AbstractID: 14328 Title: Dosimetry impact of accurate PET segmentation for radiotherapy treatment planning

Purpose: The objective of this work is to study the impact of the accuracy of tumour volume delineation on radiotherapy treatment planning. Several algorithms have been proposed for functional volume delineation. We have developed an automatic segmentation algorithm based on statistical and fuzzy modelling (Fuzzy Locally Adaptive Bayesian, FLAB). We explored in this study the performance of FLAB and its robustness in comparison with other algorithms and the impact of such accuracy on radiotherapy.

Method and Materials: Three segmentation algorithms were compared, a fixed threshold at 42% of maximum, an adaptive threshold and FLAB which can handle heterogeneous uptakes. The accuracy was studied on simulated PET data using the Monte Carlo simulation tool, GATE, which allowed the calculation of classification errors. In addition the results were compared in terms of maximum diameters with histology results for NSCLC cases, while a robustness study was carried out on multiple IEC phantom acquisitions. Finally, the simulated datasets were imported in Pinnacle in order to compare the algorithms in terms of ground-truth volume coverage and OAR sparing considering IMRT planning based on functional volumes.

Results: Threshold-based approaches were often unable to correctly assess the spatial distribution of functional tumour volumes (mean error 20%±12%). FLAB obtained lower errors (9%±8%) even considering heterogeneous uptakes. The superior accuracy of FLAB was also demonstrated on the histology results. Finally, FLAB proved robust to changes in both acquisition parameters (contrast, noise, voxel size) and scanner model, with 10%±5% errors for lesion diameters down to 13mm. Regarding the dosimetry study, accurate lesion delineation led to the best compromise on TCP and NTCP, emphasising the need for accurate functional volume segmentation.

Conclusion: FLAB has proved to be more robust and accurate than other algorithms considered, allowing in turn an improved impact in terms of IMRT planning.