§22. Measurement of Impurity Lines by a Soft X-ray Spectrometer Using a Multilayer Mirror

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Multilayer Mirror (MLM) is a dispersive element that has a high reflectivity in soft X-ray region. This MLM consists of silicon and tungsten layers. The reflectivity and energy resolution hold good in the energy range from 300 to 1000 (eV). To remove low energy photon, a 8 (μ m) Be foil is used as a filter. Formerly, fast time evolution of the electron temperature was calculated assuming a continuous spectrum, but correct electron temperature wasn't obtained in the range from 600 to 1400eV. [1]

We have optimized former spectrometer on Compact Helical System (CHS) heliotron/torsatron for spectral line measurements. The position of photodiode was changed in order to resolve two lines of OVIII 1s-2p 654 (eV) and OVIII 1s-3p 775 (eV). Measured energy region is from 620 to 800 (eV). We measured NBI (40~110msec) and ECH (20~40msec) plasmas at the strong magnetic field (1.8T) with the time resolution of 0.1msec. The electron density was 6 $\times 10^{19}$ (m^{-3}) and the electron temperature was 600 (eV) at the plasma center measured by Thomson scattering measurement. On the other hand, the signal level of soft X-ray radiation at normal magnetic field (0.88T) was inferior to the noise level. We usually measured spectrum from 660 to 800eV (Fig.1) and found two notable impurity lines at 728eV and 775eV. The line at 775eV is probably O VIII 1s-3p emission, and another is under investigation.

From the O VIII 1s-3p intensity, we estimated O VIII concentration n(O VIII 1s)/ne using corona model that would be realized in low density plasma less than 1x10^{23}(m^{-3}) (Fig.2). In the simplest corona model, convection and diffusion term is ignored and particle confinement time is assumed to be infinity. Then OVIII 1s-3p intensity is given by

$$I(\text{OVIII 1s-3p}) = n(\text{OVIII 1s})\, C(\text{1s-3p})\, ne \qquad (2)$$

where C(1s-3p) ($cm^3 s^{-1}$) is the excitation rate coefficient. As shown in Fig. 2, O VIII concentration decreases as the electron temperature decreases. But, in this model, it is difficult to discuss O VIII concentration directly because particle confinement time and other parameters are not taken into account.

We are planning to measure the spectrum from 630 to 810eV because channel number of photodiode is increased from 16 to 20 and we can measure OVIII1s-2p emission (654eV) and OVIII 1s-3p emission (775eV) at the same time. Therefore electron temperature will be estimated from line intensity ratio [2] of OVIII.

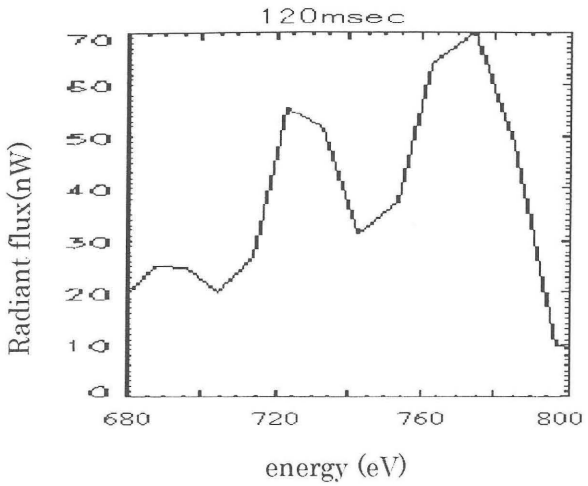

Fig. 1. Spectrum measured with the improved spectrometer in CHS plasma (#83957) at strong magnetic field. There are two notable lines (728eV and 775eV).

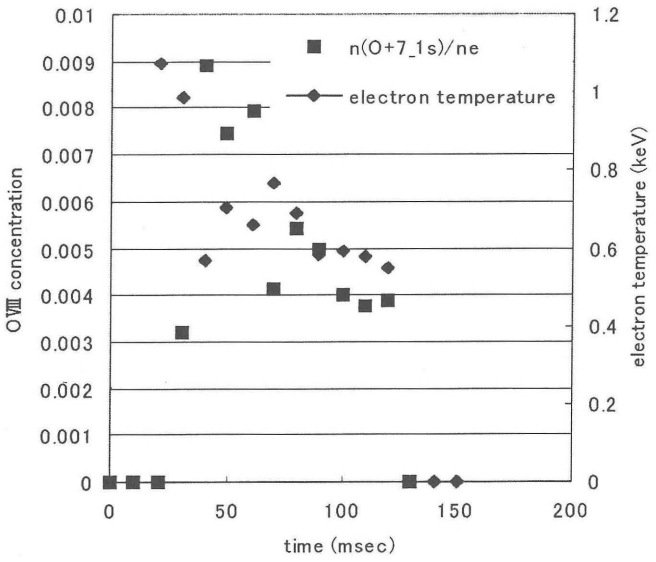

Fig. 2. Time evolution of OVIII concentration and electron temperature. OVIII concentration is estimated by a corona model.

Reference

1) Smita, D.,et al, Rev. Sci. Instrum. **72**, (2001) 1183
2) Muto, S.,et al, Rev. Sci. Instrum. 68, (1997) 1039