AbstractID: 1233 Title: A New Method of Incorporating Systematic Uncertainties in IMRT Optimization

Systematic uncertainties in treatment planning are usually dealt with by adding margins to CTV or organs at risk (OAR). This study investigates a new approach. Systematic uncertainty in the position of an anatomic structure is simulated by placing replicas of the structure in space according to the uncertainty distribution. We define a new score function that maximizes the number of replicas that satisfy user specified criteria to CTV and OAR. Our criteria consist of limits on EUD, and counting replicas is approximated by logistic functions of EUD. We present applications of the method to prostate and nasopharynx IMRT plans, in which CTV and OAR each consists of 5 replicas, one representing no error (the position in the planning CT) and the other 4 discrete systematic displacements in one dimension with equal probability. The resulting IMRT plan is compared with that from an EUD optimization with a single replica of each OAR in the planning scan position and a single PTV encompassing all CTV replicas. Preliminary results to date show that multiple-replica optimization provides better critical organ protection while maintaining similar EUD dose to CTV, when systematic error is present. In 3 prostate patients multiple-replica optimization lowers EUD to all rectum replicas on average by 4, 7 and 7 Gy, respectively, while degrading only one CTV replica with the largest systematic error in each patient by about 1 Gy in EUD. Similar results are observed in one nasopharynx case.