

## Position Verification by Fluoroscopy, CT, and other modalities

Technological advances in imaging and image processing are slowly emerging in systems for verification of position in radiotherapy. While a separate talk in this series focuses on the use of EPIDs for verification, it is also important to consider the influence of diagnostic fluoroscopy, CT, and other imaging modalities on patient and target positioning, as well as on tumor tracking and/or therapy gating.

There are currently commercially available systems for in-room CT in radiotherapy. These systems fall into two categories: 1) standard CT scanners in the treatment room with some geometric association with the treatment couch, and 2) gantry-mounted diagnostic and/or megavoltage cone-beam CT systems. Both technologies are capable of, to first order, relating a CT volume taken at or near the time of treatment to the room isocenter, although different types of corrections must be applied to each of the above mentioned systems to ensure the precision of this relationship. Motion during scanning impacts these 2 types of systems differently. Currently, the availability of software tools to use these systems to adequately verify position is limited. Example systems and applications will be discussed.

A number of diagnostic X-ray based localization systems have been marketed recently, and further development of these systems is underway. The potential for fluoroscopic tracking of implanted radiopaque fiducials has been demonstrated in the prostate, lung, liver, and spine. While not a direct visualization of the tumor in most instances, such technology offers a reasonable inference to tumor position with near real-time feedback. The dose associated with these procedures has been a recent issue, and will be discussed along with the findings from these systems.

Commercial ultrasound units have been adapted for organ localization in a treatment room. There has been some recent discussion about the accuracy and user-dependence of these systems. The results of recent studies related to ultrasound-based localization will be summarized.

Other technologies that have been explored in radiotherapy include cameras for tracking of external markers and alignment of the patient's image and/or surface. These systems will be overviewed.

### Educational Objectives:

- 1) To understand the types of technology available for position verification in radiotherapy
- 2) To learn about the current expected accuracy of such systems and their limitations
- 3) To understand the resources expected to implement and use such technology for position verification