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Impact of divertor configuration on tokamak performances: focus on WEST experiments supported by SOLEDGE2D modelling

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A matter of fundamental importance for future fusion reactors is the ability of combining a hot, high-performance core plasma with a cold plasma at the divertor plates, minimizing the heat loads onto the plasma facing components (PFC) and avoiding their erosion. These two regions are coupled by the Scrape-Off Layer (SOL), characterized by open field lines, which affects reactor performances. Indeed, it has been recently shown experimentally on JET that the divertor configuration can affect significantly the formation of the pedestal, lowering the L-H transition threshold by a factor of 2 [1], through the increase of the shear of the ExB flow in the SOL [2]. On the other side, recent analyses performed on Alcator C-mod indicate upstream plasma behavior relatively unaffected by strong changes in divertor conditions [3]. In order to progress in the understanding of the impact of divertor configuration and conditions on tokamak operation and performances we propose here further investigations based on the analysis of recent experiments on WEST tokamak supported by numerical simulations performed with the transport code SOLEDGE2D-EIRENE.
More precisely we focus on two fundamental parameters that have to be monitored during the operation: the electron temperature at the divertor plates Te,div and the pedestal pressure Pped. The aim is to minimize Te,div to values below a few eV, to avoid physical sputtering and erosion of the PFC, while maximizing Pped, determining the fusion power. In this contribution, we focus on the effect on Te,div and Pped of the misalignment between the parallel heat flux q// and the particle flux Γ at the divertor plate. Indeed, a shift between the peaks of heat and particle fluxes is observed recurrently in recent WEST experiments, in agreement with predictions from SOLEDGE2D numerical simulations performed in preparation of WEST operation [4]. We investigate the impact of divertor configuration (single null vs upper null) as well as nitrogen seeding on such misalignment completing the experimental data with numerical results obtained with the transport code SOLEDGE2D-EIRENE.
[1] X. Litaudon et al., Nucl. Fusion 57 (2017) 102001
[2] E. Delabie et al., 42nd EPS Conference on Plasma Physics, Lisbon, Portugal (2015)
[3] B. LaBombard et al, oral presentation PSI conference, 2018
[4] G. Ciraolo et al., Nucl. Mat. En., 12 (2017) 187–192

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