Nuclear Data relevant to the radiological safety of the proton accelerator

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1. Introduction

Nuclear data play an important role in assessing the radiological environmental impact of a proton accelerator, such as:

-prompt radiation fields during accelerator operation;
-radionuclides in the air of the accelerator building,
-radionuclides in the soil and groundwater,
-long lived radionuclides in accelerator components, and
-their possible migration into the environment.

In this work, benchmarks for the prompt radiation field and an evaluation for the air, soil, and ground water activation were performed on currently available nuclear data libraries, namely the ENDF/B High Energy Library (ENDF/B-HE)[1] and JENDL High Energy File[2] (JENDL-HE), for the radiological safety assessment of the high energy accelerator

2. Benchmarks for prompt radiation field

As for the assessment of the prompt radiation field, the NIMROD and TIARA benchmarks [3] calculations were performed using the MCNPX code[1] with different data libraries. In the NIMROD experiment, 7-GeV proton was incident upon the copper target of 10 mm in diameter and 50 mm in thickness. Tunnel was constructed which has a right-angled end at 11 m from the entrance of the tunnel, with a second leg of 8 m long. In the present work, neutron capture cross sections on Au-197 and C-12(n,2n) reaction cross sections were calculated at the locations along the tunnel, for the low energy and high energy neutrons respectively, with MCNPX code using both the JENDL-HE and ENDF/B-HE libraries

The TIARA benchmark consists of a labyrinth of three-legs. The neutron source in the experiment was generated in the thick copper target located in a Faraday cup and irradiated with 68-MeV protons. In the present work, we calculated the neutron dose equivalent rate in the labyrinth using both the JENDL-HE and ENDF/B-HE nuclear data libraries.

3. Nuclear data for air, soil and ground water activation

As for the assessment of the radiological impact of the accelerator to the environment, relevant nuclear reaction cross sections from the two libraries for the activation of the air, soil, and ground water were reviewed and inter-compared together with available measurements. A simple balance model was also set up and applied to estimate sensitivities on the nuclear reaction data to the radiological environmental impact of a proton accelerator.

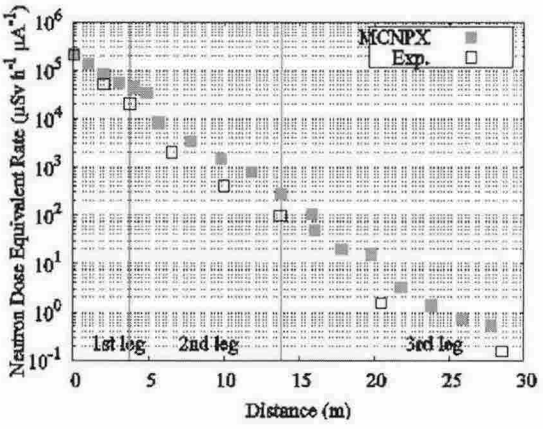

Figure 1. Measured and calculated neutron dose equivalent rate along the labyrinth at TIARA

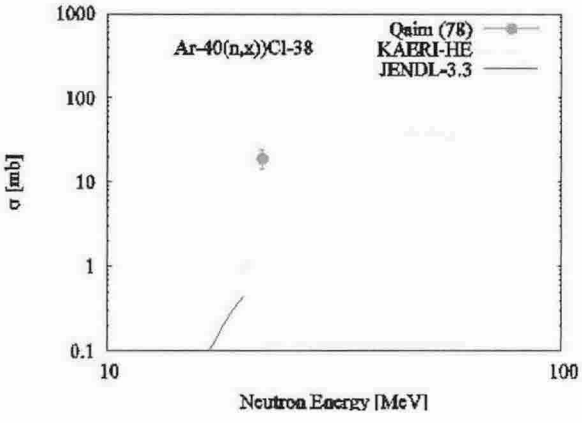

Figure 2. Evaluated tritium production cross sections compared with measurement. The reaction includes tritum, n+d and 2n+p emissions.

REFERENCES

[1] J. Hendricks et al, MCNPX EXTENSIONS VERSION 2.5.0, LA-UR-04-05870, April,
[2] T. Fukahori, JNDC of JAERI, in private communication
[3]NEA-1552 SINBAD ACCELERATOR, shielding benchmark experiments, http://www.nea.fr/abs/html/nea-1552.html