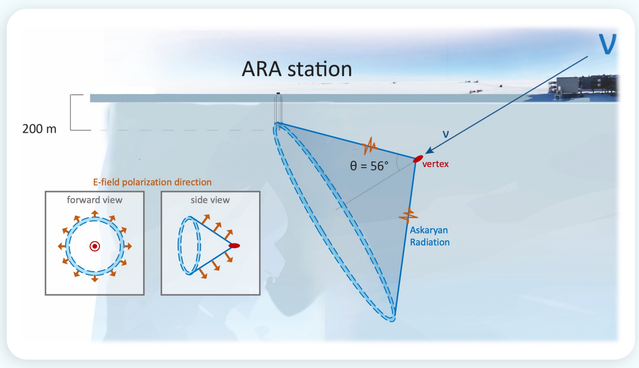


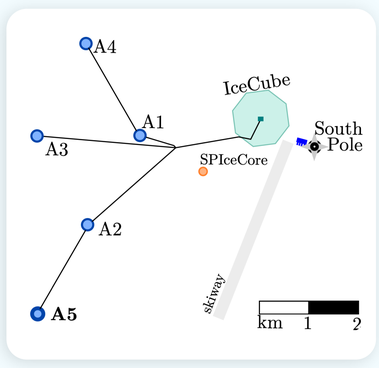
2. Askaryan Radio Array (ARA)

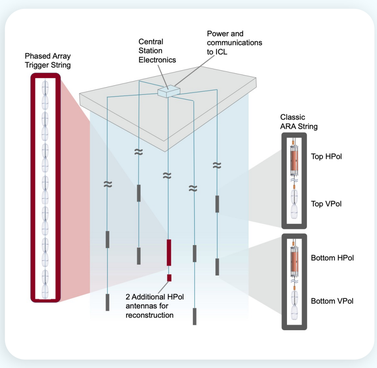
UHE neutrinos emit radio-wavelength Askaryan radiation in ice

So we installed 5 stations with radio antennas at the South Pole

Each station has 16 to 24 radio antennas

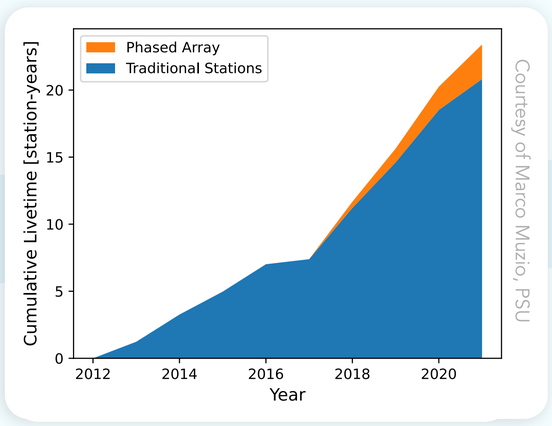




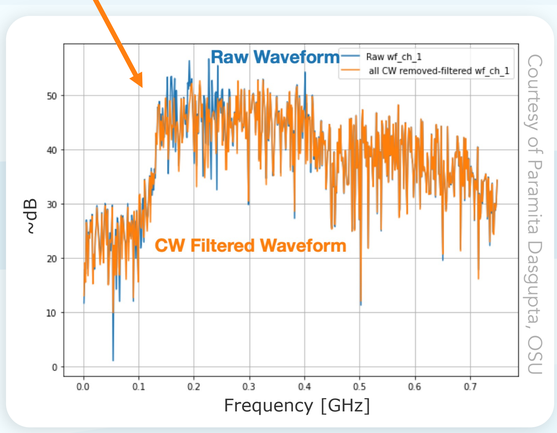


3. Analysis Chain

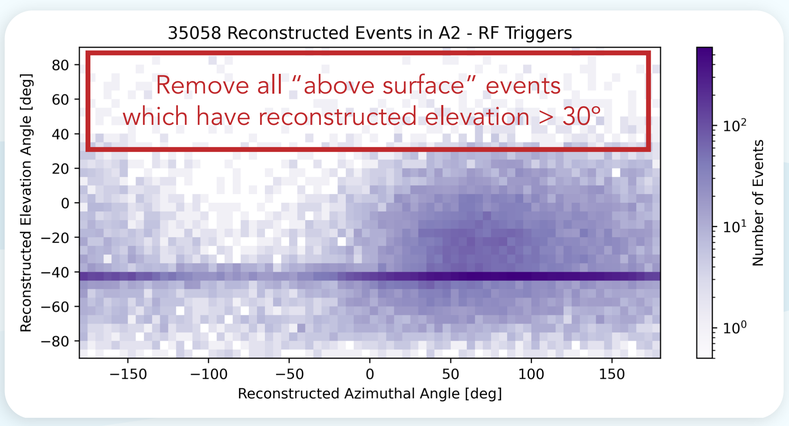
Analyze all ARA data taken from 2012-2021



Remove unwanted events like software glitches, bad events, continuous wave contamination, and more



Reject cosmic ray air shower events using reconstructed elevation angle of radio signal



Build a pure neutrino and pure noise simulation set

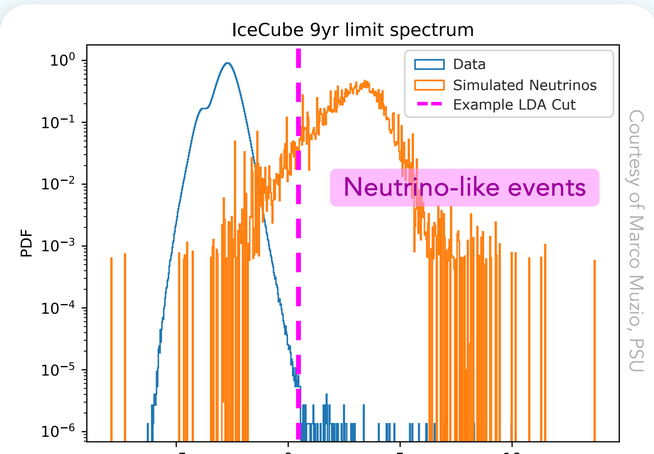
Generated with improved per-channel signal chain gain, antenna gain, and noise models

Train a brand new Linear Discriminant Analysis (LDA) with 10% of data

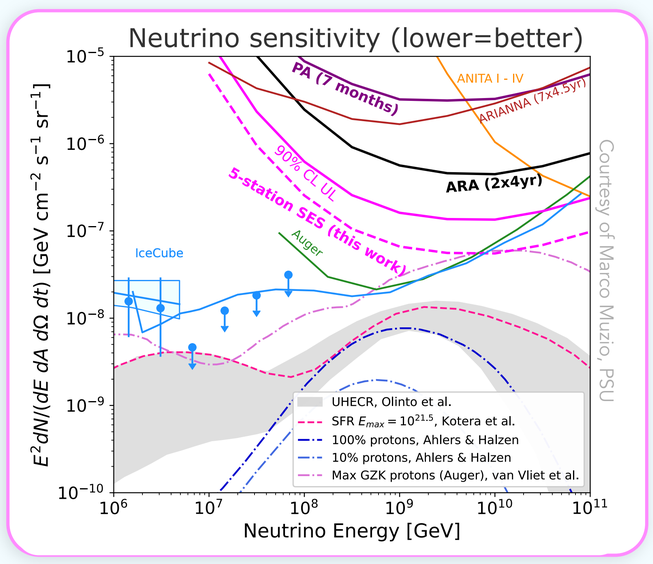
This will describe the "neutrino-ness" of each event with one number calculated from many observables

Choose LDA cut based on LDA performance over full array's data + simulation sets

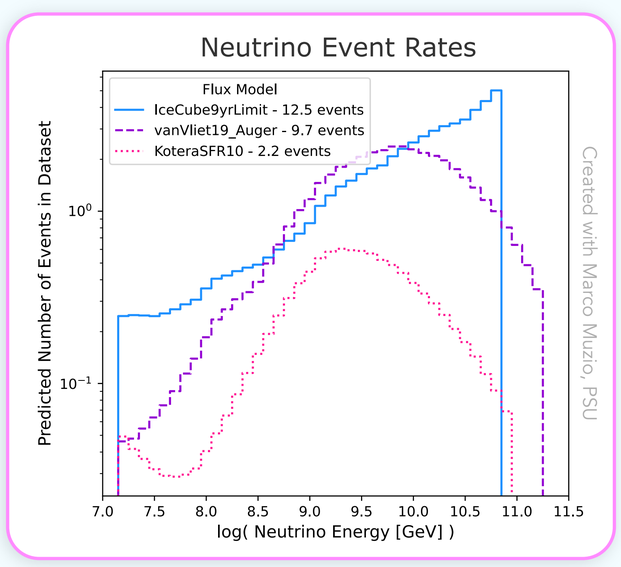
Use the LDA to identify neutrino-like events in the remaining 90% of data



4. Predicted Results



We expect to set the best limit for in-ice radio neutrino detection



Estimated event rates leave us optimistic that we could discover a neutrino in our dataset

Contact

This analysis is performed by many scientists across multiple institutions

The contact for this poster is:
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References

[1] Ackermann, Markus, et al. "High-energy and ultra-high-energy neutrinos: A Snowmass white paper." *Journal of high energy astrophysics* 36 (2022): 55-110.
[2] Dasgupta, Paramita, and Marco Stein Muzio. "Progress Towards a Diffuse Neutrino Search in the Full Livetime of the Askaryan Radio Array." *arXiv preprint arXiv:2308.12125* (2023).