LOW ENERGY PHOTON DOSIMETRY USING MONTE CARLO AND CONVOLUTION METHODS

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Low energy photon dosimetry was investigated using Monte Carlo and convolution methods. Photon energy deposition kernels describing the three dimensional distribution of energy deposition about a primary photon interaction site were computed using EGS4 Monte Carlo. These photon energy deposition kernels were utilized as the convolution kernel in convolution/superposition dose calculations. A Monte Carlo bench mark describing the energy deposition about an isotropic photon point source model was developed. The effect of the inclusion of low energy photon interaction physics on the Monte Carlo and convolution calculations was investigated. A generalized convolution/superposition algorithm was developed to explicitly account for the orientation of the energy deposition kernel for an isotropic photon point source in a brachytherapy geometry.

Energy deposition kernels calculations using the EGS4 ``scatter sphere'' code SCASPH were extended to low photon energy. Convolution/superposition dose calculations using these kernels for external beam geometries demonstrated agreement with measurements for low energy diagnostic x-ray beam spectra.

The effect of the inclusion of Rayleigh scattering using atomic and molecular coherent scattering form factor data on the kernel calculations was shown to result in an angular distribution of energy deposition consistent with the angular distribution of photon scattering described by the form factor data. Convolution/superposition dose calculations using these kernels did not exhibit any effect of the angular distribution of the kernel.

Monte Carlo calculations for an isotropic photon point source including the effects of Rayleigh scatter in a homogeneous medium did not demonstrate any effect of the angular distribution of Rayleigh scattering. Calculations in heterogeneous geometries also did not exhibit any effect of the angular distribution of Rayleigh scattering at low photon energy.

Convolution dose calculations using the generalized algorithm demonstrated agreement with the results of the Monte Carlo bench mark. The necessity of applying a correction factor when properly accounting for the orientation of the energy deposition kernel was also demonstrated. The generalized algorithm was also demonstrated to exhibit a discretization artifact from utilizing the discrete energy deposition kernel data.