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Enhancement of bremsstrahlung radiation generated by electron beam interaction in an axially-oriented scintillator crystal

Since their discovery, scintillator materials have played an important role in nuclear and particle physics, as well as in medical and industrial imaging. In particular, inorganic scintillator crystals are widely exploited for the realization of homogeneous electromagnetic (e.m.) calorimeters for high-energy physics (HEP) and astrophysics to measure the energy of e± and of γ-rays. Since for primary particles of multi-GeV or TeV energies the shower results to be ten or more radiation lengths (X0) long, high-Z scintillator crystals with X0 of about 1 cm have been introduced to realize compact calorimeters.
Despite these materials are crystalline, the lattice influence on the e.m. shower is usually completely ignored both in detector design and simulations. On the other hand, it is well known since 1950s that the crystal lattice may strongly modify the e.m. shower.
In this poster, we present an experimental investigation of the dependence of the e.m. radiation generated by a 855 MeV/c electron beam as a function of the alignment of a Lead Tungstate (PbWO4) crystal with respect to the electron beam, passing from random alignment to axial alignment. The measurements, performed at the line MAMI-B (Mainz, Germany), demonstrated that in case of axial alignment the photon production increased with respect to the random-alignment case. This effect could be advantageously exploited to reduce the amount of scintillator material in future e.m. calorimeters and γ-telescopes [1].
The PbWO4 scintillator crystal was also tested through hard X-ray at the ID11 and BM05 beamlines at the European Synchrotron Radiation Facility (ESRF) of Grenoble (France) to test its lattice quality. Indeed, the crystallographic perfection is mandatory to exploit axial effect for the enhancement of electron beam interaction in an oriented scintillator crystal.

[1] L. Bandiera et al, Phys. Rev. Lett. 121 (2018) 021603

Summary

Topic

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

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