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Geant4 Analysis of Secondary Neutrons in Proton Therapy

The use of proton therapy decreases the damage to surrounding healthy tissue compared to traditional radiotherapy due to the existence of the Bragg peak where most of the beam's energy is deposited. However, secondary particles are produced externally along the beam line and within the patient due to protons interacting with the nuclei in the beam's path. Of particular interest are neutrons produced this way as they are hard to detect through traditional means and have a high biological effectiveness.
The Geant4 simulation toolkit was used to model the path of a 191 MeV proton beam through a copper collimator with an inner radius of 50mm, and into a water phantom, corresponding to the 24cm proton beam at iThemba LABS.
Examination of the distribution of neutrons along through the depth of the water phantom showed that most internal neutron production occurred before the Bragg peak where the proton energies have lowered, maximising the cross section for neutron producing reactions. 60\% of all neutrons within the phantom are produced internally for a 60mm beam. Although externally produced neutrons contributed 63\% of the dose due to neutrons for this beam radius and 82\% for a 75mm beam. As a proportion of the total dose, the neutron dose made up .62, .95 and 1.26\% for beams of 39, 60 and 75 mm respectively.
The simulation was also used to measure the spectra and fluences of neutrons through different areas which would correspond to the placement of neutron detectors for future experiments. The placements were chosen to verify where neutron production and attenuation occurs within a treatment scenario.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

Hons

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