Studying the performance of $LaBr_3$:Ce crystals coupled with SiPM.

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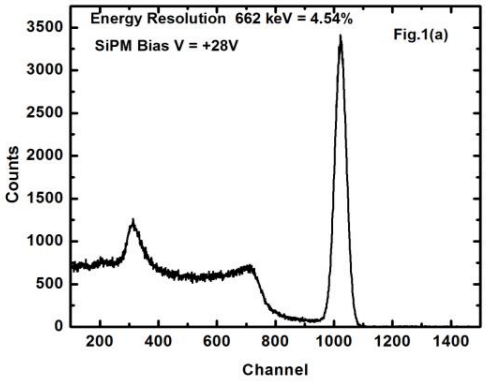
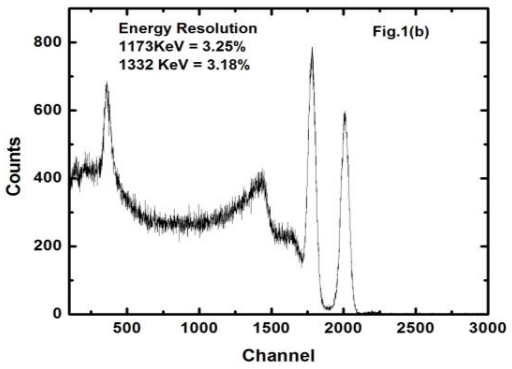
The advent of Silicon Photomultiplier (SiPM) has been a major development in the field of nuclear radiation detection [1-4]. There are some definite advantages of using SiPMs instead of photomultiplier tubes. The coupling of a scintillation detector with SiPM makes the integral assembly occupy significantly less volume than when it is viewed by a photomultiplier tube. This is an important issue while designing large array of multi-detector systems. In addition, the presence of strong magnetic field affects the working of photomultiplier tubes.

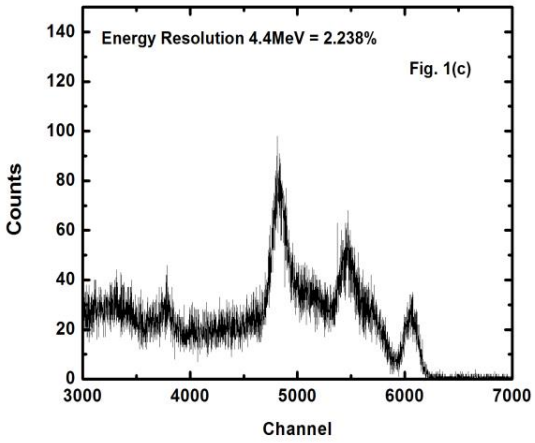


In such cases the scintillator detector is required to be coupled with SiPM instead of photomultiplier tubes. The advantages of SiPMs over conventional vacuum photo tubes have led to a flurry of activities to test and characterize SiPMs over last one decade. Here we report the performance of $LaBr_3$:Ce crystals coupled with SiPMs in measuring γ-rays from 662 keV to 4.43 MeV. We have tested the performances of both small (1"×1" cylinder) and large (2"×2"×8" square bar) volume $LaBr_3$:Ce crystals coupled with SiPMs. We have used 6 mm × 6 mm SiPMs from SensL Inc. The optimum operating voltage for these SiPMs have been determined to be around 29 V. The SiPMs are blue sensitive and work at a peak wavelength of 420 nm.



We have tested the performances of the crystals by varying the number of SiPMs viewing the crystals. We have designed and built different PCBs that can accommodate different number of SiPMs. The tests have been carried out by viewing the crystals with one, four, nine and fourteen SiPMs. For a cylindrical crystal of 1" diameter the energy resolution is rather poor at ~12% when viewed by just one SiPM. However, for the same crystal, the resolution improves to ~ 4.5% for 662 keV (Cs) and 2.2% for 4.43 MeV (AmBe) gamma-rays when viewed by 9 SiPMs covering most of the area. We have carried out the same tests for a large volume square bar (2"×2"×8"). The gamma-rays spectra have been measured with such a bar coupled with one, four, eight and 14 SiPMs. When viewed by 14 SiPMs the resolution at 662 keV is ~ 8.8%. It is to be noted that the relative area viewed by 9 SiPMs for a 1" diameter cylinder is considerably more

than the area viewed by 14 SiPMs for a 2"×2"×8" square bar. We conclude that the performance of the crystals when viewed by adequate number of SiPMs is as good as with photomultiplier tubes. We have also tested the



timing resolutions of $LaBr_3$:Ce crystals coupled with SiPMs. All these results will be presented in the meeting. The Fig. 1 (a,b.c) presents the spectra for Cs, Co, and AmBe sources for a 1"×1" diameter crystal viewed by 9 SiPMs operated at bias voltage +28V.

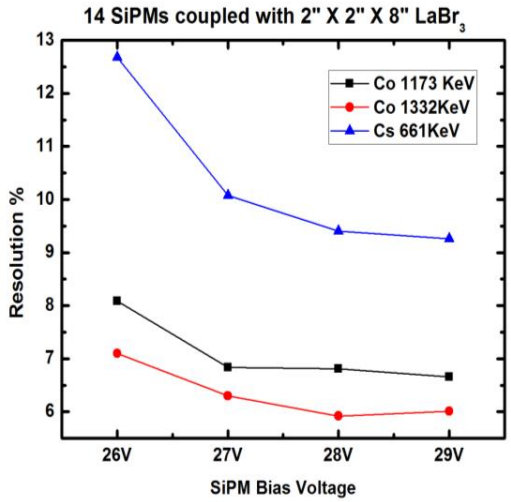


Fig.2 present the performance of the large square bar when viewed by 14 SiPMs.

The resolutions of 662 keV, 1173 and 1332 keV were plotted against the SiPM bias voltage.

Acknowledgement

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References

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