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Neutrino Target of Opportunity for the Cherenkov Telescopes Array

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The measurement of an astrophysical flux of high-energy neutrinos by IceCube is an important step towards finding the long-sought sources of cosmic rays. Nevertheless, the long exposure neutrino sky map shows no significant indication of point sources so far. This may point to a large population of faint, steady sources or flaring objects as origins of this flux. The most compelling evidence for a neutrino point source so far is the recent observation of the flaring gamma-ray blazar TXS 0506+056 in coincidence with a high-energy neutrino from IceCube. This is a result of a Neutrino Target of Opportunity (NToO) program in which all currently operating Imaging Atmospheric Cherenkov Telescopes (IACTs) take part. The case for TXS 0506+056 being a neutrino source was made stronger by evidence of a 5-month long neutrino flare in 2014-2015.
Here we investigate the chances of a detection of a gamma-ray counterpart to a neutrino source with the future Cherenkov Telescope Array (CTA), as a result of a follow-up observation of a neutrino alert. We use the FIRESONG software to simulate different neutrino sources populations, which could be responsible for the diffuse flux of astrophysical neutrinos as measured by IceCube. We scan over parameters that can be used to describe the populations such as luminosity and density (density rate) for steady (flaring) objects. Several CTA array layouts and instrument response functions are tested in order to derive optimal follow-up strategies and the potential science reach of the NToO program for CTA. We find that following neutrino alerts by IceCube, in certain parameter space regions, CTA has a very high per alert probability of detecting a matching steady source. What is more, using a model by Halzen et al. (2018), for neutrino flares similar to that of 2014-2015, we find that CTA will detect a counterpart in more than a third of the alerts.

Collaboration name

CTA Consortium, FIRESONG Team

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