Purpose: To investigate the dosimetric difference between two dose warping methods for 4D dose accumulation: direct dose mapping and energy/mass transfer mapping.

Method and Materials: Ten lung cancer patients with varied tumor motion amplitude (between 0.4 and 1.9 cm) and 10 phase 4DCT acquisition were selected for the study. Optimized treatment plans for ITV plus 3 mm margin were created on the 50% phase images (CT50) and applied to other phases for dose calculation with AAA. The other phase doses were warped to CT50 using deformable image registration and two mapping algorithms. With direct dose mapping, voxel doses in source image were tri-linearly interpolated to image grid and then transferred to the destination image grid, and interpolated back to dose grid. With energy/mass mapping, the dose on source image was converted to energy first and then transferred to the destination along with the mass. The energy and mass to dose voxel were calculated by summing up the contributions from the image grids that intersect with it, allowing accurate calculation of voxel dose by dividing energy by mass. The mapped individual phase doses were finally accumulated with weighting proportional to beam-on time spent on each phase.

Results: With 2.5 mm dose grid, the difference in mean PTV dose between the two dose mapping methods was -0.8%~1.0% (0.0+/-0.5% of mean+/-SD), and for ITV it was -0.4%~0.8% (0.0+/-0.3%). However, for the regions extending 2 cm superiorly/inferiorly outside the PTV surface a mean dose difference 8% (0.2+/-2.7%) was found. Coarser dose grid sizes caused the differences to be greater.

Conclusion: PTV mean dose differences between the two dose mapping methods are generally small in uniform dose regions; minimum dose differences were much greater. Dose/density gradients cause the differences to be significantly larger. Increasing the dose grid resolution caused greater differences between the two methods.