M3D-C1 ZOOM Meeting

9/14/2020

Agenda

1. CS Issues
    1. LBL Report/GPU solve status
    2. Local systems
    3. Other systems
    4. NERSC Time
    5. Changes to github master since last meeting
2. Physics Studies
    1. Conservation laws and energy conservation
    2. M3D-C1 coupling to RE code KORC -- Lyons
    3. RE Fluid Modeling of DIII-D Shot 177040 -- Chang Liu/S. Jardin
    4. Runaways with sources , shot 177053 Chen Zhao/ S. Jardin
    5. Test of Boozer Theory for Cold VDE … Clauser
    6. Status of first coupled M3D-C1/LP Simulation .. Lyons
    7. Other

LBL Report/ GPU Solve Status

From J. Chen TODAY 9:17 AM ET

On TRAVERSE RH8:With the help from campus, PETSc was installed last Friday with the new Superlu_dist fix. But at run time, Superlu_dist offloading crashes for the segmentation error.
We need to find a way to make it work before PETSc is ready to support cuda-11.x.

On CORIGPU:
Last status was :

Two cases failed:

1) "adapt" failed.
2) KPRAD_restart failed due to NaN

As of yesterday after scorec lib changes, code could not compile due to a linking issue. I'm working with Seegyoung to solve this.

Local Systems

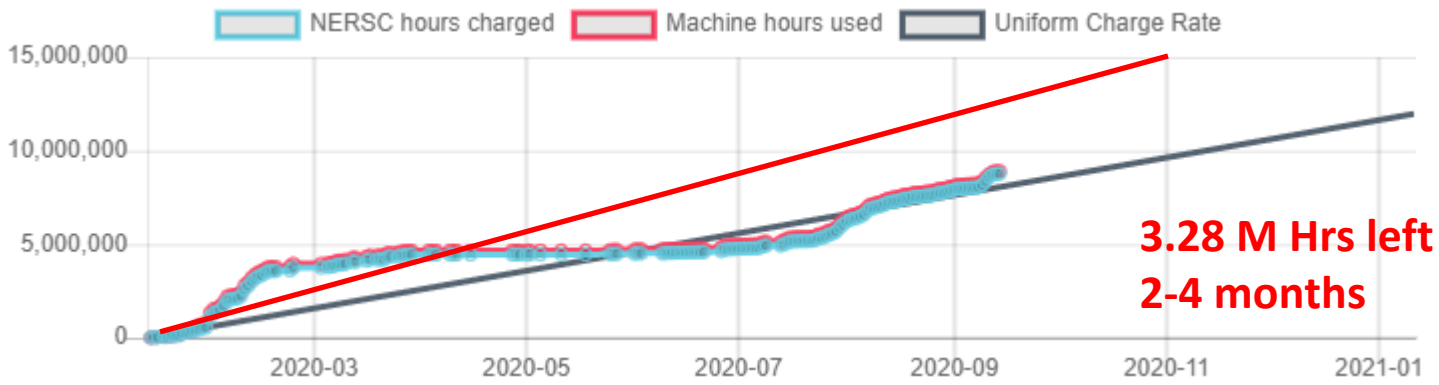
- PPPL centos7
  - 5 regression tests PASSED on centos7:
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
- PPPL greene
  - 3 regression tests PASSED
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
  - “RMP_nonlin” timed out after 4 time steps
  - No batch file found for pellet
- EDDY
  - 5 regression tests PASSED on eddy
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
- TRAVERSE
  - 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

Other Systems

- Cori-KNL
  - 4 regression tests passed on KNL
  - “adapt” failed due to diff in C1ke (0.14 fractional diff)
  - KPRAD_restart failed due to “Job not yet started”
  - Note: only 5 jobs allowed to be submitted in debug queue
- 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)

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

Changes to github master since last meeting

- J. Chen
  - 08-31: petsc update on centos7, adapt test to do
  - 09-02: traverse rh7 lib reverse
  - 09-04: traverse rh8 update
  - 09-08: CORI GPU regression test slurm scripts update
- N. Ferraro
  - 08-31: Added module for Traverse
  - 09-02: Updated a2cc to use standard command_argument_count() instead of GNU extension iargc()
  - 09-02: Fixed some coding errors in bootstrap.f90
  - 09-02: Removed some compile directives from mackenbach_profiles
  - 09-03: Added C-coil to device_data/DIII-D/rmp_coil.dat
  - 09-04: Added devel-rh7 and devel-rh8 modules for traverse. Made “devel” a copy of devel-rh8. When rh7 is phased out, we’ll just keep “devel”
  - 09-04: Updated centos7 makefile to support openmpi (OMP=1)

    Updated “make bin” to copy m3dc1_*_omp binaries to $(M3DC1_ARCH)/bin

    Added some regression test batch scripts for greene (./run greene_omp)
- S. Seol
  - 09-11 fixing crash in PPPL centos7
  - 09-13 removing unused flag and clean-up for SCOREC codes

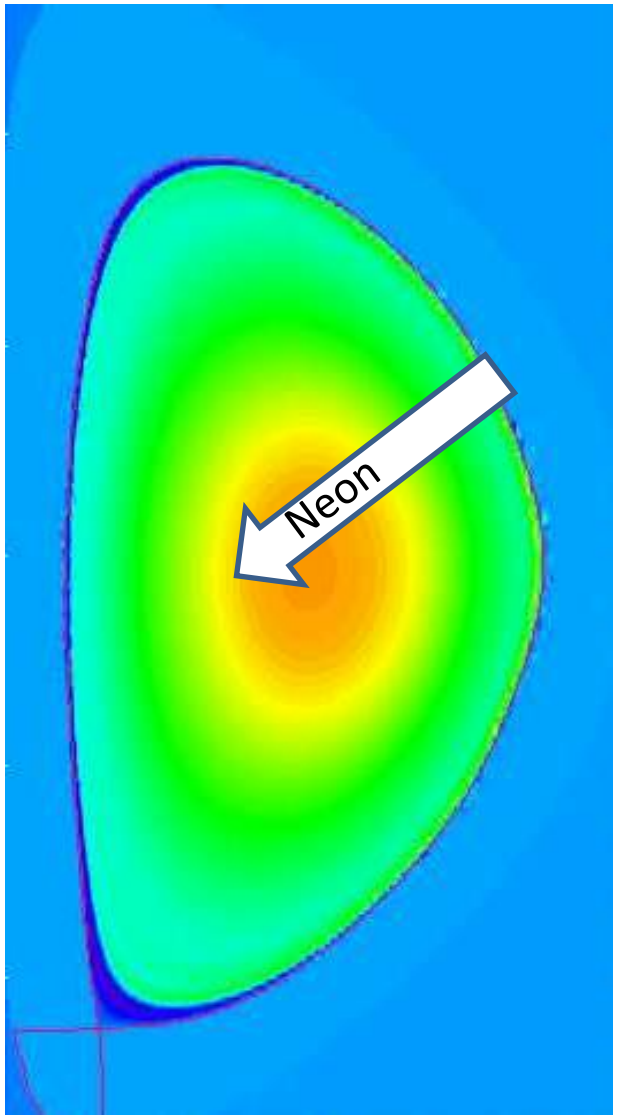
Energy conservation

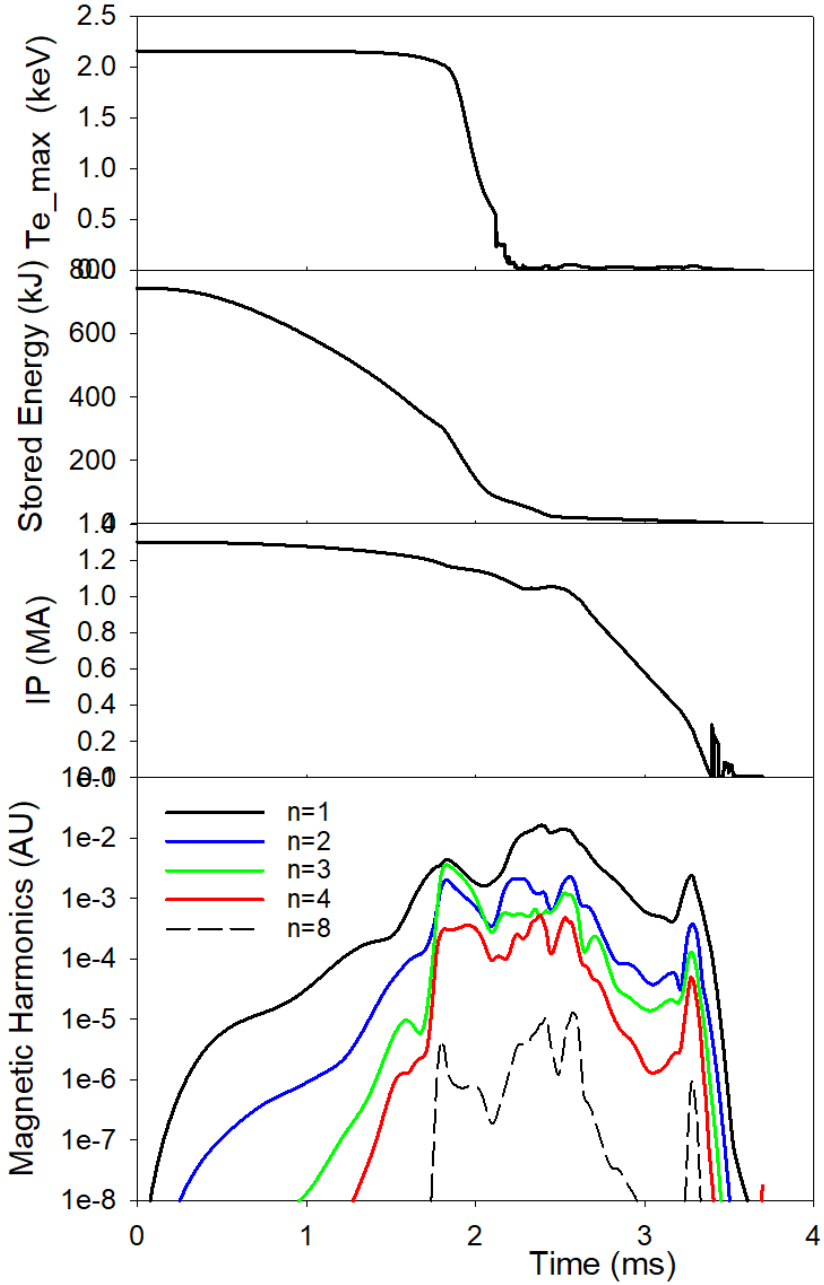
6% error does not depend on:

- dt=0.5, 1.0, 2.0
- inocurrent_pol=0,1
- inocurrent_tor=0,1
- Itemp = 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 Poyting Flux divergence: $\nabla \cdot (\mathbf{E} \times \mathbf{B})$

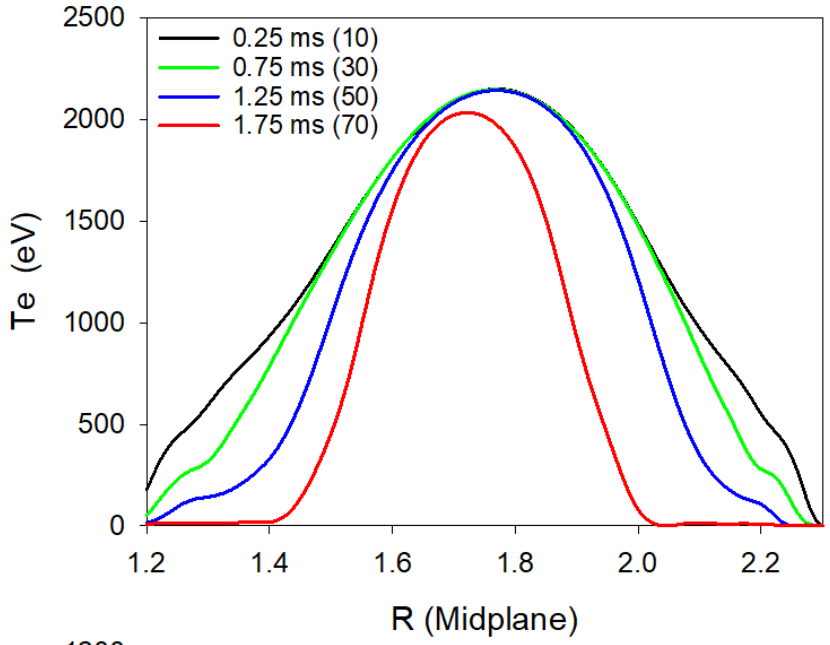
DIII-D Neon pellet mitigation simulation (for KORC)

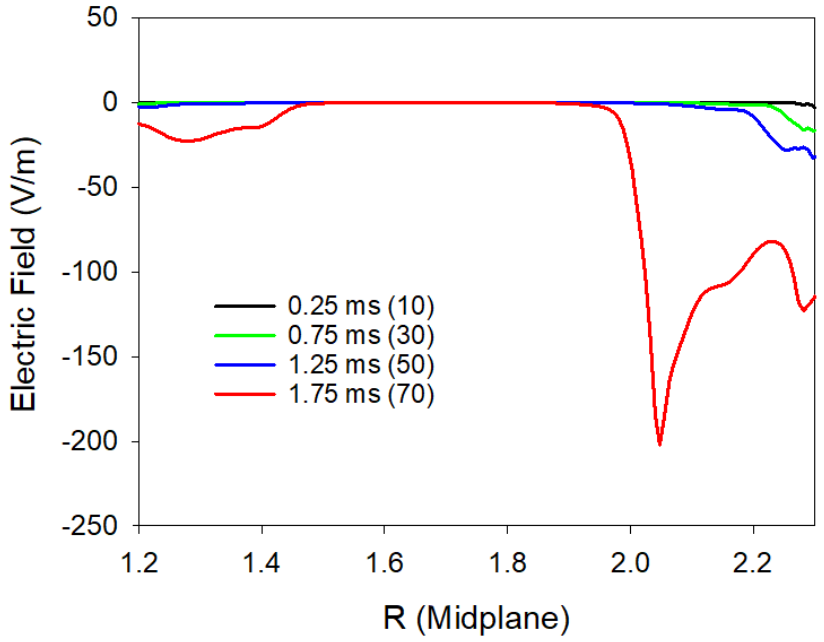


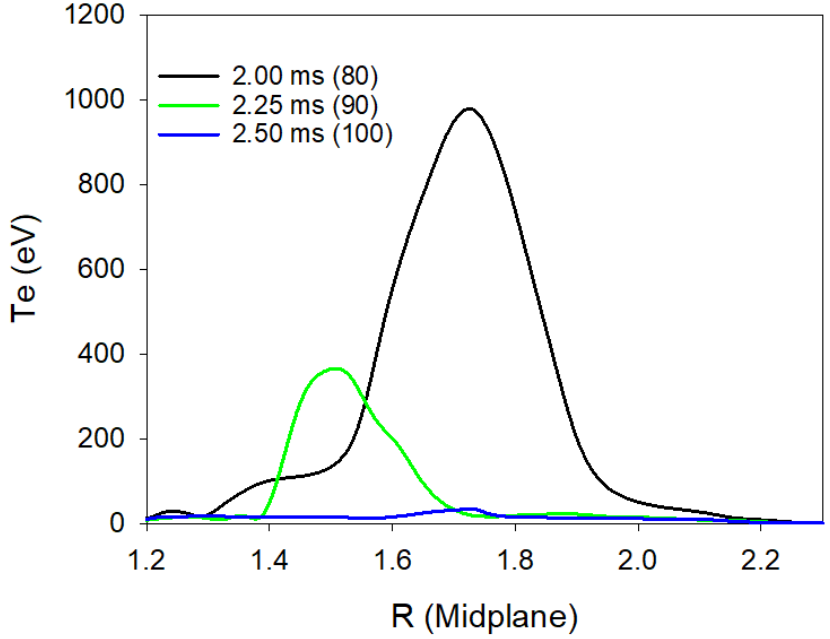


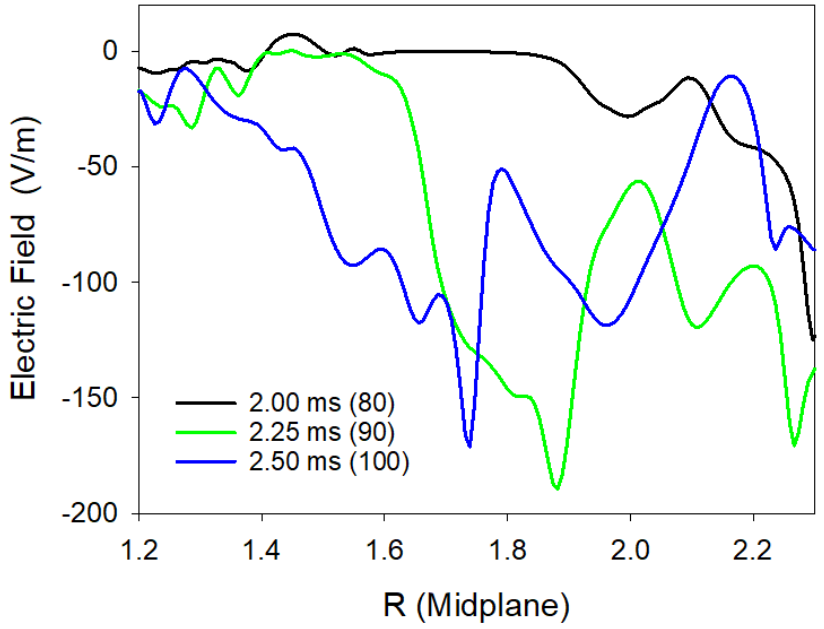
/global/cscratch1/sd/blyons/C1_33984065

Mid-plane Electron Temperature and Electric Field

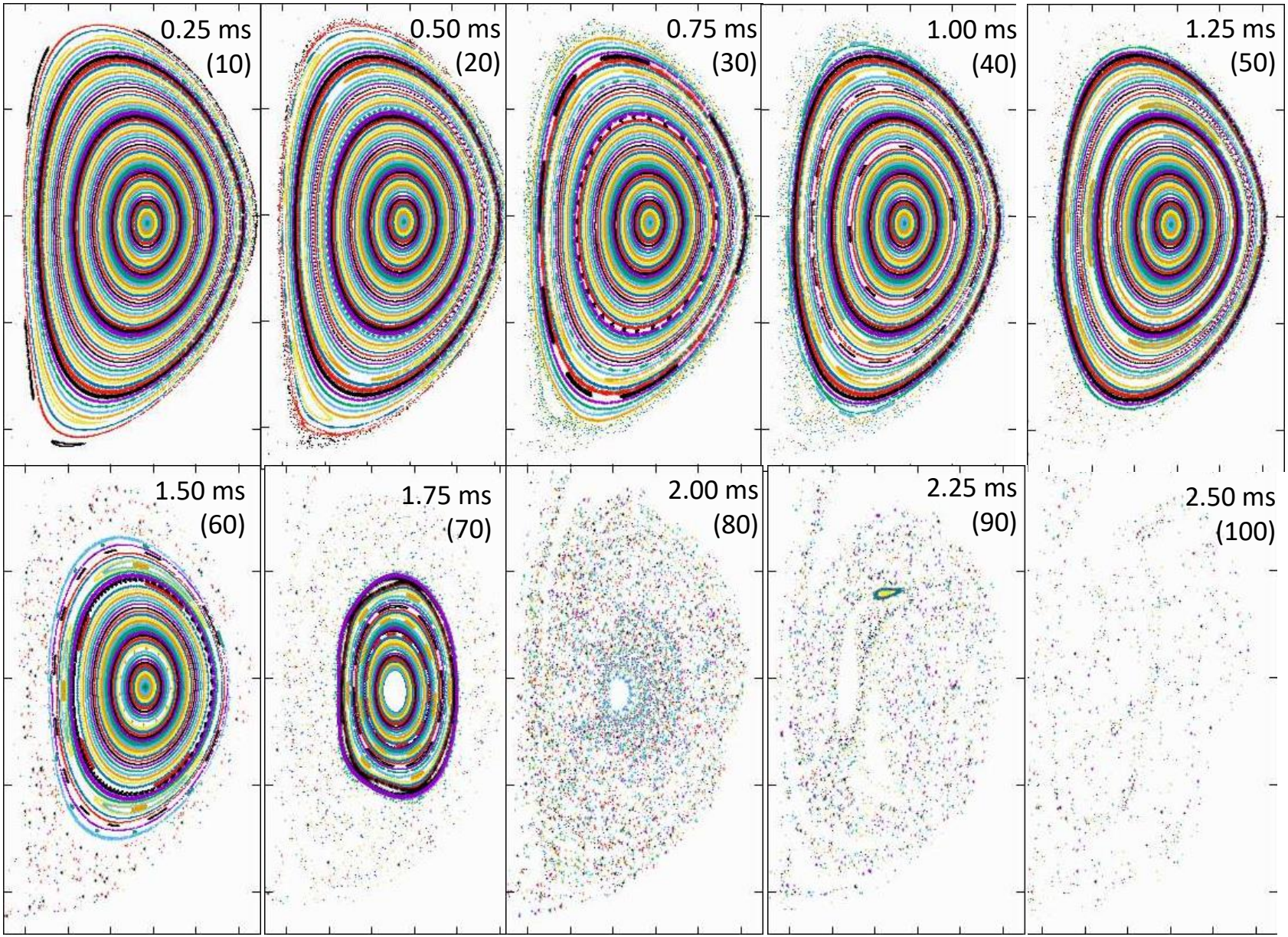




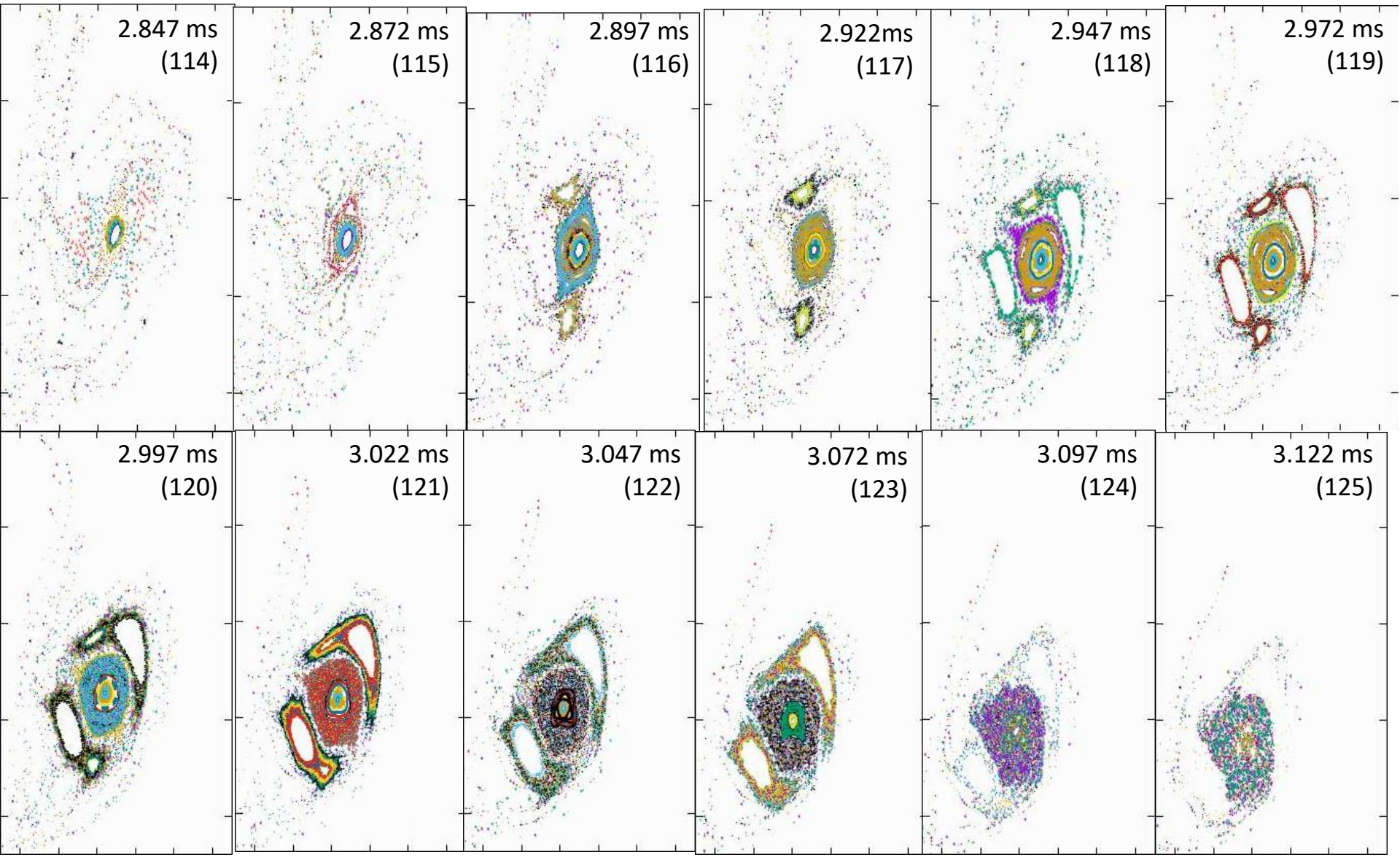




Magnetic Surface Breakup

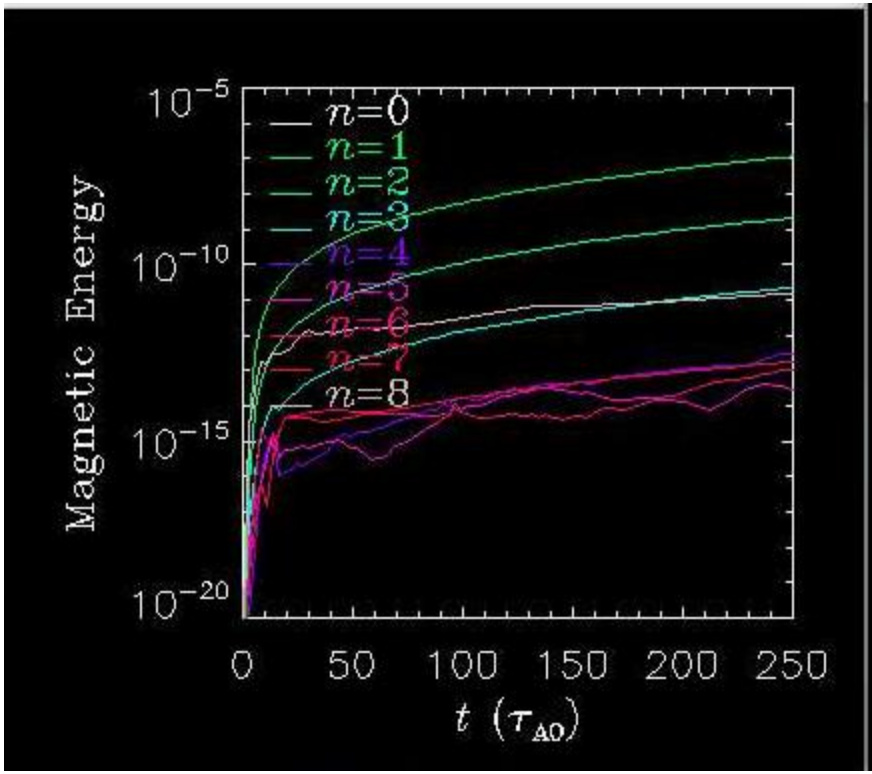


Partial Surfaces Reforming

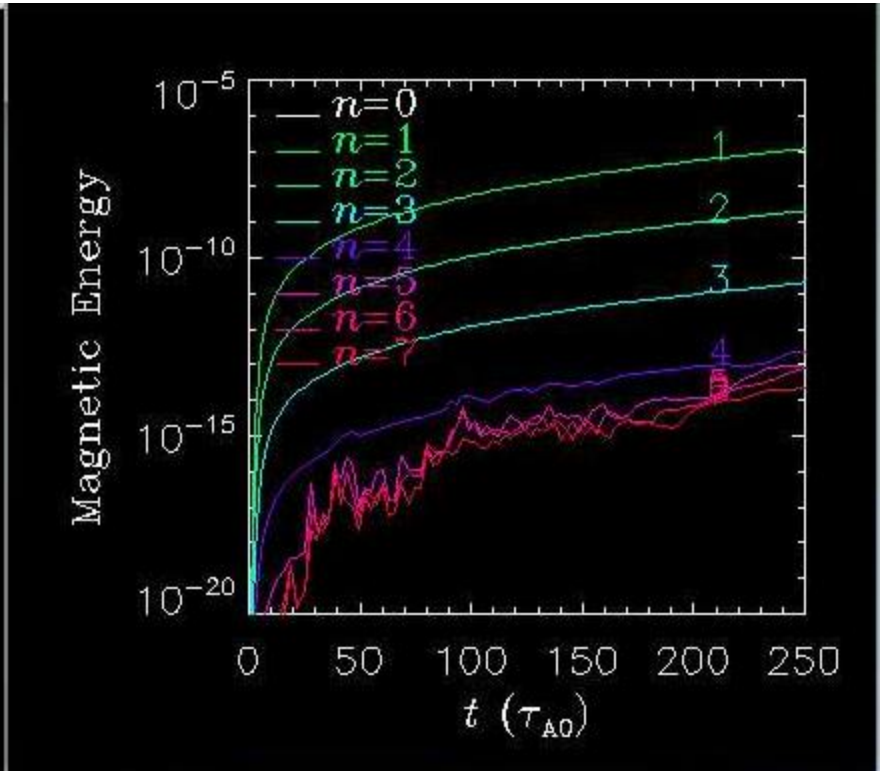


32 plane rerun now in progress

8 planes

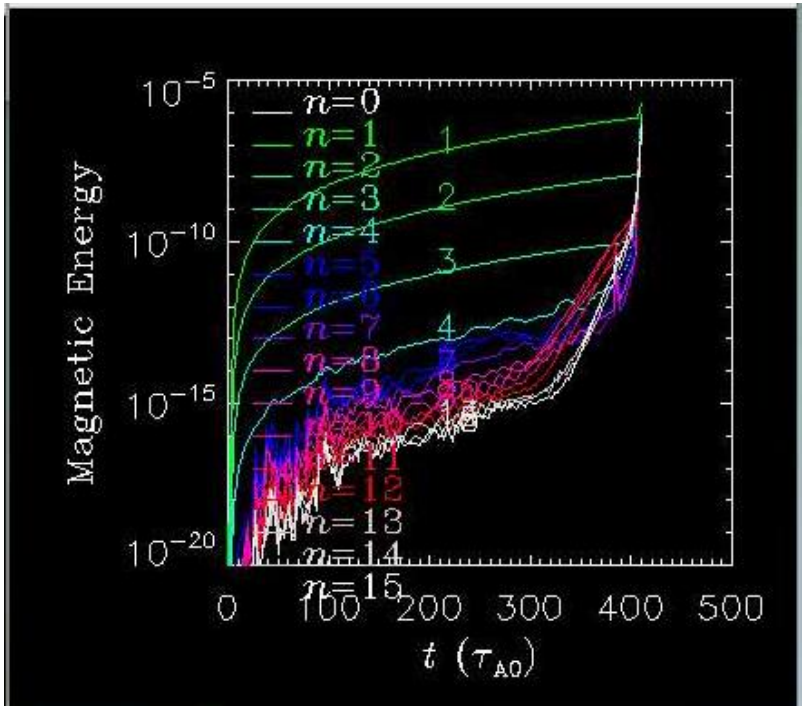


32 planes

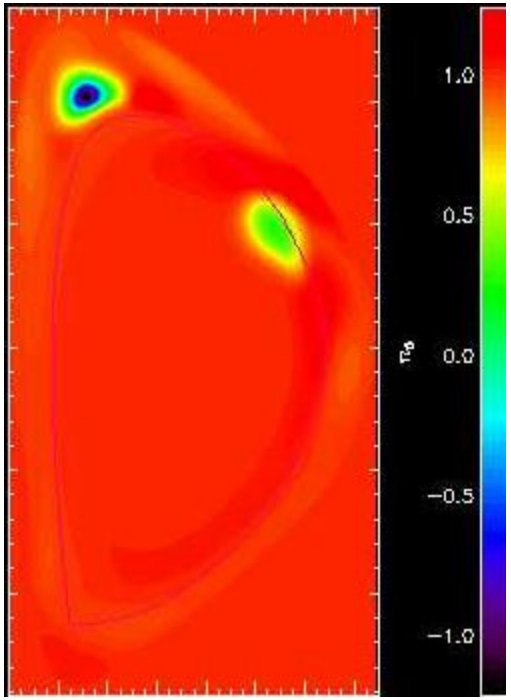


32 plane case crashed with negative density

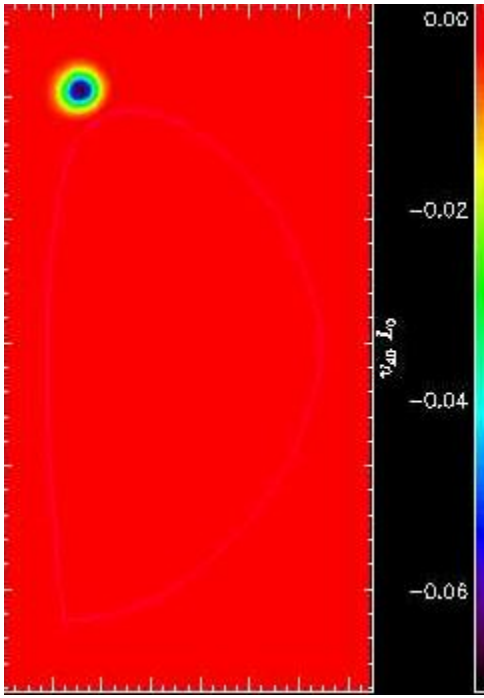
N=32 blows up at later time



density



Toroidal velocity @ 18

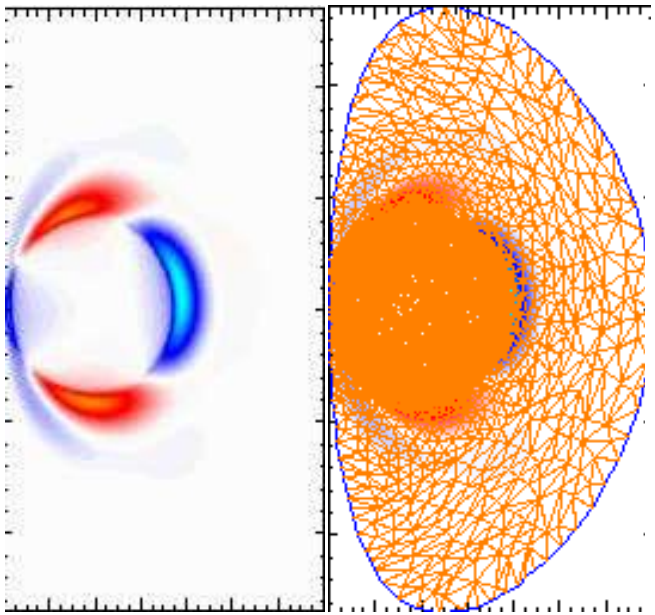


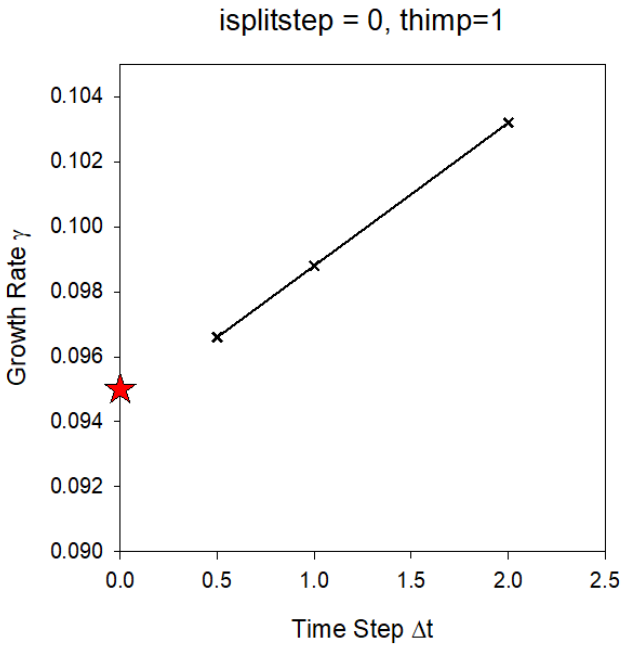
Near the end, dt > dx / V in the toroidal direction, which can lead to oscillations. Recommendations:

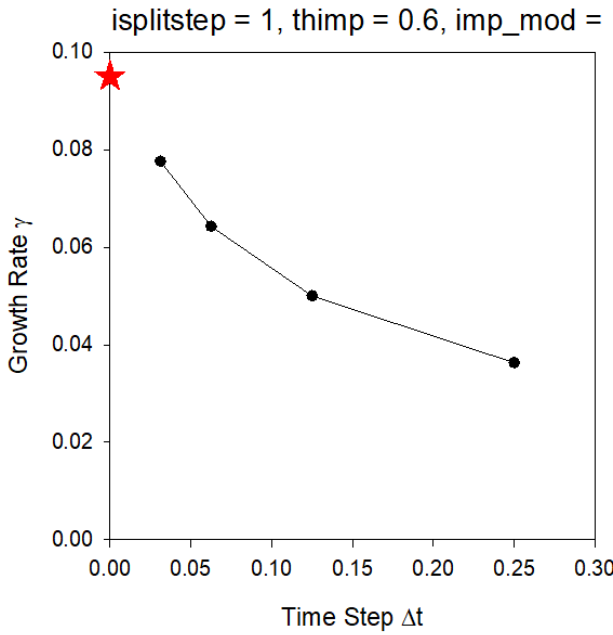
(1) iupstream=1, (2) smaller dt, (3) increase hyperv, (4) increase denm

RE Fluid Modeling of DIII-D Experiments

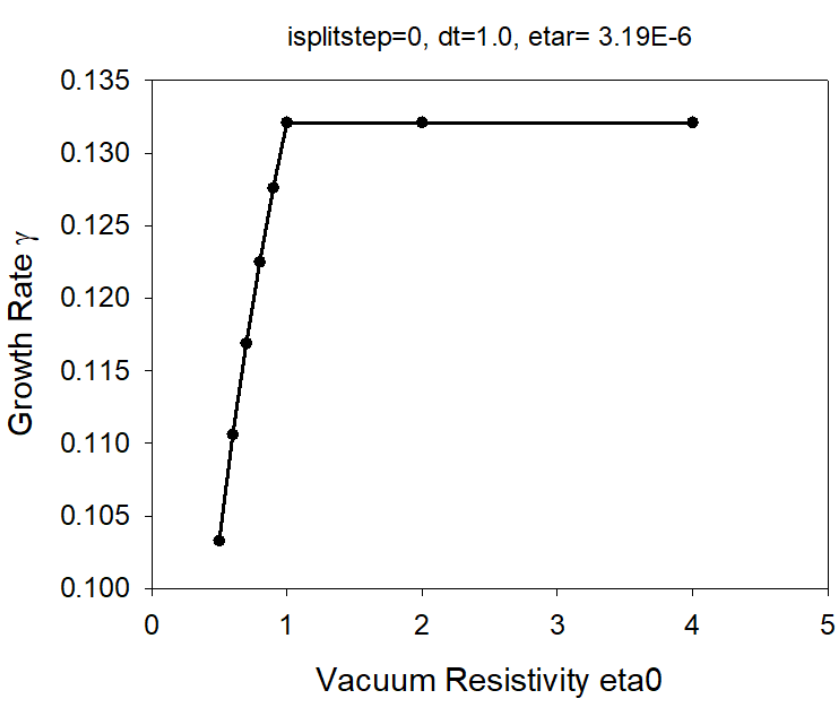
- shot 177040 has been looked at by Liu with the (linear) MARS code
- Brendan has created a new geqdsk with same q-profile but lower pressure
- ZOOM held Tuesday Sept 1 @ 2:00 PM ET
  - Chang Liu, Chen Zhao, Steve Jardin, Yueqiang Liu, Carlos Paz-Soldan
- Chang Liu to compare with MARS results, extend to non-linear

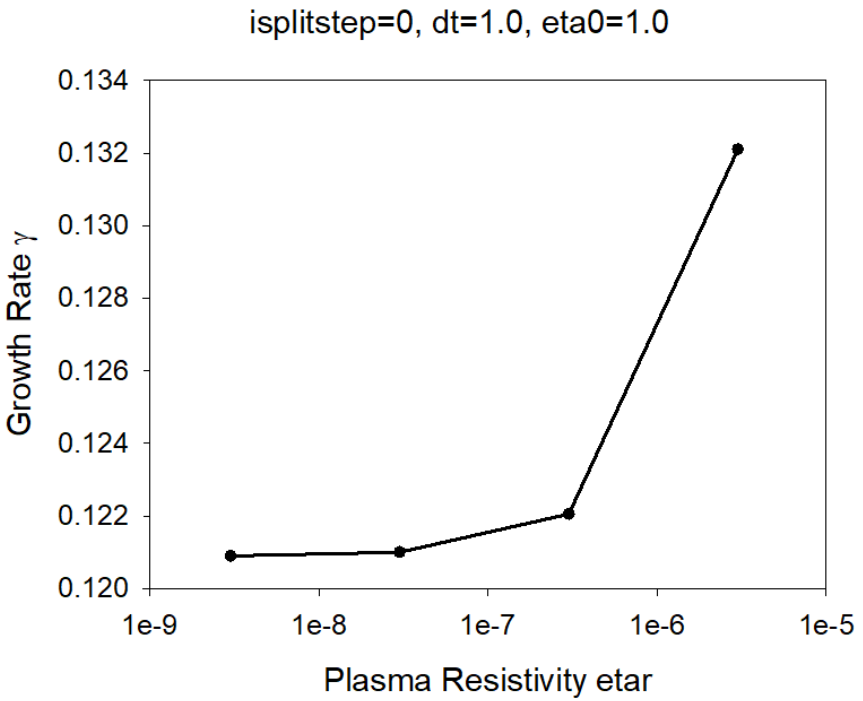




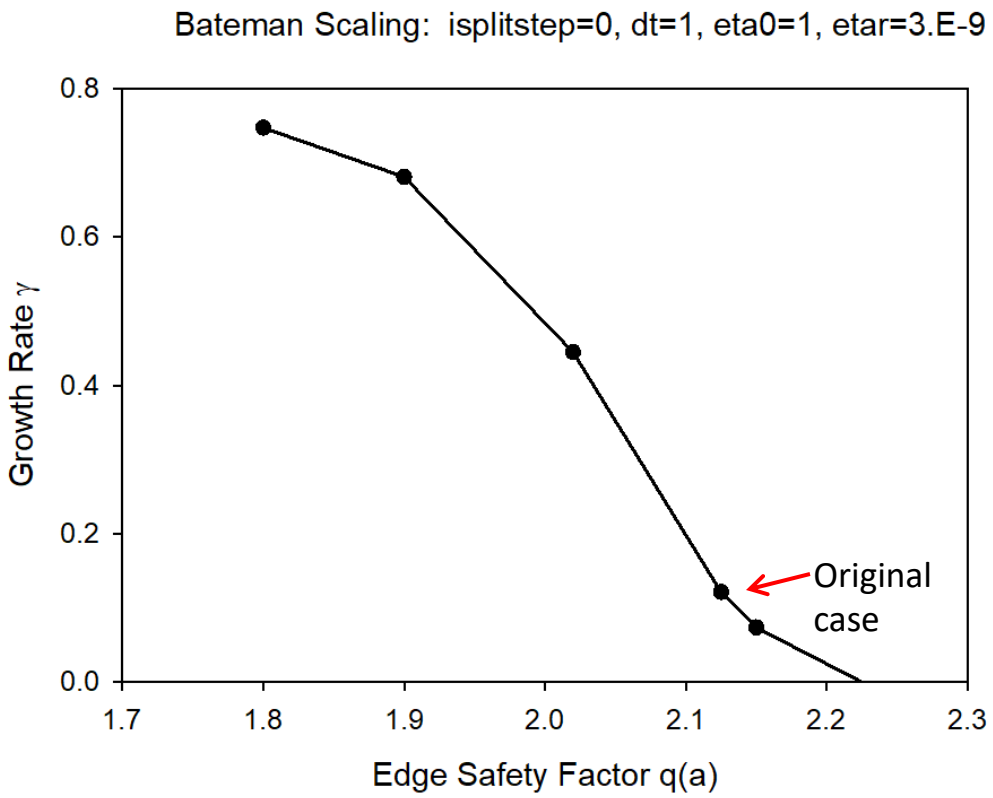


Dependence of Growth Rate on Plasma and Vacuum resistivity





Growth Rate vs q(a)



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

We should ask MARS to make a similar plot.

Runaways with Sources

New terms to be added to field-advance $\mathbf{E}+\mathbf{V}\times\mathbf{B}=\eta(\mathbf{J}+n_{re}ce\mathbf{B}/B)$

Toroidal Field Advance: $\frac{1}{R^2}\dot{F}=\cdots+\nabla_\perp\bullet\eta\left[\frac{n_{re}ce}{R^2B}\nabla_\perp\psi\right]$

Poloidal Field Advance: Either:

jadv = 0 is not compatible with imultiregion=1

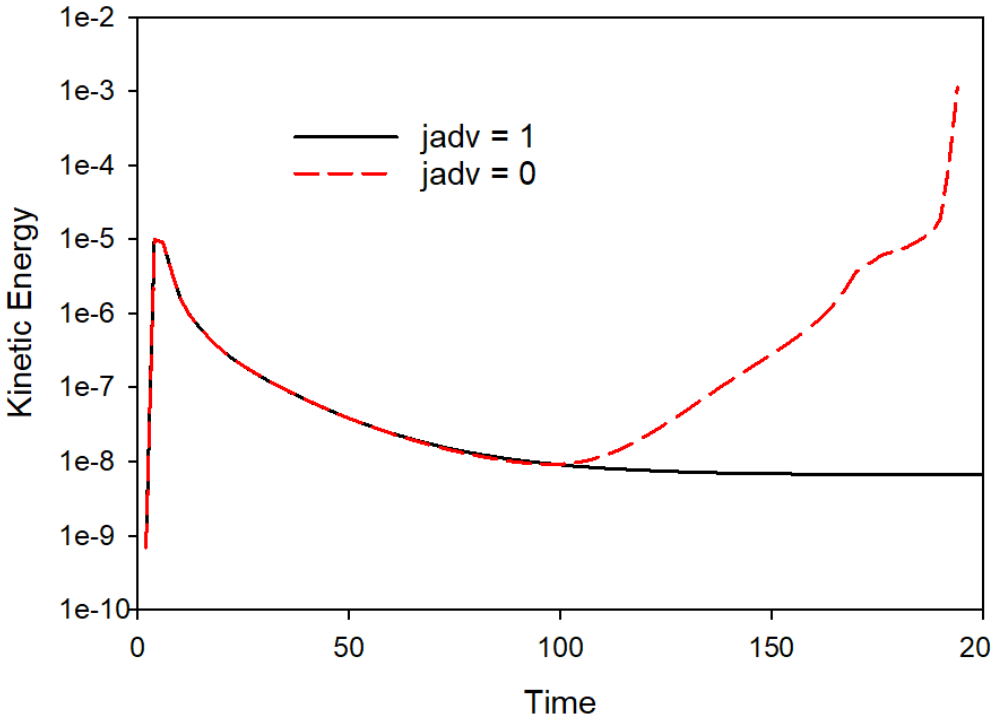
jadv=0

$$\begin{cases}\dot{\psi}=\ \cdots\ -\eta\left[-n_{re}F/B\right]\\ \nabla_\perp\bullet\frac{1}{R^2}\nabla\Phi=\ \cdots\ +\nabla_\perp\cdot\eta\left[-\left(\frac{c}{R^2B}\right)\left(\nabla\psi\times\nabla\varphi-\nabla_\perp f'+F\nabla\varphi\right)\right]\end{cases}$$

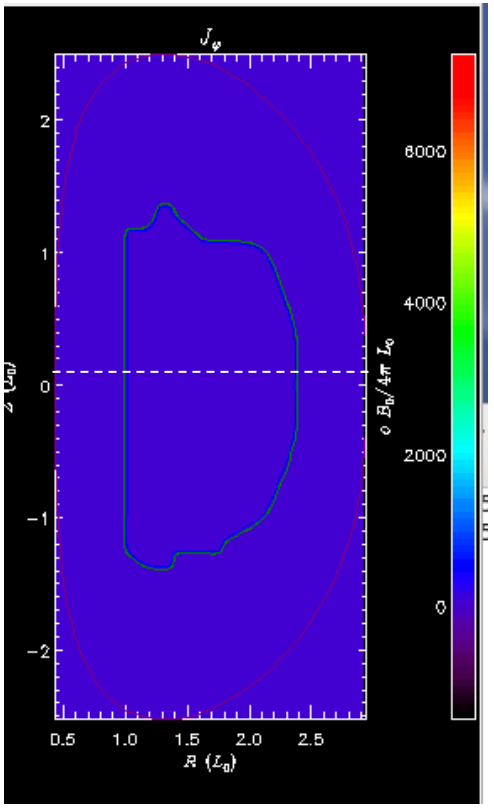
Or

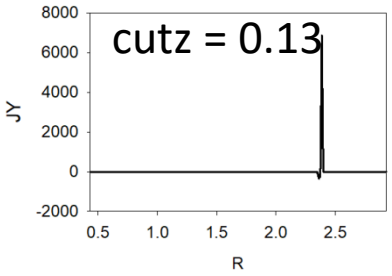
jadv = 1 $\nabla_\perp\bullet\frac{1}{R^2}\nabla_\perp\dot{\psi}=\cdots\nabla_\perp\cdot\left[\eta\left(\frac{n_{re}ec}{R^2B}\right)\left(\nabla\psi\times\nabla\varphi-\nabla_\perp f'+F\nabla\varphi\right)\right]'+\nabla_\perp\bullet\frac{1}{R^2}\nabla_\perp\left[-\eta ecn_{re}F/B\right]$

Comparison of kinetic energy for jadv=0 and jadv=1.

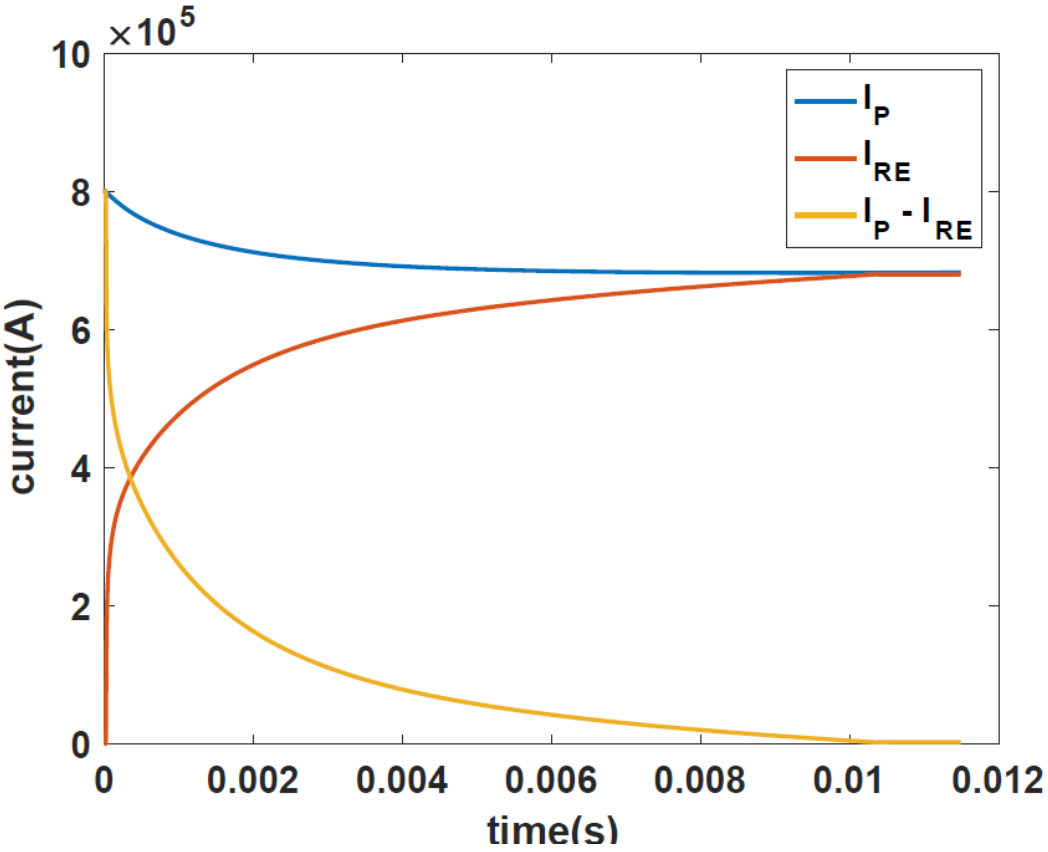


Toroidal current for jadv=0 at time 180. Lower plot has value at Z=0.13 (dotted line)





M3D-C1 new result (Chen)

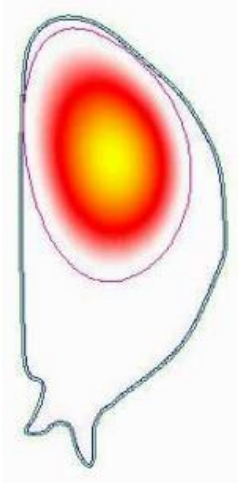


Next Steps:

1. Verify and commit changes to GIT
2. Meet with lead experimentalist for this shot. What would be useful for him? (Brendan to set up?)

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.

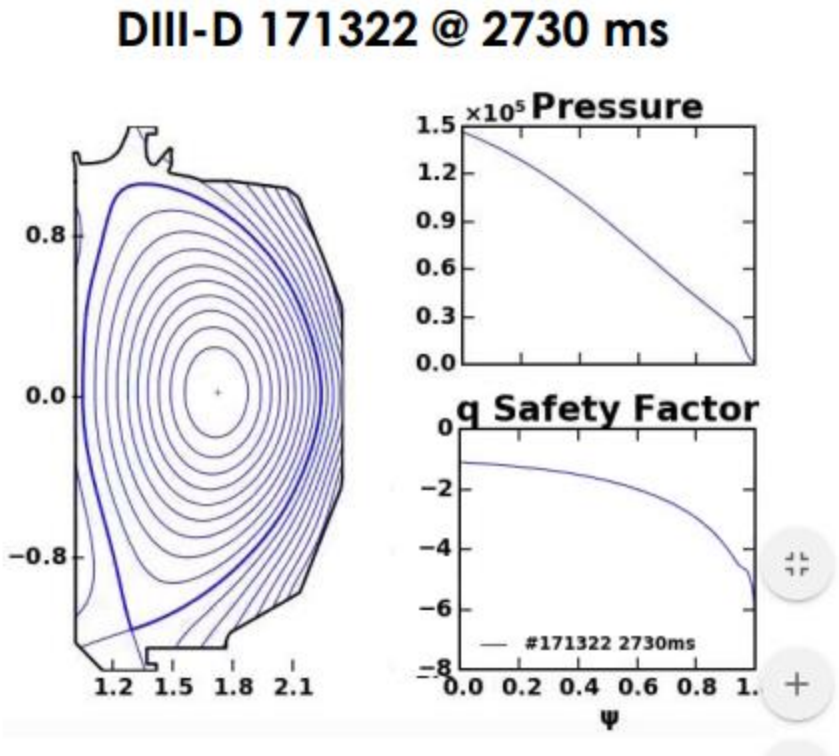


Vs.

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



Proposed 8/10/20 **….. Status?**

That’s All I have

Anything Else ?