§75. Analysis of Plasma Current Driven by Electron Cyclotron Waves

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Electron Cyclotron Current Drive (ECCD) experiments has been begun to investigate the effect of generated local current to MHD activities and plasma confinement in the LHD. The power deposition in the oblique injection (finite parallel refractive index $N_{//}$) for the ECCD experiment was evaluated using a ray tracing code developed and modified at NIFS. Figure 1 shows the power deposition of a pencil beam in a second harmonic ECCD scenario at the magnetic field of 1.5T. The power was deposited in the central region ($\rho \sim 0$). The finite Larmor radius effect in the thermal Maxwellian plasma was taken into account in the calculation. The central electron temperature was 2.5 keV. In plasmas with higher electron temperature, some relativistic effects should be included properly.

The ECCD experiments in the Lower Hybrid Current Drive (LHCD) plasma were conducted in the TRIAM-1M tokamak[1]. In the LHCD plasma, fast electrons were generated by the LH wave. The EC power deposition was evaluated using a TASK/WR code[2], including the relativistic effect. To evaluate the power deposited to the fast electrons, the velocity distribution function of the fast electrons was assumed here. The parallel and perpendicular electron temperatures for the forward fast electrons generated by the LH wave were 100 keV and 40 keV, respectively. The peak value of $N_{//}$ at the LH launcher was 1.8, and thus, the maximum parallel energy by the LH wave was 103keV. For the backward fast electrons, both the parallel and perpendicular electron temperatures were 40 keV. The bulk electron temperature was 0.7keV. The fast electron component, which explained the observed plasma current, was 3.7%. The ratio of the density of the backward electron to that of the forward electron was 0.66. Figure 2 shows the ray trajectories and the deposition power density profile for the fundamental O-mode injection with $N_{//} = 0.22$. Multiple rays in the ray tracing were radiated as parallel rays from equal-area 64 segments in the radius of 1.5 times the beam size at the antenna output aperture. There was 99.5 % power of the beam in the radius. The total single absorption rate was 0.35, and the rest was absorbed by multiple wall-reflection effect. The uniform deposition power density due to the multiple reflections is also shown in the figure.

The TASK code is rebuilt to be applied to the power deposition analysis of the LHD experiment taking the relativistic effect into consideration. The helical geometry of the LHD will be included into the code. In order to evaluate the power deposition of the injected beam properly, the beam tracing analysis with the TASK code will be conducted in the LHD configuration as well as in the tokamak configuration. Finally, the deposition analysis will be linked to the velocity distribution analysis using Monte Carlo and/or Fokker-Plank codes to evaluate the generated current by ECCD. The TASK code can treat arbitrary velocity distribution functions in general.

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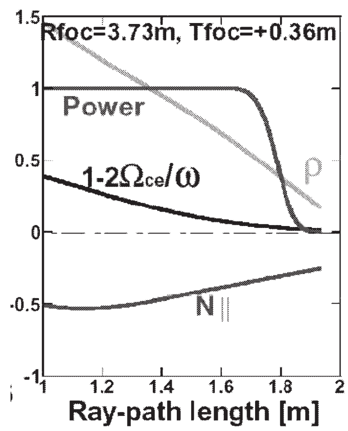

Fig. 1: Power deposition of a pencil beam at a second harmonic ECCD scenario in the LHD experiment.

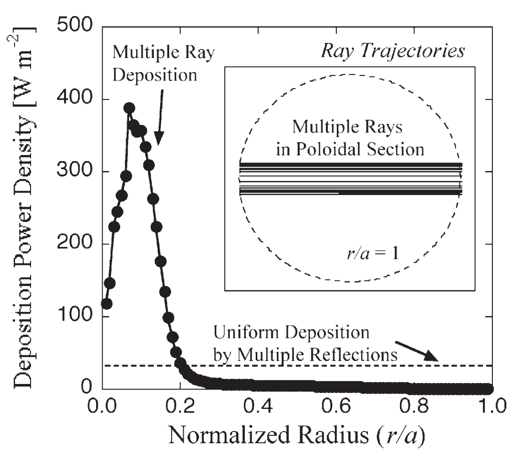

Fig. 2: Ray trajectories and the deposition power density profile for the fundamental O-mode injection with $N_{//} = 0.22$ in the TRIAM-M experiment.

References

[1] Idei, H., *et al.*, Nuclear Fusion, **46**, 489 (2006).
[2] Fukuyama A., *et al.*, Fusion Eng. and Design, **53**, 71 (2001).