Radiation measurement by using AXUV photodiode arrays with multiple optical filters in Heliotron J

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Radiation from plasma plays an important role in a power balance and affects on the accessible density range. In order to investigate the radiation power from plasma, metal-film bolometer and/or silicon photodiode have been used in fusion plasma experiment. Recently an absolute extreme ultraviolet photodiode (AXUVD) array system with multiple optical filters has been installed in the medium-sized helical-axis heliotron device, Heliotron J. In the previous experiment, the radiation in a specific energy region was measured by using a set of optical filters. However, the previous set of filters was not enough to make detailed discussions on the radiation effects by dividing its energy range. In order to improve this situation, a new set of optical filters is mounted in the system. This paper reports the results of radiation measurement by this upgraded AXUVD system and compares them with the data from a VUV polychoromator.

The AXUVD (AXUV16ELO/G, International Radiation Detectors, Inc.) system can detect photon from visible to soft X-ray range with high time resolution of 10μs. An optical filter system consists of five different types of foil:

(a) $0.2\mu m^t$ Al foil for transmittance in above 200eV and 20-80eV
(b) $1\mu m^t$ Al foil for transmittance in above 400eV
(c) Multilayer filter of Al/Ag/Parylene for transmittance in above 40eV
(d) Multilayer filter of Al/LiF/Parylene for transmittance in above 200eV
(e) Bandpass filter for transmittance in 155 nm (FN155-N-.5D-MTD-SP, ACTON)

The radiation from the specific energy region of 20–80eV can be estimated by the combination of filters by using the data with filter (a) and the data with filter (d).

The chord integral profiles of radiation transmitted each optical filter were obtained for low-density ECH plasmas ($\overline{n}_e \sim 0.4\times10^{19} m^{-3}$). It is found that the profile for the radiation in the photon energy range of > 200eV has a peak around the central chords, indicating that such radiation is dominant in the plasma core region. On the other hand, it is found that the radiation in 20-80eV has a hollow profile with local peaks at the chords which are tangent to the surface of normalized minor radius, $\rho \sim 0.6$-0.7. The radial profile of the radiation was estimated by the least squares fitting to a model function, $I_{reconst.}=I_0(1-a(1-\rho^b)^c)-d(1-(\rho-1)^2)^e)$ where I_0, a, b, c, d, e are the fitting parameters. The estimated radiation profile indicates a strong peak at $\rho \sim 0.6$-0.9. The VUV polychoromator measurement for the energy band of 31.8-72.8eV (corresponds to the wave-length of 17-39nm) indicates the strong line emission from low-Z impurities of CIV and OV in the edge region. The radial profiles of these line emissions from the low-Z impurities are also estimated by using the same method. The estimated radial profiles of the line emissions show a strong peak at $\rho \sim 0.7$-0.9, which is similar to the estimated profile by the measured signals of AXUVD system.