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Light Dark Matter eXperiment Rejection of Photon Induced Background at 8 GeV

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Viewing dark matter as thermal relics from the early universe necessitates possible dark matter production in accelerator experiments. The dark matter mass range below one GeV, in the "hidden sector", is so far less explored. The Light Dark Matter eXperiment (LDMX) is a proposed fixed target experiment that aims to be sensitive to dark matter around and below the proton mass, where few-GeV electrons will possibly recoil in a thin tungsten target through some dark matter direct production model, yielding measurable missing momentum. At higher energies the production cross-section of some models should increase, motivating the study of running the LDMX at 8 GeV, above the previously studied 4 GeV.

Due to the small and unknown rate of dark matter production, the experiment aims to ideally reject all of the background events out of approximately 10^{14} expected electrons on the target. The electrons will also recoil in the tungsten target through normal bremstrahlung. But through various photo-nuclear interactions, the resulting photon can end up in hard-to-catch hadronic final states that may appear as missing momentum. The forward electromagnetic calorimeter of LDMX can be used to veto these events, using a boosted decision tree trained primarily to distinguish between dark matter signal and such photon induced background events.

Monte Carlo simulations of a first run at 4 GeV showed a 10^{-13} background rejection. Higher energies could expect higher rates of dark matter production in some models, as well as it being easier to measure the energetic by-products of backgrounds events. The rates of some background final states may even decrease at higher energies. This study concerns these possible improvements in background rejection at an 8 GeV second run of LDMX and how the sensitivity to dark matter production is increased, a necessary endeavor when the coupling between dark matter and standard model particles is unknown and at most very small.

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