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Cosmic Ray Muon Detection and Commissioning with a Highly Granular Dual-Readout Fiber Calorimeter (HG-DREAM)

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Calorimeters play a central role in high-energy physics experiments by enabling precise energy measurements and providing critical information for particle identification and event reconstruction. Advances in calorimeter technology are essential to meet the increasingly demanding requirements of future collider experiments —such as the FCC and muon colliders—as well as non-collider experiments in neutrino physics, dark matter searches, and astrophysical observations.

Building on the success of previous dual-readout calorimeter (DREAM) studies, we constructed the HG-DREAM calorimeter at Texas Tech University—a highly granular dual-readout fiber detector instrumented with 896 silicon photomultipliers (SiPMs). The readout system combines CAEN FERS 5202 and CAEN V1742 modules for charge integration and waveform digitization, respectively, with the latter operating at a 5 GHz sampling rate.

In this talk, we present results from the commissioning of HG-DREAM using cosmic ray muons. This initial testing phase allowed us to characterize system noise, single-photoelectron resolution, response linearity, light yield, and overall detector stability in preparation for high-energy test beam campaigns at CERN. We report intriguing observations from cosmic muon events—some exhibiting minimum ionizing particle (MIP)-like behavior, while others produce showers within the detector. These measurements are compared to GEANT4 simulations, and we highlight the use of muon-induced electromagnetic showers for system debugging and preliminary calibration.

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