AbstractID: 8512 Title: Neutron Yield and Angular Distribution from the 250 MeV Proton Interactions in Water: A Geant4 Monte Carlo Study

Objective: To simulate using GEANT4 the interaction of 250 MeV protons in water to determine the neutron yield and angular distribution using various hadronic interaction processes.

Materials and Methods: A cylindrical water phantom (length=40 cm, diameter= 40 cm, density = 1 g/cm3, mean excitation energy = 75 eV) is surrounded by a spherical shell, that consists of 18 detectors, each of which covers 10 degree in theta. In Geant4, electromagnetic energy loss for hadrons and leptons are categorized as either “standard” or “low energy” processes. The low energy process is used to extend down particle interactions with energies below the standard process (for example: Protons 1 keV, electrons and photons 250 eV). The range cut for both low energy and standard process is lowered from the default value of 10^{-3} m to $1.5x10^{-5}$ m to improve the accuracy of simulation. In the case of HI, elastic processes for protons are calculated by G4LEpp and GHEISHA-style G4LElastic; whereas the inelastic processes for proton and neutron are calculated by G4PreCompoundModel below 170 MeV, and G4CascadeInterface above 150 MeV; and for neutron also by G4NeutronHPorLEInelasticModel. The neutron elastic process is calculated using G4NeutronHPorLEModel for energy greater than 4 eV. When the neutron energy is lower than 4 eV, G4NeutronHPThermalScatteringData is used. The simulations are carried out using 1 million incident pencil beam proton.

Results: Neutron fluences per incident proton as a function of theta are determined. Based on hadronic process being used in the calculation, the total number of neutrons per incident proton that reach all eighteen theta detectors ranges from 0.124 to 0.243.

Conclusions: Our results show that the hadronic processes indeed play a critical role for GEANT4 simulations. We recommend that careful selection of physics processes for particle interaction is essential in order to interpret realistically simulated results.