§28. Plasma Sustenance with High Power ICRF Heating

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The ICRF heating experiment in LHD has been started in the 2nd cycle experiment and high heating efficiency comparable to NBI heating was shown experimentally in the 3rd cycle experiment. The ICRF power was increased in the 4th cycle experiment owing to the good result of the former experiment. The number of antenna was increased. However, the transmitter and the transmission line were same as those used for pulse operation. Then, the pulse length of increased power was 500ms maximum. The power source and the transmission line will be strengthened in the near future. Figure 1 shows the progress of the ICRF power injected into the plasma. In the 2nd cycle experiment, strength of magnetic field was low (1.5 T) and heating condition was not optimized. Radiation loss power during the ICRF power was large and plasma was destroyed when the higher ICRF power was injected. In the 3rd cycle experiment, material of divertor plate was replaced from metal to carbon and radiation loss power during ICRF heating was reduced. Inner shifted magnetic configuration was adapted and ICRF heating mode was optimized. Maximum ICRF power was increased to about 1.4 MW. In the 4th cycle experiment, the maximum ICRF power was increased to 2.7 MW by increase of the antenna power.

Figure 2 shows the maximum stored energy achieved by the ICRF heating only. Strength of magnetic field was 2.775 T and the wave frequency was 40.47 MHz. Unfortunately, the ICRF heating condition was not optimized in this shot. This was because the magnetic field was not increased up to the expected value but the wave frequency was increased. Thus, the ion cyclotron resonance layer was located near the magnetic axis. The ICRF power was applied to the ECH target plasma and increased to more than 2 MW. The stored energy is also increased from 125 kJ to 240 kJ by increase of the ICRF power. The line averaged electron density is decreased during rise of the ICRF power. The central electron temperature is increased. Increase of the stored energy is caused by increase of the temperature. Increase of the radiation loss power is small during the ICRF power. Higher ICRF power seems to be possible to be injected if we have enough heating power.

In future, improvement of the transmitter and the transmission line will make possible to launch the higher ICRF power. Higher stored energy will be attained by optimization of heating mode and higher injection power.

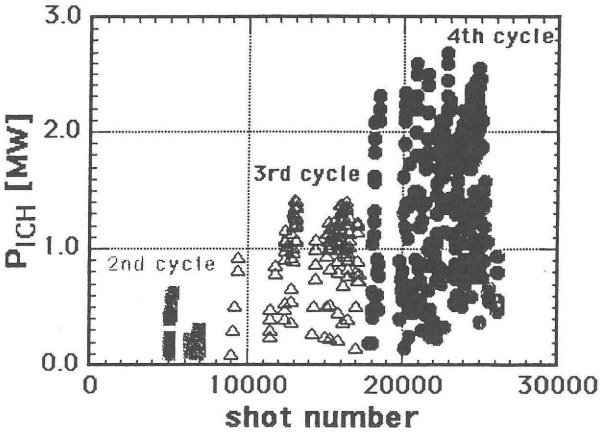

Fig.1. Progress of the injected ICRF power. Solid square, open triangle and solid circle indicate the data of 2nd cycle, 3rd cycle and 4th cycle experiment, respectively.

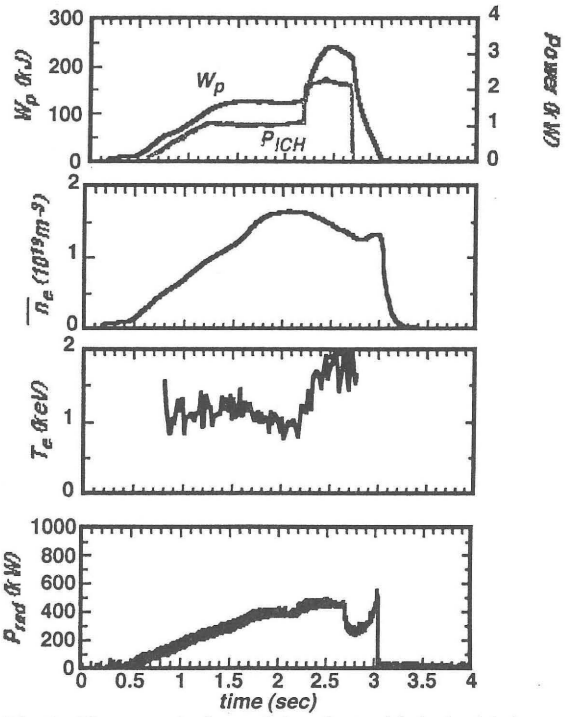

Fig.2. Time evolution of the shot which the highest stored energy was achieved by the ICRF heating only. Stored energy, injected ICRF power, line averaged electron density, central electron temperature and radiation loss power are shown.