§12. Production of High-Beta Plasma

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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. However, we also observed fluctuations due to MHD instabilities. Thus, we need further studies how much impact fluctuations have. 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 also an important issue.

To produce high-β plasma in more collisionless regeme, the magnetic field is increased to 1.5T. Figure 1 shows the achieved beta value as the function of the magnetic field in operations. In the 15th experiment campaign, achieved beta values were to 4.1% and 3.4% for *B*=0.75 and 1.0T. This was a record in the LHD experiment.

To see the impact of high temperature to the operation regeme, in fig.2, magnetic fluctuations are plotted as functions of the magnetic Reynolds number and achieved beta value. In fig. 2, points below a dashed line indicate fluctuation date before 14th campaign. If the beta is high, the fluctuation becomes strong. Red circles above the dashed line indicate data in 15th campaign. Tha parameter range is improved than previous campaign. In addition, the fluctuation level decreases due to increased Reynolds number. This means it is a possibility to distinguish the flatten profile driven by changing of the MHD equilibrium or instability. Detailed comparison is a future subject. Now it is ongoing.

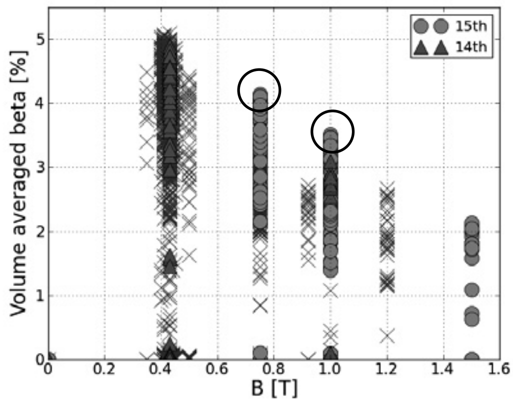

Fig.1 The achieved beta is plotted as the function of the magnetic field. In the 15th campaign, the diamagnetic beta value is achieved to 4.1% and 3.4% for *B*=0.75 and 1T. For a comparison, the achieved beta is plotted before 14th campaign.

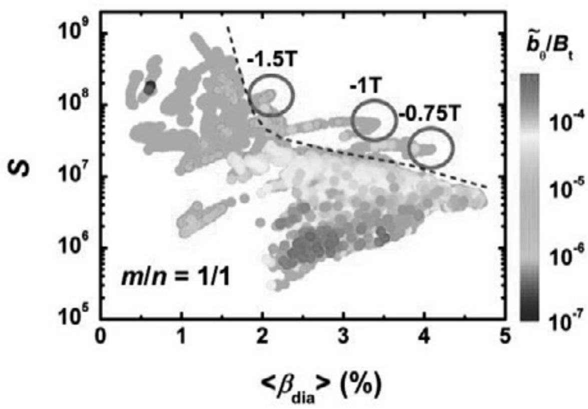

Fig.2 The magnetic Reynolds number is plotted as the function of the volume averaged beta. Plots below a dashed line are obtained data before 14th experiment campaign. Data indicated by red circles is new data in the 15th campaign. Magnetic fluctuations are decreased because the Reynolds number is increased.