§4. MHD Stability for Strongly Inward Shifted Plasmas

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For the purpose of increasing the NB heating power two NBs were switched from the balanced-injection to the co- (or ctr-) injection and IBW with 9MHz has been operational to produce the target plasma irrespective of the magnetic field strength B_t. These preparation was prerequisite for the MHD study on strongly inward shifted configurations. Two co-injected NBs showed higher injection power than before and resulted in T_e (0) of 7-800eV at n_e of 4-5x10^{13}cm^{-3}, in the configuration with R_{ax} of 92.1cm and B_t of 1.76T, of which plasma parameters had not been obtained in the balanced injection. In the standard configuration with R_{ax} of 92.1cm the neoclassical internal transport barrier (NITB) was established and it was shown that the diffusivities of electrons and ions are on the same levels of neoclassical ones, respectively. If the neoclassical transport is reduced more the performance of NITB will be more pronounced. Further reduction in the neoclassical transport is expected in strongly inward shifted configurations including the σ=1 configuration. However, the enhanced magnetic hill will be the concern for MHD stability. Here, MHD stability of the strongly inward shifted configuration was studied with R_{ax} of 87.8cm to 89.9cm.

The volume average β value $<\beta>$ of 1.2 - 1.3 % has been obtained without an elaborate wall conditioning at B_t of 0.75 T with R_{ax} of 89.9cm. The plasma passes through the range of $<\beta>$ where the interchange mode is well unstable from the Mercier criterion. However, MHD instabilities that degrade the confinement have not been observed. In the previous experiment MHD instabilities which reduced the stored energy were excited for R_{ax} of 89.9cm at $<\beta>$ of 0.8 % after a sudden increase in the stored energy and in soft X-ray signals without changing externally controllable parameters. The reason why the previous result is not reproducible has not been clear. When R_{ax} is shifted furthermore inward to 88.8cm, that is the σ=1 configuration in CHS, the confinement of the plasma with $<\beta>$ up to 0.8 % is not degraded, where the magnetic hill gets stronger. The same thing holds for the plasma with $<\beta>$ up to 0.6 % with the further inward shift of R_{ax} to 87.8cm. The decrease in the achieved $<\beta>$ is primarily due to the decrease in the plasma volume as R_{ax} is shifted inward. Mode analyses for the plasma with R_{ax} of 89.9cm show that coherent m=2 modes rotating in the ion diamagnetic direction appear at $<\beta>$ of about 1% where the position of iota of 0.5 is located near D_I of about 0.2. Burst-type oscillations are observed at lower $<\beta>$ as before. Because of the technical limitation that the IBW antenna can not reach the outermost magnetic surface of the strongly inward shifted configurations (R_{ax} of 88.8cm or more inward) for the initial breakdown, the plasma produced at R_{ax} of 89.9cm with low B_t that is not available for 53GHz ECH was shifted dynamically inward to R_{ax} of 88.2cm by controlling the poloidal field coil currents in 100 msec. During this phase the poloidal flux and the quadrupole component were kept constant not to induce OH current and not to introduce an additional effect of plasma shape of elongation on confinement. In Fig. 1 it is shown that T_e and n_e are increased by the dynamic shift in spite of the reduced plasma volume. The reason of the increase has not been known yet, however it can be said at least that there is no confinement degradation.

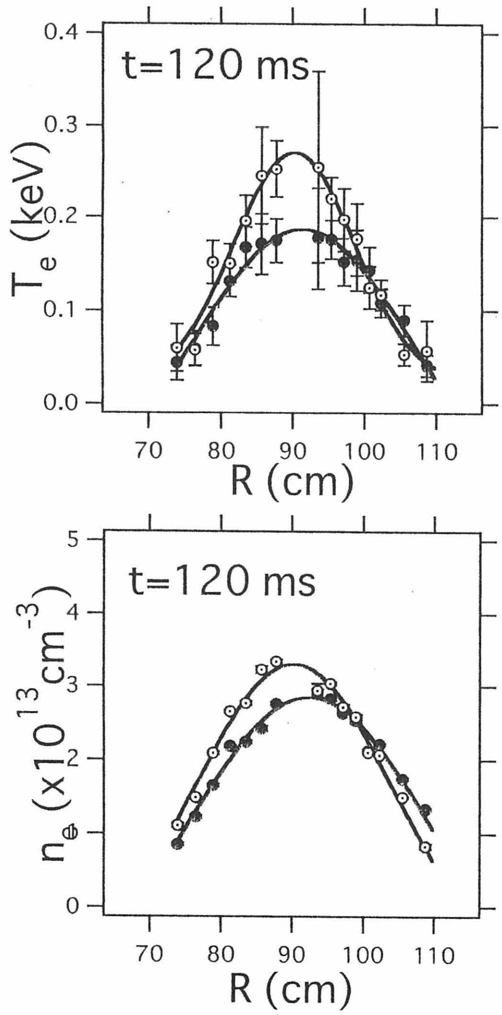

Fig. 1. T_e and n_e profiles. Open circles refer to dynamic shift from R_{ax} of 89.9cm to 88.2cm. Closed ones refer to no shift with R_{ax} of 89.9cm.