

# M3D-C1 ZOOM Meeting

9/21/2020

## Agenda

1. CS Issues
  1. GPU solve status...LBL(Jardin), Chen
  2. Local systems
    1. Bug report
  3. Other systems
  4. More on “adapt” regression test
  5. NERSC Time
  6. Changes to github master since last meeting
  7. Changes needed for matrix element calculation on GPU..C. Liu
2. Physics Studies
  1. RE Fluid Modeling of DIII-D Shot 177040 --S. Jardin/Chen Zhao
  2. Runaways with sources , shot 177053 Chen Zhao/ S. Jardin
  3. Test of Boozer Theory for Cold VDE ... Clauser
  4. Status of first coupled M3D-C1/LP Simulation .. Lyons
  5. Other

# LBL Report/ GPU Solve Status

From Yang Liu: SuperLU on Tulip (9/15/20): Single core and single amdMI100 GPU

## Factor Matrix

matrix	Flop cnt	CPU			GPU	
		Total time	Gflops		Total time	Gflops
S1_126936	9.26E10	7.30E00	12.68		1.53E01	6.04
S1_253872	7.35E11	5.12E01	14.35		2.99E01	24.6
S1_507744	5.75E12	3.94E02	14.60		1.50E02	38.42

## Solve 1RHS

matrix	Flop cnt	CPU			GPU	
		Total time	Gflops		Total time	Gflops
S1_126936	1.06E08	4.73E-02	2.24		1.49E-02	7.11
S1_253872	4.21E08	1.64E-01	2.58		2.98E-02	14.14
S1_507744	1.64E09	7.61E-01	2.15		8.11E-02	20.22

# Local Systems

- PPPL centos7(9/20)
  - 5 regression tests PASSED on centos7:
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
  - See next page for bug with linear run with superlu\_dist
- PPPL greene (9/20)
  - 4 regression tests PASSED
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
  - No batch file found for pellet
  - See next page for bug with linear run with superlu\_dist
- EDDY (9/20)
  - 5 regression tests PASSED on eddy
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
- TRAVERSE(9/20)
  - Code compiles
  - Regression test failed: split\_smb not found in PATH
  - Modules loaded by m3dc1/devel differ from readme.traverse
    - openmpi/pgi-20 .... Vs openmpi/pgi-19

## Bug report: /p/m3dc1/jardin/Bug\_09\_20\_20

./batch-mumps give the correct result

./batch-slu crashes with the error:

```
*** Error in `./m3dc1_2d_complex': free(): corrupted unsorted chunks:  
0x000000000714e760 ***
```

Works ok on eddy with superlu\_dist

## Other Systems

- Cori-KNL (09/20)
  - 5 regression tests passed on KNL
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
  - Note: only 5 jobs allowed to be submitted in debug queue (one job had to be manually started)
- Cori-Haswell
  - All regressions tests passed except KPRAD\_RESTART (J. Chen, 9/04/20)
- PERSEUS
  - All 6 regression tests PASSED on perseus (J. Chen, 9/04/20)
- MARCONI
  - All regression tests PASSED on MARCONI (J. Chen, 9/04/20)
- CORI GPU (J. Chen to report on)

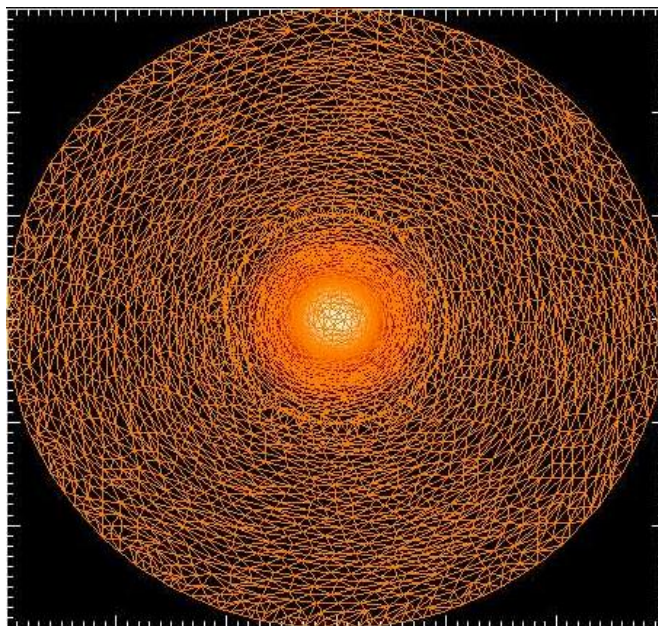
## More on “adapt” regression test

- Fails on all systems in the same way
- Only the “growth rate” differs at time 0
- Can’t compare meshes as the mesh was not saved for the “base case”
- diff C1ke ../base/. gives

```
< 0 0.0000E+00 1.6085E-01 3.6410E-11 0.0000E+00 1.6085E-01 0.0000E+00  
4.5726E+00 3.2125E+04 5.9487E+00 3.21367E+04
```

• ---

```
> 0 0.0000E+00 1.6085E-01 3.1744E-11 0.0000E+00 1.6085E-01 0.0000E+00  
4.5726E+00 3.2125E+04 5.9487E+00 3.21367E+04
```



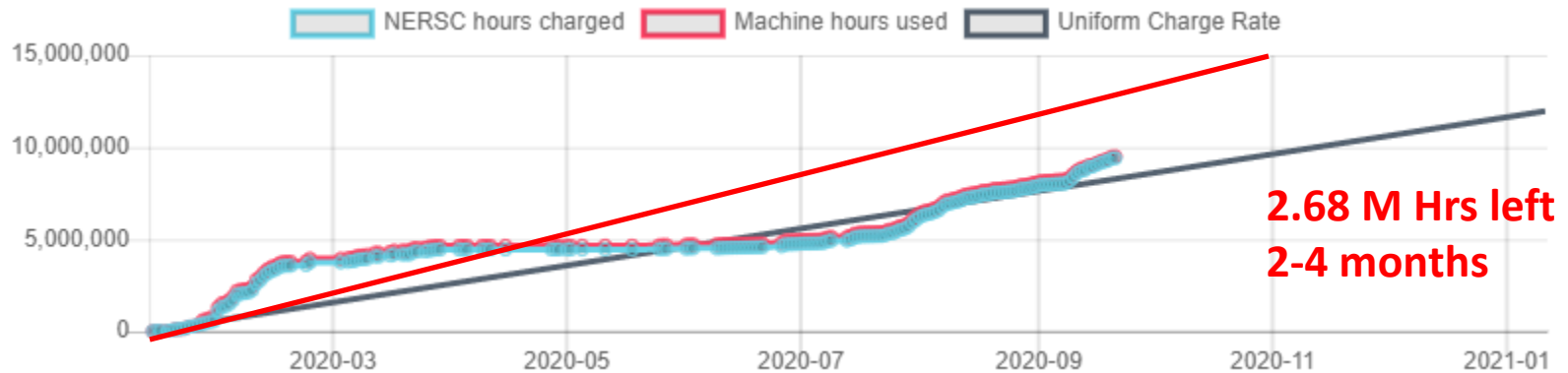
Numbers are:

Cycle, time, ke(total), **growth rate**,  
ke1,k23,ke3,me1,me2,me3,me(total)

- I suggest we redo the baseline

# NERSC Time

mp288



m3163

Closed for general use

- Should be enough mp288 time to last until new PU/PPPL computer arrives in fall – red line is linear usage until Nov 1
- John Mandrakes (DOE) sent an email that he has extra time to allocate, so I have requested some. Have not heard back yet.

# Changes to github master since last meeting

- S.Jardin
  - 09/17/20: Committed Chen Zhao's Changes for Runaways
  - 09/18/20: Lyons reverted these changes at Jardin's request
  - 09/19/20: Chen fixed bug, Jardin recommitted with Lyons help
- J. Chen
  - 09/15/20: CORI GPU Regression Tests
- B. Lyons
  - 09/14/20: Prevent shortening of scalar arrays in .h5 files at restart

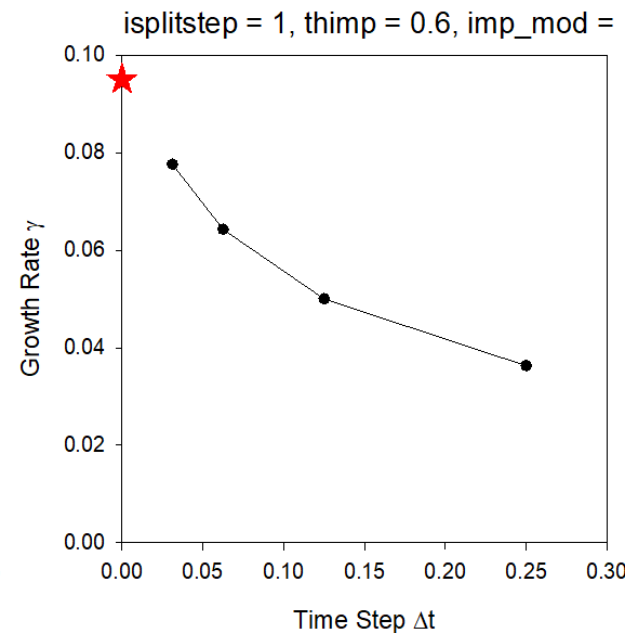
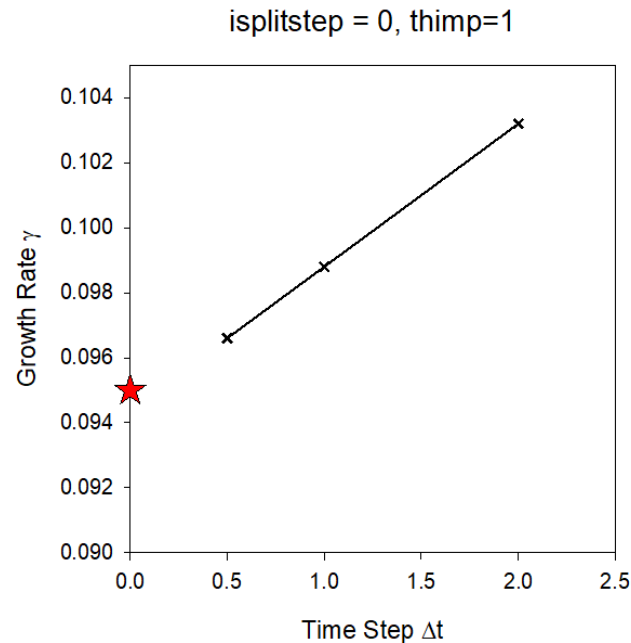
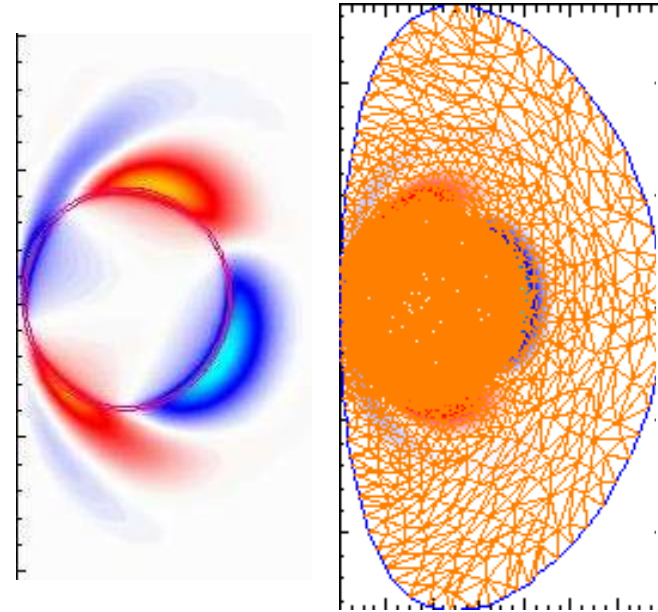


# Changes needed for matrix calculations on GPU .. C. Liu

# RE Fluid Modeling of DIII-D shot 177040

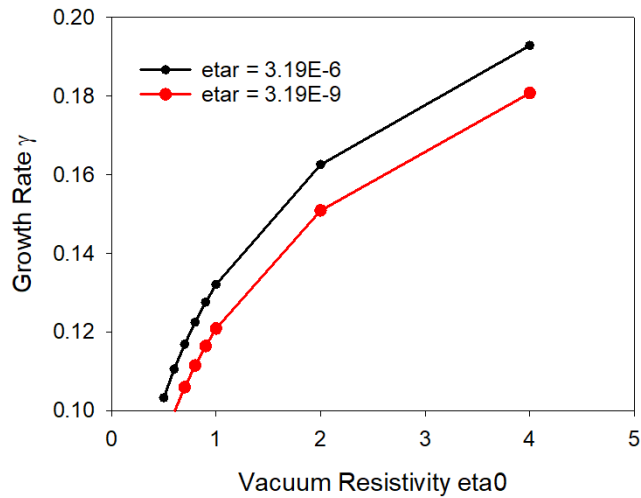
Carlos Paz-Soldan email 9/14/20

- 1) Dependence of RE current carriers (or not) on saturated mode amplitude (dB/B)?
- 2) Dependence of saturated dB/B on absolute B&I (fixed  $a$ , all  $q=2$ ). —> ITER extrapolation
- 3) Dependence of saturated dB/B on absolute  $I$  (fixed  $B$ , smaller  $a$ , all  $q=2$ ). —> DIII-D comparison

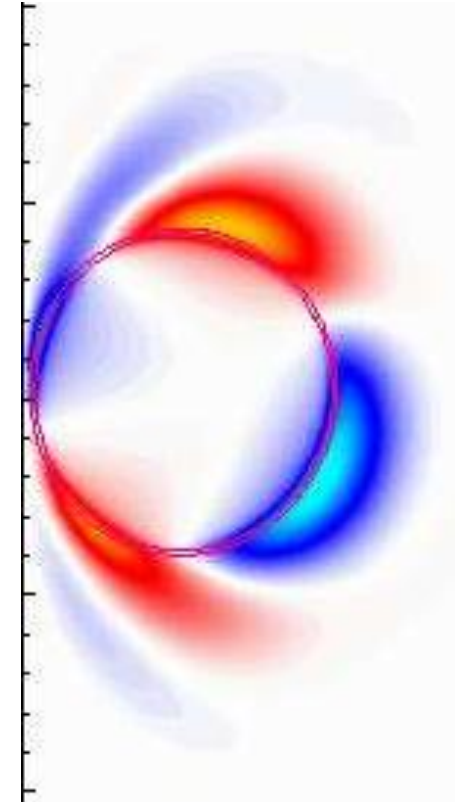
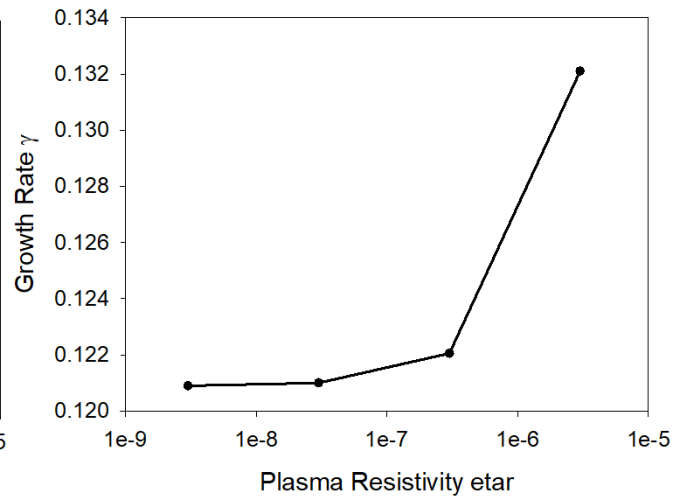


# Dependence of Growth Rate on Plasma and Vacuum resistivity

isplitstep=0, dt=1.0

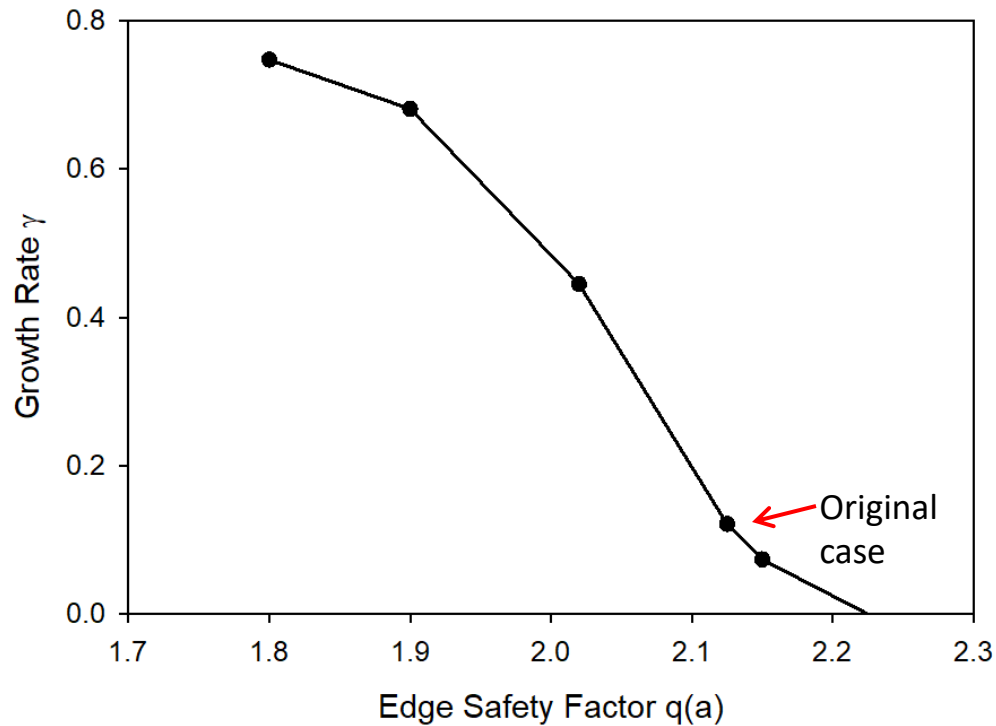


isplitstep=0, dt=1.0, eta0=1.0



# Growth Rate vs $q(a)$

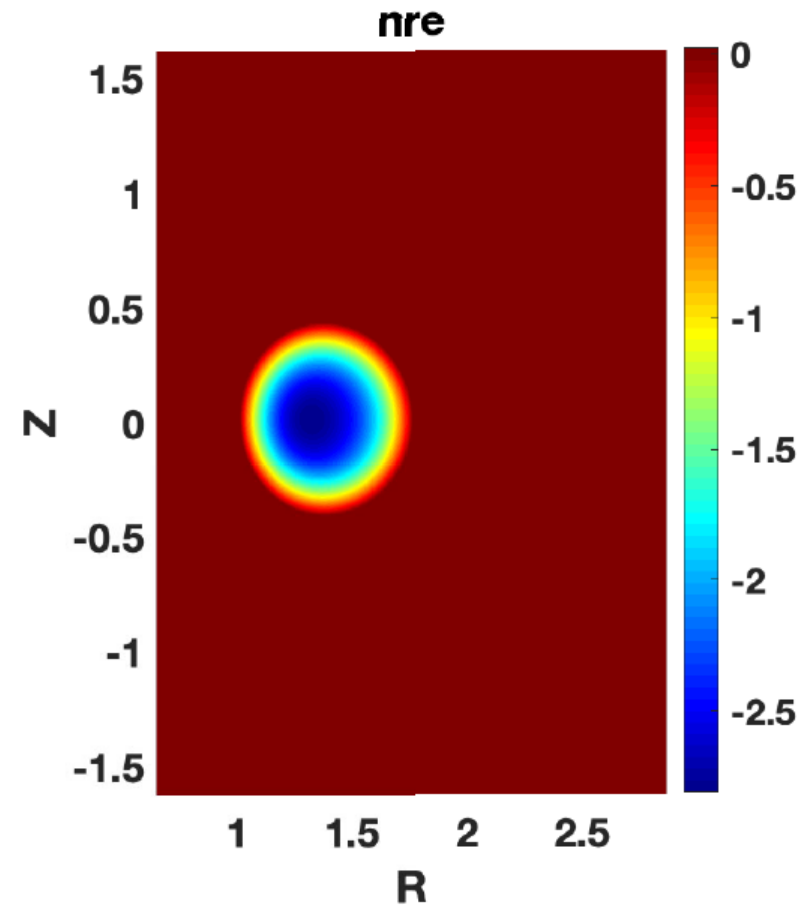
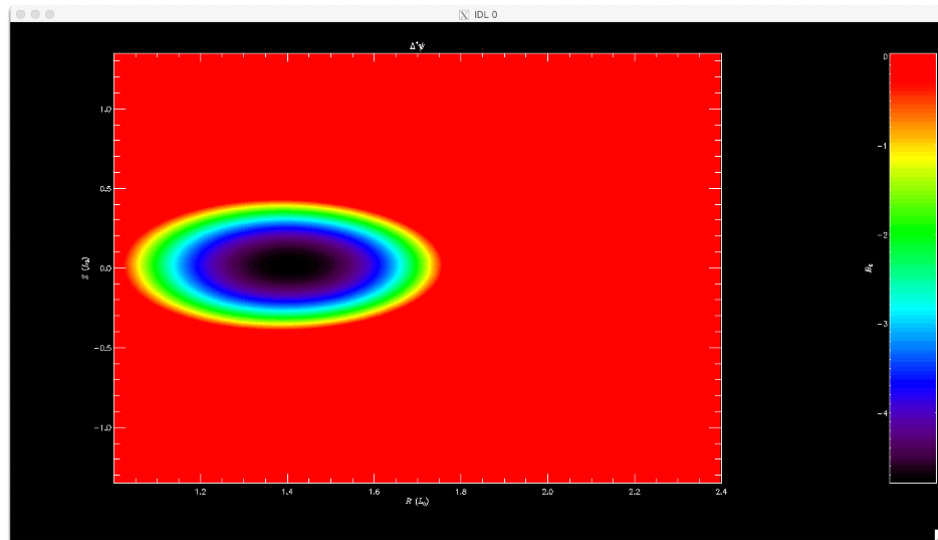
Bateman Scaling: isplitstep=0, dt=1, eta0=1, etar=3.E-9



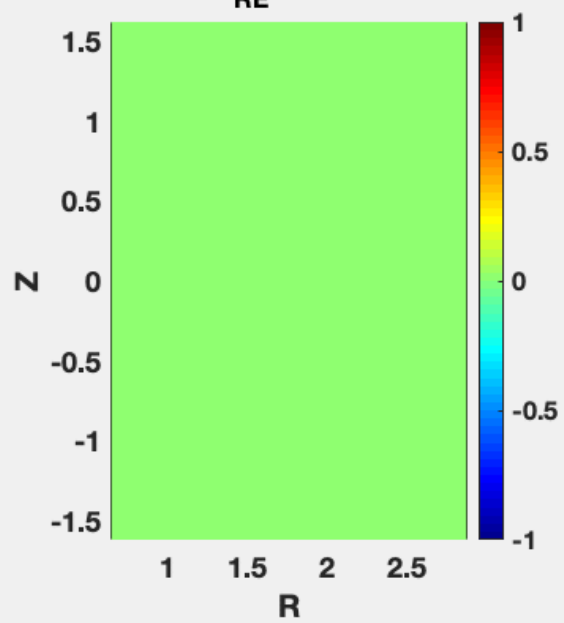
Batemanscale modifies  $F(1)$  but keeps  $p'$  and  $FF'$  fixed.

We should ask MARS to make a similar plot.

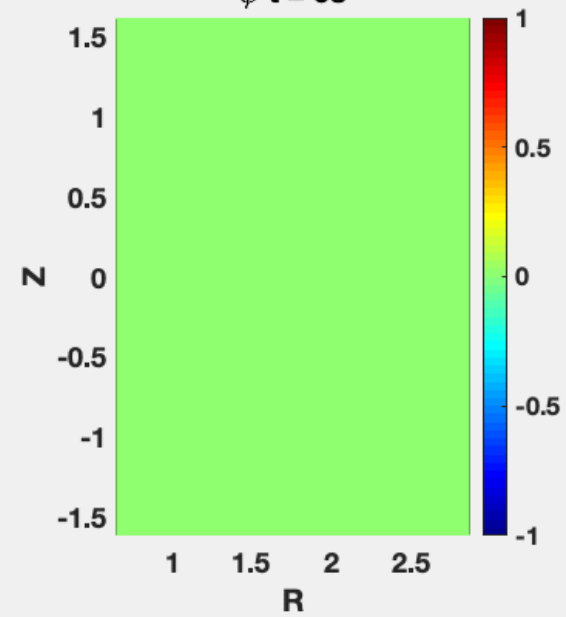
## 9/18/20 Chen Zhao: Shot 177040 with RE



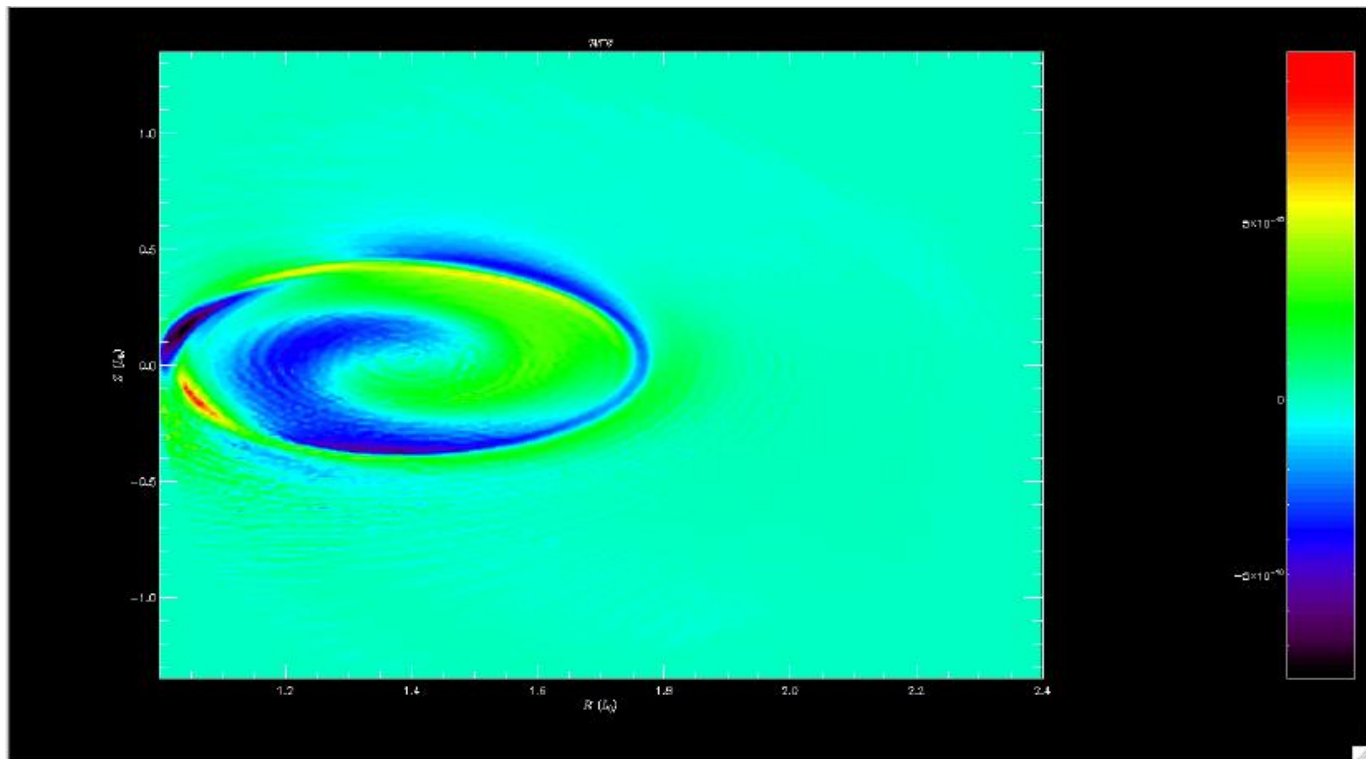
$n_{RE}$   $t = 0s$



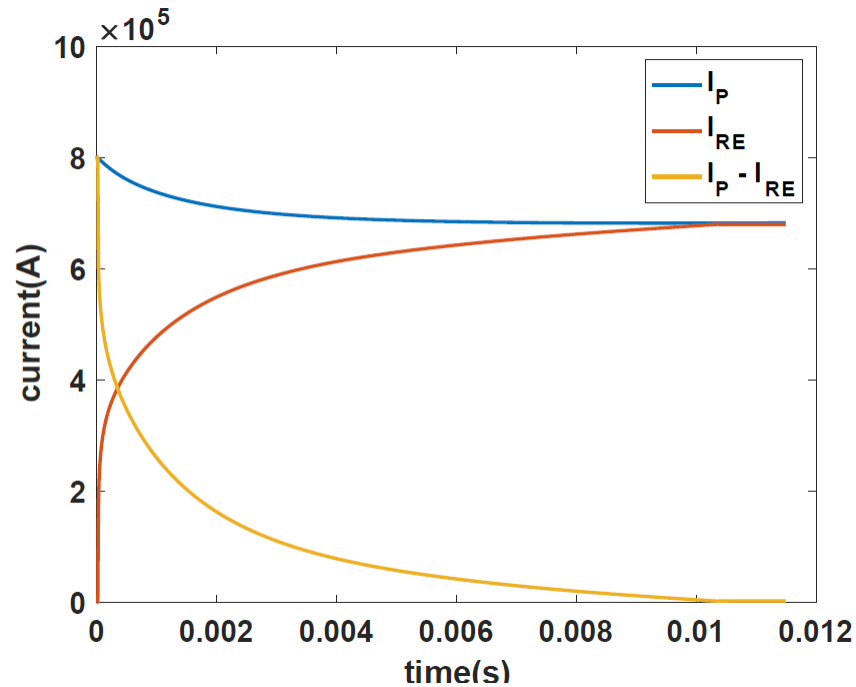
$\psi$   $t = 0s$



With ExB drift terms removed



# DIII-D Shot 177053 (with RE sources) – Chen Zhao



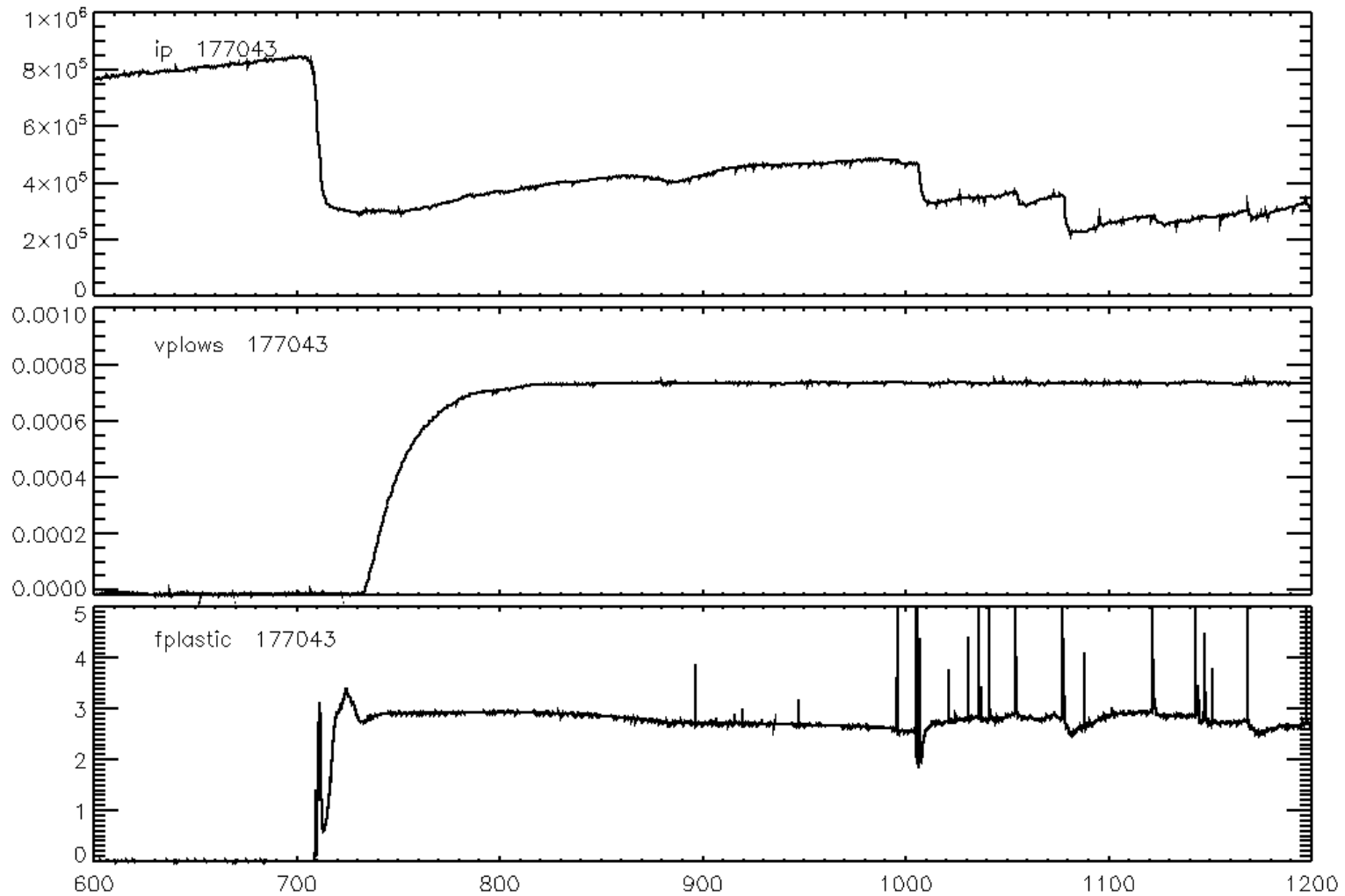
Code changes now committed to GIT

NEXT Steps:

1. Study of sensitivity to  $\kappa_{\perp}$ ?
2. Comparison with shot results
3. Presentation at DIII-D disruption meeting

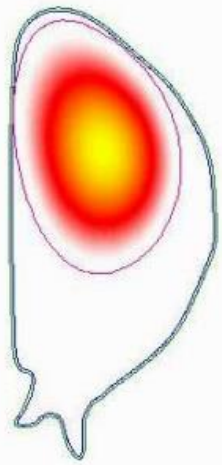


# 177053 Exp. Traces (Lyons 06/08/20)



# Test of Boozer Theory for Cold VDE (Clauser)

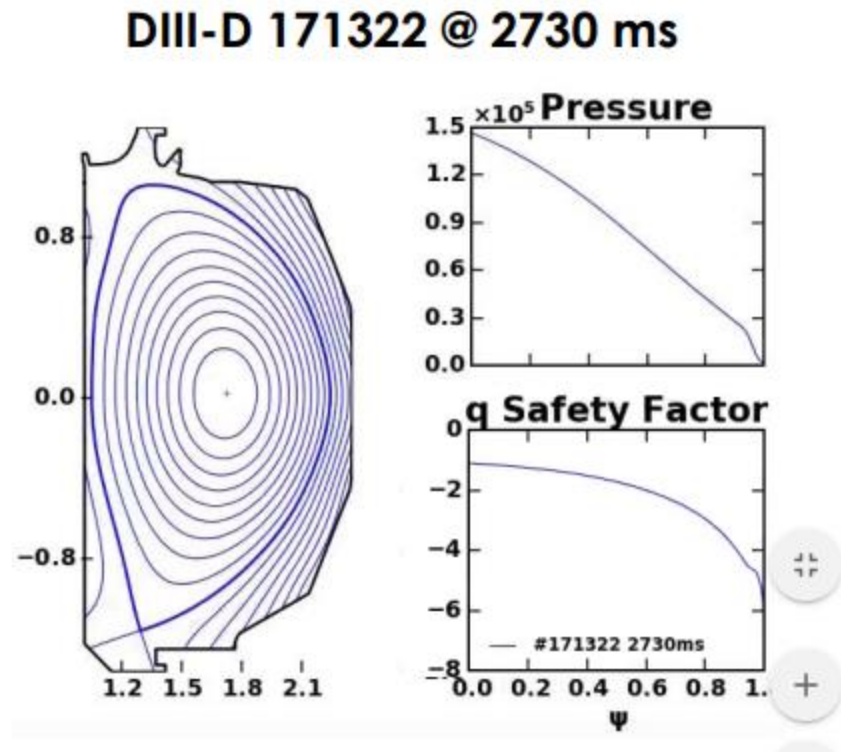
- Boozer's analytic theory that if ITER suffers a disruption on the mid-plane, such that the current decreases to  $I = 0.83 I_0$ , vertical stability will be lost, even for an ideally conducting wall.
- Cesar has tried to verify this, and finds the plasma is still VDE stable with  $I = 0.3 I_0$
- Difference is likely the wall model, Cesar to confirm.



Boozer, "Halo currents and vertical displacements after ITER disruptions", Phys. Plasmas 26, 114501 (2019)

# Status of First Coupled M3D-C1 / LP Simulation

- **Iterate independent simulations of MHD and LP codes**
  - Run pellet injection in MHD code with analytic, Parks ablation formula
  - Send plasma states along pellet path to LP code to compute ablation rate at each point
  - Rerun MHD codes with LP ablation rates
  - Iterate between codes until convergence
- **Test case for DIII-D modeling**
  - 1 mm Ne pellet using extruder parameters
  - 160606, standard case for SPI modeling
  - 171322, super-H target for upcoming small-pellet ablation experiment
  - Latter will be used for predict-first of experiment



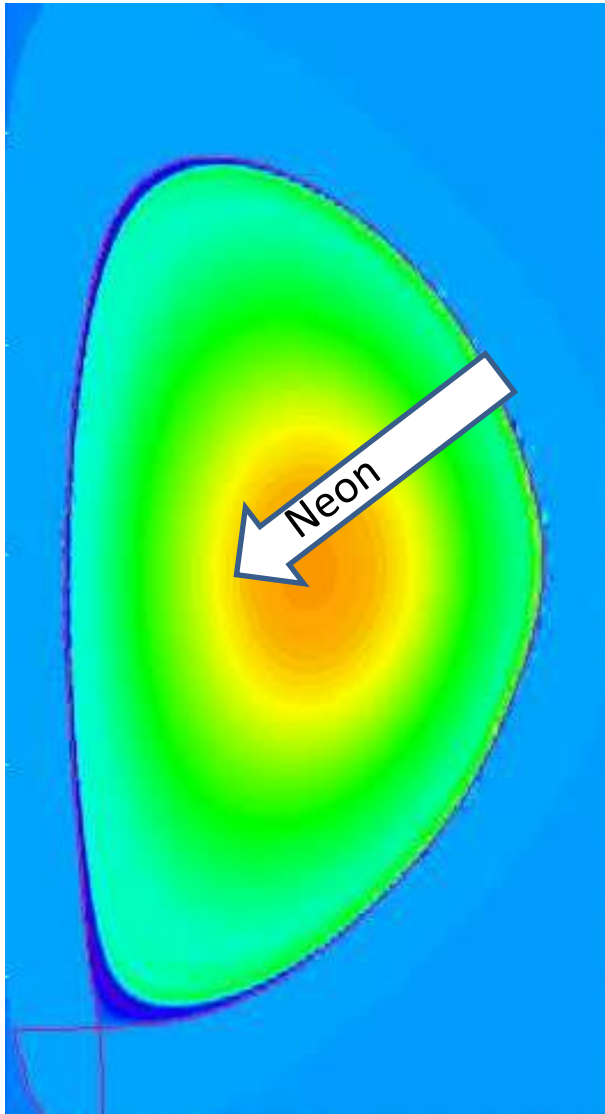
8/10/20 – proposed

9/16/20 – Roman requested status

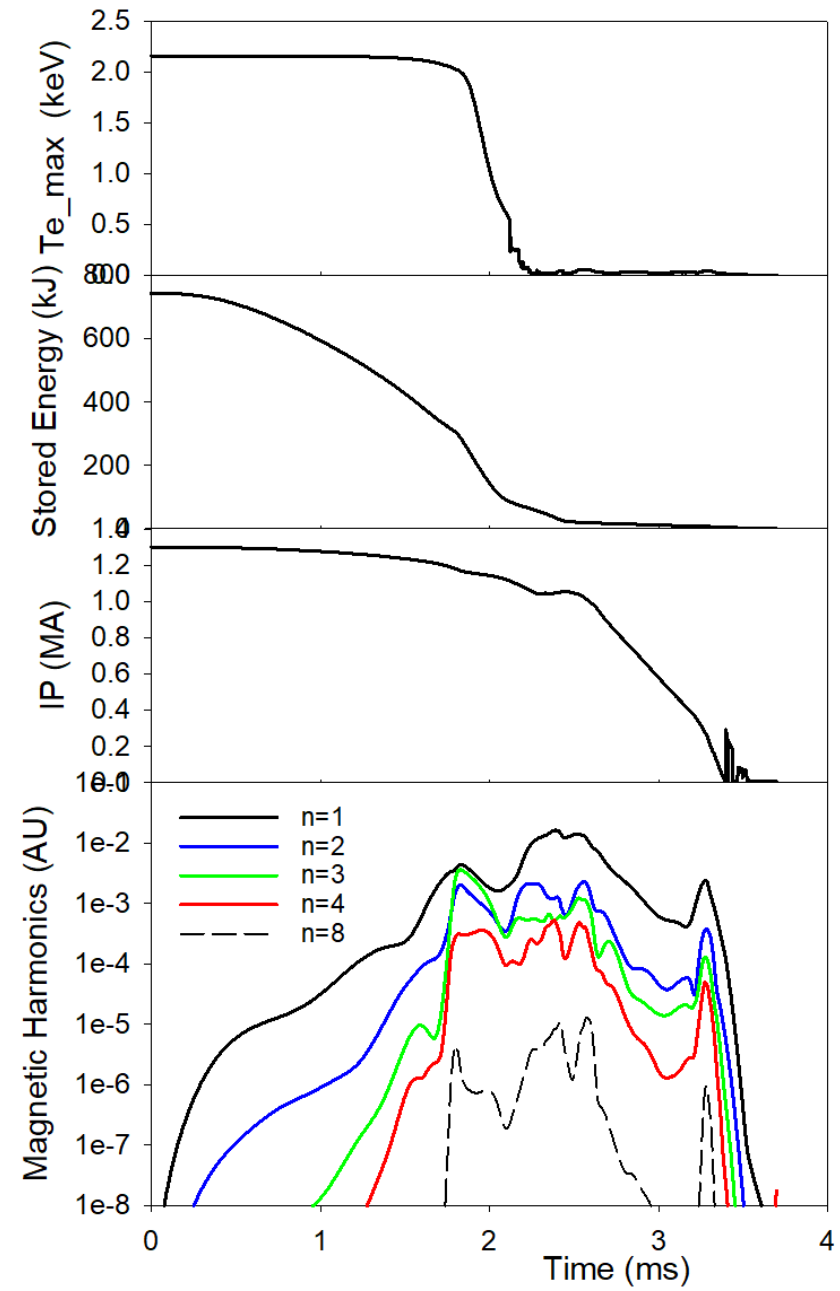
That's All I have

Anything Else ?

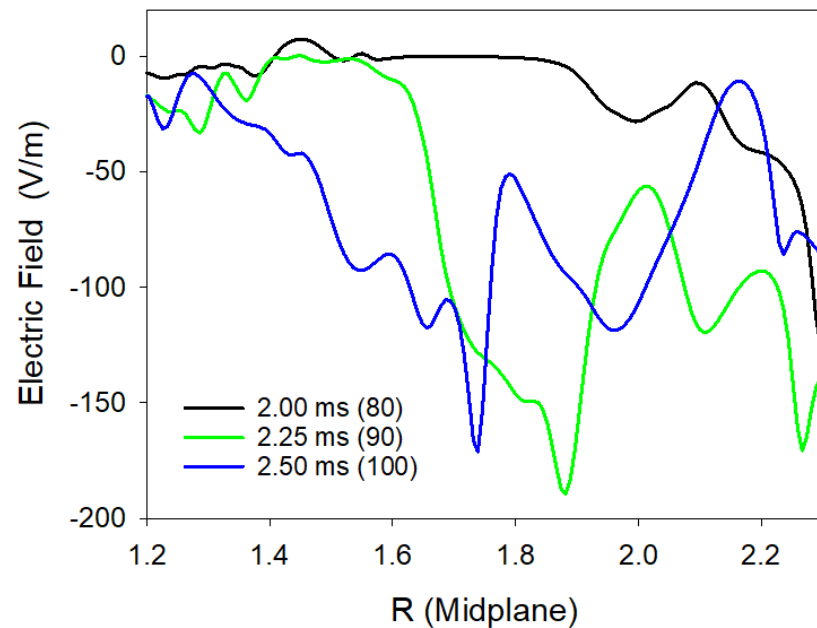
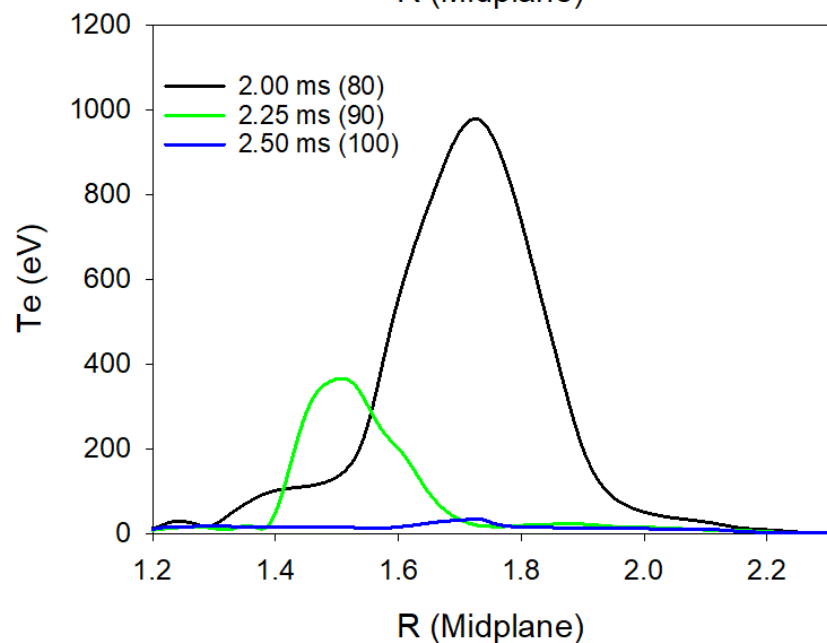
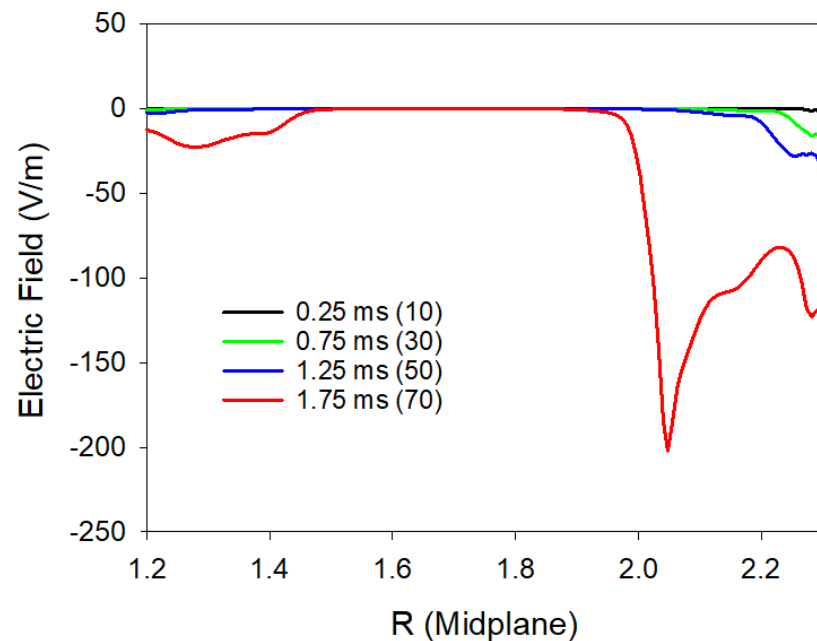
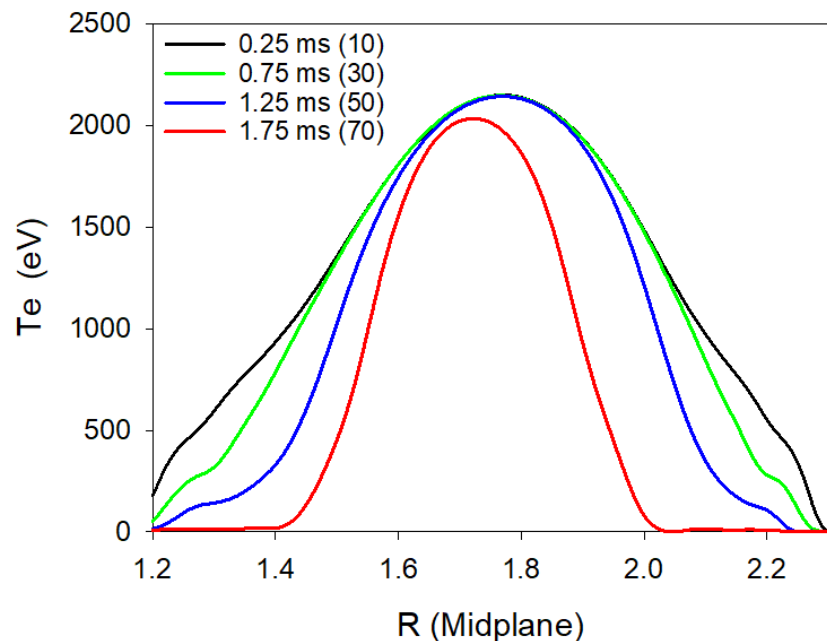
# DIII-D Neon pellet mitigation simulation (for KORC)



/global/cscratch1/sd/blyons/C1\_33984065

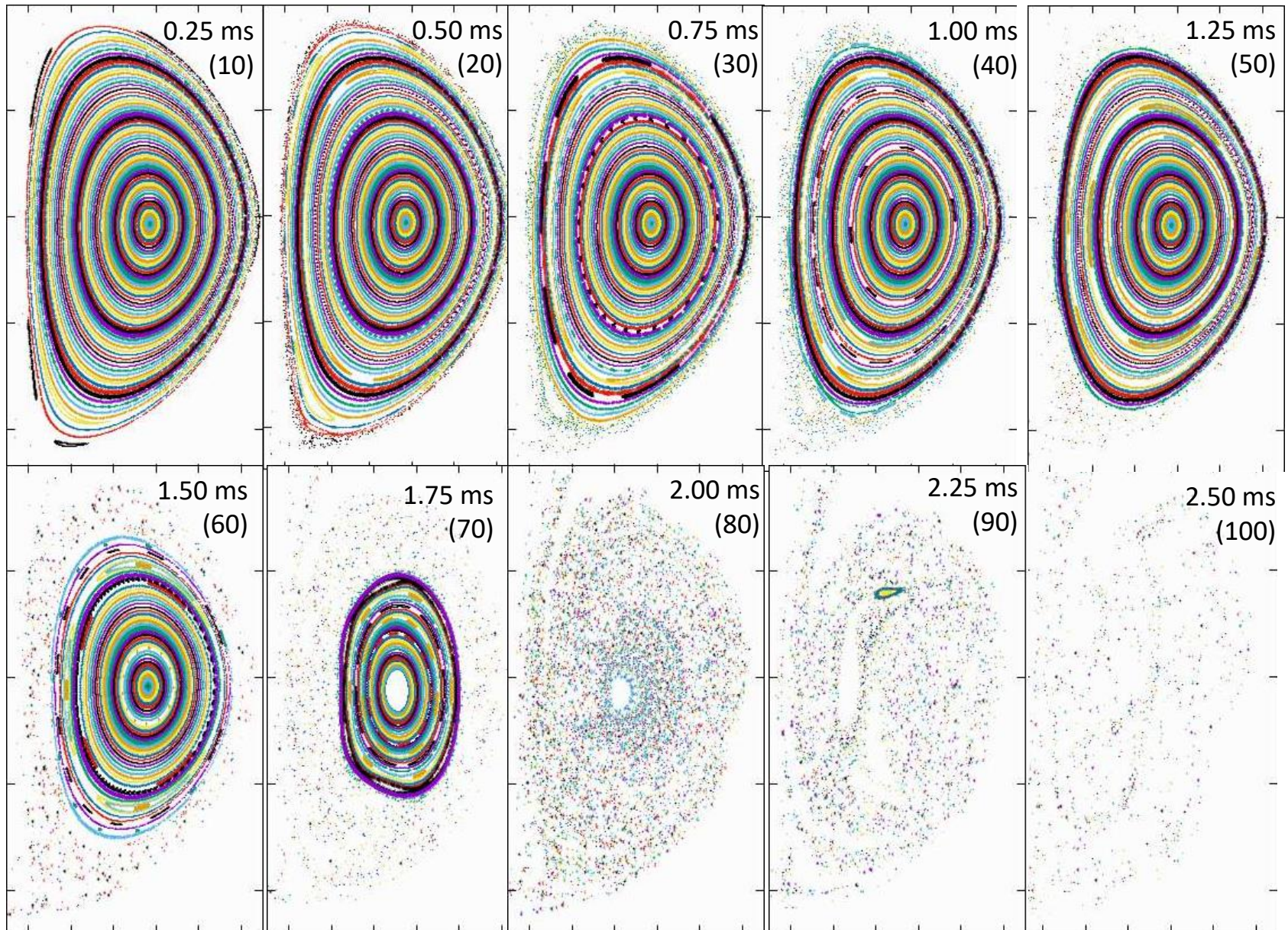


# Mid-plane Electron Temperature and Electric Field



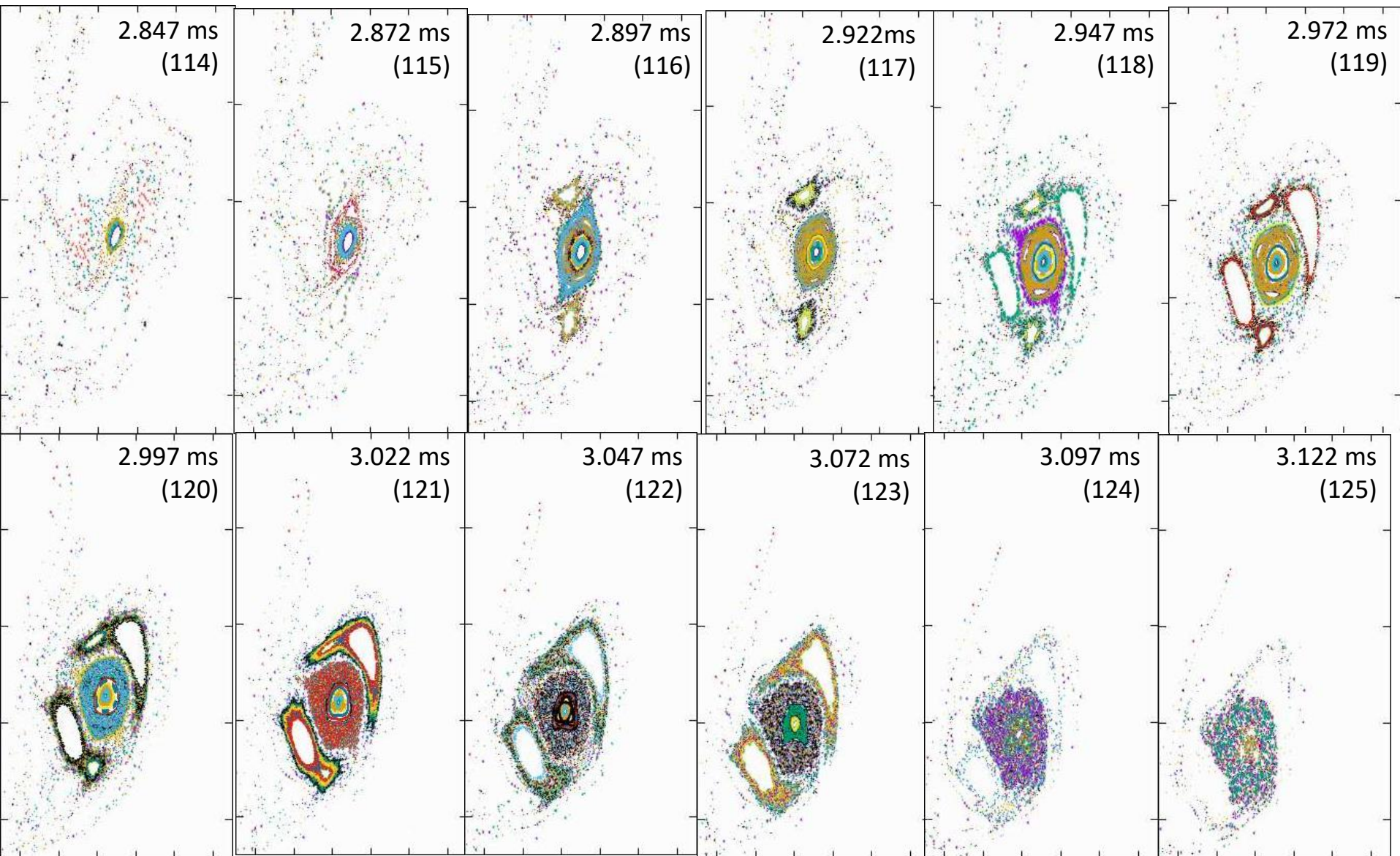


# Magnetic Surface Breakup





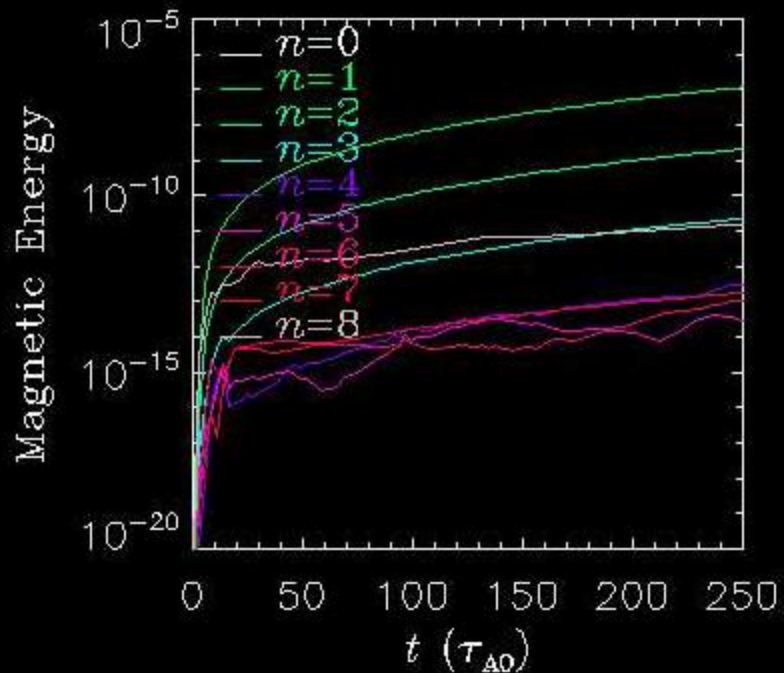
# Partial Surfaces Reforming



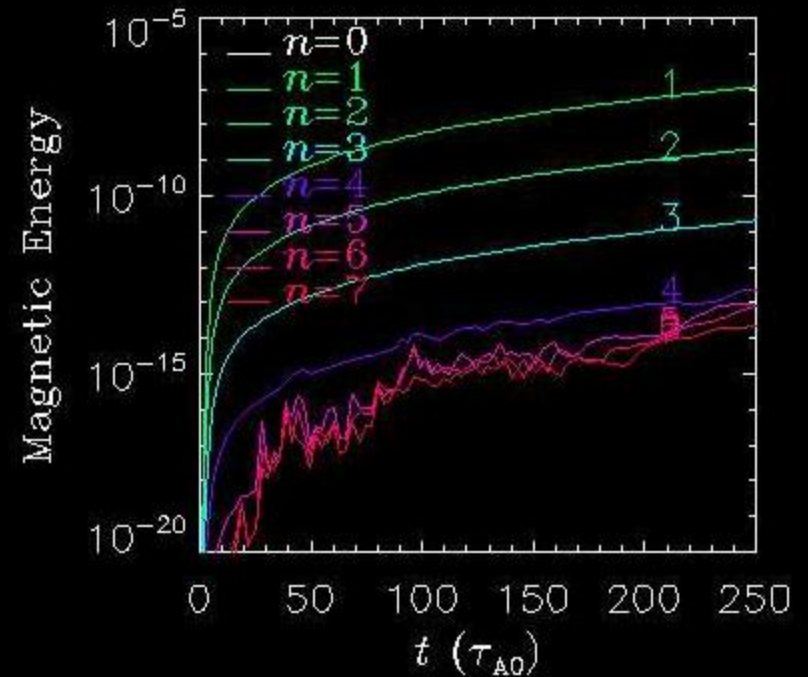


## 32 plane rerun now in progress

8 planes

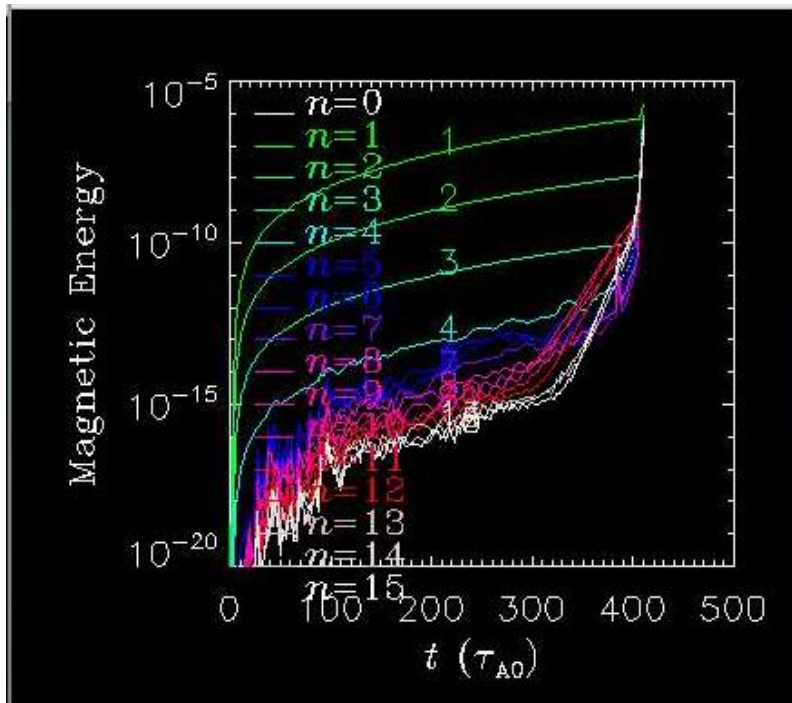


32 planes

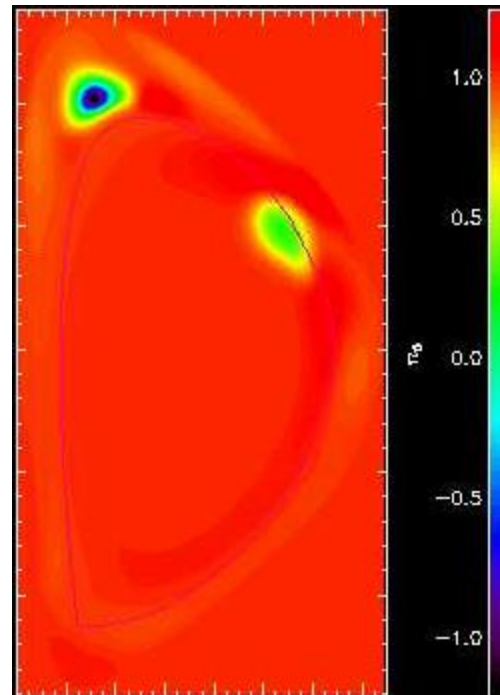


## 32 plane case crashed with negative density

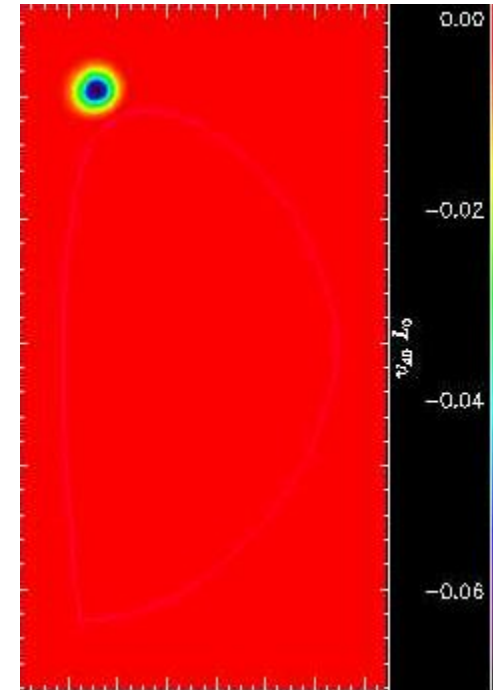
N=32 blows up at later time



density



Toroidal velocity @ 18



Near the end,  $dt > dx / V$  in the toroidal direction, which can lead to oscillations. Recommendations:

(1) iupstream=1, (2) smaller dt, (3) increase hyperv, (4) increase denm

# Energy conservation

6% error does not depend on:

- $dt=0.5, 1.0, 2.0$
  - $inocurrent\_pol=0,1$
  - $inocurrent\_tor=0,1$
  - $ltemp = 0.1$
  - $jadv = 0,1$
  - $etar = 1.e-7, 1.e-9$
  - $idens = 0,1$
- 
- Now checking dependence on magnetic boundary conditions and form of Poynting Flux divergence:  $\nabla \cdot (\mathbf{E} \times \mathbf{B})$