

Analytic Modeling of Treatment Head Scatter Factor

The head scatter factor (S_C) is the ratio of the output in air (OF) for a given field to that for a reference field (e.g. 10x10 cm). Measured output in air is proportional to the sum of primary (P) and scattered (S) photon components. P and S are each integrals of energy fluence times absorption coefficient over all photon energies. P is due to photons produced by bremsstrahlung in the target, then incident on the isocenter after being attenuated by treatment head elements, so it does not change with field size. S is due to photons scattered in the treatment head before reaching isocenter, and increases with field size (X,Y). The output factor may be written as $OF(X,Y) = M[1 + S(X,Y)/P]$, where M is the monitor backscatter factor, linear in field size. We have analytically computed the values of P and S, assuming that S is accurately modeled by first Compton scatter. The computation of the energy and angular distribution of bremsstrahlung is carried out with the Schiff formula in a thick self-absorbing target that may contain layers of different elements. The intensity spectrum at isocenter was computed for primary photons and for photons scattered from elements in the treatment head, as a function of field size. The results are compared to measured head scatter factors for square and rectangular fields.