Purpose: Develop a low dose 4D-CT method and quantify the displacement uncertainties compared to regular dose scans.

Methods: Two (2) landrace cross pigs were ventilated and scanned using a 64-slice CT scanner (GE Healthcare, Discovery CT750HD). Each animal had a breath hold helical (BH) scan of its thorax performed at 200 mA and 100 kVp. An additional regular dose 4D-CT scan (RD 4D-CT) was performed, using the same scanning parameters, covering the same area as the BH scan and consisting of 8 respiratory phases. Simulated low dose 4D-CT scans, at 10% and 1% of the original dose, were created through the addition of noise to the RD 4D-CT scans (LD10 & LD1 4D-CT). A nonlinear registration algorithm was employed to warp the BH volume to each of the of the RD & LD 4D-CT phase volumes, producing three sets of warped 4D-CT volumes (Warp(BH)-RD, Warp(BH)-LD10, Warp(BH)-LD1). The average difference in voxel value (in HU) between the RD and each warped BH volume was calculated. Additionally, 6 vessel bifurcations were selected from the RD volumes and located in the warped BH volumes using rigid registration between corresponding segmented bifurcations. The average displacement of bifurcation location in the warped BH volumes compared to the RD volume was determined.

Results: The average difference of voxel value from the RD volume was 3.9 4.5 HU and 3.7 4.4 HU for Warp(BH)-RD, Warp(BH)-LD10, Warp(BH)-LD1 volumes respectively. The average displacement compared to the RD volumes of the 6 vessel bifurcations was 1.1 0.2 mm, 1.2 0.2 mm and 1.3 0.3 mm for the Warp(BH)-RD, Warp(BH)-LD10, Warp(BH)-LD1 volumes respectively.

Conclusions: We have developed a method to reduce the dose required for a 4D-CT scan by approximately 90% and maintain an accuracy of 1.3 mm compared to 4D-CT scans acquired at full dose.