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Understanding the stability of the low torque ITER Baseline Scenario in DIII-D

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Analysis of the evolving current density (J), pedestal and rotation profiles in a database of 200 ITER Baseline Scenario discharges in the DIII-D tokamak sheds light on the cause of the disruptive instability limiting both high and low torque operation of these plasmas. The m=2/n=1 tearing modes, occurring after several pressure-relaxation times, are related to the shape of the current profile in the outer region of the plasma. The q=2 surface is located just inside the current pedestal, near a minimum in J. This well in J deepens at constant betaN and at lower rotation, causing the equilibrium to evolve towards a classically unstable state. Lack of core-edge differential rotation likely biases the marginal point towards instability during the secular trend in J. New results from the 2017 experimental campaign establish the first reproducible, stable operation at T=0 Nm for this scenario. A new ramp-up recipe with delayed heating keeps the discharges stable without the need for ECCD stabilization. The J profile shape in the new shots is consistent with an expansion of the previous "shallow well" stable operational space. Realtime Active MHD Spectroscopy (AMS) has been applied to IBS plasmas for the first time, and the plasma response measurements show that the AMS can help sense the approach to instability during the discharges. The AMS data shows the trend towards instability at low rotation, and MARS-K modelling partially reproduces the experimental trend if collisionality and resistivity are included. The modelling results are sensitive to the edge resistivity, and this can indicate that the AMS is measuring the changes in ideal (kink) stability, to which the tearing stability index delta' is correlated. Together these results constitute a crucial step to acquire physical understanding and sensing capability for the MHD stability in the Q=10 ITER scenario. Work supported by US DOE under DE-FC02-04ER54698 and DE-FG02-04ER54761