§12. Statistical Estimation of Electron Power Deposition Profile by Power Balance Analysis

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The electron power deposition profile is usually derived from ray tracing for ECH experiments. However, it does not always give real phenomena that happen in the plasma. To know the actual absorption power by electrons, the experimental investigation is the best way. For this, the power balance analysis is done with statistical treatment of experimental data. The ECH experiment with amplitude modulation is carried out and the power balance equation[1) :

$$\left.\frac{\partial W_e}{\partial t}\right|_{t=0+\epsilon}^{t=0-\epsilon} = \Delta P_{in}(r) - [\nabla \cdot \Gamma_e(r) - Q(r)]_{t=0+\epsilon}^{t=0-\epsilon} \quad (1)$$

is solved to obtain the power deposition profile. Here, W_e is the electron stored energy, $\Delta P_{in}(r)$ is the modulated input power and $\Gamma_e(r)$ is the outward energy flux by electrons. The net power density, $Q(r)$, includes the heat sources and sinks other than the modulated part of the input power. To get a fast response of the local electron temperature, the multi-channel ECE diagnostic is used.

In the analysis the confidence interval is derived by statistical treatment of ECE signal. To check the obtained deposition profile from the analysis, results from the ray tracing calculation combined with the multi reflection effect are utilized. With the plasma conditions considered here, one path absorption is not enough to neglect the multi reflection effect.

The analyzed and calculated power deposition profiles are shown in Fig.1. The error bars of data plots indicate the statistical confidence interval of 90 %. Both results fit well when the one path absorption of the input power is set at 45 % in the calculation.

To evaluate the dependence of the results from the power balance analysis on the time interval ϵ in equation (1), the regression analysis is done for various ϵ. The result is shown in Fig. 2. This figure apparently says the analyses with various time scales give different results. In Fig. 2, the time scale of 150 μs seems adequate enough to estimate the power deposition free from diffusive effects, because the 90 % confidence interval for both 100 μs and 150 μs overlaps considerably, but that for 150 μs is rather small.

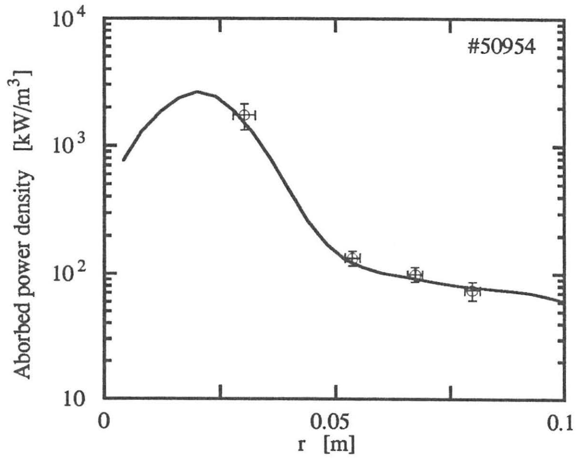

Fig.1 : Electron power deposition profile with confidence interval. Open circles (o) show the profile derived from the power balance analysis and the calculated deposition profile is shown as the solid line.

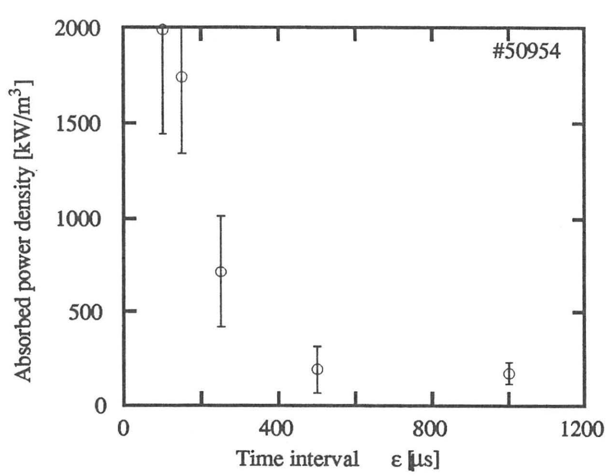

Fig.2 : Absorbed power density for various ϵ at $r = 3$ cm. The open circles (o) show the profile derived from the power balance analysis.

References
1)M. Iwase, S. Kubo, R. Kumazawa, H. Idei, K. Ohkubo, et al.: 6th Int. Toki Conf. *Transactions of Fusion Technology* Vol.27 (1995) 248