IAEA FEC 2014

Contribution ID: **205** Type: **Oral**

Recent Advances in the Understanding and Optimization of RMP ELM Suppression for ITER

Tuesday 14 October 2014 10:45 (20 minutes)

Recent experiments with applied Resonant Magnetic Perturbations (RMPs) in low-collisionality ITER Similar Shape (ISS) plasmas on DIII-D have advanced the understanding of and increased confidence in obtaining ELM suppression in the ITER standard operating regime. ELM suppression is obtained with a reduced coil set (5–11 coils) on DIII-D, demonstrating the effectiveness of mixed harmonics (n=1,2,3) with a partial coil set and mitigating the risk of reduced coil availability on ITER. Recent advances in linear two-fluid MHD simulations indicate that resonant field penetration and amplification at the top of the pedestal is ubiquitous in these ISS plasmas, together with resonant field screening and kink amplification in the steep pressure gradient region. Measurements with the X-ray imaging camera reveal new information on the plasma response to 3D fields. There is good agreement between X-ray imaging and M3D-C1 simulation in the steep pressure gradient region of the pedestal, validating theoretical predictions of resonant screening and a dominant edge-kink response. While direct imaging of islands in ELM suppressed plasmas remains elusive, measurements with the newly upgraded magnetic sensors are suggestive of partially screened fields at the top of the pedestal, consistent with M3D-C1 simulations. Indirect evidence of island formation and resonant field penetration is also provided by the observed flattening of the electron pressure profile at the top of the pedestal and concomitant shrinkage of the pedestal width when the RMP is applied. In addition, the flutter model of electron transport also predicts an electron thermal diffusivity "hill"at the top of the pedestal that is comparable to experimental values when the resonant field amplification at the top of the pedestal is included in the calculation. Optimization of the pedestal pressure is an important issue for ELM suppression in ITER given that a reduction in the pedestal pressure is commonly observed in ISS plasmas with applied RMPs. Recent experiments demonstrate that the pedestal pressure can be maintained at the level before the onset of the RMP if the effect of density pumpout is counteracted with density feedback.

This work was supported by the US Department of Energy under DE-AC02-09CH11466, DE-FG02-92ER54139, DE-FC02-04ER54698, DE-SC0007880, DE-FG02-07ER54917, and DE-AC05-00OR22725

Country or International Organisation

USA

Paper Number

EX/1-1

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Session Classification: 3D Physics