Experimental Investigation of Energy Confinement in the HT-7 Tokamak

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Lower hybrid current drive (LHCD) experiments have been carried out in the HT-7 superconducting tokamak.. The bulk electrons can be effectively heated, owing to the slowing down of the supra-thermal electrons created by the lower hybrid wave (LHW). Investigation of the energy confinement in ohmic and LHCD plasmas in HT-7 has been performed. We also use the CO_2 collective scattering diagnostics to investigate the density fluctuation.

1.The energy confinement of ohmic plasma

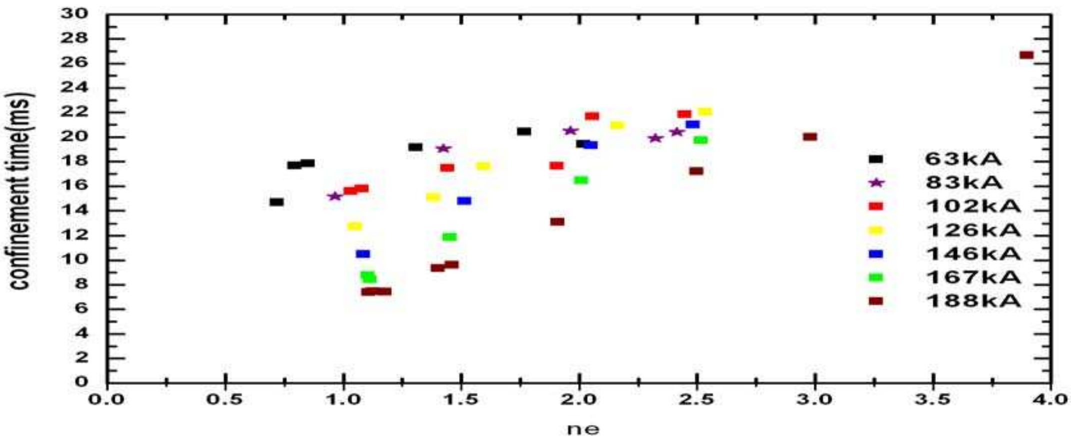

Fig.1. Energy confinement time with various electron density and current

In ohmic discharges , we have scanned electron density and current, it is shown in Fig.1 and Fig.2.. It is found that, the global energy confinement time τ_E decreases with the plasma current, it is considered that the electron temperature increases with the current, so the collision probability decreases, the anomalous transport driven by (trapped electron modes) TEMs increases. For the same reason, the energy confinement time increases almost linearly with the electron density, but it will saturate at a critical density, and the critical density increases with the current., it is because that at higher electron density, the anomalous transport driven by ion temperature gradients (ITGs) increases. So at higher electron density, the energy confinement time with large current maybe exceeds that with small current. The energy confinement time is in good agreement with the Neo-Alcator scaling law when the current is above 145kA, but there are large errors between them. We use ne*Ip$^{-1.2}$ instead of q$^{1/2}$ to fit the data, it is found that it is better than the Neo-Alcator scaling law for HT-7.

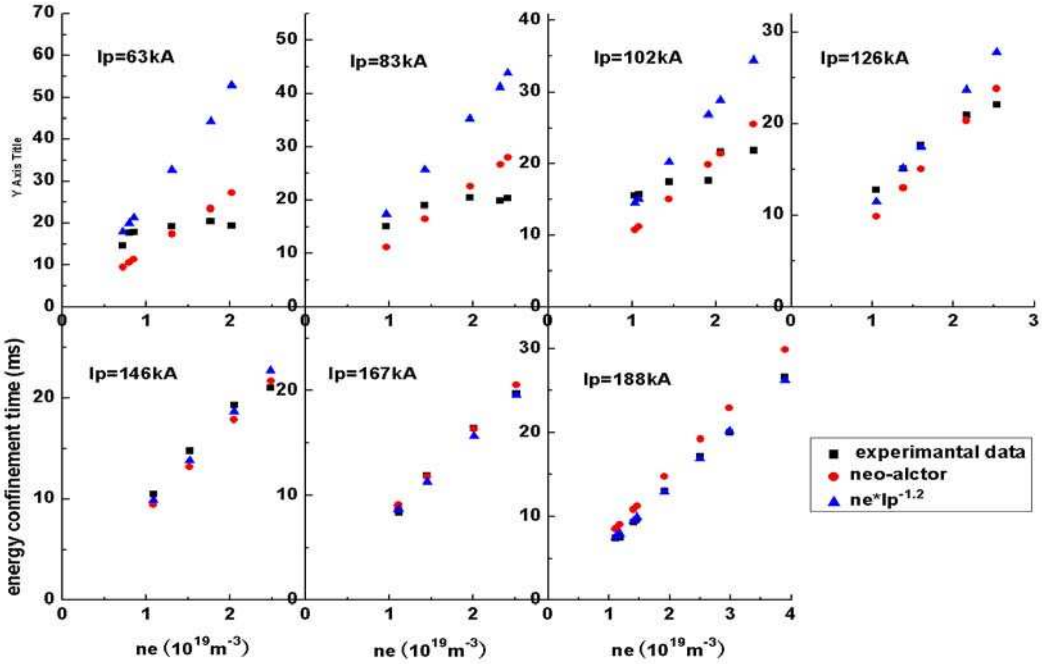

Fig.2. Energy confinement time with various scaling laws

2. The energy confinement of LHCD plasma

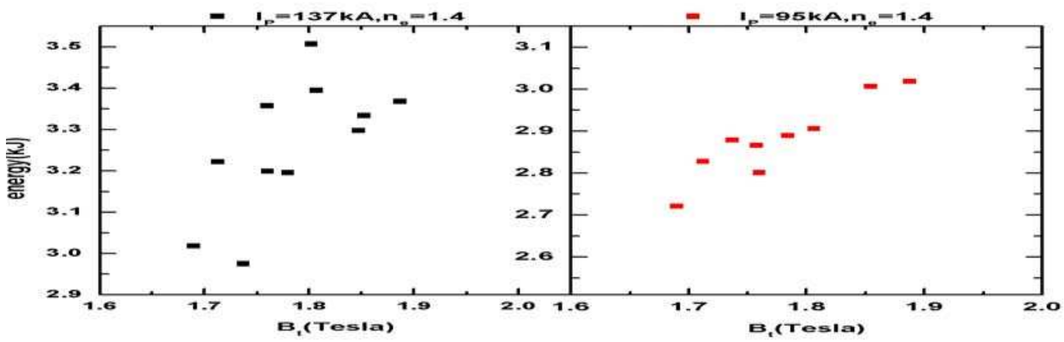

Fig.3. Energy versus toroidal field

In the LHCD discharges, we have performed current, electron density, LHW power, toroidal field scanning. In the LHCD plasmas, the global energy confinement time increases with the toroidal magnetic field, as is shown in Fig. 3, it is considered that the larmor radius and banana width decrease with the toroidal field, so the transport decreases also. The global energy confinement time decreases with the LHW power, as is shown in Fig. 4, it is considered TEMs deteriorate with the increased power. In our plasma current scanning, the energy confinement time first increases with the current when the current is below 130kA, and then decreases with the current when the current is above 130kA, that can be seen in Fig. 5. In the LHCD plasmas, the energy confinement time also increases linearly with the density, saturates at a critical density, and the critical density also increases with the current.

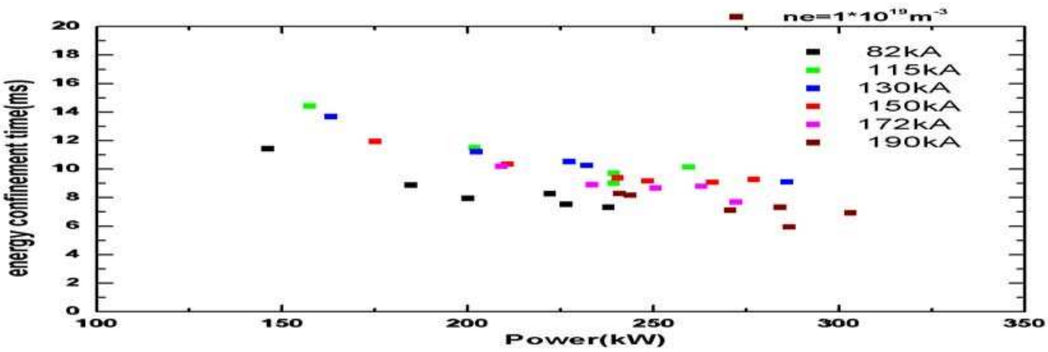

Fig.4. Energy confinement time versus toroidal field for various currents

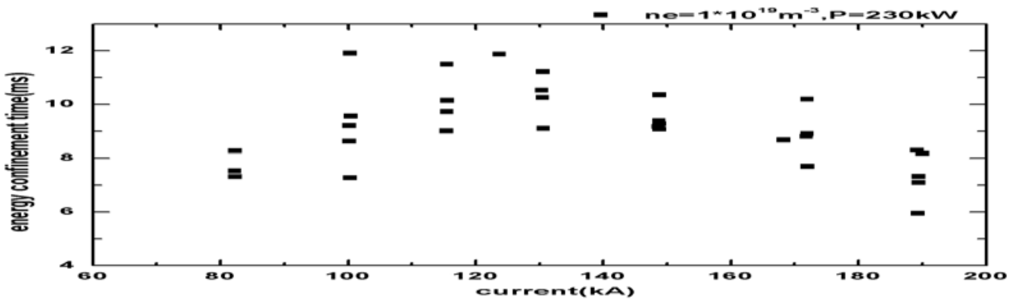

Fig.5. Energy confinement time versus current

2. The density fluctuation of plasma

We also use the CO_2 collective scattering diagnostics to investigate the density fluctuation. In most ohmic discharges, the signal's amplitude is strongly correlated with the Ha signal, and the high frequency part of the spectrum of the CO_2 signal is correlated with Ha signal also, that can be seen from Fig. 6.There is correlation between the low frequency part of the spectrum (about 200kHz) and the energy of the plasma. It can be concluded that the high frequency fluctuations maybe influence the particle transport, and the low frequency fluctuations maybe influence the energy transport. At large k, the high frequency part is too weak, so the high k has little relation to the particle transport, that can be seen from Fig. 7.

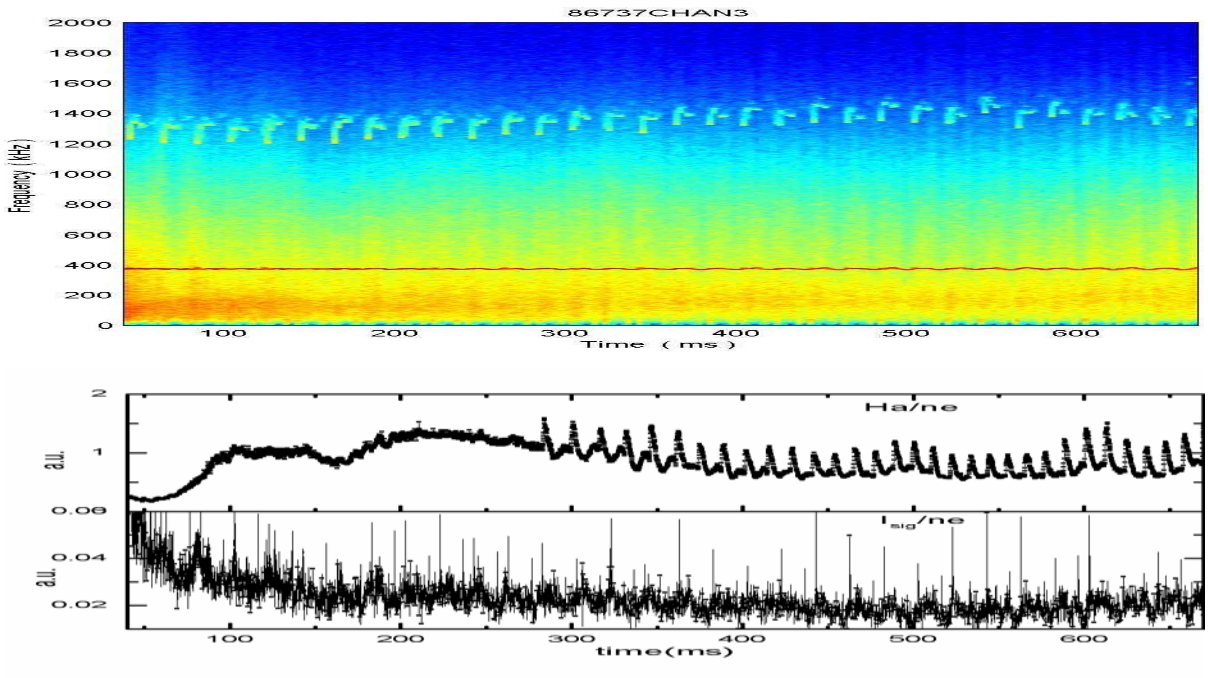

Fig.6. Spectrum, signal and Ha

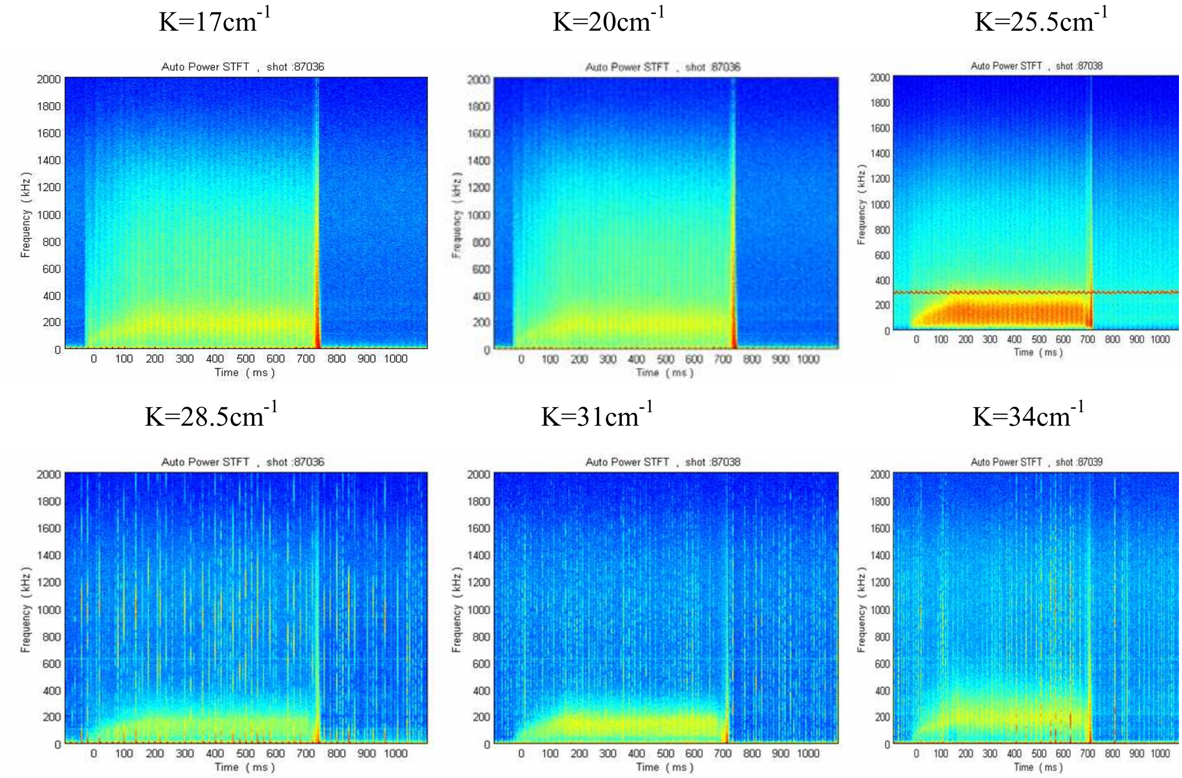

Fig.7. k scanning

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