An EGSnrc investigation of correction factors for ion chamber dosimetry

Lesley A. Buckley
Supervisor: D. W. O. Rogers
Carleton University, 1125 Colonel By Dr. Ottawa, ON Canada K1S 2B5

Radiation dosimetry is used to quantify the dose delivered during radiation therapy by using ionization chambers with several correction factors. Knowledge of these factors is needed at well below the 1% level in order to maintain the overall uncertainty on the reference dosimetry near 1-2%. The small magnitude of the corrections renders measurements very difficult. Monte Carlo calculations are widely used for this purpose, however they require very low statistical uncertainties.

A new user-code, CSnrc, for the EGSnrc Monte Carlo system is described. CSnrc uses a correlated sampling variance reduction technique to reduce the uncertainty for dose ratio calculations. Compared to an existing EGSnrc user-code from which it was developed, CSnrc shows gains in efficiency of up to a factor of 64 and achieves much lower statistical uncertainties on correction factors than previously published.

CSnrc is used to compute the central electrode correction factor, P_{cel}, in a broader range of beams than previously used and at the depths relevant to modern protocols. For photon beams, the CSnrc values compare well with the values used in dosimetry protocols whereas for electron beams, CSnrc shows up to a 0.2% correction for a graphite electrode, a correction currently ignored by dosimetry protocols. The difference from currently used values is slightly less for an aluminum electrode.

CSnrc is also used to compute the wall correction factor, P_{wall}. For cylindrical chambers in photon beams, the CSnrc calculations are compared to the currently used Almond-Svensson formalism and differ from this formalism by as much as 0.8%. The CSnrc values are used to explain some previously published experiments showing problems with P_{wall}. For electron beams, where dosimetry protocols assume a P_{wall} of unity, CSnrc calculations show a correction as large as 0.6%.

For parallel-plate chambers, there is little information available regarding P_{wall} in photon beams. CSnrc shows corrections of over 2% for some chambers. In electron beams, P_{wall} has been assumed to be unity, despite previously published evidence suggesting otherwise. CSnrc shows that for some chambers at lower energies, P_{wall} is nearly 1.02.