§15. Production of High-Beta Plasma

Suzuki, Y., Sakakibara, S.,
Nagasaki, K. (Kyoto Univ.)

In the LHD experiments, the volume beta value <β> achieved to about 5%, where disruptive events did not appear. This suggests the plasma beta does not achieve to the equilibrium beta limit. To show the equilibrium beta limit, the magnetic field structure for high-β plasma was studied by nonlinear MHD simulation codes. In that study, the beta limit is higher than the achieved beta in the experiment then experimental and theoretical consideration are consistent up to now. However, in that study, stochastic field lines of the equilibrium response are appeared due to increased β and the confinement is degraded due to increased stochastization. Since the high-β experiment is done for the low filed, the plasma is low temperature and high density, so-called the collisional plasma. If the plasma changes toward the collisionless regime, the degradation of the confinement due to stochastic field lines will be expected. To aim the production of high-β plasma in the reactor-relevant regime, studying the impact of stochastic field lines to the confinement are urgent and critical issues.

To produce high-β plasma in more collisionless regeme, the magnetic field is increased to 1.0T. Figure 1 shows the achieved beta value as the function of the magnetic field in operations. In the 14th experiment campaign, the diamagnetic beta was achieved to 3.1% for B=1.0T. This was a record in the LHD experiment.

To see the impact of high temperature to the magnetic field, in fig.2, profiles of the electron temperature in the peripheral region are plotted for B=0.425, 0.75 and 1T. The electron temperature T_e on the axis is increased higher than 1keV for B=1T. Comparing three case, differences between B=0.425 and 0.75T are not large for R > 4.5m. However, for B=1T, T_e is about 2 times higher than other cases. This means the parameter range is extended to more collisionless regime. For B=1T, flattening of the plasma pressure is observed clearly than other 2 cases. Especially, in the outside of the last closed flux surface for the vacuum, the pressure gradient is small. In additions, small flattening is appeared in the plasma. We guess flattening is consistent to rational surfaces, where magnetic islands appear due to the plasma response. However, we also observed fluctuations due to MHD instabilities. Thus, we need further studies why flattening profiles appear. For the MHD instability, if the dominant instability is the resistive interchange mode, the resistive interchange mode will be decreased due to decreased the resistivity. Thus, producing higher temperature plasma, we can distinguish flattening profiles made by stochastization of the MHD equilibrium response or instability. Such a study is a future subject.

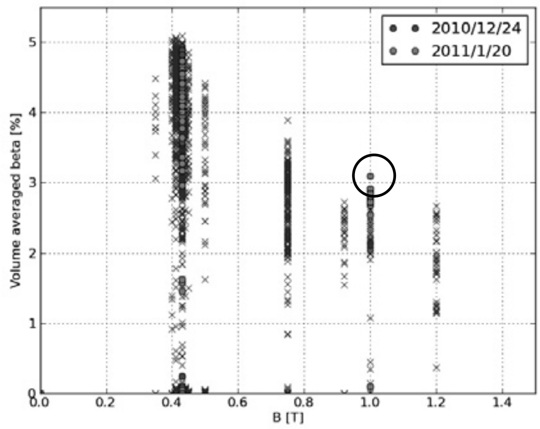

Fig.1 The achieved beta is plotted as the function of the magnetic field. In the 14th campaign, the diamagnetic beta value is achieved to 3.1% for B=1T.

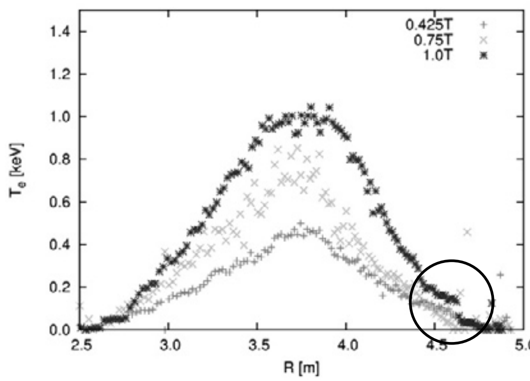

Fig.2 Profiles of the electron temperature in the peripheral region (Z=0 plane) are plotted for B=0.425, 0.75 and 1T.