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Investigation of single, random, and true counts from natural radioactivity in LSO-based clinical PET

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Objective: Lutetium oxyorthosilicate (LSO) contains natural radioactivity that emits beta particles and three gamma photons simultaneously. These beta particles and gamma photons increase the single and random rates in a positron emission tomography (PET) system while a beta particle and gamma photon produced in the same decay of Lu-176 and detected by another detector can be beta-gamma coincidence true events. The purpose of this work is to measure the single, random, and true count rates due to the natural radioactivity in LSO and determine the optimum lower energy threshold level for an energy window in an LSO-based clinical PET. ***Methods:*** First, we measured the energy spectra of these beta particles and gamma photons in LSO using a single crystal to obtain the basic data. Then, we measured single, random, and true count rates of an LSO-based clinical PET from the natural radioactivity as a function of the lower energy threshold. ***Results:*** In the PET, single and random count rates due to the natural background activity were gradually decreased as the lower energy threshold level increased. The true count rates due to the beta-gamma coincidence were more than 10 kcps below a lower energy threshold of 250 keV. However, these true count rates due to the natural radioactivity in LSO can be decreased to less than 1 kcps at a lower energy threshold level set at more than 350 keV. ***Conclusion:*** With these considerations, in an LSO-based clinical PET, a lower energy threshold level set at above 350 keV is recommended.

Key words: LSO, natural radioactivity, coincidence, PET