AbstractID: 5224 Title: An Electronically-collimated Gamma-ray Detector for Intraoperative Localization of Radiation Sources

Purpose: We are developing a radiation detector for locating radiation sources, e.g. for intraoperative localization of sentinel lymph nodes and metastases. The design emphasizes compact size and portability, wide field of view, and efficiency and accuracy in source localization. Room-temperature cadmium-zinc-telluride (CZT) detectors and electronic collimation via Compton-scatter detection are used to achieve the design goals.

Method and Materials: The detector design was simulated in GEANT4 to assess feasibility and optimize the design. The simulation model was a 6-sided box with one detector module on each end and two modules per side. One end is the primary scatter detector; the other modules detect the scattered photons, operating in coincidence with the primary module. The simulations allowed variations of detector dimensions, pixel size, energy resolution, and source energies. Experimental measurements with a 3-module partial prototype were used to validate the simulations; each module is a 16x16-pixel 38x38x5-mm^3 CZT detector.

Results: The simulations indicated ~15% of incident gamma rays produce valid direction measurements; 30-70% of these events are Compton-photoelectric interaction pairs. The measured angular resolution varied from a few degrees for 100-keV gamma-rays up to about 10° FWHM at 1 MeV. Above ~1.5 MeV, multiple Compton-scatter events limit accurate measurement of Compton cone angles; below ~50 keV, few Compton-scatter events occur. Experimental validation with the prototype system is in progress.

Conclusion: Efficiency and angular resolution vary with source energy but reasonable performance seems achievable for radioisotopes from Am-241 through Co-60. Ongoing work is investigating the effect on performance of design parameters such as pixel size and detector thickness. Coupled with concurrent development of real-time methods to calculate the directional information, this system provides localization of radiation sources with high sensitivity.

Acknowledgment: Supported by Homeland Security Advanced Research Projects Agency, and Space and Naval Warfare Systems Center San Diego; Contract N66001-05-C-6024