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Plasma Scenario Development for the HL-2M tokamak

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The HL-2M tokamak is now under construction in China, with nominal parameters as follows: plasma current I_p = 3 MA, toroidal magnetic field B_t = 3 T, major radius R = 1.78 m, minor radius a = 0.65 m, elongation κ = 1.6 - 2, triangularity δ > 0.5. Three auxiliary heating and current drive methods, 15 MW of Neutral Beam Injection (NBI), 8 MW of Electron Cyclotron Resonance Heating and Current Drive (ECRH/ECCD), 2 MW of Lower Hybrid Current Drive (LHCD), are considered for HL-2M to address burning plasma physics issues and advanced tokamak scenario in support of future machines (ITER, CFETR). This paper reports the capacity of the advanced tokamak scenario development for HL-2M.

The HL-2M scenarios are investigated with METIS which is a 0.5-D integrated modelling module (mixing of 0 D with 1.5 D equations) of the code CRONOS[1]. METIS simulates plasma evolution using the usual scaling laws (core/edge transport, global confinement) coupled with simplified source models.

HL-2A has the capability to developing the physics basis for advanced plasma scenarios with high β_N, high elongation, high triangularity, snowflake and super-X divertors. With NBI or ECCD alone, HL-2A can sustain and improve the ITER baseline scenario operation. Advanced tokamak regimes can be explored by combining NBI, LHCD with controlling the off-axis deposition of ECCD. Stable discharges with high $\beta_N \sim 3.8 (< 4 \times l_i)$ are foreseen. In addition, the plasma regimes where the ratio $T_i / T_e \sim 1$ and low torque can be investigated, which address plasma physics issues for the burning plasma regime. Complementarily to a high bootstrap current fraction, LHCD, and off-axis ECCD, HL-2M has the potential to access, and extend the duration of steady-state fully non-inductive scenario. Thus, physics at high β_N vanishing loop voltage, required for steady-state, can be explored in support of ITER and CFETR.

[1] J. F. Artaud et al. 2010 Nucl. Fusion 50 043001