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Full-radius integrated modelling of the H-mode confinement dependence on plasma size and aspect ratio and predictions of ITER and DEMO

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Plasma size is a fundamental parameter in the extrapolation from present devices to future fusion reactors. However, for several decades the impossibility of developing sufficiently reliable predictions of the entire profiles of tokamak plasmas, particularly in the H-mode confinement regime, has implied that the dependence of the confinement on plasma size could only be extracted from scaling laws obtained from regressions on experimental data. Recent progress in full-radius integrated modelling of the entire confined plasma has allowed the development of approaches which are progressively becoming data-free. A model of this type is the Integrated Modelling based on Engineering Parameters (IMEP) workflow [1-3], which combines core turbulent transport from the TGLF-SAT2 quasi-linear model [4-5] and pedestal predictions with an empirical transport model combined with the MISHKA ideal MHD code [6] and an extended two point model for the boundary conditions at the separatrix. This model has proven to be able to predict H-mode confinement on a wide database of ASDEX Upgrade, JET and Alcator C-Mod plasmas, proving the capability of also capturing the increase of confinement with plasma size. This element is here explored from a more general standpoint together with the aspect ratio, and the dependence of H-mode confinement with increasing plasma size predicted by IMEP is shown to be largely consistent with the IPB98(y,2) scaling law, more favorable than the ITPA20-IL, and close to the gyro-Bohm transport, well above the Bohm transport. From the general properties of the size dependence, we move to predictions of the ITER 15 MA baseline scenario, particularly demonstrating the limited impact of a reduction of heating power on the pedestal top pressure and the possibility of reaching operation which significantly exceeds Q = 10. Limits in the allowed W concentration are discussed. Finally projections for a DEMO reactor are presented.

References
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