

Analysis of Induced-radioactivity using DCHAIN-SP for Light Nuclei at a Mercury Target Irradiated by 2.8 or 24 GeV Protons

T. Kai, Y. Kasugai, F. Maekawa, S. Meigo, H. Takada, Y. Ikeda,

Japan Atomic Energy Agency

Reliability estimation was carried out on a radioactivity calculation code system consisting of PHITS, MCNP/4C and DCHAIN-SP 2001 by analyzing an activation experiment, which was performed by using AGS (Alternative Gradient Synchrotron) accelerator at Brookhaven National Laboratory. In the experiment, a cylindrical mercury target having hemispherical head was bombarded with 2.83- and 24-GeV protons, and 13 kinds of samples were irradiated on top and side surfaces of the mercury target. At the top surface of the target, the samples were irradiated with the incident protons and spallation neutrons. Those on the side surface of the target were mainly irradiated by spallation neutrons. After the irradiation, the radioactivity of each sample was measured by using HPGe detectors at the cooling time between 2 h and 267 d. The number of protons injected to the mercury target and the samples on the top surface were determined by an integrating current transformer (ICT) and an activation method using a copper foil, respectively. As for the activation method, the $\text{Cu(p,x)}^{24}\text{Na}$ reaction was adopted as a reference. Experimental results for boron-10, boron-11, carbon, aluminum, iron and copper samples are discussed in this presentation.

In the analysis, the calculation model included the mercury target, a target container of stainless steel, all samples and concrete walls of the irradiation room. Proton beam profile was assumed to be a Gaussian distribution which was measured parameters of a full width at half maximum (FWHM) and the center of proton beam. For each sample, proton spectrum was calculated by PHITS, and neutron spectrum was obtained by PHITS (>20 MeV) and MCNP/4C (<20 MeV). Using the proton energy spectra and the neutron energy spectra above 20 MeV, nuclear production yields were calculated by PHITS. DCHAIN-SP calculated the radioactivity of the samples by using the nuclear production yields and the neutron energy spectra below 20 MeV. For the samples on the top surface of the mercury target, the proton energy spectra were normalized to the number of protons obtained by the activation method using the copper foil. The proton energy spectra of the samples on the side surface and the neutron energy spectra were normalized to the number of incident protons measured by ICT.

Comparisons between the calculated results and the measured radioactivity will be presented.