AbstractID: 2586 Title: Use of 4D Models for Tracking Motion During Therapy

Patient anatomy and physiology, of both normal and tumor tissue, changes with time. These timescales vary from seconds (respiratory, cardiac and skeletal motion, rectal gas) to minutes (bladder filling, stomach emptying, muscle relation) and days (repositioning, tumor growth/shrinkage, radiation-induced effects on bronchiole obstructions, atelectasis regions, edema, fibrosis, functional reserve capacity). These changes challenge the current paradigm of three-dimensional radiotherapy methods, and demand the exploration of four-dimensional (4D) techniques to account for these intra-and interfractional changes. Several components need to be developed for 4D radiotherapy, including online volumetric imaging, automated planning, deformable model development and associated hardware and software modifications. This presentation will focus on the basis and role of 4D deformable models for tracking motion in radiotherapy. The input to 4D deformable models is volumetric imaging information (either 3D or 4D), and for some algorithms user-defined landmarks. The output of these models are displacement vector fields (DVFs), in which each anatomy element (imaging voxel) is tracked throughout the imaging data sets. These DVFs allow subsets of the anatomy, such as contours and dose distributions, to be seamlessly transferred from one dataset to another, facilitating reoptimization and accurate dose accumulation. An ideal deformable model would be (a) accurately predict DVFs (and be fail-safe where this is not possible), (b) be unsupervised and require no human input and (c) be fast to allow online implementation and use of the 4D models.

The educational objectives of this course include:

(1) Appreciate the importance of 4D deformable models in radiotherapy.
(2) Introduce the basis of some models that have been applied to the 4D radiotherapy problem.
(3) Describe the clinical process for 4D radiotherapy using deformable models.