Density regimes and heat deposition pattern of WEST H-mode plasmas: deuterium and nitrogen seeded simulations with SOLEDGE2D-EIRENE

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Heat deposition onto plasma facing components is regarded as one of the open issues to be addressed by ITER. Complex non-linear mechanisms are at work such as transverse and parallel transport, multi-species interactions and radiation. Important changes of regimes are known to occur for relatively weak changes of the core plasma conditions making prediction most uncertain. Several parameters are however clearly identified as being important for relevance to the fusion program. First, operation with metallic walls, with no carbon leak, is mandatory. Second, the slow evolution of tungsten radiation in leading experiments such as JET indicates that long steady state pulses are required to assess regimes of interest. Third, match to ITER constraints requires operation with little margin with respect to the H-mode threshold. In that framework, WEST operation offers a unique opportunity to investigate regime that comply with these constraints. It is also a challenge for the modeling community since predictions will soon be confronted to experimental evidence at the device comes into operation.

In view of the first experimental campaign of the WEST tokamak, we make predictions regarding the divertor operation with the transport code SOLEDGE2D-EIRENE addressing the SOL plasma up to all wall components as well as the edge plasma taking into account the double null features of the magnetic equilibrium. Simulations of the divertor density regimes are performed in H mode conditions. Both pure deuterium and nitrogen seeded discharges have been considered. We present results for a density ramp in pure deuterium plasma, obtained with gas injection located in the lower divertor private flux region and assuming 4MW of power entering the SOL. Heat deposition on divertor targets is analyzed in terms of the scrape-off layer power fall-off length, $\lambda_q$, and of the spreading factor $S$ which takes into account a local spreading in the machine-specific divertor volume. The numerical results indicate that the spreading factor $S$ increases linearly with the upstream density, in agreement with a recent scaling law. The associated physics is twofold. On the one hand the midplane density increase governs a nonlinear decrease of the divertor temperature increasing the transit time to the target plate and thus favoring cross-field transport mechanisms in the divertor volume. On the other hand, heat conductivity is strongly decreases with the temperature so that the coldest point along the field lines acts as a heat flux limiter, again favoring cross field transport mechanisms. The relative weight of these two mechanisms is under investigation, impurity seeding providing an appropriate control parameter and the opportunity to analyze the radiation pattern that will soon be compared to experimental evidence.