Experimental versus calculated perturbation correction factors for ionization chambers in clinical proton beams with energies below 100 MeV

In dosimetry of proton therapy beams, potentially systematic errors do still show up, due to uncertainties on $(W_{air}/e)_p$, water to air stopping power ratios and the lack of information on chamber dependent perturbation correction factors. Especially for the latter, only very little experimental information is currently available. Perturbation correction factors are generally assumed to be equal to one.

In the present investigation, the relative response of in total 18 ionization chambers is evaluated at three proton beam energies below 100 MeV. The majority of these chambers have a Farmer-type geometry but consist of different combinations of wall and central electrode materials. All chambers have been calibrated in terms of air kerma as well as in terms of absorbed dose to water in a ^{60}Co beam. This allows the comparison of an air kerma based dosimetry formalism and an absorbed dose to water based formalism. The relative response of the ionization chambers is compared with results of Monte Carlo simulations using PTRAN for proton transport and EGS4 for secondary electron transport.

The measurements show that both approaches for absorbed dose to water determination do not give important relative differences when using the same physical data (IAEA, TRS-277) to calculate conversion and correction factors, but small systematic differences appear when using different wall and electrode materials. Preliminary results of electron calculations indicate that the observed experimental differences might be caused by secondary electron effects.