§7. High Power EC and NB Heating Experiments in CHS

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High power heating experiment using two neutral beams and two gyrotron systems is performed in CHS. The aim of this campaign is to get high performance plasma using the maximum heating power available. For the neutral beam injection, the higher the electron temperature, the higher ion heating efficiency is expected from the classical NB heating mechanism. The superposition of the ECH and raising electron temperature by factor of 2 are tried. In the previous experiment, however, the drop of the electron density and the transition of the electric potential to positive are observed[1]. The high ion temperature mode in the low density NBI plasma is characterized by the peaked electron density profile and high ion temperature which are observed both in Heliotron-E and CHS. The effect of the ECH on this high T_i mode is also observed in Heliotron-E[3], where the superposition of the ECH degraded the high T_i mode despite of the increase of electron temperature. The effect of the potential is important. The change of the electric field might cause the change of the high energy ion confinement. In the case of the ECH superposition, the enhanced loss of high energy ions is observed. Formation of the electric potential might explain these phenomena.

The temporal evolution of the typical plasma parameters is shown in Fig. 1. The initial target plasma for NBI is produced by both fundamental and second harmonic ECH with 10 ms pulse. The line averaged electron density reaches 0.5×10^{19} m^{-3}. After the injection of the co-NBI#1, electron density gradually increases up to 1.0×10^{19} m^{-3}, where the largest ion temperature increase is observed by adding the counter NBI#2. Three cases of without, with on-axis and with off-axis second harmonic ECH are compared to see the effect of ECH. The on- and off- axis ECH is achieved by changing the beam focal point of second harmonic ECH while that of fundamental ECH is kept on axis. The electron temperature at the center T_{e0} is about 0.6 keV in the case of no ECH. T_{e0} reaches to 1.5 keV and the profile becomes peaked in the case of on-axis ECH and to 1.2 keV and profile becomes broad in the off-axis case. These indicate that power deposition to the electrons is well controlled by ECH. The electron density profile shows relatively peaked profile and manifests a specific feature of the high T_i mode[2]. The density profile barely changes by on- or off-axis ECH. Accordingly, the ion temperature profiles show the similar profile and central values observed in high T_i mode[2] . In this case, any significant changes due to ECH e.g. degradation of the high Ti mode are observed. The central ion temperature measured by charge exchange recombination spectroscopy (CSRS) during 60 to 80 ms in Fig. 1 is about 0.7 keV. After the injection of NBI#2, the electron density abruptly increases probably due to the enhanced recycling or increase of impurity influx by the direct loss of high energy ions to the inner wall. This increase of the density due to counter NBI could not be reduced during this experimental campaign despite of several wall conditionings. The temporal evolution of the ion temperature $T_{i,NPA}$ measured by the neutral particle analyzer shows the increase of $T_{i,NPA}$ due to NBI#2 until the averaged density reaches 1.5×10^{19} m^{-3}. Abrupt decrease of $T_{i,NPA}$ is seen over this density. These characteristics are not affected by on- or off-axis ECH. In the case of ECH superposition, T_{e0} is kept more than 1 keV for on-axis ECH and just below 1 keV for off-axis ECH. The electron density profiles again show relatively peaked profile and almost no significant change due to on- and off-axis ECH. The ion temperature measured by CXRS during 80 to 100 ms reaches more than 0.8 keV for no ECH case when the NBI#2 is superposed.

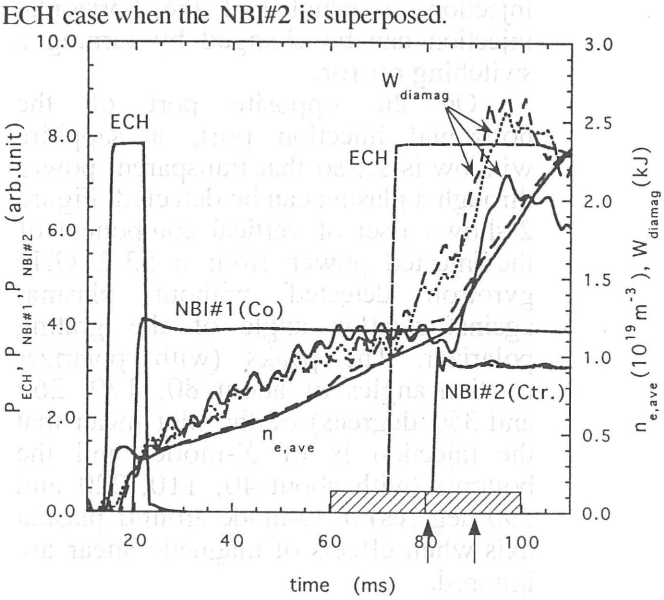

Fig.1 Time evolution of the heating power, line averaged electron density, stored energy. Thick and broken and dotted lines indicate the cases for without ECH, with on-axis ECH, and with off-axis ECH, respectively. The timings of the measured electron temperature and density profiles by the YAG Thomson scattering are shown with arrows and that by CXRS for ion temperature profiles with hatched region.

References

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