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Evaluation of spatial resolution of neutron profile monitor in LHD

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Deuterium plasma experiments in the Large Helical Device (LHD) will begin in March 2017. In LHD, neutrons are mainly generated by interaction between bulk plasmas and beam ions. Therefore, neutron emission profile measurement plays an important role in the understanding of confined beam-ion behavior.
The vertical neutron camera (VNC) has been developed to measure neutron emission profile in LHD. The VNC consists of a multichannel collimator made of heavy concrete embedded in the 2 m-thick concrete floor of the LHD torus hall, fast-neutron stilbene-scintillation-detectors, and the digital-based data acquisition system with high-speed sampling rate of 1 GHz and online/offline neutron-gamma discrimination capability.
The spatial resolution evaluation experiment of VNC was carried out in November. 2016 by using a 252Cf neutron source of 800 MBq. The 252Cf neutron source was introduced into the vacuum vessel through an aluminum pipe from an upper diagnostics port. There were two source positions. One is just on the collimator axis at major radius R=3,450 mm (case A), and the other is in the middle of two neighboring collimator axes at R=3,405 mm (case B). The positons of stilbene scintillation detectors #1, #2, and #3 were located in R=3,360 mm, 3,450 mm, and 4,260 mm, respectively.
In case A, measured neutron count rates of detectors #1 and #2 were 0.0219 cps and 2.45 cps, respectively. Neutron transport calculations using a general-purpose Monte Carlo Neutral Particle code 6 (MCNP6) indicated that the neutron count rate of detectors #1 and #2 were 0.060 cps and 2.3 cps, respectively. Here, efficiency of stilbene detectors for 252Cf neutron has been evaluated to be 0.20 counts/(neutron/cm2) with experiment. In the MCNP6 calculation, the integrated value of flux is calculated in the range of 700 keV-16 MeV, which is evaluated from experimental results in the Fast Neutron Laboratory at Tohoku University. In case B, measured neutron count rates of detectors #1 and #2 were 0.498 cps and 0.542 cps, respectively. In the MCNP6 calculation, the neutron count rates of detectors #1 and #2 were 0.68 cps and 0.61cps, respectively. Thus the experimental results agree well with the MCNP6 calculation. We confirm that VNC has sufficient spatial resolution for study of fast-ion radial transport.

Eligible for student paper award?

Yes

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