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Development of Poloidal Charge-eXchange Recombination Spectroscopy System in Heliotron J

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In magnetically confined fusion plasmas, the radial electric field is recognized as a key factor to reduce the turbulent transport through $E \times B$ shear and contribute to the confinement improvement [1]. To estimate the radial electric field, measurement of rotation velocity with high spatial and temporal resolution is important [2]. In Heliotron J, a parallel and poloidal Charge-eXchange Recombination Spectroscopy (CXRS) system have been installed. However, the spatial resolution in the core region for the Poloidal CXRS is very poor with the current sightline [3]. In this study we redesign the poloidal system to earn a better spatial resolution.

The spatial resolution is evaluated from the simulation of CXR emission. The expected intensity of CXR emission along a sightline I_{CXR} is calculated by following equation.

$$I_{CXR} \propto \int n_{imp} n_{beam} \sigma_{CXR} |v| d\omega dl$$

where n_{imp}, n_{beam}, σ_{CXR}, $|v|$, $d\omega$ and dl are the impurity ion density, the neutral particle density from NBI, the cross section of charge exchange reaction, the relative velocity, the solid angle and the line element along the sightline, respectively. The distribution of n_{beam} is estimated from the neutral beam trajectory with a Monte-Carlo simulation [4]. Figure 1 shows the current viewing chords and the n_{beam} distribution in a co-NBI case. Since I_{CXR} is an integrated value along each sightline, it is hard to obtain a good spatial resolution in the core (see Fig. 3). In order to get better spatial resolution, there are several requirements: (1) sightlines parallel to the magnetic flux surface, (2) enough sightline length at the target location to minimize the integration and (3) the narrow neutral beam density distribution. From these points of view, we redesigned the poloidal CXRS (Fig. 2). A comparison of spatial resolution between the current and the new viewing chords is shown in Fig. 3. With the new design, we can get 30% improvement of spatial resolution in the core.

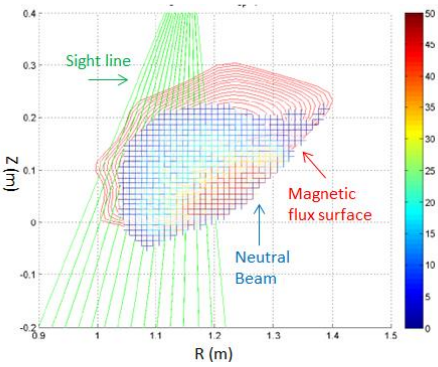

Fig.1. Current sightlines and the distribution of n_{beam} in a co-NBI case

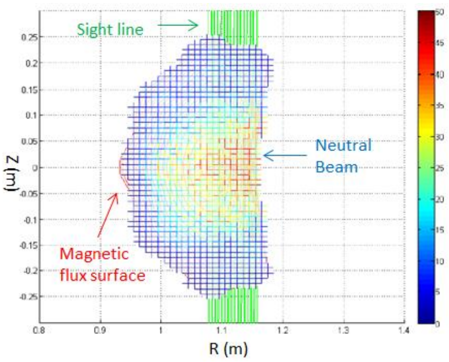

Fig.2. New sightlines and the distribution of n_{beam} in a co-NBI case

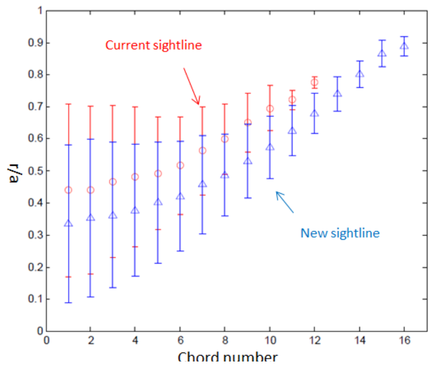

Fig.3.Spatial resolution comparison for the current and new poloidal

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