Accuracy tests of the new EGSnrc Monte Carlo system in the simulation of ion chamber response in low energy photon beams

Many applications involving ionization chambers require accurate calculation of ion-chamber response. Since cavity theories are fairly restrictive in their applicability especially at lower energies, accurate Monte Carlo calculation of chamber response is important. We tested the performance of the newly developed EGSnrc Monte Carlo system to calculate ion chamber response in low energy photon beams (10 keV – 1250 keV) by comparison against the Fano theorem. The response of a cavity with wall and gas of the same material, but only differing in density, is equal to the collision kerma in the wall material, provided corrections are made for photon attenuation and scattering, or provided the fluence is unweigthed for photon attenuation and scattering in the chamber. We compared the performance of EGSnrc for a pancake cavity (2 mm deep, 1 cm diameter, materials: carbon, aluminum, copper) irradiated from end to the Fano-predicted result and to EGS4/PRESTA under similar conditions. The results show that EGSnrc produces step size independent doses, consistent with the Fano theorem at the ±0.2% level for the materials investigated, and for default parameter settings. EGS4/PRESTA showed its expected step-size dependent behaviour of 5% for Carbon and worse for other higher Z materials. The calculated cavity dose converged typically to doses which were up to 2% wrong, depending on the material, transport parameter settings and photon energy.