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The role of the target electron temperature as a key detachment parameter in different JET-ILW divertor configurations

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Recent JET-ILW experimental results have allowed previously reported but unexplained divertor configuration differences in global confinement (H_{98},W_{dia}) and pedestal performance to be condensed into a single trend correlated with the outer target temperature, $T_{e,ot}$. By utilizing an innovative spectroscopic approach to access $T_{e,ot}$ in the range 0.6-20 eV, the critical role of $T_{e,ot}$ as the main detachment controlling parameter was confirmed using L-mode and H-mode plasmas in varied divertor configurations and D_2 puff rates. The robustness of $T_{e,ot}$ as an ordering parameter extends to the upstream separatrix and pedestal densities and temperature, and outer SOL density shoulder formation in unseeded low-δ H-mode discharges at B_t =2.3 T, I_p =2 MA. Strong $T_{e,ot}$ correlations with neutral atomic density, momentum loss and recycling cooling loss factors, volume recombination fraction and Lyman series opacity were observed experimentally on JET and shown to be in quantitative agreement with EDGE2D-EIRENE simulations. In line with experimental findings, these simulations also confirm the modest impact of available divertor configurations on upstream density. These results provide a much improved picture of the dominant detachment processes on JET-ILW with recycling cooling loss onset at $T_{e,ot}$ =10 eV, pressure loss onset at $T_{e,ot}$ =2-3 eV and the onset of volume recombination detachment at $T_{e,ot}$ =1 eV. The findings are of critical importance for informing pedestal studies by connecting the role of $T_{e,ot}$ dependencies to neutral penetration into the confined plasma, thought to be the main mechanism for density pedestal formation; they also advance the foundational understanding of pure deuterium divertor plasma physics enabling an assessment of the relative role of neutral loss channels and seeded impurity radiative losses on target heat flux mitigation.