AbstractID: 13131 Title: On the development of on-board PET with tomotherapy using open dual ring geometry

Purpose: Positron emission tomography (PET) using open dual ring geometry was investigated as an on-board system for functional imaging and PET marker tracking, specifically with tomotherapy. The dual ring PET would allow measurement of both inter and intra-fractional variation, facilitating the determination of treatment uncertainties and improving the delineation of tumor volume at any stage in the radiation treatment delivery process. This study demonstrates the field of view (FOV) of various PET ring axial gaps, the sensitivity of each system for each gap, and the image quality as a function of scan time and activity for one specified design.

Method and Materials: Investigation of FOV and sensitivity of each design was accomplished via Monte Carlo simulations with GATE, the Geant4 Application for Emission Tomography. Image quality was investigated with a fully 3D OSEM iterative reconstruction algorithm for noiseless data to investigate the FOV and noisy data to investigate the scan time at a specified activity.

Results: Even when the axial gap (G) exceeded the axial width (W) for each open ring system as in the extreme case of G = 600 mm (required to avoid actuators holding MLC's) the axial FOV was approximately 200 mm. A continuous axial and transaxial FOV (determined by PET ring diameter) of 360 mm and 450 mm respectively resulted from G=W=120mm. Reconstructed NEMA 2001 phantom images for activity of 15 mCi/70kg and scan times ranging from 10 to 100 seconds was demonstrated without the effect of attenuation, scatter, and random events.

Conclusion: For tomotherapy treatment 200 mm continuous FOV axially was sufficient and was achievable with all gaps simulated in the range from 120 mm to 600 mm. Open dual ring on-board PET has the potential to acquire images within the time limit of a tomotherapy treatment session.