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Characterisation of LaBr3(Ce) Performance for PARIS

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Summary

The Photon Array for the study of Radioactive and Ion Stable beams (PARIS) is a worldwide collaboration, the aim of which is to construct the next generation gamma-ray calorimeter using high resolution LaBr3(Ce) scintillators. Consequently, a thorough investigation into the proposed detection methods was simulated and tested. This presentation will predominately focus on two methods; the response with novel SensL SiPMs and a unique LaBr3(Ce)/CsI(Na) phoswich set-up.

Initial investigations with a 4x4 SiPM array of 3.2mmpixels of the response of the sensitivity with various LEDs was conducted, to determine the spectral range of the detector (max = 520 nm). After observing excellent response with a green LED, the temperature response was subsequently tested between 2 and 30 C with a copper heat sink, where a linear dependence between temperature and energy resolution is presented. However, when the detector was coupled to a well-matched 1"CsI(Tl) scintillator and tested with a standard 137Cs calibration source, no resolution of the 662 keV photo-peak could be obtained due to a high amount of cross-talk and noise, when using all 16 pixels.

Due to the high cost of LaBr3(Ce), two layers of scintillators; 1"-2"of LaBr3(Ce) at the front (for timing purposes), followed by an outer layer acting as a high energy gamma-ray absorber, were tested. The study of the 1"x1"x2"LaBr3(Ce) and 1"x1"x6"CsI(Na) phoswich detector with a standard AmBe source was conducted to study the pulse shapes from neutron and gamma-ray sources, subsequently used to show that (n,gamma) discrimination was not possible without ToF methods. Consequently, an activated spectrum from a 241Am/9Be source was acquired where neutron activation due to excited states of Lanthanum and Bromine (140La, 80Br and 82Br) were found. The timing response of the phoswich was also measured and found to be appx. 690 ps when used in a start-stop set-up with BaF2, where an improvement of around 40 ps was achieved by optimising the timing loop. Pile-up measurements using hot and weak 57Co sources, revealed a threshold in the counting rate of appx. 800 kHz. An experimental set-up involving a proton beam to probe resonances in the 27Al(p,gamma)28Si reaction was also studied to observe the linearity of the
detector at high energies, as well as test pulse shape techniques using several charge-to-digital (QDC) modules. These results are presented and commented upon.

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