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First experiments in WEST with tungsten plasma facing components

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WEST is a large aspect ratio full tungsten (W) superconducting tokamak, targeted at assessing power exhaust with the ITER actively cooled divertor technology and mastering long pulse operation in a metallic environment [1]. This paper reports on the achievements performed during the first phase of operation, where the lower tungsten divertor is equipped with a set of actively cooled ITER-like units, complemented with inertially cooled ones.
The first experimental campaign was performed using baking and glow discharge cleaning as conditioning. W limiters were found to be prone to runaway electron beam generation in a wide range of prefill pressure due to unexpected impurities influxes. Lower hybrid (LH) wave heating was applied to diverted plasmas up to 2.4 MW, but the operational domain remained limited, as the radiated fraction stayed very high and plasma density could not be raised without radiative collapse.
In the second experimental campaign, boronizations were performed, opening the operational domain allowing reliable startup conditions and higher density range. As expected, light impurities (C, N, O) were significantly reduced. The radiation pattern was modified with more central radiation compared to pre-boronization conditions. This core radiation is shown to be correlated with W lines and tends to produce hollow temperature profiles during current ramp up, which trigger deleterious MHD activity. Up to 5 MW of LH and 1 MW of ICRH have been injected in L mode plasmas so far but with a fraction of radiative power still around 60%. Note that the power through the separatrix is still slightly below the Martin 2008 scaling law prediction for L-H transition. Repetitive long pulse operations (~30s with 2.8MW of LH) have been demonstrated on the actively cooled upper divertor, showing a stable behavior of density and radiation.
The heat load pattern on the divertor target was monitored by a unique set of PFC diagnostics (infrared systems, Langmuir probes, thermocouples, Fiber Bragg gratings). In agreement with simulations, it is modulated by the ripple of the toroidal magnetic field modulation, while in/out divertor asymmetries are evidenced. Heat flux SOL widths of ~10 mm are estimated. They will be compared with existing database to assess the impact of large aspect ratio. In addition, plasma edge modelling with the SOLEDGE2D-Eirene code package is underway to reproduce experimental density regimes, impurity radiations, heat fluxes and W sources and get further insight in edge transport.
Experiments resume in May 2019 with more heating power (target of 10 MW) to establish a robust H-mode and continue testing the ITER-like divertor prototypes.

[1] J. Bucalossi et al., Fusion Eng. Des. 89, 907 (2014)