Steady-state High Performance H-mode Plasmas with Core-edge Integration on EAST towards CFETR

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Long pulse steady-state high performance scenarios have been successfully demonstrated with integration of core-edge solutions on EAST. A fully non-inductive RF-only discharge up to 60s is obtained with β_P ~2.1/β_N ~1.7， H_{98y2}~1.3, n_e/n_{GW} ~0.75, small ELMs and e-ITB, where the plasma configuration is the upper single null on the tungsten divertor. In the operation, the optimization of X-point, the outer gap and local gas puffing near LHW antenna were investigated to maintain RF power coupling and to avoid formation of hot spot on the 4.6 GHz LHW antenna. Global parameters (B_T, $<n_e>$, etc.) were optimized for high efficiency of LHW and deposition of ECH. The on-axis ECRH was applied for the control of high Z impurities in the core plasmas. Meanwhile, a higher β_N ~1.8 H-mode plasma with duration of 20s is achieved by the modulated neutral beam. Other features such as metal wall, low torque injection (T_{INJ}~1.0Nm), electron dominated heating ($T_e>T_i$), moderate bootstrap current fraction （f_{BS}~50%）,broaden current density profile with the central q(0)>1.0, have also been addressed in this scenario. Towards future fusion reactors, to fully integrate core-edge solutions is a big challenge: high core performance and strong edge dissipation are required simultaneously. In recent experiments, EAST has successfully achieved a compatible core and edge integration in high β_p scenarios: high confinement H_{98y2} >1.2 with high β_P~2.5/β_N~2.0, f_{BS}~50% is sustained with reduced heat flux by active divertor heat flux at high density n_e/n_{GW}~0.7. By active impurity seeding through radiative divertor feedback control via radiated power, the peak heat flux is reduced by ~30% on the ITER-like tungsten divertor, here a mixture of 50% neon and 50% D_2 is applied. It can be further reduced with divertor flux splitting by applying n=1 RMP. In this paper, the detailed physics basis will be presented for understanding fully integrates core-pedestal-SOL-divertor solutions on EAST. With features such as dominant electron heating, low torque and an ITER-like tungsten divertor, the integrated core-edge solution development EAST will make unique contributions to the critical issues for ITER and CFETR steady-state operation.