Purpose: Calculation of four dimensional (4D) dose distributions requires the remapping of dose calculated on each available binned phases of the 4DCT onto a reference phase for summation. Deformable image registration (DIR) is usually used for this task. This project validates a type of new algorithm, using 4D tissue deformation reconstruction (4DTDR) from all 4DCT generated images (or projections) to confirm voxel to voxel accuracy for the complete motion path and future 4D dose calculations.

Methods: Three electro-magnetic-tracking (EMT) fiducial were implanted into fresh porcine liver and animated in a clinically realistic phantom with highly reproducible hysteresis motion pattern previously reported on. After 4DCT acquisition, all data was copied and fiducial locations were masked in the copied set. All images were sent to the 4DTDR for reconstruction. The original 4DCT data (with fiducials) was sampled in 20 CT phase sets and fiducials' coordinates were recorded, resulting in time-resolved fiducial motion paths. Measured values of fiducial location were compared to that measured through EMT and those calculated by 4DTDR.

Results: The performance of the 4DTDR was measured to have average accuracy of 1.86 mm over all 20 phases (4.54 mm max error) in time and location, calculating a motion path that correctly represents measured hysteresis. EMT measurement confirms 4DCT and 4DTDR values.

Conclusion: Accuracy of deformation within tissue necessitates the understanding of motion accuracy over the whole motion path of deformation. Validation of the actual voxel path over the period adds a higher level of accuracy, leading away from typically quoted end-to-end accuracy to a definition that includes all motion locations at any moment or any location.