TIPP 2023
4 - 8 SEPTEMBER 2023
CTICC CAPE TOWN SOUTH AFRICA

Contribution ID: **2** Type: **not specified**

# R&D status for an innovative crystal calorimeter for the future Muon Collider

*Thursday, 7 September 2023 16:20 (20 minutes)*

The Crilin calorimeter is a semi-homogeneous calorimeter based on Lead Fluoride ($PbF_2$) Crystals readout by surface-mount UV-extended Silicon Photomultipliers (SiPMs). It is a proposed solution for the electromagnetic calorimeter of the future Muon Collider. A high granularity is required in order to distinguish signal particles from the background and to solve the substructures necessary for jet identification. Time of arrival measurements in the calorimeter could play an important role, since very large occupancy due to beam-induced backgrounds is expected, and the timing could be used to identify energy depositions compatible with the expected muon-muon interaction time. The calorimeter energy resolution is also fundamental to measure the kinematic properties of jets. Moreover, the calorimeter should also operate in a very harsh radiation environment: 1 Mrad/year total ionizing dose (TID) and a 10^14 neutron 1MeV/cm^2/year equivalent neutrons fluence. Our radiation hardness studies on crystals and SiPMs, have demonstrated we can work in this environment both for dose and neutron fluences.

A dedicated test beam, on single cell prototype (Proto-0), has been performed at CERN H2 in August 2022 with an electron energy of 120 GeV: a timing resolution better than 50 ps has been achieved for energy deposits greater than 1 GeV.

In order to validate the design choices, the proposal is to build a larger prototype, called Proto-1. The design has been optimized with the simulation studies starting from dimensions of 0.7 R⊠ and 8.5 X0 (~ 0.3⊠). This size comes from a compromise of an acceptable containment of 100 GeV electrons and cost constraints. Results will be extrapolated to the optimum length of the Muon Collider calorimeter of the order of 20 X0.

The proposal is to build Proto-1 with two layers of 3 × 3 $PbF_2$ crystals, each read out with UV-extended SiPMs (Hamamatsu S14160-3010 PS SMD sensors) as already done in Proto-0. These new SiPMs were already tested with an ultra-fast blue laser (400 nm, 100 ps) and the new electronics front-end (FEE) that showed a dynamic range from 0 to 2 V, a rise time of ~ 2 ns with full signal in ~ 70 ns and a time resolution less than 50 ps even at a charge as low as 100 pC (~ 250 Np.e.). The proto-1 operational temperature will be $0/-10^{\circ}$C and the performance will be validated in a dedicated test beam. Specifically, our goals are: 1) perform a complete operational test of the prototype, including operation with cooling; 2) obtain data for a complete analysis of digitized signals from the detector for electrons and minimum-ionizing particles; 3) test the cluster reconstruction capability and measure the time resolution; 4) measure longitudinal and transverse shower profile and compare with results obtained in simulation.

Details about the prototype mechanics and electronics will be shown; Proto-1 will be tested in a dedicated test beam at Cern before the end of 2023.

**Primary author:** SARRA, Ivano (Istituto Nazionale di Fisica Nucleare - LNF)

**Presenter:** SARRA, Ivano (Istituto Nazionale di Fisica Nucleare - LNF)

**Session Classification:** G2