§3. Transport Analysis of High-Beta Plasmas in the inward Shifted Configurations

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Ideal MHD instability is theoretically predicted in the high-beta plasmas in the inward-shifted configurations of the Large Helical Device (LHD), such as the position of the magnetic axis in vacuum, $R_{\rm ax}^{\rm vac}$, is 3.50 m. In order to evaluate the effects of the predicted instability on the local transport property, transport analysis based on the power balance in the steady state is made for the plasmas with the inward-shifted configurations. In the previous study for the high beta plasmas [1], the beta dependence of the local transport coefficients in the peripheral region were evaluated by comparing with the reference transport coefficient, $\chi^{\rm ISS04}$, which has the same parameter dependence as the ISS04 scaling [2]. The local transport was degraded at the normalized average minor radius $\rho = 0.9$ with the increment in volume-averaged beta, $\langle\beta\rangle$, even when the change of the magnetic configuration by beta increment was considered. The configuration effects were included in a renormalization factor for the local transport coefficients, $g_{{\rm ren}\chi}^{\rm ISS04^{int}}$. The value of $g_{{\rm ren}\chi}^{\rm ISS04^{int}}$ was derived from the results in the low beta region with various $R_{\rm ax}^{\rm vac}$ positions. The same evaluation method is applied for the inward-shifted plasmas in this study.

In the present analysis, the optimal magnetic configuration data for the high beta plasmas are derived based on the spatial profiles of the electron temperature, $T_{\rm e}$, from the database of magnetic configurations which are prepared in advance. The NBI deposition power is evaluated by the Monte Carlo simulation code. The thermal transport coefficients are derived by using TASK4LHD code with TR-snap which is one of the modules of TASK [3] and modified to read the 3D-equilibrium data. The effective transport coefficient $\chi^{\rm eff} = (\chi_{\rm e} + f\chi_{\rm i})/(1+f)$, $n_{\rm e} = fn_{\rm i}$ is used since $T_{\rm i} = T_{\rm e}$ is assumed. Here, $f = 1$ is used in the case of TR-snap.

Figure 1 shows beta dependence of the normalized local transport coefficients, $\chi^{\rm eff}/(g_{{\rm ren}\chi}^{\rm ISS04^{int}}\chi^{\rm ISS04})$, at $\rho = 0.5$ in three different $R_{\rm ax}^{\rm vac}$ positions which are (a) 3.60 m, (b) 3.55 m and (c) 3.50 m. The $\langle\beta\rangle$ region in Fig. 1 (b) and (c) is between 1 % and 2.5 % since the number of plasmas with high magnetic filed strength, $|B|$, in the inward shifted configurations is small. From the results in Fig. 1 (c), the value of $\chi^{\rm eff}/(g_{{\rm ren}\chi}^{\rm ISS04^{int}}\chi^{\rm ISS04})$ in the $R_{\rm ax}^{\rm vac} = 3.50$ m configuration is large in the range of $1 < \langle\beta\rangle < 2$ % and it shows decreasing tendency in the range of $\langle\beta\rangle > 2$ %. Moreover, it is needed to analyze the plasmas in the low beta region in the inward shifted configurations since more wide beta region is required to make clear the beta effects on the transport property.

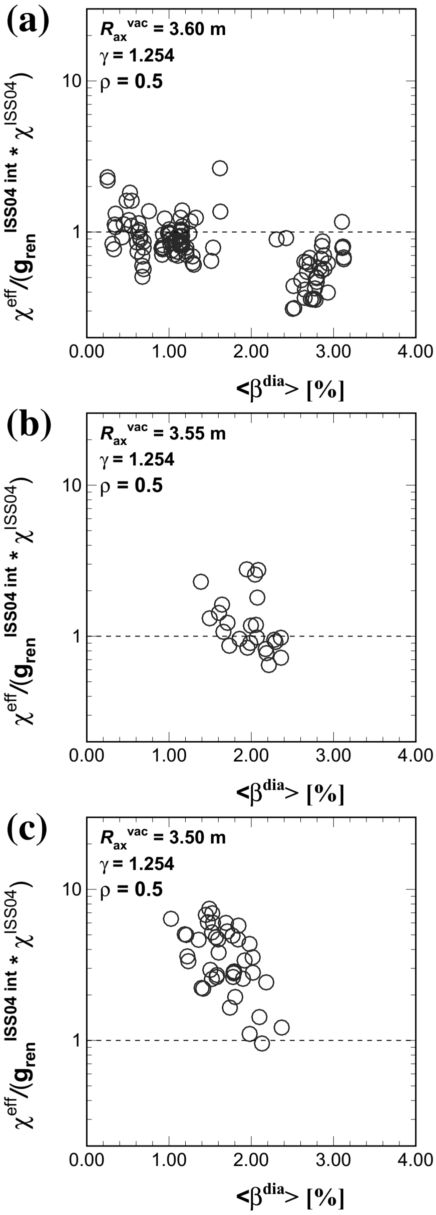

Fig. 1: Beta dependence of the normalized local transport coefficients at $\rho = 0.5$. The reference transport coefficient, $\chi^{\rm ISS04}$, has the same parameter dependence as the ISS04 scaling and the coefficient $g_{{\rm ren}\chi}^{\rm ISS04^{int}}$ contains effects of the change of the magnetic configurations. (a) $R_{\rm ax}^{\rm vac} = 3.60$ m, (b) $R_{\rm ax}^{\rm vac} = 3.55$ m and (c) $R_{\rm ax}^{\rm vac} = 3.50$ m.

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2) H. Yamada *et al.*, Nucl. Fusion **45**, (2005) 1684.
3) A. Fukuyama, *et al.*, Proc. of 20th IAEA Fusion Energy Conf. (Villamoura, Portugal, 2004) IAEA-CSP-25/CD/TH/P2-3.