Analysis of the ramp-down phase of JET ILW discharges

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The percentage of disruptions in the JET discharges with the new ITER Like Wall (ILW) configuration at high current can exceed 30%. The understanding of the physics of the causes of disruptions remains an important subject in order to reduce disruptivity, particularly for the ITER-relevant high density and high current operation. The analysis of such scenario performed at JET is presented in this work. We have analysed ramp-down phase of the set of representative high current JET ILW discharges. As a first step we have analysed the experimental data for two discharges: #92437(disrupted) and #92442 (soft landing) characterized with high plasma current I_p = 3.5MA. Both shots are similar before the start of the termination of the discharge at 13.9s, but shot #92437 develops a hollow temperature profile which runs away to disruption. The main question is whether there is a difference in impurity content or critical plasma parameters before the start of termination or a difference in impurity source or transport during the termination phase appears and that causes the discharge to diverge. The analysis is performed for four different time slots at the ramp-down phase: t = 13.9s; 14.25s, 14.5s; and 14.75s, corresponding to different levels of the electron line density and auxiliary heating power.

Since the energy balance in tokamaks with tungsten divertor depends strongly on the coupling between bulk and the SOL plasma, proper modelling requires joint treatment of both regions. Therefore our approach is based on integrated numerical modelling of plasma parameters using the COREDIV code, which self-consistently solves the 1D radial transport equations of plasma and impurities in the core region and 2D multi-fluid transport in the SOL. In particular, we have studied the influence of the plasma heating and plasma density on the impurity production and transport during plasma termination phase. Since the deuterium gas flux are different, the influence of the separatrix density is also analysed.

The main conclusion from the preliminary simulations is the observation that for the same average electron density, a decrease of the separatrix density leads to an increase of the plasma temperature at the divertor plate leading to increased W production and consequently to larger W concentration and radiation in the core. When the central electron temperature approaches the 2keV level, corresponding to the maximum of the W cooling rate, enhanced radiation in the plasma center occurs which might be the reason for the experimentally observed hollow profiles of the electron temperature.

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