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A Seed Activity Reconstruction Algorithm for a Novel Fast Pre-Insertion Verification System for I-125 Eye Plaques

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Ocular melanoma is the most common intraocular malignancy in adults and is potentially life-threatening if left untreated. A common alternative to enucleation (removal of the eye) is eye plaque brachytherapy, where small Iodine-125 seeds are arranged on the surface of a circular ophthalmic plaque. Currently, there is no rapid method to measure the activity of individual seeds, preventing hospitals from independently verifying plaque loading in a sterile environment before insertion. We present a seed activity reconstruction algorithm for I-125 ophthalmic plaques measured using a novel fast pre-insertion verification system developed at the Centre for Medical Radiation Physics, University of Wollongong.

In this system, a plaque is positioned above a tungsten collimator that projects emitted photons onto a pixelated high-spatial-resolution silicon detector, effectively forming a pinhole camera. Due to the apparatus geometry, raw detector data do not directly correspond to seed activity and require correction and calibration. These filters were established by measuring a single AgX-100 seed at various positions in ROPES 15 mm plaque and fitting the results to interpolate responses across all possible seed locations. The results were compared both analytical solution and a Monte Carlo simulation model developed using the Geant4 toolkit. The system, combined with the reconstruction algorithm, enabled identification of each seed's activity (with mean activity 0.4 mCi per seed) in a fully loaded plaque within 5 minutes. Clinical application of this method could prevent misloaded plaques from reaching patients and enable tailored loading with seeds of varying activity to achieve tumor-specific dose profiles. In the future, the apparatus could be easily expanded to work for other plaque diameters, making it viable for larger scale clinical adoption.

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