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Advance of H-Mode Physics for Long-Pulse Operation on EAST

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Since the last IAEA-FEC, significant progress has been made on EAST on both physics and technology fronts towards the long-pulse operation of high-confinement plasma regimes. EAST has been upgraded with more than 25 MW of CW heating & current drive power, along with 70 diagnostics, two internal cryopumps, an ITER-like W monoblock top divertor and resonant magnetic perturbation coils, which will enable EAST to investigate long-pulse H-mode operation with dominant electron heating and low torque input, which will be facing challenges on some of critical issues on ITER. New information has been obtained on the physics of L-H transition. Remarkable efforts have been made in mitigating type-I ELMs in a stationary state H-mode plasma with multi-pulses of supersonic molecular beam injection (SMBI), LHCD, lithium granule and deuterium pellet injection, as well as RMPs, thus potentially offering a valuable means of heat-flux control for next-step long-pulse fusion devices. Long-pulse H-mode discharges with H(98,y2) ~1 have been obtained either with ELM mitigation or in a small ELMy regime accompanied by a new electrostatic edge coherent mode, which appears in the steep-gradient pedestal region and plays a dominant role in driving heat and particles outwards. High peak heat load on the divertor due to type I ELMs, is reduced either by SMBI or LHCD. We find that ELM mitigation with SMBI is due to enhanced particle transport in the pedestal, correlated with large-scale turbulence and strongly anti-correlated with small-scale turbulence, while LHCD induces edge plasma ergodization, broadening the heat deposition footprint. Challenges and progresses on plasma control, effective H&CD, plasma-wall interactions under long-pulse, high-heat flux and high-Z metal wall conditions will also be presented.

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China

Author: Mr WAN, Baonian (China)

Presenter: Mr WAN, Baonian (China)

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