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P2.73: Position-sensitive semiconductor detectors for nuclear fuel imaging

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The Passive Gamma Emission Tomography (PGET) device was approved by the IAEA for spent nuclear fuel safeguards inspections at the end of 2017. It is based on a collimator, consisting of a linear array of narrow slits with a pitch of 4 mm, with a relatively small CZT (cadmium-zinc-telluride) gamma ray detector behind each slit. Larger detectors would have a higher probability for detecting the full energy of gamma rays, increasing the effective sensitivity and image quality (in terms of statistics and contrast-to-noise ratio). However, a larger detector would cover more than one collimator slit, requiring position sensitivity to determine through which slit a gamma ray travelled in order to maintain image spatial resolution. We are studying the use of state-of-the-art 3D position-sensitive CZT and germanium gamma ray detectors. In addition to utilizing the position sensitivity along the direction of the collimator, which gives transaxial position information, we are investigating to what extent Compton imaging can provide information on the origin of a gamma ray along the axis of a spent fuel assembly. This opens the prospect of creating 3D images with the PGET device in a single axial position, adding axial information to the current 2D transaxial images. The technology being developed is also useful for other than safeguards applications, such as the non-invasive post-irradiation examination of nuclear fuel to characterise its important properties.

A Monte Carlo simulation framework has been developed using the Geant4 toolkit and measurements using point-like and rod-shaped Cs-137 sources, the latter mimicking spent nuclear fuel, have been performed. The status and prospects of the project will be reported.

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