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Shielding analysis of ITER/TBM
ITER/TBM遮蔽解析

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Shielding analyses have been performed on the ITER/TBM and its port by using the Monte Carlo radiation transport calculation code MCNP. CAD data were automatically converted to MCNP data on the TBM, shield, pipes, flange and bio-shield plug with a CAD/MCNP conversion code, and the MCNP data were inserted to the ITER 40 degree model. We evaluated the effective dose rate in operation, nuclear heating, tritium production rate, effective dose rate after shutdown and induced activity by using this model.

1. Introduction

In order to test the performance of the breeder blanket in ITER, the WCCB-TBM (Water Cooled Ceramic Breeder Test Blanket Module) and its shield have been being developed by JAEA (Japan Atomic Energy Agency) [1]. The equatorial port #18 of ITER is separated by the frame, and two spaces are prepared for the installation of the TBM in this port. The Japanese WCCB-TBM is installed in one space, and the Korean HCCB-TBM (Helium Cooled Ceramic Breeder Test Blanket Module) is installed in the other space. The WCCB-TBM is about 50 cm in width, 1700 cm in height and 60 cm in thickness. It is composed of Li_2TiO_3 pebble bed layers as the tritium breeder, beryllium pebble bed layers as the neutron multiplier, low activation structural material F82H and cooling water. In order to evaluate nuclear properties of the JA WCCB-TBM and its shield and ensure that the design conforms to the nuclear regulation for licensing, nuclear analyses are performed for the WCCB-TBM and its port.

2. Calculation

The nuclear analysis is performed with the Monte Carlo code MCNP5.140 [2] and Fusion Evaluated Nuclear Data Library FENDL-2.1 [3]. ITER organization prepares the ITER global 40 degree MCNP model, the C-lite MCNP model, for the nuclear analysis. We create the simple CAD data on the WCCB-TBM, shield, flange, pipes, pipe forest structure and bio-shield plug for the nuclear analysis. Figure 1 shows the CAD data of the WCCB-TBM, shield and pipes. Figure 2 shows that of the structure inside the WCCB-TBM. These CAD data are automatically converted to MCNP data with the CAD/MCNP conversion codes GEOMIT [4] and MCAM [5], and the MCNP data are inserted to the C-lite MCNP model.

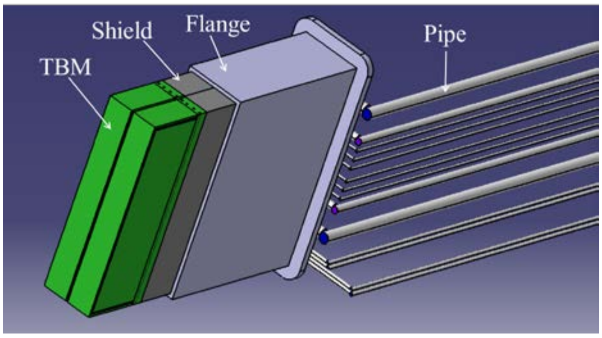

Fig.1. CAD data of the TBM, shield and pipes

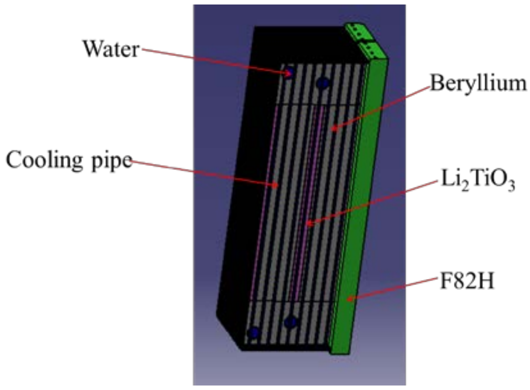

Fig.2. CAD data of the structure inside the TBM

Figure 3 shows the horizontal cross-sectional view of the MCNP geometry on the port #18 with the WCCB-TBM and its shield. Figure 4 shows the enlarged horizontal cross-sectional view of the MCNP geometry around the WCCB-TBM and its shield. Figures 5 and 6 show the enlarged vertical cross-sectional views of the MCNP geometry at the upper and lower parts, respectively. Note that single dog-leg gaps of 7 – 10 mm in width are installed at the boundary between the TBM/shield and frame. In addition, double dog-leg gaps of 15 – 30 mm in width are installed at the boundary between the frame and blanket/vacuum vessel. We evaluate the effective dose rate in operation, nuclear heating, tritium production rate, effective dose rate after shutdown and induced activity by using this model. We present the results in this conference.

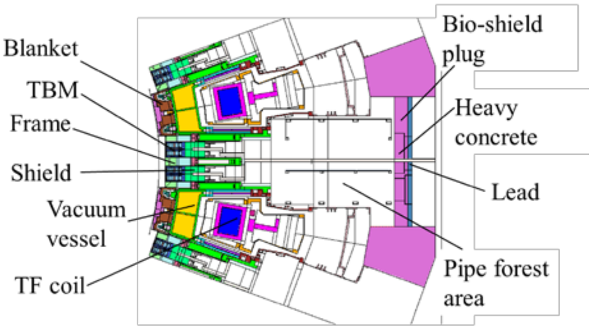

Fig.3. Horizontal cross-sectional view of the MCNP geometry

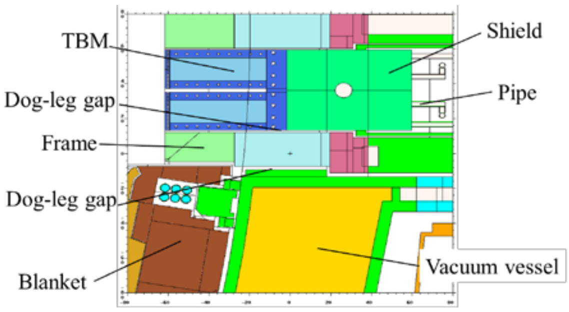

Fig.4. Enlarged horizontal cross-sectional views of the MCNP geometry

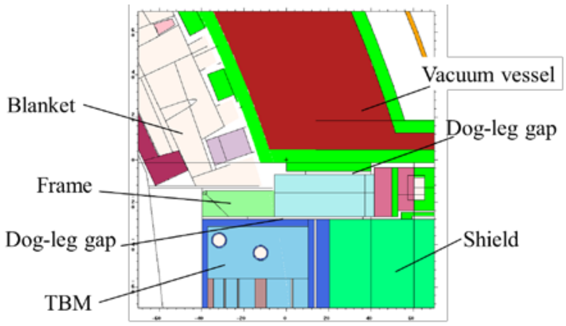

Fig.5. Enlarged vertical cross-sectional view of the MCNP geometry at the upper part

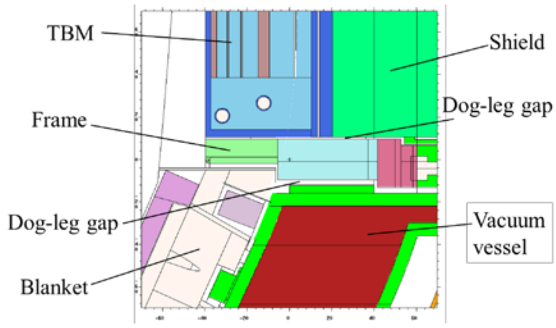

Fig.6. Enlarged vertical cross-sectional view of the MCNP geometry at the lower part

Acknowledgments

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