Tungsten transport in presence of seeded impurities: on the neoclassical and turbulent W peaking in WEST plasmas

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Introduction

Modelling of core tungsten turbulent and neoclassical transport has seen significant success in the recent years, to the point where experimental observations of e.g. tungsten accumulation or core tungsten peaking in general, e.g [1,2], can be quantitatively well reproduced and understood. In the presence of seeded impurities, in this case nitrogen [2, 3], it was found from dedicated simulations, that the neoclassical tungsten diffusion was increased and thus the central tungsten peaking reduced. To investigate further this mechanism and to validate simulations against experimental data, a database of stationary phases (in plasma current and total power) consisting of seeded experiments performed at WEST has been systematically modelled with NEO/FACIT and TGLF/QuaLiKiz for the neoclassical and turbulent transport respectively. Then, extrapolation of these results to high performance ITER-like pedestal parameters are further discussed and in particular the role of seeded neon on the neoclassical W outward pinch [4].

Central tungsten peaking in WEST seeded discharges

A set of discharges with nitrogen seeding were performed at WEST to achieve X-point radiator regimes [5] with a Lower Hybrid injected power of $P_{LHCD} = 4$ MW, plasma current $I_p = 500$ kA and line averaged densities of 4×10^{19} m^{-3}. The overall performances (neutron rate, central electron temperature and H_{98}) are observed to increase with the level of nitrogen, a reduction of the core tungsten content is also found together with a reduction of the core radiated power. While there is an impact on the divertor sources, bolometry inversions suggest a reduction of the tungsten peaking in the central part of the plasma (figure 1). To investigate the role of neoclassical and turbulent transport in such reduction of the central tungsten peaking a reduced database of steady states (in terms of injected power and plasma current) of nitrogen seeded discharges are considered using the systematic storage of WEST experimental data with the ITER Modelling and Analysis Suite (IMAS) infrastructure [6]. Informations on core profiles are extracted from fitting of direct measurements, e.g. the electron temperature from Electron Cyclotron Emission. Quantities that are not directly measured, like the impurity content