On the penetration of heavy impurities in the JET ELMy H-mode plasmas

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This paper reports the main outcomes of the recent modeling activities in which the way the penetration of medium and high Z impurities into the plasma core of JET evolves with ELM frequency and heating power has been investigated. The motivation was to assess and to provide physics basis for the ELM-control requirements in ITER.
Modeling has focused on the simulation of experiments in which traces of Ne have been puffed in ELMy H-mode plasmas with medium (12 MW) and high (32 MW) NBI power injection and in which the ELM frequency was varied by controlling the main gas fueling.
The main experimental evidences investigated by means of the simulation are the inverse proportionality between the concentration of any impurities and the ELM frequency, and the ELM-resolved time evolution of the Ne density at the edge as provided by charge exchange measurements [1]. In addition, the effect of increasing heating power has been studied: as the heating power is increased, the edge kinetic profiles change in the direction of reducing the neoclassical inward velocity of impurities and therefore in the direction of the situation expected in ITER, where heavy impurities should be repelled at the H mode barrier by a favorable combination of density and ion temperature profiles.
Full predictive modeling includes simulations by means of JETTO-SANCO with three impurities (Be, Ne, W) and integrated JETTO-SANCO-Edge2D with two impurities (Ne, W), both available in the JINTRAC suite of codes [2].
Turbulent transport in the core is simulated by means of QualiKiz [3] or GLF23 [4]. In simple cases the BgB model multiplied by a suitable factor has been used. While waiting for the input from physics based models such as JOREK [5], for the ELM description we have assumed a heuristic model with either *ad hoc* enhancements of heat and particle diffusivities in the barrier region or an *ad hoc* burst of the outward radial velocity. In this way the impact of convective versus diffusive transport during an ELM event has also been investigated. Analogously, transport in the barrier region outside the ELM event is also described heuristically imposing neoclassical transport and an ad hoc turbulent transport multiplier.

[1] Valisa M et al Proc. 44th EPS Conf.2017 http://ocs.ciemat.es/EPS2017PAP/pdf/P4.174.pdf
[2] Romanelli M et al Plasma Fusion Res. 9, 3403023 [3] Bourdelle C et al Phys Pl. 14 112501(2017)
[4] Waltz RE & Miller RL Phys Plasmas 6 4265 1999
[5] Hujsmans GTA & Czarny _Nucl .Fus 47 659 (2007)

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