DPP12-2012-000021

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Towards understanding ELM mitigation by resonant magnetic perturbations in MAST

IAN CHAPMAN, EURATOM/CCFE Fusion Association

MAST is equipped with 18 in-vessel coils for use in Resonant Magnetic Perturbation (RMP) ELM control experiments. These coils give considerable flexibility since they allow a range of toroidal mode numbers (up to n=6) and also allow improved alignment of the magnetic perturbations with the plasma equilibrium by allowing the phase of the applied field to be varied during the shot. This is complemented by modelling advances to understand the plasma response to applied fields, the resultant torque and three-dimensional displacement. The application of $n \geq 3$ RMPs in MAST results in up to a factor of eight increase in ELM frequency and the released energy per ELM dropping four-fold. The benefits of high-n RMPs include reduced core rotation braking and reduced effect on the L-H transition power with RMPs. During ELM mitigation, lobe structures near the X-point are observed for the first time in visible-light imaging of the plasma edge. These lobes, that were previously predicted, are correlated with RMP penetration and only appear when enhanced particle transport or increased ELM frequency is observed. The number and location of the lobes is well described by vacuum modelling. The toroidal corrugation of the plasma edge due to n=3 RMPs is also measured and found to be 5% of the minor radius. The electron pressure gradient drops and the pedestal width increases when RMPs are applied, which would normally suggest improved stability to peeling-ballooning modes, yet the ELMs are more frequent, or destabilised. This dichotomy is resolved with a model which suggests that the critical pressure gradient to trigger an ELM is degraded by the RMPs, due to both the presence of the lobes and the non-axisymmetric plasma corrugation. A quasi-linear code, MARS-Q code has been used to investigate the effects of the penetration process and plasma response on the observed structures. These computations quantify several factors affecting the dynamics of the RMP field penetration, in particular that the plasma response induces a larger $j \times b$ torque than the NTV torque and the penetration time is consistent with the time scale observed for the appearance of the lobe structures. *This work was funded by the RCUK Energy Programme under grant EP/I501045 and the European Communities under the contract of Association between EURATOM and CCFE. The views and opinions expressed herein do not necessarily reflect those of the European Commission.*