Recent Results in Nonlinear ELM Studies Using NIMROD

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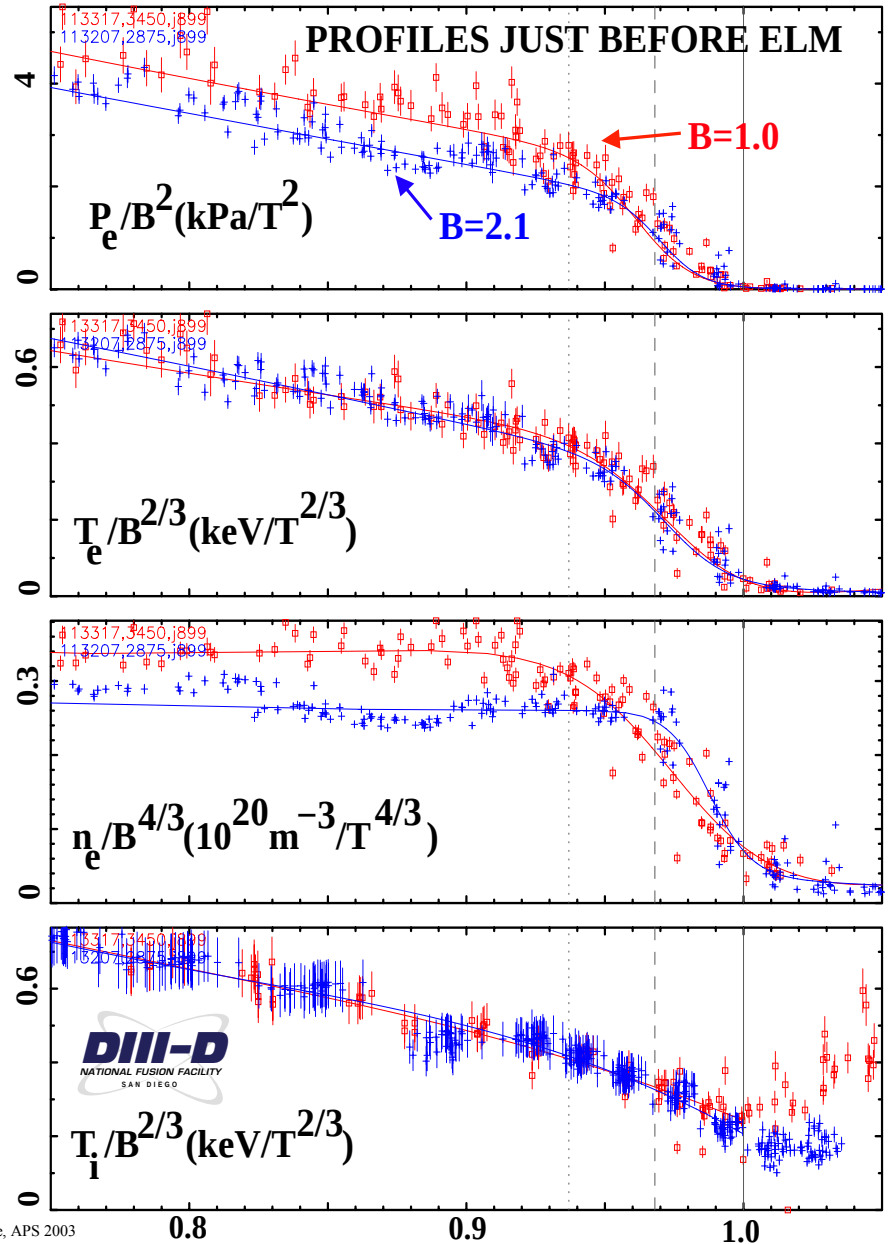
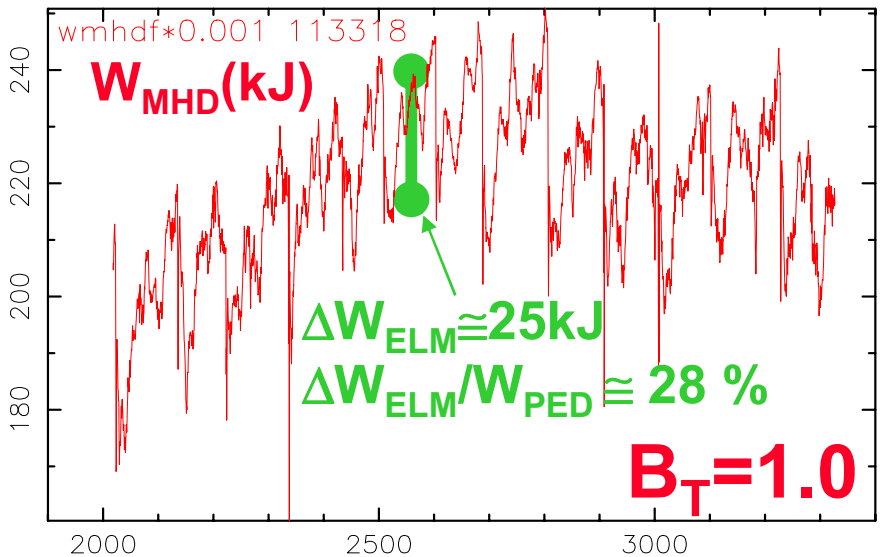
GENERAL ATOMICS

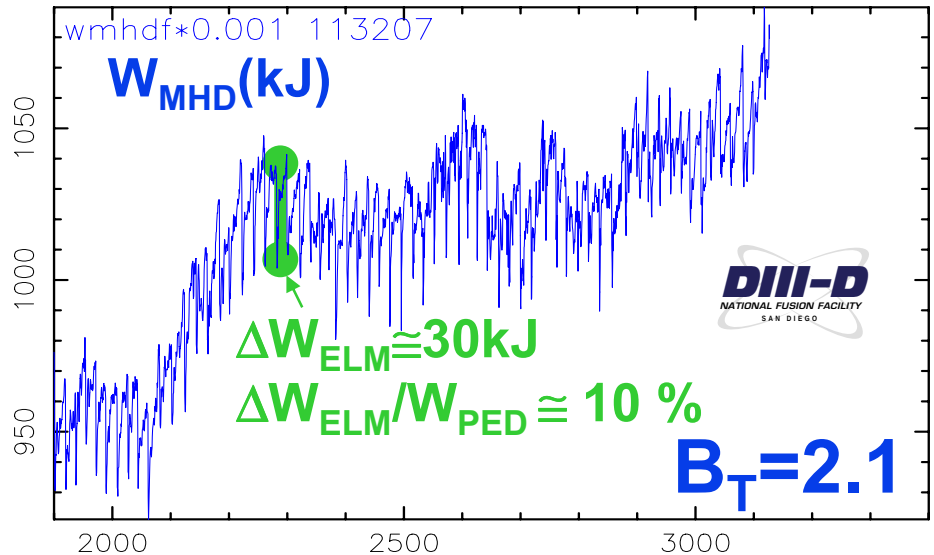
β_{PED} just before ELM is reduced at small ρ_* possibly due to outward shift of n_e profile from reduced neutral penetration

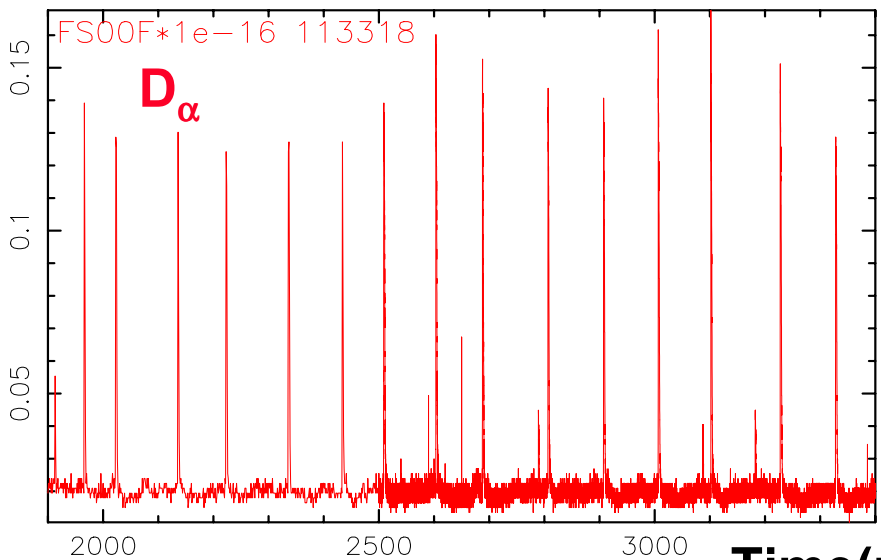


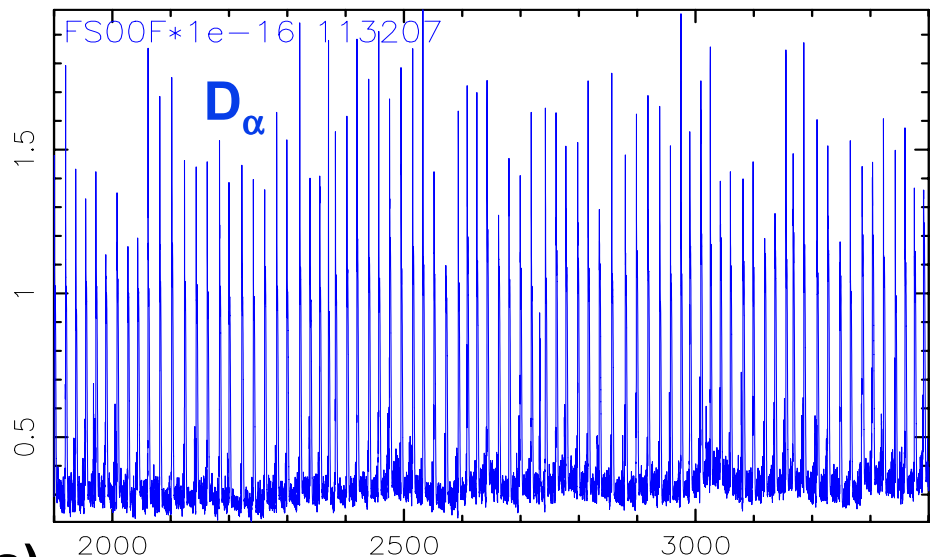
- At high B, high n_e, point in ρ_* scan, n_e profile is shifted outward relative T_e profile, and relative to n_e profile at low B, low n_e , high ρ_* point
  - High p′ region shifted outward and β_{PED} reduced at ELM crash.

$\Delta W_{ELM}/W_{PED}$ is larger and f_{ELM} smaller at larger ρ_*

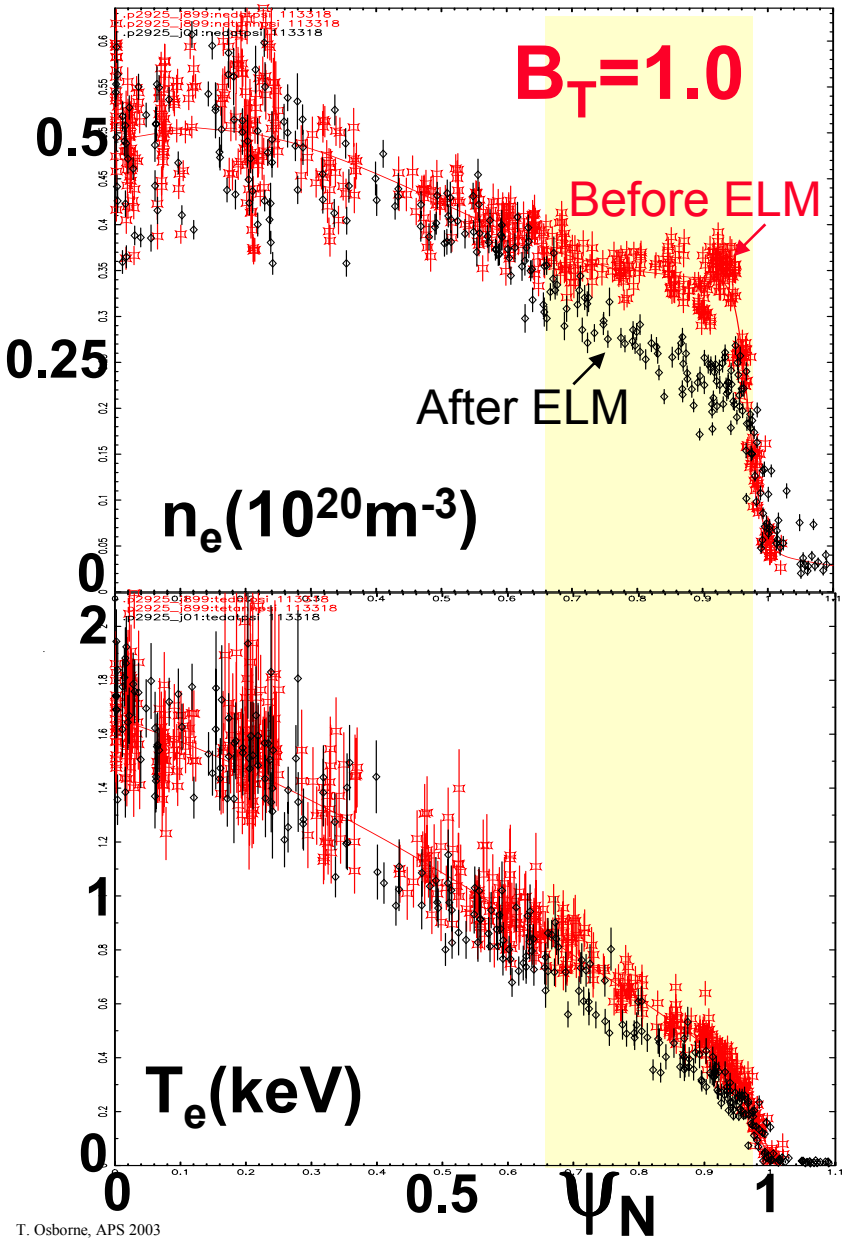


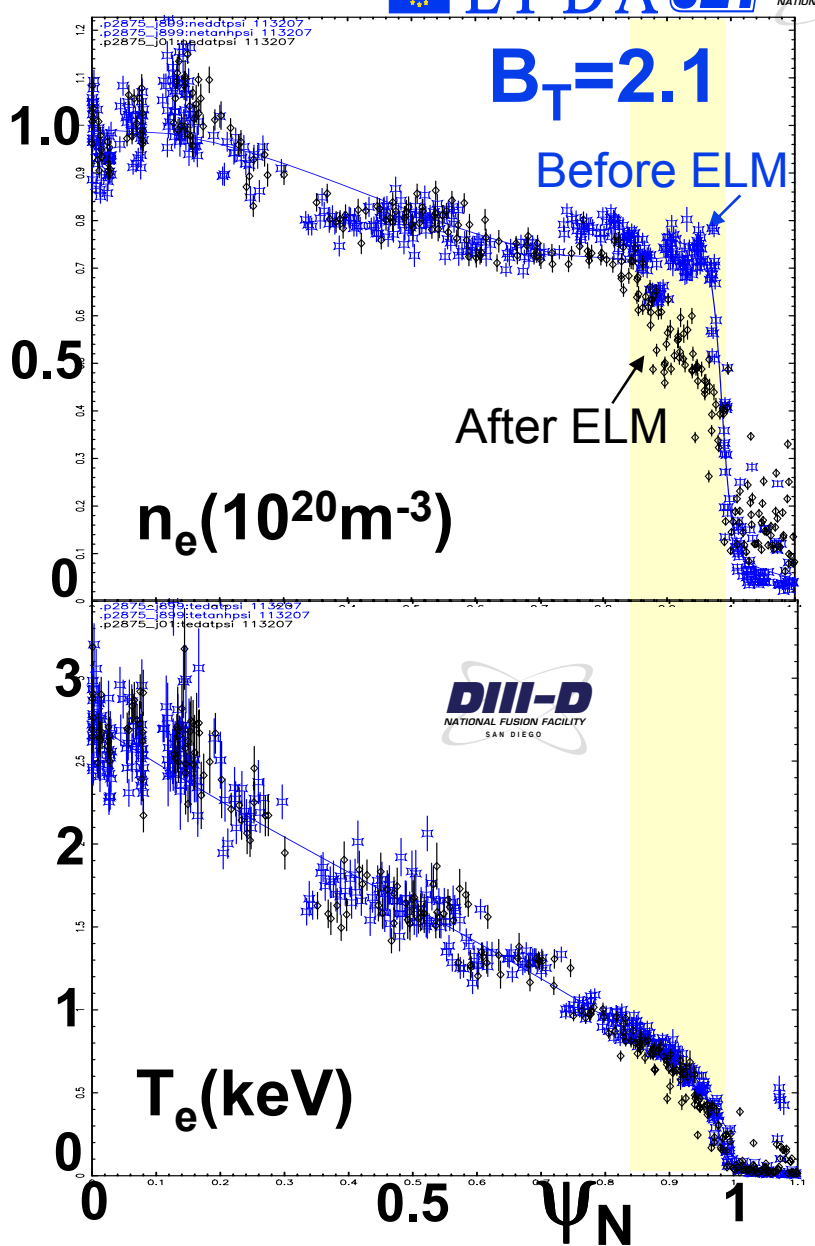




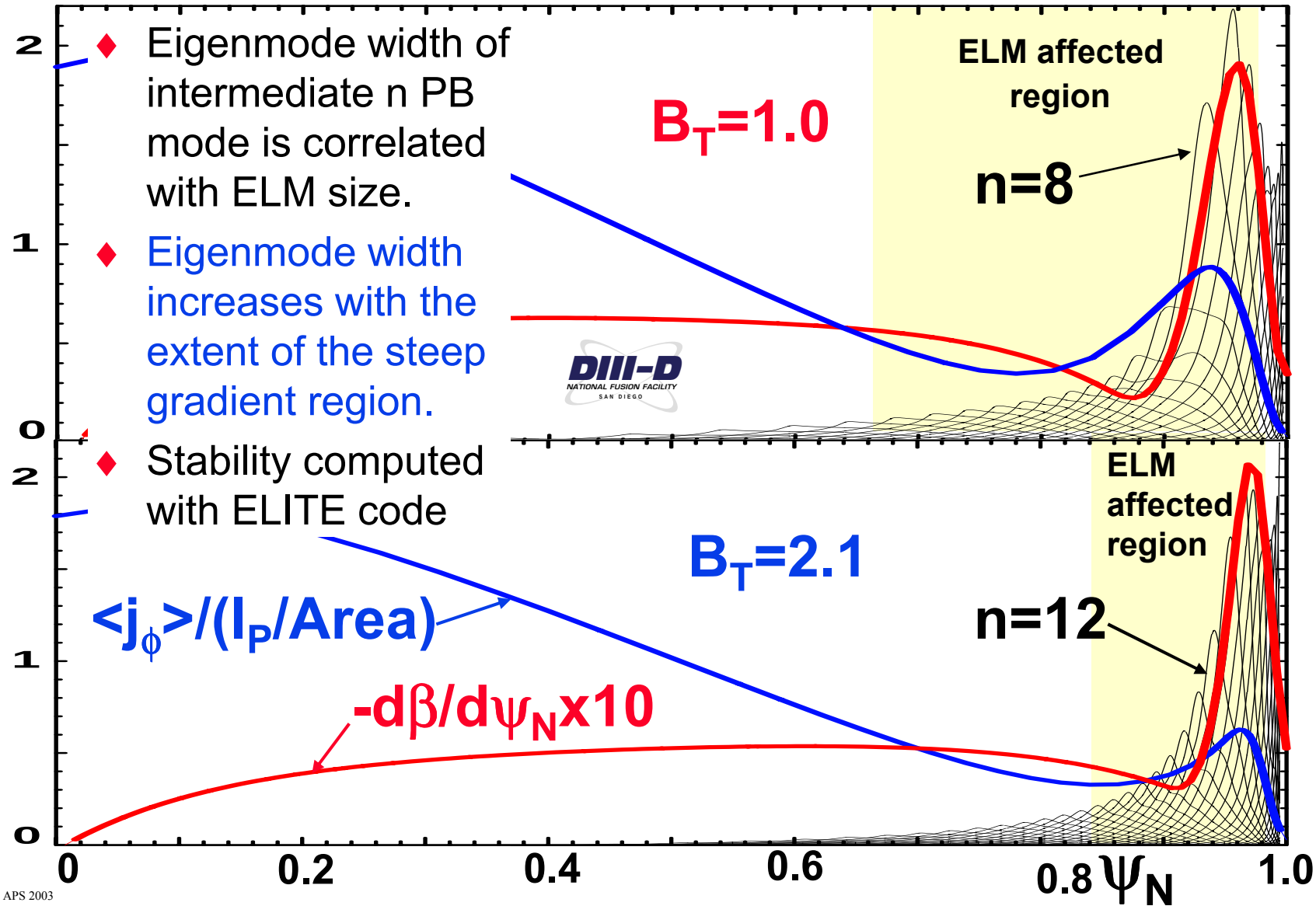


ELM affected region larger at larger ρ_* (DIII-D data)





Peeling-ballooning mode has greater radial extent in larger ρ_* discharge with larger ELMs



Profiles of equilibria show a significant difference in n, P and J

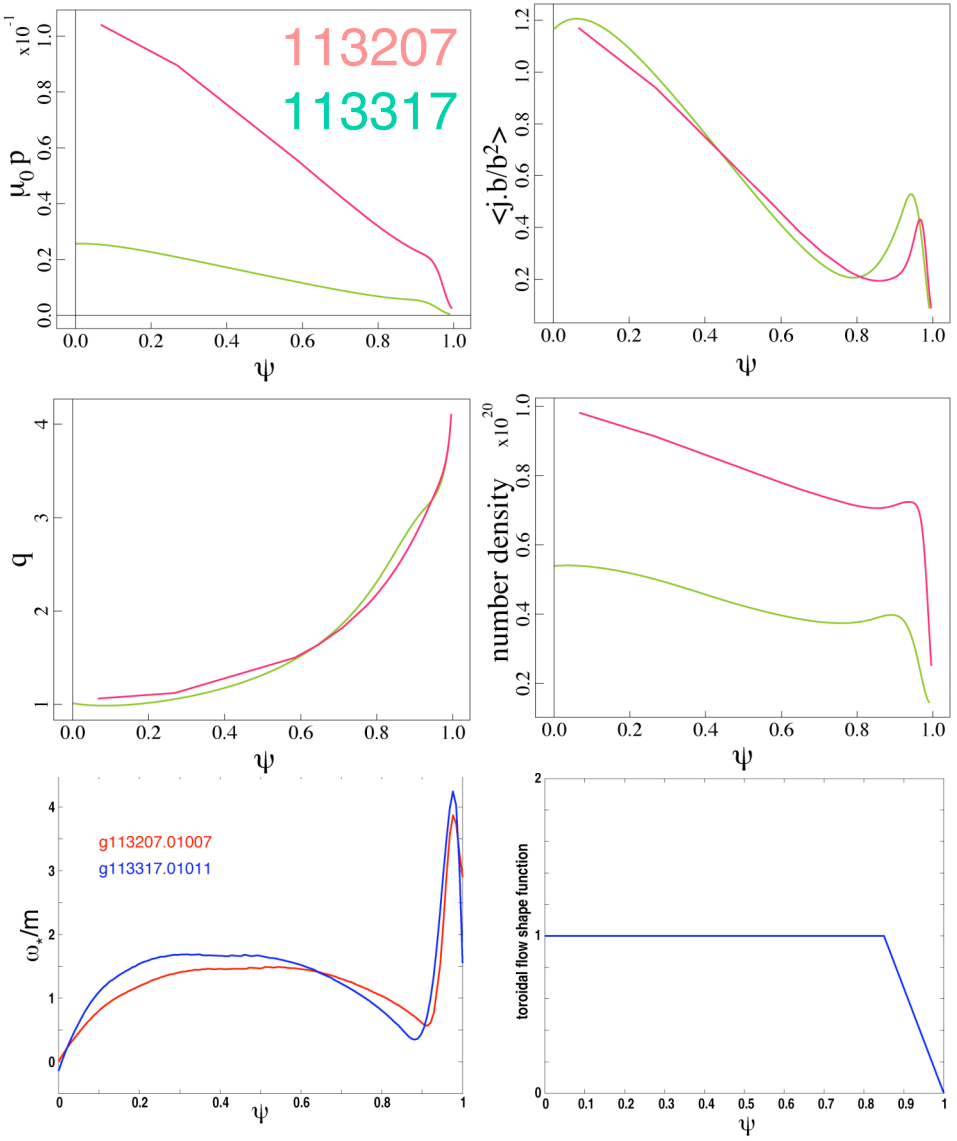
Little difference in q

Deeper pedestal at lower beta.

Both higher density and temperature at higher beta.

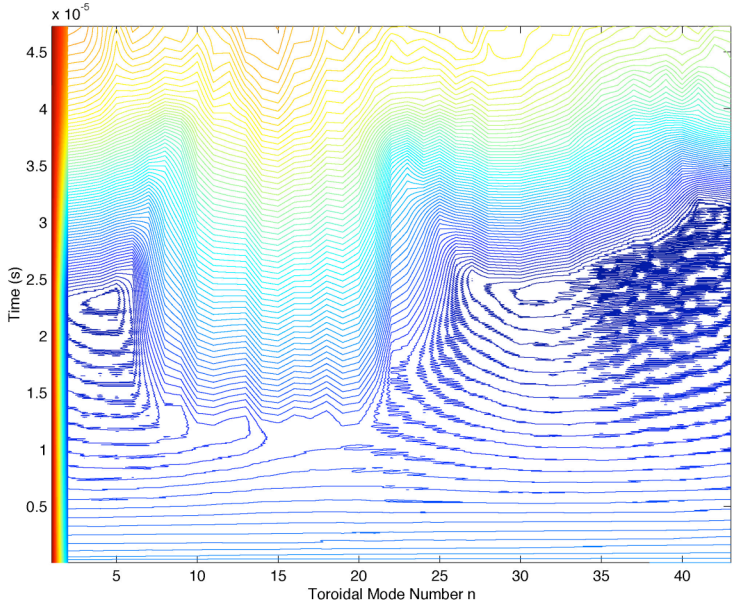
Flow imposed for comparison.

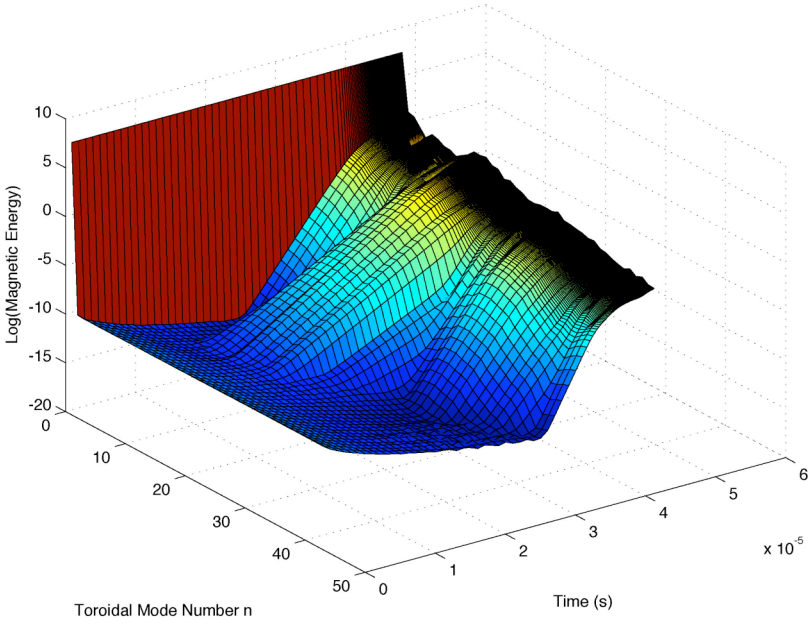
Little difference in ω_*, therefore expect linear spectrum with two fluid to have similar differences to single fluid.



Initial linear unstable spectrum spreads to higher and lower n, as usual

Linear spectrum n=5-27 peaks n~15
Remains toroidally resolved.
Little difference in n=0-20 for 22 mode run compared with 43 modes (not shown)
Subtle differences between two cases being investigated (not shown)



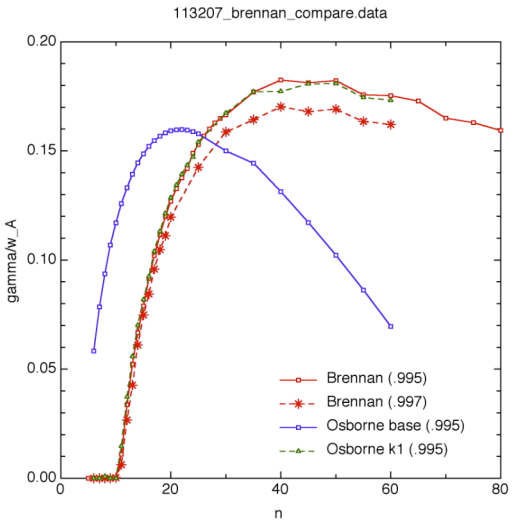


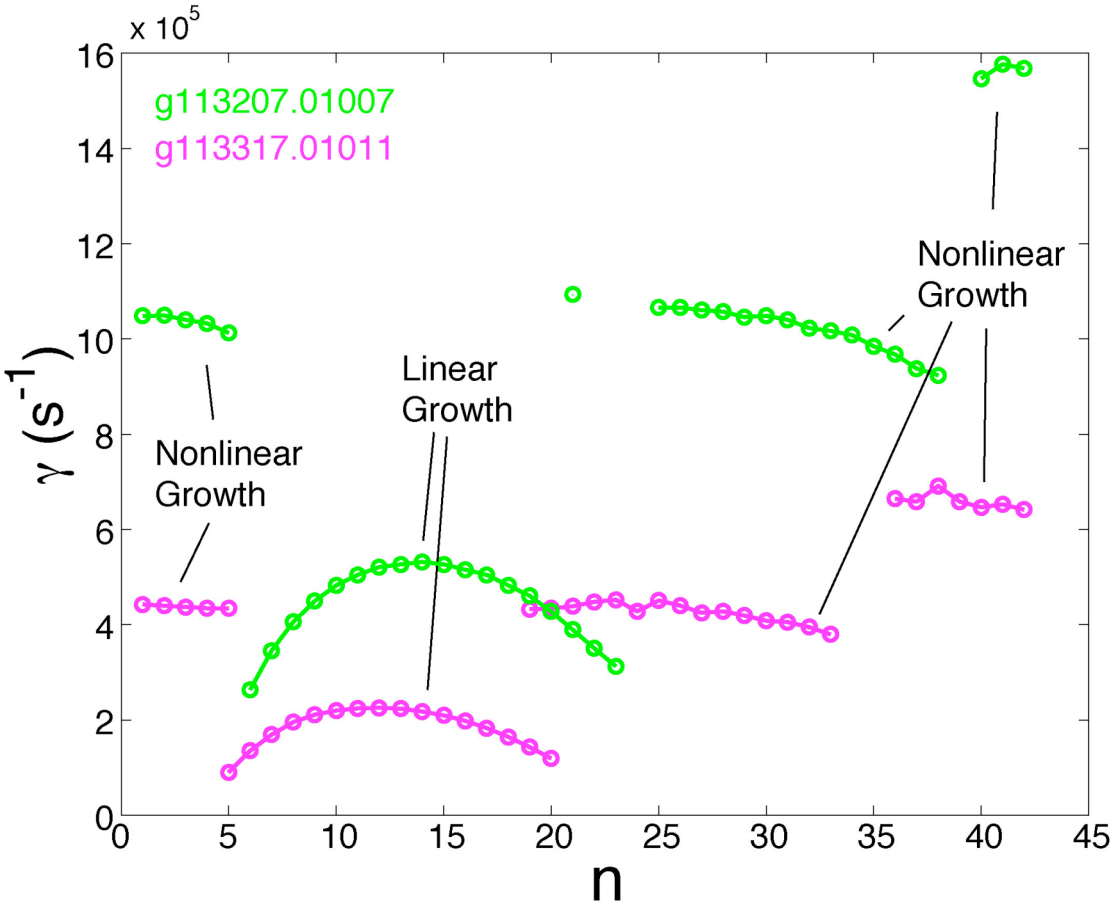
Difference in peak of linear spectrum causes difference in nonlinear growth

Higher linear growth in 113207

Higher linear growth case peaks at higher n in linear spectrum.

ELITE results show peaking at higher n~20-40





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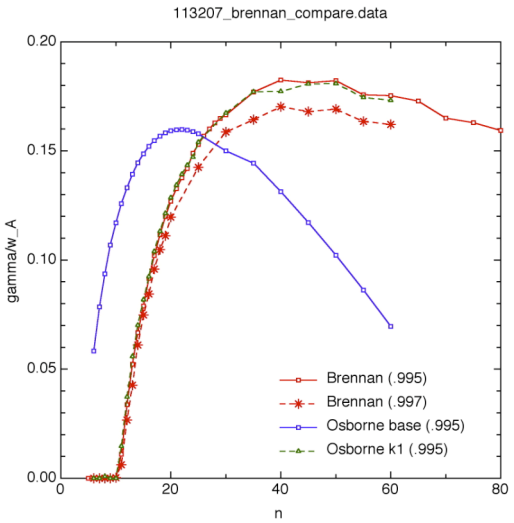
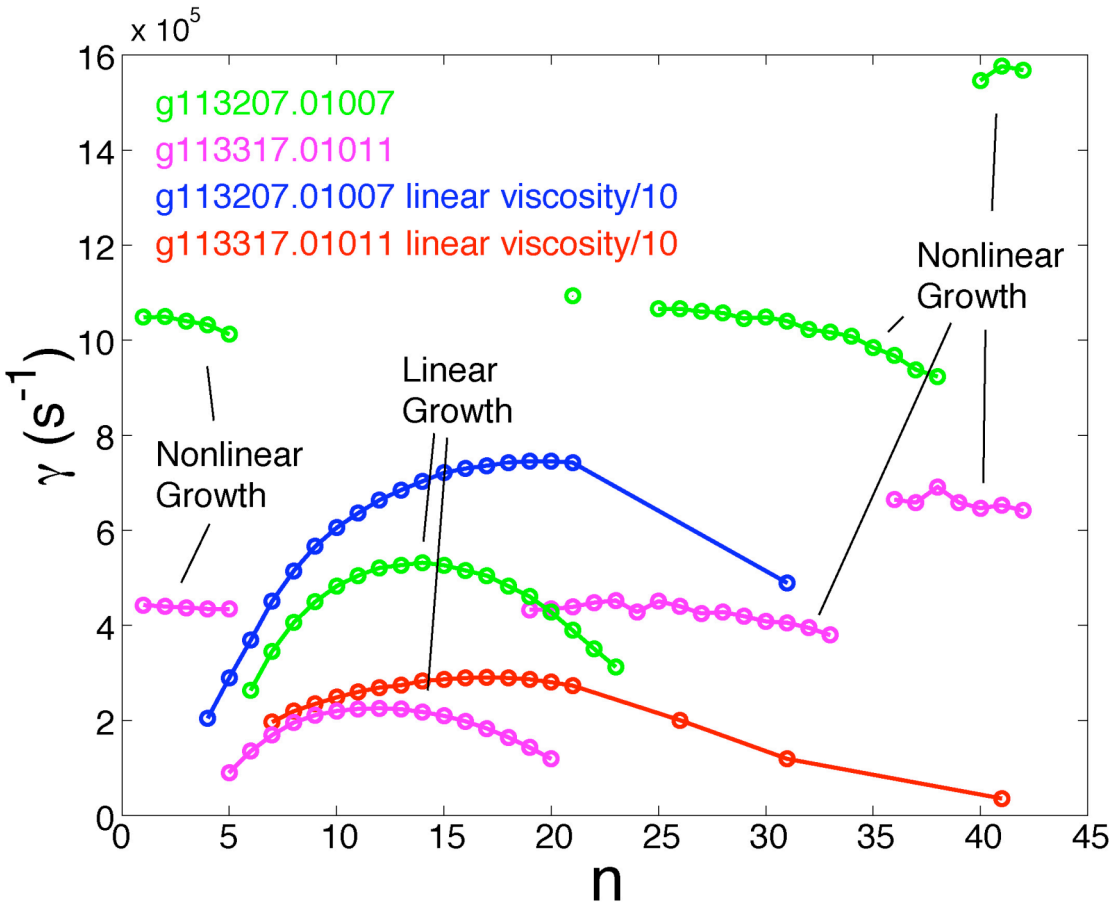




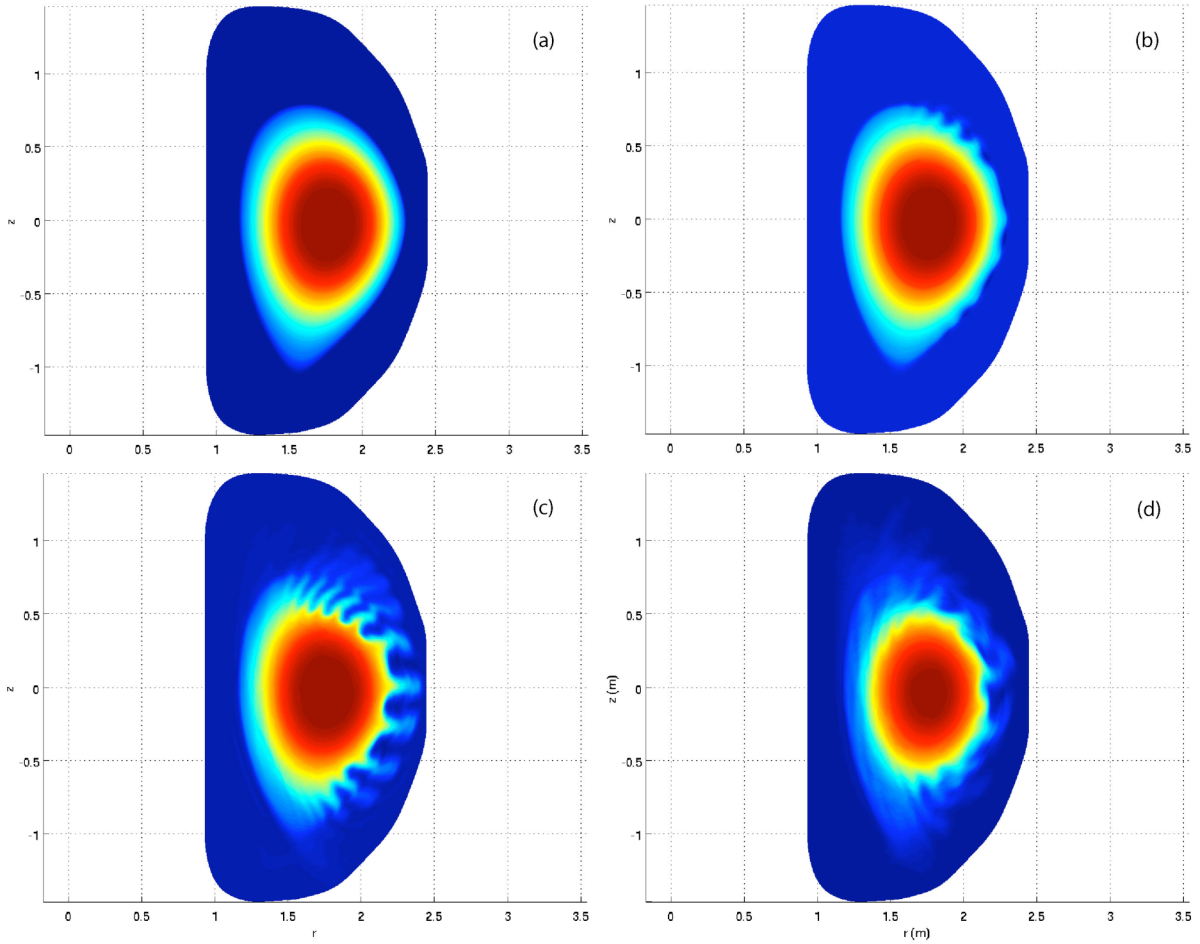
With flow shear the mode structure is limited in radial propagation

Loss of energy remains large.

Lower amplitude poloidal fluctuation and reduced radial gradients with flow shear

Possible healing.

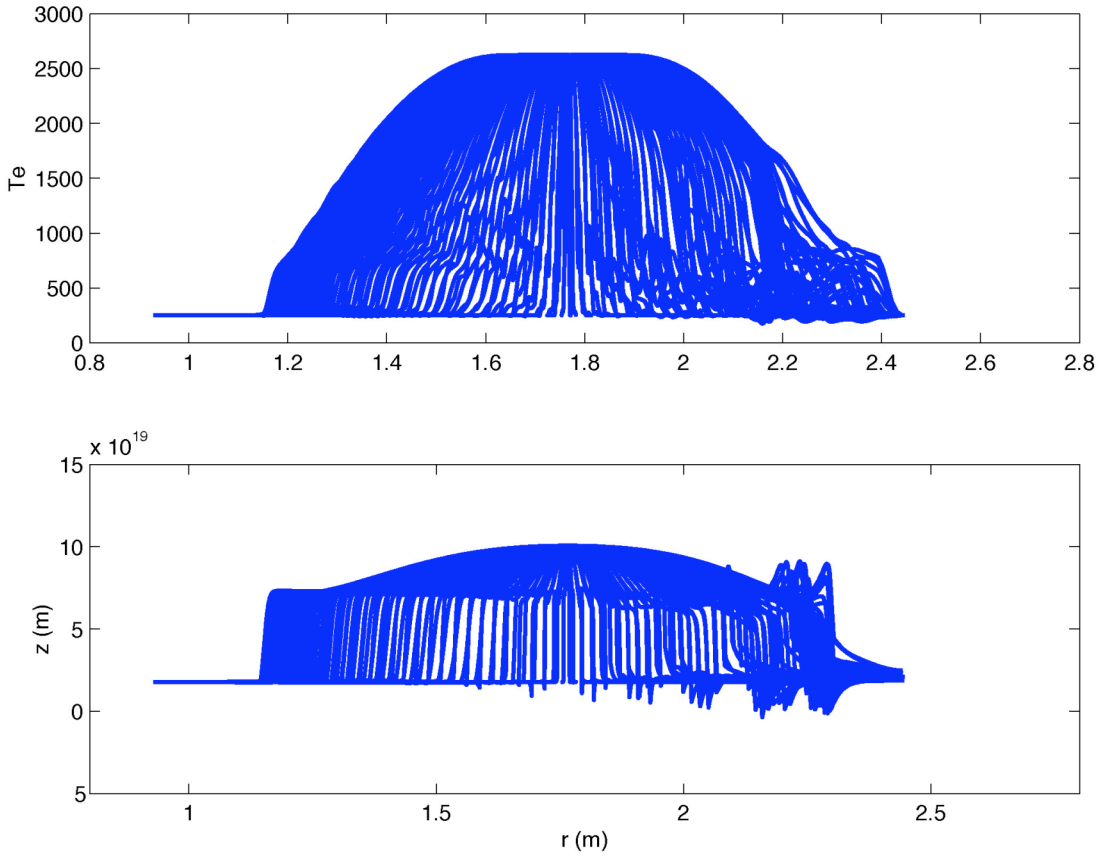
Subtle differences between cases under investigation.



Computation terminates with negative density despite large vacuum density

The density or temperature becoming negative have been the principle reasons for termination of the computations.

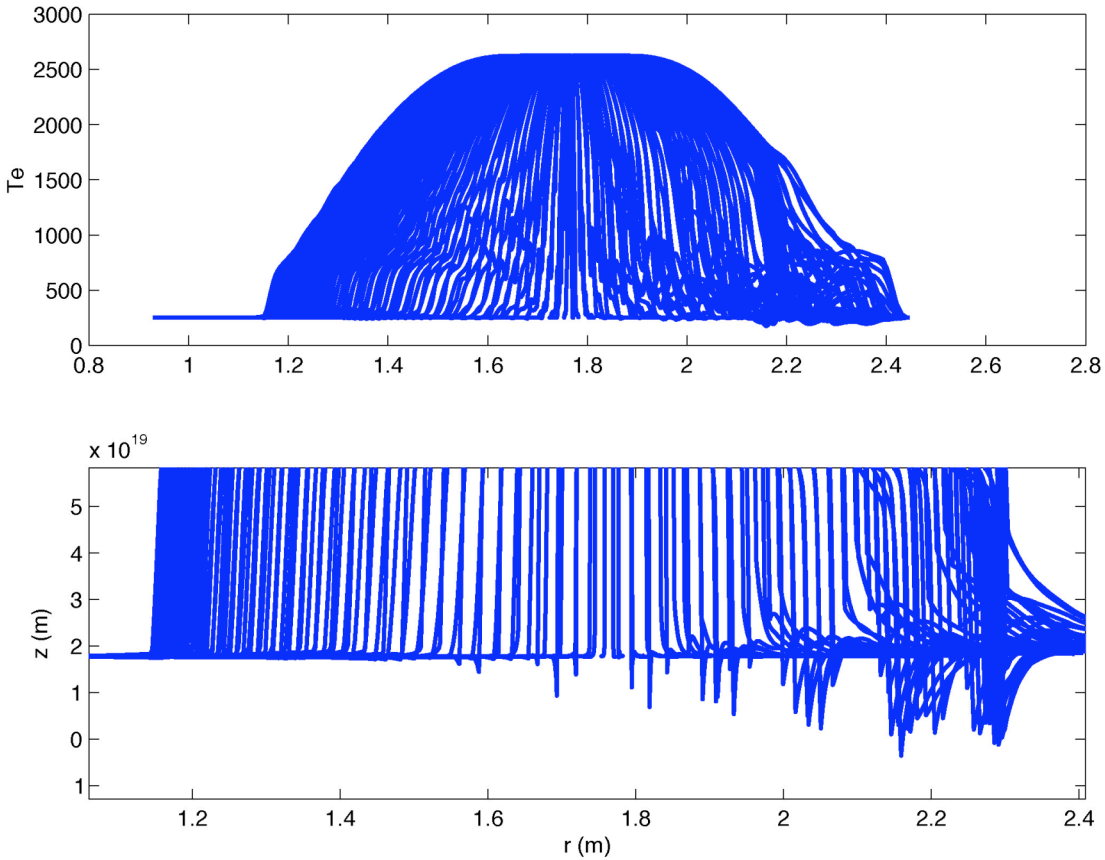
This happens despite large density in the vacuum which extends from the edge density i equilibrium.



Computation terminates with negative density despite large vacuum density

This occurs even with flow and seemably smaller perturbations.

We need physics that handles the density and temperature during rarification.



Summary

Two DIII-D cases with differing density and temperature chosen for comparative simulation of ELM evolution

Linear spectra agree qualitatively with higher peaking in 113207. Personal communications from P. Snyder indicate $\gamma_{max}/\omega* \sim 8$ for 113317 and ~11 for 113207. This comparison with two fluid NIMROD is pending.

Differences in peaks of linear unstable spectrum lead to concomitant differences in nonlinearly driven spectrum

Flow shear tends to localize and limit the radial extent of the mode structures.

Negative density, and/or temperature for low Te vacuum, are the principle reason for termination. Need physics to prevent this.

Far more work to be done.