AbstractID: 5467 Title: Evaluation of a New Computational Technique for Photons and Electrons

Purpose: To demonstrate the preliminary results of a new computational technique which computes high accuracy transport factors for patient/phantom specific parameters and to use these transport factors to compute energy deposition independently for photons and electrons

Materials and Methods: During treatment planning the transport factors are loaded into RAM and used to directly compute a first principle high speed, high accuracy solution. Presented below are planning phase equations that are iterated upon using pre-computed transport factors:

1. Double Differential Photon Scatter

$$\Phi p(E',\Omega',r) = \int_{\Omega} \int_{E} \Sigma s(\Omega \rightarrow \Omega', E \rightarrow E', r)\ \Phi p(E,\Omega,r)\ dE\ d\Omega$$

In our equations, Φ is particle flux, r position, E energy, Ω is the solid angle and Σs are the scattering cross section.

2. Explicit Photon Transport – Problem Specific

$$\Phi p(E,\Omega,r') = \int_{V} \Phi p(E,\Omega,r)\ Tp(E, \Omega, r \rightarrow r')\ dr^3$$

The Compton scattered photons are transported explicitly using pre-computed transport factors.

3. Photo-Electron Scatter

$$\Phi e^-(Ee^-,\Omega e^-,r') = \int_{\Omega} \int_{E} \Sigma sp \rightarrow e^-(\Omega \rightarrow \Omega e^-, E \rightarrow Ee^-, r)\ \Phi p(E,\Omega,r)\ dE\ d\Omega$$

Electrons from photon interactions are modeled in accordance with their angular and spatial distribution. Local photon scatter interactions are used to determine the electron source distribution from a double differential scatter matrix $\Sigma sp \rightarrow e^-(\Omega \rightarrow \Omega e^-, E \rightarrow Ee^-, r)$.

4. Electron Transport to dose

$$D(r') = \int_{V} \Phi e^-(Ee^-,\Omega e^-,r)\ Te^-(E, \Omega, r \rightarrow r')\ dr^3$$

The final dose distribution D(r') from electron transport is determined using pre-computed phantom/patient specific transport factors.

Results: Preliminary calculations with 2.5 mm voxels indicate that application of this model obtains fast, high accuracy results for clinical radiation treatment machines in various media. Preliminary research indicates considerable speed improvements over Monte Carlo without degrading accuracy.

Conclusions: This new code utilizes an innovative process to improve computational speed and accuracy for dose calculations in radiation treatment planning. Patient specific data is used to compute high accuracy transport factors. These factors are used independently for photons and electrons to calculate dose deposition.