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^{148}Gd PRODUCTION CROSS SECTION MEASUREMENTS FOR ACCELERATOR TARGET FACILITIES

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In a series of experiments at LANSCE's WNR facility, ^{148}Gd production was measured for 600- and 800-MeV protons on tungsten, tantalum, and gold. These experiments used 3 μm thin W, Ta, and Au foils and 10 μm thin Al activation foils. Spallation yields were determined for many short-lived and long-lived spallation products with these foils using gamma and alpha spectroscopy.

The production of ^{148}Gd by 800-MeV protons on thick tungsten targets is of great importance to spallation neutron facilities at LANSCE (WNR's target 4 and MLNSC's target 1), because of the limits placed by DOE on the acceptable ^{148}Gd inventory allowed in the target before requiring the facility to be defined as a "nuclear facility." Allowed isotopic inventories are particularly low for this isotope because it is an alpha-particle emitter. The activity level of ^{148}Gd is small, but it encompasses almost two-thirds of the total dose burden in the LANSCE facilities based on present yield estimates.

The upper tungsten target at the Lujan Center and Target 4 at WNR are both approximately 7 cm in length. An 800-MeV proton loses approximately 200 MeV energy in passing through these targets, thus exiting with an energy of approximately 600 MeV. Given that DOE limits the amount of ^{148}Gd production, a better understanding of the true production rate in tungsten targets was needed. This is the motivation for measuring the cross section at 600 and 800 MeV.

Its inventory is difficult to deduce in a thick target because ^{148}Gd decays only by alpha-particle emission with no associated gamma ray emission. A radiochemistry analysis, done as part of the Accelerator Production of Tritium Project decay heat experiment, measured the number of ^{148}Gd atoms in the center of three tungsten foils irradiated with 800-MeV protons [1-2]. Assuming that the isotope is only produced within the beam spot, a cross section of 16.40 ± 0.41 mb is calculated. A theoretical estimate by the CEM2k code is 18 mb [3]. Our recent yield measurements determined using alpha spectroscopy for irradiations at 600 and 800 MeV will be presented.

Another spallation product created by proton irradiation of tungsten is ^{125}I. ^{125}I emits a 35-keV gamma-ray and 150-keV beta particle. It is second only to ^{148}Gd to the dose burden for Target 4 at WNR. Efforts to measure this isotope using planar detectors have been undertaken.

From a basic nuclear physics standpoint, the ideal strategy would be to measure spallation cross sections for each tungsten isotope. However the cost of isotopically pure tungsten foils is currently cost prohibitive. An alternative was to find a mono-isotopic element close to that of tungsten (Z=74). Tantalum (Z=73), which is 99.988% ^{181}Ta, provides a good alternative for testing the physics models used at these energies. In addition, tantalum is used as target cladding material at KENS (Japan) and ISIS (United

Kingdom) spallation neutron source facilities. These facilities operate at 500 MeV and 800 MeV, respectively. By measuring production from Ta, nuclear physics codes can apply these cross sections with production cross sections from elemental W, to gain a better understanding of production rates from W isotopes, and help evaluate dose burdens at other spallation neutron source facilities.

Several other measurements of spallation product yields exist for 800 MeV protons on W and Au foils [4-6]. Gold, a monoisotopic element (Z=79), is also of interest to the Spallation Neutron Source project because of its proximity to mercury (Z=80), a candidate target material. Results from W and Au will be compared to these benchmarks to validate the present work.

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