AbstractID: 11552 Title: Radiotherapy dose reconstruction using a Compton camera imaging system

Purpose:
To reconstruct three-dimensional dose delivered during radiation therapy treatments by using a Compton camera imaging (CCI) system to detect and image photons scattered from the patient.

Method and Materials:
MCNPX was used to simulate a CCI detector system and a monoenergetic photon beam incident on a simplified head phantom. Each of two CCI detectors was modeled with parallel planar ideal scatter and absorption detectors separated by 5-cm. The two systems were positioned parallel to one another and perpendicular to the photon beam on opposite sides of the phantom. Relevant detector event data was extracted from the MCNPX output and passed to an image reconstruction algorithm. The reconstruction algorithm solved the intersection of the cone defined by the detector event information (and describing all possible points of origin of the detected photon) with each plane (slice) of the image space, producing a 3D rendering of the source spatial distribution. Voxel intensity of the reconstructed image is proportional to energy deposition at the corresponding physical location.

Results:
Detector event data from 3×10^8 source photons was used to reconstruct the scattered photon spatial distribution in the $(20\ \text{cm})^3$ space between the two CCI systems with voxel dimensions of $(1\ \text{mm})^3$. A comparison of the reconstructed image with the actual energy deposition at each voxel location as tallied by MCNPX showed good qualitative agreement. The reconstructed image accurately depicted high dose regions in the tumor and in the skull at beam entry and exit points.

Conclusion:
This work indicates the potential for a CCI system to reconstruct the dose distribution delivered to a patient during radiotherapy treatment without the need for implanted devices or secondary dose calculations. Research is ongoing to improve reconstructed image quality and to assess the performance of the proposed system under treatment-room conditions.