§13. Basic Study on Generation and Control of High-Density Plasma Flow in the Plasma Edge

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From a viewpoint of an improvement of plasma confinement, characterization and control of high-density plasma in both ends in the axial direction are important in the device GAMMA10, Plasma Research Center (PRC), Univ. of Tsukuba. Especially, in order to advance the main confinement research in this device, 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 plan in a systematic way has been established. 1) The above topics and future experimental plan, contributing to the confinement improvement, from a basic viewpoint will be discussed. 2) In order to simulate the GAMMA 10 device, the maintenance of devices such as the Large Mirror Device (LMD) [1] and the High Field Device (HFD) [2], which were carried from Kyushu Univ. to Tokyo Univ. of Agriculture and Technology (TUAT), will be performed to produce a high-density (up to 10^{13} cm^{-3}) helicon plasma [3-5]. Here, helicon plasmas have been recently attracting much attention because of a flexible operation of the external parameters such as the magnetic field, the field configuration, a fill pressure, and an excitation frequency. Note that we have been executing many experiments to have many findings on helicons [6-9]. 3) Considering the important plasma parameters in the GAMMA 10 device, an exploration of the operational parameters to have the effectively same plasma regions as that device, using the LMD/HFD in TUAT. 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.

We have carried out the above plan discussed as follows. 1) At the joint symposium held in Tsukuba, on July, 2011, our research plan was presented. Utilizing this opportunity, additional discussions have also been done. On Dec., 2011, at PRC, in a seminar style, our future plan has been discussed focusing on topics, along with the visit of the GAMMA 10 device in operation. 2) As to LMD, carried from Kyushu Univ. to TUAT, a high-density helicon plasma up to 10^{13} cm^{-3} has been successfully produced. Here, LMD has a diameter of 45 cm and an axial length of 170 cm with the axial magnetic field of 1 kG. The Radio Frequency (RF) power supply can deliver the power up to 5 kW in a frequency range of 3 -15 MHz Depending on objectives, antenna shapes can be changed, e.g., loop, spiral, and helical types. 3) A survey of expanding operational parameters has been executed, focusing the magnetic field configurations, plasma diameter, plasma density, temperature, potential, flow velocity etc. 4) Considering the future experimental 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, concretely, a research plan to form a high-density plasma flow in the edge region is being considered for the next year program: design of helicon plasma antennae, conditions of RF power supply, and a candidate of ports in the GAMMA 10 device to be used.

In conclusion, we have discussed the concrete research plan, considering the crucial points of the characterization and control of high-density plasmas in the edge region of the GAMMA 10 device, leading to the confinement improvement. We will continue this discussion executed and also the simulation experiments using LMD and/or HFD. 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.

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