

Work Plan for Simulations of Tearing Mode Stabilization Using ECCD (10-2-2009)

1) What are the physics issues to be addressed and why? Scope, logic, etc.

Time-dependent simulation of tearing mode stabilization.

Previous work used ad hoc models for the RF sources to model the tearing mode stabilization via electron cyclotron current drive. To move to a more quantitative model of RF-ECCD interaction we will use GENRAY output to replace this model. GENRAY will calculate the value of the RF quasilinear diffusion operator along ray trajectories, and NIMROD will take moments of this operator to obtain the additional terms and altered closures that the RF induces in the MHD equations.

i) Explore the physics of flux-surface equilibration of local RF deposition. What model is needed to accurately represent the physics governing the response of the plasma to local RF deposition?

ii) What is the dominant stabilization mechanism of the modes by the RF (profile modification or induced current within the island)? What are the relevant timescales on which such stabilization is possible? What does this say about the models being used to extrapolate to ITER?

iii) How can the efficiency of island suppression be improved? How does time modulation of the RF influence this process?

2) What experimental data is to be compared, or what validation studies will be done?

Our first plans are to compare with analytic theory and sort out the underlying physics that has been used in scaling studies to ITER. More detailed plans for validation will be developed after we meet with R. LaHaye of General Atomics.

3) What components are needed for the work?

NIMROD and GENRAY are critical. Monitor which uses publish/subscribe capability would work well.

4) What visualization and data analysis will be required?

Once GENRAY and NIMROD are coupled, three-dimensional visualization will be needed to understand the RF deposition in relation to the island geometry. VISIT to be used.

5) What development is needed to complete the studies? - physics code development, component script development, generalization of IPS time stepping logic ...

See bullets under first task below.

6) What are the major milestones toward completion and what is the schedule?

i) Finish the coupling of NIMROD to IPS such that simulations calling both NIMROD and GENRAY can be launched by IPS. (APS time scale)

a) Verify that the data GENRAY is working with agrees with the data NIMROD is working with. (e.g. toroidal B, n and T profiles, etc.)

b) Use monitor components (Need CS help here)

c) Finish all debugging.

ii) Merge TJ's GENRAY mods into GENRAY trunk. (This is just an svn merge and should be easy in principle.)

iii) Apply the new capability to the current equilibria and understand RF feedback stabilization of classical tearing modes, with no bootstrap current or other pressure effects. (March time scale)

iv) Get QL operator from GENRAY, and pass this operator to NIMROD using the IPS framework.

v) In collaboration with Eric Held, process the QL operator and takes the moments. As a sanity check, verify the agreement of the direct current deposition (presently in rf_genray) with the result from the QL operator.

vi) Find a suitable high-beta equilibrium which is more experimentally relevant, and where pressure effects (including bootstrap current terms) will be important. Begin simulations with new equilibrium. (Simulation of NTMs require initial equilibria with high poloidal beta, and obtaining such equilibria which are near the marginal stability point is difficult.)

vii) Increase the validity of the fluid model using increasing number of accurate terms.

viii) Collaborate with experimentalists in validating the model and collaborating on numerical and laboratory experiments for understanding extrapolation of results to ITER.

7) Who is going to do what in the study, and when will they do it?

Jenkins -- Lots of stuff, all the time

Kruger -- Help in the debugging of coupled simulations.

Held -- On the APS time scale he would like to have the quasilinear operator.

Harvey -- Provide details on QL operator and passing it to NIMROD

Elwasif -- Monitor component and provide support to Jenkins.

8) What publications/presentations are envisaged?

A publication by Hegna/Callen on the relevant formalism is eventually forthcoming.

J. Ramos is publishing his results.

Jenkins/Kruger et al. have a paper in review. Kruger will attempt to appease reviewer.

A paper on the discrete-to-continuum deposition algorithms would be good.