§30. Optimization of Fueling in Magnetically Confined Plasmas (Fueling Optimization using Hα/Dα Lineemission Measurements in Heliotron J)

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In magnetically confined plasmas, optimization of particle fueling is an important subject to achieve high performance plasmas. In Heliotron J, we have obtained high density plasmas around $1x10^{20}m^{-3}$ using short-pulsed high-intensity GP (HIGP) method[1,2]. In this FY, we have compared the characteristics between HIGP and supersonic molecular beam injection SMBI plasmas at high density condition[3].

Figure 1(a) and 1(b) show the time evolution of the plasma parameters obtained in SMBI and HIGP plasmas. The deuterium (D_2) gas is used for HIGP and hydrogen (H_2) gas is for SMBI, while the total amount of gas feed in the two cases were almost the similar to each other. The achieved stored energy (W_{DIA}) in the HIGP case (3.8kJ) was slightly higher than that for SMBI (3.5kJ). Note that, since the toroidal current at maximum W_{DIA} timing was different from each other, the effect of the toroidal current to the configuration should be taken into account. In the HIGP case, since four Piezo-valves used in HIGP is located in each toroidal section of Heliotron J, the neutral gas is fed uniformly. The H_α/D_α intensity close to the piezo-valve responds to its applied voltage. On the other hand, the H_α/D_α intensity far from the valve decays slowly after turn-of of HIGP, which shows the characteristics of hydrogen recycling in the peripheral region. In the SMBI case, on the contrary, the H_α/D_α intensity close to SMBI valve was much higher than that far from the valve, then the gas was fed at the local region.

Figure 2 shows the radial profile of the electron density and temperature obtained in the two discharges just after and at the timing of W_{DIA} maximum. The density profile in the HIGP case is slightly broader than that in the SMBI case, while the difference in the electron temperature is small. The achieved peaked density is around $5x10^{19}m^{-3}$ in the two cases. The heat transport will be discussed using beam absorption and heat transport analyses.

As shown in Fig. 3, the radial profile of the H_α/D_α intensity was measured using the H_α/D_α emission detector installed in this study. A very high H_α/D_α intensity in the outer torus side was observed in the SMBI case. The response at t=237ms was due to the operation characteristics of the SMBI valve. In the case of the HIGP plasmas, on the other hand, the change in the intensity was slower than the SMBI case. In order to understand the fueling behavior in the two cases, the neutral particle transport simulation will be carried out in conjunction with the detailed measurement by installing a newly developed H_α/D_α emission detectors.

1) T. Mizuuchi, et al., IAEA-FEC2012, 8-13 Oct (2012), San Diego, USA, EX/P3-07.
2) S. Kobayashi, T. Mizuuchi, Y. Nakashima, et al., 40th EPS conf, 1-5 Jun (2013), Espoo, Finland, P1.148.
3) N. Kenmochi, T. Minami, et al., Plasma Conference 2014, 2014/Nov/18-21. Niigata, 19pE-5.

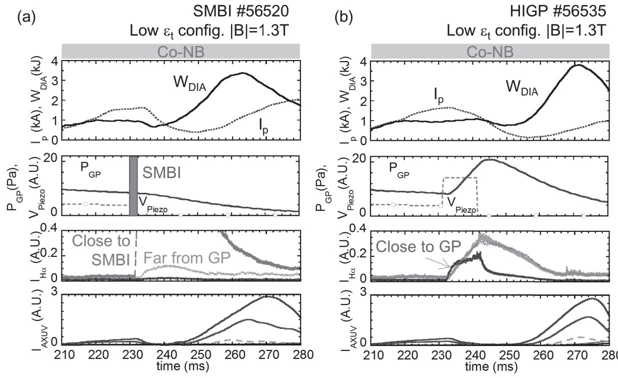

Fig. 1. Time evolution of plasma parameters obtained in (a) SMBI and (b) HIGP plasmas.

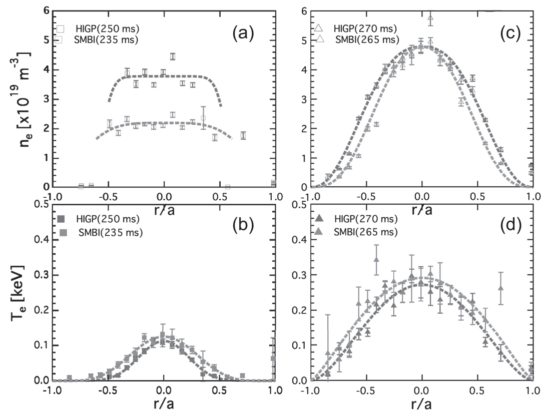

Fig. 2. Comparison of radial profile of electron density and temperature between SMBI and HIGP plasmas.

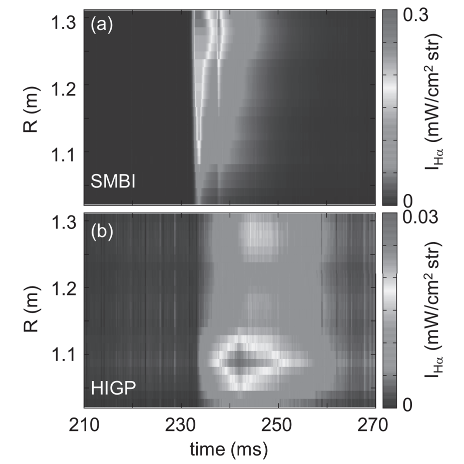

Fig. 3. Comparison of spatiotemporal evolution of H_α/D_α emission intensity between SMBI and HIGP plasmas. The H_α/D_α emission detector is located at which the sightline observes neutral gas fed by SMBI directory.