Experiments and quasi-linear simulations of ASDEX Upgrade plasmas with negative triangularity in view of DTT design

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The work presents experimental and modelling results of a comparison of negative (NT) and positive (PT) triangularity ASDEX Upgrade (AUG) plasmas using shapes like those foreseen in the DTT tokamak [1]. This activity is part of a broader effort to understand whether the good confinement properties observed in NT discharges in DIII-D [2] and TCV [3] may be extrapolated to the DTT device and DEMO future operations. The experimental AUG NT kinetic profiles are shown to recover the PT central performance due to reduced transport in the region $\rho_{tor}\approx0.7$-0.9 while exhibiting lower ELMs (Edge Localised Modes). These results demonstrate a practical gain of running plasmas in NT even if they access the H-mode. Simulations have been performed using the transport solver ASTRA [4] and the quasi-linear turbulent model TGLF-SAT2 [5]. The modelling reproduces the experiments qualitatively with reasonable accuracy. Nonetheless, the heat transport in NT cases is partially overestimated. This may be caused by TGLF exploiting the Miller equilibrium [6], which approximates the flux surfaces as up-down symmetric. This symmetric approximation for NT equilibria effectively reduces the negative upper delta effect. A numerical test to discern the impact of the geometry by symmetrically flipping the shape has shown a beneficial effect of the negative triangularity on heat transport. The modelling of the DTT NT scenario [7] is now under improvement using the same ASTRA/TGLF tools and the physics insight obtained in this work.

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