Neutron-induced proton production from carbon at 175 MeV

Masateru Hayashi[1], Yukinobu Watanabe[1], Riccardo Bevilacqua[2], Jan Blomgrem[2], Leif Nilsson[2], Angelica Öhrn[2], Michael Österlund[2], Stephan Pomp[2], Alexander Prokofiev[3], Vasily Simutkin[2], Pär-Anders Söderström[2] and Udomrat Tippawan[4]

[1]Department of Advanced Energy Engineering Science, Kyushu University, Kasuga, Fukuoka, 816-8580, Japan
[2]Department of Neutron Research, Uppsala University, Box 525, SE-751 20 Uppsala, Sweden,
[3]The Svedberg Laboratory, Uppsala University, Box 533, SE-751 21 Uppsala, Sweden,
[4]Fast Neutron Research Facility, Chiang Mai University, P.O.Box 217, Chiang Mai 50200, Thailand
Email: teru@aees.kyushu-u.ac.jp

Recently, there have been increasing nuclear data needs for neutron-induced light-ion production at intermediate energies (20 to 200 MeV) for various applications related to neutron transport and dosimetry for radiation safety and efficiency calculation of neutron detectors. To satisfy these needs, a series of experiments were performed successfully for several targets at 96 MeV using the quasi mono-energetic neutron facility at the The Svedberg Laboratory (TSL) in Uppsala. Afterward, the facility was upgraded toward measurements using more intense neutrons with higher energies.

In the present work, we have measured double-differential cross sections for proton production from carbon induced by 175 MeV quasi mono-energetic neutrons using the MEDLEY setup at the new TSL neutron beam facility. The MEDLEY setup consisting of eight three-element telescopes has been upgraded so as to detect light ions with energies up to 180 MeV. Each telescope has two silicon surface barrier detectors (either 50 or 60 μm thick and 23.9 mm in diameter for the first one, and either 1000 μm thick and 23.9 mm in diameter for the second one) as ΔE detectors and one CsI(Tl) detector (100 mm long and 50 mm in diameter) as E detector. The use of the ΔE-ΔE-E technique results in good particle identification over an energy range from a few MeV to 180 MeV. The response of new CsI(Tl) scintillator for protons has also been investigated in order to correct reaction-loss effect.

The present measurement is used for benchmarking high-energy nuclear data libraries (JENDL/HE-2004) employed in neutron transportation calculations. Also the measured data, together with experimental data of proton-induced reactions on carbon at 150 and 200 MeV, are compared with the quantum molecular dynamics (QMD) and GNASH calculations. The results of the benchmarking and the preliminary model analysis are reported.