§15. Heating Characteristics of Upper and Lower ICRF Fast Wave Antennas

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ICRF heating experiment in LHD has started from the 2nd cycle of experimental campaign. One pair of loop antennas which is installed from top and bottom ports is used. These antennas, so called, upper (U) and lower (L) antennas have the almost same structure. The difference is that the U antenna is not grounded positively but the L antenna is connected to the vacuum vessel by three thin copper straps. It is interesting to study the grounding effect on heating performance by comparing those of the U and L antennas.

Figure 1 shows the time evolution of plasma parameters in four heating cases: no ICRF heating, ICRF heating using U antenna, L antenna, and both U and L antennas. The magnetic field is 1.5 Tesla, the RF frequency is 25.6 MHz, and gap between the antenna and last closed flux surface is 5 cm. Gas puff ratio of H/(H+He) is about 0.3. The input power is the same in the case that U or L antenna is used and it is slightly large when both antennas are used. Plasma stored energy is larger than that of electron cyclotron heating (ECH) plasma when ICRF power is injected into the plasma as shown in the top figure of Fig.1. In the case that U or L antenna is used the stored energy is almost the same. The density is almost the same in these cases as shown in the middle figure of Fig.1 (line averaged electron density is 0.8×10^{19} m^{-3}). Serious impurity influx does not occur in this power level. The radiation loss power measured by bolometer increases very much by the injection of ICRF power, compared with no ICRF heating case (the bottom figure of Fig.1). In the case that one of U and L antennas is used the radiation loss is also the same level. From this experimental observation it is concluded that the upper and lower antennas have similar heating properties. It does not affect heating performance whether antenna is grounded to vacuum wall or not.

Figure 2 shows the power dependence of the store energy. The experimental condition is the same as Fig.1. Both U and L antennas are used. The stored energy increases as the increase of the ICRF power in this power level. The maximum ICRF power was limited by breakdown at the transmission line. The target plasma is produced by ECH of 300 kW. The stored energy of the target plasma is about 13 kJ. The increase of stored energy in injecting the 300 kW of ICRF power is also about 13 kJ. This means that the heating efficiency of ECH and ICRF is comparable. We are planning to increase the ICRF power and optimize the heating condition in the next experimental campaign and increase the maximum stored energy.

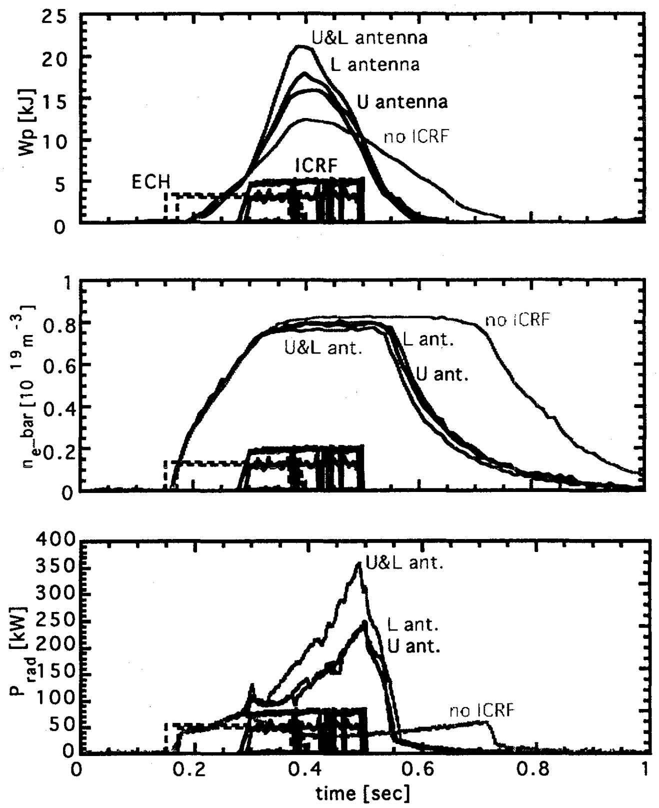

Fig.1 Time evolution of plasma parameters; top, middle, and bottom column shows plasma stored energy, line averaged electron density, and radiation loss power, respectively.

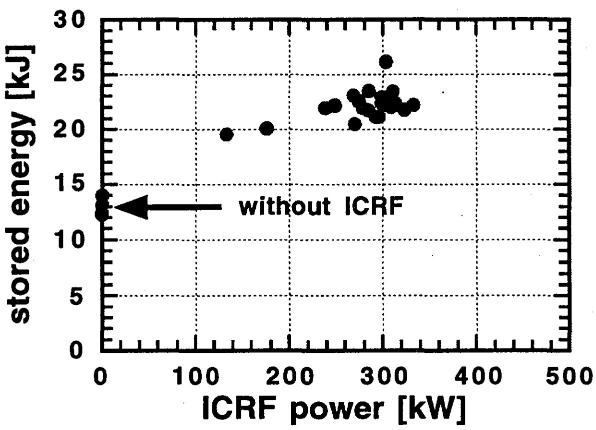

Fig.2 ICRF power dependence of plasma stored energy.