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Search for dimuon events in IceCube using decision trees

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The dominant neutrino-nucleon interaction above 100 GeV is Deep Inelastic Scattering (DIS) in which an incoming neutrino scatters off a quark in the nucleon by exchanging a weak boson, producing an outgoing lepton accompanied by a hadron shower. Two sub-dominant processes are expected to produce two high energy charged leptons in the final state. The first one is a subset of DIS where a charmed meson is produced, which can decay into a charged lepton. The second one involves the exchange of a weak boson and a photon, resulting in a final state with two charged leptons and a neutrino, in a process known as neutrino trident production (NTP).

If an excess of these events is observed above the Standard Model (SM) prediction, it can serve as an indicator of Beyond Standard Model (BSM) physics. Since IceCube Neutrino Observatory has detected thousands of high energy neutrinos above 100 GeV and has collected over 10 years of data taking, it is an excellent candidate for their search. For the purposes of this work, we consider the channel where the outgoing leptons are muons. Since muons leave a track-like Cherenkov signature in IceCube, our central goal is to search for double-track events (from two muons or dimuons) and separate them from single track events (from a single muon). In this work, we perform this classification using decision trees.

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