Transport analysis of high-beta plasmas in the inward shifted configurations on LHD

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The transport properties of high beta plasmas on the Large Helical Device (LHD) were studied mainly in the magnetic configurations of the standard (the magnetic axis position in vacuum, $R_{\rm ax}^{\rm vac} = 3.6\,{\rm m}$) or the outward shifted magnetic configurations. In those studies, the experimentally evaluated thermal transport coefficient, $\chi^{\rm exp}$ was compared with $g_{{\rm ren}\chi}^{\rm int}\chi^{\rm ISS04}$, where $\chi^{\rm ISS04}$ is a modeled thermal transport coefficient which has the same non-dimensional parameter dependence of the ISS04 scaling [1] and $g_{{\rm ren}\chi}^{\rm int}$ is a renormalization factor for transport coefficients, which corresponds to $f_{\rm ren}$ in ISS04 and represents the effect of devices or configurations. Thorough this method, the effect of the beta or the gradient of beta were evaluated separately with the effect of the change of the magnetic configuration due to beta mainly at the peripheral region [2].

On the other hand, the inward shifted magnetic configurations of LHD are important for the production of high beta plasmas since the magnetic flux surfaces shift outward with the increment in beta. In the inward shifted configurations of $R_{\rm ax}^{\rm vac} < 3.6\,{\rm m}$, it is predicted that the low-n unstable region appears in the low beta regime in the core region of the normalized average minor radius, $\rho < 0.5$, while such unstable region is not found in high beta regime. As this unstable region is due to the existence of the rotational transform, $\iota\!\!\!-\, = 0.5$, the measurement of ι is important. Therefore, in the recent experiments of LHD, the Motional Stark Effect (MSE) measurement in relatively low magnetic field strength conditions was carried out.

In this study, the thermal transport coefficient, $\chi^{\rm exp}$, at the core region in the inward shifted configurations are evaluated with the TASK4LHD system, where $\chi^{\rm exp}$ is derived based on the power balance in the steady state by TR-snap which is a modification of one module in TASK code [3], TR, by including the 3D equilibrium effect. The first result show that the ratio of $\chi^{\rm exp}/\chi^{\rm GRB}$, where $\chi^{\rm GRB}$ is the gyro-reduced Bohm type coefficient, reduces with beta increment around the volume averaged beta, $\langle\beta\rangle \geq 1.5\,\%$, in the inward shifted configurations. The some of MSE data show the separation of the σ- and π- components even in the condition of the magnetic field strength, $B = 1\,{\rm T}$, where the compatibility of high beta plasma production with the MSE measurement is intended.

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