§10. Local Transport Analysis of High-Beta Plasmas with γ= 1.20

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The dependence of the global confinement and the local transport of high beta plasmas on the magnetic configuration or the volume averaged beta value $\langle\beta\rangle$ has been studied for the LHD plasmas. For the plasmas of $\gamma = 1.254$, where γ is the pitch parameter of the helical coils, the effects of beta and magnetic configuration are evaluated separately in Ref. [1]. Since the high beta plasmas of more than 5 % were obtained in the magnetic configuration with $\gamma = 1.20$, the same method of analysis is applied for $\gamma = 1.20$ plasmas.

Figure 1 shows the $\langle\beta\rangle$ dependence of the ratio of the experimental energy confinement time $\tau_{\rm E}^{\rm exp}$ and the ISS04 scaling value $\tau_{\rm E}^{\rm ISS04}$. The data are limited by the following conditions: $n_{\rm e} \leq 5 \times 10^{19}\,{\rm m}^{-3}$, $I_p/B \leq 30\,$kA/T and $W_b/W_p^{\rm kin} \leq 0.7$, where $n_{\rm e}, I_p, B, W_b$ and $W_p^{\rm kin}$ are the electron density, plasma current, the magnetic field strength, the beam component of the plasma stored energy and the plasma stored energy which is estimated from the density and temperature profiles, respectively. Although the data number of $\langle\beta\rangle < 0.8$ is small, the $\tau_{\rm E}^{\rm exp}/\tau_{\rm E}^{\rm ISS04}$ value shows degradation at $\langle\beta\rangle < 2\,\%$. However, in the range of $\langle\beta\rangle > 2\,\%$, degradation seems to be small. Figure 2 shows the relation between $\langle\beta\rangle$ the major radius of the geometric center position $R_{\rm geo}(\rho)$ of the $\rho = 0.5, 0.7$ and 0.9 magnetic surfaces. The shift of $R_{\rm geo}(\rho)$ at $\rho = 0.9$ is small in the region of $\langle\beta\rangle < 3\,\%$, while the shift in $\langle\beta\rangle > 3\,\%$ becomes large.

The relations between $R_{\rm geo}(\rho)$ and the ratio of the local transport coefficient $\chi^{\rm eff}$ and the transport coefficient $\chi^{\rm ISS04}$ which has the same nondimensional parameter dependence at $\rho = 0.5$ and 0.9 are shown in Figure 3 (a) and (b), respectively. From the comparison of the dependence in the high beta plasmas (●) and in the low beta plasmas with three different magnetic configurations (△ or ○), the degradation of $\chi^{\rm eff}/\chi^{\rm ISS04}$ is almost same as the configuration effect at $\rho = 0.5$. On the other hand, at $\rho = 0.9$, the degradation of $\chi^{\rm eff}/\chi^{\rm ISS04}$ seems to be larger than the degradation by the configuration effect in $\langle\beta\rangle < 2\,\%$. The degradation in the high beta region seems to be small in the case of $\gamma = 1.20$. In order to evaluate the local transport property of $\gamma = 1.20$ plasmas in more detail, data in the region of $\langle\beta\rangle < 0.8$ are required.

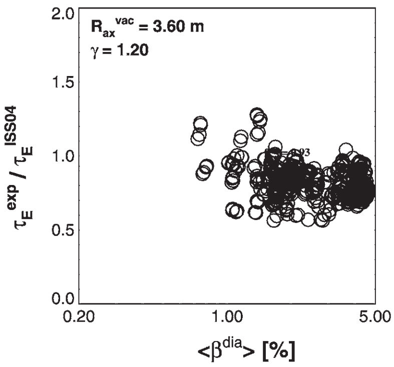

Fig. 1. $\langle\beta\rangle$ dependence of $\tau_{\rm E}^{\rm exp}/\tau_{\rm E}^{\rm ISS04}$ in $\gamma = 1.20$.

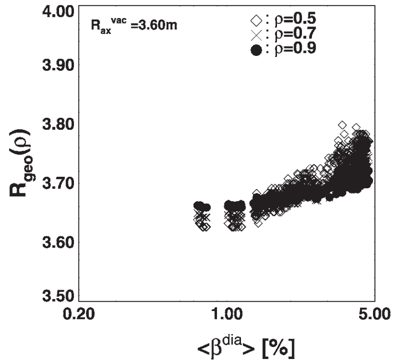

Fig. 2. Relations between $\langle\beta\rangle$ and $R_{\rm geo}(\rho)$ at $\rho = 0.5, 0.7$ and 0.9 in $\gamma = 1.20$.

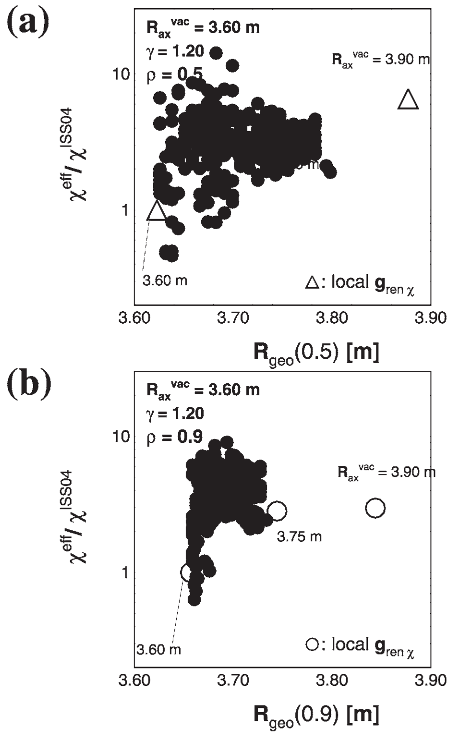

Fig. 3. Relations between $R_{\rm geo}(\rho)$ and $\chi^{\rm eff}/\chi^{\rm ISS04}$ in $\gamma =$ 1.20, (a) $\rho = 0.5$, (b) $\rho = 0.9$.

[1] H.Funaba, K.Y.Watanabe, *et al.*, Plasma Fusion Res. **3** (2008) 022.