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

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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 by turbulence fluctuation in the plasma edge may play an important role in the mechanism. To diagnose and electrically perturb the edge plasmas of the steady state spherical tokamak, an electrode which withstands high heat flux from the steady state plasma is required. In this study, we have progressed development of the electrode for biasing (bias electrode).

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.

Schematic view of the bias electrode is shown in Fig. 1. First, the electrode is made of tungsten to withstand the high heat flux. In addition, the tungsten electrode is attached to copper water cooling system without defect (Non Defective Bonding, NDB). The NDB process is used in the movable limiter and its performance of cooling has a track record. Second, to keep electrical isolation of the electrode from the SOL plasma, the bias electrode has a coaxial structure, and has the inner and outer electrodes. One electrode is electrically isolated from the other, and both the electrodes are also isolated from the vessel. The inner electrode is the main electrode which can be attached to the confined edge plasma. The outer electrode is used to guard the inner electrode from the SOL plasma. Both the electrodes is radially movable with the stoke length of 500 mm. In addition, the inner electrode is movable separately with the stroke length of 100 mm to control exposure of the inner electrode to the plasma. Third, the outer electrode has a notch at the head, and the angle position of the notch is changeable. The notch has a role to collect the bulk electron, and the outer electrode can cover the inner electrode from the high energy electron inserted from the opposite of the notch. However, even if the notch is used, there is a possibility to fail to cover the inner electrode from the high energy electron, and to fail to collect the bulk electron. In the case, combination of the two bias power supplies is considered. One power supply is used to add DC bias voltage, and the other is used to add oscillatory bias voltage through a capacitor.

Under the design concept, construction of the bias electrode has been realized, and will be completed in FY2014.

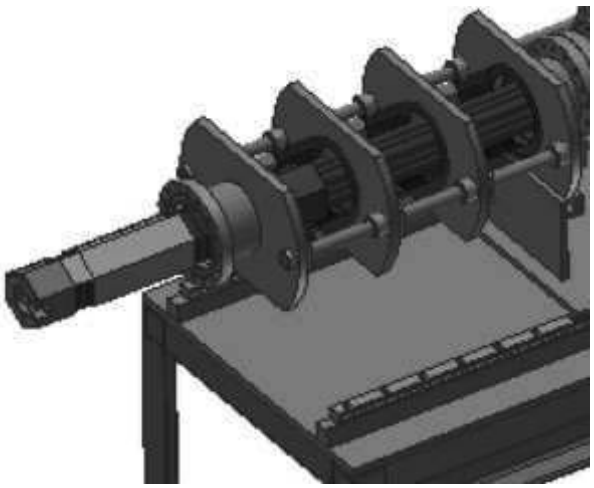

Fig. 1 Schematic of bias electrode. The left side of the figure can be attached to plasma.