APPENDIX A

Table A1: Criteria for clinical acceptability of prostate cancer treatment plans for both VMAT and HT at our clinic.

PTV	$V_{95\%}$ > 95 % $D_{2\%}$ < 107 %
rectum	$V_{75\ Gy}$ < 10 % V_{70Gy} < 20 % V_{65Gy} < 25 % V_{60Gy} < 40 % V_{50Gy} < 50 %
bladder	V_{80Gy} < 15 % V_{70Gy} < 25 % V_{65Gy} < 50 %
femoral heads	V_{50Gy} < 10 %

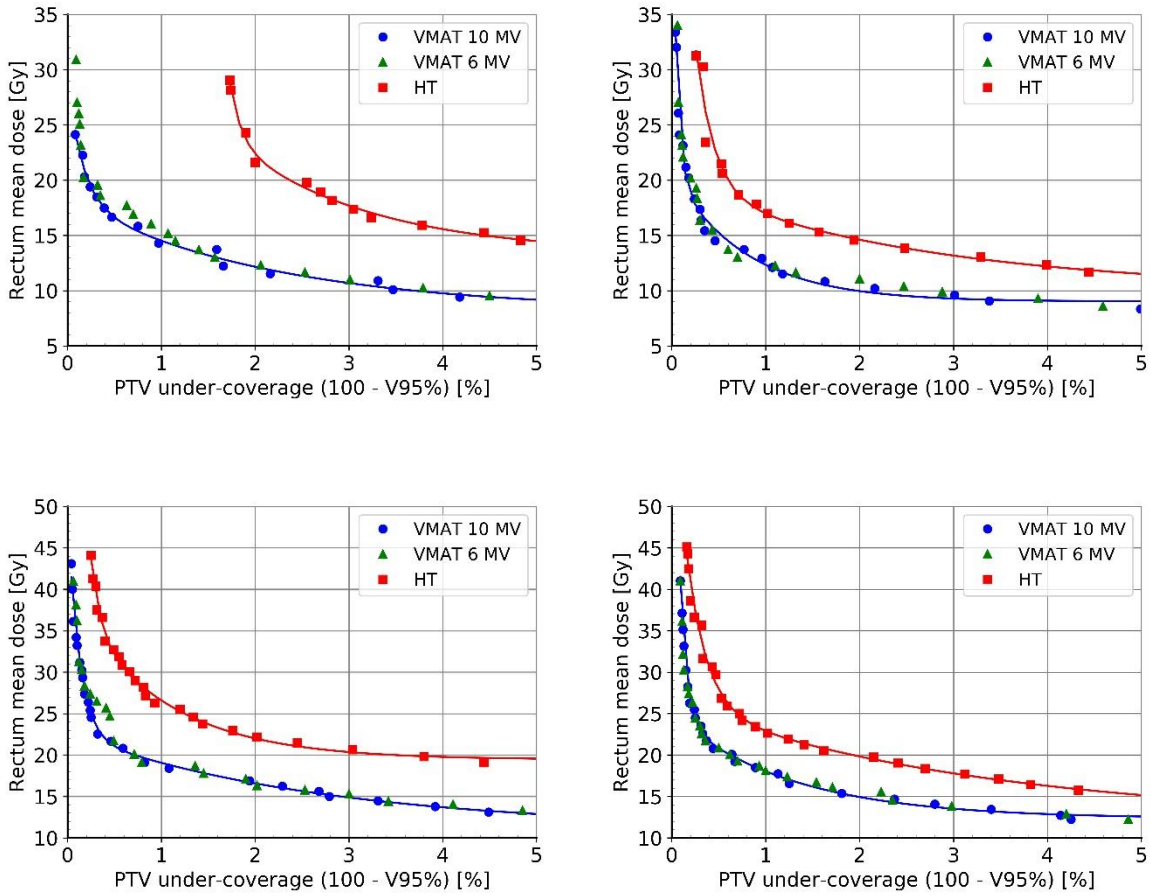

Figure A1: Comparison of the Pareto fronts for 10 MV (blue circles) and 6 MV (green triangles) VMAT as well as 6 MV HT (red squares) treatment plans for four patients of the cohort (patients number 4, 7, 11 and 15). Concerning the VMAT Pareto fronts, the decrease in beam energy kept the fronts almost identical. The treatment times were increased from (157 ± 9) s to (173 ± 12) s by an average of 16 s and the conformity indexes remained unchanged (± 0.01).

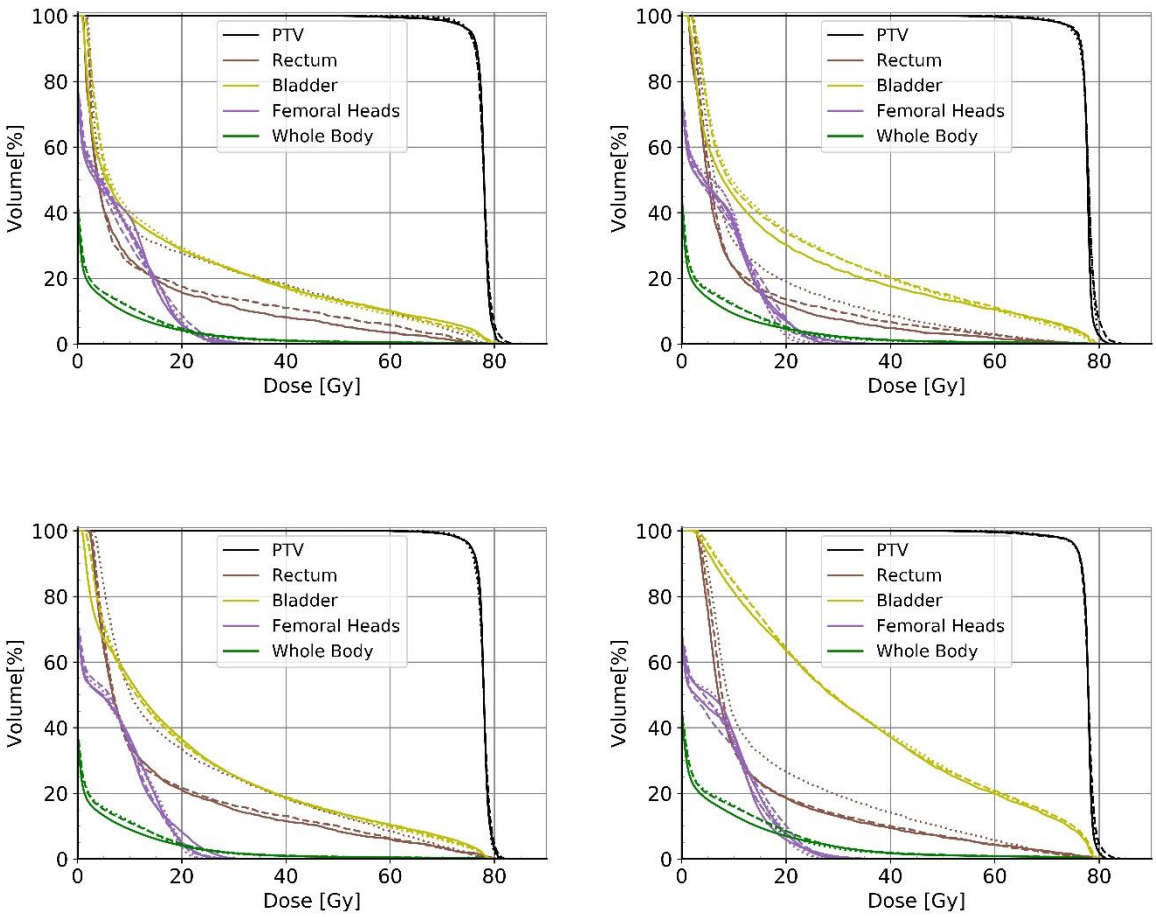

Figure A2: DVH of a VMAT plan (solid line), a HT plan using a standard pitch and maximal delivery time factor of 0.287 and 1.5, respectively (dotted line) and a HT plan using a modified pitch and maximal delivery time factor of 0.143 and 2.5 or 3, respectively (dashed line) for four patients of the cohort (patients number 4, 7, 11 and 15). For the use of the modified pitch, we had to increase the weight of the PTV objective function to a value of 1000 in order not to overdose the PTV. With the modified machine settings for HT, it was possible to achieve almost the same DVH as for VMAT. The mean rectal doses could be reduced from 20.6 Gy to 15.5 Gy (15.0 Gy for VMAT), from 17.4 Gy to 12.3 Gy (10.9 Gy for VMAT), from 17.7 Gy to 14.5 Gy (14.1 Gy for VMAT) and from 13.1 Gy to 10.9 Gy (9.6 Gy for VMAT) for the four tested patients, respectively. The treatment times increased from (250 ± 30) s to (930 ± 130) s by an average of 690 s and the CIs decreased from 0.84 ± 0.01 to 0.74 ± 0.02 for the four patients. The PTV under-coverages as well as the fixed bladder and femoral heads mean doses were kept unchanged.

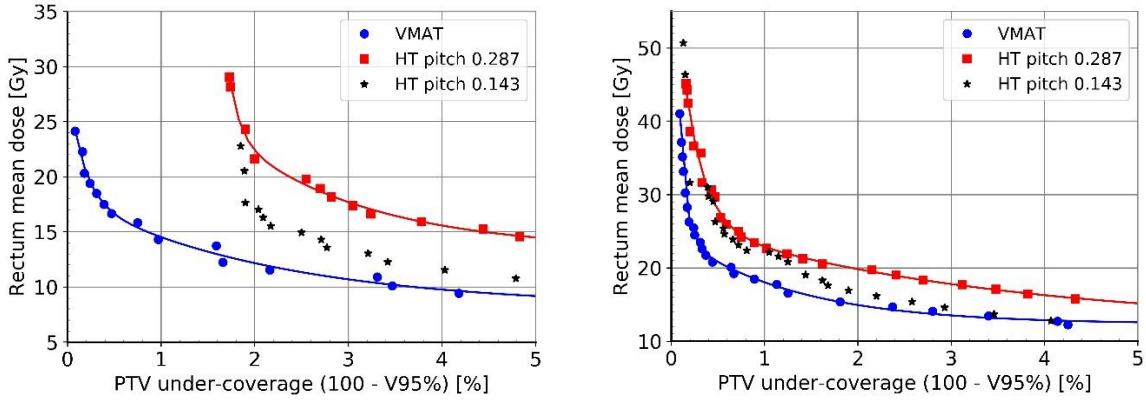

Figure A3: Comparison of the HT Pareto fronts using the standard pitch of 0.287 (red squares) and a small pitch of 0.143 (black stars) for two patients in the cohort (patients number 4 and 15). Both HT Pareto fronts have been obtained using the standard field width of 2.51 cm. The VMAT Pareto fronts (blue circles) are shown on the same plots. Lowering the pitch improved the HT Pareto fronts, but they remained inferior to the VMAT Pareto fronts. Doing so, the treatment times were increased from (250 ± 40) s to (1010 ± 150) s by an average of 760 s and the conformity indexes decreased from 0.84 ± 0.01 to 0.75 ± 0.03.

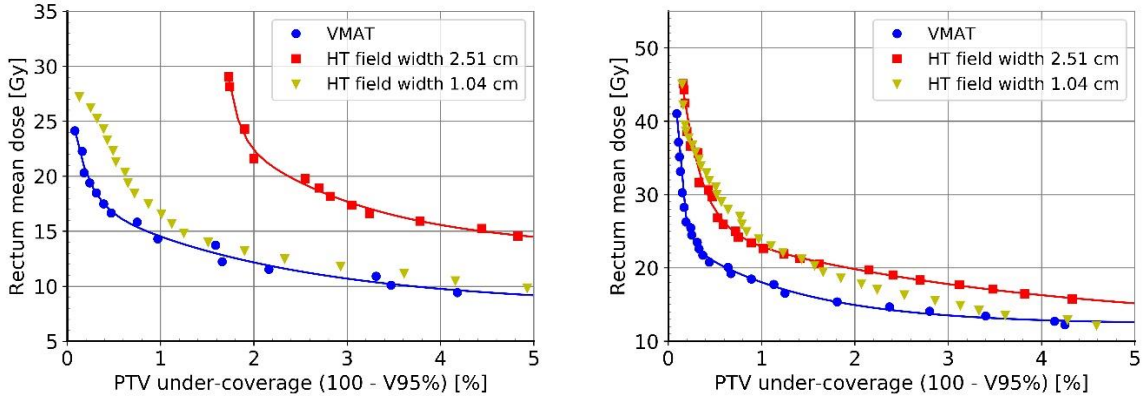

Figure A4: Comparison of the HT Pareto fronts using the standard field width of 2.51 cm (red squares) and a small field width of 1.04 cm (light green triangles) for two patients in the cohort (patients number 4 and 15). Both HT fronts have been obtained using the standard pitch of 0.287. The VMAT Pareto fronts (blue circles) are shown on the same plots. Decreasing the field width improved the HT Pareto fronts, but they remained inferior to the VMAT Pareto fronts. Doing so, the treatment times were increased from (250 ± 40) s to (1810 ± 270) s by an average of 1560 s and the conformity indexes remained almost unchanged (± 0.02).

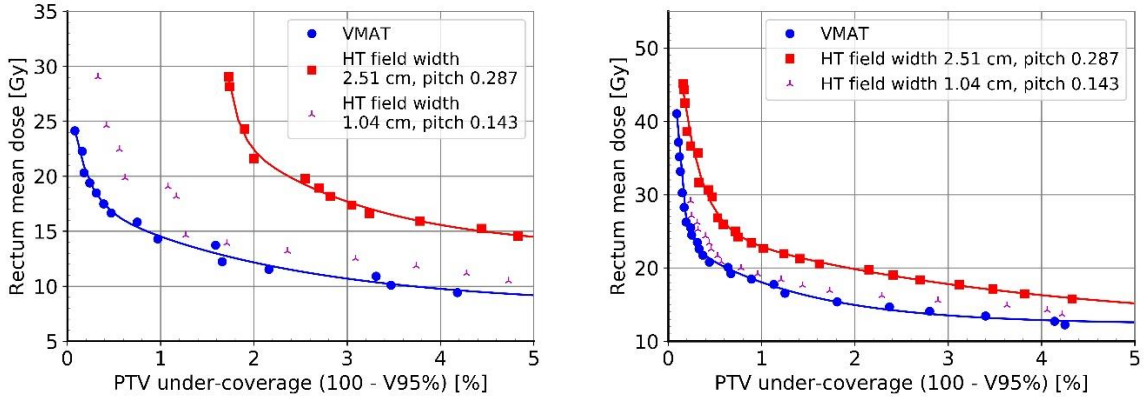

Figure A5: Comparison of the HT Pareto fronts using the standard pitch of 0.287 and the standard field width of 2.51 cm (red squares) and using a small pitch of 0.143 and a small field width of 1.04 cm (purple sign) for two patients in the cohort (patients number 4 and 15). The VMAT Pareto fronts (blue circles) are shown on the same plots. Decreasing the field width and pitch at the same time improved the HT Pareto fronts, but they remained inferior to the VMAT Pareto fronts. Doing so, the treatment times were increased from (250 ± 40) s to (3200 ± 300) s by an average of 2950 s and the conformity indexes remained almost unchanged (± 0.02).

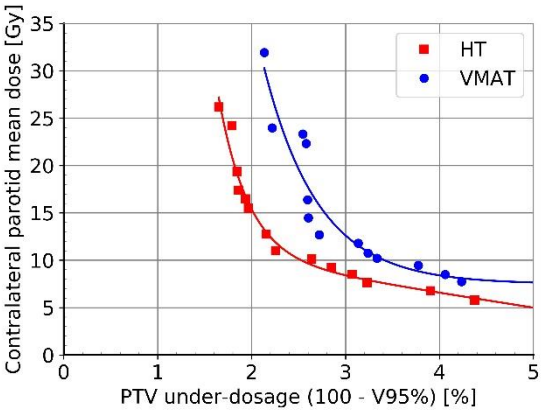

Figure A6: Comparison of the Pareto fronts using the treatment techniques VMAT (blue circles) and HT (red squares) for one oropharyngeal cancer patient. We applied a prescription of 69.96 Gy to the high risk PTV and 52.8 Gy to the low risk PTV in 33 fractions. The parameter on the x-axis of the plot is the mean of the PTV under-coverage of the high and low risk PTV. The parameter on the y-axis is the mean dose to the contralateral parotid gland. The mean doses of the parallel organs of mandible, larynx and oral cavity were fixed at certain values and the maximal dose to the spinal cord was also fixed. The fronts were generated using a script that controlled our TPS that was similar to the one described in this paper. We used the same machine settings as are used in our clinic, meaning 6 MV FFF beams, dual arcs, 3° gantry spacing and 90 s maximal delivery time per rotation for VMAT and 6 MV beams, dynamic jaws, 2.51 cm field width, 0.287 pitch factor and a maximal delivery time of 600 s for HT.