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Efficiency Studies and Simulations for an Active Neutron Veto Detector for a Dark Matter Experiment

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In direct WIMP dark matter detection experiments, neutrons from cosmogenic sources and nuclear reactions in detector materials can provide backgrounds indistinguishable from WIMP signals. To reduce this background, an active neutron veto filled with a boron-loaded liquid scintillator is being developed. The scintillator will be pseudocumene, with trimethyl borate as a boron source, and PPO as a wavelength shifter. Such a veto would detect neutrons in the volume surrounding the detector, allowing coincident background events in the detector to be rejected. Neutrons are captured by the ^{10}B with a high cross section, resulting in an alpha and ^{7}Li. The energy from these products is heavily quenched, down to as low as 30-40 keVee. However, 96% of boron captures also produce a 478 keV gamma, which is much more easily detected. In order to efficiently detect the 4% of events that do not produce this gamma, the detector must have as high a light collection efficiency as possible. To model the neutron veto concept, light yield measurements were taken for a small prototype filled with the scintillator mixture and lined with a Lumirror reflector. These results were reproduced in GEANT4 and in an independent simulation. We then applied the simulations to the DarkSide-50 neutron veto to predicts its neutron rejection power.

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