Contribution ID: **23** Type: **Oral Presentation**

EX/3-2: Understanding ELM Mitigation by Resonant Magnetic Perturbations on MAST

Wednesday, October 10, 2012 11:05 AM (20 minutes)

MAST is equipped with 18 coils (6 in the upper row and 12 in the lower row) 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) but 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. In addition, mixed spectra (e.g. n=3 and n=4) can be applied. ELM suppression has not been achieved on MAST but ELM mitigation has been established in a range of plasmas using RMPs with toroidal mode numbers of n=3, 4 or 6. The RMPs produce an increase in the ELM frequency of up to a factor of 5 with a comparable decrease of the ELM size.
Coincident with the effect on the ELMs, for the first time, clear lobe-like structures are observed near to the X-point. These lobes or manifold structures, that were predicted previously, have been observed for the first time in a range of discharges and their appearance is correlated with the effect of RMPs on the plasma i.e. they only appear above a threshold when a density pump out is observed or when the ELM frequency is increased. They appear to be correlated with the RMPs penetrating the plasma and may be important in explaining why the ELM frequency increases. The number and location of the structures observed can be well described using vacuum modelling. Differences in radial extent and poloidal width from vacuum modelling are likely to be due to a combination of transport effects and plasma screening.
Broader pedestal widths are observed during the ELM mitigated phase, resulting in lower pressure gradients which would normally suggest improved stability. T he 2D separatrix has been modified to include several lobe structures in the X-point region. These equilibria have then been used as input to ELITE stability calculations, which show that such structures can destabilise ballooning modes, consistent with the increase in ELM frequency observed. In addition, 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.

Work supported by the RCUK Energy Programme and EURATOM

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Session Classification: Pedestal Stability and Control I

Track Classification: EXD - Magnetic Confinement Experiments: Plasma–material interactions; divertors; limiters; scrape-off layer (SOL)