§2. Production of the High-temperature High-beta Plasma

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Though the plasma beta as high as 5% has been achieved in LHD, the high-beta plasma in LHD is so collisional that it is possible the reactor plasma behave differently from the present high-beta plasmas. Production of the high-temperature high-beta plasma is thus required to improve the accuracy in the prediction of plasma performance in the reactor-relevant high-beta plasma. In order to evaluate the plasma behavior in high-temperature regime, trials for producing the high-beta plasma with higher magnetic field ($B_t = 1.0$T) are made.

In the 16th campaign, high-beta plasma at $B_t = 1.0$ T was transiently realized in the vertically elongated configuration where the degradation of the heating efficiency is reduced due to the small Shafranov shift. However, the heat load towards the wall is so large in this configuration that the experiment could not be continued before the optimization of the discharge condition. In 17th campaign, optimization of the experimental condition is made where the heat load is reduced by the shorter duration of the plasma. Volume averaged beta 3.69% has been achieved transiently as shown in Fig. 1 with $B_t = 1.0$T.

Detailed optimization of the magnetic axis position is also tried in another small Shafranov shift configurations, where the aspect ratio of the plasma Ap = 6.6. Achieved beta values as a function of the line averaged density are shown in Fig. 2. When the preset magnetic axis position is smaller than 3.6m, pump-out of the plasma density is strong and the high density plasma cannot be produced. It is consistent with the observation that particle confinement degradation in Rax < 3.6m measured by the gas-puff modulation experiments. When the preset magnetic axis is larger than 3.6m, degradation of the beta with the density determines the maximum beta value. From the compromise of both effects, optimal preset magnetic axis position is determined to be about 3.62m and the averaged plasma beta 3.55 % has been achieved. Detailed analysis of the heat deposition profile, the transport analysis and the relation of the transport with MHD activities should be made to interpret these results.

The high-beta plasma has been extended in the high-temperature region. Electron temperature in the magnetic stochastic region increases as well. However, effects of the decrease of the collisionality, especially in the magnetic stochastic region, have not obviously observed. Further confirmation of these characteristics is required with more less collisional plasmas.

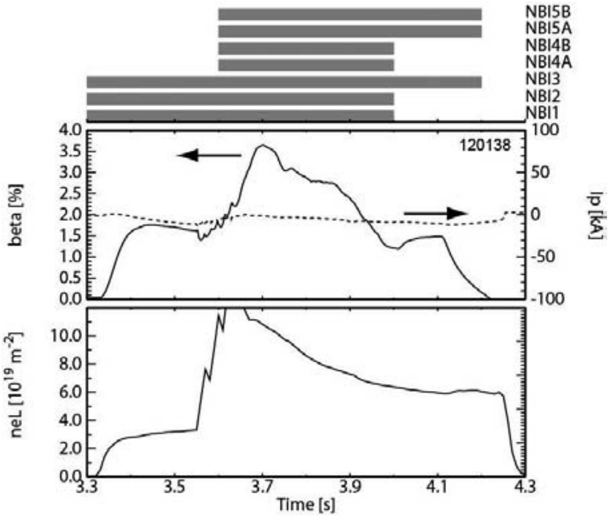

Fig. 1: Time evolution of the beta, the plasma current, the line-averaged density and H_α are shown in the highest beta discharge with $B_t = 1.0$ T.

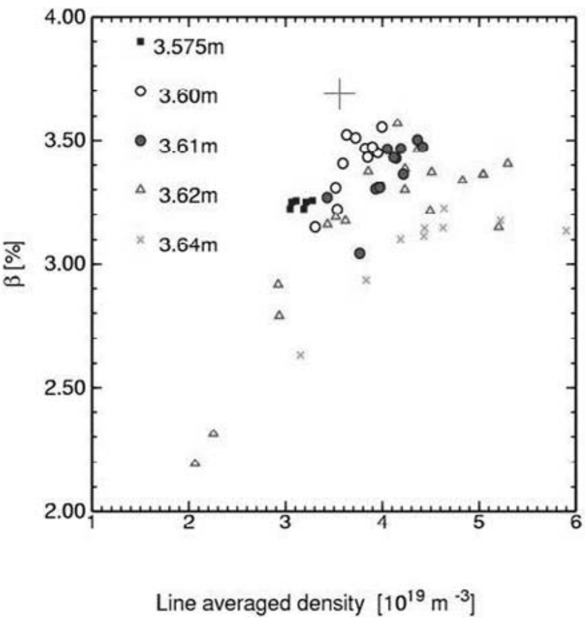

Fig. 2: Achieved beta value as a function of the line averaged density.