AbstractID: 4602 Title: Temporal correlation in Monte Carlo sampling to evaluate interplay between tumor and MLC motion in IMRT

In radiation therapy, tumor motion due to normal breathing displacements can smear out dose distributions. An additional problem in MLC-based IMRT is that the phase relationship between the patient's breathing and each MLC segment differs between fractions. For courses lasting only a few fractions, it is necessary to also evaluate the MLC-tumor interplay effects. However, calculating such effects requires precise values of quantities, such as, the starting breathing phase (τ_0), machine's dose rate (DR), interbeam delay (τ_g) and intersegment delay (τ_s). Though it may be infeasible to perform time-dependent calculations for specific deliveries, we can estimate the interplay effect by assuming typical timings involved. In this work, we extend the Monte Carlo Superposition dose engine to analyze interplay effects. The algorithm starts by randomly sampling a beam and field segment. For the segment sampled, the time elapsed until that point is calculated by using typical values of DR, τ_g, and τ_s. This time is then correlated with the tumor trajectory, and the isocenter is shifted accordingly. Photons are them sampled from the head and propagated through the collimator and the phantom. Energy is deposited by kernels issued from the photon interaction sites. Different fractions were simulated by using different τ_0. We analyzed the interplay effect by comparing correlated simulations with uncorrelated simulations (infinite fraction average). It was found that the interplay effect varies strongly with the dose rate, number of fractions, type of leaf sequencing (close-in vs. sliding window) and the direction of motion with respect to MLC's. More complex dependencies occur with MU efficiency and segment numbers. The correlated time Monte Carlo sampling method provides a way to ensure that the dose received by the patient will not deviate significantly from the more predictable ensemble average for the chosen treatment dose rate and the number of fractions.