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Characterization of Large Volume 3.5" x 8" $LaBr_3$:Ce Detectors for the HECTOR$^+$ array

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The properties of large volume, cylindrical 3.5" x 8" $LaBr_3$:Ce scintillation detectors coupled to the Hamamatsu R10233-1000SEL photo-multiplier tube (PMT) were investigated. A number of 10 of such detectors constitute the HECTOR$^+$ array which is now located at GSI in the PRESPEC experimental setup.

These crystals are among the largest ones ever produced and needed to be fully characterized from the applicative viewpoint. We tested the detectors using monochromatic γ–ray sources and in-beam reactions producing γ-rays up to 22.6 MeV; we acquired PMT signal pulses and calculated detector energy resolution and linearity of response as a function of γ-ray energy. Two different voltage dividers were coupled to the PMT: the Hamamatsu E1198-26, based on straightforward resistive network design and the "LABRVD", specifically designed for our large volume LaBr3:Ce scintillation detectors, which also includes active semiconductor devices. Because of the extremely high light yield of LaBr3:Ce crystals we observed that, depending on the choice of PMT, voltage divider and applied voltage, some significant deviation from the ideally proportional response of the detector and some pulse shape deformation may appear. In addition, crystal non-homogeneities and PMT gain drifts can affect the resolution of measurements in case of high energy γ-rays. We also estimated the time resolution of different sized detectors (from 1"x1" up to 3.5"x8"), correlating the results with the intrinsic properties of PMTs and the GEANT simulations of the scintillation light collection process.