Moderator testing toward a neutron target

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A neutron target would offer new experimental opportunities, enabling discoveries related to nucleosynthesis, stockpile science, and reactor design. Though a neutron target represents a massive technological challenge, progress is being made toward its development [1]. A neutron target intersected by an ion storage ring would allow for measurements of neutron induced reactions on radioactive nuclides. Neutron moderation should be used to optimize the neutron density and energy distribution. Every re-scattering provides a possibility for the neutron to travel back through the target volume. A model of neutron moderation has been developed (R. Reifarth) and has been benchmarked at low energy using proton beams at Notre Dame to produce neutrons.

In December, 2024, proton beams from the TAMU K500 cyclotron were used to produce neutrons from a beryllium target. The target was surrounded by an 80cm cube of graphite which moderated the neutrons. Gold wires were arranged on a line through the center of the cube spanning the width of the cube. The cross sections for the reactions (*n,γ*), (*n,2n*), (*n,3n*) and (*n,4n*) are known for thermal and higher energy neutrons. Following irradiation, gamma rays from the gold wires were measured with HPGe detectors to determine the activity and thus the quantity of the *n*+Au products. Two beam energies (45 and 9 MeV) were used, and for each beam energy the cube was configured two ways: a) full cube and b) top half removed (increasing the fast to thermal ratio). The yield predicted by a model of the moderator (using knowledge of the energy-dependent neutron-induced reaction cross sections) was compared to the measured yield as a

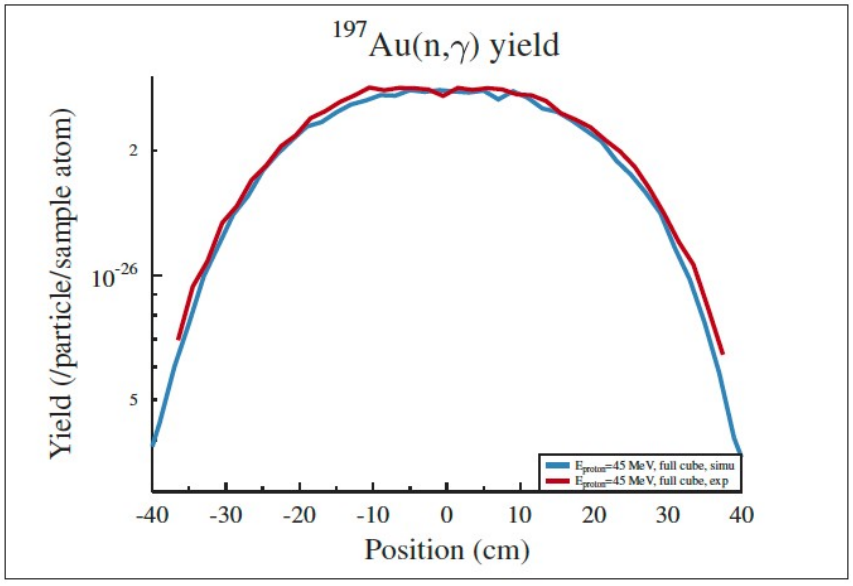

Fig. 1. Preliminary simulation (blue) and experimental (red) yields of Au-197 resulting from (n,γ) reactions at TAMU. Figure courtesy of Rene Reifarth, LANL [2].

function of position in the moderator. The normalization is a free parameter, and the shape of the curve provides a check of the moderator model. The result for the (n,γ) reactions using the full cube at 45 MeV is shown in Fig. 1, with striking good agreement. Agreement is observed in preliminary analysis of the other reactions, other beam energy, and other moderator configuration. Publication in peer-reviewed journal is anticipated. The moderator model is accurate and can play a reliable role in the development of a neutron target.

[1] Rene Reifarth *et al.*, PRAB (Phys. Rev. Accel. Beams) **20**, 044701 (2017).
[2] R. Reifarth (private communication).