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Neutron flux distributions in the LHD torus hall evaluated by an imaging plate technique in the first campaign of deuterium plasma experiment

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In the Large Helical Device, deuterium plasma experiments began in March 2017 and completed in August 2017. In this experimental campaign, about 4×10^{18} neurons were generated and activated components in the torus hall. The concentration of radioactive isotopes in the components in the torus hall must be evaluated to estimate the radiation dose for workers and to plan the decommissioning of LHD.

For this purpose, the global flux distributions for thermal, epi-thermal and fast neutrons in the torus hall of large fusion devices were experimentally evaluated for the first time in LHD using the activation foil method measured by the imaging plate (IP) and High-purity Germanium detector (HPGe). The thermal neutron flux distribution was concentrated within about 15 m from the center of LHD. In particular, the highest flux was observed at the west region underneath the LHD where an un-borated polyethylene blocks. The borated polyethylene blocks, which works as the decelerator of fast neutron and the absorber of thermal neutron, were placed on the floor underneath the LHD except the west region. It turned out that the thermal neutron was effectively absorbed by borated polyethylene blocks placed beneath the LHD. This should reduce the radioactivity of the floor and is beneficial to maintain good environment for radiation workers. The almost uniform distribution of fast neutron was observed just underneath the LHD. The flux of fast neutron near the LHD was about one order of magnitude higher than that of thermal neutron. The region with high fast neutron flux was narrower compared to that of thermal neutron due to the quick energy loss process of fast neutron.

The neutron flux distribution measurement with rough energy discrimination based on the threshold energy of neutron activation foil allows us to estimate the spatial radiation dose rate as well as the radioactivity in components in the torus hall. Therefore, the neutron flux distribution obtained here is conducive to developing the radiation safety in the deuterium plasma experiments comprehensively and to planning the future decommissioning of the LHD.

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