§16. Study on Generation and Control of High-Density Flow in Boundary Plasma

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Characterization and control of high-density plasma flow in both ends in the axial direction are important from a viewpoint of plasma confinement improvement, in the device GAMMA10, Plasma Research Center (PRC), Univ. of Tsukuba. Especially, in order to advance the main confinement research, it is essential to estimate and control the plasma density, temperature, potential, and flow velocity etc. 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) The above topics and future experimental plan, contributing to the confinement improvement, will be discussed. 2) In order to simulate the GAMMA 10 device, our devices such as the Large Mirror Device (LMD) [1] will be operated to produce a high-density (up to 10^{13} cm^{-3}) helicon plasma [2-4]. Here, helicon plasmas have been recently attracting much attention because of a flexible operation of the external parameters. 3) Considering the plasma parameters in the GAMMA 10 device, an exploration of the operational parameters will be done, using the helicon devices. 4) Based on the above results and further discussions, a design and a fabrication of new antennae will be executed 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 on this device after some analyses and detailed discussions.

In this year, we have carried out the above plan as follows. 1) At the operation time of GAMMA 10, on May and December, 2012, we joined preliminary measurements using an electrostatic probe and a high speed camera, as shown in Fig. 1. On August, 2012, at PRC, there was OS2012/ PMIF2012 conference meeting, and we reported the recent results on helicons related to this topic. Our future plan has been also discussed, utilizing this opportunity. 2) As to LMD, a high-density helicon plasma up to 10^{13} cm^{-3} has been successfully produced. Depending on objectives, antenna shapes were changed, e.g., loop, spiral, and helical types. 3) An additional survey of expanding operational parameters has been executed, focusing the magnetic field configurations (relating to a flexible operation in the GAMMA 10 device), plasma diameter, etc. We have also constructed SHD (Small Helicon Device) to investigate a frequency dependence (a wide range of 7-150 MHz) to produce a high-density helicon plasma. 4) As to the future plan, we have been discussing the above parameters in the edge region of LMD to be applied to the GAMMA 10 device, along with the diagnostics required. Furthermore, the research of forming a high-density plasma flow in the edge region is being planned.

In conclusion, we have discussed the next research plan, considering the preliminary experiments, the crucial points of the characterization and control of high-density plasmas in the edge region. We will continue this discussion and also the simulation experiments. Then, through preliminary measurements and experiments in the GAMMA 10 device, active experiments on the estimation and control of plasma parameters in edge plasma region will be expected.

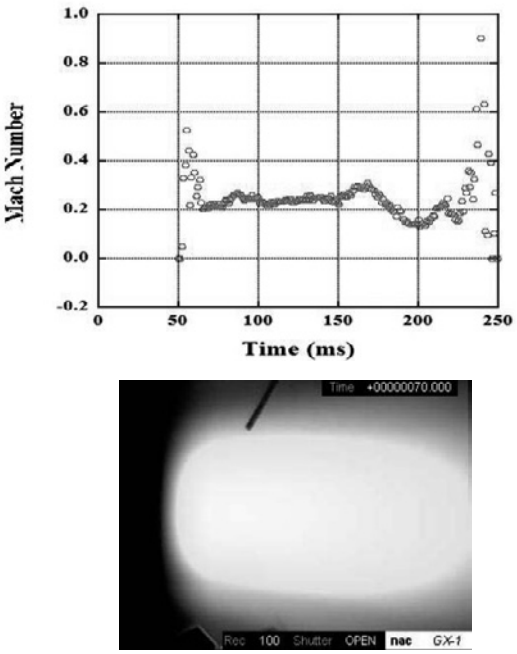

Fig. 1 Time evolution of Mach number near plasma edge by an electrostatic probe (left: SN225614), and plasma light emission by a fast speed camera (right: SN225612)

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3) S. Shinohara, 37th European Physical Society Conf. on Plasma Phys. (2010) I1.301. (Invited Talk)
4) S. Shinohara, APCPST & 23rd SPSM, 2010, IEM-05. **(Invited Talk)**