Multicriteria optimization (MCO) can produce Pareto-optimal treatment plans and may have the potential to improve plan quality and reduce hands-on planning time. This study investigates a MCO algorithm for VMAT planning of whole-pelvic and local prostate treatments and compares it to manual iterative VMAT planning in the RayStation TPS with respect to plan quality and planning time efficiency.

Results
For both optimization methods all patients fulfilled all clinical dose constraints for the sum plan. Three VMAT-MCO stage 2 plans exhibited small hotspots <113% in the PTV-LN. This was caused by the segmentation algorithm that only recreates the DVH of the Pareto plan. The spatial information of the preoptimized dose is lost for segmentation. Employment of artificial help structures might solve this problem. For stage 1, plan quality was equal with negligible differences. Stage 2 plan quality of VMAT-MCO and sVMAT was not identical. sVMAT plans exhibited better OAR sparing, especially for bowel and rectum. This was mainly achieved by a more inhomogeneous target dose and decreased low dose conformity. The hands-on planning time was reduced up to 12 and 38 minutes for stage 1 and 2 plans, respectively.

Material and Methods
For each of ten prostate cancer patients, a two stage plan was generated consisting of:
• Stage 1: 22 Gy to the prostate (PTV-P) in 11 fractions
• Stage 2: 50.4 Gy to the pelvic lymph nodes (PTV-LN) and 56 Gy to the PTV-P with a simultaneous integrated boost in 28 fractions

The single plans were generated by VMAT-MCO and standard VMAT (sVMAT) planning for an Elekta Agility 6 MV linac. Planning goals were $D_{98}>95\%$ and $D_{\text{max}}<110\%$ for the PTVs with maximum OAR sparing. The single plans and the sum plan were compared for plan quality and planning time efficiency for both optimization methods. For VMAT-MCO the number of fluence-based Pareto plans created was set to 18 and 33 for stage 1 and stage 2 plans, respectively, and the best-fitting plan was selected by navigation with the incorporated sliders. Then a deliverable plan was generated by segmentation and the resulting plan was further reoptimized if necessary. For sVMAT, conventional cost functions were used and the constraints were manually tightened in an iterative process to achieve optimal OAR sparing. The dosimetric quality of the single treatment plan stages was evaluated and compared using DVH values of PTVs and OARs. The following values were used for OARs and PTVs: $D_{\text{max}}, D_{2\%}, D_{\text{mean}}, D_{98\%}$ (PTV only). Conformity ($CI=V_{95\%}/V_{\text{PTV}}$) and homogeneity indices ($HI=(D_{2\%}-D_{98\%})/D_{50\%}$) and absolute volumes of the 60% and 80% isodoses ($100\%=22\text{ Gy/50.4 Gy for stage 1/2}$) were calculated. A two-tailed paired t-test ($\alpha=0.05$) was conducted to assess differences in dosimetric quantities. Workload was measured by recording the hands-on planning time and the total planning time for every optimization.

Conclusion
For localized prostate irradiation the plan quality of MCO-generated and manually-optimized VMAT plans was comparable. For whole pelvic treatment sVMAT optimization resulted in slightly better OAR sparing than MCO. Employment of MCO reduced the hands-on planning time considerably for whole-pelvic and local prostate VMAT treatment planning.

The financial support by the Federal Ministry of Science, Research and Economy and the National Foundation for Research, Technology and Development is gratefully acknowledged.

http://www.meduniwien.ac.at/hp/radonc