§18. Effect of Re-entering Fast Ion Produced by NB on the Heating Power Profile and Velocity Distribution Function

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In the LHD, the reactor-relevant high-beta plasmas with the volume averaged beta value, $<\beta>\sim5\%$, are achieved with about 0.5 T[1]. In such LHD high beta plasma, it is shown that most of fast ions produced by tangentially injected Neutral Beams (NB) are "re-entering fast ions" [2], which re-enter in the region of the closed flux surfaces after they have once passed out of the Last Closed Flux Surface. In order to evaluate the heating power profile and the velocity distribution function of fast ions with taking "re-entering fast ions" into account, we have developed the Monte-Carlo code based on the real coordinates (MORH)[2], which use the equilibrium magnetic field calculated by the HINT code[3].

In the LHD, the re-entering fast ion produced by tangential-NB was measured by using a hybrid directional probe[4] in order to validate the MORH and to investigate a behavior of the re-entering fast ion. A comparison of this measurement of "re-entering fast ions" with the MORH results needs to evaluate the heat flux of "re-entering fast ion" to the probe. In the low field such as the LHD high beta discharge, it is important for the comparison to consider the finite Larmor width. Until last year, in order to include the effect of the Larmor movements, the finite Larmor width model (see Fig. 1) was developed and is introduced to MORH with guiding center orbit. In the model, the circle with Larmor radius is calculated for each step of orbit tracings with the guiding center and the "imaginary particles" are assumed on its circle.

To compare of dependence of the heat flux between the MORH and the measurement, the heat flux of fast ions is measured by a hybrid directional probe with change in the magnetic configuration such as the position of the magnetic axis in vacuum. In this measurements, the field strength and the coil pitch is not changed, Bt = 1.0 T and γ =1.254. Figure 2 shows the temperature rise of probe during a discharge. From Fig. 2, the heat flux of fast ions is found to increase proportion to "the position of magnetic axis in vaccum" and the gradient of temperature rise rarely changes regardless of probe position.

In the future, we will compare the calculations of the MORH with the measurements in high beta discharges with the higher field strength. Then, the assumption where fast ions are produced by NB only in the LCFS will be reviewed because some of the fast ions produced outside the LCRF are not promptly lost in the higher field. In addition, the behavior of the "re-entering fast ion" including its charge exchange loss will be investigated.

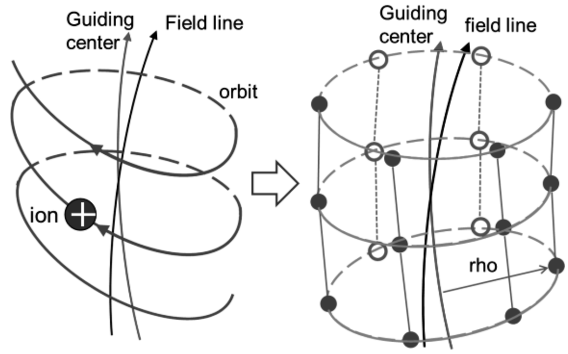

Fig. 1 Finite Larmor width model.

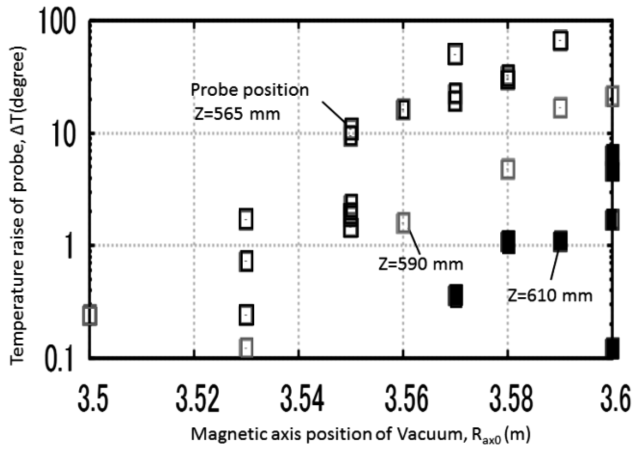

Fig. 2 Temperature rise of probe during a discharge.

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[2] R. Seki, et al., Plasma Fusion Res. **5** (2010) 014.
[3]K. Harafuji, T. Hayashi and T. Sato, J. Comput. Phys. **81** (1989) 169.
[4]K. Nagagoka *et al.*, Rev. Sci. Instrum. 79 10E523 (2008).