APPENDIX B

To get a better understanding of how each treatment machine exploits its degrees of freedom, we defined a beam angle selection score S as a function of the beam angle θ for both VMAT and HT. S(θ) combines the three factors that enable the selection of different beam angles, namely the modulation using the multi leaf collimator (MLC), the dose rate and the gantry speed. The VMAT plan in the example (Figure 3) opens its MLC to form areas between 12 cm^2 and 37 cm^2 whereas the variation in area with the gantry angle is limited by the maximum speed of the MLC leaves. The dose rate of this plan varies between 150 cGy/min and 1900 cGy/min and it jumps from one extreme to the other within the distance of two control points which are spaced by 3° in our example (120 cGy/min and 1100 cGy/min for 6 MV VMAT). The gantry rotation speed of this plan has a constant value of 4.9°/s (4.0°/s for 6 MV VMAT) but could in theory also vary with the beam angle. For VMAT, we defined S(θ) as the area opened by the MLC A times the dose rate dr times one over the gantry rotation speed α and normalised the curve such that the integral equalled one:

$$S\,(\theta) = \frac{A(\theta) * dr(\theta) * \frac{1}{\alpha(\theta)}}{\int_{0^\circ}^{360^\circ} A(\theta) * dr(\theta) * \frac{1}{\alpha(\theta)}\, d\theta}$$

(B1)

In order to do an equivalent calculation for HT, we summed up the leaf open fractions LOF of all leaves l at a certain beam angle θ over all slices s and normalised the curve such that the integral equalled one:

$$S\,(\theta) = \frac{\sum_s \sum_l LOF(\theta)}{\int_{0^\circ}^{360^\circ} \sum_s \sum_l LOF(\theta)\, d\theta}$$

(B2)

The HT plan in the example (Figure 3) has a constant dose rate of 1000 cGy/min and a constant rotation speed of 20°/s. It is important to note that this beam angle selection score is not a formula for precise dose calculation but rather a tool to get a feeling about which beam angles are preferred.