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Impact of machine parameters on divertor detachment with ITER-like tungsten divertor in EAST

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High particle and heat fluxes onto plasma facing components (PFCs), especially the divertor targets, is one of the most important issues for steady state operation of fusion devices. The detached divertor operation, as characterized by a strong reduction of both heat/particle fluxes, offers the most plausible solution to these issues for future reactor size devices, such as ITER [1]. In order to further clarify physics mechanism of detachment, the experimental study has been systematically performed in both L-mode and H-mode plasmas on EAST with ITER-like W divertor in the recent campaigns. The divertor detachment is mainly indicated by the rollover of particle flux and the drop in electron temperate down to ~5 eV, as measured by the Langmuir probes at the divertor target [2]. In the study, it was found that the more closed lower divertor has a lower detachment threshold than the more open upper divertor on EAST. In addition, increasing heating power increases the electron temperature at the upstream, leading to higher density at the onset of detachment. However, for high plasma current platform, the normalized detachment threshold is definitely lower due to higher Greenwald density limit [3]. Furthermore, the asymmetries in detachment onset and other characteristics between the inboard and outboard divertor plasmas is found to be primarily driven by plasma E×B drifts [4].

A campaign of pure helium discharges for providing important input for ITER non-nuclear operation phase has also been performed in the EAST tokamak. The detachment in helium plasma was obtained for the first time. The divertor detachment is similar to those in D operations with the rollover of particle flux and the reduction of electron temperature. New results also show that the detachment begins at a higher upstream density than in previous deuterium plasmas, especially for the high power across the separatrix (P_{SOL}) in EAST. The effect of the heating power on the detachment onset was also investigated in helium discharges. Moreover, the comparison of detachment density threshold was made between L-mode and H-mode plasmas. It is very difficult to achieve the detachment by simply density ramping-up, due to the higher power threshold of L-H transition for helium discharges. In order to further clarify the detachment physics, comparisons with SOLPS simulations for matched EAST helium discharges are underway.

In the next research project, integration of detachment control and regulating divertor conditions for steady-state long pulse operations will be carried out on EAST. New advances that may arise in the next research project will also be presented.

References:

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