

Strong impact of separatrix conditions on full-radius L-mode predictive integrated modelling

B. Liu¹, C. Bourdelle², S. Wiesen¹, T. Fonghetti²

¹*DIFFER, De Zaale 20, 5612 AJ Eindhoven, Netherlands*

²*CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*

Turbulent transport in the tokamak edge region plays an important role in determining global confinement, pedestal structure, and the L–H mode transition [1]. Theoretical studies and numerical simulations of L-mode plasmas indicate that edge turbulence exhibits characteristics distinct from core turbulence, arising from steeper density and temperature gradients, higher resistivity, and increasingly non-adiabatic behaviour of passing electrons [1]. Moreover, L-mode database studies show clear correlations between separatrix parameters and core plasma performance [2], motivating a full-radius investigation to understand the causality behind the reported correlations.

The present study is based on a WEST L-mode plasma heated by Lower Hybrid Current Drive, for which electron density and temperature profiles have been successfully predicted up to the separatrix using the High Fidelity Plasma Simulator (HFPS)—an IMAS-coupled version of the JINTRAC workflow [3]. Turbulent transport is modelled using the TGLF-sat2, previously validated against experimental profiles in ASDEX Upgrade L-mode plasmas [4].

In this work, HFPS is employed to investigate the effects of separatrix parameters—electron density, electron and ion temperatures, and neutral energy—on particle and heat transport as well as plasma profiles. Radiative losses and heating sources are kept fixed. Changes in separatrix electron temperature and density have global impacts on the energy content, density peak through modified turbulent transport, while variations in ion temperature have expected impact on ion temperature profile only in case of stiff transport. The propagation of boundary condition changes is explored in various scenarios: frozen particle flux vs feedback on the line-averaged density (as applied experimentally). Moreover, standalone analyses with TGLF-sat2 and the higher-fidelity gyrokinetic code GKW [5] further explore the individual roles of collisionality, density peaking, and electron-ion temperature ratio (T_e/T_i).

References

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