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Simulating a high-rate liquid xenon calorimeter for the PIONEER experiment

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PIONEER is a next-generation pion decay experiment that has been approved as high priority at the Paul Scherrer Institute in Switzerland. Building on the former PIENU experiment at TRIUMF, which to date provides the most precise measurement of the ratio of pion decays to electrons compared to muons $\left(R_{e/\mu}\right)$, PIONEER aims to improve this $R_{e/\mu}$ measurement by at least an order of magnitude. This would match the precision of the Standard Model calculation and provide a stringent test of lepton flavour universality. To achieve this goal, PIONEER will employ a modern detector based on two key components: an active highly segmented target, and a large acceptance, 25-radiation length calorimeter. Two calorimeter technology options are being compared: LYSO crystals, and liquid xenon (LXe). Both technologies are fast responding with high light yield, with a key difference being the homogeneity of LXe compared to the natural segmentation of crystals. Liquid xenon homogeneity allows for better energy resolution and angle-independent response, but the lack of natural segmentation raises potential pileup suppression questions. LXe has been successfully used in several low-rate experiments, for example in dark matter and neutrinoless double beta decay searches, but has rarely been used in high-rate experiments. The MEG experiment's LXe calorimeter is the closest comparable to PIONEER, operating at a ˜MHz rate but with a completely different geometry and background configuration. I will present initial Monte Carlo simulations that assess the performance of the envisioned PIONEER LXe calorimeter in combination with the rest of the detectors using a realistic beam simulation.

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rare decays

Keyword-2

precision measurements

Keyword-3

accelerator

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