Commissioning of a $LaBr_3$(Ce) array with EURICA at RIBF

Z. Patel,[*1,*2] F. Browne,[*1,*3] A. M. Bruce,[*3] N. Chiga,[*4] R. Daido,[*5] S. Nishimura,[*1] Zs. Podolyák,[*2] P. H. Regan,[*2,*6] O. J. Roberts,[*3] H. Sakurai,[*1] P.-A. Söderström,[*1] T. Sumikama,[*4] and H. Watanabe[*7]

An array of 18 $LaBr_3$(Ce) detectors were introduced to complement the HPGe EURICA (Euroball-RIKEN Cluster Array) detectors for the Spring 2013 campaign at RIBF. These detectors were supplied by The University of Surrey and The University of Brighton to provide fast-timing information on the half-lives of excited states within radioactive nuclei[1].

$LaBr_3$(Ce) crystals are very fast scintillators with high effective Z and a fast decay time. This makes them superior to other detectors for γ-ray decay time measurements, as they are able to measure half-lives with a picosecond-nanosecond range while also possessing good energy resolution[2,3].

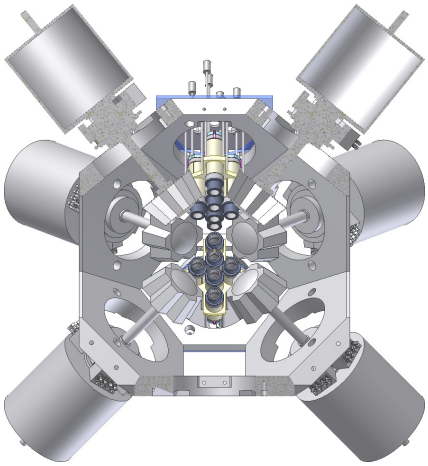

Fig. 1.: A schematic of one-half of EURICA with $LaBr_3$(Ce) detectors, viewed perpendicular to the beam line. The remaining unseen detectors are arranged at the bottom of the array.

Radioactive isotopes were delivered by BigRIPS to the experimental area, where they were implanted into WAS3ABi (Wide Angle Silicon Strip Stopper Array for Beta and ion implantation). The resulting γ rays following the isotope's decay were detected by the surrounding HPGe and $LaBr_3$(Ce) detectors (Fig. 1). Two plastic scintillators were added to WAS3ABi (one upstream and one downstream) to provide a stop signal for the short-range TDC of the $LaBr_3$(Ce) detectors, as the silicon detector's time resolution is too poor at hundreds of nanoseconds.

*1 RIKEN Nishina Center
*2 Department of Physics, The University of Surrey
*3 School of Computing, Engineering and Mathematics, The University of Brighton
*4 Department of Physics, Tohoku University
*5 Department of Physics, Osaka University
*6 Radioactivity Group, National Physics Laboratory
*7 Department of Physics, Beihang University

The $LaBr_3$(Ce) crystals are ∅ 1.5" x 2", each coupled to a H10570MOD Hamamatsu PMT. The crystals have removable 5 mm lead shields to prevent crosstalk between detectors. The configuration can be seen in figure 1. The plastic scintillators measured 45 mm x 150 mm x 2 mm and were placed approximately 3 - 5 mm from the first and last DSSDs.

The PMTs of the $LaBr_3$(Ce) detectors have an anode and a dynode output for timing and energy measurements respectively. The energy signal was taken from the last dynode of the 8-stage PMT and passed to a CAEN N568B shaping amplifier followed by a CAEN V785 ADC. The time signal from the anode is passed to an Ortec 935 CFD and then divided between a CAEN V775 short-range TDC and a CAEN V1190A long-range TDC. A stop signal from the plastic scintillator at F11 ($\sim$ 1 m before WAS3ABi) or from WAS3ABI is used for the long-range TDC. The stop signal for the short-range TDC is taken from the plastic scintillators.

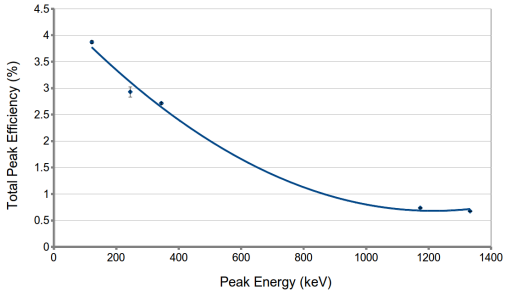

Fig. 2.: Absolute efficiency of the $LaBr_3$(Ce) detectors measured using ^{152}Eu and ^{60}Co sources.

The absolute efficiency of the $LaBr_3$(Ce) array is shown in figure 2. This was measured using ^{152}Eu and ^{60}Co point sources placed inside the WAS3ABi chamber, with the $LaBr_3$(Ce) detectors positioned on average $\sim$ 10 cm from the silicon strip detectors.

Analysis of data taken by the $LaBr_3$(Ce) detectors is in progress: preliminary results from half-life measurements in Zr isotopes can be found in reference 4.

References

1) O. J. Roberts *et al.*, Nucl. Instr. Methods A **748**, 91 (2014).
2) P. H. Regan *et al.*, EPJ Web of Conferences **63**, 01008 (2013).
3) O. J. Roberts *et al.*, EPJ Web of Conferences **63**, 01018 (2013).
4) F. Browne *et al.*, Measurement of Lifetimes of Excited States in ^{102}Zr and ^{104}Zr in this report.