AbstractID: 1423 Title: Development of tempero-spatial (4D) radiotherapy optimization techniques

With the recent availability of 4D-CT, the accuracy of information on internal organ motion during respiration has improved significantly. We investigate the utility of organ motion information in IMRT treatment planning, using an in-house 4D optimization system, currently under development at the MGH. Four approaches are compared: (1) planning with optimized margins (ITV), based on motion information; (2) a probabilistic approach using a modified pencil beam kernel ("motion kernel"); (3) the use of time-weighted influence matrices, in which phase-independent intensity maps, one per beam direction, are optimized simultaneously for multiple "snapshots" of anatomy (4D-CT phases); and (4) optimal tracking with phase-dependent intensity maps. The optimization is based on a gradient technique and can handle both physical (dose-volume) and equivalent uniform dose constraints. Except for the ITV approach, optimization requires voxel tracking from phase to phase in order to score the dose in individual voxels as they move. This was implemented through volume deformation matrices obtained by optimized morphing of CT images from different phases of motion, using the registration toolkit VTK (CISG, King's College, London). The study uses 4D-CT data sets of lung and liver patients, with the amplitude of target motion of the order of 10 mm. Preliminary results show that, compared to the other approaches, margin expansion has a significant disadvantage by increasing the integral dose to patient by 5-10%. Approach 3 (time-weighted) does not provide a dosimetric advantage, compared to approach 4 (optimal tracking), but might lead to more efficient delivery. (Supported in part by NCI grant.)