Topic: EXW

First results of LH coupling and current drive in WEST full metallic environment and commissioning of the new ELM resilient ICRF antenna

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The WEST tokamak has now achieved L-mode X-point plasmas with 12 s duration (I_P = 0.5 MA, $n_e \sim 3\times10^{19}$ m^{-3}, B_T = 3.7 T). WEST is the first and only full W-device relying on radiofrequency systems for heating and current drive. This paper presents the results of the Lower Hybrid Current Drive (LHCD) experiments in WEST, together with the commissioning of the first new load-resilient long-pulse Ion Cyclotron Range of Frequencies (ICRF) antenna, manufactured in collaboration with ASIPP.

The high power CW LHCD system has been extensively used in Tore Supra, and has since undergone modifications for WEST. In the first WEST experimental campaign (Oct. 2017 – Feb. 2018), several plasma equilibria were tested in order to optimise the LH wave coupling. Once adequate plasma equilibria had been found, the LH power could rapidly be increased above 2 MW in less than two days. In the summer campaign 2018, two boronisations were carried out, which allowed to operate at higher plasma density ($n_e \sim 3\times10^{19}$ m^{-3}), thus to improving the LH coupling further. L-mode discharges lasting 12 s were achieved, with 1.9 MW LH power for 9.5 s. The LH current drive efficiency is now found to be similar to that obtained in Tore Supra.

The WEST ICRF system is designed to operate at 9 MW during 30 s or 3 MW during 1000 s. The first ICRF antenna has been successfully commissioned on WEST plasmas in summer 2018. Before installation on the tokamak, the antenna underwent three categories of pre-qualifications tests, aimed at validating the design and accelerating the antenna commissioning. Firstly, milliwatt-range RF experiments were carried out, assessing the load-resilience using a moveable glass aquarium filled with salty water. Secondly, leak detection tests were carried out in the TITAN test bed. Thirdly, high RF voltage tests were carried out in TITAN, in order to raise the RF voltage and current at the straps to their nominal peak values. One these tests completed, the ICRF antenna was installed on WEST and commissioned on plasma up to 0.3 MW for 2 s, and 0.6 MW of peak coupled power. The experiments have indeed allowed confirming the load-resilient behaviour of the antenna. VSWR remained below 3.0 during excursions in edge electron density and coupling resistance, as predicted by the low power tests and RF modelling.