§4. Impurity Ion Temperature Measurements Using a Visible and Ultraviolet Spectrograph in the GAMMA 10 Plasma

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Spectroscopic measurements are important study for fusion plasmas. They have a lot of important information of the fusion plasmas, such as plasma particle confinements, impurity transport, plasma density, and plasma temperature, etc. We have studied impurity ion and neutral hydrogen radiation intensities in the fusion plasma GAMMA 10 for plasma diagnostics. In these days, a collisional-radiative model (CR-model) is an important model for the plasma spectroscopy. We have constructed the oxygen and carbon ions CR-models.[1-4] In this year, the impurity ion spectroscopy for the impurity ion emission intensity and the ion temperature measurements with the variety of plasma heating sequences were carried out by using the visible and ultraviolet (UV/V) spectrograph in GAMMA 10.

The UV/V spectrograph system views the plasma column vertically. The spectrograph covers the range from x = -20 cm to x = 20 cm. The observable waveslength of the spectrograph is in the range of 250 nm to 700 nm. The output images of the spectrograph are recorded by the CCD camera whose frame rate is 30 frames/s. The plasma in GAMMA 10 is produced and heated by ion cyclotron heating (ICH) and the confining potentials are produced by electron cyclotron heating (ECH) at the plug/barrier region. The typical electron density, electron and ion temperatures are about 2×10^{12} cm^{-3}, 0.08 keV and 5 keV, respectively.

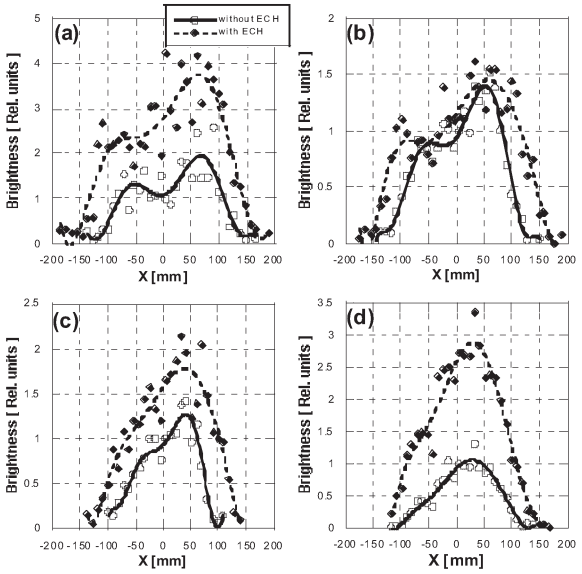

Fig. 1. Oxygen ions radial brightness profiles. (a), (b), (c), and (d) show the radial brightness profiles of OII, OIII, OIV, and OV ions, respectively.

Oxygen ions radiation radial profiles were measured before applying ECH and during ECH. Figure 1 (a) , 1 (b), 1(c), and 1 (d) show the OII, OIII, OIV, OV radiation radial profiles before (open circles) and during ECH (closed circles), respectively. In this plasma, the oxygen ion radiation intensities in the upper region were stronger than those in the lower region. These results show that the impurities came into the plasma from the upper side of the plasma. On the other hand, we observed the plasma by using the high-speed camera. The obtained movies show that the plasma moved to the upper side and the plasma edge touched the central limiter at the upper side. This is comparable to the results obtained by the UV/V spectrograph. Moreover, oxygen ions temperatures were measured by using Dopplar broadening measurement of the emitted spectral line profiles. Figure 2 shows the ion temperature radial profiles of OII (a), OIII (b), OIV (c), and OV (d), respectively. Here, open circles and closed circles show those without ECH and those with ECH, respectively. The higher charged oxygen ion temperature of about 1.4 keV were observed. The OV ions are heated by ICH because of the OV ion cyclotron frequency is the same as forth harmonics of the hydrogen ion cyclotron frequency.

1) Kato, T., et al.: Fusion Eng. Des., **34-35** (1997) 789.
2) Yoshikawa, M., et al.: Annual Report of NIFS, April 2003-March 2004 (2004) 98.
3) Yoshikawa, M., et al.: Annual Report of NIFS, April 2004-March 2005 (2005) 450.
4) Yoshikawa, M., et al.: Annual Report of NIFS, April 2005-March 2006 (2006) 482.

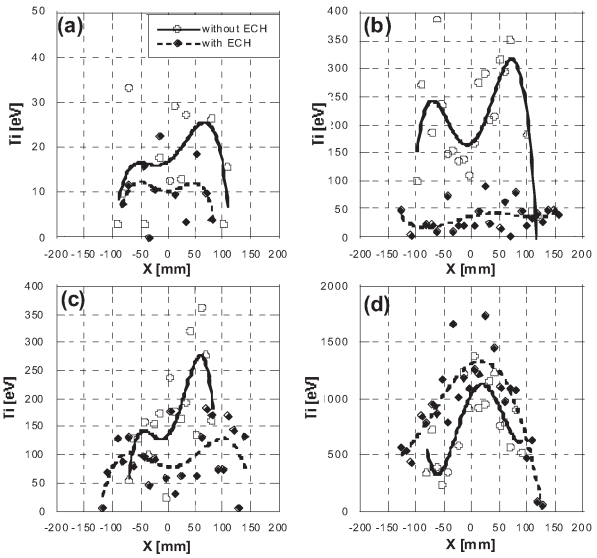

Fig. 2. The oxygen ions temperature radial profiles of OII (a), OIII (b), OIV (c), and OV (d), respectively.