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Design and Evaluation of CZT-based Micro-activity Calibration System for TAT Application using Monte Carlo Simulation

A novel dose calibrator based on CZT detector has been designed to accurately measure low-level activities that conventional dose calibrators cannot reliably measure. In order to ensure that the dose delivered to the patient is what is intended in radiopharmaceutical therapies, dose calibrator is a priory. Errors in exact activity measurement would otherwise result in overdose or underdose which are both undesirable effects. Especially for targeted alpha therapy (TAT), low-activity alpha emitters as low as μCi to nCi is typically used. However, conventional dose calibrator, or high pressurized gas-filled ionization chamber has limited sensitivity and lack of energy discrimination which makes it not suitable for measuring micro-activity. Therefore, we designed a CZT based micro-activity calibration system (20mm x 20mm x 10mm) in a box shaped well configuration to achieve nearly 4π solid angle coverage using GATE simulation.
The performance of the designed CZT-based micro-activity calibrator was evaluated by comparing it with NaI-based well counter or gamma counter (HIDEX Automatic Gamma Counter) which serves as an alternative to conventional dose calibrator. An alpha-emitting 225Ac point source was simulated using Monte-Carlo based GATE simulation sequentially lowering its activity from 1 μCi to 0.01 nCi while measuring for the same duration each. As the activity decreased, the CZT-based micro-activity calibrator showed lower error rate compared to the NaI-based gamma counter. Future work will involve constructing the system based on this simulation and conducting real-world experiments.

Workshop topics

Detector systems

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