

O5.104 High fusion power in tritium rich scenario in JET

Friday, 12 July 2019 12:25 (15 minutes)

See the full abstract here <http://ocs.ciemat.es/EPS2019ABS/pdf/O5.104.pdf>

Series of isotope control experiments in H/D mixtures on JET [1] have shown that NBI fuelling species has only a weak effect on the core isotope composition, which remains determined by the edge H/D ratio and therefore by the injected gas. The analysis of the core particle transport of the ion components revealed a fast isotope mixing ubiquitous in plasmas with dominant ITG turbulence [2-4]. Fast isotope mixing offers an opportunity to significantly boost the fusion power in JET DTE2 campaign in a variant of a hybrid scenario [5,6] with unbalanced (tritium rich) D/T isotope composition and pure D-NBI heating, as opposed to the symmetric 50/50 D/T mixture and combined D- and T-NBI. High PDT brings substantial benefits to the physics goals of DTE2, such as investigation of alpha particle physics and demonstration of the alpha heating.

Thermonuclear fusion reactivity reduces as the plasma composition deviates from the balanced 50/50, although injection of fast deuterium into thermal tritium plasma greatly enhances the beam-target fusion, due to the large cross-section of D-fast-T reactions and increased number of the tritium targets. In the parameters space of JET hybrid scenarios that gives a net increase of the total number of fusion reactions, with larger gain at higher tritium concentrations.

Further to the NBI fast-thermal reactions, the low expected D/T ratio (n_D/n_e 35%) enables the usage of deuterium fundamental harmonic ICRH heating scheme which further boosts the fusion power, as, unlike in 2nd harmonic schemes, it avoids accelerating fuel ions to energies well above the peak of the DT cross section (~ 120 keV). The fundamental D minority heating demonstrated the highest $Q_{fus}=0.22$ in DTE1 (1997) for a 4 second stationary state plasma [7]. In the proposed scenario, part of the ICRH power will also be absorbed by the fast D-NB ions and the intrinsic Be impurity as the resonant species in a three-ion heating scheme [8]. TOMCAT and TORIC simulations have shown that the fractions of the total ICRH power absorbed by the individual components depend on the exact plasma D/T composition, with more power going to the thermal and fast deuterium in more T-rich plasmas. Therefore, larger D/T imbalance also provides larger boost to the fusion reactivity from the ICRH heating.

Combination of the NBI beam-target reactions with the ICRH effects in the proposed scenario has the potential of boosting the fusion power significantly over an otherwise similar hybrid plasma with $n_D=n_T$. This contribution will present the present status of development for this scenario, modelling results and extrapolations to DT.

[1] King D.B. et al, 44th EPS (Belfast, 26-30 June 2017) <http://ocs.ciemat.es/EPS2017PAP/pdf/O3.112.pdf>

[2] M Maslov et al 2018 Nucl. Fusion 58 076022;

[3] C Bourdelle et al 2018 Nucl. Fusion 58 076028

[4] M Marin et al, 45th EPS (Prague, 2-6 July 2018) <http://ocs.ciemat.es/EPS2018PAP/pdf/O2.102.pdf>

[5] L Garzotti et al, 27th IAEA FEC, Ahmedabad, India (21-26th October, 2018)

[6] J Garcia et al, 27th IAEA FEC, Ahmedabad, India (21-26th October, 2018)

[7] D.F.H. Start et al, Phys. Rev. Letters, 1998, vol. 80, num. 21

[8] J. Ongena et al, EPJ Web. Conf. 157, 02006 (2017)

pppo

Presenter: MASLOV, M. (EPS 2019)

Session Classification: MCF

Track Classification: MCF