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3D numerical modeling of power exhaust and W migration in WEST plasma taking into account the impact of realistic wall and magnetic geometry

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The tokamak concept exploits the geometrical symmetry of the toroidal magnetic field to confine the plasma away from the vessel walls. Notwithstanding, toroidal ripple and/or localized wall components, such as antennas and limiters, break such symmetry and have been observed to cause a significant change in the power exhaust picture in nowadays experiments [1]. In particular, vessel wall asymmetries have been shown to be an important source of tungsten (W) impurities in metallic environments such as WEST, a major concern in the design of the future tokamak fusion devices [2].

In this contribution, we present the first studies of the power exhaust and W migration in WEST plasmas [3] using SOLEDGE3X [4] simulations including realistic 3D wall shapes and magnetic geometries with toroidal ripples and comparisons with experiments. SOLEDGE3X is a multispecies, electromagnetic, drift-reduced Braginskii code able to run plasma in asymmetric conditions and coupled to neutral models to provide self-consistent plasma-neutral reactions. By comparing simulations of the same experimental scenario with and without toroidal ripples, we assess the effect of the magnetic perturbation in modulating the plasma outflow. These findings are supported by a series of comparisons with experimental data, in particular, the 3D profiles of the target temperatures obtained with WEST infrared cameras and the analysis of SOLEDGE3X simulations with the PFCflux [5] code. Scans on the input power and plasma density baseline are also performed to map the plasma parameter space and identify where the 3D effects are more detrimental for W migration. These results are obtained with the interpretative modeling of the simulations with ERO2.0 code [6], thus allowing for the estimation of the impurity concentration, radiation, and channels for core contamination whose findings are then compared against a series of observables obtained by reflectometry, Langmuir probes, and visible spectroscopy.

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