Coupled Core/SOL Modelling of Fuelling Requirements During the Current ramp-up of ITER L-mode plasmas

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Active control of the gas fuelling is needed during the current ramp-up phase of ITER baseline scenario in order to insure a low enough electron density for the plasma to remain attached to the divertor plates and at the same time a high enough line average density to allow for neutral beam injection to trigger the L-H transition.

A series of simulations with increasing gas injection-rates has been carried out with the integrated Core/SOL suite of codes JINTRAC [1] in order to assess the possibility of reaching by gas-puff alone the minimum line average density (approximately $2.9\text{x}10^{19}$ m^{-3}) for safe NBI operation during the current ramp up of the ITER baseline scenario. Impurity seeding has been included in the simulations in order to keep the power density at the divertor below 10 MW/m^2 The currents used for this study are:, 5 MA, 10 MA and 15 MA; with Electron Cyclotron Heating (ECRH) of 5 MW, 10 MW and 20 MW respectively. For each current we have increased the deuterium, tritium injection-rates until detachment was detected. The simulations have been continued until steady state was reached for a given input power and main gas inlet rate. Steady state conditions correspond to a steady core density during at least one energy confinement time, which for L-mode ITER plasmas is around 3s. In average the simulations took 10 s of plasma time to reach steady state. Results indicate that for plasma currents of 5 MA and 10 MA the ITER L-mode plasma could be fully detached before the line average density reaches the minimum required for NBI operations. Use of ECRH/ICRH heating power above 20MW could allow a further increase the density at 10MA. Further more the gas inlet rate has to increase along with plasma current and heating power to avoid that the power deposited into the divertor exceeds the 10 MW/m^2 threshold permitted by ITER divertor design.

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[1] M. Romanelli et al., JINTRAC: A system of codes for Integrated Tokamak Simulations, Plasma and Fusion Research, 2014