

AbstractID: 12861 Title: Direct investigation of geometric coincidence among Calypso system, onboard kV imaging, and MV treatment beam imaging

Purpose: The Calypso 4D localization system and onboard kV imaging systems have been developed and applied clinically to improve accuracy of tumor localization for radiation therapy, particularly for Stereotactic Body Radiation Therapy (SBRT). However, the accuracy of the treatment and the dose delivery depends on the coincidence of both the treatment beam and localization systems. These are calibrated separately, and nominally to the room lasers which have additional sources of uncertainty. The purpose of this study is to investigate a direct method for determining the geometric accuracy and coincidence of treatment beam and localization systems.

Method and Materials: A CIRS prostate phantom with three Calypso Beacons was imaged by both MV and kV beams at a series of gantry angles on a Synergy accelerator while the Beacon positions were simultaneously tracked using the Calypso system. A kV cone-beam CT (CBCT) scan was also performed to locate the Beacons. Beacons were automatically detected on kV and MV projection images using in-house software and their 3D positions were calculated from MV orthogonal pairs (MV-pair), kV orthogonal pairs (kV-pair), and CBCT scans, and then compared with Calypso. A special geometric QA procedure was developed to assess geometric accuracy of MV and kV imaging systems at every gantry angle. Geometric parameter deviations, particularly detector center offsets, were applied to correct the 3D position calculations.

Results: Systematic differences among Calypso, kV-pair, kV CBCT, and MV-pair results were observed. Using geometric QA corrected MV-pair results as treatment positions, averaged deviation of Calypso results is 1.1 mm. Deviations from MV-pair, kV-pair, and CBCT results drop from 1.7 mm, 1.1 mm, 1.0 mm to 0, 0.1 mm, and 0.2 mm, respectively, after geometric QA correction.

Conclusion: Systematic deviations among Calypso, kV pairs, kV CBCT, and MV results were directly and quantitatively evaluated with a geometric QA.