Purpose: To analyze and verify feasibility of single fiducial tracking using four different types of fiducial markers with the Synchrony® technique in CyberKnife® (CK) SBRT lung treatment.

Methods: A dynamic thorax phantom (CIRS Inc.) was scanned in a static mode using a Philips Brilliance Big-Bore CT scanner. Four fiducial types were used: short wire, long wire, curl, and multi-coil (Cook® Medical). A single fiducial was placed in a target volume in vertical, horizontal and parallel orientations relative to the treatment imaging system. Correlation and confidence level of the fiducial marker compared to external markers were recorded. CT images were transferred to MultiPlan® system for treatment planning. After the plan was completed and authorized, dual x-rays were used for tumor tracking. Breathing and tumor tracking motions were correlated by a combination of x-rays and infrared external markers. For confidence level and correlation error, phantom-based tracking was simulated for regular breathing motions and these parameters were collected until Synchrony established a full breathing cycle.

Results: Tracking confidence levels of the fiducials ranged from 72% to 89.3%, with correlation errors of 0.23 mm to 1.1 mm. The 0.5 and 1.0 cm wire-type fiducials were the most sensitive to error dependent upon insert direction. Using these markers, if the orientation was parallel to the phantom’s rib cage, the CyberKnife was unable to register due to adjacent high density areas such as bony structures. The curl and multi-coil types were more robust to orientation bias.

Conclusions: It is possible to use single wire fiducials for Synchrony but continuous tumor tracking may not be reliable due to their high dependency on orientation. Curl or multi-coil type fiducials are less sensitive to orientation and, as a result, may be better suited for single-fiducial tracking.