W control in long pulse operation : feedback from WEST to ITER

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The WEST superconducting tokamak, featuring a full tungsten environment and equipped with an actively cooled ITER-grade divertor [1], provides valuable inputs for future ITER operation. Challenges related to plasma start-up and plasma current ramp up have been addressed, utilizing Ion Cyclotron assistance for breakdown in low electric field conditions, and evidencing the gradual degradation of the radiated fraction in the limiter phase due to tungsten deposits on low Z (Boron Nitride) limiter material. Remarkable progress has been made with successful long pulses, exceeding 2 min, and the completion of a high fluence campaign in attached divertor condition, cumulating 3h of plasma and a divertor particle fluence equivalent to one ITER shot [2]. However, the emergence of thick W deposited layers triggers impurity events, progressively hampering plasma operation. The core tungsten peaking is sensitive to ICRH induced rotation and light impurity seeding, but remains moderate except during radiative collapse events [3]. In terms of contamination, a resilient radiative fraction is observed due to the strong connection between tungsten sources and radiative losses [4]. Mitigation strategies include wall conditioning, utilizing an impurity powder dropper [5], and adopting the X-point radiator regime, which was successfully feedback-controlled for over 10s in L-mode and showed improved confinement [6]. These approaches show promising prospects for extending this divertor-preserving regime, crucial to reactor operation, to long duration.

References

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