Effects of gas-fueling by SMBI on plasma performance in Heliotron J

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This paper discusses the effects of the gas-fueling by the supersonic molecular beam injection (SMBI) technique on plasma performance in Heliotron J.

The selection of gas fueling method is one of most important factors to obtain a high density and good performance plasma from two aspects; (1) the profile control of the core plasma through the controlled penetration depth of neutral particles and (2) the reduction of neutral particles in the peripheral region. Supersonic molecular beam injection, which has been developed by L. Yao et al. [1, 2], is one method to obtain the deep penetration length compared to the normal gas-puffing. Therefore, this technique is considered to be especially effective for a medium sized device.

Recently high-pressure SMBI is examined as a fueling method in Heliotron J, a medium sized helical-axis heliotron device ($\langle R_0 \rangle / \langle a_p \rangle$ = 1.2/0.17 m, $B_0 \leq 1.5$ T) with an L/M = 1/4 helical coil [3, 4]. The initial plasma in Heliotron J is produced by using the second harmonic X-mode ECH (70 GHz, < 0.45 MW) launched from a top port. The hydrogen neutral beam (< 30 keV, < 0.7 MW/beam-line) is injected using two tangential beam-lines facing each other (BL-1 and BL-2). The SMBI system is installed on a horizontal port in Heliotron J. This system is originally introduced to Heliotron J for the diagnostic purpose such as the gas-puff imaging measurement with a fast video camera [5]. By increasing the plenum gas pressure (≥ 1 MPa) and the pulse width (0.4-0.7 ms), this system can be used for the fueling.

A gas fueling by SMBI is successfully applied to ECH/NBI plasma in Heliotron J. Although the optimization of this fueling method for the Heliotron J experiment is in progress, in a combination heating condition of ECH ($P_{inj.}$ ~ 0.35 MW) and NBI ($P_{port\text{-}through}$ ~ 0.6 MW), the stored energy reached ~ 4.5 kJ, which is about 50 % higher than the maximum one achieved so far under the normal gas-puff fueling condition [6] in Heliotron J.

[1] L. Yao et al., Proc. 20th EPS Conf. on Controlled Fusion and Plasma Physics (Lisbon, 1993) vol. 17C(I), p303.
[2] L. Yao et al., Nucl. Fusion **47** (2007) 1399.
[3] F. Sano, et al., J. Plasma Fusion Res. SERIES **3**, 26 (2000).
[4] T. Obiki, et al., Nucl. Fusion 41, **833** (2001).
[5] N. Nishino, et al., J. Nucl. Mater., **337-339** (2005) 1073.
[6] T. Mizuuchi, et al., J. Plasma Fusion Res., **81** (2005) 949

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