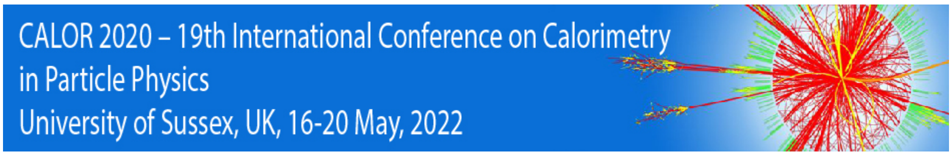

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Mechanical Design of an Electromagnetic Calorimeter Prototype for a Future Muon Collider

Crilin (crystal calorimeter with longitudinal information) is a semi-homogeneous calorimeter proposed for the future Muon Collider. It is based on Lead Fluoride (PbF2) crystals readout by surface mounted UV extended Silicon Photomultipliers (SiPMs). Crilin has a modular architecture made of stackable and interchangeable submodules composed of matrices of 10x10x40 mm3 PbF2 crystals, where each crystal is individually readout by 2 series of 2 UV-extended surface mount SiPMs each. It can provide: high response speed, good pileup capability, great light collection hence good energy resolution throughout the whole dynamic range, resistance to radiation, and fine granularity which is also scalable with SiPMs pixel dimensions. To complement measurements of scintillation properties in the picosecond and sub-picosecond ranges carried out at the test bench facilities of the other partners, the INFN Frascati/Torino/Padova collaborators are developing techniques for the measurement of the timing properties of crystal calorimeter components and small prototypes at test beam facilities. This provides important feedback information to assist in the extrapolation of test bench measurements to estimate the potential for instruments constructed with candidate detector materials to achieve 30 ps time resolution in the real world.
In order to validate the design choices relative to the optoelectronic, mechanical, and cooling architecture of the calorimeter, the proposal is to build a prototype (Proto-1) made of two layers of 3x3 PbF2 crystals each. The layers are arranged in a series and assembled by bolting, thus obtaining a compact and small calorimeter: this solution allows easy assembling of the calorimeter with submodules arranged in series obtaining 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.

The on-detector electronics and SiPMs must be cooled during operation, so as to improve and stabilize the performance of SiPMs against irradiation. Our design is capable of removing the heat load due to the increased photosensor leakage current after exposure to the expected 1014 n1MeV /cm2 fluence, along with the power dissipated by the amplification circuitry. The total heat load was estimated as 350 mW per channel. 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 0/-10 ⊠C.

The cooling plant supplies the cold plate with a glycol-based water solution at the required flow, temperature, and pressure.

The main features of the cooling plant are:

1. Primary cooling circuit (chiller, pump, electrical heater, valves): it supplies the cooling power which is used by the secondary circuit.
2. Secondary circuit: it is this circuit that supplies the cooling power required to remove the heat generated by the electronic board and SiPMs. The fluid used is a glycol-based water solution.
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.

To improve the thermal performance of the cold plate, a micro-channel fin structure has been chosen to provide high thermal performance in a compact size. Micro-channels are formed on the top side of the base of the cold plate; the cold plate is made by brazing a cover onto the base. The coolant inlet pipe and the outlet pipe are also connected to the cold plate by brazing. The micro-channel fins on the top side of the base part enable the cold plate to cool effectively.

Author: SAPUTI, Alessandro (INFN e Laboratori Nazionali di Frascati (IT))