17th Kudowa Summer School "Towards Fusion Energy" Kudowa Zdrój, 3 – 7 June, 2024

Overview of high performance D-T experiments in JET-ILW

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Abstract

More than twenty years after the last high fusion power Deuterium-Tritium (D-T) experiments in tokamaks, high performance D-T plasmas were recently investigated in JET-ILW using plasma facing materials relevant for ITER (Be first wall, Tungsten divertor) [1]. Up to 29MW of mixed D-T neutral beam injection (NBI) and 5MW of Ion Cyclotron Resonance Heating (ICRH) were available to develop high performance scenarios and an extensive number of fusion relevant diagnostics [2] provided good data coverage for the interpretation of the experiments and for the validation of numerical tools. Two different approaches were used for achieving large steady fusion power in the D-T experiments: (i) Baseline scenarios with high plasma current (>3MA), high stored energy, moderate β_N~2.0 and relatively high core collisionality [3]; (ii) Hybrid scenarios with moderate plasma current (I_P=2.5MA), low central magnetic shear ($q_0 \geq 1$), high β_{pol} and low core collisionality [4]. This presentation will focus on the latter, which achieved the best fusion performance in the last D-T experimental campaign, namely sustaining a 5s averaged fusion power of ~10MW. Various aspects of this scenario were explored, such as edge impurity screening with high pedestal ion

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temperature [5], the relationship between edge localized modes (ELM's), gas injection and plasma performance, assessment of different ICRF heating schemes in terms of plasma heating and RF fusion enhancement [6] and maximization of the fusion performance by using T-rich plasmas with pure D-beam injection, thus increasing the beam-target fusion reaction component [7]. State-of-the art interpretative and predictive simulations were performed for these discharges in different conditions and showed that, in general, the present heating and transport models available for core tokamak plasma physics studies are adequate for the interpretation of the experiments [8,9] and can be used for predicting the plasma properties and fusion performance in JET and in future fusion devices with a certain degree of confidence. The main results achieved with the high performance hybrid-like D-T plasmas will be reviewed and the different approaches to achieve high fusion power in JET-ILW will be discussed, including some modeling results that support the experimental interpretation.

References

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