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Improved Confinement in JET High Beta Plasmas with an ITER-like Wall

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The replacement of the JET carbon wall (C-wall) by a Be/W ITER-like wall (ILW) has affected plasma confinement by the direct effect of wall materials on key plasma parameters and by the impact of operational techniques necessary to avoid damage to plasma facing components. To investigate the effect of changing wall materials on energy confinement scaling, experiments have been performed with both the C-wall and ILW to vary the heating power over a wide range with two different plasma shapes, spanning the beta-N domain between the ITER baseline ELMy H-mode (beta-N less than 2) and hybrid plasmas (beta-N up to 3). With the ILW the power degradation of thermal energy confinement was found to be weak; much weaker than the IPB98(y,2) scaling. This is consistent with the observation of higher H98 in the hybrid domain (typically 1.2-1.3 at beta-N close to 3) compared with baseline plasmas (typically 0.7-1.0 with beta-N=1.5-2.0) seen in the wider JET database. This weak power degradation of confinement, which was also seen in the C-wall experiments at low triangularity, is mainly due to increased edge pedestal pressure and core density peaking at high power. By contrast, the high triangularity C-wall plasmas exhibited elevated H98 over a wide power range with strong, IPB98(y,2)-like, power degradation. This strong power degradation of confinement appears to be linked to an increase in the source of neutral particles from the wall as the power increased. The loss of the improved confinement domain at low power with the ILW may be partly due to operational factors such as higher gas fuelling and increased distance between the outer divertor strike-point and the cryopump. But plasma radiation from the plasma core was also higher with the ILW, and other experiments with nitrogen seeding suggest that plasma composition may also play a role. The results presented in this paper show that the choice of wall materials can strongly affect core plasma performance, even changing confinement scalings that are relied upon for extrapolation to future devices.

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