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Towards a Large Calorimeter based on LYSO or LaBrCe Crystals for Future High Energy Physics

State of the art research in particle physics at the precision frontier aims at finding evidence of physics beyond the standard model by measuring prohibited or suppressed processes and quantities with an unprecedented accuracy. For such experiments it is common to search for a faint signal in a waste amount of backgrounds. In the field of charged lepton flavour violation (cLFV), one is investigating various decays, some of which contain photons in the final state. To discriminate between a signal of new physics beyond the standard model and standard model background, detectors providing excellent resolutions in all particle variables are crucial. Muon decays are of special interest as they are at comparably low energy and easier to produce with respect to tau leptons. The photons in muonic charged lepton flavour violating decays are expected to be on an energy scale in the range of 10 MeV to 100 MeV. The state of the art technique to detect these is a calorimeter based on a scintillating material coupled to photosensors of various kind.

Two very promising materials for a future calorimeter are on the one hand LYSO and on the other hand Lanthanum Bromide. Recent progress in the crystal growing process makes it feasible to build a prototype with a crystal of about 10 cm length and 7.5 cm diameter in near future and to test its response to photons of the expected energy scale of future high precision experiments.

Coupling such a crystals to $\mathcal{O}(100)$ silicon photomultipliers results in a granular detection of the optical photons. This provides geometrical information about the distribution of the light amongst the photon sensors and hence allows for a three dimensional reconstruction of the position of the first interaction between the incident γ -photons and the scintillator. The candidate SiPMs for the prototype and potential future applications have been recently characterised and the obtained results will be shown.

The simulated response of both, LaBr₃:Ce and LYSO prototypes fired by gammas of an energy of 55MeV had been studied previously and very promising results were obtained. More specifically, for a prototype using a LYSO crystal of 10 cm length and 7.5 cm diameter an energy resolution around 1.7%, time resolutions below 30 ps and position resolutions around 5 mm are suggested.

In this contribution we will discuss for the first time the extension to a large calorimeter made of several of such a basic units for covering a large solid angle for a straight application to a high energy physics experiment. The response

of the SiPMs in combination with the whole data acquisition system is validated with the data obtained from the SiPM characterisation.

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