

Accurate, compact representations of Monte Carlo simulations of accelerator-specific source components (target, primary collimator, flattening filter) are critical for implementing clinically useful Monte Carlo treatment planning calculations. We have developed a method that characterizes the accelerator-specific portion of commercial photon beams in terms of coupled energy and angular distributions in order to support efficient, accurate Monte Carlo sampling. The method uses standard, general-geometry Monte Carlo codes (BEAM, MCNP) to generate a file that contains the phase space description (energy, position, direction, and weight) for a large number (millions) of particles as they exit the flattening filter. This method characterizes the exiting particles by dividing the beam into three types of subsources - direct (unscattered) photons, scattered photons, and electrons. Each subsource contains radially-dependent fluence and coupled energy/angular distributions. This method allows Gigabyte-size phase space files to be described accurately with files that occupy only 150 kilobytes. Highly efficient sampling methods (~85% for a 10x10 cm open field) allow rapid generation and transport of particles to the patient. Comparison of the fluence at isocenter produced by this method with that of the underlying full-physics Monte Carlo photon phase-space indicates that fluence errors are less than 1% of the maximum fluence for a range of open-field sizes. Comparison of calculated and measured jaw-edge penumbræ shows that the angular distributions of the photons are reproduced accurately.

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