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Low-Energy Electron-Track Imaging for a Liquid-Argon Time-Projection Chamber using Probabilistic Deep Learning

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The GammaTPC is an MeV-scale single-phase liquid-argon time-projection-chamber gamma-ray telescope with a novel dual-scale pixel-based charge-readout system. It promises to enable a significant improvement in sensitivity to MeV-scale gamma rays over previous telescopes. The novel pixel-based charge readout allows for the imaging of the tracks of electrons scattered by Compton interactions of incident gamma rays. The two primary contributors to the accuracy of a Compton telescope are its energy and position resolution. In this work, we are concerned with optimization of the position resolution and also reconstruction of the direction of the electron scattered in a Compton interaction. To this end, we utilize different deterministic and probabilistic deep learning approaches to estimate the position and initial direction of the scattered electron, and to quantify the uncertainty in the predictions. We show that the deep learning models are able to predict precise locations of Compton scatters of MeV-scale gamma rays from realistic pixel based data. Additionally, the predictive uncertainties are used to restrict the specific gamma interactions to be analyzed, leading to improvements in fidelity and reliability of the reconstruction.

In-person or Virtual?

In-person

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