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Novel type of compact e.m. calorimeter based on oriented crystals for high-energy physics and astrophysics

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Twenty years ago at CERN it was demonstrated that the strong crystalline field of a single-element crystal, e.g. Si or W, may lead to a huge decrease in the shower length, if the beam direction is aligned with the crystal axes. Recently, we extended these studies to high-Z scintillator crystals typically exploited in electromagnetiiccalorimeters used in HEP and astrophysics. In particular, we measured a strong radiation length reduction for 120 GeV electrons interacting with a lead tungstate crystals (PWO) [1], demonstrating an increase of a factor 2 of the scintillation peak in case of axial alignment as compared to random orientation (see figure).

The effect of shower length reduction can be exploited to develop an innovative type of electromagnetic calorimeter based on oriented scintillator crystals with the key feature of a reduced volume w.r.t. the state of the art. To demonstrate this possibility we developed a dedicated a Geant4 simulation package [2].
These results open the way for a variety of applications in High-Energy Physics and Astrophysics. Such applications span from forward calorimeters/preshowers, to compact active beam dumps for the search for light dark matter, to pointing-strategy in satellite-borne gamma-ray telescope to decrease the required size to fully contain the e.m. shower generated by GeV to TeV particles.

[1] L. Bandiera et al, Phys. Rev. Lett. 121 (2018) 021603
[2] L. Bandiera et al, Nucl. Inst. Meth. Phys. Res. A, 936 (2019) 124

- On behalf of the ELIOT experiment

Summary

Topic

1. Crystal Channeling and related mathematical, physical and chemical issues

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