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

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In the plasma edge, especially, in both ends in the axial direction, characterization and control of high-density plasma are important from a viewpoint of plasma confinement improvement and the divertor physics in the device GAMMA10, 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) The above topics and future experimental plan, contributing to the confinement improvement, will be discussed from a basic point. 2) In order to simulate the GAMMA 10 device, devices in our univ. will be operated 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) 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. 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 the activity done last year, we have published a paper [2] and discussed our future plan. 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 constructed was also characterized [3,4]. 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 [5,6]. 4) As an initial experiment for producing a helicon plasma in the GAMMA 10 device, we have used the present antenna and end diagnostics, as shown in Fig. 1.

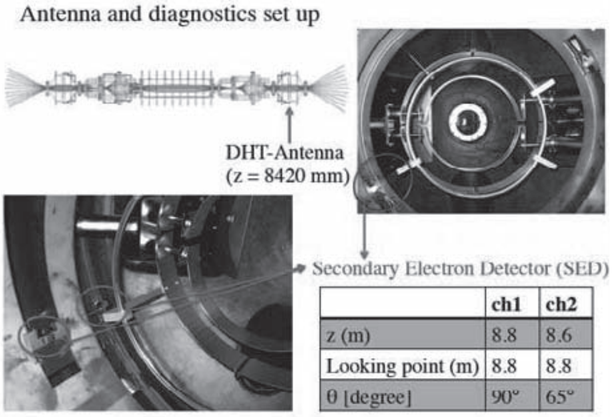

Fig. 1 DHT antenna and SED in the edge region of the GAMMA 10 device.

We have produced the target plasma with a low density by ECR method, and tested the density increase by the use of the antenna in the edge region. Here, the excitation rf frequency is between the electron and ion cyclotron frequencies, thus the magnetic field was lower than a normal operation. Since a fill pressure of hydrogen was less than 0.1 mTorr, the density increase was lower than expected. It is necessary to consider the gas species and its fill pressure in addition to the antenna shape and its position, and also the magnetic field configuration as a next step plan.

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 univ. We have also executed the initial experiment in the GAMMA 10 device to try to increase the electron density in the edge region using the present facilities.

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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5) S. Shinohara, PPPS 2013, 2013, 6F-7. (**Invited Talk**)
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