AbstractID: 4839 Title: Variations of energy spectra and water-to-material stopping-power ratios in three-dimensional conformal and IMRT photon fields

Purpose: Complex dose distributions and dose gradients in IMRT may cause spatial variations in photon- and electron-energy spectra. This study examined the change of photon- and electron-energy spectra, and their effects on dosimeter response and water-to-material stopping power ratios (SPR) for 3D and IMRT beams. The later term is an important factor for dosimetry protocols and obtaining dose-to-water conversion in Monte Carlo dose calculations.
Method and Materials: The Monte-Carlo BEAM-EGSnrc system was used to simulate external-beam photon fields with 3D or IMRT features. Electron and photon energy fluences and spectra were calculated on a voxel-by-voxel basis using track-length estimation for 3D and IMRT treatment plans. The water-to-material SPR were averaged over the voxel of interest with the electron spectra using the Spencer-Attix theory. The relative response of ion chambers, films, and TLDs were modeled using the photon and electron spectra.
Results: There was a strong spatial dependence of photon-energy spectra in both the 3D and IMRT fields. The low-energy (<100 keV) component of the photon spectra increased inversely with doses because of the contribution of the scattered photons. A similar effect was observed for electrons but to a much smaller extent. As a result, the response of film could increase by more than 10% in the low-dose region, whiles the changes of ion chamber and TLD response were within 3%. On the other hand, the variation of the water-to-material SPR with energy spectra and spatial locations was not clinical significant (< 1%) for soft tissue, cortical bone, and lung, and was less than 2% for dry air.
Conclusion: Photon- and electron-spectra are spatial- and dose-dependent in 3D and IMRT photon fields. The spectra variation should be considered for certain dosimeters whose responses are energy dependent. For patient-like materials, the water-to-material SPR was relative stable in spite of the spectral variation.