AbstractID: 6471 Title: Experimental evaluation of a robust optimization method for IMRT of moving targets

Purpose: Tumor motion during irradiation reduces target coverage and increases dose to healthy tissues. The standard clinical approaches using margins are overly conservative because they only take into account the maximum amplitude of the movement. Comparable coverage and reduced dose to healthy organs appears achievable with robust motion-adaptive treatment planning, based on the nominal expected probability distribution of target position, and considering the uncertainty of its realization during treatment. We test a robust approach to IMRT [Chan et al. Phys Med Biol 51:2567-2583 (2006)] using patient data, to evaluate the effect of target motion variability and the MLC motion interplay on the outcome.

Method and Materials: We built our robust framework using external marker motion data (traces), acquired during patient treatments. These included 251 traces from two lung, one cardiac and one liver patient. Long-term shifts (such as exhale baseline drift) were removed from the data by band pass filtering. IMRT plans with varying grades of robustness were tested on 52 traces of two patients. A computer-controlled motion phantom reproduced traces during plan delivery on a linac. The dose was measured with a two dimensional detector array consisting of 1020 chambers with a resolution of 7.6 mm.

Results: Although tumor coverage differed for each delivery fraction due to MLC interplay and motion variability, it converged to the expected level after multiple fractions. For equivalent target coverage, 17mm peak-to-peak motion, the integral dose was reduced by 15% compared to the margin solution.

Conclusions: Dosimetric tests largely confirmed that the robust motion-adaptive approach to IMRT planning allows one to better manage the effect of motion, and can be extended to any uncertainty described by probability density functions. With target monitoring during the treatments, motion-adaptive plans and the underlying robust framework could be verified and re-adjusted if necessary.