

AbstractID: 8465 Title: Comparison of MCNP and GEANT4 Monte Carlo codes on photo-neutron generation in high energy X-ray beams

Purpose: Photo-neutrons generated in high-energy X-ray beams are of increasing interest. Secondary neutrons introduce concerns such as neutron shielding and additional dose to patients. The Monte Carlo method is an appropriate choice for studying photo-neutron production and transport. However, unlike interactions of photons with orbital electrons, photonuclear reactions suffer from the incompleteness and inconsistency of the cross section data. The purpose of this investigation is to compare two major Monte Carlo codes MCNP and GEANT4 in implementing the photonuclear process.

Method and Materials: Cross section data (total photonuclear cross section, neutron production yield, and neutron energy/angular distribution data) were extracted from the respective external cross section files (MCNP) or from the code (GEANT4) directly for the major materials/elements in linear accelerator and human body. The Varian linear accelerator with multi-leaf collimator (MLC) was modeled identically with MCNP and GEANT4. Neutron generation in major components in the linear accelerator was simulated and compared.

Results: MCNP and GEANT4 implemented the photonuclear process in very different manners. Significant differences in cross section data between MCNP and GEANT4 were discovered. Several institutions provided the cross section data used in MCNP, and the cross section data for the same isotope from different providers may also present large discrepancies. The results of photo-neutron production in linear accelerator components simulated with the two Monte Carlo codes can be quite different. Although neutrons were not transported in our simulations, appreciable differences in neutron fluence or neutron dose can be expected.

Conclusion: MCNP and GEANT4 are two major Monte Carlo codes, capable of simulating photon-neutron generation and transport. The discrepancies between the two codes indicate the lack of comprehensive understanding in physics of the photonuclear process. The investigators who worked with either code should be aware of the potential uncertainties in their results regarding to secondary photo-neutrons.