§4. Density Control for Successful ICRF Heating

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We discuss how a good ICRF heating discharge can be achieved with the aid of measurement of helically trapped ions loss with high energy. Details in helically trapped ion loss measurement are described in another section, Measurement of Helically Trapped Particle. In the series of experiments, RF power was injected only from U-port antenna(single strap).

In this experiment, we confirmed the effectiveness of controlling deuterium gas puffing rate to achieve the good ICRF heating discharge, which means how radiated power can be reduced and how long stored plasma energy can be sustained during ICRF heating period. The gas puffing rate was controlled between 0-9torrl/sec. We had several ICRF heating discharge before acquiring good discharges. At the beginning of the series of the experiment, the gas puffing was not applied during ICRF heating pulse as shown in Fig.1. The average electron density was $1.2\text{-}1.5\times10^{13}\text{cm}^{-3}$ and the plasma stored energy increased up to 700J at its peak value. Then the plasma store energy began to decrease with increase in helically trapped ion loss as shown in the bottom. It took ten ms for high energy ions to be produced and escape the plasma confinement region. The radiated power loss began to increase, delaying another ten ms after detecting helically trapped ion loss. The radiated power(in dashed line) increased up to 200kW, which is almost same amount of ICRF heating power as shown in Fig.1. At the last half of ICRF heating pulse, the plasma stored energy completely disappeared and the electron density gradually decreased because of decrease in ICRF heating power.

We applied deuterium gas puffing with pre-programming method, following no gas puffing discharges. We could sustain and heat the plasma without serious radiated power as shown in Fig.2. In this successful discharge, deuterium gas puffing was applied at 2torrl/sec at the beginning of ICRF heating pulse and was increased to 9torrl/sec at 70ms. The initial target electron density was same as that in Fig.1, however, the average electron density gradually increased to $2.5\times10^{13}\text{cm}^{-3}$ at the end of ICRF heating pulse and the plasma stored energy reached 1kJ. The radiated power was suppressed to less than 100kW except for the beginning of ICRF heating pulse. In this discharge, we did not observe helically trapped ions. In the series of the experiments, we found the correlation between the observation of helically trapped ions and the increase in the radiated power. We can conclude that it is important issue not to produce high energy ions to achieve successful ICRF heating discharges. The reason why high energy ions were not produced in the high density operations is not understood yet, however, an RF power fraction to electrons seems to increase with electron density in the mode-conversion heating scheme. This analysis is now underway.

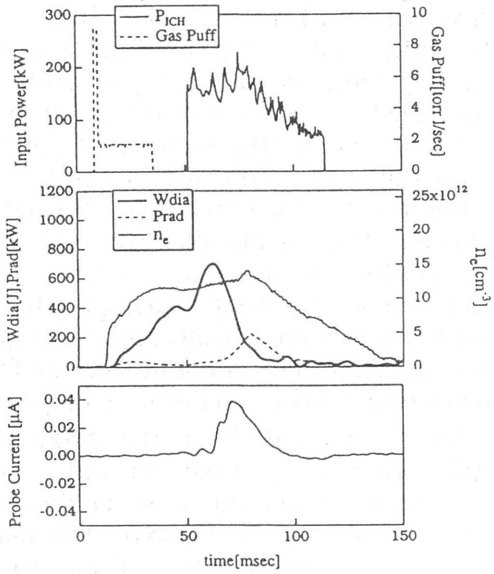

Fig.1 Time evolutions of gas puffing rate, input RF power, stored energy, radiated power, average electron density and helically trapped ion loss without gas puffing during ICRF heating pulse.

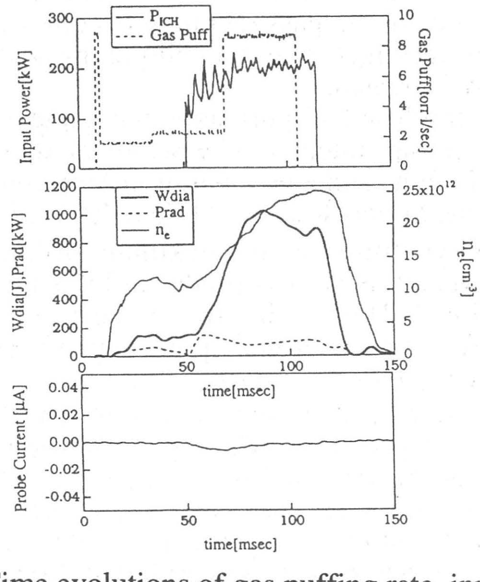

Fig.2 Time evolutions of gas puffing rate, input RF power, stored energy, radiated power, average electron density and helically trapped ion loss with gas puffing during ICRF heating pulse.