Characterization of a $CeBr_3$ Scintillator in Gamma Spectrometry

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In this study the γ spectrometry of the 10x10x5 mm^3 $CeBr_3$ scintillator was measured. The crystal has a very good light output and an energy resolution, fair linear response to γ quanta, an effective atomic number (Z_{eff}) almost identical to that of $LaBr_3$:Ce and a fast decay time of 22.2 ns±1.0 ns (see Fig. 1) [1, 2].

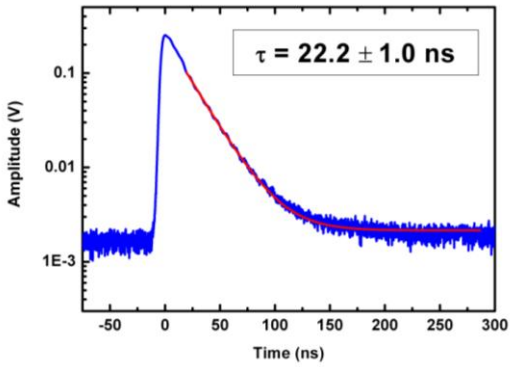

Fig. 1 *Decay time measured with $CeBr_3$ scintillator.*

The crystal was coupled to the photomultiplier (PMT) with silicone grease to improve optical contact with the photodetector window. Measurements of the crystal energy resolution and non-proportional response to X and radiation were carried out with a Photonis XP5200B PMT. The signal was amplified by a Canberra 2005 preamplifier, then shaped by an Ortec 672 spectroscopy amplifier. The gaussian signals were recorded by a Tukan 8K USB Multi-Channel Analyzer [3]. The scintillator decay time was measured using a Photonis XP2020 timing PMT, signals from the PMT anode were recorded by a Tektronix digital oscilloscope.

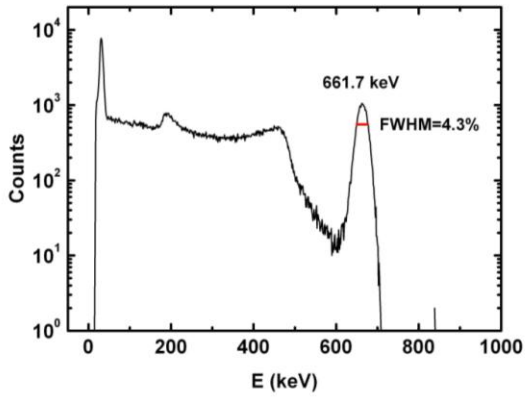

Fig. 2 *Spectrum of a ^{137}Cs source measured with $CeBr_3$ scintillators.*

The gamma spectrum from a ^{137}Cs source recorded by $CeBr_3$ is presented in Fig. 2. The energy resolution of the tested sample was calculated by a fitting procedure of the gamma peak with a Gaussian function and estimating its full-width-at-half-maximum (FWHM). The crystal tested in this paper shows very good energy resolution of 4.3% ± 0.2%, much better than that obtained with NaI:Tl and CsI:Tl, typically between 5% and 6% [4, 5]. The light yield of the $CeBr_3$, measured at 0.5 μs shaping time, was estimated to be 53400 ph/MeV ± 2700 ph/MeV. A comparison of the energy resolution of $CeBr_3$ with other scintillators is presented in Fig. 3.

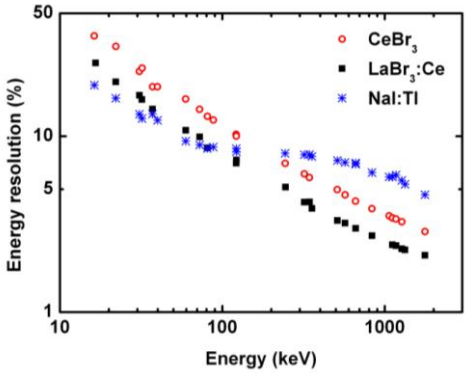

Fig. 3 *Energy resolution of $CeBr_3$, $LaBr_3$:Ce and NaI:Tl measured for γ energies from 22 to 1770 keV. Error bars are within the size of the points (preliminary).*

Summarizing, $CeBr_3$ is a very promising inorganic scintillator due to its high light output, fair linearity of response to γ-rays and fast scintillation decay time. Further study will cover additional measurements of different scintillators potentially used as a gamma camera, applied to a plasma monitoring in tokamaks.

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References

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