On the mechanism of the plasma fuelling in JET experiment with external gas puff.

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Scenario development for ITER requires an understanding of the mechanism of the plasma fuelling with external particle source. Experiments on plasma fuelling with modulated gas puff have been done on JET [1] to clarify details of the particle penetration into the plasma core. The modulation caused a periodic variation of the plasma parameters in the scrape off layer (SOL), divertor and the plasma core, which have been measured by numerous JET diagnostics. An evolution of the plasma parameters has been modelled with the JINTRAC code [2]. The modelling results have been compared with the experimental data.

The plasma fuelling in the experiment was provided by a constant source from the NBI system, and modulated gas puff from the top of the plasma chamber [1]. The level of the puff was relatively small, and it did not change the global plasma confinement significantly. The experiments have been done in D and H plasmas. Qualitatively, the observations were similar in both gases. The density variation caused by the modulated gas puff were observed propagating from the plasma periphery to the core. The modulation footprint was seen in the plasma SOL and divertor.

The integrated suite of core and SOL/divertor transport codes JINTRAC [2] has been used to self-consistently model the plasma evolution during modulated gas puff. The suite couples JETTO/SANCO, a 1.5D core transport solver that includes impurities, with EDGE2D/EIRENE, a 2D SOL/edge multi-fluid solver that includes plasma interactions with the JET Be wall and W divertor.

Transport properties in the core were assumed to be governed by a combination of the neoclassical and Bohm/gyro-Bohm model with anomalous particle pinch. The boundary conditions were deduced from EDGE2D calculations. The accuracy of the predictive modelling of the plasma temperature and density was tested against free parameters used in the model. Good agreement between measured and modelled plasma parameters in the core, SOL and divertor has been found, including density evolution, saturation ion current and ion flux in the divertor. The modelling revealed the relationship between the variation of the gas puff rate, plasma density in SOL/core and the neutral particle flux through the separatrix. The modelling results showed that the modulated core plasma fuelling is defined by the boundary conditions on the separatix rather than by the neutral particle flux from the gas puff through the separatrix. This conclusion is valid for both H and D gases and it does not depend on the choice of the model describing the transport, provided that the evolution of the plasma parameters is consistent with experimental observation.

[1] A.Salmi et al., “Investigation of gas fuelling characteristics in JET experiments”, EPS 2017

[2] M.Romanelli et al., “JINTRAC: A System of Codes for Integrated Simulation of Tokamak Scenarios”, Plasma and Fusion Research, 9, 3403023 (2014)

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