Enhancing the mode conversion efficiency in JET plasmas with multiple mode conversion layers

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The constructive interference effect described by Fuchs et al. [V. Fuchs et al 1995 Phys. Plasmas **2** 1637–47] shows that the mode conversion and thereby the overall heating efficiency can be enhanced significantly when an integer number of fast wave wavelengths can be folded in between the (high field side) fast wave cutoff and the ion-ion hybrid layer(s) at which the ion Bernstein or ion cyclotron waves are excited. This effect was already experimentally identified in (^{3}He)-D plasmas [D. Van Eester et al, Plasma Phys. Control. Fusion **51** (2009) 044007] and was recently tested in (^{3}He)-H JET plasmas. The latter is an 'inverted' scenario, which differs significantly from the (^{3}He)-D scenarios since the mode-conversion layer is positioned between the low field side edge of the plasma and the ion-cyclotron layer of the minority ^{3}He ions (whereas the order in which a wave entering the plasma from the low field side encounters these layers is inverted in a 'regular' scenario), and because much lower ^{3}He concentrations are needed to achieve the mode conversion heating regime. The presence of small amounts of both ^{4}He and D in the discharges gave rise to two mode conversion layers rather than a single one, which made the interpretation of the results more complex but also more interesting: Three different regimes could be distinguished as a function of X[^{3}He]. Both at low (<3-4%) and high (>6-7%) concentrations of ^{3}He efficient heating was observed but – because of the different wave dynamics – the 2 regimes have a different signature, e.g. the fast particle and neutron yield differ greatly. At intermediate X[^{3}He] poor coupling and absorption was observed. Analysis showed that this was due to a mode conversion layer in front of the antenna, blocking access to the waves. Whereas (1-D and 2-D) numerical modeling yields quantitative information on the heating efficiency, recent analytical work by Kazakov [Kazakov et al., Plasma Phys. Control. Fusion **52** (2010) 115006] permits to grasp the dominant underlying wave interaction physics. The heating efficiency can be tuned by modifying the confluence layer positions, making use of the sensitivity of these layers' positions to the various plasma constituents. The potential of inducing toroidal plasma rotation in the mode conversion heating regime was confirmed in both D(^{3}He) and H(^{3}He) experiments in JET. A summary of the main results concerning the efficiency of the ICRF waves to induce plasma flow and the role of the short wave absorption in this process will be addressed briefly.

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* See the Appendix of F. Romanelli et al., Proceedings of the 23rd IAEA Fusion Energy Conference 2010, Daejeon, Korea