§15. Confinement Characteristics on Minority Ratio in ICRF Heated Plasma

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In the 16th experiment cycle (2012) the dependence of a heating efficiency η and a confinement characteristics C_{eff} on the hydrogen minority ratio, i.e., H/(H+He) were examined in detail in subsequence of the same experiment as done on the last experiment cycle (2011). In general the heating efficiency η is improved as the ratio of H/(H+He) decreased up to the LHD experiment limit, i.e., H/(H+He)~10%. The magnetic configuration and the strength has been at R_{ax}=3.6m and B=2.75T in the experimental condition routinely employed for the ICRF heated plasma. In this case the L-cutoff layer is shifted outward by 20 cm from the magnetic axis at H/(H+He)=10% as seen in Fig.1. Then the confinement characteristics, i.e, C_{eff} is decreased by 50% with the decrease in H/(H+He) from 20% to 10%. It is thought that the high-energy ions can be produced at this L-cutoff layer and the heating of the bulk plasma occurs there.

In this experiment cycle the magnetic field strength of B=2.6T is employed, because the L-cutoff layer is just on the magnetic axis at H/(H+He)~10% as seen in Fig.2. The experimental results are summarized in Fig.3. But the H/(H+He) can be changed to only 14% from 20%. $C_{eff}\eta^{0/39}$, η and C_{eff} are plotted against H/(H+He) with solid squares, solid triangles and solid circles, respectively. The arbitrary unit of $C_{eff}\eta^{0/39}$ is derived from measured values of the plasma-stored energy W_p, the electron density n_e and the injected ICRF power from the antennas P_{RF},

$$C_{eff} \times \eta^{0.39} \propto \frac{W_p}{n_e^{0.54} P_{RF}^{0.39}}$$

$C_{eff}\eta^{0.39}$ is almost constant against H/(H+He). On the other hand the heating efficiency η is increased from 55% to 70% with the decrease in H/(H+He) as seen in Fig.3. Unfortunately C_{eff} is almost constant or decreased a little with the decrease in H/(H+He), which should have been increased.

As seen in Fig.3 if H/(H+He) is further decreased to 10%, it is expected that C_{eff} will be increased. In this series of the ICRF heating experiments only the He gas was externally injected and the hydrogen gas was naturally supplied from the vacuum wall. The ration of H/(H+He) is affected with the electron density n_e. It is confirmed that the low 10% of H/(H+He) can be obtained at the electron density more than $n_e=3.5\times10^{19}m^{-3}$. In general the maximum electron density n_{emax} is strongly affected with the ICRF heating power, P_{RF}. $n_{emax}(\times10^{19}m^{-3})=1.8P_{RF}(MW)$ in the case of B=2.75T. But in the case of B=2.6T, $n_{emax}(\times10^{19}m^{-3})=1.2P_{RF}(MW)$. Therefore when the injected RF power is achieved at P_{RF}=3MW, the plasma of $n_e=3.5\times10^{19}m^{-3}$ will be able to be obtained and H/(H+He)=10% will be obtained.

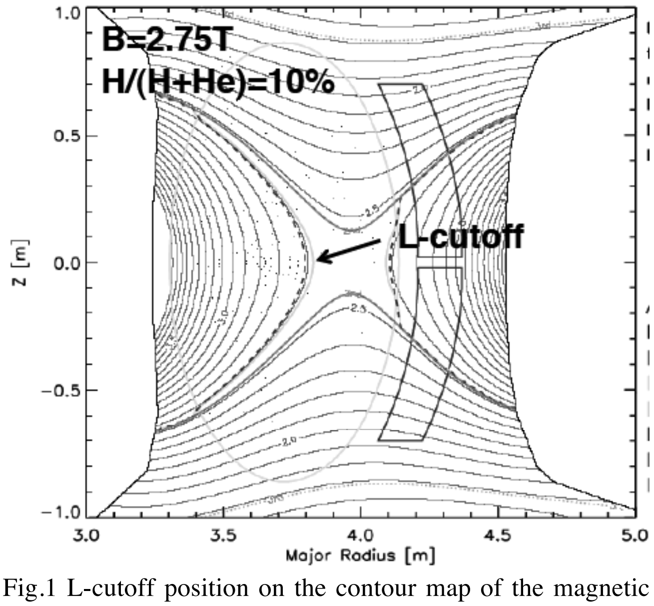

Fig.1 L-cutoff position on the contour map of the magnetic field strength at H/(H+He)=10% in B=2.75T.

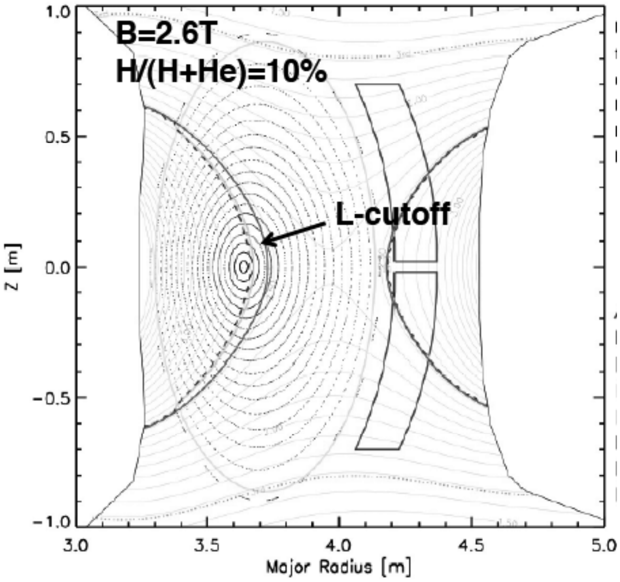

Fig.2 L-cutoff position on the contour map of the magnetic field strength at H/(H+He)=10% in B=2.6T.

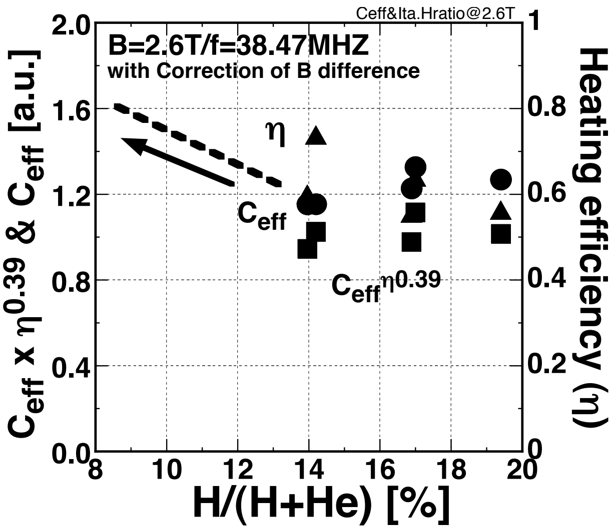

Fig.3 Dependence of $C_{eff}\eta^{0/39}$, η and C_{eff} on H/(H+He) at B=2.6T.