Plasma breakdown in the WEST tokamak

E. Nardon[1], H. Heumann[2], J.F. Artaud[1], N. Fedorczak[1] and the WEST team

[1] *CEA, IRFM, F-13108 Saint-Paul-Lez-Durance, France*

[2] *CASTOR, INRIA SAM, 06902 Valbonne, France & LJAD, Université de Nice Sophia Antipolis, 06108 Nice Cedex 02, France*

The WEST project involved important changes from Tore Supra in terms of magnetic configuration, the main ones being two new in-vessel divertor coils surrounded by stainless steel casings and two new copper stabilizing plates. These additional components had major consequences on the magnetic field map at breakdown. In the initial WEST configuration, breakdown could be achieved but the plasma current would not go above a few tens of kA. This was attributed to induced currents in the stabilizing plates. It was therefore decided to remove the lower stabilizing plate and, when this proved not sufficient, to also cut the upper one (which was hard to remove). This finally allowed successful plasma breakdown and I_p ramp-up, using a high electric field (~1V/m) and low D_2 prefill pressure (~3mPa). Due to these parameters, plasma breakdown is however often accompanied by runaway electron (RE) formation but, counter intuitively, it has been found that reducing the prefill pressure can help avoid RE. Extensive vacuum magnetic field modelling has been performed, for both preparation and analysis of the experiments. For the preparation, inverse time evolutive simulations with the FEEQS.M code have been used to calculate optimal premagnetization poloidal field coils currents and voltages to be applied in the breakdown phase. For the analysis, magnetic field maps have been reconstructed with two different approaches: direct time evolution simulations with FEEQS.M (starting from measured coils currents and applying measured voltages) and extrapolation from magnetic measurements with the FREEBIE_ID code. FEEQS.M- and FREEBIE_ID-reconstructed field maps are consistent with each other and with fast visible camera images, which allows for a precise assessment of the necessary conditions in terms of magnetic field for plasma breakdown in WEST.