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EX/P5-34: Symmetries and Asymmetries in the Divertor Detachment in ASDEX Upgrade

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Large burning plasma fusion devices such as ITER and DEMO require divertor detachment to not exceed the tolerable power load densities (<5MW/m^2) for long pulse operation. The understanding of the processes leading to divertor detachment is currently incomplete and a reliable prediction for future large scale devices out of reach. In ASDEX Upgrade divertor detachment has been studied for Ohmic and L-mode density ramp discharges with deuterium and hydrogen as a fuelling species and both toroidal field directions. The effect of seeding nitrogen has been tested. Prior to the detachment of the outer divertor a fluctuating detachment state appears in the SOL of the inner divertor, characterized by strong radiative fluctuations close to the X-point. Simultaneously a region with high n_e appears in the inner far SOL and X-point regions. Once these radiative fluctuations disappear detachment occurs along the entire inner target plate and the outer divertor reaches a state of complete detachment. The integrated ion flux at the inner target reaches its peak value at an only ~10-20% lower line averaged density than for the outer divertor target. However, the maximum of the integrated ion flux to the inner target remains well below what is observed at the outer target.
Numerical transport code packages, such as SOLPS5.0, contain an as complete as possible model of our current understanding of the basic processes present in the Scrape Off Layer. Under common assumptions for the model it is found that the roll over of the ion flux at the inner and outer targets occurs at a similar n^sep. Contrary to experimental findings the simulated peak values remain comparable for both target plates and no strong reduction of the ion flux density is seen for the inner divertor. The experimental observation of the high n_e in the far SOL during the fluctuating phase indicates that plasma is transported outward into the far SOL and/or strong radiation spontaneously sets in over a large volume in the far SOL. Based on these observations various levels of perpendicular transport in the X-point region of the inner divertor are assumed and recycling impurities such as oxygen and nitrogen are included. This leads to a shift of the simulated peak ion flux into the far inner SOL and a reduction of its peak value at the roll over by more than a factor of 3.

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