AbstractID: 2901 Title: The development and implementation of a new variance reduction technique in Monte Carlo code PEREGRINE

Purpose: The development and implementation of a new variance reduction technique (NVR) in Monte Carlo code PEREGRINE.

Method and Materials: The NVR technique was designed to reduce computing time (to increase efficiency) of Monte Carlo (MC) simulations of therapeutic photon beams in arbitrary media. A simple case of monoenergetic photon beam in water phantom is sufficient to describe the idea of NVR. As the primary photon fluence attenuates exponentially with phantom depth z, statistical uncertainty of absorbed dose increases with z as $(N_z)^{-1/2}$, where $N_z=N_0\cdot\exp(-\mu z)$ is the number of histories available at depth z, N_0 is the number of initial histories and μ is the linear attenuation coefficient for primary radiation in water. If at a depth of interest d, N_d yields an acceptable dose uncertainty, then instead of N_0 initial histories, one can use only N_d histories if this number is maintained invariant with phantom depth. This can be done by "recovering" each interacted primary photon back to the primary fluence, thus making it available for further interactions. In doing so, all offspring particles should be given a dose weight factor $\exp(-\mu z)$ corresponding to the depth z of the primary photon interaction. Because $N_d \ll N_0$, computing time is significantly reduced.

Results: Implemented in PEREGRINE, NVR increases computational efficiency without biasing the dose distributions in various heterogeneous phantoms. In the case of a patient-specific CT-based anatomy, NVR reduces the computing time by a factor of ~2, and in metals (blocks, wedges, MLCs) by a factor of 10 or more.

Conclusion: NVR is an unbiased technique compatible with other variance reduction techniques. Therefore, it can be combined with such techniques to further increase efficiency of MC codes. NVR results in an enhancement of MC efficiency that is clinically significant.

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