AbstractID: 5260 Title: Building a PET time series using information from 4DCT data

Purpose: To build PET time series to be used for radiation treatment planning of lung cancer. Recent advances in time-related treatment strategies call for datasets that account for respiratory motion. Gated PET techniques allow timing information to be used, but suffer from poor signal-to-noise ratio. Non-gated PET images describe the distribution of metabolic activity as a temporal integral over several respiratory cycles. Non-rigid image registration could be used to map this integral representation back to short intervals within the respiratory cycle.

Method and Materials: CT/PET data were acquired by means of a GE Discovery scanner. 4DCT volumes in different respiratory phases were summed to obtain a volume corresponding to integral PET data. Deformation fields mapping integral CT to single-instant CT volumes were obtained by means of a non-rigid registration algorithm based on a local rigidity regularization method. Results were examined as a function of different regularization parameters. Once a proper value was chosen deformation fields were applied to corresponding PET datasets, obtaining single-instant PET volumes with higher signal-to-noise ratio compared to gated techniques.

Results: Light regularization parameters caused improbable transformations. In particular, the diaphragm is subject to large global displacement with low spatial frequency. Light regularization may cause high frequency deformations to take place. Optimum weighting factors of the regularization term were found to be between 0.01 and 0.1.

Conclusion: Multi-modality non-rigid registration is challenging; we avoided it by performing intra-modality registration between CT datasets and by applying obtained deformations to PET data. This strategy may help using PET for treatment planning in 4D treatment modalities. Strategies consisting of penalizing deformations that locally differ from rigidity must be carefully used in thoracic applications. A more suitable approach may consist of a linear combination of low frequency basis functions. Further investigation is needed, including feasibility of on non-uniform control point spacing.