AbstractID: 8186 Title: Energy Distributions of Particles Generated for Proton Interactions in Water: A Simulation with GEANT4 Monte Carlo Code

Purpose:
To simulate using GEANT4 (version 4.8.3), interaction of proton in water with energies of 60, 100, 150, 200, and 250 MeV for accurate determination of energy distributions of particles generated such as protons and neutrons.

Method and Materials:
A cylindrical water phantom (thickness = 1 cm, diameter = 2 cm, density = 1 g/cm3) was placed in front of a sensitive detector having the same dimension as the phantom. A pencil beam proton directed perpendicularly towards the water slab was used with the detector on the other side recording the energy distributions of particles generated. The simulations were carried out by 4 million incident protons for each of the proton beam energy. Electromagnetic energy loss processes for hadrons, electrons and positrons are categorized in GEANT4 as either "standard" or "low energy". To extend down particle energies below the standard process, the low energy process was used in the simulation to cover protons with 1 keV; and electrons and photons with 250 eV. Range cut is lowered from the default value of 1mm to 15μm to improve the accuracy of simulation. The Hadronic process includes low energy elastic and inelastic scattering that consists of a pre-compound nuclear interaction below 170 MeV, and a Bertini cascade model for energies above 150 MeV. The energy distributions of protons and neutrons are then normalized per incident proton.

Results:
The normalized proton and neutron energy spectrum show that the statistical uncertainties are mostly lower than 10% for most of the points in the proton energy distribution curves and that 20% for neutron curves.

Conclusion:
We have demonstrated that the GEANT4 toolkit has the ability for the radiation therapy proton beam simulation. This code will primarily be used as a standard code for our proton facility design and planning in our institution.