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Investigation of the intrinsic detector background for SMILE-3 balloon experiment

MeV gamma-ray observations are a probe for uncovering various physical phenomena, such as the search for dark matter and primordial black holes, and the study of the nucleosynthesis in the Universe. However, the current sensitivity of MeV gamma-ray observations is not enough to achieve scientific goals.
For high sensitivity MeV band observations, we have been developing an electron-tracking Compton camera (ETCC). The ETCC uses a gaseous time projection chamber (TPC) and pixelated $Gd_2SiO_5(Ce)$ (GSO(Ce)) scintillator arrays (PSAs). Compton scattering occurs when incident MeV gamma rays interact in the TPC, and the recoil electrons and scattered gamma rays are absorbed in the TPC and PSA, respectively. The ETCC can measure the trajectory of the recoil electron in the TPC, completely reconstruct the Compton scattering process, and uniquely determine the direction of arrival of the gamma rays. This is one of the most important features of the ETCC.
We are planning the Sub-MeV/MeV gamma-ray Imaging Loaded-on-balloon Experiment 3 (SMILE-3). We will be using ETCC that is an upgrade from the previous balloon experiment, SMILE-2+, with a wider dynamic range and a larger effective area. The first balloon flight of SMILE-3 will observe MeV gamma rays for about one day flight in Australia.
Each PSA comprises an 8×8 array of $6 \times 6\,\mathrm{mm}^2$ GSO(Ce) pixels. The thickness of scintillators installed at the side (bottom) of the ETCC is 13 (26) mm. Radioisotopes in GSO(Ce) can produce false triggers in the PSA, which may accidentally coincide with TPC detection signals and thus lead to background events. We recently revealed that this radioisotope-induced background is non-negligible from the results of SMILE-2+. Therefore, we measure the intrinsic background of all the GSO(Ce) scintillators to be used in the SMILE-3 experiment and thoroughly investigate its characteristics. Through these measurements, we obtained the background rate for each scintillator and evaluated the feasibility of screening scintillators based on their background rates for SMILE-3.
In this poster, we present the results of the GSO(Ce) intrinsic background measurements.

Collaboration(s)

SMILE-3

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