§24. Experimental Study of the Effect of Carbon Impurity on the Energy Confinement of Heliotron J Plasmas with a Filtered AXUV Diode Array

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In the Heliotron J, a quasi-omnigeneous property in the magnetic field configuration on the Boozer coordinates is adopted in order to achieve a good balance between a particle confinement and MHD stability. Past Heliotron J experiments indicate Heliotron J plasmas have a good capability of the energy confinement (1.5 ~ 2 times better than that predicted by an ISS95 scaling.), which would be attributed to the good particle confinement. Therefore there is concern that an impurity is going to be accumulated in the well-confined plasma of the Heliotron J. In order to avoid the impurity accumulation in the Heliotron J plasma, it is necessary to gain a better understanding of the impurity behavior in the Heliotron J plasma. To this end, we have installed a carbon impurity ion profile measurement system, which consists of an Absolute eXtreme UltraViolet (AXUV, IRD inc., AXUV-16ELO/G) photodiode array and an optical filter. This filter (Acton Research Corp Inc., 155-N-.5D-MTD-SP) can transmit a C IV line emission (155 nm: $1s^2 2s$-$1s^2 2p$). A rotating filter holder is installed in the system to select the optical filter in accordance with the intended use. For a bolometer-like measurement, the AXUV diode array without any filter can be also selected. Figure 1 shows a transmittance of the C IV filter as a function of wavelength. The maximum transmittance of 15.6 % is obtained at the wavelength of 153.3 nm. And the full width at half maximum for the transmitted spectral profile is 26.6 nm. Figure 2 shows lines of sight of the carbon impurity ion profile measurement system, together with a cross-section of magnetic flux surfaces of the Heliotron J plasma in the so-called "standard" configuration. The system can observe over the whole plasma region.

Figure 3(a) shows a typical data measured with the C IV-filtered AXUV diode array in an NBI heated plasma of the Heliotron J. It should be noted here that the data shown here is chord-integrated value. As a reference, a data measured with the un-filtered AXUV diode array under almost the same experimental condition as that in Fig. 3(a) is also shown in Fig. 3(b). The profile of signals obtained with the C IV-filtered AXUV diode array shows a very hollow, although the peaked signal profile is obtained with the un-filtered AXUV diode array. The very hollow profile is consistent with the expected C^{3+} ion distribution in the Heliotron J plasma. However, a stray light may contaminate the signals from the peripheral channels of the AXUV diode array and thus the there is room for further investigation.

For the next Heliotron J experiment, the suppression of the stray light and some other improvements (e.g. in signal conditioning circuits) will be performed.

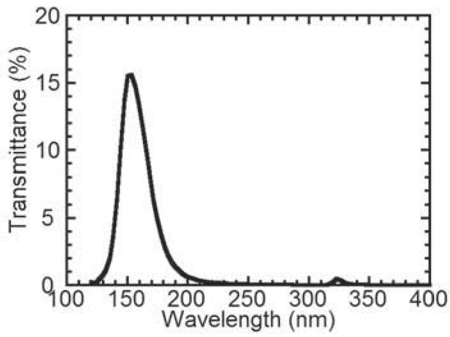

Fig. 1. Transmittance of the C IV filter as a function of the wavelength.

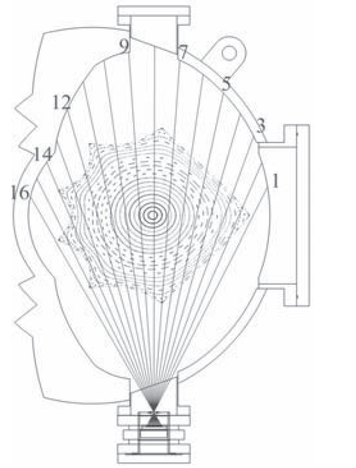

Fig. 2. Lines of sight of the carbon impurity ion profile measurement system, together with a cross-section of magnetic flux surfaces of the Heliotron J plasma in the so-called "standard" configuration.

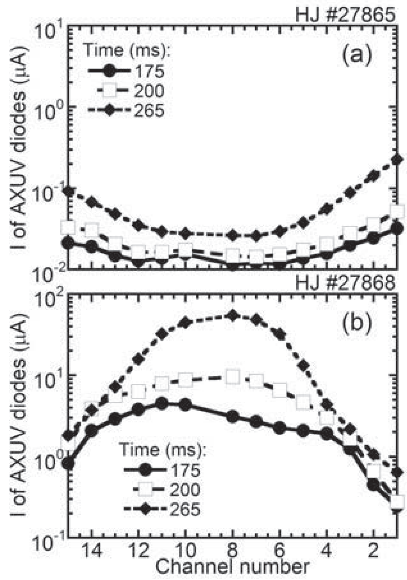

Fig. 3. Typical data from the AXUV diode array (a) with the C IV filter and (b) without the C IV filter in an NBI heated plasma of the Heliotron J.