AbstractID: 7974 Title: Planning target volume determination

Treatment planning should be based on a high fidelity representation of the patient's anatomy, as it will be at time of treatment. The imaging setup (couch, immobilization, alignment) should therefore be representative for the treatment situation. When basing a treatment plan on a single scan (which is current clinical practice), the optimal imaging strategy is therefore to create an anatomical model that is as close as possible to the "average" anatomy. For random organ motion, plan optimization can therefore be achieved by averaging the geometry of multiple scans (i.e., adaptive radiotherapy). For periodic motion it has been proposed to use a scan with the organs as close as possible to their time-weighted average position – by selecting a single scan out of 4DCT. Using these methods, the systematic errors due to treatment preparation are minimized and the dose distributions will be very close to a full 4D planning (using all scans out of a 4DCT scan). Using image guidance some other error sources can be eliminated. However, even with image guidance there are residual errors: such as uncertainty in GTV and CTV delineation, in image registration, and in setup correction and uncertainty due to intra-fraction motion. Currently, simple margin recipes are used to estimate the correct CTV-PTV margin such that the net effect of all these uncertainties does not compromise the goal of the treatment: eradicate the tumor while sparing normal tissues. One should be aware, however, that the most simple margin recipes are based on many assumptions: such as Gaussian distributions, penumbra width in water, systematic error SD > random error SD, and plans with a more or less uniform dose distribution. In case of image guidance for lung tumors all of these assumptions break down, and simple recipes typically will overestimate the required margin. Based on a more detailed analysis, it appears that the margin that can be used for hypofractionated lung radiotherapy can be very small (1 cm or less), even for large respiratory amplitudes (2 cm).

Educational objectives:

1) Understand the need for a representative planning CT, i.e., minimize systematic errors
2) Understand the difference between systematic and random errors, and the effect that respiratory motion has on the delivery of radiotherapy
3) Understand the need for margins, even in case of image-guided radiotherapy
4) Understand the derivation of margins for image-guided radiotherapy of lung cancer