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Simulation and Testing of LDMX Prototypes

Dark matter is a theorized, yet unknown form of matter that makes up the majority of the mass of the Universe. One compelling explanation for its origin is the thermal freeze-out mechanism, which posits its mass to be somewhere in the MeV to TeV range. While dark matter with mass above 1 GeV is being thoroughly searched for by an ample amount of experiments, very few experiments to date search for light dark matter - dark matter with a mass between 1 MeV and 1 GeV. The Light Dark Matter eXperiment (LDMX) is one of those few. It consists of a 4-16 GeV electron beam shot at a fixed tungsten or aluminium target, the results of which are analysed using missing-momentum techniques to find dark matter creation events. It can therefore conclusively test most models of light dark matter. First commissioning data from the LDMX is expected as early as fall 2024.

In order to build a detector sensitive enough to detect dark matter events, its detecting components - the trigger, trackers, electromagnetic calorimeter, and hadronic calorimeter - must be thoroughly tested and their behavior exactly described. To achieve such precise instrumentation, a prototype of the trigger and hadronic calorimeter was tested this April. The main objective of the test beam measurements was to tune the simulation of the hadronic calorimeter. For this purpose, a detailed simulation of the HCal has been developed.

This contribution focuses on the results from a Geant4 based simulation of the prototype HCal, using different beam characteristics, embedded in the LDMX software framework. Additionally, it focuses on the experimental results of the LDMX prototype that was recently tested under a beam.

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