Contribution ID: **91**

Type: **Poster**

Nonlinear simulation of ELM dynamics in the presence of RMPs and pellet injection

Tuesday, 18 October 2016 08:30 (4 hours)

We report on nonlinear simulation studies on the dynamical behaviour of ELMs under the influence of RMPs and/or the presence of pellet injection using a two-fluid
initial value electromagnetic nonlinear global code (CUTIE). The full set of model fluid equations are solved for the so-called mesoscale, an intermediate scale between
the device size and the ion gyroradius, incorporating approximations for the underlying classical and neoclassical transport effects. To simulate ELMs we introduce a particle source in the confinement region and a particle sink in the edge region. The code also incorporates turbulent transport effects and allows the development of profile-turbulence interactions thereby enabling a self-consistent description of the
evolution of the mode. To study ELM control using RMPs we have applied an n=2 static external magnetic perturbation at the edge and made numerous runs under varying conditions for the machine and plasma parameters typical of COMPASS-D. Our results show that ELM mitigation is possible for RMP powers beyond a specific threshold consistent with experimental observations of several tokamaks. The results also provide valuable insights into the RMP induced modifications of the complex
nonlinear dynamics of the ELMs, in particular on the redistribution of mode energy and the cascading of energy to shorter scale lengths. We also observe a hysteresis in
states as we increase the amplitude of RMPs and then decrease it to the same value. Preliminary simulations with pellet injection also show encouraging ELM mitigation
results with corresponding changes in the ambient electromagnetic turbulence. Based on these results we have also used CUTIE in a predictive manner to map out parametric regions for safe operation of SST-1 by in terms of RMP thresholds and pellet pacing frequency for ELM control/mitigation in SST-1 H mode scenarios.

Paper Number

TH/P1-27

Country or International Organization

India

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Session Classification: Poster 1

Track Classification: THS - Magnetic Confinement Theory and Modelling: Stability