DOSE CALCULATION FOR ORTHOVOLTAGE RADIOTHERAPY USING SWISS MONTE CARLO PLAN

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Introduction

Dose calculation for low energy (kV) treatments are mainly based upon measured depth dose curves and output factors in water for the used energies and add-ons. Therefore planning is limited and interpretation of clinical outcome of the treated patients becomes very difficult because of not knowing the delivered 3D dose distributions. Due to difficulties in low energy dose calculation using analytical models, Monte Carlo dose calculation is preferred in this situation. The goal of our work was to enable the dose calculation of an orthovoltage beam with the Swiss Monte Carlo Plan (SMCP)[1].

Material and Methods

To implement the geometry of our PANTAK DXT300 all beam defining parts were measured and inserted in BEAMnrc[2]. Parts within the vacuum tube could not be measured and therefore the dimensions supplied by the manufacturer were used. Phase spaces were generated after the exit window of the PANTAK system for nominal energies of 50 kV to 300 kV and additionally after the add-ons. These phase spaces were then used in SMCP to calculate dose distributions. Validation of the phase spaces was performed by comparing the calculated depth doses and profiles in a water tank with measured ones.

Results

Calculated and measured percentage depth doses (PDD) agreed in 100% of the calculated points for gamma criterions 3 mm/3 %. As an example calculated and measured PDD curve of the 5 cm cone at 100 kV are shown in figure 1 a. Results for relative dose profiles at 5 mm depth for the 2.5 cm cone at 50 kV are shown in figure 1 b. The solid black line represents the simulation, the green dashed line the measurement. Figure 2 represents the resulting 3D dose distribution of an academic skull treatment using 5 fields with an energy of 100 kV each defined with an adjustable collimator calculated with SMCP.

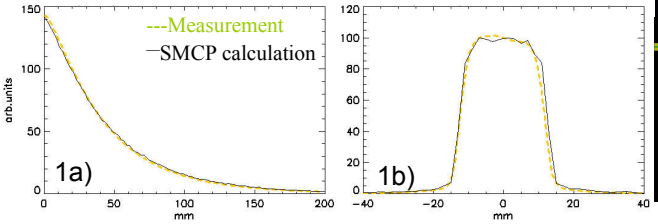

figure 1 a: PDD
for 5 cm cone at 100 kV

figure 1 b: crossplane-profile
for 2.5 cm cone at 50 kV

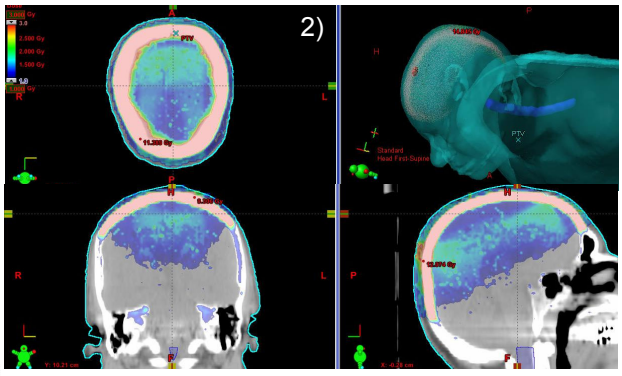

Figure 2: calculated SMCP 3D dose for a skull treatment using 5 fields

Discussion

3D dose calculations of an orthovoltage treatment were performed with SMCP using phase space data derived with the BEAMnrc user code. To improve statistics and accuracy of simulations an optimization of the geometries as well as increasing the numbers of simulated particles are work in progress.

References

[1] Fix M K et al, An efficient framework for photon Monte Carlo treatment planning, Phys. Med. Biol. 52, N425-N437, 2007
[2] Kawrakow I, Rogers DWO, The EGSnrc Code System: Monte Carlo Simulation of Electron and Photon Transport, NRCC Report PIRS-701, 2003