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Performance assessment of tightly-baffled long-leg divertor geometries in the ARC reactor concept

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A means to handle the extreme power exhaust from tokamak-based fusion power reactors remains to be demonstrated. Advanced divertor configurations have been proposed as potential solutions, including double-nulls, long-legs and magnetic field flaring with secondary X-points. Modelling of tightly-baffled, long-leg divertor geometries in the divertor test tokamak concept ADX has shown the potential to access passively stable, fully detached divertor regimes over a broad range of parameters [1]. The question remains as to how these advanced divertor configurations may perform in a reactor setting. To explore this, we have performed numerical simulations of these configurations in the context of the ARC reactor concept [2]. The ARC design has been recently updated to include a tightly-baffled, long-leg divertor with an X-point target [3]. ARC provides an appropriate reactor test scenario for advanced divertor configurations, with a projected SOL heat flux width of 0.4 mm and total power exhaust requirement of 105 MW.

Using the divertor geometry and magnetic equilibrium from the updated ARC design, simulations of the ARC edge plasma and divertor are carried out with UEDGE [4]. The anticipated radial plasma profiles at the outer midplane are specified and power exhaust from the core is scanned over a wide range. Anomalous radial transport in the scrape off layer and divertor legs is modelled by a combination of radial diffusion and advection consistent with experimental observations, which also provide guidance for power sharing between the inner and outer divertor legs. Initial studies employing a Super-X Divertor configuration and 0.5% fixed-fraction neon impurity radiation have shown that a stable detached divertor regime exists for power exhaust in the range of 80 to 108 MW [5]. Simulations are presently being extended to study the performance of the X-point target geometry in ARC and to explore the sensitivity of the solutions to modelling assumptions and input parameters. The latest results from these studies will also be presented.

[1] M.V. Umansky et al., Phys. Plasmas 24 (2017) 056112; [2] B. Sorbom et al., Fusion Eng. and Design 100 (2015) 378; [3] A.Q. Kuang et al., 59th Annual Meeting of the APS DPP, C04.6, pp66 (2017); [4] T.D. Rognlien et al., J. Nuc. Mat. 196 (1992) 347; [5] M. Wigram et al., PET 2017 conference, submitted to CtPP.

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