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Monte Carlo model of an ETHOS radiotherapy beam

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Purpose: To implement, commission and validate a Monte Carlo (MC) model of an ETHOS radiotherapy beam within the Swiss Monte Carlo Plan (SMCP).

Methods: The geometry and material of the treatment head model consisting of the target, the primary collimator, the monitor chamber, the secondary collimator and the double-stack multi-leaf collimator (MLC) was implemented into SMCP following the information provided by the vendor. For the commissioning, parameters for the Gaussian shaped position and direction distributions as well as for the energy spectrum of the initial primary electron beam impinging on the target were tuned in order to match measured dose distributions. For this purpose, depth dose curves and lateral dose profiles in five depths ranging from 1.3 cm to 15 cm were measured for square MLC shaped field sizes ranging from 1 x 1 cm^2 to 28 x 28 cm^2 at a source to surface distance (SSD) of 100 cm in units of cGy/MU. For the validation the analogous set of dose values at SSD of 90 cm were measured and compared with the corresponding calculated dose distributions using the commissioned MC model. In addition, a complex irregular shaped MLC field (fish-bone) with MLC leaf openings down to 2 mm were measured with a radiochromic film in a depth of 5 cm of a solid water phantom at SSD of 95 cm and compared with the corresponding MC dose calculation.

Results: An MC model of the ETHOS radiotherapy beam was successfully implemented in SMCP. The commissioned MC model agreed in general within 1% (global) or 1 mm for all depth dose curves and lateral dose profiles in units of cGy/MU for all square field sizes considered. For the fish-bone shaped complex MLC field dose differences of up to 5% (in regions with a large dose gradient) or 1 mm were observed.

Conclusion: A commissioned and validated MC model of an ETHOS radiotherapy beam is now available in the SMCP framework for accurate dose calculations.

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