§14. Generation and Control of High-Density Flow in Open System Plasma

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Characterization and control of high-density plasma in the plasma edge are important from a viewpoint of plasma confinement improvement and the divertor physics in the device GAMMA 10, Plasma Research Center (PRC), Univ. of Tsukuba. In order to advance the research in this device, it is essential to estimate and control the plasma density, temperature, potential, and flow velocity in the boundary plasma regions.

Therefore, for the purpose of generating and controlling a high-density plasma flow in the edge plasma region, the following research must be considered. [1] Discussions on the above topics and future experimental plan, contributing to the confinement improvement. [2] Simulation experiments, using devices in our university to produce high-density (up to 10^{13} cm^{-3}) helicon plasmas.[1] Here, helicon plasmas have been recently attracting much attention because of a flexible operation of the external parameters. [3] An exploration of the operational parameters, using the helicon devices. [4] A design and a fabrication of new antennas to produce a high-density plasma flow in the GAMMA 10 device. Then, we will find a clue to solve problems of the confinement improvement after some analyses and detailed discussions. Final targets are as follows: electron density > 10^{13} cm^{-3}, particle flux 10^{24-25} $cm^{-2} \cdot s^{-1}$ and energy flux 10 $MW \cdot m^{-2}$.

In this fiscal year, we have carried out the above plan as follows. [1] Continuing discussions,[2] we have considered future plan with some constraints. [2] As to Large Mirror Device LMD, a high-density helicon plasma up to 10^{13} cm^{-3} has been successfully produced and characterized. Small helicon device SHD was also characterized.[3-5] [3] Expanding operational parameters has been executed, focusing the magnetic field configurations (relating to a flexible operation in the GAMMA 10 device), plasma diameter, plasma density, its temperature and potential, and flow velocity.[6-10] [4] As a test experiment for producing a helicon plasma in the GAMMA 10 device, we have been continuing the experiment, using the present antenna and end diagnostics. The magnetic field configuration in the experiment is shown in Fig. 1, using a pre-ionization technique by ECR.

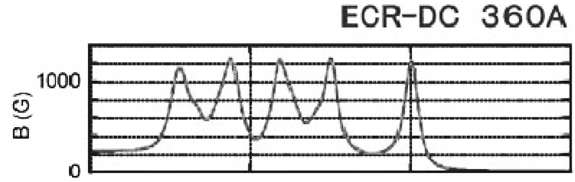

Fig. 1 Magnetic field profile in the present experiment.

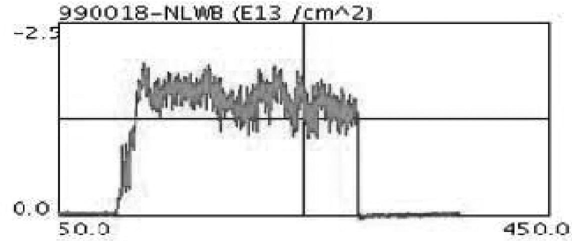

Fig. 2 Time evolution of line-integrated electron density.

In addition to hydrogen gas, we have used argon gas with the lower pressure to reach the region of typical helicon discharges. However, a density increase was smaller than expected in the plug/barrier region. Figure 2 show time evolution of a line-integrated electron density (mean electron density was ~ 10^{12} cm^{-3}). Here, we have changed the pulse width of gas puffing, whose flow rate is proportional to a tank pressure, and rf power (up to 100 kW).

In conclusion, we have discussed the next research plan, considering the crucial points of the characterization and control of high-density plasmas in the edge region, as well as the simulation experiments in our university. We have also executed the test experiment in the GAMMA 10 device to try to increase the electron density in the edge region. In future, we must advance the initial experiment using the GAMMA 10 device actively to estimate and control the high-density plasma flow.

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