AbstractID: 5663 Title: Monte Carlo Direct Aperture Optimization (MC-DAO) for IMRT

Purpose: To improve the accuracy/efficiency of IMRT planning by combining Monte Carlo (MC) dose calculation with direct aperture optimization (DAO).

Method and Materials: A 6 MV beam arrangement is applied to an IMRT phantom and patient examples. A phase space is calculated below the secondary jaws of a virtual Varian 21EX linac by MC simulation (BEAMnrc code (NRC, Canada)). The phase space is subdivided into 2.5x5.0 mm^2 beamlets and the dose distribution from each beamlet is calculated to organs-of-interest within the patient/phantom using DOSXYZnrc. This information is input into DAO inverse planning software. The DAO includes multileaf collimator transmission and leaf motion limitations as it modifies the shape/weight of the treatment apertures. The optimized leaf sequence requires no additional leaf motion calculation step. A final forward MC dose calculation is performed. The MC doses are verified with ion chamber and film measurement. MC-DAO is applied to a difficult phantom geometry, namely a c-shaped target with embedded organ-at-risk located directly adjacent to a 5.0cm-thick air slab. Clinical sites include nasopharynx and lung.

Results: The MC optimization allows for accurate modeling of the electronic disequilibrium introduced by the air cavities. For the phantom example, MC reveals that the plan optimized with a pencil beam (PB) algorithm fails to provide adequate coverage to the PTV close to the air cavity, whereas the MC-DAO plan demonstrates adequate coverage. For the nasopharynx, the PB plan showed errors during ion chamber/film verification, probably due to the small (~5x4 cm^2) fields whereas the MC-DAO plan showed good agreement. The reduction in monitor units for MC-DAO plans is 20 – 40% compared to a commercial fluence-based (PB) treatment planning system.

Conclusion: MC simulation generates accurate input data for IMRT inverse treatment planning in difficult-to-calculate regions. The addition of DAO results in a more efficient treatment plan delivery.