§10. Ion Temperature Measurements by Using DNB-CXS for CHS ECH Plasmas

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Ion temperature profile is an essential parameter for the plasma transport analysis. The recent CHS experiments show that in the low density ECH discharges, the electron temperature can become very high and have a "dome" profiles. These are called high Te mode which suggests the transport barrier in the electron energy is formed.

We have developed charge exchange recombination spectroscopy using diagnostic neutral beam (DNB-CXS) on CHS. The power though the injection port is about 50kW, which is much smaller than the typical power of the NBI for heating, 500kW. Furthermore, because the DNB is injected almost perpendicular to the torus(turned +4.4°), the fraction of the power deposited to the plasmas is considered to be too small to influence the plasma parameters, even in the ECH discharges with the typical heating power of 120kW.

The intensity degradation of the CX light caused by this low deposition power is compensated by the following "dig-dag" CCD scheme. By synchronizing DNB modulation and forth-back charge shifts in the cooled CCD tips, the light from the viewing line for both the DNB on and the DNB off is accumulated in the single CCD image frames. As a result, the signal to noise ratio enough to determine the ion temperature can be smaller, because one need not care about the ambiguities in the toroidal asymmetry in the line intensity and in the individual difference between the fiber optics.

The plasma was initiated and sustained by a 53.2GHz ECH having the input power of 120kW and pulse width of 100ms. The density was kept constant about $8 \times 10^{12} cm^{-3}$ during the period including the single exposure time, 48ms(51-99ms). The DNB was injected to the horizontally elongated section almost perpendicular to the torus(turned +4.4°) having the acceleration voltage of 38kV and beam current of 3A. Modulation frequency was set to 83.3Hz with the duty cycle of 50%(6ms on and off).

For these plasma parameters, summing of 4 shots with good reproducibility was necessary to yield sufficient signal-to noise ratio.

Figure 1 shows the temporal evolution of the CX line of CVI(n=8->7, 5290.5Å) measured by using the 25cm monochrometer and photo-multiplier tube(PMT) viewing whole DNB line. The decay of the light intensity on switching the beam-off is quite instantaneous(<200μs, which is a sampling rate of the A/D converter) compared with the single pulse width, 6ms, so that the overlapping of the beam-on stripes and the beam-off stripes in the CCD frame is ignorable.

The beam or "hot" components are derived by subtracting the beam-off stripes from the beam-on stripes for each spatial channel. Then, the ion temperature profiles are derived by determining the spectral width of the hot components for each spatial channel, shown in Fig. 2. The observable radial region is restricted to about r/a > 0.5 by the port access at the outside port on the top of the CHS, 4M port. Therefor, we have installed one channel viewing only around the central region from the horizontal direction, 4O port.

The central electron temperature measured by using the YAG-Thomson scattering is about 1 keV having the high Te like profiles, while the central ion temperature is about 0.13keV and the dependence on the electron temperature is not observed, implying that ion energy transport is not improved in the high Te like discharges.

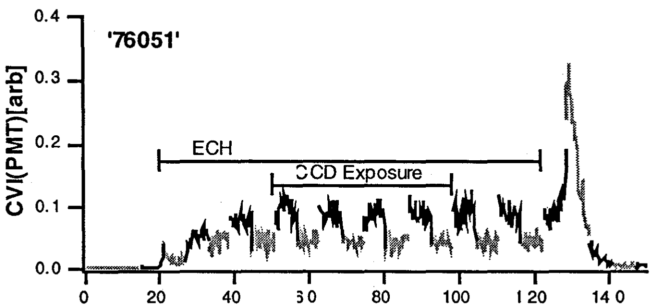

Fig. 1 Temporal evolution of the CX line of CVI measured using the 25cm monochrometer. The gray lines are the "beam-off phases" and the black lines are the "beam-on phases."

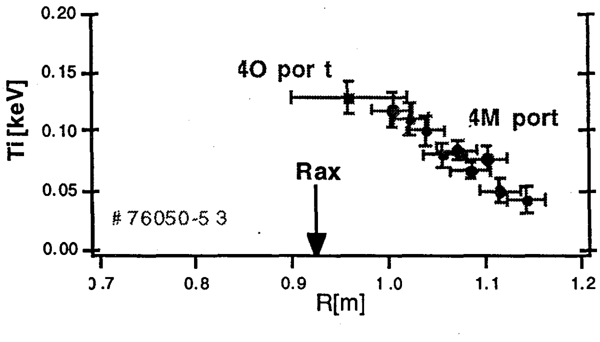

Fig. 2 Ion temperature profiles for the ECH plasmas. The horizontal error-bars represent the spatial resolution of the single fiber channel. B=0.9T, Rax=0.921m(STD). 4M port is a vertical port while the 4O port is a horizontal port.