§23. Optimization of Fueling in Magnetically Confined Plasmas
— Analysis of Neutral Behavior and Optimization of Particle Fueling in Open Magnetic Field Plasmas —

Kobayashi, S., Mizuuchi, T., Okada, H., Kemmochi, N., Harada, T., Kirimoto, M. (Koto Univ.), Nishino, N. (Hiroshima Univ.), Nakashima, Y., Sakamoto, M., Iwamoto, M., Hosoda, Y., Shimizu, K. (PRC, Univ. Tsukuba), Shoji, M.

In magnetically confined plasmas, optimization of particle fueling is an important subject to achieve high performance plasmas. In GAMMA10 tandem mirror, supersonic molecular beam injection (SMBI) has been demonstrated as a new particle fueling method to produce high density plasmas [1]. In this FY, we have tried a new heating-fueling scenarios to obtain low density and high density plasma for the divertor simulation experiments using conventional gas puffing system.

In this experiment, the additional gas fueling was applied from the gas puffer located at the midplane of the central cell (GP#7, Z=+11.6cm, see Fig.1). A plasma-gun is used to produce the initial electrons. In the operation for the normal hot-ion-mode plasmas of GAMMA10, the plasma is produced by RF1 and ion heating in central cell is done by RF2. In this case, on the contrary, the RF1 heating alone is used to produce a low-temperature and high-density plasma (see Fig.2). The hydrogen neutral gas is fueled from the central cell throat regions (GP#3 and #4) to maintain the plasma density. The fueling from GP#1a and #2a is used to control the target plasma density for the additional fueling experiment. In this case, the target plasma density was around 1.5×10^{18} m^{-3} at line-averaged value. The plenum pressure of GP#7 was 400 Torr and operation duration was t=170ms-175ms. After the additional gas fueling by GP#7, the line-integrated electron density increases from 6×10^{13} cm^{-2} to 10×10^{13} cm^{-2} simultaneous with increase in the H_α intensity close to the gas puffer.

The temporal and spatial evolution of line-integrate density is plotted in Fig. 3, which is measured by the multi-chord microwave interferometer system. The arrows in the figure corresponds the measurement positions of the microwave interferometer. The peak position of the radial profile of the line-integrated electron density and the positions at the 90 % of the peak value are also plotted in Fig. 3 using a Gaussian function fitting. The peak position shifts positive y direction around 1-4 cm just after the GP#7 turn-on (t=172-174ms). Since the GP #7 is set about 10 cm in the positive y direction, the shift is may be due to the direct ionization of the neutral gas from GP#7. At that time, some plasma expansion can be seen in the radial direction. During the timing when the maximum electron density is obtained (t=174-177ms), the peak position returns back to the original position and the radial expansion becomes the initial width. To understand the phenomena, both the plasma and neutral particle transport should be analyzed.

In summary, by means of trying the new heating/fueling scenarios, we have obtained a high-density plasma which is suitable for the experimental divertor simulation in GAMMA10/PDX. The comparison to the SMBI fueling will be carried out in the next experimental campaign.

1) K. Hosoi, Doctoral Thesis, Tsukuba (2014).

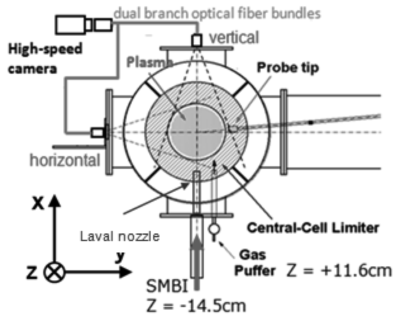

Fig. 1. Cross section of the GAMMA 10 central cell midplane, SMBI with Laval nozzle and gas puffer GP#7.

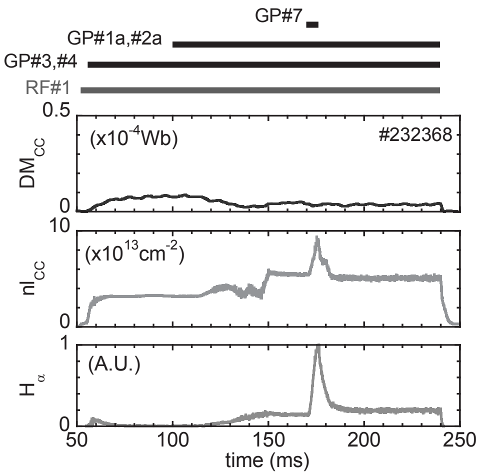

Fig. 2. Heating and fueling scenarios and time evolution of stored energy, line-integrated electron density and H_α intensity in the high density experiment.

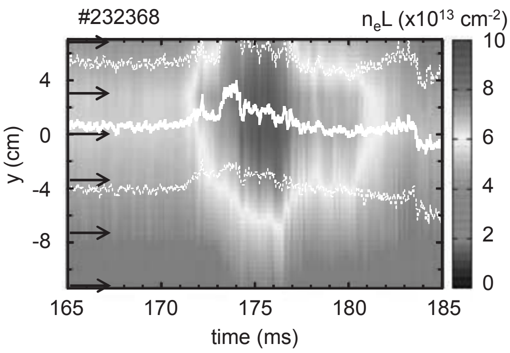

Fig. 3. Temporal and spatial evolution of the line-integrated electron density. The solid and dashed lines are the peak position of the line-density and the position at the 90% of the peak value, respectively.