# Study of $CeBr_3$ crystal for $\gamma$-ray measurements

Y. M. Sharma[1], I. Mazumdar[1], R. Sariyal[1,2],* S. M. Patel[1], P. B. Chavan[1], V. Ranga[3], S. Panwar[3], and A. K. Gourishetty[3]

[1] *Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai - 400005, INDIA*

[2] *Department of Physics, Panjab University, Chandigarh - 160014, INDIA and*

[3] *Department of Physics, Indian Institute of Technology Roorkee, Roorkee - 247667, Uttarakhand, INDIA*

The recent discovery and subsequent marketing of Lanthanum Halide scintillation crystals have led to an upsurge in the growth of scintillation crystals for detection of gamma rays. The much superior properties of both Lanthanum Bromide and Lanthanum Chloride over time tested NaI(Tl), CsI(Na), $BaF_2$ etc. have made them primary choices for gamma ray spectroscopy [1]. A very recent entrant in the market is the $CeBr_3$ scintillation crystal with properties very similar to the Lanthanum Halide. This paper presents our detailed studies of the $CeBr_3$ crystal and comparisons with the Lanthanum Bromide ($LaBr_3$:Ce). The measurements were carried out with a 1" $\times$ 1" $CeBr_3$ crystal manufactured and supplied by St. Gobain Inc. The crystal is encapsulated in 2 mm thick Al casings with a glass window on one of the side for coupling to PMT. A variety of photomultiplier tubes were used for the measurements to select the one best suited for optimal performance of the detector. The energy signals were taken from the last dynode and timing signals were taken from the anode of the photo multiplier tubes. The various properties measured were, energy and timing resolution, linearity of response, internal activity, detection efficiencies etc. Figure 1 presents the typical spectrum of gamma rays taken with different low energy gamma ray sources. The energy Resolution of the detector was found to be around 4.79% for 662 keV. The timing resolution at Co energy is about 310 ps. The absolute Photopeak efficiency for 662 keV was determined to be $\sim$ 13.16%. The experimentally determined value matched very well with the simulated value by GEANT4. While the energy resolution of $CeBr_3$ is found to be somewhat inferior to Lanthanum Bromide the other properties like, timing and detection efficiency are very similar to that of Lanthanum Bromide. What is most important about $CeBr_3$ vis-à-vis

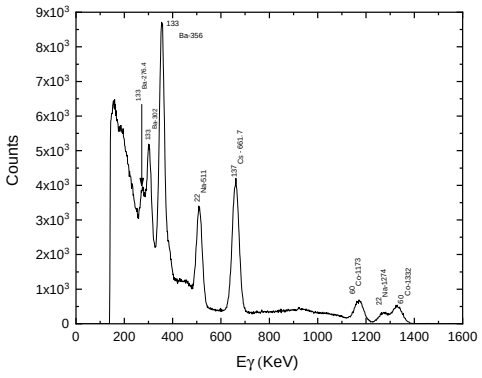


FIG. 1: $\gamma$-ray Photo Peak Position from different radiation sources.

$LaBr_3$:Ce is considerably less internal activity of $CeBr_3$. We carried out detailed measurements to determine the nature and strength of the internal activities of the 1" $\times$ 1" $CeBr_3$ crystal. It was found that unlike $LaBr_3$:Ce there is practically no internal gamma radiation in $CeBr_3$. The only internal radiation of $CeBr_3$ is from $\alpha$ particles from the decay of $^{227}$Ac present in the crystal. Figure 2 shows a typical spectrum taken with a heav-

*Electronic address: ranjansariyal17@gmail.com

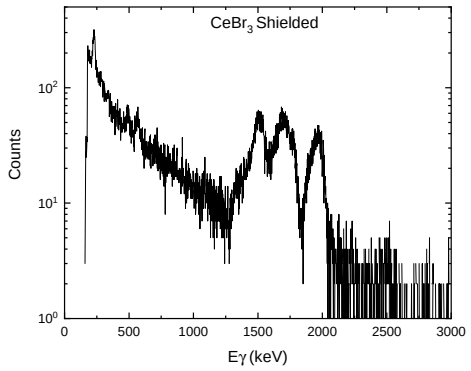


FIG. 2: Internal Activity Spectra of $CeBr_3$

ily shielded $CeBr_3$ detector and without any radioactive source. The spectrum shows no internal gamma ray lines and only three peaks due to the internal $\alpha$ emissions. In conclusion one can say that the $CeBr_3$ is very similar in performance to Lanthanum Bromide and has the added advantage of much less internal activity. The growth and production of $CeBr_3$ in large volumes have great significance for future high energy gamma ray spectroscopy.

## Acknowledgement

One of the authors (R.S) acknowledges Department Of Science Technology (DST), Govt. Of India for the INSPIRE fellowship.

## References

[1] I. Mazumdar *et al.*, Nucl. Instrum. Meth. A, 705 (2013) 85.