NEUTRONIC ANALYSIS FOR ITER POLOIDAL POLARIMETER

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Neutronic analysis is necessary for design and optimization of diagnostics in ITER. Especially, neutronic analysis onto diagnostics installed in the port plug are very important, because first mirrors of diagnostics which have the optical systems are directly exposed to strong neutron and gamma flux and then it could lead to damage and temperature increase of those components. Design of the neutron shield could affect not only diagnostic components but also bio-shield region and toroidal/poloidal field coils near the port plug. Therefore, evaluation of neutron/gamma flux, spectrum and nuclear heating at and outside the location of the diagnostics with neutronic analysis are essential to design a neutron shield and/or a cooling system. In this paper, results of neutronic analysis applied to the ITER poloidal polarimeter[1] are presented.

The poloidal polarimeter measures the profile of the toroidal current and the safety factor in the core region using multi laser beams. The optical mirrors will be installed in the upper and the equatorial port plug. It must have the labyrinth strucutre to shield neutron/gamma flux and the active mirror cooling system to remove nuclear heating. In order to design the neutron shield system effectively, precise estimations of neutron/gamma fluxes, nuclear heating and dose rate are necessary. In the previous work, the nuclear heating rates of the optical mirrors in the upper port plug were calculated[2] trough neutronic analysis with MCNP code. It was found that the nuclear heating rates of the first mirrors were high (> 1 W/cc), and the neutron shield could reduce this rate only by a factor of 2 ~ 4, because of the effect of streaming neutrons due to an overlap of the beam lines. It was also found that the nuclear heating rate could be reduced by reducing the diameter of the beam. However, the effect of the design of the neutron shield on the outside region of the upper port plug, such as coils and the bio-shield, has not been analyzed, yet.

In this work, the nuclear heating rate of the toroidal and poloidal field coils near the upper port plug was evaluated to investigate whether the neutron shield in the port plug can suppress those heating rate below the allowable value (1 mW/cc) or not. It is found that the nuclear heating rate of the poloidal field coil, that is located above the upper port plug, can be reduced much lower than the allowable value when the neutron shield (SUS 70% and water 30%) is filled in the port plug. The dose rate in the bio-shield region about 10 days after operation shutdown was also evaluated because the dose rate levels after shutdown is very important for hands-on maintenance. The modified MCNP program[3], in which nuclear data libraries were replaced prompt gamma spectra with decay gamma spectra, was utilized in order to evaluate the shutdown dose rate. In this paper, effects of several designs of the neutron shield (structure and material, etc.) of the poloidal polarimeter system on the equipments in the outside region of the upper port plug to decide the optimum design are investigated.

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