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§18. A study of Peripheral Plasma in Heliotron J by a Fast Camera

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Heliotron J [1, 2] is a flexible helical-axis Heliotron device with an L=1/M=4 helical coil (<R_0> = 1.2m, B_0=1.5T max.) based on the helical-axis Heliotron concept [3]. Using fast cameras peripheral plasma measurement was held by one of authors (N.N.) for a long time. Recently SMBI (supersonic molecular beam injection) is used to increase the electron density without increase the recycling of whole region. During this experiment the diamagnetic signal, which indicated the confinement energy, increased and this increment was more than that of electron density. This means that the electron/ion temperature did not drop during SMBI. Therefore, it is interesting to investigate the peripheral plasma behavior during SMBI, and it is very important to reveal what mechanism in peripheral region related to the confinement.

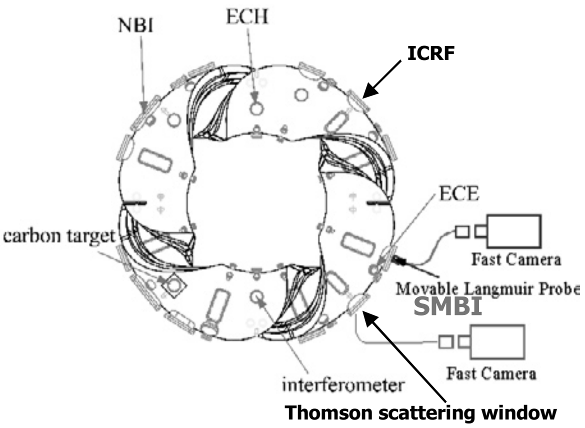

Fig.1 Top view of Heliotron J
SA5 is installed in the tangential port, and K-5 is installed in the horizontal port, in which SMBI is also installed.

Figure 1 shows the top view of Heliotron J and the location of the fast camera used this experiment.

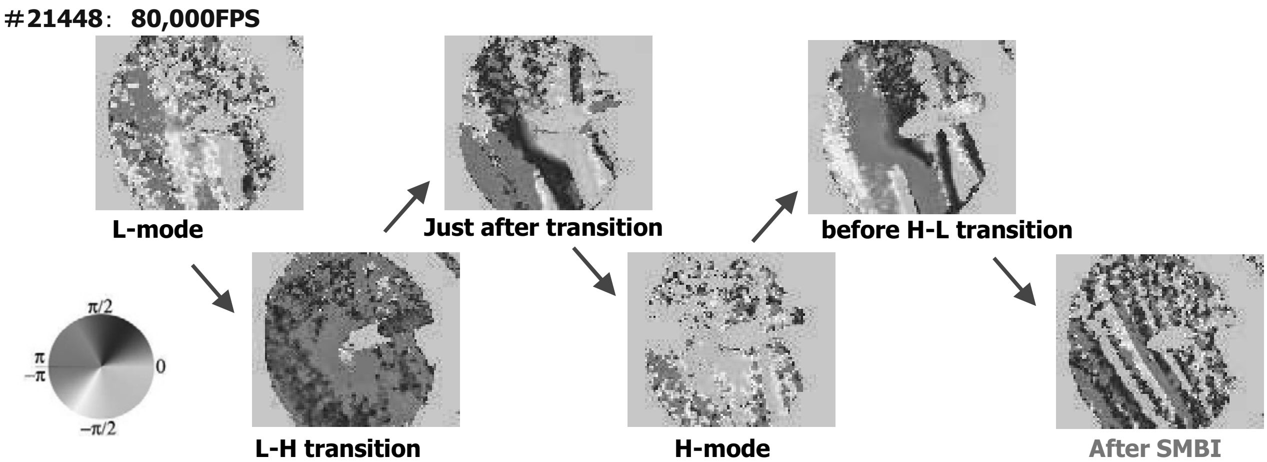

Fig.2 Two-dimensional phase diagram of Heliotron J plasma (ECH+NBI+SMBI)

One of fast cameras (FX K5, blue in Fig.1) views plasma with horizontal port, and the other (SA5, green in Fig.1) views plasma with tangential port. The SMBI was performed in ECH (70GHz,< 0.45MW) +NBI (< 30 keV, < 0.7MW/beam-line) plasmas. Figure 2 shows typical peripheral plasma behavior during SMBI [4,5]. This picture is not original image. In L-mode of this shot ~7kHz peak exist in power spectra in image data [5]. Therefore, two-dimensional phase diagrams at each confinement mode are shown in Fig.2. In these figures the lower column of the right side shows the status of the phase pattern of 'after SMBI'. Comparison this pattern with that of 'before H-L transition' (the upper column of the right side) and/or 'L-mode' (upper column of the left side) it is easy to find the fine filament structure in 'after SMBI'. In the experiment we do not use any optical filters, therefore, the light emission is mainly Ha/Da. In this situation the brighter region should be relatively high pressure region [6]. One reason to find the fine filament structure probably the SMBI provides much gas quantity in local place. Thus, the ionization rate (is nearly proportional to the excitation rate) in high pressure region is larger than that of low pressure region. Therefore, it is easy to see the filament structure. However, the second reason is the SMBI creates the local cooling and this cooling generates the filament structure predicted by Ref[7].

In the near future we will plan to have the combination of Langmuir probe/ magnetic probe and fast camera measurement system. We hope that system will reveal the generation mechanism of the filament structure.

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4) N.Nishino, et al., 2008 *J. Plasma Fusion Res.* **3** S1023
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6) S. Zweben, et al., 2004, Nuclear Fusion 44, 134
7) N.Nishino, 2006 Nucl. Fusion S658