First LHCD experiments in WEST

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The WEST tokamak has achieved X-point plasmas in lower single null configuration with plasma current up to I_P = 0.8 MA, magnetic field B_T = 3.7 T and q_{95} ~ 3 [1]. WEST is the first and only full W-device relying on only radiofrequency systems for heating and current drive. This paper presents the first lower hybrid current drive (LHCD) experiments performed in WEST with the two launchers designed for coupling 6-7 MW power in view of long pulse operation at high density ($n_e = 6\text{-}7\times10^{19}\ m^{-3}$) [2]. The experiments presented here were carried out in low density plasmas ($n_e = 1.7\text{-}2.2\times10^{19}\ m^{-3}$) with up to 2.4 MW coupled LHCD power.

Several plasma equilibria were tested aiming at minimising the reflection coefficient (RC) of the LHCD power. As expected, it was found that RC was sensitive to the radial outer gap (ROG), which was generally different for the waveguides rows above and below the mid-plane. The average RC was typically 5-10% for ROG = 3 cm and ~ 30% for ROG = 6 cm. Langmuir probes installed in a poloidal limiter showed very low electron densities, < $1\times10^{18}\ m^{-3}$ at 15 mm in front of the poloidal limiter, indicating that the density at the launchers was near or below the LH cut-off density (at f = 3.7 GHz). This was consistent with the high RC values measured. The main focus of the experiments was thus to find reproducible plasma equilibria giving sufficiently low RC (< 20%) over the whole launchers.

Once adequate plasma equilibrium had been found, maximum 2.4 MW LHCD power was coupled to the plasma (and 2.3 MW for 2 s). As the LHCD power was increased, loop voltage dropped from 1.2 V to 0.4 V, the central electron temperature exceeded 2 keV and bremsstrahlung measurements in the hard X-ray range (40-200 keV) gave evidence of an increasing fast electron population. The radiated power fraction in the plasma bulk decreased as the LHCD power increased, from $P_{Rad,bulk}/P_{Tot}$ ~ 80% down to 45%. The time evolution of the radiated power followed that of the W-signal from VUV spectroscopy, suggesting that W contributes to the radiated power. Simulations with the METIS code are used to check the overall coherency between radiation, loop voltage, plasma composition, etc.

[1] E. Nardon et al., this conference

[2] C. Bourdelle et al., Nucl. Fusion **55** (2015) 063017