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Characterization of the Direct and Scattered Neutron Flux Around Cyclotron

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This study was part of a project that aims to investigate direct and scattered neutron flux, specifically, thermal and epithermal energy ranges around an unshielded PetTrace 880 cyclotron's target in several locations at a medical facility in the western region of Saudi Arabia. Efforts were made to characterize the neutron flux in a diagonal formation using a 3D-printed holder array within the allowable safe distance from the cyclotron target. The foil activation method was employed to estimate the thermal and epithermal neutron fluxes. The experimental design aimed to: 1) irradiate three batches of several sets of gold foils with and without cadmium filters, 2) collect the activated foils and finally 3) measure the photons emitted from the activated foils using a calibrated Broad Energy Germanium (BEGe) Detector. Initially, bare gold foils were irradiated to measure the direct and scattered thermal and epithermal neutron fluxes. Then, a second batch of one-side cadmium-covered gold foils was irradiated to account for the direct epithermal and scattered neutron fluxes. The third foil batch setup was made slightly different than the first two, where gold foils are inserted between two cadmium filters in a sandwich setup before the irradiation. The objective of the third batch irradiation was to isolate the thermal neutrons from the direct and scattered epithermal neutron fluxes. The mean thermal neutron flux was found to be in the order of 1.1E+06 ± 1.1E+05 neutrons cm-2s-1 at almost all investigated locations. The mean epithermal neutron flux was found to be in the order of 6.7E+05 ± 1.7E+04 neutrons cm-2s-1 at all investigated locations. The contribution from the scattered neutrons was found to be reduced by 20-50% after applying the sandwich setup. Further experiments will investigate neutrons with higher energies in the fast range to fully characterize the area around the cyclotron's target.

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