World Academy of Science, Engineering and Technology
International Journal of Nuclear and Quantum Engineering
Vol:15, No:12, 2021

Design and Simulation of a Radiation Spectrometer Using Scintillation Detectors

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Abstract : The idea of this research is to design a radiation spectrometer using LSO scintillation detector coupled to a C series of SiPM (silicon photomultiplier). The device can be used to detects gamma and X-ray radiation. This device is also designed to estimates the activity of the source contamination. The SiPM will detect light in the visible range above the threshold and read them as counts. Three gamma sources were used for these experiments Cs-137, Am-241 and Co-60 with various activities. These sources are applied for four experiments operating the SiPM as a spectrometer, energy resolution, pile-up set and efficiency. The SiPM is connected to a MCA to perform as a spectrometer. Cerium doped Lutetium Silicate (Lu_2SiO_5) with light yield 26000 photons/Mev coupled with the SiPM. As a result, all the main features of the Cs-137, Am-241 and Co-60 are identified in MCA. The experiment shows how photon energy and probability of interaction are inversely related. Total attenuation reduces as photon energy increases. An analytical calculation was made to obtain the FWHM resolution for each gamma source. The FWHM resolution for Am-241 (59 keV) is 28.75 %, for Cs-137 (662 keV) is 7.85 %, for Co-60 (1173 keV) is 4.46 % and for Co-60 (1332 keV) is 3.70%. Moreover, the experiment shows that the dead time and counts number decreased when the pile-up rejection was disabled and the FWHM decreased when the pile-up was enabled. The efficiencies were calculated at four different distances from the detector 2, 4, 8 and 16 cm. The detection efficiency was observed to declined exponentially with increasing distance from the detector face. Conclusively, the SiPM board operated with an LSO scintillator crystal as a spectrometer. The SiPM energy resolution for the three gamma sources used was a decent comparison to other PMTs.

Keywords : PMT, radiation, radiation detection, scintillation detectors, silicon photomultiplier, spectrometer
Conference Title : ICHENP 2021 : International Conference on High Energy and Nuclear Physics
Conference Location : Cairo, Egypt
Conference Dates : December 13-14, 2021

Open Science Index, Nuclear and Quantum Engineering Vol:15, No:12, 2021 publications.waset.org/abstracts/144058.pdf