Abstract ID: 16316 Title: Evaluation of Tissue-Equivalent 3D Polymer Gel Dosimeters as Phantoms for PET/CT Verification of Proton Beam Deliveries

Purpose: to investigate the potential of polymer gel dosimeters for concurrent measurements of three-dimensional positron emission activity and dose distributions; to evaluate the ability of this technique to identify dosimetric errors due to delivery uncertainties, including those due to range modification and target motion.

Methods: three BANG3-Pro2 gel dosimeters irradiated by proton beams were imaged in a PET/CT scanner, starting within 3 minutes after irradiation. The radiation was delivered as a pristine beam under static conditions, as well as an SOBP, with and without phantom motion. The motion trace was defined by a sinusoidal curve with 2 cm peak-to-peak amplitude and the frequency of 0.25 Hz. The dose was read out using an established optical CT scanning procedure. PET/CT images of activated gels were validated against analytical calculations of activity and correlated to measured dose. The effects of target motion on activity and dose distributions were evaluated by volumetric gamma analysis against the treatment plan.

Results: The profiles of positron emission activity along the central beam axis were found to be consistent with analytical calculations. Temporal dependence of activity decay suggests that the observed PET signal is due mainly to decay of 15O and 11C. Lateral profiles were found to exhibit good spatial correlation throughout the beam range. This allowed using a modified gamma analysis method to compare the signatures of target motion in PET and dose images. Mean gamma for static PET and dose datasets was 0.07 and 0.11, respectively. For the motion delivery, the mean gamma value increased to 0.63 for both datasets. The spatial distributions of the gamma criterion for PET and dose datasets were qualitatively similar.

Conclusions: Polymer gels can accurately capture both dosimetric and activation information. Dosimetric errors due to target motion can be quantified by PET/CT using a novel method of analysis.

Funding Support, Disclosures, and Conflict of Interest:

This work was supported by the Bankhead-Coley Florida Biomedical Research Program under Grant No. 1BD10-34212.