§21. A Study on Plasma Current of ECH Plasmas in CHS

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The directions of plasma currents vary in some shots in ECH plasmas in which R_{ax}=0.949 or 0.921 [m] in CHS, while ECH power and the microwave injection direction are almost same and the other plasma parameters have similar time histories. Here R_{ax} is the major radius of the magnetic axis.

We surveyed dependence of plasma currents on R_{ax} as one of ways to clarify the characteristic of plasma currents of ECH plasmas in CHS (figure1). The figure shows that currents tend to flow in co<counter>-direction as the magnetic axis is shifted inward<outward>. The currents do not depend on the microwave injection direction, thus they are not currents driven directly by the microwave. So we have estimated a bootstrap current(BSC) with the calculation code[1].

Figure 2 shows profiles of geometric factors(G) for two collisionality regime limits(1/ν and plateau) in cases of R_{ax}=0.888, 0.921 and 0.949 [m]. They indicate that even if electron density (n_e) and electron temperature (T_e) profiles decrease monotonously in the radial direction, the BSC in the interior region flows in the opposite direction (co) to that(counter) in the outer region. The point G=0 shifts inward as the magnetic axis is shifted outward. Thus the counter direction component of the BSC increases as the magnetic axis is shifted out. This trend agrees with experimental results qualitatively.

We calculated the BSC with T_e and n_e profile shown in figure 3, to estimate the influence of n_e profile on the BSC. In this case electrons belong marginally to the plateau regime near the boundary between the plateau and 1/ν regime. The plasma current is about 1.0kA and the direction is co-direction. The results of calculation are shown in figure 4. It shows the total amount of the calculated current is nearly in agreement with the experimental one. The figures indicate that a little difference in the n_e profiles influences the BSC. And the BSC in the interior region flows in the different direction to that in the outer region. So the direction of the total current possibly changes according to the n_e profile especially in case co- and counter-component of currents nearly match. The difference of the n_e profile probably causes the dispersion of the total amount of current and the reverse of currents in the cases R_{ax}=0.949 and 0.921 as mentioned at the beginning of this report.

We can interpret qualitatively the behavior of the currents in CHS as properties of the BSC. However the BSC is sensitive to n_e profile as mentioned above. The radial electric field also influences the BSC in nonaxisymmetric toroidal plasma. We should investigate more closely on the basis of precise radial profiles of T_e, n_e and potential.

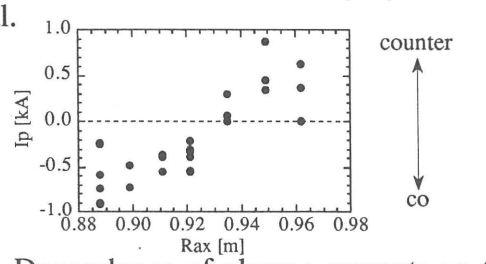

Fig. 1 Dependence of plasma currents on the position of the magnetic axis (R_{ax}).

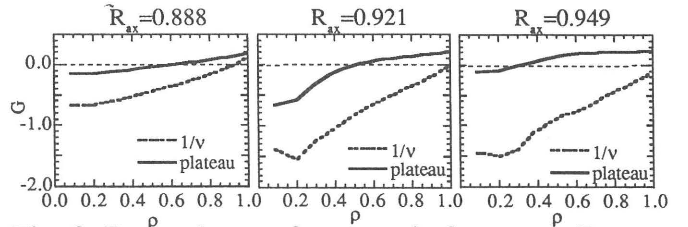

Fig. 2 Dependence of geometric factors on R_{ax}.

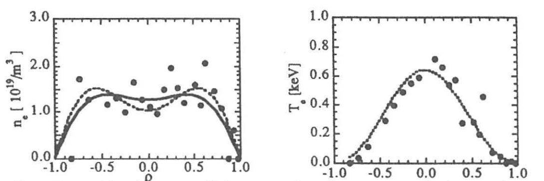

Fig. 3 Radial profiles of electron density and electron temperature. The data fitted to the experiment were used in calculation.

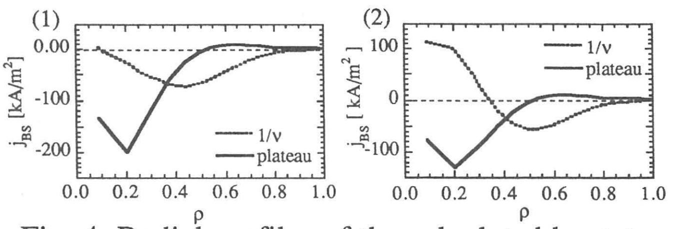

Fig. 4 Radial profiles of the calculated bootstrap current density. The left figure(1) is the result of calculation with peaked n_e profile (solid line in Fig.3) and right one(2) is in the case of hollow ne profile (dashed line in Fig.3). Total current :
(1) -2.91kA(1/ν) ,-1.98 kA(plateau)
(2) -1.30kA(1/ν) ,-1.28 kA(plateau)

1) Watanabe, K.Y., et. al., Nucl. Fusion 35(1995)335