Influence of MHD on impurity peaking in JET

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* See the Appendix of F. Romanelli et al., Proceedings of the 24th IAEA Fusion Energy Conference 2012, San Diego, US.

Since operation commenced with the ITER-like wall (ILW) in JET, which includes tungsten in the divertor structure, core impurity accumulation which leads to performance degradation in some cases, has become an issue. The effect is particularly pronounced in hybrid scenario pulses where tailoring of the current profile is used to achieve higher normalised beta and confinement ($H_{95y}>1$), than in the ELMy H-mode.

In the hybrid pulses a causal link is found between the occurrence of low-n MHD and impurity accumulation. In many pulses there is off-axis localisation of the high-Z impurities on the low field side. In pulses with a 3/2 NTM, coincident with the NTM being destabilised (usually by a sawtooth) rapid on-axis impurity accumulation commences and there is a strong rise in core radiation and degradation of confinement. n>2 NTMs have an equivalent but weaker effect. The initial low field side impurity localisation is predicted by neo-classical theory including centrifugal effects on the high-Z impurities. It is thought that 3/2 NTM islands observed to be of ~10cm width facilitate rapid transport of the off-axis accumulated impurities into the core; initial modelling with the JINTRAC code suite supports this hypothesis and more detailed results will be presented. There are a few pulses where core impurity accumulation precedes the NTM onset and in these the NTM does not accelerate the accumulation process – which is consistent with the island transport model.

Although NTMs have the most dramatic effect on impurity accumulation, core n=1 MHD is in fact the more common occurrence in hybrid ILW pulses. Most typically impurity accumulation occurs, but the sawteeth flush the impurities from the core (this behaviour also happens in ELMy H-mode pulses). In ILW hybrid pulses, as opposed to C-wall pulses, the n=1 MHD seems to be stronger and more continuous in general, and results of a systematic study of this will be presented. ECE phase analysis shows that m=n=1 islands frequently develop and there is evidence that the W-impurity accumulation is helical (Fig 1), probably within the m=n=1 island. It is thought the localised island radiation might contribute to increasing the drive for the instability.

Experiments to use ICRF heating to inhibit core impurity accumulation are planned and the role of MHD in these discharges will be examined.

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