§28. Fueling Optimization Using Multi-channnel H_α/D_α Line-emission Measurements in Heliotron J

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In magnetically confined plasmas, optimization of particle fueling is an important subject to achieve high density plasmas. In Heliotron J, several fueling methods have been tried to obtain the high performance plasmas: Supersonic molecular beam injection (SMBI) and shot-pulsed intense gas puffing (Intense GP). In this study, we report on the neutral particle transport by measuring the spatial profile of the H_α/D_α line-emission to aim at understanding the fueling property and the particle transport.

SMBI (H_2) and Intense GP (D_2) fueling experiments were carried out (see Fig. 1) [1]. SMBI was fed from #11.5 port. The strong peak of the H_α intensity at #11.5 was due to SMBI (t=198 and 200ms), while the H_α/D_α intensity at the opposite side (#3.5) had no response to SMBI. Then the localized fueling was demonstrated. Just after SMBI, the stored energy relatively decreased and recovered 5ms after SMBI. A high stored energy (4.4kJ) was obtained 20ms after SMBI. The intense GP was applied at #14.5 port to compare the fueling property by SMBI from the viewpoint of localized fueling. The decrease in the stored energy was not observed after the intense GP, while the maximum stored energy (3.4kJ) was slightly smaller than that for the SMBI discharge. The time history of the AXUV intensity will be discussed later.

Figure 2 shows the temporal and spatial distribution of the H_α intensity with the multi-chord H_α/D_α-line emission detector. In this experimental campaign, the H_α detector system was installed at the same cross section as SMBI [2]. The spectral transmission profile of the interference filter has a trapezoid shape with a passband of 1 nm to measure the H_α/D_α-line emission simultaneously. In the SMBI discharge, strong peak was observed by SMBI. The gas speed of SMBI is estimated to be about 1km/s from the time evolution of the emission. We are now planning to measure the spatial profile of the H_α/D_α-line emission at the same cross section as the intense GP.

The relation between the stored energy and the peaking factor of the AXUV intensity is plotted in Fig. 3. In the case of SMBI, the peaking factor increases just after SMBI. After that, the stored energy increases with decreasing the peaking factor. Since the AXUV intensity is proportional to $n_e^2 T_e^{1/2}$, the density profile is expected to be peaked one just after SMBI. The peaked density profile is preferable for the core heating by NBI, which may contribute to achieve a high stored energy. As for the Intense GP case, on the contrary, the change in the peaking factor is small at the phase when the stored energy increases. The results obtained by the two fueling methods indicate that the control of the density profile is key factor to achieve the high performance plasmas in Heliotron J.

1) T. Mizuuchi, et al., IAEA-FEC2010, 11-16 Oct (2010), Daejeon, EXC/P8-11
2) S. Kobayashi et al., Rev. Sci. Inst. 77, 10E527 (2006)

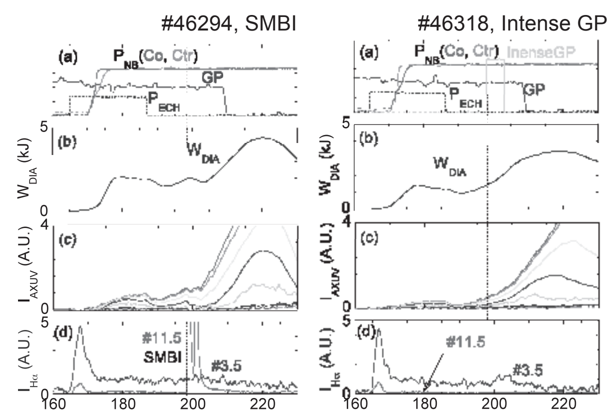

Fig. 1. Time evolution of heating, fueling and plasma parameters obtained in SMBI (left:#46294) and Intense-GP (right:#46318) discharges in Heliotron J.

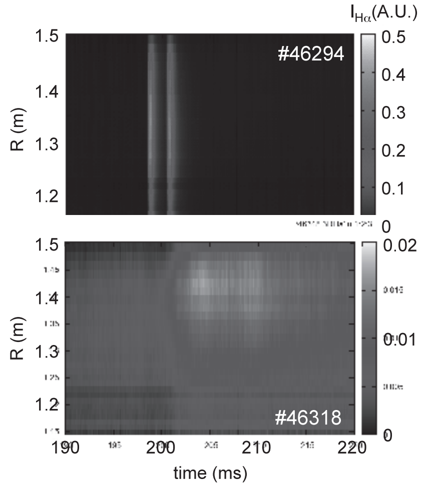

Fig. 2. Time and spatial evolution of the H_α/D_α-line emission intensity for SMBI (#46294) and intense GP (#46318) discharges.

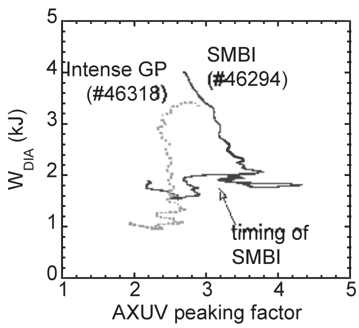

Fig. 3. Relation between the stored energy and the peaking factor of AXUV intensity.