AbstractID: 13308 Title: PET Image Simulation of Isotopes Produced in Patient during Proton Therapy

Introduction -- During proton therapy, positron emitting radio-isotopes are produced along the track where incident proton beam interacts with human tissue. The isotope activity profile is related to the proton dose distribution and can be imaged using a PET scanner. Many factors affect the obtained PET images, such as various patient geometry, time interval between proton therapy and PET scan, the PET scan duration, and PET scanner design. In order to quantitatively relate the obtained PET image to the dose delivered in patient, an understanding of these factors in the PET image is necessary. This work is to develop a simulation pathway to facilitate such study.

Method – The simulation starts with proton beam irradiating the patient geometry, obtains isotopes distribution, records in list-mode gammas from positron annihilations arriving at PET ring geometry, and finally reconstructs the PET images. The patient DICOM CT are input to GEANT4 code to construct the geometry. Experimental isotope cross-section data are built into the simulation. The positron emitter 3D map is used as the source in the PET scanner simulation. The PET scanner geometry, crystal detector type and its cross-section are the input parameters. The received signals in PET crystals are output in list-mode. Image reconstruction is performed with iterative TOF image reconstruction together with data corrections for scatter and attenuation.

Results – The 3-D proton dose and isotope distributions are obtained. The reconstructed isotope distribution from PET simulation correlates with the original isotope map generated from proton beam irradiation. Some of the factors affecting the obtained PET images will be addressed. In the future, the simulation can be used to quantitatively correlate to the proton dose. It can also facilitate the design of a PET system that can yield an accurate and efficient reconstruction of the isotope activities and verify the proton dose.