True coincidence effect studies in HPGe detectors

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The true coincidence effect is studied in three High Purity Germanium (HPGe) detectors for a variety of isotopes, source geometries and source to detector configurations, via computational tools based on Monte Carlo simulations. In particular, the upgraded patch of MCNP code MCNP-CP [1] and the 2018 version of PENELOPE [2], which take into account the actual decay scheme of each cascade emitter, are used to calculate the Full Energy Peak Efficiency (FEPE) for the corresponding gamma-ray energies. The true coincidence correction (TCC) factors are calculated as the ratio of the FEPE derived for each nuclide taking into consideration the true coincidence effect, to the FEPE estimated neglecting the phenomenon. In all cases, an excellent agreement is observed between the TCC factors calculated using MCNP-CP and PENELOPE 2018. Moreover, the calculated TCC values are compared against correction factors obtained using the TrueCoinc software [3].

The calculations are validated against experimental results and a very good agreement is observed. In order to "produce" FEPE curves comparable to the experimental ones, the calculated TCC factors are applied on the simulated FEPE for the "non-coincidence" case, namely the efficiency values estimated neglecting the phenomenon.

The results of this work contribute to the validation of the computational tools and codes used to study the true coincidence effect and determine the corresponding correction factors, providing important data for gamma-spectrometry studies of cascade emitters.

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[1] A. N. Berlizov, MCNP-CP Upgrade Patch Version 3.2, Institute for Nuclear Research National Academy of Sciences of Ukraine
[2] F. Salvat, PENELOPE–2018: A Code System for Monte Carlo Simulation of Electron and Photon Transport, NEA/MBDAV/R(2019)1, OECD Nuclear Energy Agency, France, 2019
[3] S. Sudar, TRUECOINC v. 1.01, A program for calculation of true coincidence corrections for gamma rays, Institute of Experimental Physics, Kossuth University, Debrecen, Hungary, 2000