Scenarios for physics experiments in the COMPASS Upgrade tokamak

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The COMPASS Upgrade tokamak [1] will be a tokamak of major radius R_0 = 0.894 m with the possibility to reach high field (Bt ~ 5 T), high current (Ip ~ 2 MA) along with high shaping capabilities (κ=1.8, δ=0.6). The main auxiliary heating system used to access H-mode will be 4 MW of Neutral Beam Injection (NBI) power, assisted with 2 MW of ECRH. The baseline scenario of COMPASS Upgrade will mimic the expected high triangularity plasma shape of ITER (δ_u=0.43, δ_l=0.58, κ=1.8).

The new tokamak should have access to two types of H-mode observed in C-Mod [2]: the usual ELMy H-mode at lower densities and the stationary, ELM-suppressed Enhanced Dα (EDA) regime, seen at high densities and higher values of q_{95}. Furthermore, thanks to the large toroidal field, the window of operation of I-mode [3] will be significant, especially at reversed field or Upper Single Null operation. We introduce also plausible access to more advanced confinement regimes such as Super H-mode [4] and QH-mode [5].

The three main distinct confinement regimes (ELMy H-mode, EDA H-mode and I-mode) occur at significantly different values of the pedestal top density and collisionality. Based on existing scaling laws as obtained from Alcator C-mod [2], we can described the pedestal for various sets of achievable engineering parameters using the METIS code [6]. The ELMy pedestals are compared against the results of the more detailed MHD stability code EPED [7]. We make predictions for plasma performance for several scenarios and discuss plasma density and temperature profiles, NBI power density, separatrix parameters and their relation to SOL and divertor conditions. We demonstrate the relevance of the COMPASS Upgrade project as an exploratory device for the edge physics dimensionless parameter space and estimation of subsequent power exhaust in view of a fusion reactor.

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