AbstractID: 7369 Title: Dosimetric impact of motion mitigation strategies in the irradiation of moving tumors: a 4D Monte Carlo simulation study

Purpose: To quantify the effects of motion on dose distribution in a 4D Monte Carlo simulation framework and to understand the gain of motion mitigation strategies in high precision radiation therapy.

Method and Materials: A simulation engine based on 4D-CT modeling and 4D Monte Carlo dose calculations was specifically designed. The NCAT (NURBS-based cardiac-torso) computational phantom provided a database of 48 anatomical 4D-CT models, featuring breathing patterns up to 4 cm diaphragm motion and 3 cm chest-wall expansion. Lung tumors of variable size were placed at different locations in the NCAT models. Monte Carlo dose calculation software, based on the Dose Planning Method (DPM), was utilized to compute dose-volume histograms on the simulated 4D-CT database. Variations in the dose distribution as a function of irradiation technique (IMRT, 3D conformal), motion mitigation strategy (ITV, gating, tracking) and treatment margins are under investigation. The performance of the implemented simulation framework was examined on a test IMRT case featuring 4.0 cm diaphragm motion and 2.0 cm extension of the chest-wall, with a spherical tumor (1.0 cm radius, 70 Gy prescription dose) located close to the diaphragm.

Results: Results show variations in IMRT target coverage as a function of the breathing phase in tumor tracking. Dose coverage for 95% of the target volume measured 67.5 Gy and 72.1 Gy at inhale/exhale, indicating under/over-dosage, correspondingly. Such results correlate with anatomical variations due to breathing in the deformable phantom.

Conclusion: The complexity in the irradiation of moving targets has been reduced to a controlled simulation environment where the effects of several treatment options can be easily modeled and quantified. Preliminary results illustrate that the anatomical changes due to breathing may significantly alter dose deposition during tumor tracking. Further data analysis is currently exploring the sensitivity of alternative strategies to motion.