

Purpose: To test the correlation between lung tumor motion and three anchored beacons during 10 phases of 4DCT to determine the best treatment delivery approach.

Method: A 4DCT and Breath Hold BH-CT for patient receiving SBRT, 50 Gy in 5 fractions, to the right upper lung lobe were obtained. The patient had three electromagnetic transponders implanted in the RT lung to track and possibly gate patient's treatment with Calypso System. Lung tumor motion was analyzed using the 10 4DCT phases (CT0 to CT90), BH-CT and the maximum intensity projection CT MiP to determine tumor motion excursions. The motion of the three transponders was analyzed in Anterior/Posterior, Superior/Inferior, and Left/Right directions for all 10 phases with respect to BH-CT and compared to tumor motion. Spearman correlation coefficients were used to assess correlations between all three beacons motion individually then on average for all three of them with tumor motion in each single phase (CT0 to CT90).

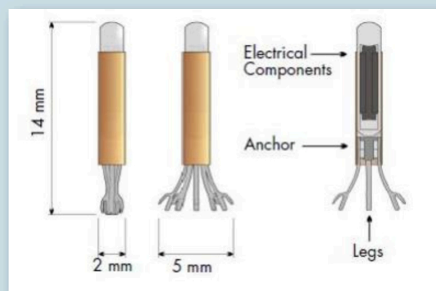


Fig 1: Calypso anchor beacons by Varian

Results: There was no significant correlation between beacons motion and tumor motion during the 4DCT acquisition ($p > 0.05$) in any direction AP, SI, or LR. Which limits the capability of relying on the beacons for free breathing gated treatment delivery, however breath hold gating is still viable safer choice.

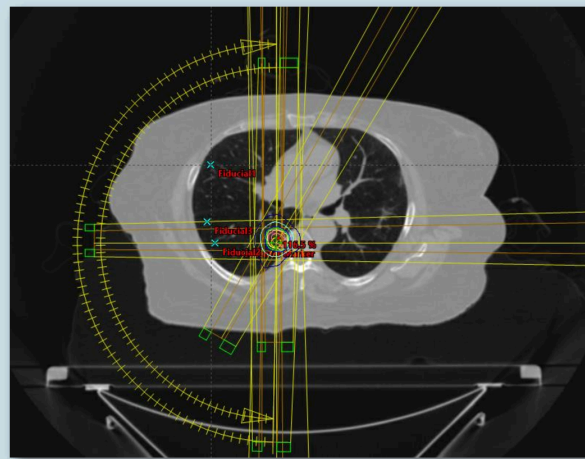


Fig 1: Rt Lung SBRT Plan and 3 Anchor Beacons

Conclusion: It is a standard practice to assess tumor motion in the 4DCT acquisition during all phases and MiP CT for deriving margins and determining the treatment delivery modality (free breathing no-gating, free breathing phase or amplitude gating, or breath hold,). However, it is crucial also to examine the beacons motion throughout the 4DCT phases to evaluate the correlation between the tumor motion and beacons motion for safer tumor margins,

more realistic tracking motion limits presets, and gating if feasible. Our work is still in progress to analyze more patients' beacons motion with respect to tumor motion using 4DCT phases, we are expecting to collect and analyze more patient data with anchor beacons treatments when the COVID 19 situation resolves

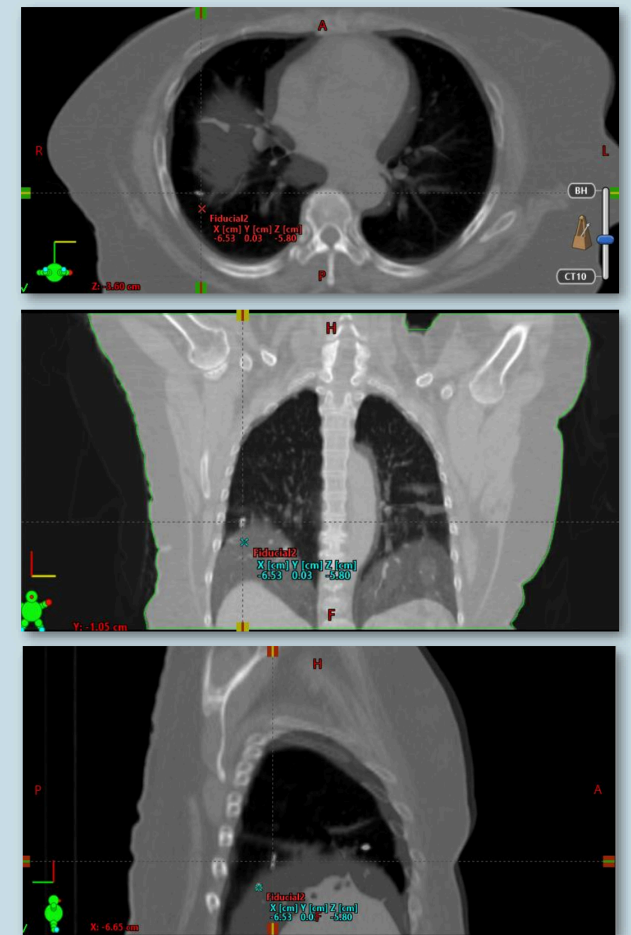


Fig 4: CT phase 10 blended with BH CT and fiducial2 (anchor beacon) motion is analyzed between the 2 data sets in all 3 directions.