§85. Study of Temporal Response of Electron Supply from Plasmas to Fast Collection of Bulk Electron: Development of a Bias Electrode

Nagashima, Y., Zushi, H., Hanada, K., Fujisawa, A., Nakamura, K., Idei, H., Hasegawa, M. (RIAM, Kyushu Univ.),
Takase, Y., Ejiri, A. (Univ. Tokyo)

Research on confinement and circulation of plasma particles in confined and scrape-off layer plasmas is one of the most important studies in fusion community. In the QUEST steady state spherical tokamak in RIAM, Kyushu University, mechanism of particle circulation has been investigated. Edge particle transport driven by turbulence fluctuation in the plasma edge may play an important role in the mechanism. To investigate the edge transport in the steady state spherical tokamak, a novel method has been suggested. In this study, we apply a high frequency voltage to an electrode which withstands high heat flux from the steady state plasma, and a flux surface where electron population has decreased relative to quasi-neutral plasmas will be made. After stopping the application of the voltage, we observe a time evolution of the recovering time of the electron population in the flux surface. From the recovering time, we try to extract stationary and fluctuating electron transport on the flux surface.

Design concepts of the electrode are as follow. First, the electrode should withstand high heat flux. In particular, the movable limiter on the vessel wall in QUEST which can have high temperature of a few hundreds centigrade without water cooling system suggests that the electrode is exposed high heat flux even in the SOL plasma. Second, the electrode should be isolated from the scrape-off layer (SOL) plasma to apply bias voltage at the radially localized position. Third, the electrode collecting the electron should have a reasonable “floating potential”, and therefore insertion of high energy electron to the electrode should be avoided as much as possible. This is because that the bias voltage is applied by a power supply with practical specification such as voltage dynamic range. However, the floating potential of the bias electrode can become negatively high (close to an order of kV) when the electrode collects the high energy electron. If necessary, the bias voltage will be applied through an isolation capacitor.

Progress of the development of the electrode is described. The tungsten electrode attached to copper water cooling system without defect (Non Defective Bonding, NDB), that is, NDB plate, was completed in 2013 fiscal year, and some improvement in detail was made in 2014 fiscal year. In the previous schedule, installation would be made within H26 fiscal year. However, the NDB plates are so heavy, and a complete design change of the mounter of the NDB plates was necessary to keep ease radial movability of the electrode. Therefore, a new schedule of the installation of the electrode is around the end of June, 2015.

We also considered the additional power supply for the high frequency biasing. This is because we do not have sufficient information of required specification of the power supply for the frequency response or the slew rate. Now we have a power supply up to 100 kHz. For the high bias power supply with the frequency higher than 100 kHz, we need radio-frequency (RF) power source. In addition, we need a matching circuit and/or an impedance transformer circuit. The development of the circuits is challenging. After the bias experiment using the low frequency power supply, in the next fiscal year, we will develop the circuits. At the preliminary phase of the high frequency bias experiment, we will use the developed circuits and the high frequency RF power supply borrowed from the other facilities.