Purpose: To complete a CBCT for a treatment using ABC, multiple breath hold (BH) (>3) were used due to the slow gantry rotation and the short BH period. Inter-BH tumor position variability may introduce distortion in the reconstructed images. This study aims to determine a threshold of the inter-BH scan displacement so that the inconsistency can be identified from the CBCT images.

Methods: A numerical phantom was constructed to represent the thorax region of a human body. To simulate the inter-BH displacements, known magnitudes of motion (s = 0, 1, 3, 5 mm) along the longitudinal direction were introduced for the "tumor" and "diaphragm" in the phantom. Two different irregular motion patterns (s1=s3=/=s2 and s1=/=s2=/=s3) during CBCT scans were tested. Furthermore, a physical phantom with a movable insert was scanned using a commercial CBCT system. The insert of the phantom was programmed to move in the longitudinal direction according to the same motion patterns as designed in the numerical simulations. Subsequently, nine CBCTs in "half-fan" mode for the physical phantom were acquired with the insert in various positions. These CBCT images were then fused to the reference CT by aligning to either the body of the phantom or the "tumor" inside the insert.

Results: Based on numerical simulation, position variation >1mm can be observed from the reconstructed CBCT images. Based on acquired CBCTs of the physical phantom, position variations of >3mm or 5mm were observed, depending on the motion pattern during the data acquisition. Because of the use of half-fan mode, we observed the order of position displacements of the tumor during CBCT acquisition drastically affected the outcome of imaging registration.

Conclusions: Using ABC device, the inter-BH variability during a CBCT acquisition affects accuracy of tumor localization. A patient individualized planning margin might be necessary to account for this effect.