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Calibrating Inner-Shell Electron Recoils in a Xenon Time Projection Chamber

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Liquid noble detectors, used for dark matter and neutrinoless double beta decay searches, rely heavily on calibrations to understand each detector's response to predicted electron recoil backgrounds. These calibrations often use beta- or gamma-decay sources to approximate all electron recoil backgrounds. Existing models assume that interaction topology does not affect detector response below 10keVee despite the more local energy deposition profile from the released binding energy of an inner shell electron compared to a typical ionization track, such as from beta decay. We have constructed a xenon time projection chamber at Fermilab to compare the light and charge yields of Xe-127 electron capture to those of tritium beta decay. In a small enough detector, any gammas associated with the electron capture decay are lost, leaving only energy deposited by the released binding energy of the captured electron, allowing a direct comparison of the charge and light yields for the two energy deposition profiles.

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