講演番号
**7P44**

# ヘリオトロンＪの EUV 分光システムにおける空間分布再構成法の評価

# Evaluation of the spatial distribution reconstruction scheme in EUV spectroscopy system in Heliotron J


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Impurity behaviors has been regarded as an important part of in the study of fusion plasmas. Extreme ultraviolent (EUV) spectroscopy has been applied to study these behaviors in fusion relevant magnetic confinement plasmas [C. Dong *et al.*, Plasma and Fusion Research **6**, 2402078 (2011)]. In general, however, the measurement of the spatial distribution is sometimes still difficult due to the limited port access and sight lines.

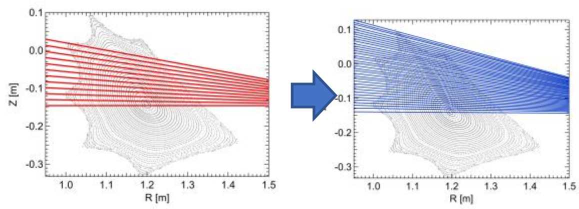
In this paper, we attempt to use the sight-line interpolation scheme to reconstruct the local emission intensity of impurity ions in different plasma shape in Heliotron J. A Soft-X ray CCD camera [ANDOR company, DO940P-BEN, 2048 × 512 pixels with enhanced soft X-Ray QE] has been applied to obtain the impurity spectra at 16 – 40 nm. Spatial position was scanned for each shot from the plasma center (0˚) to the peripheral region (-11˚). From line-integrated intensities of these impurity spectra, local emission distribution was reconstructed based on the matrix operations as the following equation:

$$\begin{pmatrix} \varepsilon(\rho_1) \\ \varepsilon(\rho_2) \\ \vdots \\ \varepsilon(\rho_j) \end{pmatrix} = \begin{pmatrix} L_{1,1} & L_{1,2} & \cdots & L_{1,j} \\ 0 & L_{2,2} & \cdots & L_{2,j} \\ \vdots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & L_{i,j} \end{pmatrix}^{-1} \cdot \begin{pmatrix} I_1 \\ I_2 \\ \vdots \\ I_i \end{pmatrix}$$

Where $L_{i,j}$ is the sight line lengths between each magnetic flux surface. $I_i$ and $\varepsilon(\rho_j)$ correspond to the line-integral and local intensity for $i$th sight line and $j$th flux surface, respectively.

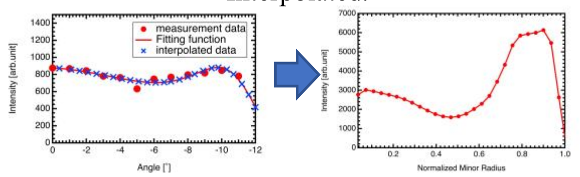
Since the reconstruction demands smooth spatial distribution with small spatial separation, we interpolated original 12 measurement sight lines (Fig 1a) to over 30 lines (Fig 1b) by considering the magnetic flux surface that correspond to the average minor radius to improve the spatial resolution.

Appling this method to the experiments, some lines of impurity ions have been reconstructed, such as the O V ($O^{4+}$, $2p^2(^1D)$-$2s4f(^1F^{\circ})$, 19.30 nm) emission, as preliminary shown in Fig 2. The reliability of the result is still in discussion in terms of the effects of error in the light-line length as well as the hidden path outside of the scannable angle on the matrix inversion. We also planning to apply more robust algorithm, such as regularization technique that had been developed for the interferometry in Heliotron J [N. Shi *et al.*, Rev. Sci. Instrum.**85** 053506 (2014)].




(a) (b)

Fig 1: Sight lines for analysis. (a) measurement; (b) Interpolated.




(a) (b)

Fig 2: Line integral with and without interpolated (a) and reconstructed (b) spatial emission profile of O V (19.30 nm).