19PB-087

Observation of Bremsstrahlung in Heliotron J by Vacuum Ultraviolet Spectrometer

真空紫外分光器を用いたヘリオトロンJにおける制動放射の観測

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In vacuum ultraviolet (VUV) spectra in high temperature plasmas, bremsstrahlung can be significantly superposed by line spectra. It is necessary to separate the components of bremsstrahlung and line spectra. In this study, the wavelength regions where the component of bremsstrahlung can be detected were examined in the measured VUV spectra in Heliotron J device. There are several wavelength regions such as 19.76 nm and 30.88 nm, where the observed intensity is considerably low throughout the discharge period. These regions can be candidates to be used to measure the bremsstrahlung.

1. Introduction

Impurity control has a great contribution to producing and maintaining high temperature plasmas. Since the impurity is mainly emitted from the plasma facing wall, it is important to monitor the wall condition to control the impurity amount. In high temperature plasma experimental devices, such as Heliotron J in the present study, the intensity of spectral lines from the light impurity like oxygen (OV) and carbon (CIII) in visible region is commonly used as the relative index to monitor the condition of plasma facing wall. In the vacuum ultraviolet (VUV) region, on the other hand, the monitors of metal impurity ions like Fe and Ti are also possible. In this region, however, continuous spectrum of bremsstrahlung can significantly be superposed by line spectra [1,2]. Therefore, it is necessary to separate the components of continuous and line spectra both to analyze the bremsstrahlung and to evaluate the line spectra quantitatively.

In this study, the wavelength regions where the component of bremsstrahlung can be detected were examined in the measured VUV spectra in Heliotron J.

2. Experimental Setup

An oblique incidence vacuum ultraviolet spectrometer [3,4] was used in the experiment. Unequal spacing concave diffraction grating was adopted for the spectrometer. The reciprocal linear dispersions are 0.018 nm/ch around 18 nm and 0.026 nm/ch around 39 nm. The measurable wavelength range is 5 - 40 nm by moving the detection position. The minimum time resolution is 5 ms.

3. Identification of the Wavelength Regions for Observation of Bremsstrahlung

Figure 1 shows the VUV spectrum for 17 - 39 nm for the shot #51282 which is for an ECH (Electron Cyclotron Heating) plasma. There are several wavelength regions where the observed intensity is considerably low throughout the discharge period. These wavelength regions are marked in red circles in Fig. 1.

We examined the wavelength regions of 19.76 nm, 30.88 nm, 17.5 nm and 22.87nm. Figure 2 shows the expanded spectra of those in Fig. 1. One can see that there seems to be a wavelength region free from line spectra around 19.76 nm. The adjacent line is at 20.02 nm. The full width at half

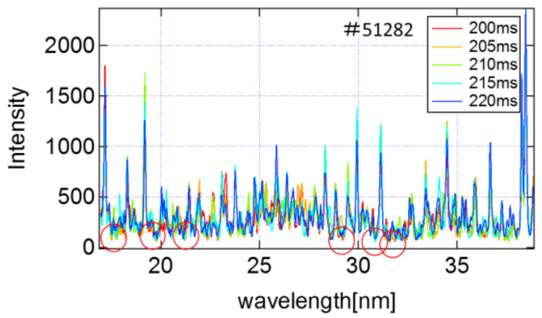

Fig. 1. Temporal evolution of VUV spectrum and wavelength regions for observation of bremsstrahlung showed in red circles

maximum instrumental function is 0.09 nm at 20.02 nm. Therefore, the region can be a candidate to be used to measure the bremsstrahlung. In order to confirm this, temporal evolution of the intensity averaged around 19.76nm was compared with the one around 20.02nm, as shown in Fig. 3.

The temporal evolutions of these two wavelength regions, in general, were different and the one at 19.76 nm is always lower. Therefore there seems to be no contamination from the adjacent line for 19.76 nm, and this region can probably be used for bremsstrahlung measurement.

Furthermore, after the same procedure, we verified that 30.88 nm can also reflect pure bremsstrahlung component. The temporal behaviors of the intensity at 19.76 nm and 30.88 nm were similar as shown in Figure 4. However, several data points seem to be deviated to each other. The reason of this needs to be confirmed in near future. The regions at 17.5 nm and 22.87 nm were found to be contaminated.

It is desirable to find at least three wavelength regions to fit to the theoretical curve of bremsstrahlung. We also plan to extend the wavelength region to be searched.

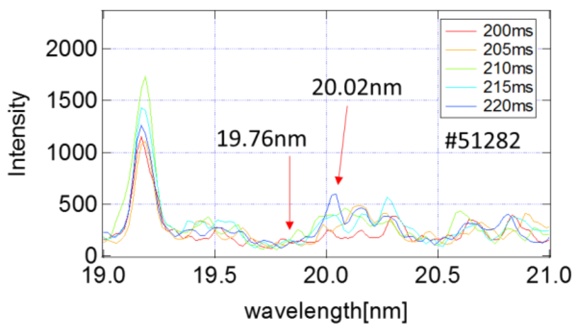

Fig. 2. VUV spectra at around 19.76 nm

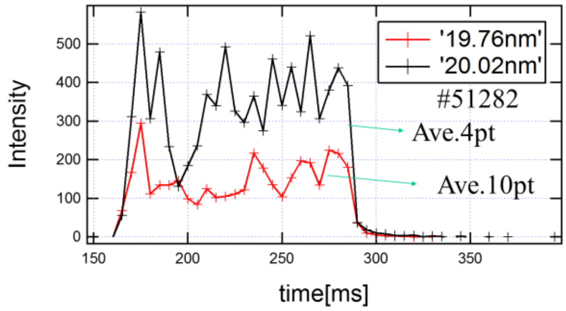

Fig. 3. Temporal evolution of the intensity at around 19.76 nm and 20.02 nm

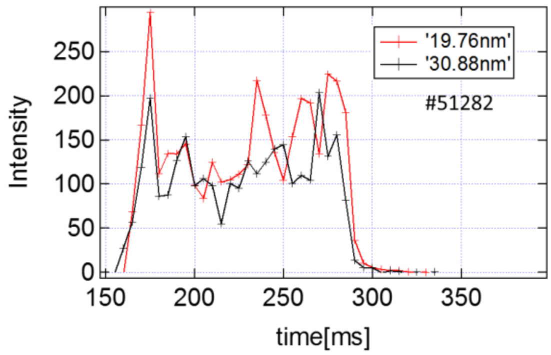

Fig. 4. Temporal evolution of the intensity at around 19.76 nm and 30.88 nm

4. Summary

The regions at 19.76 nm and 30.88 nm can be regarded as candidates to be used to measure the bremsstrahlung. On the other hand, the regions at 17.5 nm and 22.87 nm were found to be contaminated.

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