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Recent Progress of Long-pulse High-confinement Plasma on EAST

J. Huang[1*], B. Wan[1], X. Gong[1], J. Qian[1], A. Loarte[2], R. Ding[1], L. Zeng[3], X. Zhang[1], M. Li[1], H. Xu[1], W. Liu[1], B. Zhang[1], L. Xu[1], P. Li[1], G. Zuo[1], F. Ding[1], A. Ekedahl[5], B. Xiao[1], Y. Sun[1], Q. Zang[1], G. Li[1], L. Wang[1], H. Liu[1], Q. Yang[1], G. Xu[1], J. Hu[1], K. Lu[1], Y. Song[1], J. Li[1] and EAST team[1]

[1]ASIPP, China, [2]ITER Organization, France, [3]Tsinghua University, China, [4]CEA, IRFM, France

*e-mail (speaker): juan.huang@ipp.ac.cn

Significant progress has been achieved on Experimental Advanced Superconducting Tokamak (EAST) in the development of long-pulse steady-state advanced plasmas in support of future fusion reactors. A new record H-mode plasmas over 1066-second [1] with the total injected energy up to 3.05GJ with Radio Frequency (RF) power has been achieved with Te(0)~10keV on EAST with full metal wall using an actively cooled ITER-like tungsten divertor. Energy confinement remains high (H_{98y2} > 1.35) with poloidal beta~2.0 and e-ITB at LSN configuration. Key technical and scientific challenges have been addressed for steady-state operation. A robust plasma control is demonstrated to keep the equilibrium with good accuracy overcoming the challenge of drift in magnetic measurements over long pulses. A flux loop feedback controlled to maintain zero loop voltage, ensuring fully non-inductive plasma with the bootstrap fraction~50% and electron density at 60% of the Greenwald density. A grassy ELM regime with OSP on the horizontal target, facilitating efficient RF power coupling and reducing W sputtering/erosion. Low Z materials wall coating and real-time powder injections to improve particle control capability. No W impurity accumulation was observed throughout discharge.

To support ITER new research plan, a dedicated set of joint ITER-EAST experiments have been performed [2], and the related key technical and scientific challenges have been addressed. In boron wall, we demonstrated a stationary 100s H-mode plasma. A high poloidal beta scenario has been developed in boron wall at q_{95} ~ 6, a range attractive for ITER steady-state operation, with high energy confinement quality (H_{98y2} ~1.25/β_N ~ 2.0) by dominant electron heating. To account for the ITER heating and current mix, we have also explored high βp regime without lower hybrid wave systems. All the ITER H&CD systems were used and found suitable for high βp plasmas in a LSN configuration. High performance achieved with β_p ~ 2.1, β_N ~ 1.85, H_{98y2} ~ 1.2 at q_{95} ~ 6.2, f_{GW} ~ 80%, P_{EC} ~ 1.4MW, P_{IC} ~ 4.0MW, P_{NB} ~ 3MW. The details will be illustrated in detail in the report, which can offer unique contributions in support of the ITER new research plan.

References

[1] X. Gong, overview oral, 30th IAEA FEC 2025.
[2] A. Loarte, et al., PPCF 67 (2025) 065023.
[3] J. Huang, oral, 30th IAEA FEC 2025.

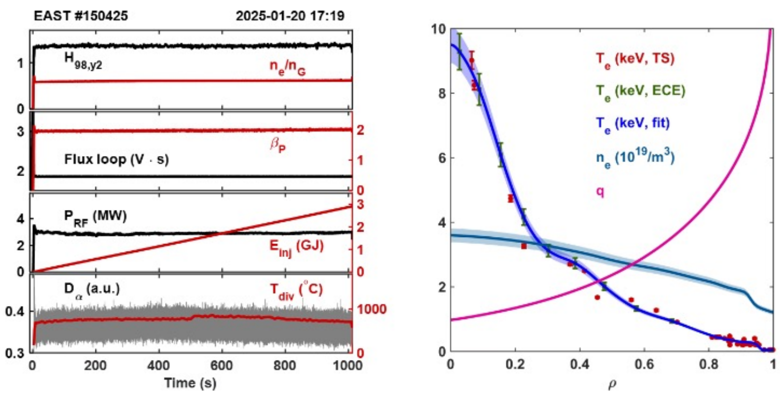

Figure 1 Time histories of EAST long-pulse H-mode discharge (Left), $H_{98,y2}$ and electron density n_e/n_G, Poloidal flux and β_P, RF power and total injected energy, Divertor temperature (IR) and D_α emission. Electron density and temperature, current profile (Right).

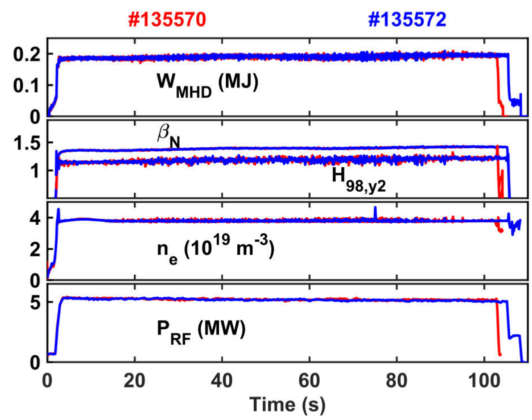

Figure 2 Time history of stationary ~100s H-mode plasma under boronized full metal wall with P_{EC} ~ 3.0MW, P_{LH} ~ 2.2MW with optimization of heating and current driven coupling and well controlled high Z impurity .