Public Abstract

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Title:Computational Modeling of Neutron Production by a Siemens Oncor Linac and Benchmarked by Experimental Data

Modeling neutron production by an electron driven linear accelerator using Monte Carlo N-Particle (MCNP) transport code can show the potential for this accelerator to be used as a neutron generator to produce short-lived radioisotopes or potentially as an external beam source for neutron therapy. Applications of this modeling include calculating activation of other materials in this and similar systems, adjusting the size of the system to adjust neutron production, and many other potential uses.

Modeling results show that a Siemens Oncor electron driven accelerator fitted with an x-ray (heavy metal) converter can produce a thermal neutron flux of 1.33E5 neutrons/cm2/sec in a 1 liter beaker of heavy water 76.37 cm away from the beam source. When irradiating a square shaped 1.2 cm by 1.2 cm piece of natural gold (Au-197) foil positioned up in the heavy (deuterated) water for 10.2 minutes, Au-198 production resulted from the Au-197(n, ?)Au-198 reaction. The experimental data showed the activity to be 40.29 decays per second (DPS) using a Geiger Muller (GM) detector for counting the 411.85 keV gamma radiation associated with Au-198. Computational modeling results showed Au-198 activity to be 43.77 DPS. Experimental results from the Au-198 production experiment in 2014 at the University of Missouri-Columbia were used to benchmark the MCNP transport modeling in this project. The 1 liter of heavy water (D2O) modeled in MCNP had a neutron flux of 5.17E7 neutrons/cm2/sec. The 1.2 cm by 1.2 cm thin piece of gold foil had a neutron flux of 2.12E7 neutrons/cm2/sec. The gold foil had a thermal neutron flux of 5.61E4 neutrons/cm2/sec. The relative error for the Au-198 production tally (f014 tally, Appendix B) was 5.15% and the variance of variance (VOV) was 2.25% after 1E11 source particles were run. In future work, this code can be used to investigate this type of systems in applications such as neutron generation in neutron therapy and activation of short-lived radioisotopes for radio-pharmacology. Variation of tank size configuration as well as varying electron beam drivers can be investigated.