ELM Suppression Characterisation by Plasma Response Computation on ASDEX Upgrade

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Edge Localised Modes (ELMs) in H-mode tokamak plasmas may be controlled or entirely suppressed by applying 3D magnetic perturbations (MPs). The applied perturbation is amplified by the plasma response, and it has previously been established that the size of the peeling component of this response is a reliable indicator for expected ELM control on ASDEX Upgrade [2] and MAST [3]. This motivates further studies of the connection between the peeling response and ELM behaviour. Using the MARS-F linear MHD code [4], the global plasma response to applied n=2 MP fields was computed at 33 points in time from 3 recent ELM suppression experiments on ASDEX Upgrade. The amplified peeling response was characterised using a previously employed [5] set of figures of merit, based on the total magnetic perturbation and plasma displacement. The computed amplified peeling response for poor mitigation, good mitigation, and suppression were compared. Good mitigation is defined here as an increase in ELM frequency over the natural frequency of more than 50% (not referring to target plate heat load reduction). It is found that the values of the peeling response of the ELM suppressed cases occupy a relatively small subspace of that occupied by the ELM mitigated cases. Although the sample size is small, it appears that the peeling response may take larger maximum values for ELM mitigated cases than suppressed cases, consistent with a previous suggestion a sufficiently large peeling response may inhibit or reverse ELM suppression [6]. However, the peeling response for suppressed cases does not appear to be systematically higher or lower than for mitigated cases. It has been previously suggested [7], that the observation that ELM suppression access is easier at high triangularity may be related to the larger pedestal pressure gradient in these cases amplifying the peeling response. To investigate this, the pedestal pressure gradient of a standard ASDEX Upgrade equilibrium is scanned from shallow to steep. The plasma response to an applied MP is then computed for this scan. The results indicate that the amplitude of the amplified peeling response is not strongly sensitive to the magnitude of the pedestal pressure gradient. These observations appear inconsistent with the suggestion that a larger pressure gradient leads to a more strongly amplified peeling response which eases the transition from mitigation to suppression. These results are discussed in the context of the broader pursuit of a predictive theory for ELM suppression access, and the outlook for this effort briefly examined. Further investigation into the cause of the lower spread of peeling response values in ELM suppressed relative to ELM mitigated cases is underway and will be reported.

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