§11. Poloidal Distribution of Impurity Emissions in Edge Ergodic Layer of LHD

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The 2-D distribution of impurity emissions has been measured in LHD by scanning the optical axis of the space-resolved EUV spectrometer. Typical results are shown in Fig. 1 for CIV (384.174 Å, E_i = 64.0 eV), CVI (2 × 33.73 Å, 490.0 eV), FeXV (284.164 Å, 456.2 eV) and FeXVIII (93.92 Å, 1357.8 eV). All of the 2-D distributions are measured during a flat-top phase of ICRF discharges at magnetic axis position of R_{ax} = 3.60 m with similar plasma parameters, i.e., line-averaged electron density of $n_e \sim 1\times10^{13}cm^{-3}$. There is no obvious variation in all the parameters during the horizontal scanning. The intensity of impurity line emissions is absolutely calibrated using radial profiles of bremsstrahlung continuum in EUV and visible ranges [1]. In the 2-D distribution the spectral intensity near the top and the bottom plasma boundaries is enhanced due to a long chord length passing through the edge plasma. The inboard X-point trajectory is also enhanced for CIV and CVI indicating a non-uniform poloidal distribution in the ergodic layer. In the figure it is appeared with bright diagonal trace from top right (Y~200, Z~500mm) to bottom left (Y~-250, Z~-500mm).

The poloidal emissivity distribution is evaluated from the 2-D distribution shown in Figs. 1 (a)-(d) using the emission at the top and bottom [2]. The result is plotted in Figs. 2 (a)-(d) against horizontally elongated plasma cross section. It indicates the radial location of impurity ions moves inwardly as the ionization energy increases and the poloidal distribution is non-uniform for impurity ions existing in the ergodic layer or in the vicinity of LCFS. The non-uniformity becomes stronger with reduction of the ionization energy of impurity ions. This means the impurity ion located in outer region of the ergodic layer exhibits larger non-uniformity in the poloidal distribution. In addition, the emissivity is stronger as the impurity location is close to the X-point, while it is weak at both the top and the bottom O-points, which is defined by poloidal positions of the elliptical plasma boundary adjacent to helical coils.

In order to compare the non-uniformity among four impurity species in details, the emissivity distribution from the top and bottom regions is normalized by the emissivity at the top and bottom O-points. The normalized poloidal distribution becomes gradually uniform as the radial location of impurity ions moves inside. The poloidal profile of CIV located in the ergodic layer shows an extremely non-uniform distribution. On the contrary, the poloidal profile of FeXVIII located at $0.78\leq\rho\leq0.90$ indicates a relatively flat distribution. This means the FeXVIII emissivity is a function of magnetic surface.

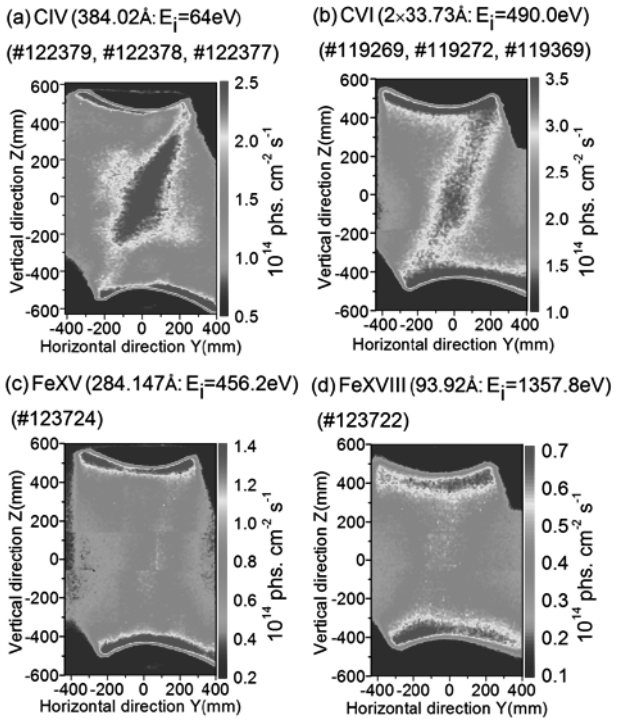

Fig.1 2-D distributions of (a) CIV, (b) CVI, (c) FeXV and (d) FeXVIII at R_{ax} = 3.60 m. The shot number is denoted for each figure.

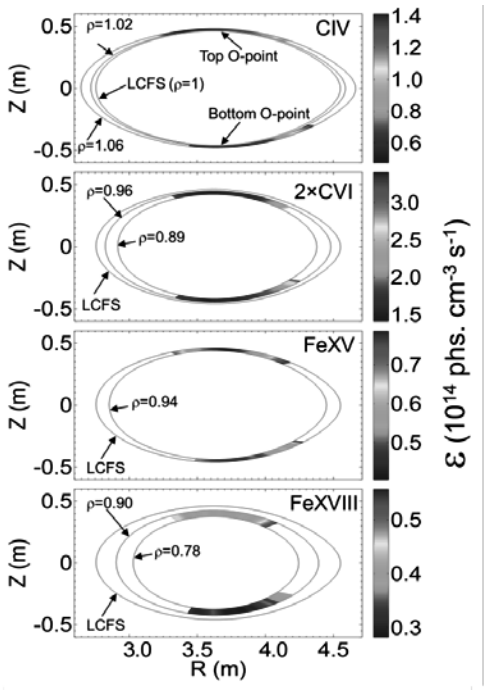

Fig.2 Poloidal distributions of (a) CIV, (b) CVI, (c) FeXV and (d) FeXVIII at horizontally elongated plasma cross section. The emissivity is expressed in different colors.

1) C. F. Dong, et al.: Rev. Sci. Instrum. **82** (2011) 113102.
2) H.M.Zhang et al.: PFR **10** (2015) 3402038.