Investigation of $LaBr_3$:Ce scintillator with excellent property

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Synopsis In order to satisfy high precision requirement for the modern nuclear physics experiment detectors and radiologic imaging technology equipments, we do some researches in improving the resolution of the detector with $LaBr_3$:Ce scintillator .

Nowadays, scintillations are widely used in detection and spectroscopy of energetic photons (such as γ-rays and X-rays). These detectors are commonly used in nuclear and particle physics research, medical imaging, nondestructive testing, nuclear treaty verification and safeguards, geological exploration and so on[1-3].

An ideal scintillating material should satisfy requirements concerning high detection and scintillation efficiency, good energy, good time and spatial resolution, short dead time, fast scintillation response, mechanical and chemical stability. However, these requirements cannot be completely met by any of the commercially available scintillators (BaF_2, NaI(Tl), CsI(Tl), BGO). As a result, there is continued interest in search for new scintillators with enhanced performance. For the first time, a new $LaBr_3$:Ce scintillation crystal was developed. Its comprehensive outstanding performance makes it possible to satisfy the requirements.

$LaBr_3$:Ce scintillator presents an emission of light photon number higher than NaI(Tl), (61000-68000 photons/MeV) at a peak emission wavelength (380nm) suited for the Bi-alkali photocathode.

The change for $LaBr_3$:Ce crystal property is small influenced by environment temperature[4]. The differences of light yield are smaller than 5% from -65°C to145°C. It also shows a good radiation absorption property. In addition, the crystal shows a scintillation decay time as short as 16ns, which allows high-rate experiments and provides good time resolution (100-300ps).

The energy resolution response of $LaBr_3$:Ce crystal is very good in a wide dynamic energy range. As shown in Fig.1, $LaBr_3$:Ce shows high energy resolution at 60-3000 keV energy dynamic range [5,6], the difference of the value is smaller than 10% (6.6%@122keV,1.6%@2651keV). From the figure, it is proved that the energy resolution of $LaBr_3$:Ce is not influenced by the dimension of scintillation crystal under the same conditions.

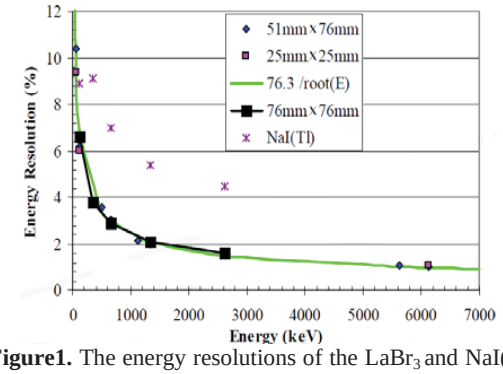


Figure1. The energy resolutions of the $LaBr_3$ and NaI(Tl) scintillator

In our research, the system consists of a pair of $LaBr_3$:Ce (Φ20mm×25mm) crystals coupled to Hamamatsu PMT R4998. Some crucial factors affecting the time resolution are studied in our research. The best coincidence timing resolution of the system for the pairs of 511 keV gamma rays is 276ps (FWHM), and the energy resolution is 4.4% (FWHM). The research will be useful to make $LaBr_3$:Ce scintillator widely used in medical and high-energy physics applications.

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References

[1] E.V.D. van Loef *et al* 2001 *Appl. Phys. Lett.* **7910 1**.
[2] K.S.Shah *et al* 2003 *IEEE Trans. Nucl. Sci.* **NS50 6 2410.**
[3] S.Surti *et al* 2004 *Phys. Med. Biol.***49 4593**
[4] BrilLanCe380 specification, **www.detectors.saint-gobain.com**
[5] B.D.Milbrath *et al* 2007 *Nucl.Instr.Meth.Phys.Res.A*, **572 774**.
[6] C.M.Rozsa *et al* **www.detectors.saintgobain.com**.

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