Optimization of q-profile towards high-fusion-performances at JET in preparation of DTE2 campaign

F. Jaulmes[1], J. Urban[1], C.D. Challis[2], J.-F. Artaud[3] and the JET team[*]

[1] *Institute of Plasma Physics of the CAS, Prague, Czech Republic*

[2] *CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK*

[3] *CEA, IRFM, F-13108 Saint Paul Lez Durance, France*

** See the author list of "X. Litaudon et al 2017 Nucl. Fusion 57 102001"*

Prospective JET (Joint European Torus) DT operation scenarios are modelled by the fast integrated code METIS [1]. METIS combines scaling laws, e.g. for global and pedestal energy or density peaking, with simplified transport and source models, whilst retaining fundamental nonlinear couplings, in particular in the fusion power. We have tuned METIS parameters to match JET-ILW high performance experiments, including baseline and hybrid. By adjusting the dependencies of the scaling laws (eg. the dependence on input power) we manage to reproduce an entire JET pulse (simultaneous evolution of temperatures, densities, radiated power and stored energy). Based on recent observations, we assume a weaker input power scaling than IPB98y2 for hybrid pulses and we also adjust DT simulations according to DT performances obtained in [2]. Whilst a large uncertainty remains on the actual final DT fusion power, our approach can guide experiment development by providing trends in predictions in a wide range of conditions.

The investigation focuses on the possible shaping of the safety factor profile during hybrid discharges. We are able to reproduce precisely the hybrid pulses of the previous JET campaign and derive them into a family of simulations by varying parameters in a small range around experimental data. In particular, this allows us to explore a complete range of shapes of safety factor profiles by adjusting the timing of the heating, current and density ramp-up. We retain some promising heating and current ramps that will allow longer pulses with higher performances, some of which include an Internal Transport Barrier [3].

Furthermore, we aim at finding a one to one correspondence between pure Deuterium pulses and the DT modelling, following principles derived in [2]. In our approach, care is given to the stationarity of the safety factor profile and the possibility to reproduce Deuterium performances in DT. The experimental MHD stability (eg. NTMs, fishbones) of the pulses is considered, as well as some estimation on the evolution of the impurity content (overall radiative losses) during the flat-top.

[1] - Artaud J.F. et al. 2010 *Nucl. Fusion* **50**, 043001

[2] - J Garcia *et al* 2017 *Plasma Phys. Control. Fusion* **59** 014023

[3] - T. Tala *et al* 2006 *Nucl. Fusion* **46** 548