§ 1. Confirmation of High Ion Temperature with NPA on N-ITB in EC Heated NBI Plasma

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The internal transport barrier (ITB) of the helical device is formed due to the positive electric field and the electric field shear. The radial electric field is determined by the ambipolar diffusion of neoclassical particle fluxes, so that this internal transport barrier is called neoclassical internal transport barrier (N-ITB).

For the first time, the N-ITB has been observed as an improvement of the electron transport in the electron cyclotron heating (ECH) plasma. In Tokamak experiments, the ITB improves not only electron thermal transport, but ion thermal and particle transport. Recently the N-ITB has also been observed for EC heated NBI plasma. In this experiment, the increase of the ion temperature by the increase of the ion transport has been observed. These results was reported in the annual report in the last year.

In this fiscal year, the study of the N-ITB is further progressed [1]. There is a problem of a validity of the ion temperature measurement for the low density N-ITB plasma. The ion temperature measurement is a key point for the result of the ion transport improvement. When the 53.2GHz 2nd harmonic EC wave ($P_{inj} \sim 130kW$) is injected into the NBI plasma ($P_{inj} \sim 0.7MW$) with the central electron density ($n_e(0) = 3.5 \times 10^{12} cm^{-3}$), the ion temperature increases up to approximately 500 eV from 200 eV with the charge exchange spectroscopy (CXS) measurement.

In this experiment, it is possible that the impurity lines that are included in the charge exchange signal. This can be confirmed from direction of plasma rotation on both inside and outside the plasma: if there is the intense light from the impurity lines, it is misleading into observing the directions of the plasma rotations being same. The direction of the plasma rotation with the CXS is opposite, then the effect of the impurity lines is negligible, and the CXS measurement denotes the plasma ion temperature.

In addition, the neutral particle analyzer (NPA) is also used for the confirmation of the ion temperature measurement. Fig. 1 shows the spectrum of the NPA for the EC heated NBI plasma with the N-ITB that has almost same parameter as above mentioned experiments. The spectrum clearly shows that the ion temperature is about 400 eV. These results are in a good agreement with the result of CXS measurement.

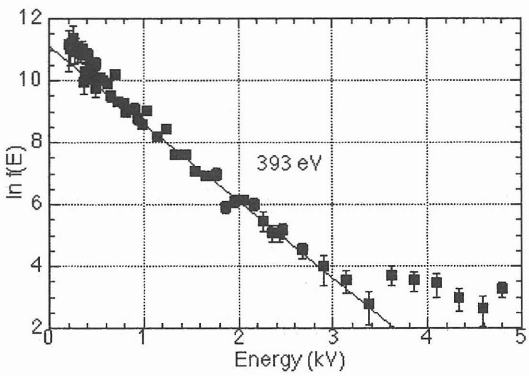

Fig. 1: NPA spectrum in EC heated NBI plasma with N-ITB. The fitting show that the ion temperature is $\sim 400eV$.

In this period, the density profile is almost flat, thus the mechanism for the high ion temperature is not the same as the high Ti mode[2], because the high T_i mode is caused by the density peaking due to gas-puff switched off. However, density profile is flat or hollow shape and is not peaked during forming N-ITB.

Consequently, the increase of the ion temperature during N-ITB formation is further confirmed.

References

[1] T.Minami, et.al., Nuclear Fusion submitted.

[2] K.Ida, et.al., Nucl. Fusion 39 (1999) 1649