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Developing an alternative calorimeter solution for the future Muon Collider: the Crilin design

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The Crilin calorimeter instantiates a semi-homogeneous calorimetric system incorporating Lead Fluoride (PbF2) crystals interfaced with surface-mounted UV-extended Silicon Photomultipliers (SiPMs). This innovative design is proposed as the electromagnetic calorimeter for the prospective Muon Collider. Considering the need to discriminate signal particles from background noise and address substructures critical for jet identification, a high level of granularity is deemed necessary.
Considering the expected substantial occupancy resulting from beam-induced backgrounds, with simulations indicating a photon flux of average energy of 1.7 MeV and approximately 4.5 MHz/cm2 fluence, prioritizing time-of-arrival measurements within the calorimeter becomes essential. This temporal information could be instrumental in associating clusters with their respective interaction vertices. Moreover, the calorimeter's energy resolution assumes pivotal importance in accurately determining the kinematic properties of jets.

Operation within a challenging radiation environment is a crucial consideration, with exposure levels reaching 1 Mrad/year total ionizing dose (TID) and a neutron fluence equivalent to 10^14 neutrons 1 MeV/cm^2/year. Our exhaustive radiation hardness studies on both crystals and SiPMs confirm the system's capability to function effectively under these extreme conditions, encompassing both dose and neutron fluences.

A prototype (Proto-1), consisting of two layers of 3x3 PbF2 crystals each, underwent testing in 2023 using 450 MeV electrons at the LNF Beam Test Facility and 40-150 GeV electrons at CERN H2. The achievement of a timing resolution of less than 50 ps for energy deposits exceeding 1 GeV underscores the robustness of the system. A comprehensive overview of the prototype's mechanics and electronics, along with the outcomes of the test beams, is presented for consideration.
We are currently in the process of constructing a larger prototype featuring a 5x5 crystal matrix and comprising 5 layers. The realization is scheduled for completion in 2023, with testing set to commence in the summer of 2025.

Collaboration

IMCC

Role of Submitter

I am the presenter

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