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Event by Event classification of alpha-n and IBD Interactions at SNO+

In the study of reactor and geo antineutrinos, tagging of the inverse beta decay (IBD) positron-neutron coincidence signature allows for the elimination of most backgrounds. In many detectors, the primary remaining background is caused by captures on 13C —so called (⍺, n) events —which release a neutron and closely mimic the IBD's signature. The most common (⍺, n) prompt event is produced by protons recoiling from the neutron, which gives rise to a distinct pulse shape compared to that of the positron from an IBD. A powerful classifier is thus presented, able to purify the IBD signal from most of its (⍺, n) background, by discriminating between these pulse shapes. Particular attention is paid to the construction of appropriate training data from Monte-Carlo simulations. The tuning of the β and proton scintillation timing models in these simulations for SNO+ is also discussed. Tuning of the former is achieved via the selection of a high purity sample of in-situ 214Bi to 214Po decays. The latter makes use of the deployment of a radioactive Americium-Beryllium source. Finally, results of this classification on expected reactor and geo-neutrino signals are shown, and the question of over-tuning is tackled.

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