Coupled Core/SOL Modelling of Fuelling Conditions for Stationary H-mode in ITER DT Baseline Scenarios

P Belo[1], M Romanelli[1], V Parail[1], G. Corrigan[1], D Harting[1], L Garzotti[1], F Koechl[2], E. Militello-Asp[1], M Mattei[3], R Ambrosino[3], A Loarte[4], A Kukushkin[4], R Sartori[5], M Cavinato[5]

[1]*CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK*
[2]*Technical University Wien, 1020 Vienna, Austria*
[3]*CREATE, University of Naples"Federico II", Italy*
[4]*ITER Organization, Route de Vinon sur Verdon, 13115 St Paul Lez Durance, France*
[5]*Fusion For Energy Joint Undertaking, Josep Pla 2, 08019, Barcelona, Spain*

Fuelling conditions required to achieve a certain density level in the stationary good quality H-mode regime in the flat-top phase of the ITER DT baseline scenario at varying levels of current and magnetic field (5 MA, 7.5 MA, 10 MA, 15 MA at 5.3 T, 7.5 MA at 2.65 T) have been investigated with the integrated Core/SOL suite of codes JINTRAC [1] in fully predictive simulations.

Scans in gas flux have been performed at an auxiliary heating power of 33 MW NBI + 20 MW ICRH in order to assess the maximum achievable density level and fusion performance without additional fuelling by pellets at which the plasma remains partially attached. Ne impurity seeding has been applied for divertor heat flux control. The core confinement conditions, SOL power and particle balance, heat flux to the targets, and required gas flux level have been evaluated. In addition, simulations of a pellet fuelled 15 MA DT baseline H-mode plasma have been performed to investigate whether a target density of ~80-90% of n_{GW} with Q_{fus} ~ 10 can be achieved and pellet-induced perturbations in the heat flux to the target plates remain tolerable.

Results indicate that with gas injection only a volume averaged electron density of ~$3.5\text{-}5\cdot10^{19}$ m^{-3} could be achieved for currents between 7.5-15 MA, which is sufficient for NB heating. The maximum power density deposited in the divertor remains below to the engineering limit of ~10 MW/m^2 except for the case at 15 MA with negligible Ne impurity seeding (max. Q_{fus} ~ 5); there, the power density is predicted to reach ~20 MW/m^2 close to the strike point position on the outer target. In all cases the density gradient in the pedestal is very small which is a consequence of a very low neutral influx at the separatrix (< ~10^{21} s^{-1}), the neutral ionisation source being located at the very edge of the plasma and negligible core particle sources from neutral beams only (< ~$3\cdot10^{20}$ s^{-1}).

Preliminary results for the pellet fuelled 15 MA H-mode plasma indicate that the power density deposited on the target plates fluctuates strongly during a pellet injection cycle, however the transient peaks observed in the simulation seem to be compatible with the engineering limits for a temporary excess of 10 MW/m^2 of a few ms.

This work was funded jointly by the RCUK Energy Programme and ITER Task Agreement C19TD51FE.

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