Discharge recovery by means of EC assisted start-up

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In view of an efficient pulsed operation scenario of future nuclear fusion reactors, the effectiveness of a prompt and reliable plasma start-up is essential to improve plasma performance and reproducibility, especially after a disruptive event, as well as to reduce dwell time between pulses. The foreseen solution to widen the operational window with respect to the pre-pulse conditions (background pressure and impurity content) is the use of Electron Cyclotron (EC) additional heating, which can compensate for radiation losses and sustain the plasma burn-trough phase.

In order to design the operational scenario of future demonstration reactors (DEMO) it is mandatory to set appropriate codes capable of extrapolating from present experiments to future scenarios. Experiments on the TCV tokamak focused on discharge recovery by means of EC assisted start-up (82.7 GHz, XM2) have been carried out with toroidal electric field of 0.7 V/m, pressure before startup ranging between 2 and 10 mPa and neutral composition dominated by Ar impurity. In the deuterium-dominated plasma, the use of EC makes start-up effective even at reduced pumping speed (to mimic the DEMO dwell phase) assuming enough power (>400KW). As expected, on this background, adding Ar as impurity leads to an increased power threshold for a sustained startup. Experimental results have been reproduced successfully with simulations provided by BKD0 code, which models in detail the burn-though phase and includes a consistent calculation of the EC absorbed power computed by the beam-tracing code GRAY in low density plasma and with a realistic description of the beam injection conditions, including polarization mix after beam reflection at the inner wall. The required additional power and impurity impact on startup have been determined for TCV and extrapolated to ITER, JT-60SA and DEMO.

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