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$LaBr_3$:Ce crystal: The latest advance for scintillation cameras

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Abstract

Recent availability of $LaBr_3$:Ce crystal is attracting researchers for the development of new advanced SPECT e PET systems. The crystal shows excellent energy resolution values good radiation absorption properties and speed. At present, $LaBr_3$:Ce crystal is available with continuous shape covering $5 \times 5\,cm^2$ area with a thickness up to 1 in. With the aim of analysing the imaging performances of $LaBr_3$:Ce for Single Photon Emission Tomography (SPET), we tested three continuous crystals with the same detection area of $5 \times 5\,cm^2$ and various thicknesses ranging between 4 and 10 mm. Three small scintillation cameras were assembled by coupling LaBr3:Ce crystal to Hamamatsu H8500 Flat panel PMT. The results show very good imaging performances for single photon emission application with superior energy and spatial resolution up 7.5% and 0.9 mm, respectively, and a detection efficiency up to 95% at 140 keV photon energy.

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Keywords: Inorganic scintillator; $LaBr_3$:Ce; γ-ray imagers; PSPMT; Nuclear medicine

1. Introduction

For the first time, a new scintillation crystal, $LaBr_3$:Ce, presents an emission of light photon number higher than NaI(Tl), (63,000 MeV) at a wavelength suited for the photocathode. In addition, it shows a scintillation decay time as short as 16 ns. Furthermore, the crystal shows an excellent energy resolution values and good radiation absorption properties [1–3]. At present, $LaBr_3$:Ce crystal is available with continuous shape covering $5 \times 5\,cm^2$ area with a thickness up to 1 in. Working under the basic principle of Anger camera for position determination, continuous crystals can offer the best position sensitivity, energy resolution and detection efficiency. With the aim to evaluate the imaging performances of $LaBr_3$:Ce for Single Photon Emission Tomography (SPET), three small scintillation cameras were assembled by coupling $LaBr_3$:Ce crystal to Hamamatsu H8500 Flat panel PMT.

2. Equipment and method

Three 2 in. square $LaBr_3$:Ce continuous canned crystals have been realized and coupled to flat panel PSPMTs for position sensitive measurements. Two of them, 4 and 10 mm thick, respectively, have 3 mm thick glass window (because of the material hygroscopicity). The third one, 5 mm thick, was integrally assembled with PSPMT [4]. For all crystals, surface treatment was chosen to carry out the best light output still providing a good determination of light centroid position. The back rough surface is covered with white diffusive reflector, while black light absorber

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Table 1
Scintillation cameras performances

Crystal size (mm)	Crystal thick (mm)	Optical window (mm)	Energy resolution FWHM* (%)	Expected spatial resolution (mm)	Measured spatial resolution (mm)	Efficiency* (%)
50×50	4	3	7.5	0.85	1.1	70
50×50	5	Integral assemb.	7.5	0.70	1.0	80
50×50	10	3	12	1.90	1.9	95

*Values at 140 KeV, crystals coupled to Hamanmatsu H8500 PSPMT.

was placed on edges. The tube has a system of charge multiplication and positioning based on metal channel method. Charge is collected by a 8×8 anode array that works connected to a multiplexed read-out system, which consists of 64 independent chains of preamplifiers, sample and holds [5]. Free and collimated point radioactive sources were used for energy resolution measurements as well as for crystals scanning to investigate spatial resolution and position response.

3. Results and conclusion

A summary of the results is shown in Table 1 where it is clearly visible how the crystal with 5 mm thickness, integrally assembled, is the best trade off between spatial resolution and detection efficiency at 140 keV photon energy. It is worth to note that measured spatial resolution values are the best obtained for continuous scintillation crystals for such high detection efficiencies. Though the scintillation light spread of the crystal with 10 mm thickness is wider than the crystal side, spatial resolution is better than 2 mm, that represents the size of a crystal pixel currently used for many SPET applications.

References

[1] P. Dorenbos, J.T.M. de Haas, C.W.E. van Eijk, IEEE Trans. Nucl. Sci. NS-51 (3) (2004) 1289.
[2] E.V.D. van Loef, P. Dorenbos, C.W.E. van Eijk, K.W. Krämer, H.U. Güdel, Appl. Phys. Lett. 79 (2001) 1573.
[3] R. Pani, M.N. Cinti, F.de Notaratistefani, R. Pellegrini, P. Bennati, M. Betti, et al., in: IEEE MIC Conference Proceeding, Rome, October 2004.
[4] H. Kyushima, H. Shimoi, A. Atsumi, M. Ito, K. Oba, Y. Yoshizawa, IEEE Nucl. Sci. Sym. 1 (2000) 7/3.
[5] HX2/RAL/SS System Readout, Rutherford, Applet on Labs Micro-electron Group, Tech. Data Sheet, Chilton-Didcot, Oxfordshire, UK, 1995.