Conclusions: GTV shrinkage of rectal tumors treated with neoadjuvant chemoradiotherapy already occurs in the first two weeks of treatment and continues up to 7 weeks post-treatment. The observed volume reduction during treatment suggests a benefit for a sequential boost on the remaining tumor after CRT or for volume adaptation in case of a simultaneous integrated boost.

PO-0785
Inverse planning of beam-on times for precision image-guided 3D small animal radiotherapy treatments
M. Balvert\(^1\), S.J. Van Hoof\(^2\), P.V. Granton\(^3\), D. Trani\(^2\), D. Den Hertog\(^4\), A.L. Hoffmann\(^5\), F. Verhaegen\(^6\)
\(^1\)Center for Economic Research (CentER) Tilburg University, Econometric and Operations Research, Tilburg, The Netherlands
\(^2\)Maastricht Radiation Oncology (MAASTRO Clinic), Physics Research, Maastricht, The Netherlands

Purpose/Objective: Advances in small animal radiotherapy enable the delivery of increasingly complex heterogeneous dose distributions on the millimeter scale, but methods to plan complicated small animal treatments remain in their infancy. A pre-clinical irradiation plan is usually created based on cone beam CT data with the animal in treatment position under anesthesia. Combined with demands on throughput, fast and easy treatment planning methods and algorithms are required. The purpose of this study is to develop an optimization model that determines beam-on times for a given beam configuration, and to assess the benefits of automated treatment planning for small animal radiotherapy.

Materials and Methods: The applied model determines a Pareto-optimal solution based on user-provided weights for objectives. An interactive approach allows the user to select the plan that yields the most preferred trade-offs. Two cases based on cone beam CT data of a rat were used, and manual and model-based optimization results were compared using dose-volume metrics. The kidneys, spine and gastrointestinal tract (GI) were delineated as organs at risk (OARs) and a fictitious planning target volume (PTV) was created around the spine. In case 1, the left kidney was targeted as PTV with four 10x10 mm\(^2\) beams and for case 2, twelve 8x10 mm\(^2\) beams were used to target the PTV around the spine. A PTV dose of 8 Gy was prescribed, with a mean dose between 8 and 10 Gy as constraint. Differences between prescribed and planned PTV dose, as well as OAR doses were included in penalty objectives. The model was integrated in a research version of Monte Carlo based small animal treatment planning system SmART-Plan (v2.0 Precision X-ray).

Results: Results show that manual and automated treatment planning yields plans of similar quality as shown in the figure and table. A similar amount of time was needed for manual and model-based optimization. In this period, manual optimization generates a single plan, while a set of Pareto-optimal plans is created with automated optimization, allowing for a more substantiated choice on trade-offs. Automated optimization often uses fewer beams than manual optimized plans, therewith lowering treatment delivery time. Additional benefits of automated planning include a decreased dependence on the planning skills of the user (often absent in pre-clinical research), and the potential to improve treatment standardization among institutions. For more complex irradiations, manual planning becomes infeasible, making automation a necessity.

Conclusions: Automation of treatment planning offers benefits to optimize plan quality in the short available time for treatment planning, to decrease dependence on user skills, to give more insight in trade-offs, and to improve standardization. The interactive Pareto-optimization framework was be able to produce plans of good quality, and allows for extension to full inverse treatment planning.