§9. Investigation of Spontaneous Toroidal Rotation Excited with Electron Cyclotron Heating in LHD

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Momentum transport and intrinsic rotation/torque attract much attention because of the possibilities of toroidal rotation to control MHD stabilities in tokamak plasmas, and they have been intensively studied in helical plasmas as well as tokamak plasmas. Intrinsic toroidal rotations depending on ion temperature gradient, radial electric field and collisionality have been observed in LHD so far. The response of toroidal rotation to the ECH was investigated for development of external control technique of toroidal rotation. The responses of toroidal rotation to the ECH in the co-direction was identified in the low density regime, and the other response in the counter-direction was also observed in the high density regime.

In the 18th campaign, the ECH modulations were applied to the plasma without any external torque input, and the responses of the toroidal rotation have been investigated. The radial scan of the electron cyclotron resonance position was carried out in the low density regime, which the response pf toroidal rotation to the ECH is expected in the co-direction.

Figure 1 shows the comparison of (upper) the electron temperature profiles and (bottom) the toroidal rotation profile between with and without ECH application. The left-hand side graphs show the results in the case of on-axis ECH (r_{eff_focal} = 0 - 0.1 [m]), and the right-hand side graphs show the results with slightly off-axis case: r_{eff_focal} = 0.05 - 0.2 [m], where the r_{eff_focal} is the averaged minor radus in which the ECH power is mainly deposited. The profile of ECH power density deposited in the plasma calculated by the LHDGAUSS code is also plotted in every graph. In the case of on-axis ECH, the very peaky electron temperature profile was observed and the large response of the toroidal rotation was also observed in the co-direction. In the case of off-axis case, the increase of electron temperature and response of toroidal rotation are smaller than those observed in the on axis case. The responses of toroidal rotation seem to be more widely spread than the responses of electron temperature. The more wide range of radial scan of ECH focal point was performed in this series of discharges, however, these discharges were not included in this analysis because of a problem of ECH operation, which will be re-tried in the next campaign. The response of the micro-turbulence will be also analyzed.

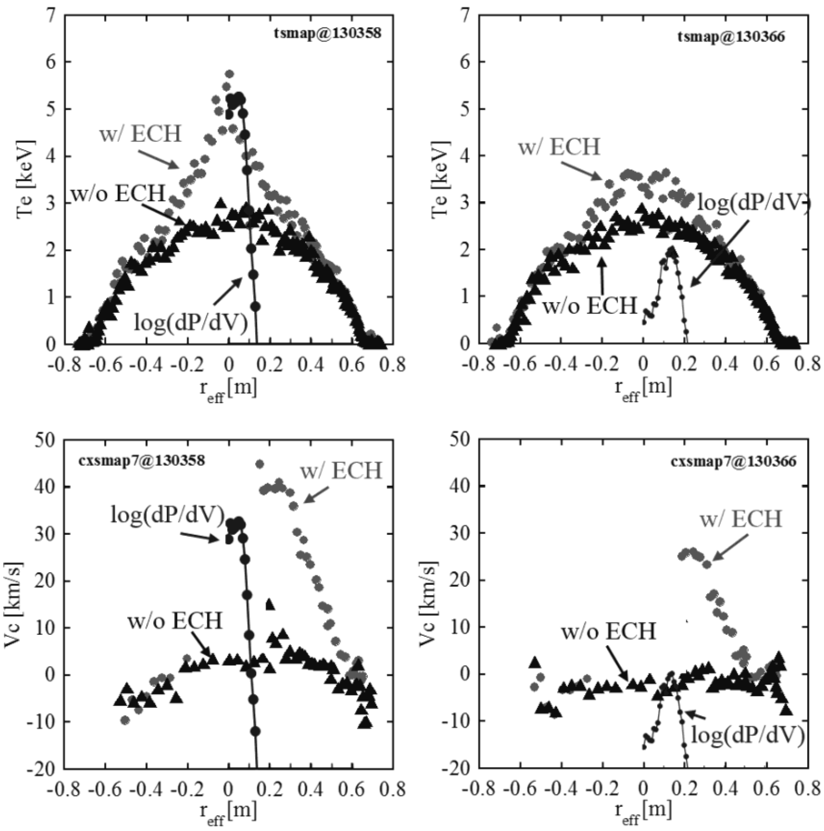

Fig. 1 Comparison of (upper) electron temperature profiles and (bottom) toroidal rotation velocity between with and without ECH application during ECH modulations. (Left-hand side) The on-axis ECH case and (right-hand side) the slightly off-axis ECH case are also compared. The ECH power density profile calculated LHDGAUSS code are also plotted in the graphs in the logarithmic scale.