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Study on magnetic field and pH response with angular correlation measurement of Yb-169 for double photon coincidence imaging

In the field of medicine, nuclear medicine imaging is a crucial technique for obtaining non-invasive information about the body's interior. It involves detecting radiation emitted from within the body and visualizing its distribution externally. A novel approach in nuclear medicine imaging is being developed, which combines angle correlation measurements with the fusion of magnetic fields, pH values, and radioisotopes.
In this study, we utilized Yb-169, a multi-photon nuclear species with a relatively long-lived intermediate state, as a replacement for In-111, which is commonly used in clinical applications such as SPECT. The unique property of changes in the emission angles of gamma rays when influenced by external fields such as magnetic or electric fields during the intermediate state of cascade nuclear decay was leveraged. This allowed us to detect the precession motion of atomic nuclei induced by the application of a static magnetic field and changes in solution pH, which manifest as oscillations in gamma-ray angle correlations. Additionally, by comparing the observed information on gamma-ray angle correlations with calculated frequencies and pre-known values of magnetic field strength or pH, we were able to acquire information about the distribution of radioactive isotopes.
In this research, the measurement system employed 8x8 arrays of GAGG (Gd3(Al, Ga)5O12(Ce)) scintillators arranged in a ring as detectors. For the photodetectors, Hamamatsu Photonics' MPPC (Multi Pixel Photon Counter) was utilized. The readout circuitry adopted a system using a dToT (dynamic Time over Threshold) board. This system allowed for the simultaneous and independent readout of detection timing and detection energy for all channels. In this experiment, the angle correlations of coincidence events associated with Yb were measured, and the changes in temporal response when applying a magnetic field and varying the pH value were quantified.

Submission declaration

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Track Classification: New ideas and future applications