AbstractID: 13239 Title: Evaluating intra-fractional prostate motions by post-treatment PET/CT imaging in In-vivo verification

Purpose: To evaluate intra-fractional prostate motion by post-treatment PET/CT imaging in *in-vivo* verification.
Methods: A total of 50 PET/CT imaging studies were performed immediately after daily proton therapy treatment through a single lateral portal. The PET/CT and planning CT were registered by matching the pelvic bones, and the beam path of delivered protons was defined in-vivo by the positron emission distribution seen only within the pelvic bones. At each fraction treatment, a beam path defined by the fiducial markers seen in the post-treatment CT is used as a surrogate for the intended beam; it can be different from its planned location at initial treatment planning due to a translational shift during the patient positioning. The discordance between the PET-defined path and the intended path were derived. The PET-defined path was compared to the positron-emission distribution in lipomatous tissues around prostate to determine whether the prostate motion occurred before or after beam delivery.
Results: For 30 of the 50 studies with small discordance between the intended and PET-defined paths, average displacements are 0.6 mm and 1.3 mm along anterior-posterior (D_{AP}) and superior-inferior (D_{SI}) directions, respectively. For the remaining 20 studies demonstrating a large discordance, 13 studies also show large misalignment while 7 studies show no mismatch between the field edge and the positron emission distribution in lipomatous tissues around the prostate. The standard deviations for D_{AP} and D_{SI} are 5.0 mm and 3.0 mm are for these 13 studies, and 4.6 mm and 3.6 mm for last 7 studies.
Conclusion: Systematic analyses of proton-activated positron emission distributions provide patient-specific information on prostate motion and patient position variability during daily proton beam delivery. Small fraction of PET/CT studies (approximately 14%) with ~4-mm displacement variations may require different margins. Such data are useful in establishing patient-specific planning target volume (PTV) margins.