§36. Ion Heating Scheme of Ion Cyclotron Heating Experiment in LHD Observed by Code Calculation

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To heat ions directly is a shorter way in comparison with the electron heating in making a fusion reaction. Fast wave heating using ion cyclotron range of frequency (ICRF) has been used for ion heating method as well as electron heating method in the tokamak plasmas. In LHD, fast wave heating will be used for increasing ion temperature. To study the ion heating by fast wave we have calculated using ORION code.

Figure 1 shows frequency dependence of absorbed power. Most of plasma parameters are same as the electron heating scheme. However, concentration of minority hydrogen ion is 3 % in this calculation. In the frequency range from 40 MHz to 52 MHz, the power absorption by minority ions is dominant. Ion absorption is strong in this code calculation. Ion heating is dominant if ion cyclotron resonance layer exists in the plasma. Even if it is electron heating scheme, ion heating is dominant when the cyclotron resonance layer places at plasma core region as shown in Fig.2 in Ref.[1].

Figure 2 shows power deposition profile on flux surface in 44 MHz and 46 MHz. In 44 MHz case, intensive minority ion absorption occurs at the plasma center. Power deposition profile has a center-peaked shape as shown in Fig.2 a). In 46 MHz case, the cyclotron resonance layer is located side by side at the vicinity of plasma center as shown in Fig.1 c) in Ref.[1]. Thus, ion absorption occurs at the off-center region and the power deposition profile also has the maximum value at the off-center range (Fig.2 b)). Power absorption profile at the poloidal plasma cross section shows that the power absorption at the cyclotron resonance layer in front of antenna is stronger than that at the other layer.

In helical system, it is predicted that the high energy ions produced by ICRF heating escape from plasma through helical ripple. In the CHS experiment[2], ion and electron temperature and stored energy start decreasing and radiation loss power increases during radio frequency (RF) pulse. Ion loss flux was measured with ion loss detector during ICRF ion heating. This code calculation shows that the ion heating will occur in relatively wide parameter range. However, confinement of high energy ions is much important to achieve the successful ion heating.

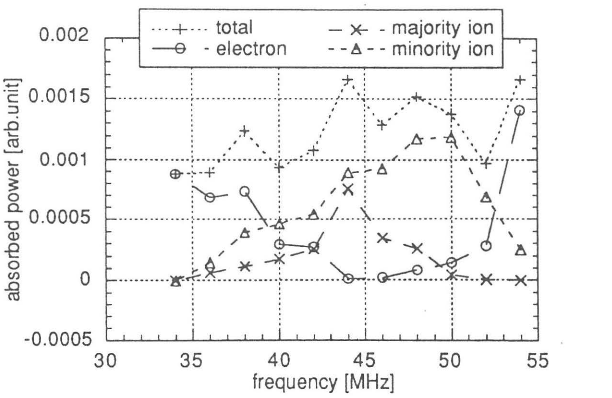

Fig.1. Power absorption dependence on frequency of RF wave.

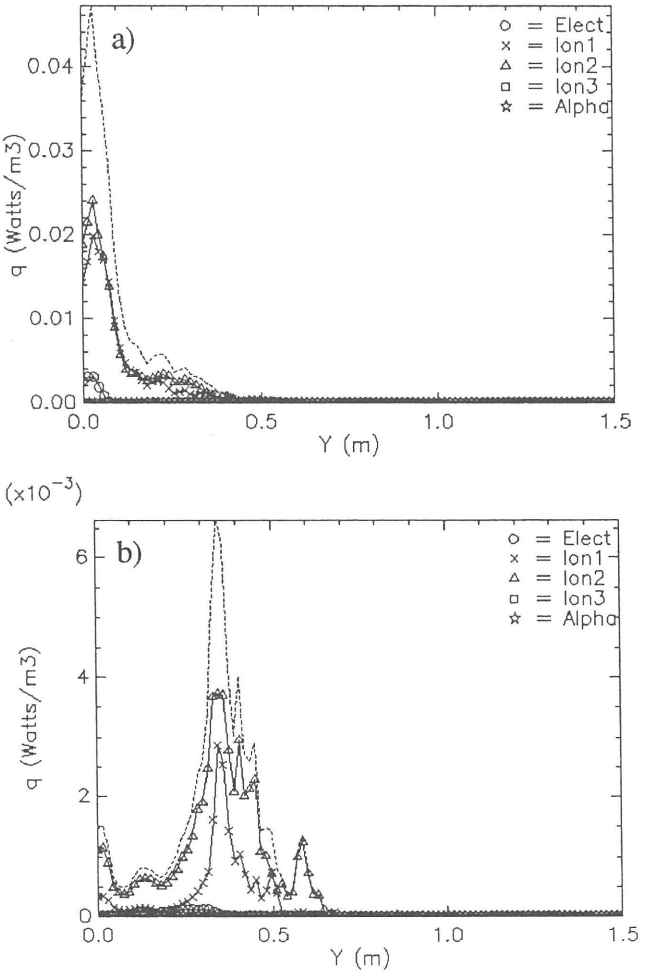

Fig.2. Power deposition profile on flux surface. Frequency of RF wave is; a) 44 MHz, b) 46 MHz.

References
1) Seki, T., et al. : Ann. Rep. NIFS(1996-1997) to be published).
2) Masuda, S., et al. : Nucl. Fusion 37(1997)53.