§24. Modulated ECRH Experiment in CHS

Iwase, M. (Graduate University for Advanced Studies)
Wilgen, J., Rasmussen, D., Lyon, J. (Oak Ridge National Laboratory)
Kumazawa, R., Kubo, S., Idei, H., Ohkubo, K., CHS Group

The amplitude modulated ECRH experiment is carried out in CHS. The ECE (electron cyclotron emission) signal is measured to investigate the response of the electron temperature at several points along the horizontal direction. The incident power from 2 gyrotrons of 53.2 GHz of ECRH is focused at the center of the plasma. The output power of each gyrotron are 100 kW (Varian tube) and 400 kW (Russian tube) respectively. During the modulation experiment, the central electron temperature and density are 1.0 keV and 1.5×10^{13} cm^{-3} respectively. The magnetic field at the center of the vacuum vessel is 1.76 T, and the second harmonic electron cyclotron frequency is about 70 (at edge) ~ 110 (on axis) GHz. The modulation frequency of ECRH heating is 0.2~1.0 kHz. The modulated amplitude of ECRH input power is varied from 10 to 100 % of Varian tube.

The absorbed power deposition profile by electrons is derived from the power balance analysis. ECE signal is calibrated by the electron temperature profile measured by Thomson scattering. The time derivative of ECE signal at the time of turn off of the modulated power is used to derive the absorbed power by electrons. It is assumed that the density variation is negligible.

The derived absorbed power deposition profile of the 100 % modulation is shown in Fig.1. The absorbed power density profile shows that the power is mainly absorbed at the center region of the plasma. The integrated power becomes about 70 kW. The result of the 10 % modulation experiment is shown in Fig.2. This figure shows the absorbed power density profile has a peak at the center and the total absorbed power is about 7kW. Both results indicate about 70 % of the input power is absorbed by electrons.

The critical issue in deducing the power deposition profile is the adiabatic time within which the diffusion effect is negligible. It determines the time scale to calculate the time derivative of the ECE signal. To estimate this adiabatic time, eq.(1)

$$\tau(r) = \frac{W_e(r)}{\chi_{PB}\left\{\frac{P(r)}{\chi_{PB}} - \frac{\partial}{r\partial r}\left(r\frac{\partial W_e(r)}{\partial r}\right)\right\}} \qquad (1)$$

derived from the power balance equation is used. In Fig.1 and 2, the time scale of analysis is 100 μs. The adiabatic time becomes about 2~5 ms at $\rho \geqq 0.3$, but in the center region it is shorter than 100 μs. To get the power deposition profile correctly, it is better to make the sampling time of the data more shorter. The technic to reject all sorts of noises is also necessary for the precise analysis of time derivative of ECE signal.

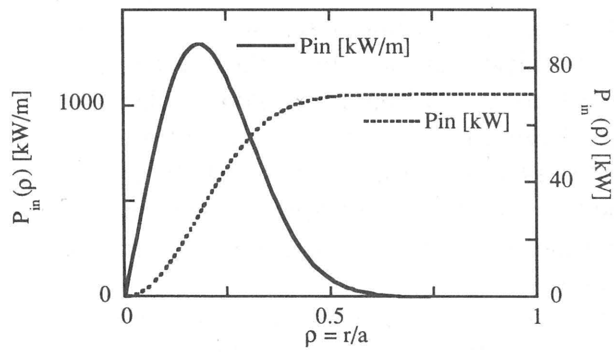

Fig. 1 Electron power deposition profile of 100 % ECRH modulation experiment.

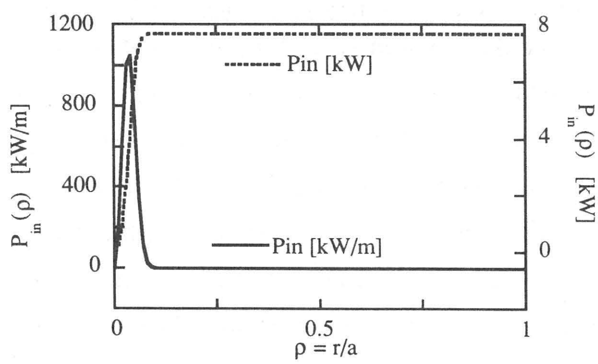

Fig.2 Electron power deposition profile of 10 % ECRH modulation experiment.