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The gamma-ray follow-up platform in IceCube for identifying astrophysical neutrino flares in realtime

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In the budding field of multi-messenger astrophysics, neutrino observatories such as IceCube play a crucial role in identifying targets of opportunity with their near 100% up-time and view of the whole sky. IceCube aims to identify sources of astrophysical neutrinos using a cubic kilometer of instrumented ice located at the South Pole. Many candidate neutrino sources, such as blazars, have time-variable emission observed in various wavelengths of light. Therefore, flares in photons that coincide in direction and time with neutrino signatures help to distinguish true neutrino flares from background fluctuations. Such a source was identified when IceCube reported a high-energy neutrino from the direction of TXS 0506+056 and the resulting follow-up found the blazar to be in a flaring state across the electromagnetic spectrum including very-high-energy gamma rays (E > 100 GeV). Here we discuss a specific channel of IceCube alerts known as the gamma-ray follow-up (GFU) alerts which seeks to identify significant clusters of neutrinos in time and space, such as that found from TXS 0506+056, with low latency to trigger follow-up by telescopes. The stream has been operating in its current configuration since 2019 and has been sending alerts to partner imaging air Cherenkov telescopes. We will present results from an offline analysis of IceCube's archival GFU data from May 2011 to October 2022 in which we identified the most significant flares. We also present concepts for future updates to the GFU stream to improve its performance using updated event reconstruction techniques, new source lists employing updated gamma-ray data and models of neutrino emission, and collaborations with other telescope partners including other neutrino telescopes.

Poster prize

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