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SEARCH FOR TWO-PHOTON EMISSION FROM EXCITED 0+ STATE N 72GE USING PULSE-SHAPE ANALYSIS WITH HIGHLY-SEGMENTED GERMANIUM DETECTORS

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Two photon emission is a second order nuclear decay process which can, in principle, compete with any single photon or electron decay mechanism. In practice, such a process is very difficult to observe in the presence of a competing single-photon decay due to it being indistinguishable from Compton scattering. The two-photon branch can, however, be distinguished where no single photon decay is possible, such as the case of a 0+ -> 0+ transition which can only proceed by electron emission (or pair production for high energy transitions). The few examples of nuclear two-photon emission so far measured are in 16O, 40Ca and 90Zr, where the lowest excited state unusually has spin/parity of 0+. In each case, the two-photon branch was found to be ~10-4 [1].

We have carried out a search for two-photon emission from the first excited 0+ state in 72Ge. This isotope is a major component (28%) of natural germanium. Two highly segmented coaxial hyperpure germanium detectors were used as both the target and the detector. The excited 0+ state at 690 keV in 72Ge was excited within the detector using 2.45 MeV pulsed neutrons from the unique pulsed neutron facility at Chalmers University of Technology. The detectors were triggered with a delay to the prompt neutron pulse which allowed the clean seperation of the transition from the 0+ state of interest, which has a 400ns half-life. For each event, the full pulse shapes in each detector segment were recorded. In the analysis, two photon events will be distinguished from single electron events on the basis of their multiplicity and their range, as deduced from the pulse shape analysis. Reference pulse shapes for the detectors were obtained from a seperate measurement using a collimator source and x-y tracking table at Liverpool.

Simulations of the detector setup with Monte Carlo code, GEANT4, indicate a high efficiency for detection of two-photon decays within the detector of around 20%. The details of these simulations will be reported as well as the outcomes of the ongoing analysis. The effects on the recorded pulse shapes of the fast neutron flux will be discussed.

[1] J.Kramp et al., Nucl. Phys. A474, 412(1987)

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