EFOMP COMPANY MEMBER ARTICLE

Sun Nuclear: Beam quality correction factors for radiation therapy with high energy photon beams

Ionization chamber measurements of the absorbed dose to water in high photon energy beams are an essential part of radiation therapy dosimetry. The response deviation of an ionisation chamber in reference conditions and clinical beam qualities is corrected for by the beam quality correction factor k_Q, which provides one of the most significant sources of uncertainty in the measurement of the absorbed dose to water.

k_Q values depend on the design, size and material composition of the components and are chamber specific. International dosimetry protocols often provide tabulated data for k_Q values. However, the recent release of ICRU 90 [1] provided updated values of the mean ionization energy of water and graphite (I-values), as well as updated density correction parameters. Consequently, k_Q values based on ICRU 37 [2] should be revised.

While Monte Carlo simulations using science grade algorithms like EGSnrc [3] (National Research Council, Ottawa, Canada) are the method of choice to calculate kQ values for clinically used ionization chambers, the implementation and validation of ionization chamber models is not trivial. To ensure the highest quality standard, we connected two leading research groups, the Canadian national metrology institute NRC, and the Institute of Medical Physics and Radiation Protection of the University of Applied Sciences Mittelhessen, Germany, for the revision and calculation of k_Q according to ICRU 90 [1]. Both groups independently created and validated Monte Carlo models of the reference class ionization chambers SNC 125c and SNC 600c to determine k_Q values according to TRS 398 [4], AAPM TG 51 [5] and DIN 6800-2 [6]. The Monte Carlo calculated data sets agreed with experimentally determined kQ values presented in NRC reports PIRS-3224 [7] and PIRS-3327 [8].

Figure 1 presents Monte Carlo calculated beam quality correction factors kQ for the reference class ionization chambers SNC 125c and SNC 600c, independently determined by NRC and THM according to the TRS 398 [4] protocol. The kQ values were calculated for various clinical photon beams with nominal energies ranging from 4 MV up to 24 MV. A polynomial function was fitted to the joint data sets calculated by THM as well as NRC.

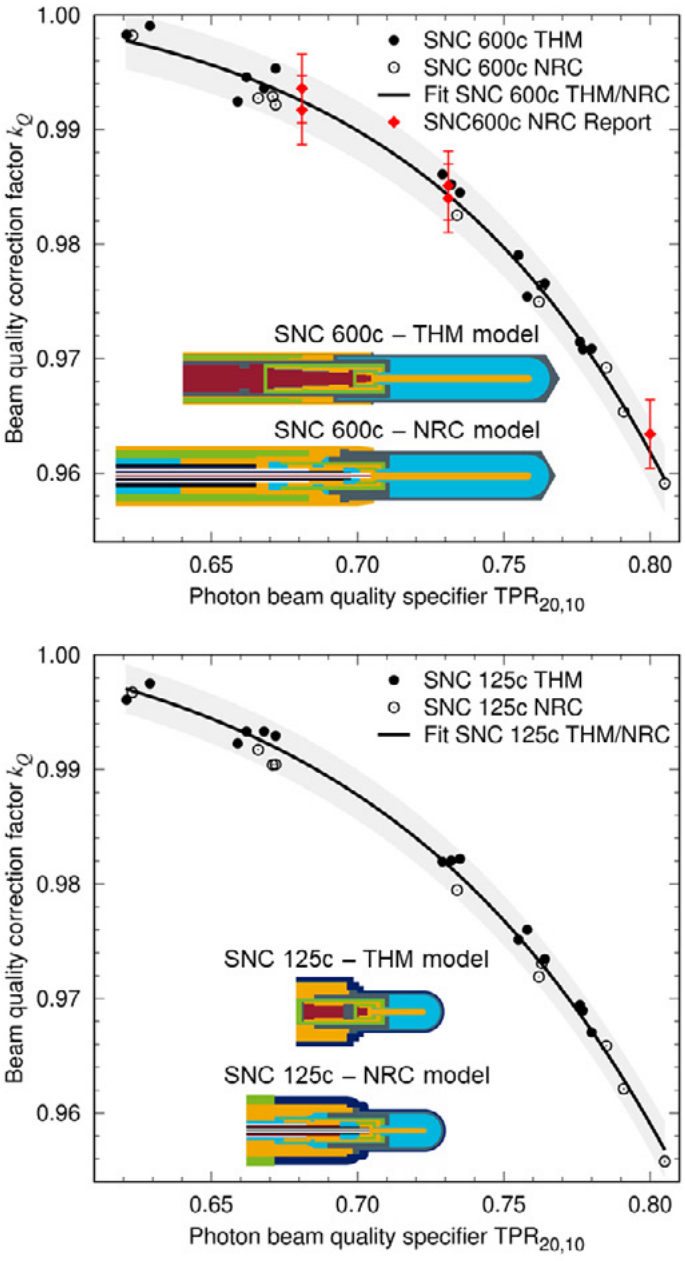

Figure 1: Calculated beam quality correction factors for the reference class ionization chambers SNC 125c and SNC 600c. Experimental data according to TRS 398 [4] is shown for the SNC 600c and available for the SNC 125c according to TG 51 [5] in Alissa et al. (2021) [9].

k_Q data according to TRS 398 [4], AAPM TG 51 [5] and DIN 6800-2 [6] for Sun Nuclear's ionization chambers SNC 125c and SNC 600c, as well as the corresponding fit parameters can be openly accessed in Alissa et al. (2021) [9].

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