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Towards large calorimeters based on Lanthanum Bromide or LYSO crystals coupled to silicon photomultipliers: A first direct comparison for future precision physics

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The challenge for new calorimetry for incoming experiments at intensity frontiers is to provide detectors with ultra-precise time resolution and supreme energy resolution.

Two very promising materials on the market are BrilLanCe (Cerium doped Lanthanum Bromide, LaBr3 (Ce)) and LYSO (Lutetium Yttrium OxyorthoSilicate, Lu2(1-x) Y2x SiO5 (Ce)), supported by recent developments aiming at providing new relative large crystals.

The response of both LaBr3 (Ce) and LYSO detectors having silicon photomultipliers as photosensors have been studied via detailed Monte Carlo (MC) simulations. The impinging gammas are in the range of 50-100 MeV. The MC simulations are based on GEANT4, including the full electronic chain up to the waveform digitization and finally the reconstruction algorithms.
For the (R = 4.45 cm, L = 20.3 cm) LaBr3 (Ce) crystal an energy resolution of σE /E ~ 2.3(1)% and a timing resolution of σt ~ 35(1) ps have been predicted. The energy resolution can be further improved by using larger crystals (either R = 6.35 cm or R = 7.6 cm, L = 20.3 cm) approaching respectively a σE/E ~ 1.20(3)% or a σE /E ~ 0.91(1)%.
Due to the shorter radiation length and smaller Moliere radius the LYSO crystal of the available size (R = 3.5 cm, L = 16 cm) performs better in terms of energy deposit compared to the currently available larger crystal made of LaBr3(Ce). An energy resolution of σE /E ~ 1.48(4)% can be obtained, and that can be further improved using bigger crystals (R = 6.5 cm, L = 25 cm, σE /E ~ 0.74(1)%). A σt ~ 40(1) ps can be also achieved.

The size of the crystals considered here is optimal for assembling segmented big detectors as will be shown. Such results put these future high-energy calorimeters at the detector forefront at intensity frontiers.

Collaboration

MEGII

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