§37. Radiation Field Estimation for the Diagnostic Components by Monte Carlo Neutronics Calculations with LHD 3-dimensional Modeling

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LHD plans to start the deuterium experiment in the spring of 2017. The deuterium experiment is nine-years campaign, in which the total neutron budget is 2.1 × 10^{19} neutrons for the first six years, and 3.2 × 10^{16} neutrons for the next three years. One of the most important issues of the deuterium experiment is irradiation effect on diagnostics components and control devices. The precise estimation of the radiation (neutron and gamma) field is necessary for responding to the influence of irradiation effects on those components.

Here, we evaluated the radiation field in the LHD torus hall by Monte Carlo neutrons calculation with three-dimensional modeling of LHD. The MCNP Monte Carlo neutronics code (MCNP-6) is used with the cross-section library of ENDF B-VI. In the MCNP calculation geometry, the LHD components within the support structure are divided by small toroidal angle pitch based on the CAD drawing with some simplification as shown in Fig.1, and the components are assumed to be toroidally symmetric in a toroidal pitch angle.

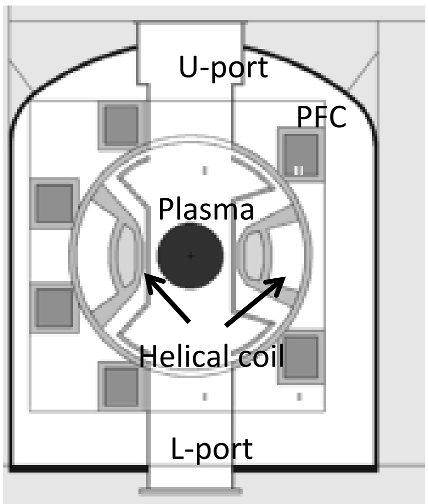

Fig.1 MCNP calculation geometry. LHD was modeled at each 6 degrees toroidal angle pitch.

Three-dimensional maps of neutron and gamma-ray fluxes in the LHD torus hall were obtained. Figure 2 shows the neutron and gamma-ray flux profiles in the torus hall for the neutron yield of 1.9 × 10^{16} neutrons/s compared with the two-dimensional DORT calculation which was done previously for the radiation safety analysis. Neutron and gamma fluxes by MCNP are about 2/3 of those by the DORT calculation where the neutron and gamma fluxes are derived by averaging those fluxes by two cylinder models based on the O-port and the U/L port cross-section without port flanges.

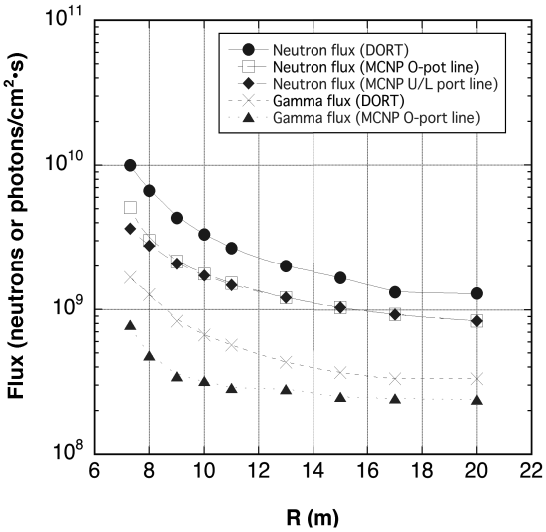

Fig.2 Neutron and gamma-ray flux profiles in the torus hall for the plasma with the total neutron yield of 1.9 × 10^{16} neutrons/s compared with the DORT calculation.

The radiation damage on the electronic devices with high integrated circuits, such as a PLC (Programmable Logic Controller) for diagnostics, and control systems is one of the most urgent issues for the LHD deuterium experiment. Figure 3 shows the profiles of the dose on Silicon, which is a major composition of the electronics devices during nine years of the LHD deuterium experiment. The gamma-ray absorbed dose for Si is 20-70 Gy during nine years of operation [1].

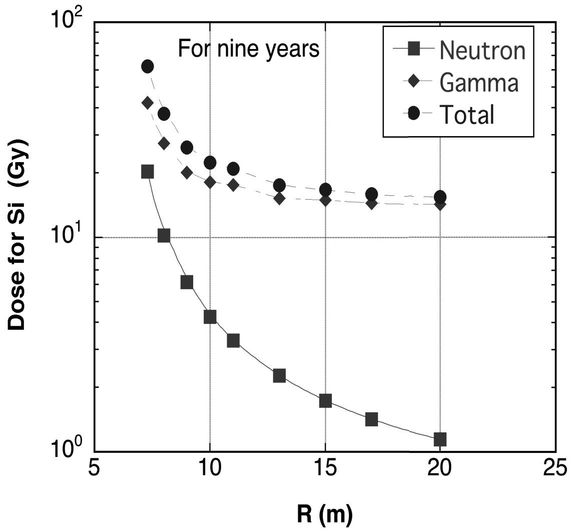

Fig.3 Dose profiles for Si in the torus hall on the mid plane during nine years of the LHD deuterium experiment.

1) Nishitani, T. Ogawa, K., Nishimura, K., and Isobe, M.: Plasma and Fusion Research **11** (2016) 2405057.