Study of antenna loading resistance of LHD ICRF antenna

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Ion cyclotron range of frequencies (ICRF) heating is one of the heating methods using for the plasma heating in the magnetic confined fusion plasma experiments. It is used in the Large Helical Device (LHD) and contributes to the high power and steady state experiments. Loop antennas located at the outer region of the torus launch the fast waves. Several heating modes are utilized by changing the wave frequency, strength of the magnetic field, working gas and so on.

Antenna loading resistance is important for the ICRF heating. High antenna loading resistance is required for the high power injection. More than five ohms is needed for injecting 1 MW per one antenna loop in LHD ICRF antenna.

There are many elements which have influences on the antenna loading resistance. The plasma density in front of the antenna is important. The loading resistance increases with the plasma density. Distance between the antenna and the plasma boundary is closely related to the plasma edge density. It is important to keep the antenna away from the plasma in the steady state operation and the reactor relevant plasmas. It is important issue that high power injection is carried out in the low-density plasma and/or the case of long distance of the antenna from the plasma.

Dependence of the loading resistance on the wave frequency is also investigated. Many kinds of the heating modes such as the minority heating, the mode-conversion heating, the second and the higher harmonic heating are included. The cases of the ICRF heating only and with the superposition of the ECH and/or NBI are also included. The frequency dependence is most serious than any other plasma parameters. The loading resistance is very low at the low frequency range around 25 to 28 MHz. High power injection using such frequencies was difficult in the plasma heating experiments.

The antenna loading resistance will be evaluated using calculation code with inclusion of the plasma and compared to the experimental results. These results will contribute to the design of the new ICRF antenna and the ICRF heating experiment in LHD and the ICRF heating in the future plasma devices.