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Direct measurment of shower acceleration in an oriented crystal scintillator

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Progress in experimental high-energy physics has been closely tied to developments of high-performance calorimeters. Since their invention, crystal calorimeters have consistently achieved the best resolution for measurements of the energies of electromagnetic (e.m.) particles (electrons and photons). Recently, we experimentally demonstrated the possibility to significantly accelerate the e.m. shower development inside a lead tungstate (PWO) crystal, when the incident beam is aligned with the crystal axes within some tenths of a degree. Here, we present the results obtained at the H2 line of CERN SPS with a hundred-GeV electron beam with different PWO samples (0.5, 1 and 2 radiation length thick), coupled with SiPM for direct measurement of scintillation light enhancement in case of beam alignment to the main crystal axes. This is indeed the first direct measurement of scintillation light enhancement due to shower acceleration caused by the strong axial field. Since the angular acceptance of the crystal strong field depends little on particle energy, while instead the decreasing of the shower length remains pronounced at very high-energy, a crystal based calorimeter on oriented crystals would feature a consistent compactness enhancement while rivaling the current state of the art in terms of energy resolution in the range of interest of present and future forward detectors, beam dumps for light dark matter search and source-pointing space-borne γ-ray telescopes.

Collaboration

INFN AXIAL experiment

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