AbstractID: 11549 Title: Time-dependent Monte Carlo dose calculation method for dynamic movement of all linac components in presence of patient motion

Purpose: Radiation therapy has become increasingly complex over the past several years, with simultaneous moving parts, such as the gantry/MLC (IMAT), or gantry/MLC/couch (Tomotherapy). With multiple moving components, deterministic dose calculation methods will prove ineffective as the computational cost of discretization in *n*-dimensions increases exponentially with *n*. Monte Carlo methods, which are immune to the effects of increased dimensionality, can be exploited for this purpose. In this work, a dynamic Monte Carlo dose calculation engine is developed to account for arbitrary rotational and translational movements of the jaws, MLC, gantry and couch in the presence of patient's breathing motion within the approximation of rigid body motion.

Methods and Results: In each history of the dynamic Monte Carlo run, a point in the delivery control point sequence of a dynamic delivery is randomly sampled. The values of 130 variables (angles or positions) are determined by linear interpolation between adjacent control points. A photon is sampled from a source and raytraced through the detailed collimator structure and the patient simulation phantom. Dose is deposited via randomly sampled monoenergetic kernel rays issued from photon interaction poins. The method also enables temporal correlation with breathing motion waveforms, and can be used to evaluate time-dependent interplay effects of patient motion with respect to all moving parts of the linac. A typical plan using a 4 mm voxel grid requires approximately 5-10 minutes to compute on a single 2.4 GHz Pentium microprocessor to achieve 2% statistics in the peak dose region.

Conclusion: The method allows simultaneous simulation of gantry, collimator, MLC, couch and patient motion, and, therefore, provides an efficient and accurate means to calculate dose for arbitrarily complex dynamic treatments. It opens the computational door for exploring more degrees of freedom in treatment planning to achieve better dose distributions for radiation therapy patients.