Modelling of high field side high density region with the nonlinear MHD code JOREK with kinetic neutrals

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It has been shown that controlling the X-point radiator in a fully detached H-mode plasma can lead to a naturally more ELM-stable regime [3]. This might become an important strategy in heat load-, and ELM-control. Precursing the X-point radiator is the HFSHD-region (High Field Side High Density region). Poloidal $\overrightarrow{E} \times \overrightarrow{B}$ flows below the X-point redistribute part of the main plasma from the outer to inner divertor; this aides the onset of inner target detachment and leads to the formation of the HFSHD-region [4]. The nonlinear extended MHD code JOREK [2, 1] has recently been extended with a module for kinetic neutrals and more plasma and neutral wall interaction physics. With this addition, JOREK has been successfully benchmarked against SOLPS-ITER simulations for fueling-driven detachment in ITER PFPO-1 [5]. It also allows for the simulation of the HFSHD-region. With simultaneously including impurities from the kinetic module, it is possible to create an X-point radiator. This then allows for further investigation of ELM-stability in such operation.

In this contribution, we present the development of the HFSHD-region in JOREK simulations with kinetic neutrals for early ITER operation (the PFPO-1 phase). We investigate different key parameters influencing the formation of the HFSHD-region. Ramping up the fueling rate (in the divertor) decreases gradually the heat flux towards the divertor target. Once the ionisation front comes off the wall, cross field transport moves neutrals and plasma across the separatrix. Building up the (off-separatrix) density in the high field side. Around a critical upstream density, the plasma undergoes a sharp transition to form the HFSHD-region carried by the formation of an ExB vortex. This ExB vortex increases and displaces the inner target ion flux upwards. Switching off ExB drifts strongly reduces cross-field transport and thus does not allow for the density buildup at the high field side as shown in Fig. 1.

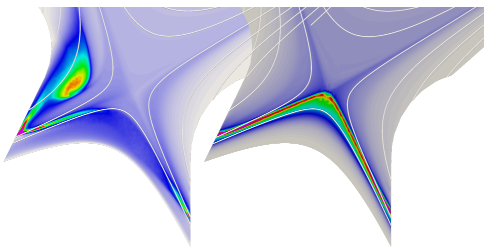

Figure 1: n_e *profiles. (left) HFSHD-region formed after detachment of the inner divertor target. (right) Without drifts.*

References

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