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ELECTRON DOSE KERNELS TO ACCOUNT FOR SECONDARY PARTICLE TRANSPORT IN DETERMINISTIC SIMULATIONS

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ABSTRACT

For low energy photons, Charged Particle Equilibrium (CPE) usually exists within the patient treatment volume, in which case the photon absorbed *D* dose is equal to the collisional kerma *Kc*; however, this is not true for the dose buildup region near the surface of the patient, or at interfaces of dissimilar materials such as tissue/lung, where corrections for secondary electron transport may be significant. Moreover, as the energy of the ionizing radiation increases, the penetration power of the secondary charged particles increases more rapidly than the penetration power of the primary radiation, leading to CPE failure. This failure is caused by the small number of charged particles produced at initial penetration depths compared to deeper points along the primary radiation field direction.

In the case of low energy beams transporting in heterogeneous media, secondary electrons need not specifically be modeled using charged particle transport methods to accurately determine global dose distributions. Alternatively, at higher photon energies, this is not the case, and charged particle transport and corresponding interactions yielding energetic electrons must be considered over the problem phase space to yield an accurate dose distribution. This is readily treated in Monte Carlo codes, and quite difficult to treat explicitly in deterministic codes due to the large optical thicknesses in electron transport problems. To properly treat 3-D electron transport physics deterministically, yet still achieve reasonably fast and accurate whole body computation times using high energy photons, we are developing angular and energy dependent transport "electron dose kernels." These kernels are being derived via full physics Monte Carlo electron transport simulations, and upon integration into the PENTRAN-MP code system, will enable a very efficient and complete whole body dose, even in the case of high energy photon beams.

Using Monte Carlo calculations, we plan to generate electron dose kernels for pre-determined photon energy groups in terms of the energy deposited in voxel (i', j', k') as a result of the incident primary photons in a given energy group propagated from a voxel (*i, j, k*). When producing these kernels, the photons of energies lower than the limits of the energy group will be cut off in order to prevent a cascading contribution to the EDK for lower energy groups. These kernels will then be applied using net current on a fine mesh and/or coarse mesh bases. This is possible because the PENTRAN discrete ordinates code preserves angular information explicitly in process-scalable parallel data storage arrays.