AbstractID: 9849 Title: Treatment planning in the presence of respiratory-induced target motion

Traditional fan-beam scans provide an anatomical model of the patient which often does not correspond well with any of the patient's anatomy during respiration. As a consequence, dose distributions computed using such image data could deviate, sometimes significantly, from the doses received by patients during the course of their treatment. Moreover, the increased uncertainty in target definition due to imaging artifacts, together with the need to account for motion excursion, may lead to large planning margins, thus increasing unnecessarily normal tissue doses, while preventing potential dose escalations.

By contrast, time-resolved computed tomography (4D CT) generates multiple volumetric image sets that are more accurate descriptors of the various patient geometries during breathing; by using this information at the time of planning one can evaluate more accurately physical dose distributions in the presence of motion.

The question is how to use the available time-dependent anatomical information when designing treatment plans. The answer will depend on whether the same treatment plan or different treatment plans will be delivered at various phases of the breathing cycle. Regardless, dose computations may be required on multiple image datasets, followed by an accumulation of doses from all datasets onto a single dataset ("planning dataset"), via time-weighting coefficients representing the relative amount of time spent at a particular breathing phase. The accumulation of doses involves tracking anatomical voxels between various datasets, and is accomplished by using image registration techniques that provide non-rigid (if organ deformations are involved) voxel mapping between datasets.

This lecture will provide an overview of dose accumulation techniques, planning aspects for various delivery approaches, sources of error specific to 4D planning. Also, several clinical lung and liver studies involving dose computations in the presence of motion will be reviewed.

Educational objectives:

1. Understand the rationale for accounting for respiratory motion during treatment planning;
2. Understand the principles of cumulative dose computation;
3. Learn about various sources of error specific to 4D-based treatment planning;
4. Learn about the clinical importance of the changes induced by the respiratory motion.