AbstractID: 13654 Title: Quantitative Analysis of Dose Enhancement Contributed by Different Photon Interactions in X-ray Irradiation with the Presence of HZ Materials with Geant4 Monte Carlo Simulation

Purpose: To study the overall dose enhancements and those contributed by different processes quantitatively in the presence of HZ materials and X-ray with different energies with Monte Carlo method.

Method and Materials: A virtual phantom is constructed with three layers, with the first and the third layers made of water, sandwiching the second layer composed of water and HZ materials, including Gold (Au), Platinum (Pt), Gadolinium (Gd), or Iodine (I). The phantom is irradiated by X-ray with mono and spectrum energies. The dose deposited in the phantom along photon incidence direction is recorded with a space resolution of 0.1mm. The percent depth dose (PDD) curves for these sources are generated with d_{max} calculated. The overall dose enhancement ratios and those contributed by different processes, such as Pair Production, Compton Scattering, and Photoelectric Effect, are analyzed quantitatively.

Results: The dose enhancement ratios (r_{D-E}) for different HZ materials with the same molar concentration increase with the atomic numbers. For example, with concentration at 0.1882 mmol/ml and 0.25MeV X-ray energy, the overall r_{D-E}s are 152.69%, 150.57%, 127.64%, and 114.32% for Au, Pt, Gd, and I, respectively. Higher energy source gives lower r_{D-E}. For example, a 5 MeV source gives a r_{D-E} of 105.2% for Au. These can be explained by analyzing the dose contribution from each process and the r_{D-E} for that process.

Conclusion: A new method is implemented in MC simulation for analyzing percentage dose contribution from different processes to the total dose. This helps to select the right X-ray energy and HZ atom as well as the concentration in HZ-enhanced Radiation therapy. Lower energy source gives higher r_{D-E} because more doses are contributed by Photoelectric effect, which gives very high r_{D-E}. At the same molar concentration, materials with larger atomic number give higher r_{D-E}.