Master Thesis Proposal – Scientific Working Content - MedAustron (A. Carlino, M. Stock)

Topic: **Analysis of patient specific quality assurance results for different dose calculation algorithms and beam lines with protons at MedAustron**

Start: Q4 2017

Background / Introduction:

MedAustron (MA) is a particle therapy and research center located in Wiener Neustadt, where cancer patients are currently treated with protons. The active scanning technique with proton beams clinically implemented at MA allows to build-up the dose as a superposition of many thousands of individually placed and weighted pencil beams. The increased complexity places new demands on Quality Assurance (QA) programs, as well as innovative instrumentation and detectors for beam characterization and checks. The medical physics team is responsible for the acceptance and medical commissioning of all medical products which are related to ion beam therapy and imaging application. Frequent quality assurance procedures are performed to guarantee a safe and accurate delivery of treatments. On top of the machine specific QA also patient specific quality assurance is performed. The planned dose distribution in the treatment planning system (TPS) has to be verified periodically in homogeneous and/or inhomogeneous medium, and patient-specific plan verification is a highly recommended dosimetric procedure within the QA program. Quite extensive amount of data is already available after one year of clinical operation and more of 80 patients treated with protons in two irradiation rooms (IRs) at MedAustron.

Scientific Content:

Since December 2016 patients are treated at MA with protons. The TPS implemented in clinical routine is RayStation RS (RaySearch Laboratories, Stockholm, Sweden). Three different dose algorithms (pencil beam PBv3.5, PBv4.1 and Monte Carlo MCv4.0) of RS were commissioned and clinically used in treatment planning at MA. Patients are treated in two different beam lines (the horizontal beam line in IR2 and IR3). For each beam of a treatment plan per patient the dose is measured in a water phantom with 24 PinPoint ionization chambers (model TM31015, PTW Freiburg) [2]. The aim of the project is to analyze the data acquired for PS-QA over one year of clinical operation in order to re-assess tolerances and action levels based on the gained experience. An evaluation of the performance of the three clinically validated dose engines (PBv3.5, PBv4.1 and MCv4.0) will be done for a selection of clinical cases (e.g. very superficial tumors, in presence of large air gaps and lateral patient heterogeneities). The patient data will be grouped according to target location (head, head and neck, pelvis and extremities) and planning techniques (Single Field Optimization SFO and Multiple Field Optimization MFO). Special attention will be paid to the impact of the passive elements on the PS-QA results (e.g. the use of a range shifter). The actual exclusion criteria for the ionization chamber analysis based on dose gradient threshold and minimum dose level will be part of the investigation and it will be re-defined based on the results of this study. In addition, for some clinical cases which exhibit results above our established tolerance levels, a re-computation of the actual delivery based on log files will be done and compared with the original planned dose distribution in the TPS.

Material and Methods:

At MedAustron the PS-QA measurements are carried out in a water phantom (MP3-P, PTW Freiburg) based on a multi-ionization chamber system which fixes up to 24 PinPoint ionization chambers (model TM31015, volume $0.03cm^3$ and inner diameter 2.9 mm) [1]. For each patient plan the measured dose is compared with the computed dose by the RS TPS. The lack of commercial software solution to interface two different medical products (RayStation TPS on the one side and the PTW equipment on the other side) has been overcome by the integration in clinical routine of in-house developed software [2]. The results of PS-QA are consistently analyzed based on scripting tools written in python language.

Competences:

The student would need to have a back ground in medical physics or bio-medical engineering. Competences in data analysis and software programming are beneficial. In particular experience with python language is an advantage.

References:

[1] Karger C P, Jaekel O, Hartmann G H and Heeg P 1999, A system for three-dimensional dosimetric verification of treatment plans in intensity-modulated radiotherapy with heavy ions Med. Phys. 26 2125–32

[2] A. Carlino, "Implementation of advanced methodologies in the commissioning of a light ion beam therapy facility", PhD thesis, 2017.

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