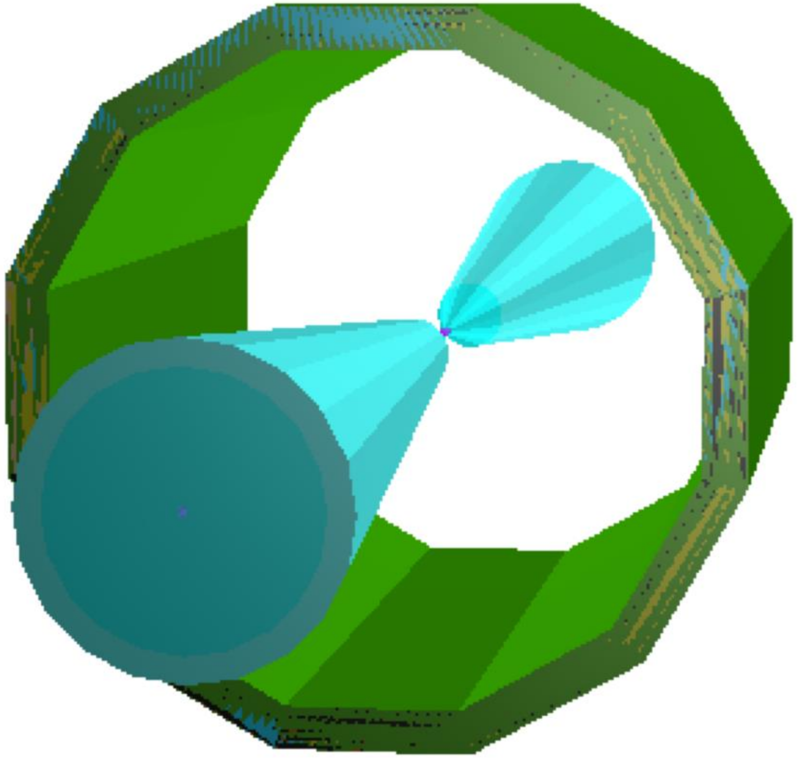
Istituto Nazionale di Fisica Nucleare
SEZIONE DI FERRARA

Mechanical Design of an Electromagnetic Calorimeter Prototype for a Future Muon Collider

A.Saputi, I. Sarra, D.Paesani, D.Tagnani – 19th May 2022

The CRILIN Calorimeter

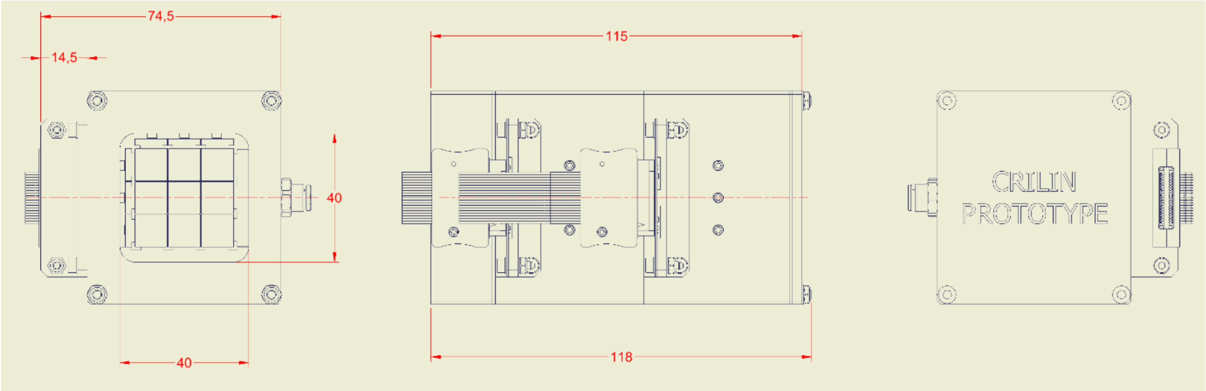
- The goal is to build a crystals calorimeter, fast, relative cheap, and with high granularity (both transversal and longitudinal) optimized for muon collider.
- Our proposed design, **Crilin**, is a **semi-homogeneous** electromagnetic calorimeter made of **Lead Fluoride Crystals** (PbF_2) matrices where each crystal is readout by 2 series of 2 UV-extended surface mount **SiPMs.**
- 5 Layer of crystals (1x1x4 cm^3 each) are longitudinally alternated with readout layer of SiPMs (2 series of 4 SiPMs of 3x3 mm^2) —> a double readout per crystal.
- **It represents a valid and cheaper alternative to the W-Si Muon Collider ECAL**.
- See also "Crilin: a semi-homogeneous calorimeter for a future Muon Collider" - E. Di Meco – 18th May 2022

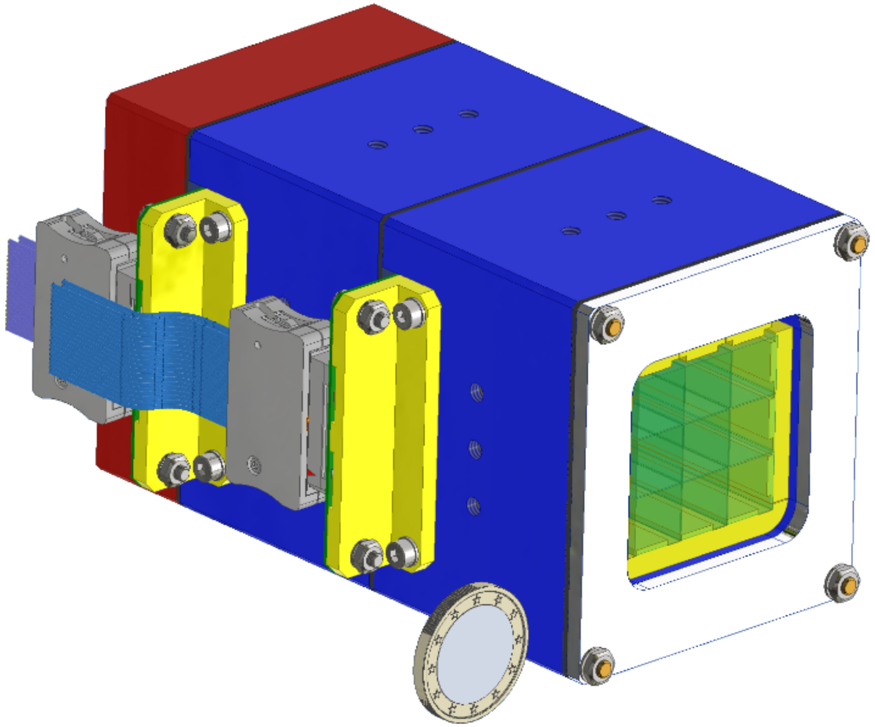


Geant4 realization of Crilin

The CRILIN Prototype

In the current design, the prototype consists of two submodules, each composed of a 3-by-3 crystals matrix. The submodules are arranged in a series and assembled by bolting, thus obtaining a compact and small calorimeter. This solution allows an easy assembly of the calorimeter and allows to assemble the calorimeter with submodules arranged in series and in parallel to obtain any configuration needed.





Each crystal matrix is housed in a light-tight case which also embeds the front-end electronic boards and the heat exchanger needed to cool down the SiPMs.

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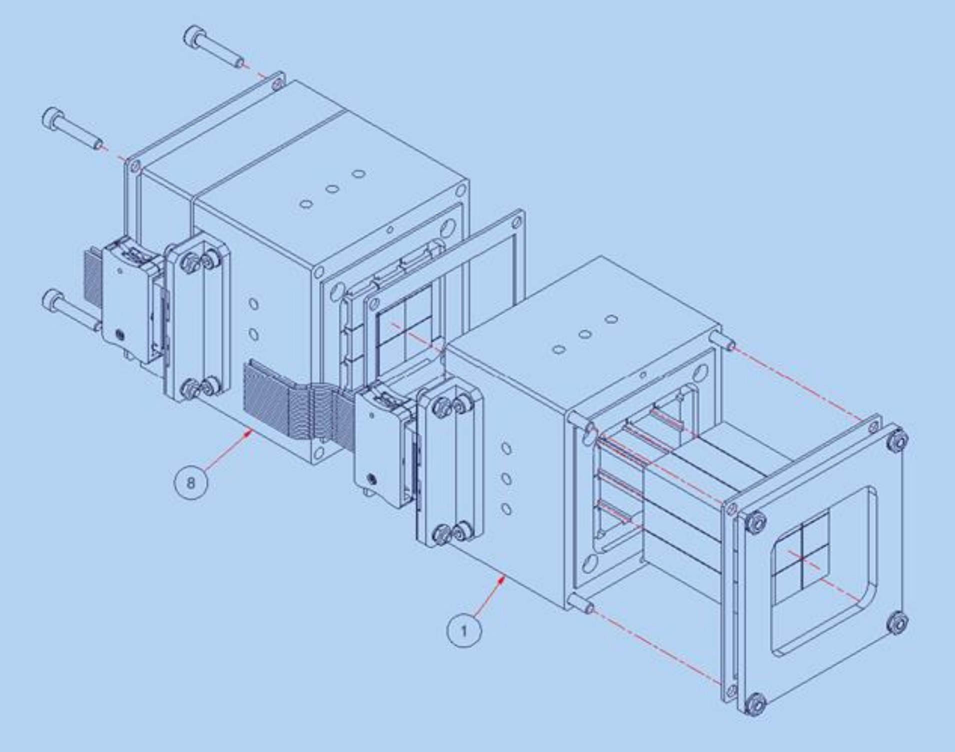
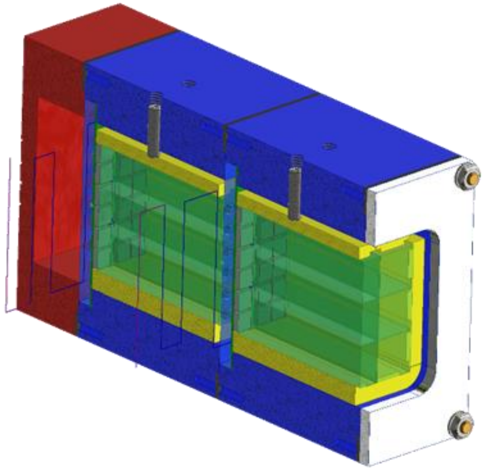
CRILIN Mechanical Architecture





The mechanical architecture of CRILIN comprises the following key elements:

1. The cases house the crystal matrix and embed the front-end electronic boards. They are manufactured in ABS plastic to minimize the thermal exchange with both the external environment and between the modules.
2. The locking plates, to which the positioning and blocking of crystals are entrusted, are manufactured in ABS. This solution eases the assembling, positioning and locking of the crystals matrix.
3. The hydraulic connectors, transport dry gas into the individually sealed modules. The dry gas is fluxed inside the active volume of the prototype to prevent condensation.
4. Between the modules are installed seals, which make each submodule light-tight. The modules are bolted together using special screws that allow assembling the modules in series. A windows made of Tedlar and a cap close the calorimeter at either end.

CRILIN Cooling System

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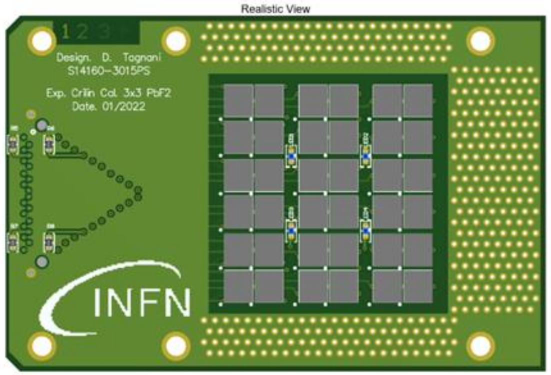
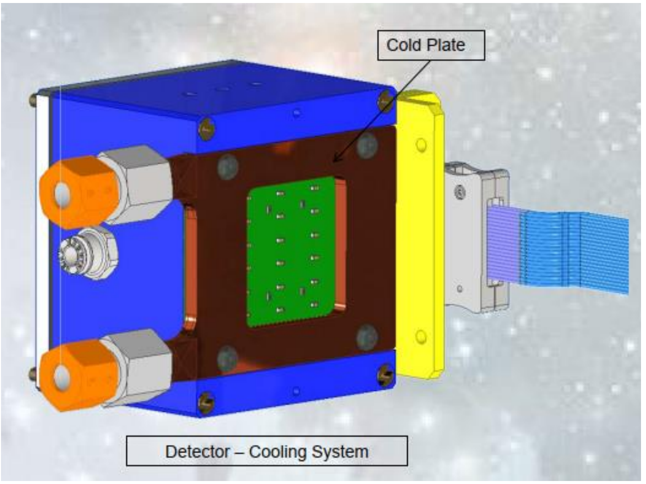
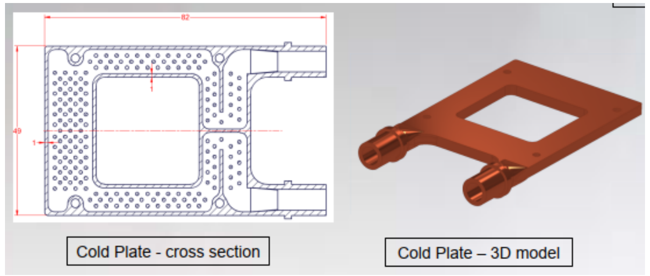
The on-detector electronics and SiPMs must be cooled during operation, so as to improve and stabilise the performance of SiPMs against irradiation. Our design is capable of removing the heat load due to the increased photosensor currents after exposure to the expected 1012 n1MeV /cm^2 fluence, along with the power dissipated by the amplification circuitry. The total heat load was estimated as 350 mW per channel.





Detector – Cooling System


Cold Plate - cross section

Cold Plate – 3D model

The CRILIN cooling system consists of a cooling plant and a cold plate heat exchanger in direct contact with the electronic board. It will provide the optimum operating temperature for the electronics and SiPMs at around 0 ◦C.

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