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Very Late Afterpulses and Search for the Neutron Echo in IceCube

While high-energy astrophysical neutrinos are well-established, their flavor composition remains relatively unconstrained. In IceCube, long muon tracks from ν_μ-CC interactions are easily identified but the detector geometry does not allow sufficient granular resolution to distinguish the cascade-type events. The Neutron Echo - a delayed light signal in the detector from neutron capture and de-excitation - can probe the shower' s hadron content and thus the underlying interaction. A significant background arises from the late PMT afterpulses, which are temporally coincident with the physics signal. The traditional IceCube DAQ has a limited readout window with significant deadtime between triggers, which is insufficient to capture the late pulses. A recently developed deadtime-free DAQ mode, with an extended readout window, enables their detection. An observed excess in the delayed time spectrum over the background would be compatible with the Neutron Echo hypothesis.
In this contribution, we summarize the physics scope of delayed signals, discuss the timing spectrum of the signal and PMT background, highlights the capabilities of the new DAQ system for recording late pulses and emphasize the potential of IceCube for particle identification through delayed signals.

Collaboration(s)

IceCube

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