

Experimental Studies Improving LHCD Capability at High Density on EAST

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High density is a challenge of lower hybrid current drive (LHCD) experiments. Reactor relevant high plasma density regimes have faced the LHCD tool with the challenge of effectively penetrating the main plasma without excessive power dissipation of the coupled radio frequency (RF) power at the edge, mainly due to parametric instabilities (PI), collisional absorption (CA), and scattering from density fluctuations (SDF).

Aiming at fusion reactor, effective current drive at high density is necessary for LHCD. Progress in understanding LHCD at high density has been made through experiments and modeling in EAST, which is encouraging given the need for an efficient off-axis current profile control technique in burning plasma, so as to improve LHCD capability in ITER-relevant regimes, where the dimensionless parameter (f_{pe} / f_{ce}) that characterizes LH wave accessibility and wave refraction is expected to 0.5~0.6 in the steady state scenario phase.

Firstly, the LHCD experiment at high density was investigated with poor and strong lithiation, so as to study the recycling effect on LHCD. Results suggest that strong lithiation gives a significant

improvement on current drive efficiency in the higher density region than $2 \times 10^{19} \text{m}^{-3}$. Studies indicate that the sharp decrease in current drive efficiency is mainly correlated with PI and CA in edge region.

Secondly, in order to demonstrate the PI effect of LHCD, experiments with 2.45GHz and 4.6GHz LH wave were further carried out. It shows that higher source frequency is preferred to improve LHCD capability at high density due to the mitigation of parasitic effects of edge plasma, mainly ascribed to PI. A link between the degradation of current drive (CD) efficiency and the spectral broadening shows that the spectral broadening has a negative and significant effect on CD efficiency. Also, it has been observed for the first time the correlation between the onset of parametric instability of lower hybrid waves and modification in edge plasma current profile on EAST.

Recently, experimental effect of density fluctuation in edge region on LHCD, another candidate related to parasitic effect, has been observed for the first time in EAST. Results show that the current drive capability enhances with decreasing density fluctuation at density of $3.5 \times 10^{19} \text{m}^{-3}$. Such degradation of LHCD at higher density fluctuation is mainly ascribed to the effect of density fluctuation in edge region on launching wave, which is firstly evidenced by the frequency spectrum measurement, leading to more power deposited in the edge region.

In general, studies demonstrate the role and mitigation of parasitic effects of the plasma edge in LHCD and reducing the effect is preferred for LHCD at high density. Results benefit the realization of the fully non-inductive H-mode discharges over 100s in EAST.