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Experimental research of EAST start-up towards the first plasma of ITER

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The experiments on plasma initiation performed in EAST with the electron cyclotron wave (ECW) pre-ionization and assisted start-up have demonstrated that ITER can produce plasma initiation in a low toroidal electric field (<0.3V/m). The parameter domain of breakdown is significantly extended towards higher prefill gas pressure. The effect of ECW injection timing, power, toroidal injection angle on breakdown were also investigated with commonly used wide null-field configuration (NFC), in which the stray poloidal magnetic field is lower than 2×10^(-3) T in most area of the vacuum vessel. The electron cyclotron heating (ECH) power threshold for breakdown in EAST is approximately 0.4 MW. In the range of ECH power tested in this work, higher ECH power is advantageous for achieving earlier and faster breakdown. During the ECW-assisted startup, the process of burn-through is prolonged by the higher pre-filled gas pressure even though it enhances the ease of breakdown. Besides the wide NFC, the newly developed mirror-like trapped particle configuration (TPC) was also tested for the ECW assisted startup. The comparison of different poloidal magnetic field configurations shows that the particle confinement and the formation of closed flux surface strongly depend on the shape, not only the strength of the magnetic field. The ECW assistance has an effect in preventing the generation of runaway electrons and improving the safety of device during start-up with the comparison of LHW assistance. The ECW assistance also exhibits a high tolerance to the impurity and thus ensures a high ramp rate of plasma current even with a high impurity level. In addition, simulations of EAST plasma initiation with the consideration of engineering design models of the PF coil, vessel and PF power systems, have produced the time-evolution of plasma current, electron density and temperature etc, suggesting a reasonable agreement with experimental measurements.

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