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Low-energy Monoenergetic Neutron Production with a DD-Neutron Source for sub-keV Nuclear Recoil Calibrations in the LUX and LZ Experiments

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Nuclear recoil (NR) calibrations are vital for understanding detector responses to dark matter candidates and neutrino-nucleus signals in direct detection experiments. Low-mass (<5 GeV) dark matter candidates and ^{8}B neutrinos drive the need for high-statistics/low-systematic calibrations at sub-keV NR energies.
We report the results of NR calibrations in the LUX dark matter detector using 2.45 MeV (94 keV FWHM) neutrons from an Adelphi Technologies, Inc. DD neutron generator and describe the R&D done to increase the instantaneous intensity to 10^{10} n/s and reduce pulse width to 12 μs FWHM. Complete kinematic reconstruction has allowed the charge and light yields to be determined down to 0.27 keVnr and 0.45 keVnr, respectively. We also describe techniques to reduce the incident neutron energy via controlled backscattering off deuterium- and hydrogen-based targets, achieving neutron energies of 350 keV (85 keV FWHM) and 10-100 keV, respectively, needed to probe even lower mass dark matter candidates.

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