7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Measurement of heat quantity incident into a bias-type calorimeter for divertor thermal load reduction by direct energy conversion

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In a tokamak reactor, the plasma facing surface of the divertor plates will be exposed to high heat flux, and the thermal load reduction of the plates is one of the significant subjects. As one of the solutions, an application of a Cusp-Type Direct Energy Converter (CuspDEC), which was originally designed for a D-^{3}He Field Reversed Configuration fusion reactor, was proposed.[1] According to the proposal, high-energy charged particles from core plasma are separated in polarity in the CuspDEC. The separated ions and electrons are guided to different divertor plates. Each particle is decelerated by an electric field due to the appropriately biased divertor plate.

We are planning a simulation experiment using a bias-type calorimeter (CM).[2] The CM has a function to measure incident current (I_{in}) as well as temperature of the target plate. In the previous research of an analytical experiment, we used the CM to find an optimum bias voltage for thermal load reduction. To establish a reliable scheme, we needed the relation between heat quantity detected by the CM (Q_{det}) and estimated heat quantity incident into the CM (Q_{in}).[3] Q_{in} was sum of the energy given by the incident particles. The particle energy was calculated by using a model in which particles were accelerated or decelerated by the potential difference between the plasma and the CM. However, the plasma in the experimental device was floating, so we were unsure of the exact plasma potential and had a difficulty to evaluate Q_{in}.

We have started a similar experiment with a different device in which an extraction electrode is equipped with the outlet of the plasma source to estimate plasma potential accurately by the information of the electrode voltage.[4] This experimental device is schematically shown in Figure 1. Argon plasma was generated by applying RF power inductively. The plasma was guided to the CM to which bias voltage (V_{bias}) was applied. In this device, we obtained the voltage of the extraction electrode (V_{ex}) as well as signals of the CM. In the last report,[4] the incident heat quantity was too small to evaluate precisely. In the present experiment, we applied bias voltage to convergence electrode (V_c) and succeeded to improve heat quantity incident into the CM.

Figure 2 shows measured I_{in}-V_{bias} characteristic of the CM. Blue filled circles and open red circles are results of the last experiment and the present one, respectively. The convergence electrode was floated in the last experiment, and biased with 300V in the present one. We can find the incident current for the same bias increases significantly. In response to I_{in}, Q_{det} also increased. The detailed results will be shown in the conference.

This work is supported in part by the bilateral coordinated research between PRC, Univ. Tsukuba, NIFS, and Kobe Univ. (NIFS19KUGM147).

References

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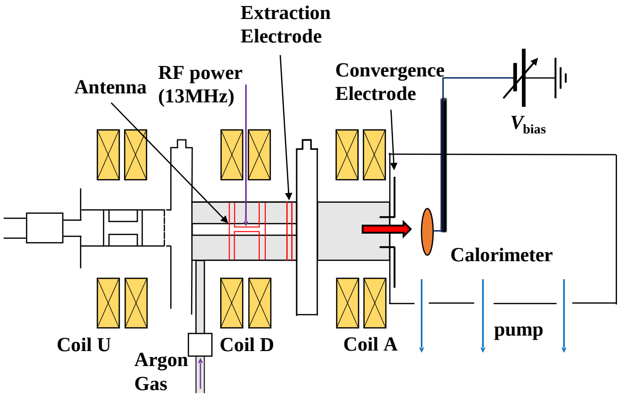

Figure 1. Schematic image of the experimental device.

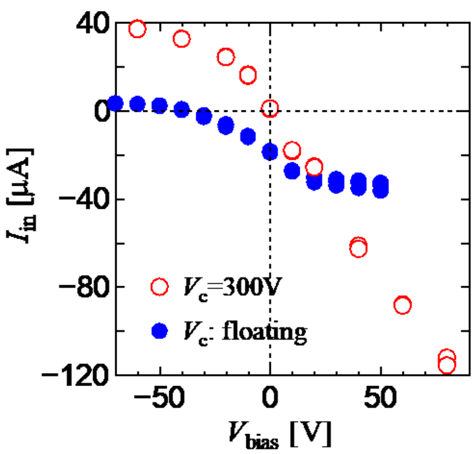

Figure 2. Measured current versus bias voltage of the calorimeter.