Isotope wall content control strategy in the upcoming D, H and T experimental campaigns in JET-ILW

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JET is the largest tokamak in use and currently the only one capable of handling tritium (T). Equipped with the ITER-like wall (ILW), a tungsten (W) divertor and beryllium (Be) main chamber, JET will soon operate with pure hydrogen isotopes in order to prepare scenarios for ITER [1]. The total budget of 10^{20} 14 MeV fusion neutrons for the upcoming isotope campaigns in JET being consumed in 250 high power plasma pulses (40MW/5s) with only 1%D in the T campaign (or 1%T in the following D campaign), a strategy for reducing the D (T) wall inventory below this level before the T (D) campaign is mandatory.

In this paper, we present the elaborated strategy to control and measure the D wall inventory. The efficiency of the different methods which are composing it are evaluated, as well as their combination aiming at maximizing access to different D retention areas in the JET-ILW. We also discuss the review of experimental data and diagnostics (divertor spectroscopy, sub-divertor Rest Gas Analysis) undertaken in order to reliably assess the isotope ratio and thus the strategy efficiency. The strategy includes one week vacuum vessel baking at 320°C, combined with isotopic exchange by hydrogen Glow Discharge and Ion Cyclotron Wall Conditioning, preferentially accessing D retained in the main chamber. Post-mortem analysis of JET PFCs after the first two ILW campaigns revealed however that the majority of the fuel is retained in Be deposited layers at the inner divertor top [2] with thickness up to 40μm, and that complete thermo-desorption of the co-deposited fuel requires surface temperatures beyond 550°C [3]. Analysis of IR measurements in plasma discharges with inner strike point raised to the inner divertor top shows that such temperatures and beyond can be reached. Whereas spectroscopy in these shots reveals the enhancement of Dα, Be I and Be II emission intensities at the strike point, BeD emission intensity is almost absent, consistently with the fact that chemical sputtering of the co-deposited layers is inhibited if surface temperature is higher than 270ºC [4]. Similarly, another scenario designed with strike points on vertical targets will aim at depleting D stored in the outer divertor.

[1] X. Litaudon et al. Nucl. Fusion 57 (2017) 102001; [2] A. Widdowson et al, Nucl. Fusion 57 (2017) 086045
[3] K. Heinola et al. Nucl. Fusion 57 (2017) 086024; [4] R.P. Doerner et al, J. Nucl. Mater.681 (2009) 390–391