# Nuclear heating calculation for the high flux test module in IFMIF

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The international Fusion Material Irradiation Facility, IFMIF, is being developed by Japan, Europe, USA and Russia under the umbrella of the IEA. A highly-intense accelerator based deuteron-Lithium neutron source has been planned in IFMIF. Conceptual nuclear design of this facility has been done in Forschungszentrum Karlsruhe (FZK) mainly [(1)]. The neutron energy is distributed up to around 50 MeV, therefore the behavior of neutrons with energy higher than 14 MeV should be estimated with sufficient accuracy. For this purpose, several high-energy particle Monte Carlo calculation codes (MCNPX, PHITS, etc.) are now available in combination with recently-released high-energy nuclear data libraries.

We choose the PHITS code[(2)] to develop a neutronics calculation system for the High Flux-Test-Module (HFTM) in IFMIF. As the first step, neutron energy spectrum and nuclear heating over the HFTM are calculated and compared to FZK results in order to examine the applicability of the PHITS code to IFMIF neutronics calculations. The sensitivity of three nuclear data libraries (LA150, JENDL/HE-2004, and NRG2003) to nuclear heating and the validity of KERMA approximation are discussed. Furthermore, we investigate the influence of the d-Li reaction source term on nuclear heating using TTY data of the Li(d,n) reaction measured recently in Tohoku University [(3)].

The configuration used in the present calculation is illustrated in Fig.1. At first, the d-Li source term has been calculated using QMD model in PHITS, but the calculation result is not in good agreement with experimental results. Therefore, we use the energy and angular distributions calculated by the M$^{C}$Delicious code [(1)] as the source term. The neutron spectrum and nuclear heating in the HFTM are calculated with LA150 library to compare the previous FZK result, and good agreement is obtained within 10 %. This indicates that the PHITS code is applicable to IFMIF neutronics. Fig.2 shows the calculations performed with three libraries (LA150, JENDL/HE-2004, NRG2003) to see the dependence of the nuclear data libraries on neutron flux and nuclear heating. The difference in the neutron flux is negligible among three calculations, while the difference in the nuclear heating is rather large (up to 50%). It was found that this is due mainly to the difference in the KERMA factor included in the libraries. Further investigation of the validity of the KERMA approximation and the sensitivity of the d-Li reaction source term will be discussed in our presentation.

**References**

(1) S.P.Simakov, et al., IFMIF neutron source term simulation and neutronics analysis of the high flux test module . Report FZKA 6743, Karlsruhe,2002

(2) H.Iwasa, K.Niita, and T.Nakamura , J.Nucl. Scvi. And Technol.,vol39, pp1142-1151 (2002).

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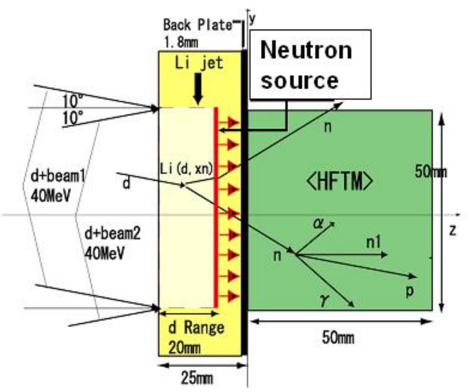
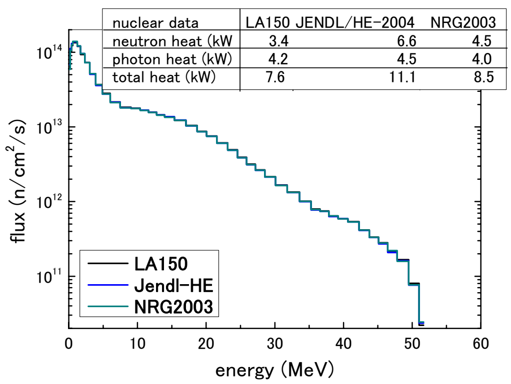



Fig.1 Configuration of the lithium target and HFTM




| nuclear data | LA150 | JENDL/HE-2004 | NRG2003 |
|---|---|---|---|
| neutron heat (kW | 3.4 | 6.6 | 4.5 |
| photon heat (kW) | 4.2 | 4.5 | 4.0 |
| total heat (kW) | 7.6 | 11.1 | 8.5 |

Fig.2 Neutron flux and nuclear heating