Deuterium-tritium experiments in JET with the ITER-like wall

J. Garcia and JET contributors
EUROfusion Consortium and CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France.
e-mail (speaker):Jeronimo.garcia@cea.fr

In 2021, high fusion power deuterium-tritium experiments (DTE2) were performed in JET for the first time since the 1997 D-T campaigns in TFTR and JET (DTE1). This represents the culmination of a plan in support of ITER that started with the conception of the ITER-like wall in 2006, and included several enhancements as well as dedicated experimental campaigns to expand the operational space in JET-ILW and prepare the plasmas required to exploit JET's currently unique tritium handling capabilities. DTE2 delivered fusion energies exceeding the previous record (59MJ compared to 22MJ in DTE1) with fusion power up to 13MW and demonstrated the compatibility of sustained high performance D-T plasmas with the ILW. This was obtained following different plasma configuration routes, i.e. baseline and hybrid scenarios, which have provided a broad operational space to explore DT plasmas in view of ITER.

Experiments designed to address specific physics questions provide a unique set of data, with several notable preliminary results. In particular, isotope effects on transport and confinement and the impact of alpha particles on plasmas have been a key aspect addressed. Compared to their deuterium counterparts, D-T plasmas require lower input power to reach the high confinement mode (H-mode) relied on in ITER and show better energy confinement. The plasma edge (H-mode pedestal) pressure increases with the ratio of T to D and the core confinement increases in T with respect to D at high input power and high beta [1]. Reduction of turbulent transport and improvement of confinement in the presence of T was anticipated in a strong modelling effort performed before the DTE2 campaign [2,3,4]. The fusion power in the different operational scenarios performed is consistent with predictions made also before DTE2 using an integrated modelling approach [5]. Unambiguous observations of alpha particles and of alpha-driven instabilities were obtained using different techniques, such as afterglow plasmas or bump-on tail distribution functions. In particular, thermal confinement does not seem to degrade in the presence of Alfvén activity destabilized by alpha particles or ICRH, which may indicate some interplay between fast particles and main turbulence as found previously for D plasmas.

This contribution will summarize the motivation for, and the journey towards DTE2, describing some of the differences with respect H and D and highlighting how the unprecedented observations inform the preparation for ITER and other future fusion devices D-T operations.

References

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