§18. ICRF Heating Experiment Using Faraday Shield Less Antenna in LHD

Seki, T., Mutoh, T., Saito, K., Kasahara, H., Seki, R., Kamio, S., Osakabe, M., Igami, H.,
Nagasaki, K. (IAE, Kyoto Univ.)

Impurity influx during ICRF heating has been a serious problem from the early phase of fusion research. It was thought that the RF electric field parallel to the magnetic field line near the antenna caused the impurity influx, and Faraday Shield (FS) was thought to be necessary to shield out such an electric field. If the FS is possible to be removed, the design and the construction of the antenna become much easier. It will have an impact on the designing of the antenna for the steady-state fusion devices. Some experiments without FS have been carried out in tokamak devices in short pulse length [1-4]. Those results were different from the device-to-device and high-power and long-pulse experiments have been awaited.

In LHD, Faraday Shield of one strap of PA (Poloidal Array) antenna was removed as shown in Fig. 1. Another purpose of removing FS of this antenna is avoidance of arcing between FS and inner conductor, which occurred during the long pulse operation in former experiments. The experiments evaluating the antenna and the heating performance were carried out at the wave frequency of 38.47 MHz and the condition of minority heating. Figure 2 shows the plasma loading resistance of with and without FS antenna. The loading resistance without FS was increased twice or more, which means the higher power can be injected from the FS less antenna when the same power is supplied from the RF amplifier. The voltage of the transmission line connected to the FS less antenna can be reduced due to the higher loading resistance. Increase of the loading resistance is larger at the large antenna-plasma gap. This is a favorable dependence when the antenna is operated far from the plasma.

Fig. 1. Photo of PA antenna. FS of upper antenna was removed.

Behavior of the plasma parameters was directly compared in the same plasma discharge as shown in Fig.3. Heating power of about 600 kW was injected from without and with FS antenna, respectively. Behaviors of plasma stored energy, line-averaged electron density, central ion temperature, CIII intensity, radiation loss power were almost same. They were slightly large in the case of with FS antenna because of the slightly higher injection power. Harmful effect such as severe impurity influx and radiation collapse was not observed during the injection from without FS antenna. More than 700 kW was injected from the FS less antenna like other antennas in high power injection. Injection power of 150 kW was injected in 48 minutes operation without problem so far.

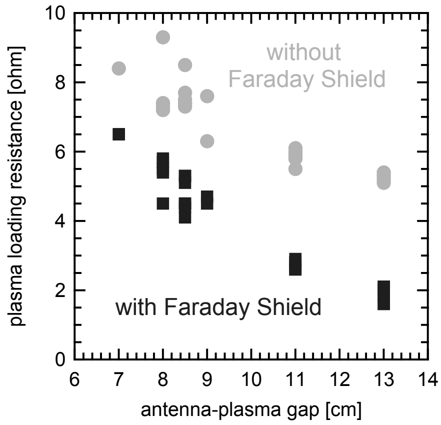

Fig. 2. Comparison of loading resistance with and without FS as a function of antenna-plasma gap.

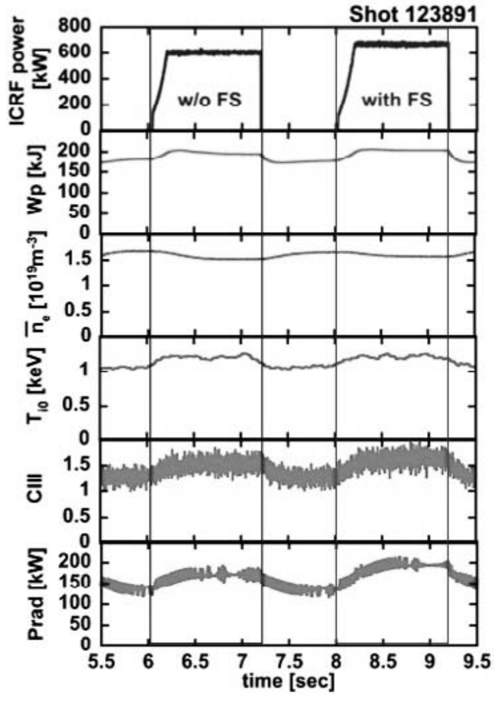

Fig. 3. Time behavior of plasma parameters for injection from without and with FS antenna.

1) Van Nieuwenhove, R. et al.: Nucl. Fusion **32** (1992) 1913.
2) Sorensen, J. et al.: Nucl. Fusion **33** (1993) 915.
3) Noterdaeme, J.-M. et al.: AIP Conf. Proc. **355** (1995) 47.
4) Swain, D. W. et al.: Nucl. Fusion **37** (1997) 211.