Integrated Modelling of ITER plasma scenarios in the SRO phase

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The ITER Research Plan (IRP) has been re-developed with consideration of a tungsten wall and a new heating mix. The envisioned operation stages consist of an initial Start of Research Operation (SRO) phase in which 40 MW EC-heated Hydrogen L-mode scenarios up to I_{pl} = 15 MA and B_0 = 5.3 T and Deuterium H-mode scenarios up to I_{pl} = 7.5 MA and B_0 = 2.65 T are foreseen to be established. In this context, new integrated simulations are necessary to predict plasma performance and operational constraints with tungsten as the main heavy ion impurity.
For this purpose, the High Fidelity Plasma Simulator (HFPS), comprised of the DINA free boundary equilibrium evolution code and the JINTRAC integrated core (JETTO + SANCO + TGLF-SAT2) + edge / SOL-div (EDGE2D + EIRENE) transport solvers embedded in the IMAS workflow environment have been applied. Full scenario calculations, focusing on H-mode scenarios and H-mode accessibility, have been performed for the limiter, current ramp-up, flat-top and ramp-down phases including a scan of the impact of W sputtering at the wall as function of SOL transport conditions, and constraints on the operational space have been assessed. In particular, the core contamination efficiency of W released at the wall vs. the divertor and options for actuator adjustment in each phase of the scenario for the minimisation of core W accumulation have been evaluated. It is shown that it is possible to operate at quasi-stationary conditions at a high W self-sputtering induced core radiation fraction of ~70-80% in the limiter phase provided that central EC heating in excess of the central radiation losses is continuously applied. In the diverted current ramp-up phase, the W core concentration is predicted to reduce strongly when the plasma is moved away from the wall at X-point formation and while the W sputtering source at the divertor remains negligible due to modest predicted temperatures and power densities at the targets of up to a few MW/m^2 with moderate EC heating of $P_{EC} \leq 20$ MW and a Greenwald density fraction $n_{e,lin.-avg.}/n_{GW}$ ~0.4. In the flat-top phase, divertor heat flux control by Ne seeding may be required despite efficient W screening in the pedestal in H-mode in case of operation at lower densities below $n_{e,lin.-avg.}/n_{GW} < 0.4$ at P_{EC} = 40 MW. For the ramp-down phase, strategies for an optimum H-mode termination, heating, fuelling and plasma shape evolution schedule for a well controllable plasma termination at minimum W contamination are exemplified.