Purpose: To find an optimized workflow for the use of respiratory-gated PET (4D-PET) in target volume delineation of tumors subject to respiratory-gated radiation therapy.

Methods: 15 patients with lung (11) and pancreas (4) tumors who had FDG-PET-CT for target delineation prior to EBRT were studied. Patients were selected among the group that showed respiratory-induced tumor motion >5mm. 4D-PET was performed by means of a Philips Gemini BigBore scanner, using the Varian RPM gating system. An identical system was available at the linac for treatment. The breathing cycle was equally divided in 4 phases, according to a previous study. Since planning was made on a single CT-phase, no ITV was explicitly built from the set of phases. The BTV was identified with SUV=2.2 threshold and the PTV was obtained expanding the BTV by 8mm(S-I), 5mm(A-P) and 3mm(L-R) to account for residual motion and setup errors. The most advantageous CT-phase for treatment planning was then identified by simulating plans on each phase and analyzing the resulting DVHs of OARs (lung, trachea, oesophagus, spinal cord, left ventricle).

Results: The observed maximum range of motion was 5.5mm(L-R), 12.3mm(A-P) and 19.2mm(S-I). The standard deviation of the BTV volume in the 4 phases ranged from 6% to 13.7%. V20 (lung) ranged 7.1%-15.2% in inspiration and 7.8%-18.6% in expiration. The mean dose to the oesophagus ranged 0.1-2.2Gy in inspiration and 1.4-2.0Gy in expiration. In general, the dose to OARs was smaller when planning on a single phase than on the overall, respiratory-uncontrolled volume (p-value<0.05).

Conclusions: The BTV volume was almost constant between phases, confirming that the motion might be described by 4 phases. There was no obvious choice of the optimal phase for treatment planning, suggesting patient-by-patient studies. However, planning and delivery on one phase consistently allowed dose sparing to be obtained compared to non-gated techniques.