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O2.101 Alternative divertor configurations - physics basis and plans for ASDEX Upgrade

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Power exhaust is expected to become a problem in a future fusion reactor based on the Tokamak design in conventional single-null (SN) configuration. As a potential solution, alternative divertor geometries are currently discussed and investigated by many laboratories in the world [1]. In order to study a series of alternative configurations [2] in a machine with a high heating power (30 MW) compared to its size (R=1.65 m) and compare them to the conventional SN configuration the installation of a pair of in-vessel coils in the close proximity of the upper outer strike-point (SP) of ASDEX Upgrade is currently in preparation [3]. The upgrade offers unique possibilities to address, among others, the following outstanding scientific questions: Can the secondary SPs appearing in a snowflake (SF) configuration be activated, as it was partially observed in TCV [4]? Is the 'churning mode' postulated for the null-region of a SF [5] or another mechanism responsible for this enhanced cross-field transport and does it scale with beta-pol and/or machine size such that all SPs would be fully activated in a reactor? Can the position of the secondary X-point be controlled accurately enough to exploit the SOL splitting [6] observed in TCV [7,8] as a heat-flux mitigation effect? Does a SF configuration with a secondary X-point on the low-field side of the primary one (LFS SF-) offer a better radiation characteristics [6,9] than a SN and does this furthermore allow an easier access to detachment as predicted by recent SOLPS simulations [9]. Does the configuration affect the detachment threshold or only the degree of detachment after the roll-over as observed in TCV for the SF [10] and the X-divertor configurations [11]? Do engineering tolerances and/or 3D magnetic fields caused by the current-feeds of the new coils limit the exploitation of the large poloidal flux expansion of an X-divertor [3,12]? Where would we expect this limit in a reactor? This contribution will discuss the physics basis of these questions and present the status and the plans for the practical realization of the divertor upgrade as well as its diagnostics. In addition to that an overview over recent results of state-of-the-art SOLPS and EMC3-EIRENE modeling of alternative configurations will be given.

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