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Numerical Modeling for Divertor Design and in Support to the WEST Project

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Operating a fusion reactor requires handling high heat loads on the divertor plasma facing components. In support of the ITER divertor strategy, the WEST project on Tore Supra aims at studying tungsten monoblocks behaviour when submitted to heat flux, and high plasma fluence, representative of ITER conditions during long pulses. A considerable simulation effort is dedicated to properly estimate the power load on the materials and understand diverted plasma specificities in term of impurity screening. In this context we report recent results from the SOLEDGE2D plasma transport code coupled with the MonteCarlo EIRENE code for neutral transport. Complex and realistic geometries can be handled by SOLEDGE thanks to the penalization technique allowing us to properly taking into account the interaction between the plasma and the multiplicity of objects located in the vessel. Thanks to these specific numerical capabilities, we can address the synergy between plasma transport and geometry of plasma facing components on, for example, neutral recirculation or impurity contamination, with a good insight on the influence of divertor, including the secondary X-point effect, and baffle geometries. In the perspective of the WEST operation, simulations are performed to address reference operational domain of the tokamak. We present simulations results for the different plasma density regimes obtained in the divertor region, from the low density sheath limited regime to the high recycling regime up to the detachment for higher plasma density. Moreover, we report investigation on supersonic parallel flows. We demonstrate that supersonic parallel flows into the divertor volume are ubiquitous at low density and governed by the divertor magnetic geometry. As density is increased subsonic divertor plasmas are recovered. On detachment, we show that the change in the geometry of the particle source can also drive a transition to a supersonic regime. The comprehensive theoretical analysis is completed by simulations for the WEST geometry. Such results are essential in assessing the divertor performance and when interpreting measurements and experimental evidence.

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