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Tungsten sources and core contamination in WEST diverted configurations

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Over the first phase of WEST exploitation, the full tungsten environment consisted in a mixture of coated tiles and actively cooled ITER-like monoblocks. Using a combination of LHCD and ICRH heating, diverted L-mode scenarios were extended up to 50 s and stationary heat loads reaching 6 MWm-2 were deposited on ITER-like monoblocks. Despite input power levels generally above expected thresholds for onset of improved confinement modes (3-4 MW), unmitigated core radiation levels, in the range of 50% of the input power, prevented routine access to those improved modes. Core tungsten concentrations are generally estimated in the range of 10-4 from absolutely calibrated VUV spectroscopy, bolometry or soft X-ray.
Tungsten sources from divertor targets do show significant variability across plasma scenarios despite relatively constant core radiation levels, suggesting efficient screening even in compact divertor geometry. On the contrary, RF power coupling requires to adapt the plasma-antenna gap, in turn potentially enhancing the source strength and penetration from their tungsten limiters. These limiter sources are believed to rule core contamination, despite that there is no strong experimental evidences supporting this statement. Introduction of boron nitrite bumpers in the tokamak chamber helped stabilizing the plasma start-up (initially done on tungsten bumpers) but did not show hysteresis effects on diverted scenarios. The choice of replacing RF antennae limiters by boron nitrite coated tiles shall be taken next year, although this moves WEST away from a full metal environment, and despite no strong experimental arguments.
The true problem is rather to understand if the constant 50% radiation level in WEST can effectively be tamed by replacing some or all antennae limiters, or if this level of radiation is simply a stiff balance between power exhaust and core radiation. Based on SOLEDGE & ERO2 simulations of the tungsten transport at the edge of WEST [1], a phenomenological model can be built in order to relate core radiation and gross sources from different locations. Parametric sensitivity study help to disentangle the dominant mechanisms at task in the transport of the eroded tungsten to the core plasma. In particular, it is possible to recover a 50% radiation level across any density and input power variations, due to divertor sources. The model will be explored to test if divertor or antenna limiters have similar impact on global scenarios.

[1] S. Di Genova et al, Nucl. Fusion 61 (2021)

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