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I4.103 Modelling radiative power exhaust towards future fusion devices

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Power exhaust in future electricity producing fusion device like DEMO features difficulties which, compared to ITER, are harder to tackle in terms of operational control requiring an improved physics understanding. For a given power loss density Ploss/R the plasma facing components need to withstand a maximum heat flux not exceeding 5MW/m^2 in steady state on timescales lasting days or weeks. To achieve this, a pronounced detached divertor regime is to be exploited with low divertor temperatures Te,div < 1-2 eV [1]. For a DEMO sized device a total dissipated fraction fdiss=Pdiss/Ploss close to 95% or higher is required to reduce the total target heat load. The amount of achievable radiation loss in the scrape-off layer (SOL) is limited by the amount of removable pressure inside the SOL [2]. In DEMO, Pdiss must not only cover the diverted plasma and SOL regions, but also part of the confined region to reduce upstream pressure. Validated numerical models like SOLPS-ITER including neutral kinetics and SOL drifts & currents are required to accurately predict such exhaust regimes in varying geometries [3]. A numerical model must be scalable to qualify detachment criteria bridging the gap towards ITER and DEMO exhaust operational regimes. To clarify the role of machine size (Rmaj) on critical numerical parameters (e.g. anomalous transport), similarity experiments on power exhaust for JET and ASDEX-Upgrade (AUG) have been undertaken. A N2-seeded partially detached H-mode JET discharge in vertical target configuration was performed (2.5MA/2.7T, PNBI=20.6MW). SOLPSITER model constraints were derived from diagnostic JET divertor characterization. An AUG N2seeded similarity discharge matching the SOL q|| was obtained by controlling Pheat/R, Te,div and q95 (0.8MA/2.5T, PNBI=10MW). A similar SOLPS-ITER model has been setup to the matched AUG discharge to quantify remaining discrepancies to the JET case. The results highlight the criticality of other model parameters like neutral conductance to match accurately the total divertor pressure.

[1] M. Wischmeier et al., J. Nucl. Mater. 463, 22 (2015);

[2] C. S. Pitcher and S. P. C., Plasma Phys. Control. Fusion 39, 779 (1997);

[3] S. Wiesen et al., Nucl. Mater. Energy 12, 3 (2017)

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