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COINCIDENCE SPECTRA EVOLUTION WITH DELAY BETWEEN GAMMA SPECTROMETER AND ITS VETO SHIELD

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Two low-background, digital gamma-ray spectrometers with digital data acquisition systems have been designed and developed in the Department of Nuclear Physical Chemistry, Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN), Krakow, Poland.
The first spectrometer is equipped with Broad Energy Germanium detector BE5030 (Canberra, USA), multilayer passive shield and active shielding which consists of five plastic scintillators (Scionix, Netherlands) with areas in range 0.14 to 0.49 m^2. Data acquisition and initial signal pre-processing are carried out by digital analyzer DT5725 (CAEN, Italy) while data offline analysis is performed with purposely written code VETO (Gorzkiewicz et al. 2019). The second spectrometer, constructed in 2021, consists of coaxial HPGe detector (Baltic Scientific Instruments, Latvia), 10 cm lead shield and five plastic scintillators (all with areas 0.49 m^2) and new version of CAEN DT5725S digitizer. Thanks to the size of the spectrometer chamber (about 60x60x60 cm), 12 containers with water (5 L each) can be placed inside to thermalize background neutrons. Both spectrometers are routinely used in low-background gamma ray spectrometric measurements. However thanks to manifold, off-line data exploration continuous monitoring of the cosmic-ray muon flux is performed (Gorzkiewicz et al. 2021).
Short time resolution of used digitizers (4 ns) enables precise determination of the delays between veto detectors as well as between germanium and each veto detector. In the case of used germanium and scintillation detectors, the delays between coincidence events are at the level of 1 - 3 μs. Such property of devices is the starting point of the presented research project, involving analysis of the changes of germanium detectors spectra as a function of the shift and width of the coincidence windows. Empirical time shift distribution reveals some structure. The gamma spectra corresponding to certain parts of this structure were subject of present study. Conducted analyses showed changes in shape of germanium detector background spectrum with increasing delay of coincidence window which correspond to structure of coincidence events time distribution. In addition, the presence of 511 keV peak and peaks corresponding to the excitation and activation of shielding and detectors materials nuclei, depends on the delay of the coincidence window. Moreover line 692 keV (emitted due to reactions ^{72}Ge(n, n')^{72}Ge*) is observed for coincidence events delayed over 2000 ns.

Gorzkiewicz K. et al., 2019. "Low-background, digital gamma-ray spectrometer with BEGe detector and active shield: commissioning, optimisation and software development". J Radioanal Nucl Chem 322, 1311–1321, https://doi.org/10.1007/s10967-019-06853-7

Gorzkiewicz K. et al., 2021. "Investigations of Muon Flux Variations Detected Using Veto Detectors of the Digital Gamma-rays Spectrometer" Applied Sciences 11, no. 17: 7916. https://doi.org/10.3390/app11177916

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