§41. Distribution Function Analysis of High Energy Particles in Heliotron J

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It is one of the important issues to evaluate the heating efficiency by NBI in Heliotron J. Heliotorn J has the relatively large region, in which the closed magnetic surface is not formed, outside the last closed flux surface (LCFS). Thus, a number of high energy particles are likely to become re-entering particles which are repeatedly go out and into the LCFS. The distribution function of high energy particles including re-entering particles has not been analyzed in Heliotron J. In the present study, we investigate the heating efficiency of NBI and the high energy particle behavior in Heliotron J by means of the calculation of the distribution function of high energy particles including the re-entering behavior of particles.

We develop a Monte-Carlo code based on the real coordinate system to investigate the distribution function of NBI-produced ions including the re-entering behavior of ions. The developed code is applied to the typical plasma in the standard magnetic configuration of Heliotron J.

Figure 1 shows the density distribution of ions produced by co-NBI in two particle loss boundary cases ((a) vacuum vessel wall and (b) LCFS). The difference between two particle loss boundary cases mainly represents the density of re-entering particles. It can be seen from Fig. 1 that there exist many re-entering particles in Heliotron J. Thus, re-entering particles is expected to greatly contribute to the plasma heating in Heliotron J. The heating power by co- and ctr-NBI is shown in Table 1 when the injected power is 0.5 MW. The heating power decreases by 15% in the co-NBI case. In ctr-NBI case, the heating power including re-entering particles becomes twice to that not including re-entering particles.

We develop a Monte-Carlo code to investigate the NBI-produced particles including re-entering behaviors and apply it to the typical plasma in the standard magnetic configuration of Heliotron J. It is found that the many re-entering particles exist in Heliotron J and influence to the heating efficiency of NBI, especially to that of ctr-NBI.

The charge exchange loss influences re-entering particles passing through the outside region of LCFS, in which the cold neutral density is relatively high. The heating efficiency including the charge exchange loss will be evaluated. In addition, the effect of the bumpiness on re-entering particles will also be treated.

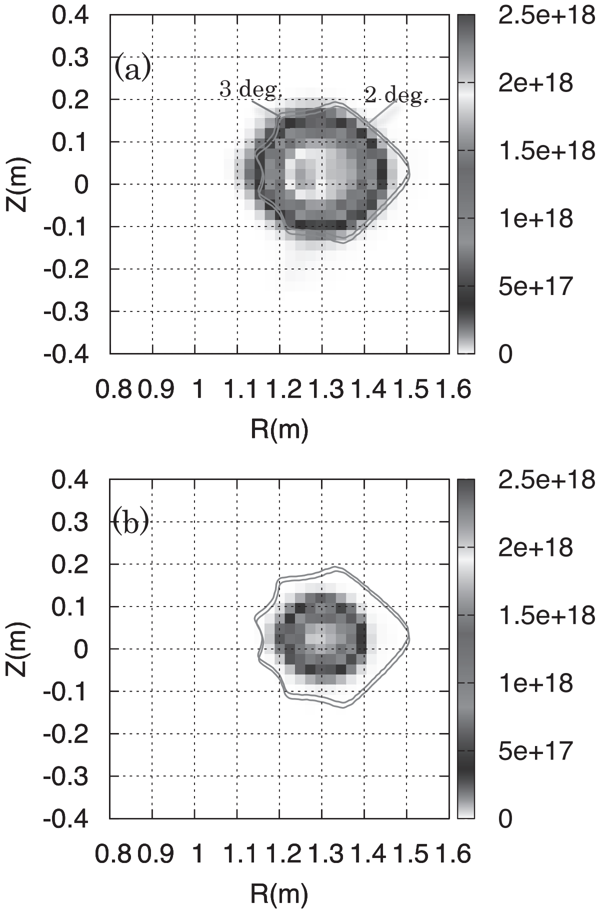

Fig. 1. Density distribution of ions produced by NBI in two loss particle loss boundary cases: (a) vacuum vessel wall and (b) LCFS.

Table 1. Heating power by NBI when the injected power is 0.5 MW. Here, VV is vacuum vessel, and RD the relative deviation of LCFS case from VV case.

		P_{heat} (kW)	
		electron	ion
BL1(co)	VV	89.92	53.46
	LCFS	48.28	28.79
	RD(%)	86.2	85.7
BL2(ctr)	VV	164.7	91.25
	LCFS	52.44	30.82
	RD(%)	214	196