Deep inspiration breath hold (DIBH) is a cardiac sparing technique to treat left-sided breast cancer. By supervising a patient holding her breath at the deep inspiration level, we can deliver tangent radiation beams to effectively treat tumors while reducing the dose to the heart. Research has confirmed both the effectiveness of this treatment, and the reduction in cardiac toxicity. Most clinics in the US are treating DIBH through external surrogate. However, for breast irradiation, the ideal way to implement DIBH would be through direct breast surface matching. This lecture will use AlignRT Beam Hold system (VisionRT Ltd., London, UK) as an example to provide an overview of breast surface matching based DIBH. Clinical implementation will be addressed.

Each DIBH patient will have a breath hold CT scan. Patient will also have conventional tattoos. The skin rendering of the breath hold CT is generated and transferred to the AlignRT Beam Hold system. Region-Of-Interest (ROI) is selected, and the ROI is the reference image to be matched on during the treatment. There are two criteria for the ROI selection. First, the ROI needs to cover the treatment area. Second, it is important to include some computer vision distinguishable features to assure the accuracy of the surface matching result.

On the treatment day, the patient is first setup based on the conventional tattoos. Then, she will be guided to take a deep breath and hold. The AlignRT Beam Hold system will obtain real-time patient surface images and register it to the reference image. The registration result includes the six degree (translational vertical, longitudinal, and lateral, and rotational vertical, longitudinal, and lateral) displacements and the magnitude displacement. The magnitude displacement is the Euclidian norm of the three translational displacements. All seven displacements are called real-time deltas. While the patient is still holding her breathe, therapist can adjust the table so that all the real-time deltas are within pre-selected tolerances. Now, patient will be instructed to breath normally for a moment followed by another breath hold for verification purpose. If all the real-time deltas are still within tolerances, the treatment can start.

The translational real-time delta tolerance is selected as follows. On the DRR in the beam eye's view (BEV) with the tangent beam shape and the heart contour, we can measure the shortest distance between the beam edge to the heart. Any number smaller than that shortest distance can be the real-time delta tolerance. Rotational tolerance is selected empirically.

Either audio or video coaching will be used during the treatment to guide patient breathing in and out to bring the breast surface to the planed level. AlignRT Beam Hold again will report the real-time deltas. Radiation beam will be turned on automatically when real-time deltas are within the tolerance and off otherwise.

The Learning Objectives of this lecture are:

1. Understand the principal of surface matching on left breast DIBH treatment
2. Get familiar with the clinical flow of left breast DIBH treatment