Island aware JINTRAC simulations of JET pulses with neutron deficit

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The presence of an NTM island in a tokamak is known to potentially harm the integrity of the machine and to degrade confinement. For this reason, large effort both from the experimental and from the analytical / numerical point of view has been put on the study of MHD instability on one side and of transport on the other.

Recent studies suggest one of the mechanism through which the island degrades tokamak performance could be the expulsion of part of the fast ions from the core of the plasma, thus reducing the rate of nuclear reactions, and ultimately producing a neutron yield lower than expected. Fast ion dynamics simulations with the Monte Carlo code ASCOT\textsuperscript{[1]}, in which the underlying magnetic flux grid has been modified to account for the magnetic island presence, confirm qualitatively this pattern when compared with tokamak data.

In this work we analyse the effects of an NTM island in JET pulses where both a neutron yield less than expected and the presence of the island have been assessed. The suite of transport codes JINTRAC\textsuperscript{[2]} has been specifically modified in order to account for the change in magnetic topology in a self-consistent way. ASCOT has been substituted with the version used in [1] while, inside JETTO, transport coefficients have been dramatically raised in the island region, whose position and width are determined post-processing experimental data (mainly Mirnov coils and electron cyclotron emission signals).

We run JINTRAC with the Bohm/Gyro-Bohm model in a predictive way and we find that, after the simulation of one second of discharge, calculated electron temperature and density profiles appear closer to the experimental ones when the island is accounted for. This shows the importance of tackling MHD driven transport problems in an integrated way. Moreover, always when the island is accounted for, the rate of nuclear reaction is reduced and the kinematics of the fast ions suggests that they migrate from the core toward an external, colder region, as expected from the expulsion mechanism above mentioned.


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