§14. Development of MeV Neutron Diagnostic for LHD Deuterium Operation

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On the LHD deuterium operation, 1 MeV triton and 3 MeV protons are mainly created by bulk deuteron and energetic deuteron reactions. Study on a confinement/loss of those MeV ions give us the knowledge to understand the confinement of MeV ions such as alpha particles in a fusion reactor, because the velocity distribution of those ions is isotropic in the velocity space. To study the confinement of MeV ions, we have been developing a triton simulation code, 14 MeV neutron diagnostics, and lost MeV ion diagnostics.

Toward study the confinement of MeV triton, we developed the numerical simulation code based on GNET (Global Neoclassical Transport) code. Calculated emission profiles of 14 MeV neutron caused by MeV triton and bulk deuteron reactions are changed according to electron density (Fig. 1). The simulation predicts that the emission ratio of 14 MeV neutron to 2.45 MeV neutron in LHD is around one order smaller than that in JT60-U.

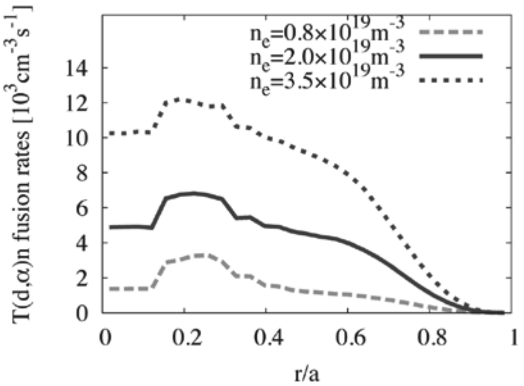

Fig. 1. 14 MeV neutron emission profile calculated by GNET code.

To measure 14 MeV neutron, we designed the scintillating fiber detector by means of PHITS code. We found that scintillation light emission by incident neutron mainly occurs away from a photomultiplier tube coupled to the fiber because of self-shielding effect. Therefore, the transmission characteristic of the scintillating fiber bundle should be improved because it strongly affects pulse heights.

For development of 14 MeV neutron detector such as the fiber based detector and an artificial diamond, 14 MeV neutron source is needed. Unfortunately, Fusion Neutronics Source (FNS) at JAEA, which was used for detector development, do not provide 14 MeV neutron anymore. As an alternative to FNS, we start to setup 14 MeV neutron source at two possible neutron generators: Fusion Neutronics Lab (FNL) of Tohoku University and OKTAVIAN of Osaka University. Toward preparation of a tritium target, we made a deuterium target in collaboration with Toyama University. The deuterium target was used to generate 2.45 MeV neutrons on FNL (Fig. 3). The neutron yield was estimated to be 1.6×10^7. We plan to make a tritium target in next fiscal year.

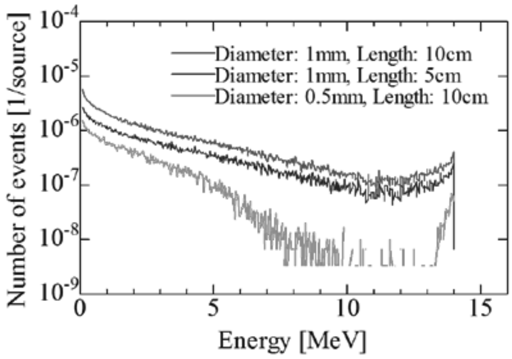

Fig. 2. Distribution of energy deposited by neutron in the scintillating fiber detector.

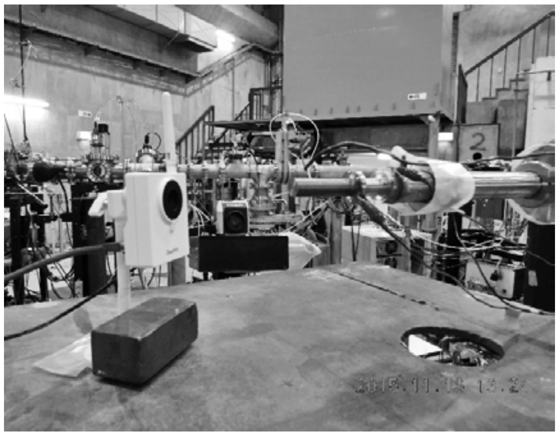

Fig. 3. Experimental setup of DD neutron generation on FNL in Tohoku University.

To get special profile of energetic ion, 3 MeV protons promptly lost from the plasma are plan to be measured. For feasibility study, we used Lorentz orbit simulation to search a possible positon to install the detector. From results of the orbit simulation, we found that the outboard side of the horizontal elongated cross section is one candidate (Fig. 4).

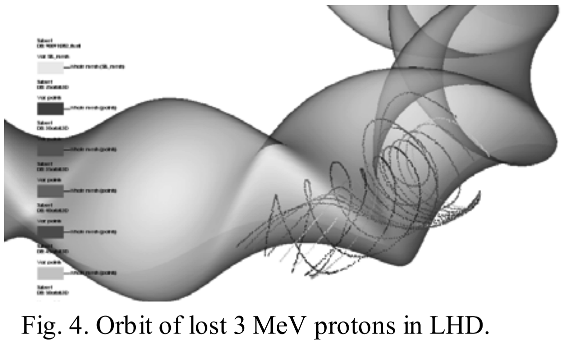

Fig. 4. Orbit of lost 3 MeV protons in LHD.