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Partial Detachment of High Power Discharges in ASDEX Upgrade

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To ensure a sufficient divertor lifetime ITER and a future DEMO reactor will operate under at least partial detachment (PD). PD is defined as a significant reduction of heat flux and pressure along field lines between mid-plane and divertor target for the first few power decay lengths in the scrape-off layer. For PD conditions in ASDEX Upgrade (AUG) the peak heatflux in the divertor is below 5 MW/m2. Strong divertor radiation will be required to achieve PD at reactor relevant power fluxes Psep/R = 15 MW/m, given by the condition Psep/PLH > 1.5-2 for the achievement of good H-mode performance. While ITER can accept only low core radiation levels, the high core power flux in DEMO has to be removed to a large extent by core radiation for the avoidance of divertor power overload.
Partial detachment in high power AUG discharges is achieved by double feedback of core and divertor radiation with Ar or Kr as core radiating species and N as divertor radiator. A high neutral divertor pressure is generally required to achieve PD, which is invoked by the combination of radiative losses and momentum loss processes like charge exchange and recombination. So far AUG has achieved 50 % of the foreseen ITER performance in terms of Psep/R under PD conditions and up to 70 % core main chamber radiated power fraction. The total heating power was up to 23 MW in these experiments. A further enhancement is expected due to a recent optimization of power supplies, enabling a higher maximum heating power, and a switch for reducing the cryo pumping speed, enabling a higher divertor neutral pressure.
The paper will report recent achievements, describe technical solutions for PD control and address the rise in pedestal and core electron density, which is routinely observed under PD conditions in AUG.

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