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Characterizing New Calibration Sources in Liquid Xenon Dark Matter Searches

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ABSTRACT

In order to use the XENON1T liquid xenon detector as a means for detecting dark matter, the response to nuclear and electronic recoils must be well calibrated. Electronic-recoil calibration of XENON1T will be done by using the noble gas radon-220 that emanates from a custom thorium-228 source to observe the electron recoils that its daughter elements induce in liquid xenon. A silicon PIN diode was constructed to ensure that the Th228 source does not contaminate the system with the long-lived isotopes Th228 ($T_{1/2}$ of 1.9 y) or Radium-224 ($T_{1/2}$ of 3.6 d). The PIN diode was fixed in a custom vacuum vessel capable of being mounted inline on a gas system. The response of the silicon PIN diode was calibrated with standard alpha particle sources, and the integrated background rate from 2-10 MeV was measured to be $(3.21 \pm 0.26) \times 10^{-4}$ counts/sec. With xenon gas flowing over the source and through the vessel, the measured alpha particle count rate due to Th228 and Ra224 are consistent with background levels. These initial results are promising, and imply a negligible increase in the overall XENON1T background level.

KEYWORDS

Dark Matter, Liquid Xenon, PIN Diode, Alpha Spectroscopy