Divertor plasma scenarios for the EU-DEMO

F. Subba[1], D. Coster[2], S. Varoutis[3], R. Zanino[1]

[1] *Politecnico di Torino, NEMO Group, Torino, Italy*

[2] *IPP, Garching, Germany*

[3] *KIT, Karlsruhe, Germany*

The divertor is expected to be a critical part of the EU-DEMO fusion reactor, which is currently in its pre-conceptual design phase. Among the many functions to be served by this component, of major importance are the exhaust of P_{sep} ~150 MW power crossing the separatrix via conduction/advection, and of ~7.3×10^{20} s^{-1} He atoms produced by the D-T reactions necessary to obtain ~2GW fusion power. In order to deal with such high power with the ITER-like divertor expected to be installed, it will be necessary to radiate more than 90% P_{sep}, which we plan to do through addition of a proper amount of Ar in the divertor plasma. Although EU-DEMO could be operated in such high-radiation condition [1], we should also guarantee not to exceed an upstream density larger than 0.5 n_{GW}, so as to avoid degrading the confinement performances. Moreover, it should be checked that the added Ar does not reach core concentrations higher than a few percent at most, otherwise the net electrical power could drastically reduce due to the strong radiative cooling and the consequent need to increase the auxiliary heating to maintain the desired reactor plasma conditions. Furthermore, the divertor should provide a sufficiently large He pressure, of the order of ~10 Pa, in order to allow efficient pumping, taking into account that current technologies limit the foreseeable pumping speed to ~100 m^3/s.

We present the first development of a possible scenario for the EU-DEMO in high-radiating divertor conditions done using the SOLPS-ITER code with fully kinetic model of the neutral gas transport. We consider an upstream density $n_{up}=2.7\times10^{19}$ m^{-3}, and P_{sep}=150 MW. Starting from a pure D+He plasma, corresponding to strongly attached conditions, we scan the Ar puff rate increasing its content up to driving fully detached conditions. As a reference, we take for this study a power decay length λ_q~3 mm, to ease comparison with previous fluid-neutral studies. Our modeling shows that He accumulation can be a critical factor to determine the acceptable operating window for the EU-DEMO divertor.

[1] F. Subba, et. al, Modeling of mitigation of the power divertor loading for the EU DEMO through Ar injection, *Plasma Physics and Controlled Fusion*, **60**, 035013, (2018)