AbstractID: 10325 Title: In-vivo verification of proton beam path using post-treatment PET/CT imaging

Purpose: To establish the utility of *in-vivo* verification of the path of proton beam in a patient using proton activated positron emission distributions.

Methods: A total of 50 PET/CT imaging studies were performed on ten prostate cancer patients immediately after proton therapy treatment with through a single lateral portal. The beam path of delivered protons was defined *in-vivo* by the positron-emitter distributions see within the pelvic bones. Whereas the beam path defined by fiducials seen in the post-treatment CT was used as a surrogate for the intended beam path in each fraction. The angular variation and discordance between the PET-defined path and the intended path were computed. A second set of CT images was also acquired after PET imaging in each case to investigate prostate motion due to physiological changes.

Results: The derived angular variation was found to be less than 2.0 degree thus indicating that the patient roll was minimal within the immobilization device. 30 out of 50 study sets show small (6 mm or less) discordance. For these 30 study sets, average displacements along anterior-posterior, D_{AP} and superior-inferior directions, D_{SI} from PET-defined path to intended path was found to be 0.6 mm posterior and 1.3 mm superior with standard deviations of 1.6 mm and 1.6 mm respectively. In the remaining twenty study sets the discordance was much larger. The larger displacements correspond to patients that had a large volume of rectal gas between the first CT (before) and the second CT (after) PET imaging. These displacement, D_{AP} and D_{SI} were 4.8 mm and 3.3 mm respectively

Conclusion: Systematic Analyses of proton activated positron emitter distributions provide patient specific information on intrafractional prostate motion and patient position variability during proton beam delivery. Such data are useful in establishing patient-specific planning target volume (PTV) margins.