AbstractID: 4757 Title: A directional algorithm for an electronically-collimated gamma-ray detector for intraoperative localization of radiation sources

Purpose: An electronically-collimated gamma-radiation detector for intraoperative localization of sentinel lymph nodes and metastases is under development. Analogous to Compton telescopes and Compton cameras, localization is achieved using the coincidence detection of Compton-scattered gamma rays. Electronic collimation allows the device to operate without physical collimation, providing high sensitivity while also allowing directional information to be determined. We report on implementation of algorithms to calculate the direction to the source.

Methods and Materials: Two approaches to direction reconstruction were evaluated. The first technique backprojects each event onto the surface of a sphere centered on the device's primary detector. To use Fourier filtering methods for deblurring, the sphere's surface is mapped by stereographic projection onto a plane, filtered in Fourier space, and then projected back onto the sphere. The second technique also backprojects events onto the sphere, then determines the rectangle that circumscribes the backprojected cone; localization is obtained by intersection of all circumscribed rectangles.

Results: Performance of the algorithm has been evaluated using randomly generated ideal Compton-scatter events from point sources for our detector geometry. Direction angles are calculated within 5% accuracy for source positions up to 45° off-axis for the filtering approach and ~30° for the circumscription approach. Error in calculated direction angles depends on the arbitrary diameter of the sphere; optimally, the sphere should intersect the source. The circumscription technique converges to an estimate of direction angles in ~50 events; the filtering approach requires ~1000 events.

Conclusion: The two methods complement each other in speed and field-of-view. Monte Carlo simulations and experimental testing of a prototype system are ongoing as a separate part of the overall project; data from these will further supplement evaluation of the algorithms.

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