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Ion-Induced Afterpulsing in the Neutron Multiplicity Meter's Photomultiplier Tubes CHRISTOPHER NEDLIK, RICHARD SCHNEE, RAYMOND BUNKER, YU CHEN, Syracuse University, NEUTRON MULTIPLICITY METER COLLABORATION — The nature of the dark matter in the Universe remains a mystery in modern physics. A leading candidate, Weakly Interacting Massive Particles (WIMPs), may be detectable via scattering from nuclear targets in terrestrial detectors, located underground to prevent fake signals from cosmic-ray showers. The Neutron Multiplicity Meter (NMM) is a detector capable of measuring the muon-induced neutron flux deep underground, a problematic background for WIMP detection. The NMM is a 4.4-tonne Gd-loaded water-Cherenkov detector atop a 20-kilotonne lead target in the Soudan Mine. It measures high-energy neutrons (> 50 MeV) by moderating and then detecting (via Gd capture gammas) the secondary neutrons emerging from the lead following a high-energy neutron interaction. The short time scale ($\sim 10\ \mu$s) for neutron capture in Gd-loaded water enables a custom multiplicity trigger to discriminate against the dominant gamma-ray background. Despite excellent rejection of the gamma-ray-induced background, NMM neutron-candidate events are not entirely background-free. One type of background is from ion-induced afterpulsing (AP) in the four 20" Hamamatsu R7250 photomultiplier tubes (PMTs) used to monitor the NMM's two water tanks. We show that ion-induced AP in the PMTs can mimic the NMM's low-energy neutron response, potentially biasing a candidate event's measured multiplicity. We present detailed studies of the AP in order to allow identification of AP-induced background events.

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