§1. Realization of High-β Plasma

Matsuoka, K., Okamura, S., Nishimura, K., Tsumori, K., Akiyama, R., Yamada, H., Torus Exp. Group

Realization of high-β plasma had been one of major experimental objectives in CHS, for which the low aspect-ratio can manifest its advantage. For this purpose the NBI power had been increased by installing the second beam line in March 1992, and the extensive wall conditioning which includes boronization with decaborane $B_{10}H_{14}$ and titanium gettering in between shots was done.

The experiment was done using two neutral beam lines in a balanced injection of which beam power through the port were 1.1 MW (co-inj.) and 0.8 MW (ctr-inj.), respectively. Their injection timings were tried in a variety of manners; delayed injection of the co-beam into the ctr-injected plasma and vice versa. However, the simultaneous injection was employed finally. The magnetic field strength B_t was lowered as low as possible and it was found that B_t of 0.61 Tesla was the optimum to maximize the β value, which means weaker dependence of the energy confinement time on B_t than that of the LHD or gyro Bohm scaling at such a low B_t.

In Fig. 1 the progress in the maximum volume averaged diamagnetic β value $<\beta_{dia}>$ in a day is plotted in this experimental campaign. The daily progress is obtained with a gradual improvement in the wall condition by the intensive titanium gettering. To monitor the plasma performance, the quantities of global radiation power P_{rad} with one-channel pyroelectric detector, H_α intensities around the torus with an eight-channel visible spectrometer, OV intensity with one-channel grazing VUV spectrometer are observed in addition to the stored energy W_{dia}. Usually W_{dia} is closely related to these monitored quantities normalized by the line averaged electron density n_e; W_{dia} improves as these signals decrease, however, when β_{dia} approaches 2% the clear correlation between W_{dia} and these signals disappears. This means that the increase in W_{dia} depends on more localized physical quantities. In Fig.2 the time trace of typical high-β plasma with good reproducibility is shown. Reheat mode, where W_{dia} increases after the turn-off of strong gas puff, is employed in this experiment. The value $<\beta_{dia}>$ reaches 2% at n_e of $6.5 \times 10^{13}cm^{-3}$ at the timing of 155 ms. Deposited NBI power P_{net} is estimated to be 1.4MW. The volume averaged equilibrium β value $<\beta_{eq}>$ is estimated to be 2.1%, which is the highest value realized so far in helical plasmas[1].

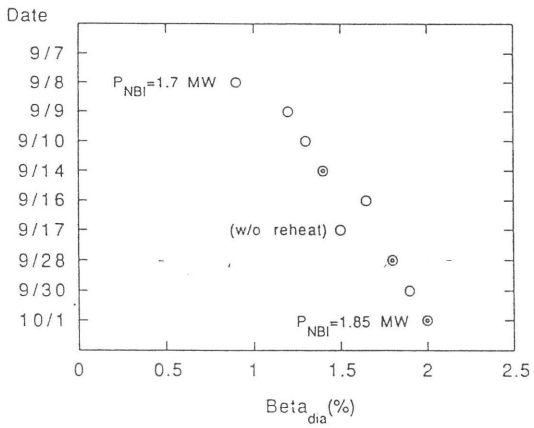

Fig.1. Daily progress in $<\beta_{dia}>$ due to intense titanium gettering.

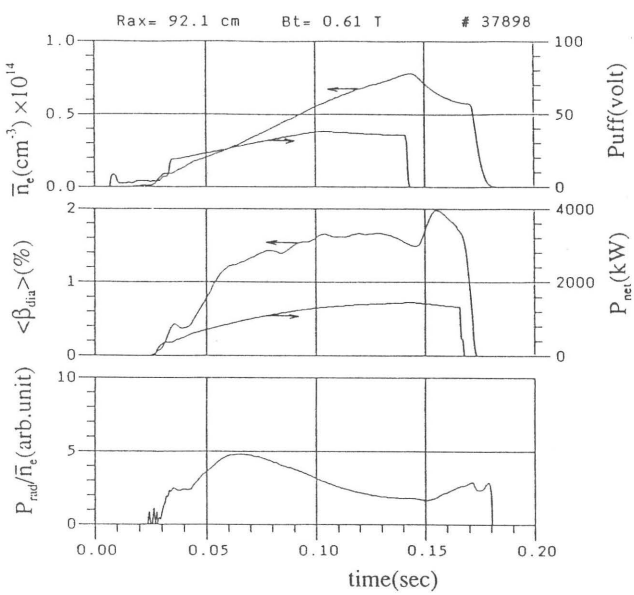

Fig.2. Typical high-β discharge with good reproducibility. From the top are shown the applied voltage to a piezo-electric valve, n_e, $<\beta_{dia}>$, P_{net}, P_{rad}/n_e.

Reference

1) Matsuoka,K., Okamura,S., et al., to appear in Fusion Engineering and Design.