Commissioning of a Monte Carlo algorithm for the proton Gantry installed at MedAustron ion therapy center

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Einleitung

In this work we report the results of dosimetric commissioning of the Monte Carlo algorithm MC5.3 available in the Treatment Planning System RayStation RSv11B (RaySearch Laboratories, Sweden). The beam model reflects the scanned proton beam delivery at the gantry of MedAustron (MA).

Material und Methode

Measurements were performed with detectors and water phantoms positioned at different air gaps between the extractable snout and the isocenter including plans with range shifter (RaShi). For 1D/2D, integrated radial dose profiles as function of depth in water, lateral spot profiles in air and absorbed dose to water in reference conditions were measured. For 3D tests the complexity was increased from box-shaped fields in homogeneous phantoms at gantry angles 0° and 90° to more complex clinical cases measured with 24 PinPoint ionization chambers (PTW, Freiburg) (figure 1). At gantry angle 150° 2D dose distributions of box-shaped fields and clinical cases were acquired at different depths of RW3 with a 2D detector array, the PTW OCTAVIUS 729 (PTW-T10040), mounted onto the gantry nozzle (figure 1).

Resultate

The TPS-predicted physical range (R80%) in water agreed within ±0.1mm with the measured R80% at isocenter. For the spot profiles, the deviation between measured and calculated full width at half maximum (FWHM) was below 4%. The validation for box-shaped plans in water showed an average global dose deviation within ±0.6% for isocentric and non-isocentric setups with and without RaShi. Regarding the clinical cases, the average global dose deviations were

0±0.6% and 1±0.6% for beams without and with RaShi respectively. At gantry angle 150° the 2D dose validation was based on 2D gamma index analysis (DD=2%, DTA= 2mm) which resulted in an average pass rate of 97.4%. (figure 2).

Diskussion

Extensive TPS commissioning validation was done before starting patient treatment with the MedAustron Gantry. Based on the positive results of the dosimetric commissioning the beam model was safely integrated in the clinics for treatment planning. The majority of measurements were performed at G90, but comparing measurements with G0 and G150 validated the beam model for these angles as well. The described stepwise methodology is broadly applicable and the validation of different treatment plans gives an indication of capabilities and limitations of the MC5.3 algorithm over the entire clinical range.

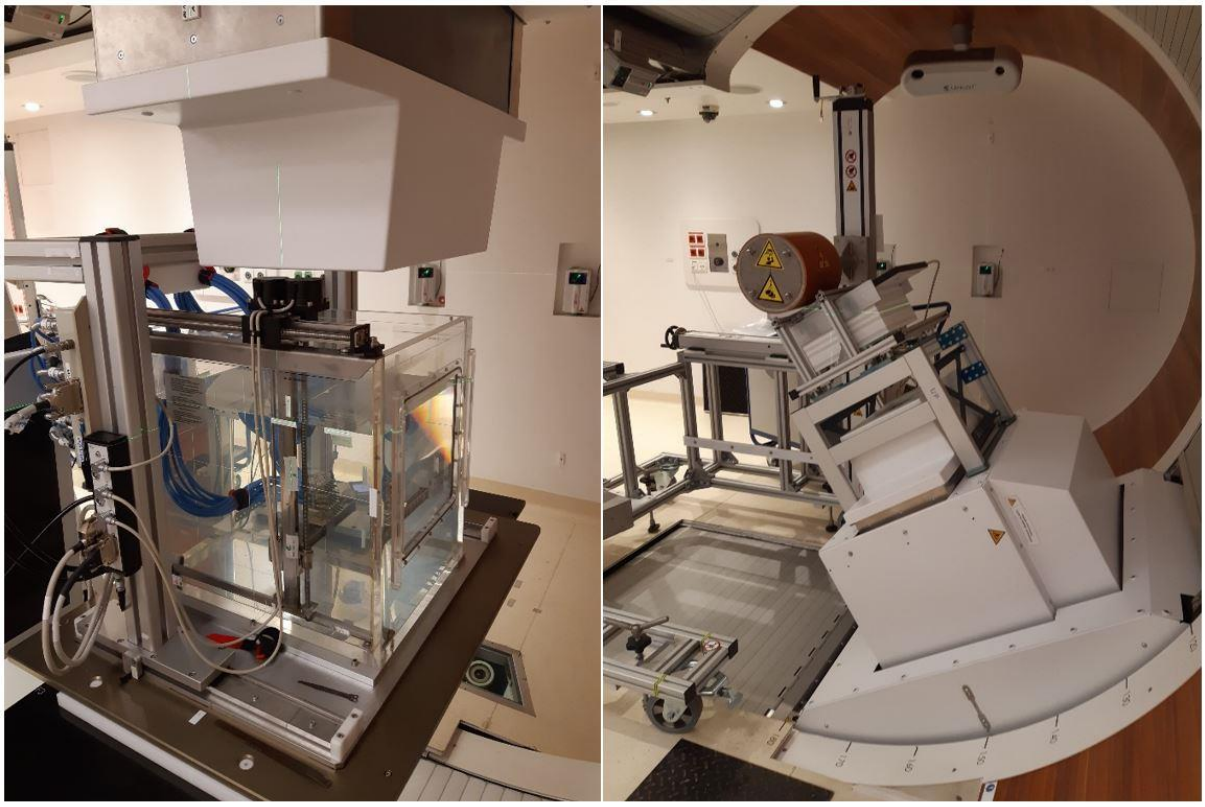

Figure 1: Measurement setup in the gantry room for measurements with the MP3-P waterphantom with PP array-block and with the PTW Octavius in the gantry treatment room

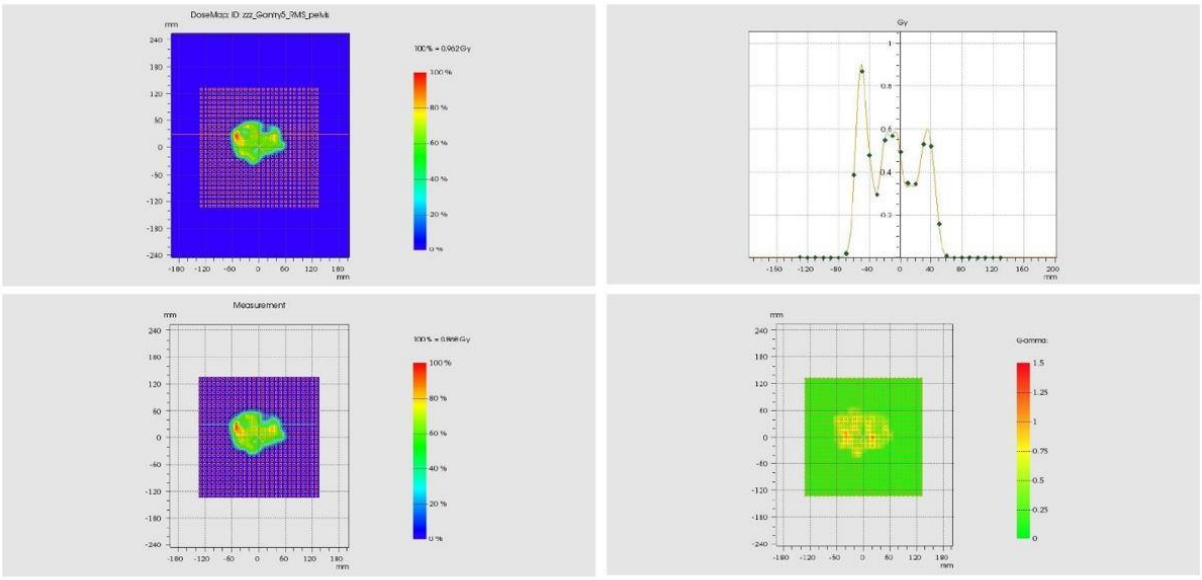

Figure 2: 2D Gamma analysis (DD=2%, DTA=2mm) for a clinical test case at G150. The figure summarizes the calculated dose map (top left), the measured dose distribution (bottom left), a dose profile (top right) as well as the gamma results map (bottom right)