

We present a method for superposition dose calculations using Fermi-Eyges (FE) based 3D kernel scaling for primary photon dose. In contrast to the density scaling method which accounts only for the average density along the line between the interaction and dose deposition sites, the FE scaling method accounts for the effects of tissue density distribution on the multiple scattering of primary electrons set in motion by primary photons. The basic concept of this approach is: (i) to determine standard deviation of the lateral electron planar fluence distribution at dose deposition sites for electron pencil beams starting from photon interaction sites, (ii) to scale the distance between the interaction and dose deposition sites for the primary kernel by the ratio of the inhomogeneous to homogeneous lateral electron distribution standard deviations, and (iii) to scale the scatter kernel using the density scaling method. FE scaling is shown to improve dose accuracy in inhomogeneous media where electron disequilibrium can occur, especially at tissue interfaces for small field sizes of high energy photon beams. We compare superposition dose distributions in heterogeneous media using both FE and density scaling to measurements and FFT convolution calculations for a wide range of beam energies and field sizes. Results show: (i) superposition dose calculations with FE scaling is more accurate than density scaling method alone, and (ii) maximum error is reduced by 3.5% and 2.5% for 18MV 3x3cm and 15MV 5x5cm fields, respectively in a lung phantom. Improved accuracy occurs at the expense of some additional computation time.