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Recent Advances in Long Pulse High Confinement Plasma Operations in EAST¹

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Significant progress has been made in the EAST superconducting tokamak toward steady-state operations, achieving a new H-mode regime with a record duration over 30 s, using predominantly Lower Hybrid Current Drive (LHCD) and Lithium (Li) wall conditioning [1]. A key feature of the long pulse H-modes relies on the achievement of tiny ELMs with a dramatic reduction in ELM energy, compared to Type I ELMs. The small ELMs are rather benign with a frequency of 0.5 – 1 kHz and peak heat fluxes largely below 2 MW/m². This new small ELMy H-mode regime exhibits a confinement quality modestly lower than Type I, but higher than Type III ELMy H-modes, with an confinement enhancement factor, $H_{98(y,2)} \sim 0.9$, similar to Type II ELMy H-modes. What is truly remarkable is that LHCD induces a three dimensional distortion of the edge magnetic topology by driving helical current filaments at the edge [2], thus mitigating ELMs, similar to RMP (Resonant Magnetic Perturbations). Another important facet is that the small ELMs are accompanied by a quasi-coherent MHD mode at 30 – 50 kHz throughout the H-mode phase, which can provide continuous particle and heat exhaust, hence facilitating long pulse operations. This new, small ELM regime, enabled by Li wall conditioning and LHCD, exhibits a dramatic reduction in ELM transient power loads and good global confinement without significant impurity accumulation, thus potentially opening a new avenue in long pulse H-mode operations.

[1] J. Li, H. Y. Guo*, B. N. Wan et al., “Achievement of a new long pulse high confinement plasma in EAST superconducting tokamak,” submitted to Nature Physics (under review).

[2] Y. Liang, X. Z. Gong, K. F. Gan et al., Phys. Rev. Lett. **110**, 235002 (2013).

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