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High fusion performance at high Ti/Te in JET-ILW baseline plasmas with high NBI heating power and low gas puffing

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This paper presents the transport analysis of high density baseline discharges in the 2016 experimental campaign of the Joint European Torus with the ITER-Like Wall (JET-ILW), where a significant increase in the Deuterium-Deuterium (D-D) fusion neutron rate (~2.8 x 1016 sec-1) was achieved with stable high Neutral Beam Injection (NBI) powers of up to 28MW and low gas puffing.

Increase in Ti exceeding Te were produced for the first time in baseline discharges despite the high electron density, and this enabled a significant increase in the thermal fusion reaction rate. As a result, the new achieved record in fusion performance was much higher than the previous record in the same heating power baseline discharges where Ti=Te.

In addition to the decreases in collisionality and the increases in ion heating fraction in the discharges with high NBI power, Ti > Te can also be attributed to positive feedback between the high Ti/Te ratio and stabilisation of the turbulent heat flux resulting from the Ion Temperature Gradient (ITG) driven mode. The high Ti/Te ratio was correlated with high rotation frequency. Among the discharges with identical beam heating power, higher rotation frequencies were observed when particle fuelling was provided by low gas puffing and pellet injection. This reveals that particle fuelling played a key role for achieving high Ti/Te, and the improved fusion performance. The impact of particle fuelling on high Ti/Te has an important implication for 2019 D-T experimental campaign, as it can provide a further increase in the fusion performance with the present heating power capability.

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