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Overview of the gas baffle effects on TCV Lower Single Null edge plasmas: multi-code simulations and comparison with experiments

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A gas baffle is being installed in the vessel of the tokamak à configuration variable (TCV) [1], in order to improve the closure of the divertor region. This upgrade has been envisaged, along with a foreseen increase in the available input power, in order to facilitate the access to detached divertor regimes at lower plasma collisionality, namely in more ITER-relevant conditions. It is necessary, in this framework, to be able to predict the impact of gas baffles, at the same time validating the current numerical tools available for the simulations of the edge plasma.
The design of the gas baffle tiles has been supported by SOLPS-ITER simulations of TCV edge plasmas [2]. The optimized parameter is the neutral compression ratio, namely the ratio of neutral density in the divertor region and the one in the main chamber, at a given upstream electron density. The performance of the gas baffles in terms of neutral confinement has been predicted for an ideal case with intermediate plasma current, as a function of plasma density and input power [3]. These simulations predict an improvement of the compression ratio, with the current baffles, of a factor of approximately five for attached low-density plasmas, which increases to up to 10-20 at higher upstream densities. Envisaging a future modification of TCV gas baffles, a further numerical investigation on the optimal baffle extension has been carried out, by means of the SolEdge2D-EIRENE code [4]. The main advantage of this code is the possibility to simulate realistic shapes for plasma-facing components, thus coherently describing plasma parallel fluxes impinging on gas baffles. This analysis shows that the neutral compression factor in detached conditions could be further improved by almost a factor two by extending the Low-Field Side baffle by a few cm. With such a solution, the recycling on the baffle tip would still be acceptable.
Both the mentioned numerical tools have been tested against experiments, SOLPS-ITER simulating an average current, Lower Single-Null scenario, and SolEdge2D-EIRENE a case at lower plasma current. Numerical results have been compared to experiments with baffle-compatible plasmas, in absence of the baffle. The density ramp imposed in experiments is reproduced numerically, and it allows the investigation of different divertor conditions. Transport coefficients are chosen to match experimental upstream profiles: numerical results are shown to reproduce, almost in a quantitative way, the experimental results at divertor targets. Keeping transport coefficients fixed, two additional wall geometries have been simulated, one including the High-Field Side baffle, and one with the full gas baffle. With the first experiments in baffled operation, both mentioned tools are tested against experiments: the results of the comparison will be discussed, shedding light on the capability of 2D transport codes of predicting the edge plasma behaviour in presence of gas baffles.

References

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