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A new concept to achieve a higher fuel burn-up fraction in a DEMO reactor

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One of the key challenges for a fusion power plant is the need to increase the tritium burn-up fraction significantly from the values of only some 0.1% which result from extrapolation (at least above 5%). For a DEMO reference fusion power of 2 GW the fuelling rate necessary to replenish the burnt fuel is rather small (˜ 2.7 Pa-m3/s) and the fuel burn-up fraction equal to the ratio of the burnt fuel to the particle throughput is small, indicating the need to maintain the lowest possible fuel throughput for reducing the required tritium inventory. The fuel throughput in DEMO is mainly determined by the necessity of He ash removal [1].
This paper proposes plasma bypassing from the divertor to the SOL region to ensure the He ash exhaust without required large D/T flow. As additional effect in case of a suitably chosen DEMO divertor configuration, He enrichment is expected because of the larger mean free path for neutral helium particles compared to the one of DT neutrals, which allow He to penetrate into the divertor region easier than DT atoms. These effects allow one to achieve the lowest possible fuel throughput for reducing the required tritium inventory. The divertor configuration with the dome and fuel bypassing from the plenum to the SOL is suggested as a promising divertor configuration which could facilitate He removal with moderate flow rates to be pumped and low tritium inventory.

[1] Yu. Igitkhanov, Ch. Day, P. Lang and B. Plöckl, paper to TOFE, 2016, Philadelphia.

Eligible for student paper award?

No

Authors: Dr IGITKHANOV, Yuri (KIT, Germany); Dr DAY, Christian (KIT, Germany); Dr STULIANOS, Varoitis (KIT, Germany)

Presenter: Dr IGITKHANOV, Yuri (KIT, Germany)

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