

§14. Plasma Wall Interactions of ICRF Heated Plasma in LHD

Mutoh, T., Seki, T., Masuzaki, S., Watari, T.

Plasma wall interaction is an important subject on ICRF heating in toroidal devices. In many helical devices, a radiation signal is increased during the ICRF pulse and it was a serious problem for high quality ICRF heating. In the 2nd cycle experiment in the LHD, radiation signal was also increased during the ICRF heating. Impurity line intensities were also increased in the experiment. Oxygen, carbon and iron lines are observed and especially oxygen and iron lines were increased significantly. As shown in the former pages, OV line increased at early phase of ICRF pulse and also at decay phase of stored energy. It seems to depend on the oxygen influx and also on the edge electron temperature. On the other hand FeXVI line intensity increased monotonically and it has a similar time evolution to the bolometer signal.

Significant change during ICRF pulse was also observed in divertor plasma. Divertor plasma parameters were measured at inboard side of the toroid and far from the ICRF loop antenna. In Fig.1, time evolution of probe temperature is shown. Probes are placed just inside the vacuum vessel and on one of foot points of divertor legs. During the ICRF pulse, large increase of the divertor plasma temperature is observed. Normally the divertor temperatures of ECH heated plasmas remain below 20 eV. In Fig.2, electron density of the probe measurement is also shown. The density behavior depended on the minority ion ratio which related to the wave damping mechanism. In the high H concentration region, density does not increase as in Fig.2, but it increased in low concentration region.

The heating properties of main plasma depended on the minority ion ratio. In Fig.3, the radiation power, impurity line FeXVI and averaged electron density are shown. In the high H concentration region of above 10 %, strong electron damping of excited wave occurred. Then RF field strength on edge and vacuum region seemed to be low and in this region the divertor plasma energy was decreased. The decreases of bolometer and impurity lines were also observed in Fig.3.

In the experiment of 1998, the antenna coupling resistance was quite low and it reflected on the RF field in the vacuum vessel. In the 1999, the resistance is expected to be increased a lot by increasing the LHD magnetic field. Due to the better confinement of fast ions and the reduction of RF field, the impurity problem will disappear in the next campaign.

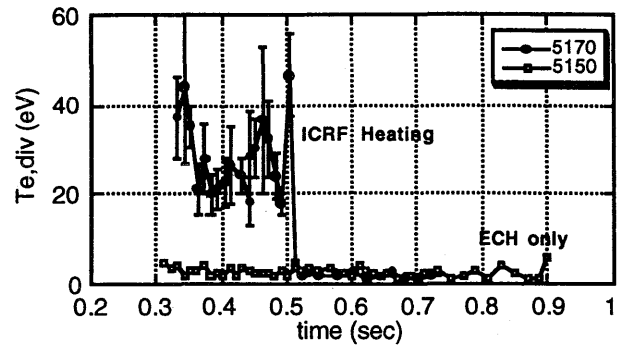


Fig.1 Time evolution of electron temperature of divertor leg plasma with and without ICRF pulse. ICRF pulse was added from 0.3 to 0.5 second. Electro static probes were located at 90 degree away in toroidal direction from the ICRF antennas. ($H/(H+He)=30\%$, $B=1.5T$, $n_e=8 \times 10^{18} m^{-3}$, $P=300kW$, $freq=25.6MHz$)

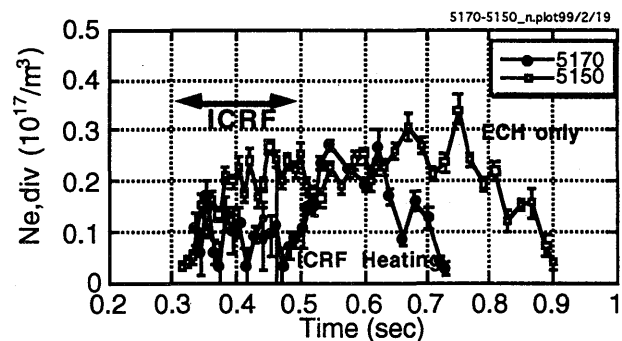


Fig.2 Time evolution of electron density of divertor leg plasma with and without ICRF pulse. During the ICRF pulse, density was increased in low $H/(He+H)$ ratio and decreased in high $H/(H+He)$ ratio.

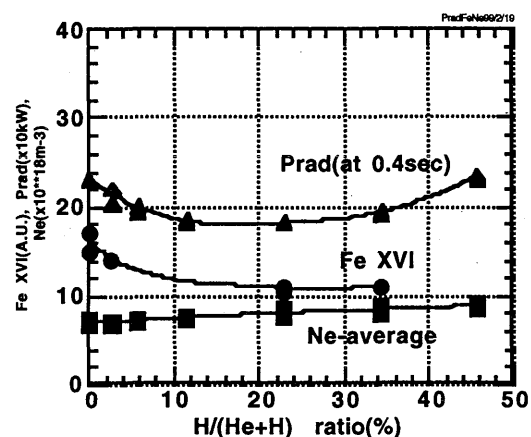


Fig.3 Dependence of bolometer signal, Fe XVI line intensity and averaged electron density on minority ion ratio of plasma. In low $H/(H+He)$ ratio, wave damping by electrons is weak in wave theory.