§11. Control of Power Deposition Profile by ECH Polarization Scan

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To control the electron power deposition profile, the polarization of the microwave beam of 53.2 GHz is varied from O-mode to X-mode. Those two modes are defined by the angle θ between the direction of the oscillating electric field and that of the magnetic field at the plasma surface where the microwave beam is injected. The fundamental ECH experiment with amplitude modulation is carried out to investigate the power deposition profile. In the case of B_t = 1.7 T, one path absorption is rather high at O-mode and that at X-mode is negligible. So the dependence of the power deposition profile on the polarization is determined by θ.

During the polarization scan, the change in the electron temperature profile is observed with YAG Thomson scattering measurement as shown in Fig. 1. The profile is more peaked for O-mode heating, and it broadens for X-mode one. It is clear that the focused power of O-mode beam in the center region brings about these different temperature profiles. This change of the temperature profile is attributed to the change of the deposition profile.

The power deposition profile $p(r,\theta)$ is expressed as the addition of the power absorption $p_1(r)$ by the first path of the microwave and the secondary absorption $p_2(r)$ after the multi reflection at the vessel wall. In the case of negligible loss at the wall, the total absorbed power is kept constant and only the deposition profile changes, because the same input power is operated during the polarization scan. The deposition profile $p(r,\theta)$ is written as the square function of $\cos\theta$;

$$p(r,\theta) = \alpha p_1(r)\cos^2\theta + \left(1-\alpha\cos^2\theta\right)p_2(r) \qquad (1)$$

where, α is the ratio of the total first path absorption to the total input power. The variable $p(r,\theta)$ is normalized so as to be unity for the integration during the plasma volume. The variables of $p_1(r)$ and $p_2(r)$ are also normalized as $p(r,\theta)$, and correspond to the probabilities of the absorption by the first path and the multi reflection, respectively.

The results of analyses and calculations are shown in Fig.2. With regard to the polarization dependence of the deposited power, the values at the center region (r=3.2 cm) is compared for polarizations, because the drastic change of the absorption power is expected only in the center region. The calculated results fall in 90 % confidence interval of analyzed data.

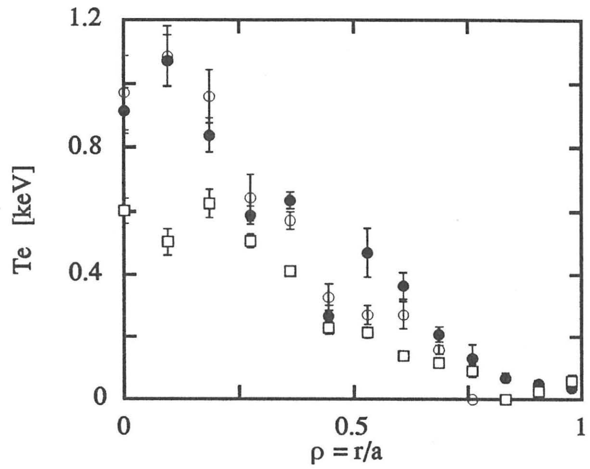

Fig.1 : Electron temperature profile for various polarizations. Open circles (○), closed circles (●) and squares (□) show electron temperatures for θ = -14, -44 and +76 degree, respectively.

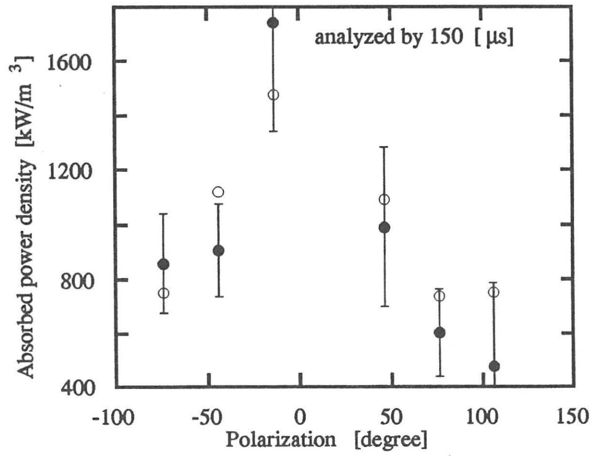

Fig.2 : Absorbed power density at r=3.2 cm for several polarizations. The open (○) and closed circles (●) show results from the calculation and the power balance analysis, respectively. Error bars indicate 90 % confidence interval.