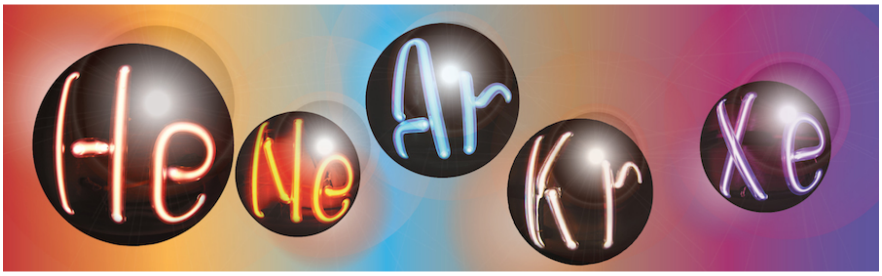

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Machine Learning-Assisted Energy and Position Reconstruction in the Light-only Liquid Xenon (LoLX) experiment

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The Light-only Liquid Xenon (LoLX) experiment operates at McGill University in collaboration with TRIUMF. The experiment uses silicon photomultipliers (SiPMs) to examine liquid xenon (LXe) scintillation characteristics for rare physical events searching experiments, such as neutrinoless double beta decay or dark matter. The primary goals are to understand SiPM performance and study LXe scintillation characteristics in the light-only channel. The LoLX detector is a 4-cm cube consisting of two types of SiPMs—HPK VUV4 and FBK HD3—and a VUV-sensitive photomultiplier tube (PMT). During the first commissioning run, we used external gamma sources (^{133}Ba, ^{137}Cs) to study the detector's performance. To address strong position-dependent variations in event response, we developed a detailed photon propagation simulation using Chroma, a GPU-based photon simulation framework, to model position-dependent energy smearing. By combining experimental data with simulation and applying machine learning techniques for energy and position reconstruction, we have improved our understanding of LXe scintillation and enhanced the detector' s resolution. In this work, we present the measured light yield and energy resolution at 356 keV (^{133}Ba) and 661 keV (^{137}Cs), demonstrating the capabilities of the LoLX detector and our reconstruction approach.

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