AbstractID: 13894 Title: Emission Guided Radiation Therapy: A simulation study of treatment without margins

Purpose: Accurate tumor tracking remains as a major challenge in radiation therapy. Margins are added to the clinical target volume (CTV) to ensure the treatment of tumor in the presence of patient setup uncertainty. Fiducial seeds and calypso markers are commonly implanted into the disease sites to further reduce the dose delivery error due to tumor motion. For more accurate dose delivery and improved patient comfort, the use of radioactive tracers in positron emission tomography (PET) as non-invasive tumor markers has been proposed – a concept called emission-guided radiation therapy (EGRT). **Method and Materials:** Instead of using images obtained from a stand-alone PET scanner for treatment guidance, we mount a positron imaging system on a radiation therapy machine. Such an EGRT system is able to track the tumor in real time based on the lines of response (LOR) of the tumor positron events, and perform radiation therapy simultaneously. One main algorithmic difficulty of EGRT implementation is how to deliver the dose based on an existing treatment plan and the acquired real-time tumor location information. In this work, we illustrate the EGRT concept using computer simulations and propose an adaptive algorithm for dose delivery. **Results:** EGRT's advantage on increased dose delivery accuracy is demonstrated using a prostate treatment case without the setup margin. The emission process is simulated by Geant4 Application for Tomographic Emission package and Linac dose delivery is simulated using a voxel-based Monte Carlo algorithm. A treatment setup error of 1cm is simulated on the prostate. The dose distributions show that the proposed EGRT can accurately deliver the prescribed dose to the CTV without using margins to compensate for the setup error. **Conclusion:** Although still in a preliminary research stage, EGRT has the potential to substantially reduce tumor location uncertainties and to greatly increase the performance of current radiation therapy.