Purpose: Irregular breathing causes variation in delineation of internal target volume (ITV), which is typically generated in the maximum intensity projection (MIP) images [1]. Previous studies have shown that MIP-based ITV can underestimate true tumor range [2]. This study examines a simple method to reduce such errors by combining the GTV of 3D-CT with the ITV of MIP.

Methods: The Computerized Imaging Reference Systems (CIRS) Dynamic Thorax Phantom Model 008A (CIRS, Norfolk, VA) with CIRS motion control software was used to model 4 irregular patient respiratory profiles and one regular respiratory profile (sine wave). A 3 cm tumor insert was used as target. For each breathing profile, a 3D-CT and 3 repeated 4D-CT scans with random intervals within the breathing profile were performed on a 4-slice clinical scanner (Lightspeed, GE, WI). The RPM system (Varian, Palo Alto, CA) was used to track the respiratory profiles. GTV was contoured on 3D-CT, and ITV was contoured on each MIP (ITVMIP) using a consistent lung window by the same person. The new method of creating ITV was to combine the GTV and ITVMIP, namely ITVCOMB. To evaluate which ITV is more accurate, ITVCOMB and ITVMIP were compared to a 'ground truth' ITV (ITVGT) which was generated by combining the three ITVMIPs.

Results: For the regular profile, both ITVMIP (27.25 cm³) and ITVCOMB (28.12 cm³) were comparable to ITVGT (27.25 cm³). For irregular profiles, the mean absolute difference between ITVCOMB and ITVGT (6.3%±4.9) was significantly (p-value=0.0078) smaller than that between ITVMIP and ITVGT (18.1%±12.3).

Conclusions: The results suggest that combining GTV of the 3D-CT with the ITV of the MIP is more accurate than the ITV of the MIP alone, and thus would be a simple method to reduce breathing irregularity induced errors in ITV delineation for treatment planning of lung cancer.