
STUDIES IN LANTHANUM BROMIDE DETECTORS

Indranil Mazumdar, Tata Institute of Fundamental Research, Mumbai, India

S. Basu¹, P.B. Chavan¹, D.A. Gothe¹, S.M. Patel¹, S. Roy¹, M. Dhibar², A. K. Gourishetty², M.W. Ahmed³, A. Kafkarkou³, J.M. Mueller³, L.S. Myers³, M.H. Sykora¹, H.R. Weller³, W. R. Zimmerman³

¹ Tata Institute of Fundamental Research, Mumbai, India

² Indian Institute of Technology, Roorke, India

³ Duke University, Durham, USA

The invention of Lanthanum Halide detectors, namely, Lanthanum Bromide (LaBr₃:Ce) and Lanthanum Chloride (LaCl₃:Ce) has been one of the most significant recent developments in the field of scintillator detectors. The production and marketing of the LaCl₃:Ce and LaBr₃:Ce crystals have resulted in a flurry of activities for their testings and characterisations. The excellent energy resolution of LaBr₃:Ce, ~3% at 662 keV, is better than any other commercially available scintillator detector. The fast decay time of 35 ns, with no intense slow component and afterglow, leads to a time resolution of about a few hundred picoseconds. The high density of LaBr₃:Ce (5.08 gm/cm³) and the high Z of Lanthanum result in higher detection efficiency than NaI(Tl). These highly attractive properties make it suitable for both low and high energy γ -rays spectroscopy. We embarked upon a programme to study the properties of Lanthanum Bromide detectors of different shapes and volumes and to measure their responses to γ -rays, neutrons and charged particles. Our measurements are also supported by exhaustive and realistic Monte Carlo (GEANT4) simulations to reproduce the measured spectral shapes and efficiencies. The measurements have been carried away using radioactive γ -ray sources, high energy monochromatic γ -rays from nuclear reactions and the HI γ S facility and monochromatic neutrons from nuclear reactions. The measurements completed so far are,

- complete characterisation of LaBr₃:Ce crystals with volumes ranging from 13 to 946 cm³
- measurement of 22.5 MeV γ -rays in a large volume cylindrical LaBr₃:Ce detector
- measurements of response function up to 30 MeV using γ -rays from the HI γ S facility
- measurement of response of large volume square bars of LaBr₃:Ce to fast neutrons
- study of the volume dependence of the properties of LaBr₃:Ce crystals over a wide range
- determination of the quantum efficiency of LaBr₃:Ce crystals
- performance of small and large volume LaBr₃:Ce crystals using SiPM
- performance of a phoswich of LaBr₃:Ce and NaI(Tl)
- performance of an array of large volume square bars of LaBr₃:Ce up to 22.5 MeV
- performance of a combined assembly of large volume cylindrical LaBr₃:Ce and annular NaI(Tl) detector for measuring high energy (up to 20 MeV) γ -rays.

We intend to present the salient features of all these measurements mentioned above in the meeting. Some of these measurements have been reported in references mentioned below.

REFERENCES

- [1] A.K. Gourishetty et al. Nucl. Instr. Meth. A610, (2009) 522
- [2] A.K. Gourishetty et al. Nucl. Instr. Meth. A609, (2009) 183
- [3] I. Mazumdar et. al. Nucl. Instr. Meth. A623, (2010) 995
- [4] I. Mazumdar et. al. Nucl. Instr. Meth. A705, (2013) 85