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Measurement and simulation of secondary neutron production from a 66 MeV proton beam

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Prompt gamma rays (PGs) produced by nuclear collisions during proton therapy (PT) can be used for *in vivo* proton beam range verification through a technique known as prompt gamma imaging (PGI). During PT, the production of PGs within the tissue provides a reliable location map for the proton dose deposition. The detection of these PGs using a Compton Camera (CC) can be used to construct a source image of the PGs. Since the reconstructed source image is dependent on the quality of the detection, the detection efficiency of a CC device can be negatively affected by additional secondary radiation (particularly neutrons) produced alongside the prompt gamma rays. The goal of this work is to understand the characteristics of these secondary neutrons during a proton beam irradiation and their potential impact on a CC.

The experimental setup consisted of a 66 MeV pencil beam of protons on a variety of targets (HDPE, water, graphite) with the neutron measurements made using an organic liquid scintillator detector (BC-501A) at several angles within the K600 vault (S-line) at iThemba LABS. To obtain neutron energy spectra with the BC-501A an unfolding procedure is typically used, where energy spectra are deconvolved from the measured, and calibrated, neutron light output spectra. As the quality of the unfolding is dependent on the prior knowledge of the energy spectrum, a Geant4 simulation was constructed to better understand the produced neutron field and aid the unfolding process. A comparison of the experimental and simulated results will be discussed.

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