M3D-C1 ZOOM Meeting

06/28/2021

Announcements

CS Issues

1. GPU solves (w LBL)
2. Mesh adaptation
3. stellar.Princeton.edu anomalies
4. NERSC Time
5. Changes to github master since last meeting & regression tests

Physics Studies

1. New paper submitted (CC)
2. Paper by Pustovitov on disruption forces
3. ITER sideways force: compare baseline with high resistivity wall
4. Porcelli theory on ideal MHD diverted plasma and n=0 mode
5. Toroidal field boundary condition: iconst_bz=0 or iconst_bz=1 ?
6. Pellets with RE … Chen Zhao
7. Other

Note: meeting minutes posted on m3dc1.pppl.gov

In attendance

Steve Jardin
Hank Strauss
Sam Williams
Chen Zhao
Patrick Kim
Andreas Kleiner
Adelle Wright
Yang Liu
Brendan Lyons
Mark Shephard
Usman
Cesar Clauser
Seegyoung Seol
Chang Liu
Nate Ferraro

Announcements

- No meeting next week (July 4th holiday)
- Theory and Simulation of Disruptions Workshop (TSDW) July 19-23
  - M3D-C1 talks by Lyons, Samulyak, Sovinec, Strauss, Liu, Zhao
- Virtual Sherwood Meeting August 16-18
  - Abstracts due by July 9
  - Registration until August 9
- APS Nov 8-12
  - Abstracts due by July 15
  - Meeting will be IN PERSON with virtual option
  - M3D-C1 Invited talks by C. Liu, A. Wingen, ???

GPU Solve Status

LBL update

Sam Williams
Yang Liu
Nan Ding
Xiaoye Li (on vacation)

Mesh Adaptation

1. Brendan set up a 2D pellet case which he ran with iadapt=0 (no mesh adaptation)

2. Seegyoung tried to run this with the new adaptation capability in which iadapt is ignored (compile with OPT=1 ADAPT=1 ARCH=centos7)

3. # faces reduced from 2519 to 318 and code crashes after adapt in fortran code

4. Request to reduce number of fields to transfer in adaptation from 91.   (maybe just transfer fields that are read in at restart time…sj)

Seegyoung Seol
Brendan Lyons

Mesh Adaptation – Strauss request

There are two parameters:

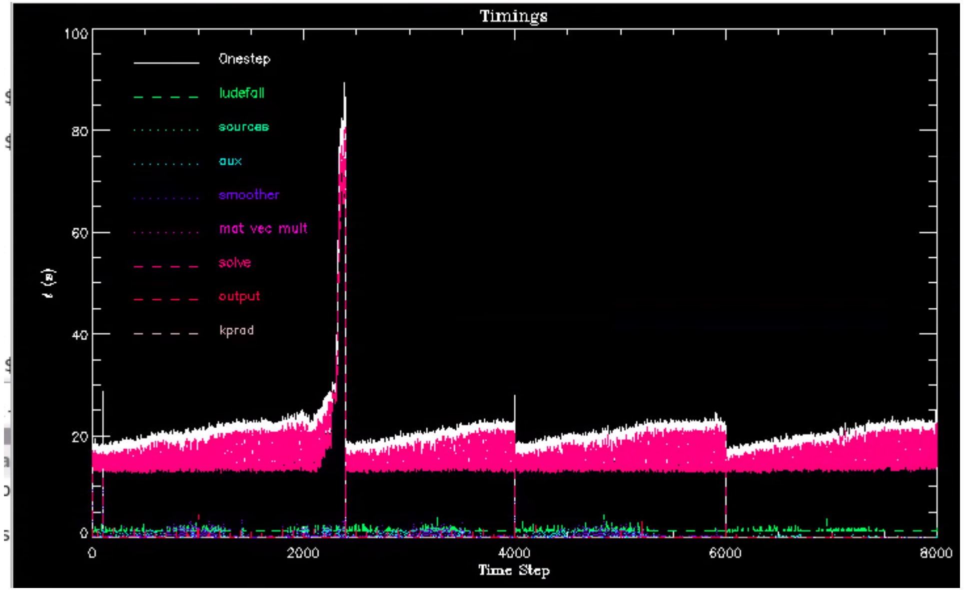
adapt_psin_wall and **adapt_psin_vacuum**.

Setting these tells the adaptation routine to treat the entire wall or vacuum region as having that particular value of psi_normal. So if you pack the mesh around the q=2 surface at psi_norm=0.5 (for example), then setting adapt_psin_wall=0.5 will give very fine resolution in the wall.

N. Ferraro, B. Lyons

See m3dc1.pppl.gov

Stellar.Princeton.edu

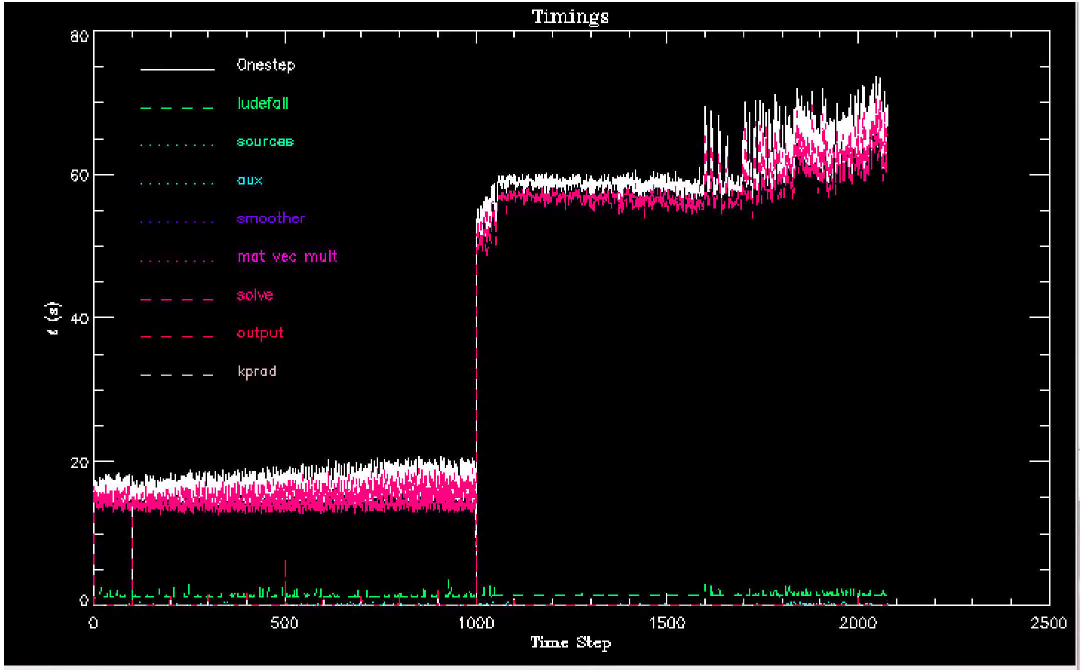


29863
30181
30348
30349

2D run. 96 p, 1 node
SuperLU_dist

/home/sjardin/data/ITER/Run03NM-redo

stellar.princeton.edu



30351 (good)
30391 (bad)

Same type of run with different input coefficients

/scratch/gpfs/sjardin/ITER-05NM

Stellar Bug report

Yao Zhou
Tue, Jun 22, 7:01 PM (18 hours ago)
to Jin, Adelle, Nathaniel, Brendan, me

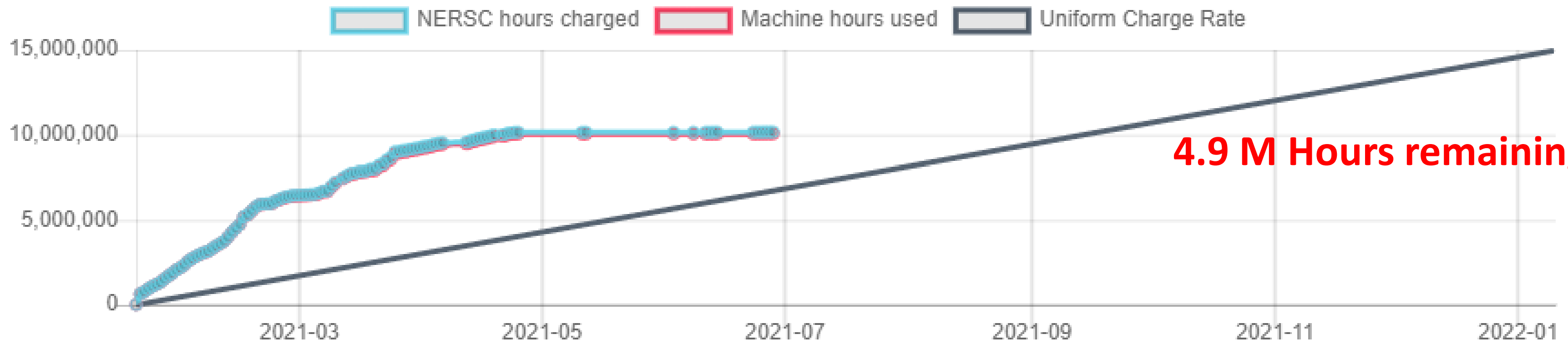
OK, I just doubled checked and the problem occurred with the tokamak version in the stellarator branch but not the master branch. So it appears to be something wrong with the stellarator branch. I tried unloading the NetCDF module, which is loaded in the stellarator branch, but it didn't make a difference. I cannot think of anything else that could have caused this but will keep looking. Thanks for all your input!

Yao Zhou

Yao

NERSC Time

mp288



4.9 M Hours remaining!

- mp288 received 10M Hrs for CY 2021
- Initial allocation exhausted by May 1
- John Mandrekas (DOE) added 5M Hrs additional
- More time may be possible if this is exhausted
- Pearlmutter time will not be charged for this FY

Changes to github master since 06/20/21

- **Seegyoung Seol**
  - **06/21/21:** updating centos7.mk to support SCORECVER=adapt
  - **06/22/21**: minor sanitization added for adaptation
  - **06/22/21**: Adding Zoltan mid balance option to address empty part issue during Mesh Adapt
  - **06/26/21:** updating config.sh and readme for SCOREC RHEL7 (romulus)

- **Nate Ferraro**
  - **06/24/21:** Corrected definition of q_cyl when itor=0

- **Usman Riaz**
  - **06/25/21:** Clean up: Mesh Adaptation Routines

Local Systems

- PPPL centos7(06/21/21)
  - 6 regression tests **PASSED** on centos7:
- PPPL greene (06/21/21)
  - 5 regression tests **PASSED on greene (m3dc1)**
- STELLAR (06/28/21)
  - 6 regression tests **PASSED** on stellar
- TRAVERSE(03/29/21)
  - Code compiles
  - Regression test failed: split_smb not found in PATH

Other Systems

- Cori-KNL (2/08/2021)
  - 6 regression tests passed on KNL
- Cori-Haswell (2/08/2021)
  - 5 regression tests passed
  - KPRAD_RESTART did not pass, but differences are very small in velocity variables. All magnetic and thermal good. Similar difference as Cori-KNL
  - RMP_nonlin initially failed …: There was an error in partitioning the mesh, but passed on resubmission
- 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 (10/26)
  - ??

Cesar to submit paper to Nuclear Fusion

Modeling of carbon pellet disruption mitigation in an NSTX-U plasma

C F Clauser[1]‡, S C Jardin[2], R Raman[3], B C Lyons[4], N M Ferraro[2]

[1]Lehigh University, Bethlehem, Pennsylvania 18015, USA
[2]Princeton Plasma Physics Laboratory, Princeton, New Jersey 08543, USA
[3]University of Washington, Seattle, Washington 98195, USA
[4]General Atomics, San Diego, California 92121, USA

E-mail: cclauser@lehigh.edu

Abstract. Single carbon pellet disruption mitigation simulations using M3D-C^1 were conducted in an NSTX-U-like plasma to support the electromagnetic pellet injection concept (EPI). A carbon ablation model has been implemented in M3D-C^1 and tested with available data. 2D simulations were conducted in order to estimate the amount of carbon needed to quench the plasma, finding that the content in a 1 mm radius vitreous carbon pellet ($\sim 3.2 \times 10^{20}$ atoms) would be enough if it is entirely ablated. 3D simulations were performed, scanning over pellet velocity and parallel thermal conductivity, as well as different injection directions and pellet concepts (solid pellets and shell pellets). The sensitivity of the thermal quench and other related quantities to these parameters has been evaluated. A 1 mm radius solid pellet only partially ablates at velocities of 300 m/s or higher, thus being unable to fully quench the plasma. To further enhance the ablation, approximations to an array of pellets and the shell pellet concept were also explored. 3D field line stochastization plays an important role in both quenching the center of the plasma and in heat flux losses, thus lowering the amount of carbon needed to mitigate the plasma when compared to the 2D case. This study constitutes an important step forward in 'predict-first' simulations for disruption mitigation in NSTX-U and other devices, such as ITER.

Interesting Preprint

Models and scalings for the disruption forces in tokamaks

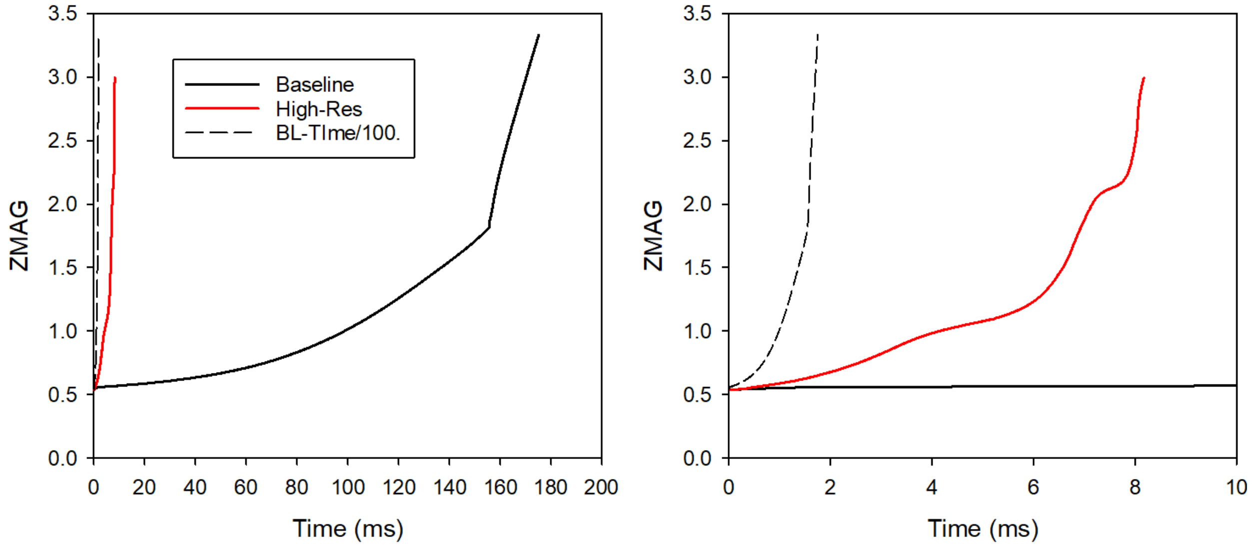
V.D. Pustovitov[1,2]

[1] National Research Centre 'Kurchatov Institute', Pl. Kurchatova 1, Moscow 123182, Russian Federation

These equations and their consequences show a special role of two harmonics of the magnetic perturbation, $n = 0$ and $n = 1$. The former is responsible for the vertical force on the wall, and the latter for the sideways.

The sideways force still remains a mystery in a sense that, at present, no model can plausibly reproduce the estimated 4 MN in JET. The other unanswered questions are why the sideways force has been documented on JET, but not observed to be as large on other machines [12, 13, 65], and why this force has a preferential direction in JET, from octant 5 towards octant 1 [3, 4]. Put together, these facts and consequences of equations (10) and (14) suggest that the reason may be a properly phased $n = 1$ wall nonuniformity in JET. In other words, the wall ability to partly convert the plasma-produced $n = 0$ perturbation into the $n = 1$ mode at the outer side of the wall (simply because of the holes braking its symmetry) should be investigated. This can be complemented by the interplay of the intrinsic 3D effects with the conventional $n = 1$ mode. These considerations and estimates by (33) imply that extrapolations from JET to ITER cannot be straightforward. It becomes clear that so-called Noll's formula cannot be used for that.

ITER Sideways Force



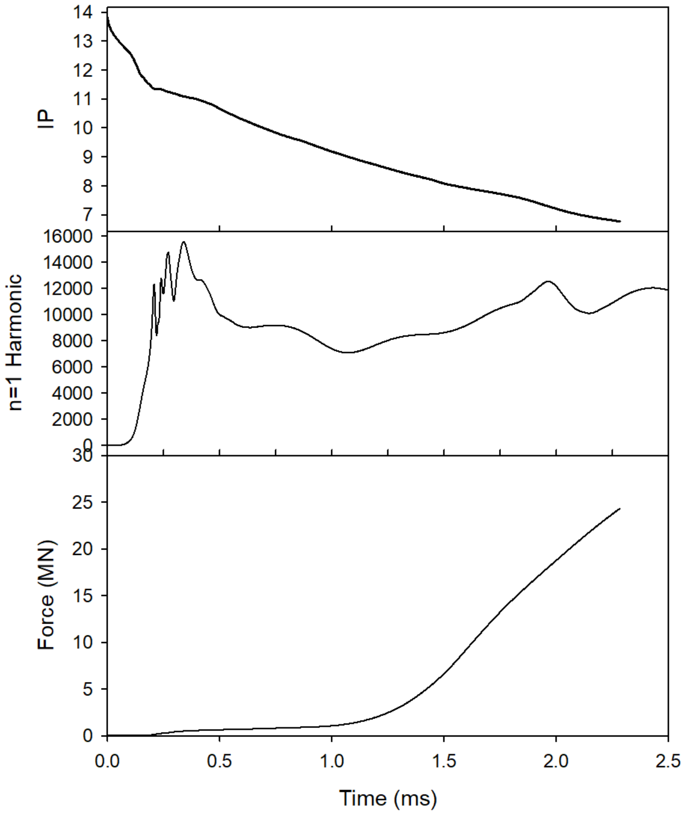
	High-Res	Baseline
eta_wall	.4e-4	.4e-6
eta_wallRZ	.4e-4	.4e-6
wall_region_eta	1.0	1.e-2
wall_region_etaRZ	.5e-6	.5e-8

eta_te_offset	1.009943e-3	1.00668e-3
eta_max	1.29242	1.29242e-2
amu	4.e-5	1.e-4

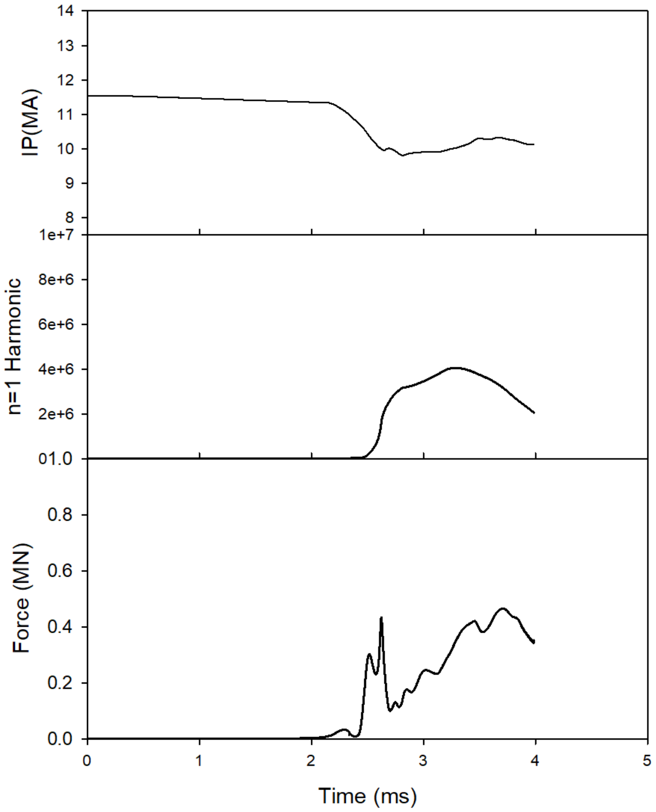
tedge = 1.01010e-3

ITER Sideways Force

100 x vessel resistivity



Realistic vessel resistivity



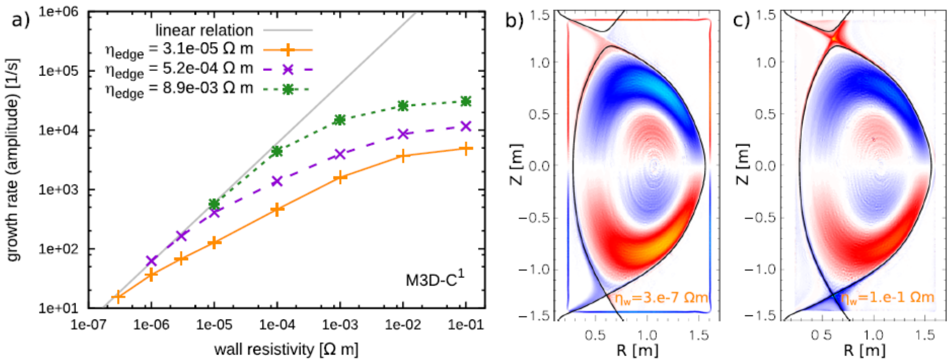
Porcelli Theory

A new preprint claims that an ideal MHD diverted plasma will be stable to the vertical instability: Opportunity to demonstrate this numerically (or not)

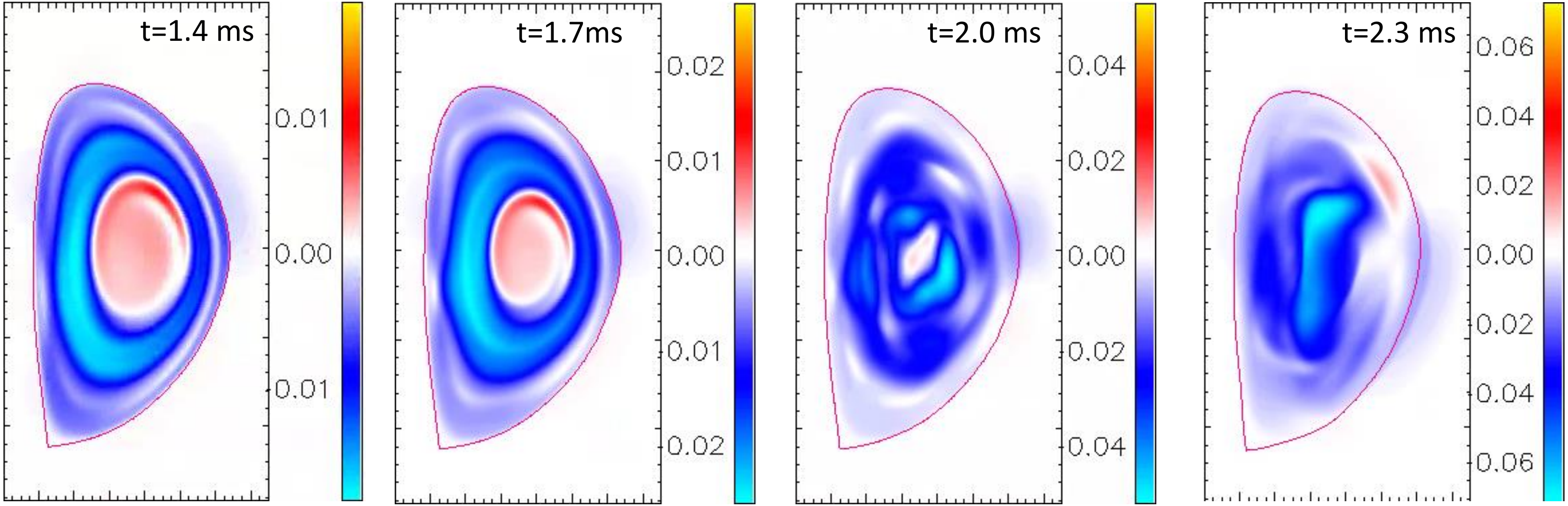
Impact of magnetic X-points on the vertical stability of tokamak plasmas

A. Yolbarsop[1,2], F. Porcelli[1], and R. Fitzpatrick[3]
[1] *DISAT, Polytechnic University of Turin, Torino 10129, Italy*
[2] *KTX Laboratory, School of Nuclear Science and Technology, University of Science and Technology of China, Hefei, 230022, China*
[3] *Institute for Fusion Studies, University of Texas at Austin, USA*
(Dated: March 7, 2021)

The ideal-MHD theory of axisymmetric modes with toroidal mode number $n = 0$ in tokamak plasmas is developed. These modes are resonant at the magnetic X-points of the tokamak divertor separatrix. As a consequence, current sheets form along the separatrix, which profoundly affect the stability of vertical plasma displacements. In particular, current sheets at the magnetic separatrix lead to stabilization of $n = 0$ modes, at least on the ideal-MHD time scale, adding an important ingredient to the mechanism of passive feedback stabilization.



Why is toroidal magnetic energy increasing for iconst_bz=1?



Plotted is the difference between initial RB_T and the RB_T at that time. Note initial RB_T is negative everywhere. RB_T is being held fixed at plasma boundary.

/scratch/gpfs/bclyons/C1_8511

Energy is coming from voltage required to maintain TF constant at boundary

$$\frac{\partial \mathbf{B}}{\partial t} = -\nabla \times \mathbf{E} \quad \Rightarrow \quad \frac{\partial}{\partial t}\int \mathbf{B} \bullet d\mathbf{A} = -\oint \mathbf{E} \bullet d\ell$$

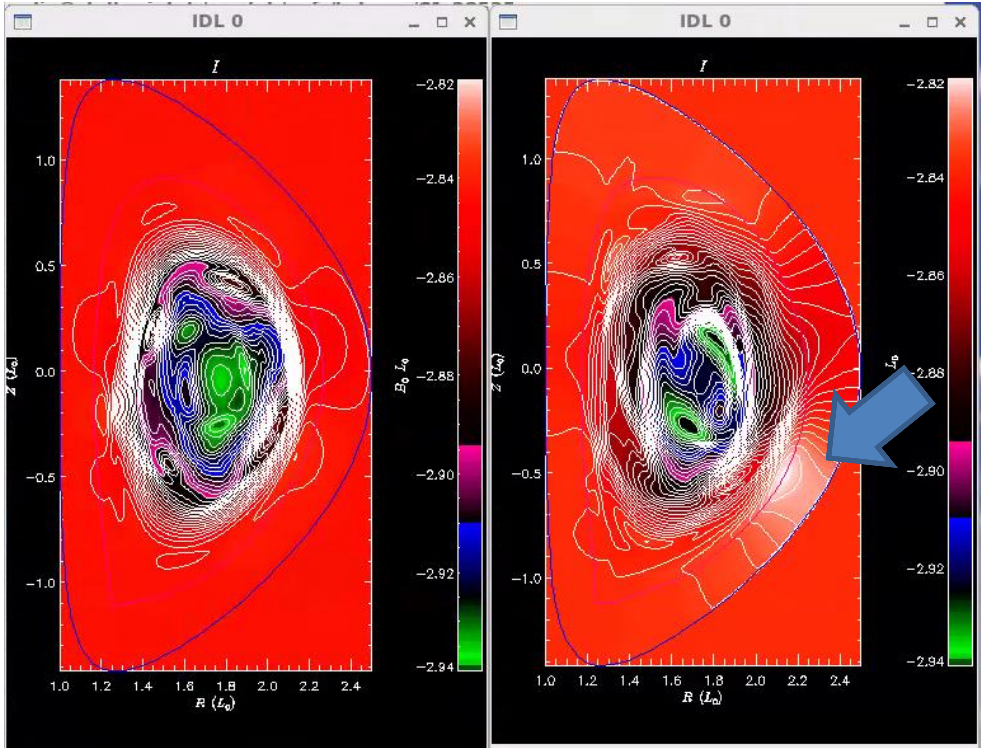
As pressure decreases, plasma becomes more para-magnetic to maintain equilibrium. ➔ toroidal flux in plasma increases

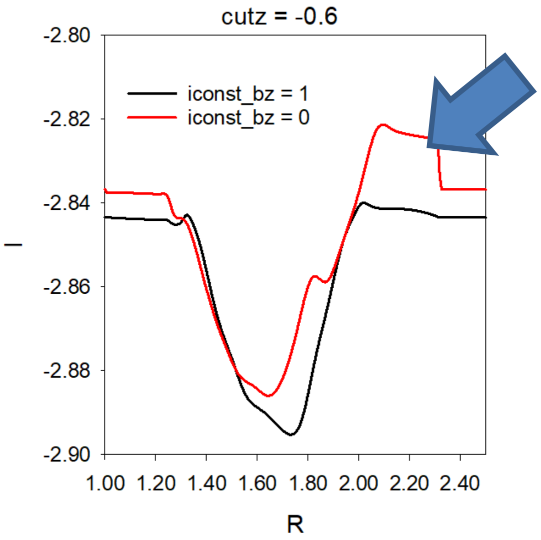
The increase in toroidal flux inside the plasma produces a poloidal electric field. That poloidal electric field would tend to reduce the poloidal current in the TF coils and lower the toroidal field, thus conserving the toroidal flux in the plasma.

We are keeping the toroidal field at the boundary constant. To do this in reality, one would need to increase the voltage in the TF coils to counter the poloidal field coming from the flux change.

Compare iconst_bz=0 and iconst_bz=1

iconst_bz = 1 iconst_bz = 0



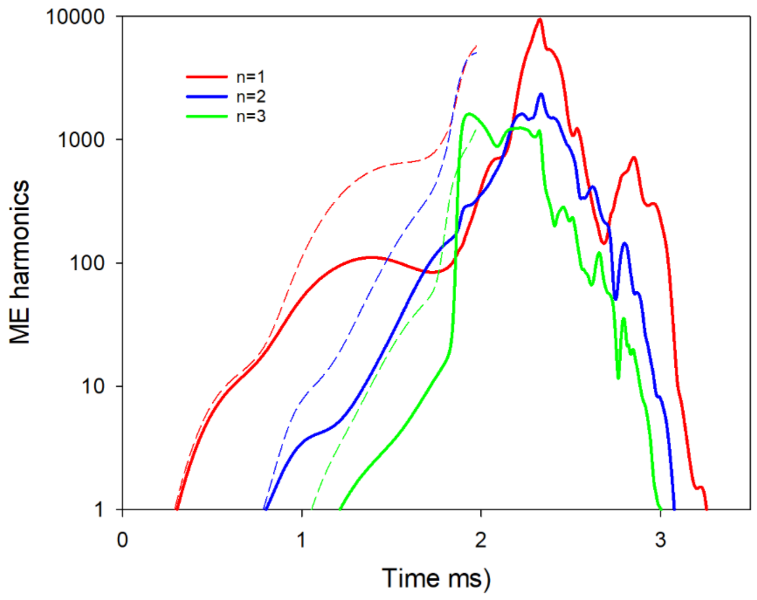


iconst_bz = 0 develops RBz glitches on open field lines. Unphysical?

plot_field,’i’,19,/lines,/lcfs,/bound

/scratch/gpfs/bclyons/C1_8511 iconst_bz=1
/scratch/gpfs/bclyons/C1_28525 iconst_bz=0

Compare iconst_bz=0 and iconst_bz=1



Magnetic energy in first 3 toroidal harmonics

Solid iconst_bz = 1

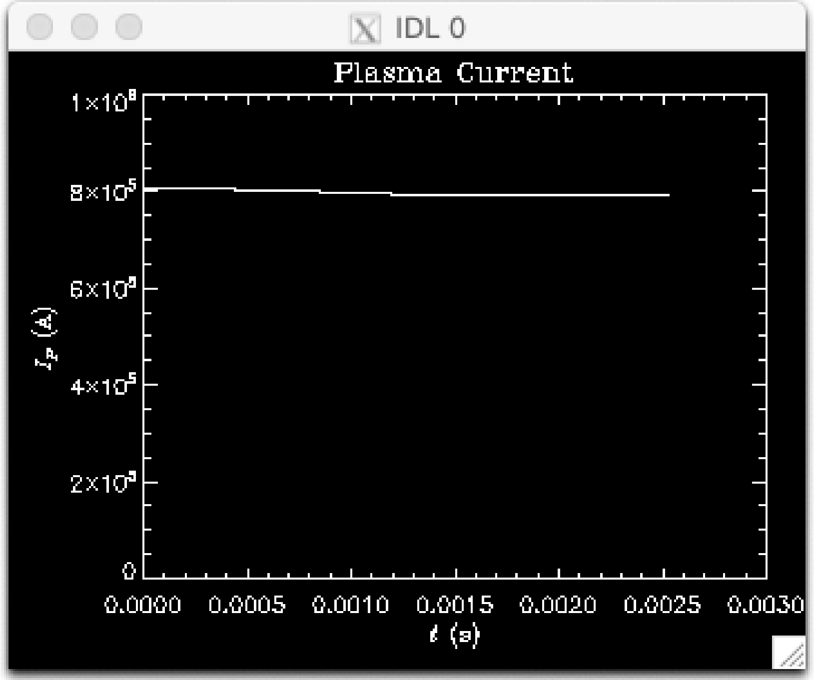
Dashed iconst_bz = 0

Note: iconst_bz=0 always goes unstable

Pellet with RA

06/28/21

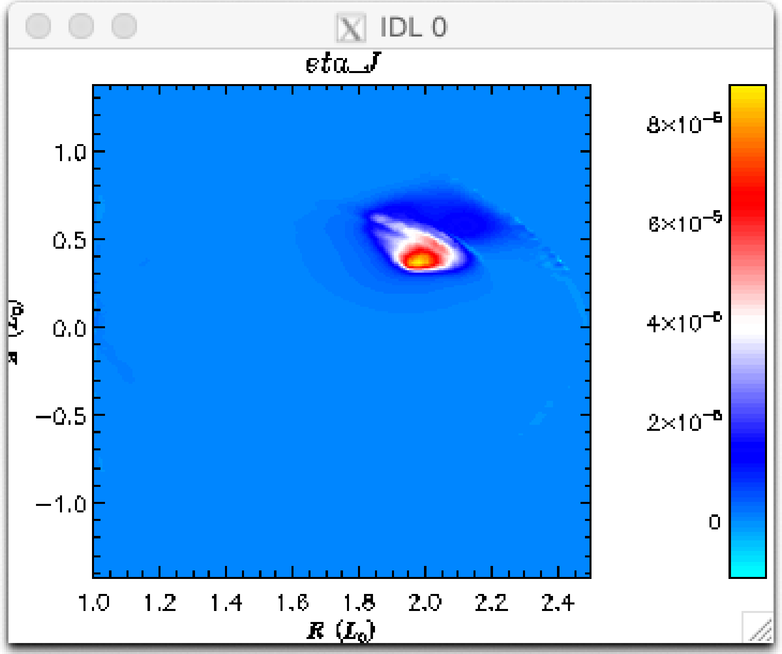
DIII-D shot 177053
Chen Zhao

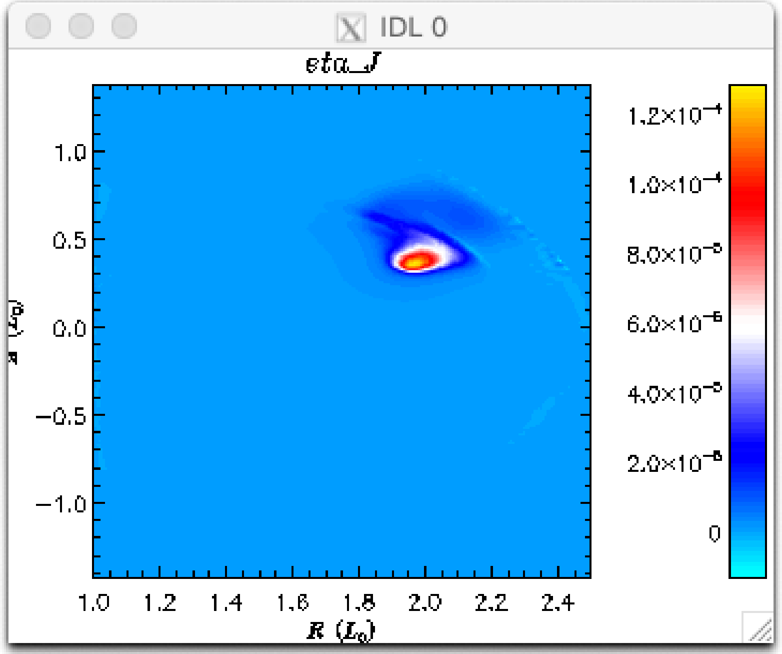


The plasma current stop dropping down at about 1.3ms.

I think that is not match the experiment, how could we change the parameters to fit the experimental current decreasing rate?

SJ: The pellet has to cool the plasma to increase the resistivity, and then the current will drop.

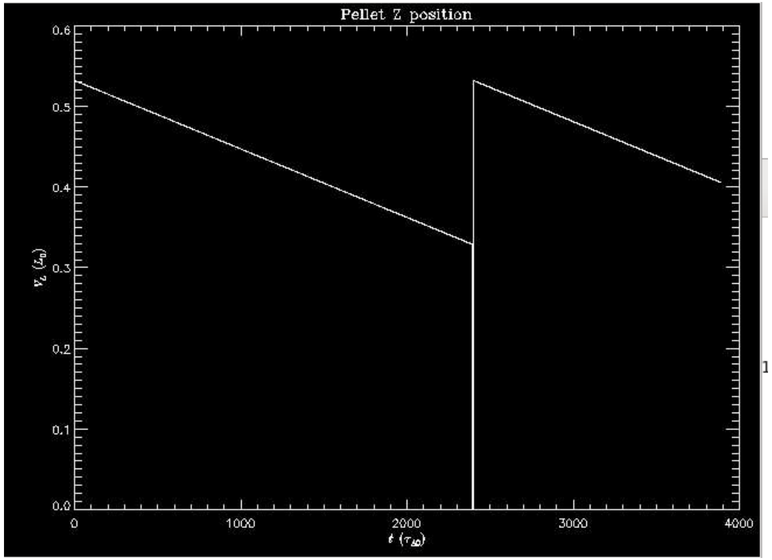


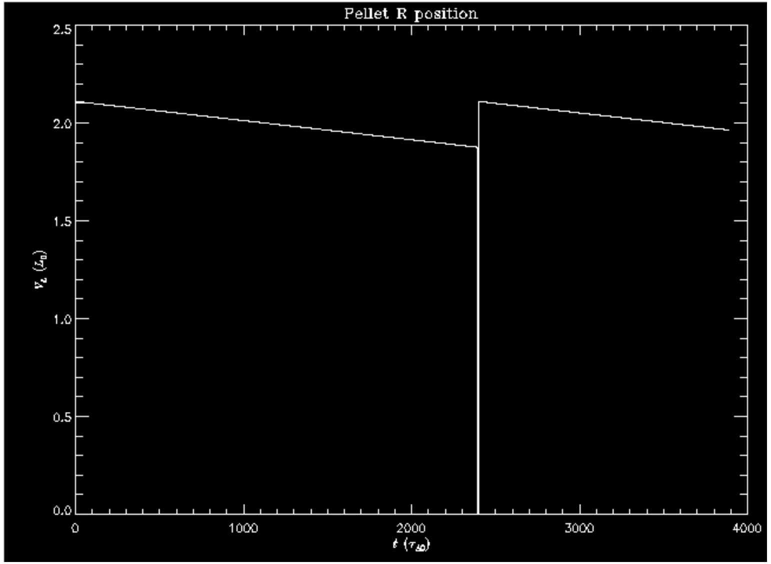


The pellet seems stop moving to the center but start moving along the field line at about 1.5ms.

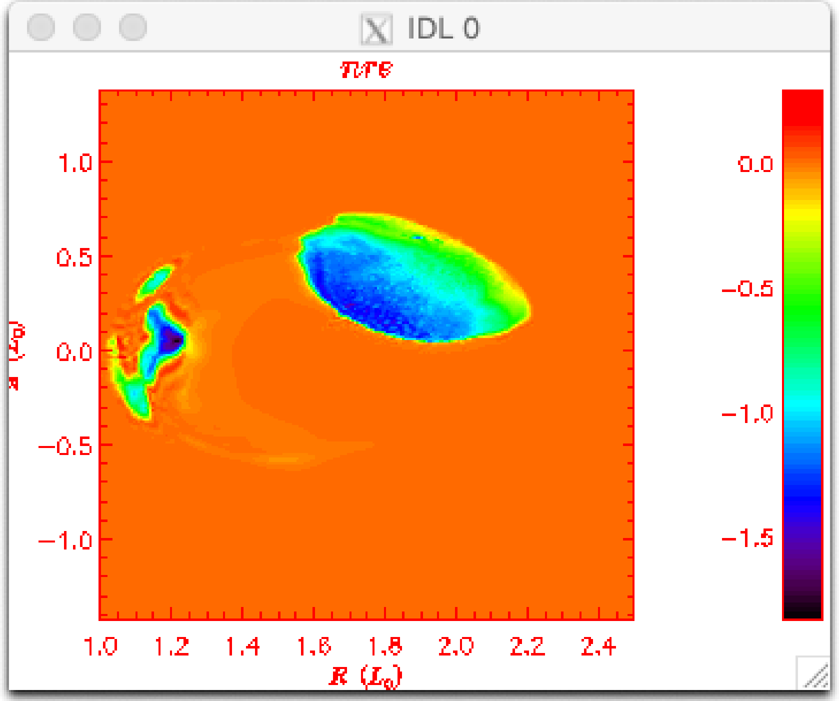
SJ: see the next vg

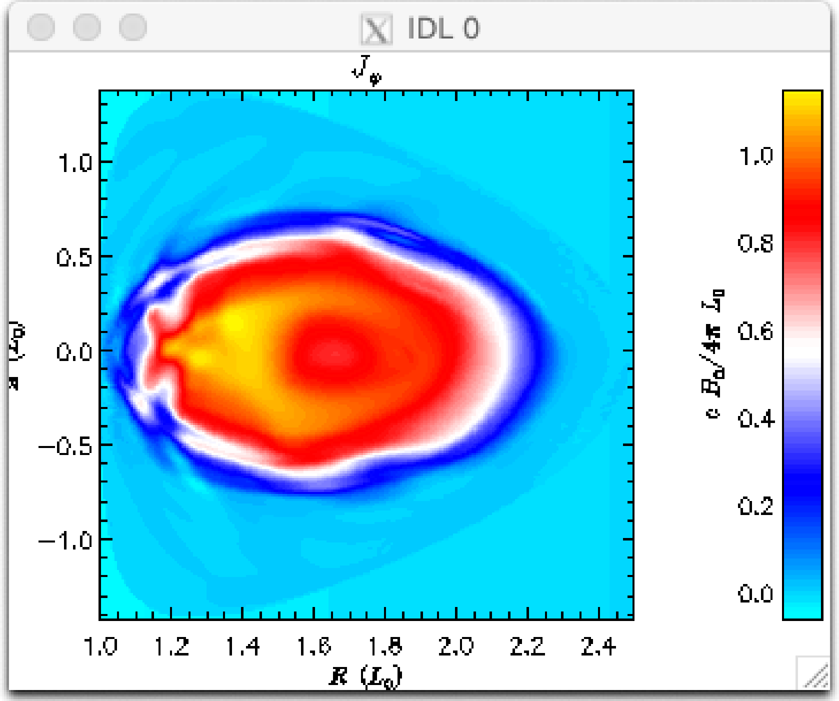
Pellet position being reset at restart time!

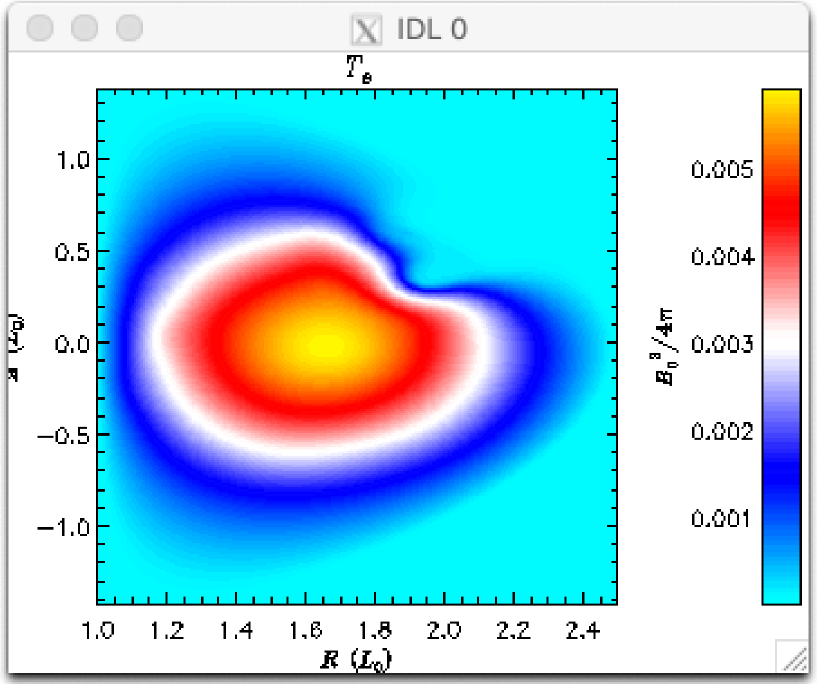




Runaway current density and plasma current density at 2.5ms







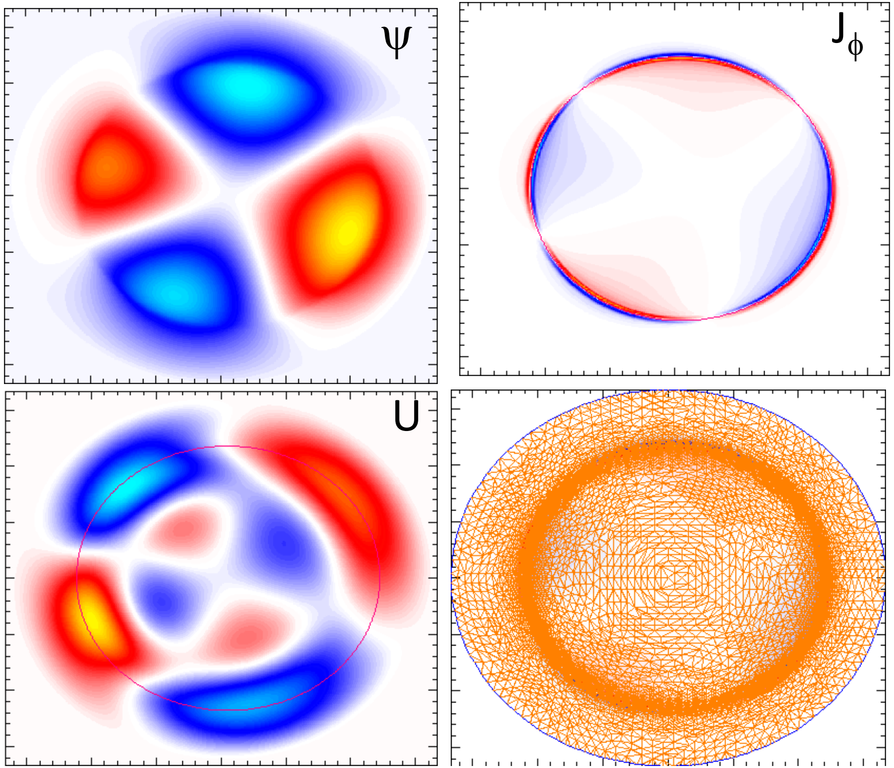
Electron temperature at 2.5ms

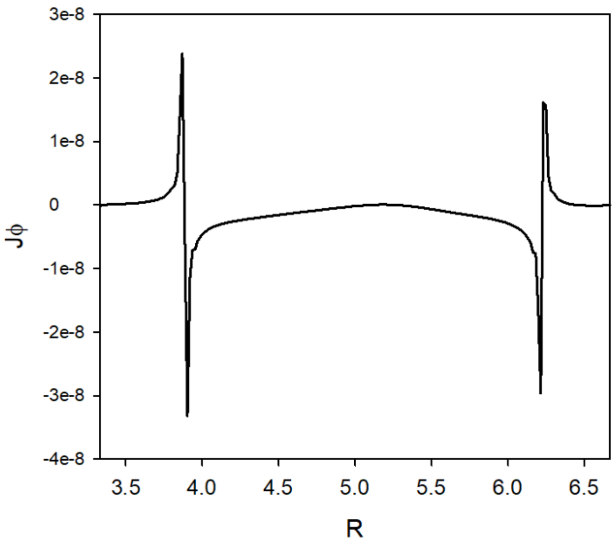
SJ: you should include /mks in the IDL plot_field,'te' command in order to get the temperature in eV. This is about 300 eV.

That’s All I have

Anything Else ?

Typical Tearing Mode





$\eta = 2.e\text{-}6$

$1.1 < q < 2.9$

$\gamma\tau_A = 10^{-4}$

DIII-D Resistive Wall Mode

Email from Hank Strauss on 5/27/21

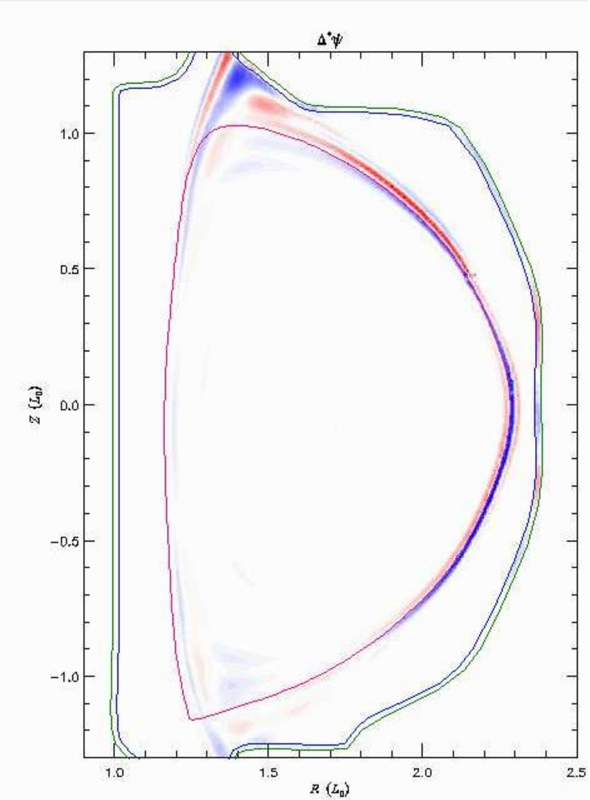
I tried to find D3D RWMs (RWTM)s with Brendan's mesh and C1input files, but it seems that the wall is behaving like an ideal wall. It needs much more adaptive refinement. I also tried a nonlinear run, but even though eps > 0, it didn't have a 3D perturbation.

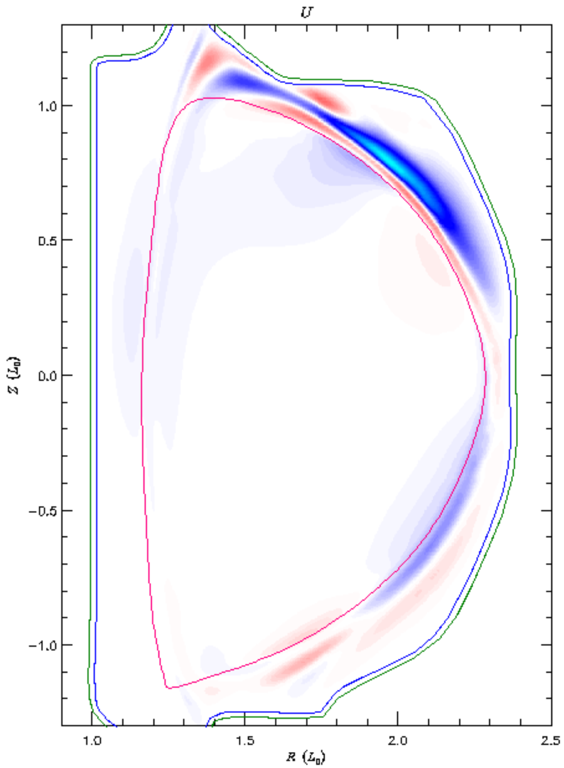
A linear run is in /scratch/gpfs/hs9956/d3d_eb1_1f_eq_l11 and nonlinear in rw1_nl_54576.03354_945b2.

I think lack of resolution at the wall is also causing AVDE simulations to fail at small eta_wall. The mesh needs adaptive refinement at the wall.

An ADVE simulation is in JETm3dc1_0.12h9b4.

Linear Eigenfunction





Physical mode? Not tearing.

Chen Zhao paper on RE with sources

Simulation of the runaway electron plateau formation during current quench

C. Zhao[1], C. Liu[1], S. C. Jardin[1], N. M. Ferraro[1], B. C. Lyons[2]
V. Bandaru[3], M. Hoelzl[3]

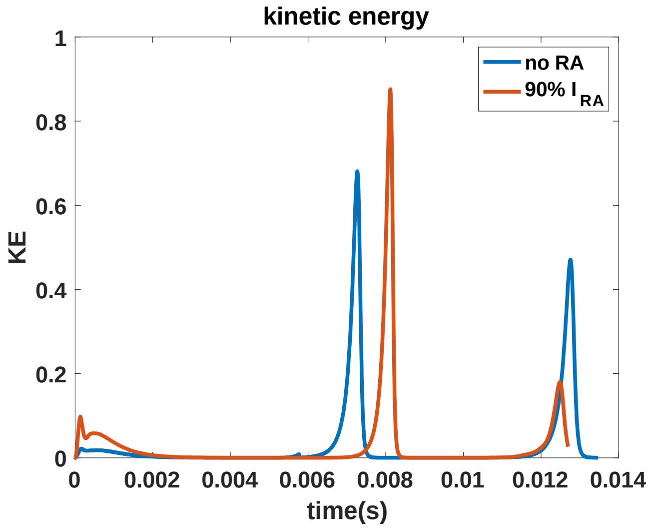
[1] Princeton Plasma Physics Laboratory, Princeton, NJ, United States of America
[2] General Atomics, San Diego, CA, United States of AmericaGeneral Atomics, San Diego, CA, United States of America
[3] Max Planck Institute for Plasma Physics, Boltzmannstaße, Garching, Germany

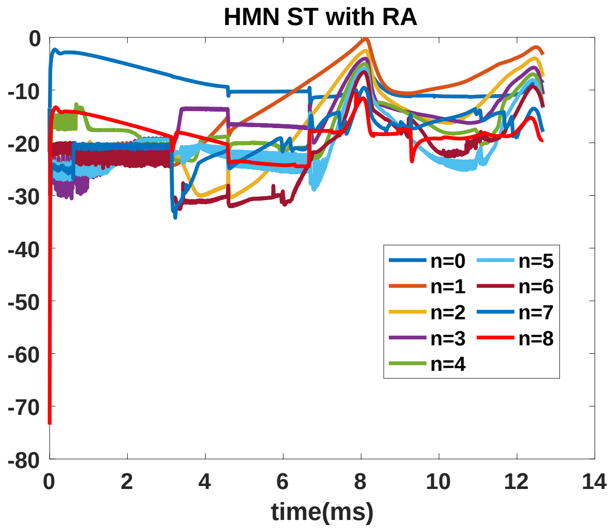
- Source terms and coupling to MHD
- Runaway source test case and benchmark with JOREK
- Current quench result with DIII-D parameters

Isabel ST with RA

06/1/21

- Both cases are use Isabel eq with mesh 0.01m

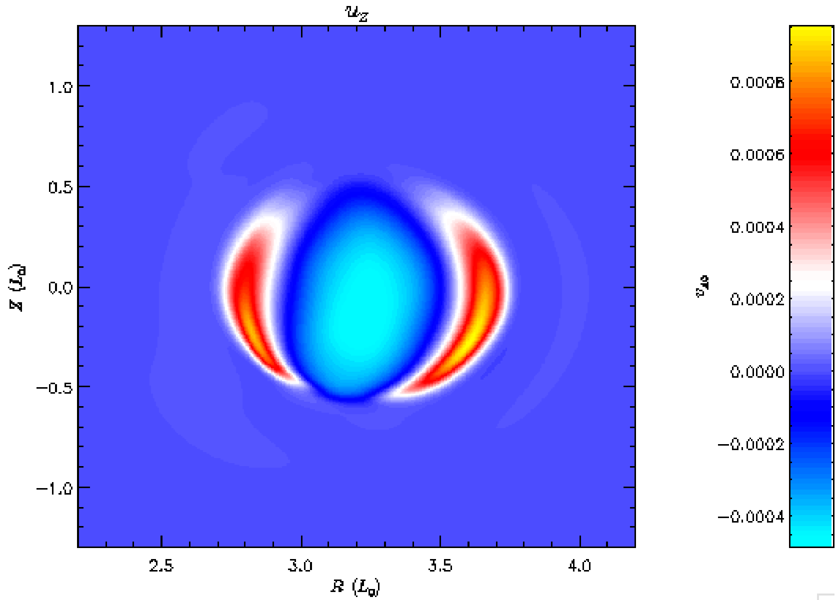




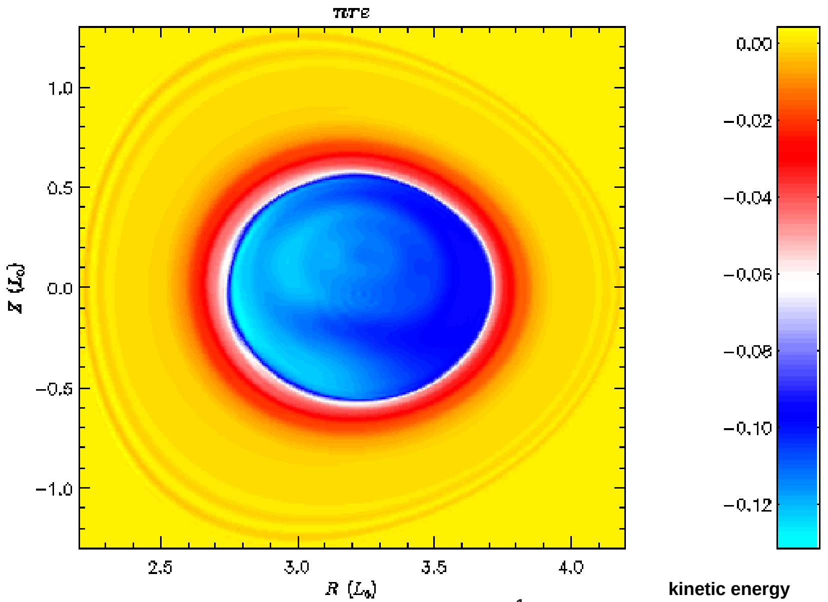
- It needs more time to see if there is only on ST phase with RA
- Most unstable mode is n = 1 with RA

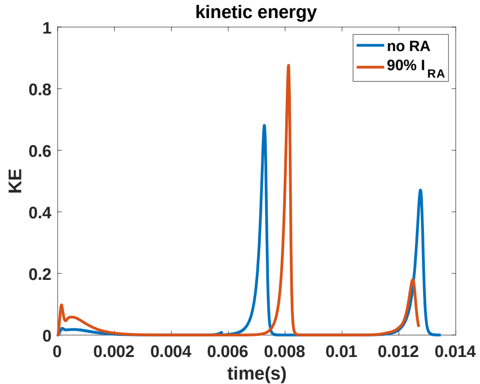
Profiles at 8ms with RA (1st ST phase)

V_z



J_RA

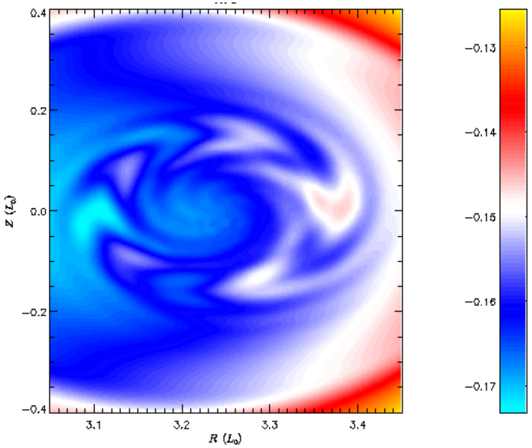




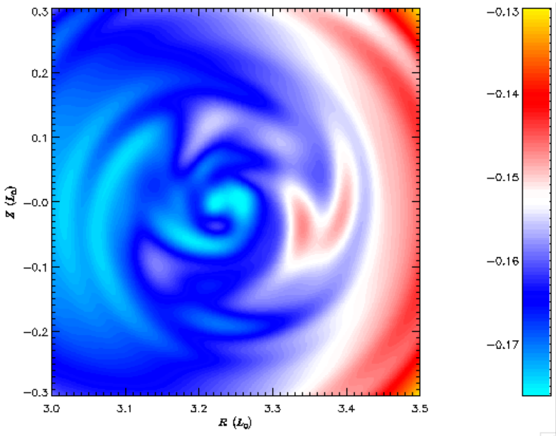
- No clear mode in runaway current

Runaway current during 2nd ST phase

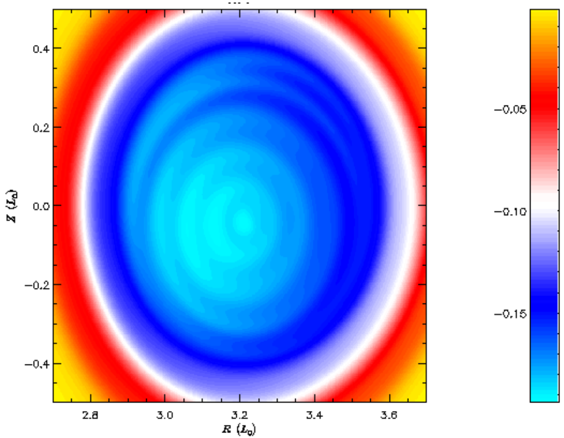
J_RA 10.6ms



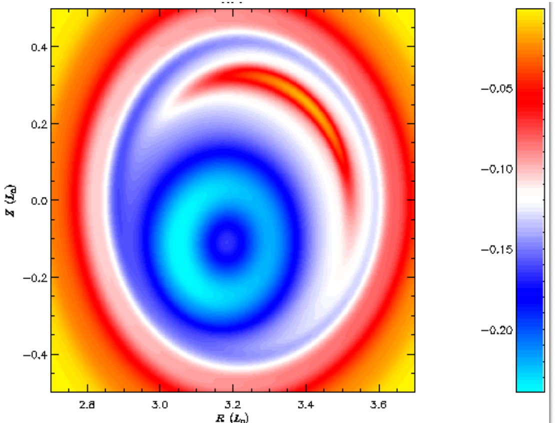
J_RA 10.8ms



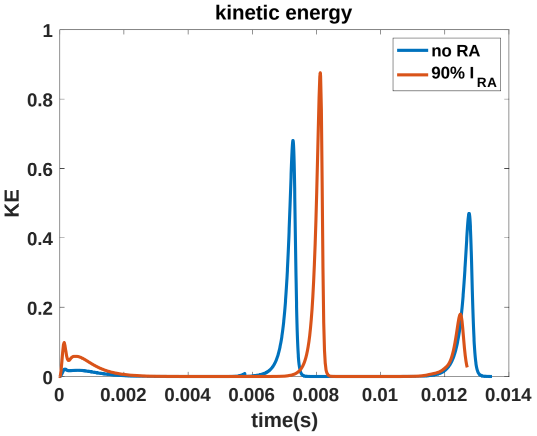
J_RA 11.4ms



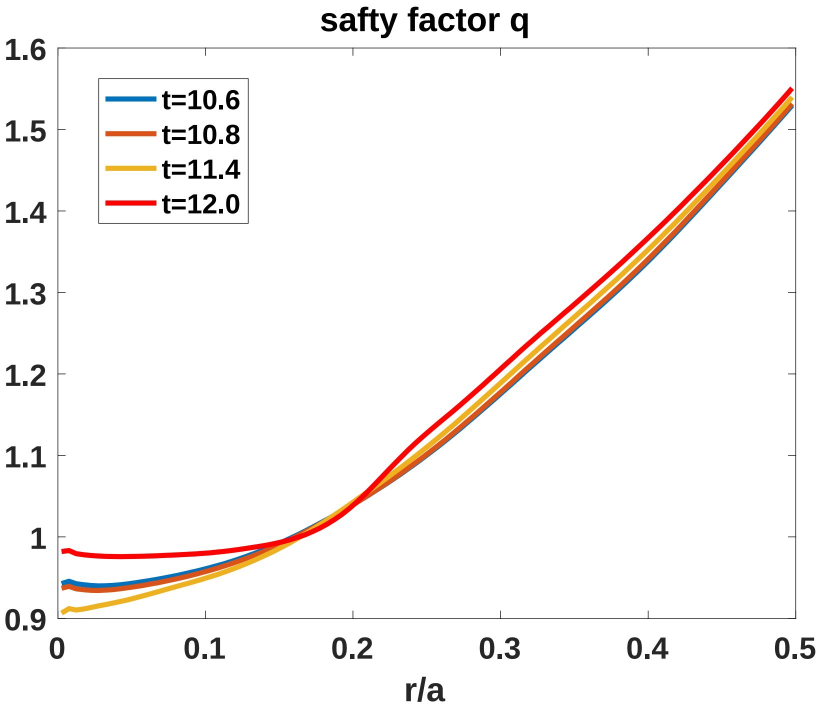
J_RA 12.0ms

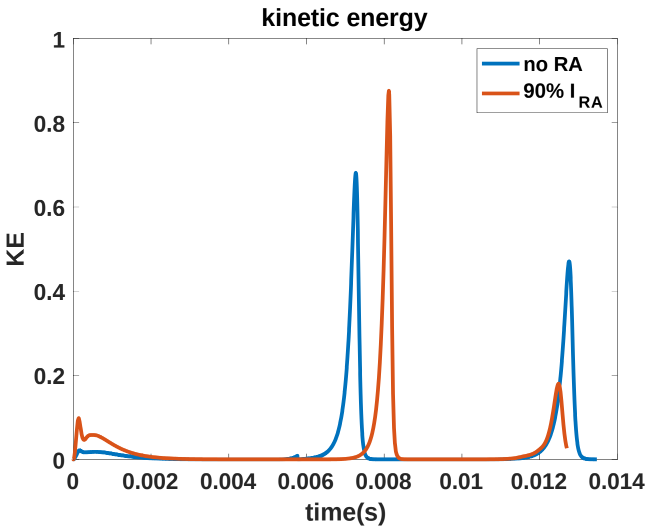


- At 2nd ST phase there is a n~5 mode reduced to n~1 mode in runaway current
- The instabilities in runaway current may cause the much lower kinetic energy at 2nd ST phase.



q profile during 2nd phase





Directory : /projects/M3DC1/chenzhao/Chen2D-mod3/

2D ITER modeling of SPI -- Brendan Lyons 5/6/21

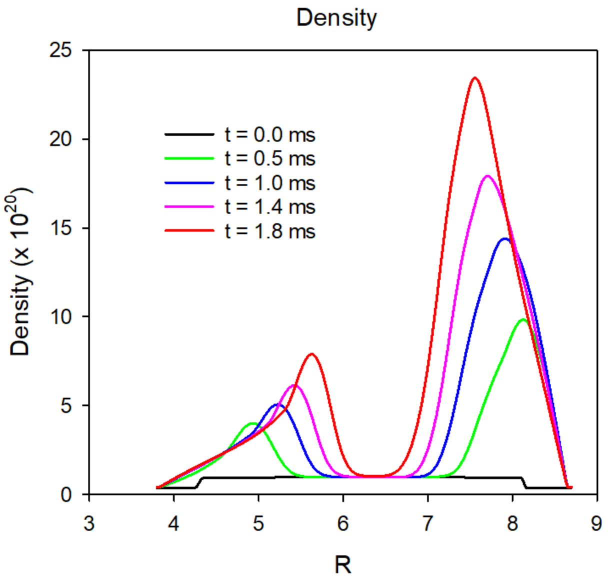
- I've recently started some 2D ITER modeling of SPI and I'm getting a weird result.
- The attached video show the density, every time step, from /scratch/gpfs/bclyons/C1_11735 on stellar.

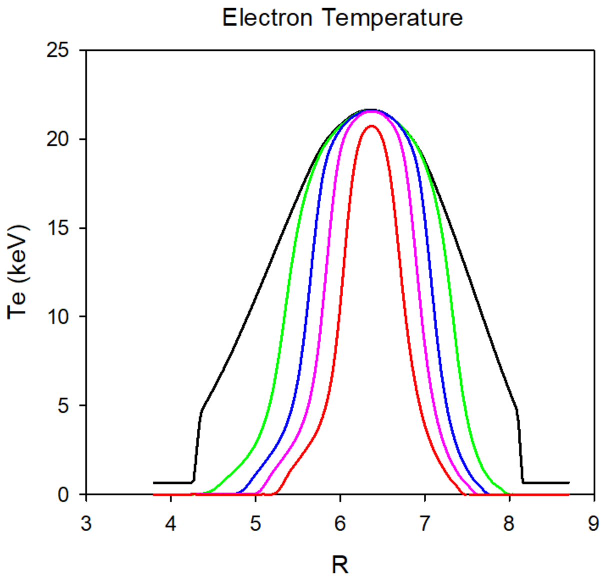
- Good NEWS
  - I got this to run to 2 ms by setting pedge=.01, idenmfunc=1

- Bad NEWS
  - After that time, code crashes with segmentation fault in velocity solve
  - Doesn’t always crash at same time step, and numbers can be different for different runs restarting from same time!!

/scratch/gpfs/sjardin/Brendan

2D ITER SPI Modeling (cont)





- Density and temperature at Z= 1m at different times
- However, calculation stops with “segmentation fault” at seemingly random time steps…also, differing results!

Inconsistencies in 2D nonlinear restarting at N=1000

-1 slurm18347 died 1018 SEGV (SuperLU)

1000	2.7500E+03	3.0076E-01	3.6364E-01	2.8914E-02	2.7081E-01	1.0371E-03	6.3888E+02	2.1293E+04	3.2050E+02	2.22524E+04
1001	2.7528E+03	**3.0125E-01**	**2.9180E-04**	2.9007E-02	**2.7121E-01**	1.0298E-03	6.3882E+02	2.1293E+04	3.2028E+02	2.22521E+04
1002	2.7555E+03	**3.0170E-01**	**2.7516E-04**	**2.9101E-02**	2.7157E-01	**1.0278E-03**	6.3875E+02	2.1293E+04	3.2005E+02	2.22518E+04
1003	2.7582E+03	3.0214E-01	**2.6496E-04**	**2.9189E-02**	**2.7193E-01**	**1.0246E-03**	6.3869E+02	2.1293E+04	3.1982E+02	2.22515E+04

-2 slurm18516 died 1088 SEGV (SuperLU)

1000	2.7500E+03	3.0076E-01	3.6364E-01	2.8914E-02	2.7081E-01	1.0371E-03	6.3888E+02	2.1293E+04	3.2050E+02	2.22524E+04
1001	2.7528E+03	**3.0124E-01**	**2.8901E-04**	2.9007E-02	**2.7120E-01**	1.0298E-03	6.3882E+02	2.1293E+04	3.2028E+02	2.22521E+04
1002	2.7555E+03	**3.0169E-01**	**2.7320E-04**	**2.9100E-02**	2.7157E-01	**1.0279E-03**	6.3875E+02	2.1293E+04	3.2005E+02	2.22518E+04
1003	2.7582E+03	3.0214E-01	**2.6685E-04**	**2.9188E-02**	**2.7192E-01**	**1.0250E-03**	6.3869E+02	2.1293E+04	3.1982E+02	2.22515E+04

-3 slurm18607 died 1049 SEGV (SuperLU)

1000	2.7500E+03	3.0076E-01	3.6364E-01	2.8914E-02	2.7081E-01	1.0371E-03	6.3888E+02	2.1293E+04	3.2050E+02	2.22524E+04
1001	2.7528E+03	**3.0124E-01**	**2.9042E-04**	2.9007E-02	**2.7121E-01**	1.0298E-03	6.3882E+02	2.1293E+04	3.2028E+02	2.22521E+04
1002	2.7555E+03	**3.0170E-01**	**2.7414E-04**	**2.9101E-02**	2.7157E-01	**1.0278E-03**	6.3875E+02	2.1293E+04	3.2005E+02	2.22518E+04
1003	2.7582E+03	3.0214E-01	**2.6593E-04**	**2.9189E-02**	**2.7193E-01**	**1.0248E-03**	6.3869E+02	2.1293E+04	3.1982E+02	2.22515E+04

Each of these died in the velocity solve with a segmentation fault at different time steps!

/scratch/gpfs/sjardin/Brendan

5/31/21 meeting w JOREK regarding RE benchmark

* A recent paper has appeared using the 1 ½ D code ASTRA-STRAHL to examine in detail a ASDEX-U mitigation shot that produced Runaway Electrons.
Linder, et al. "Self-consistent modeling of runaway electron generation in massive gas injection scenarios in AUG", NF 60 (2020) 096031

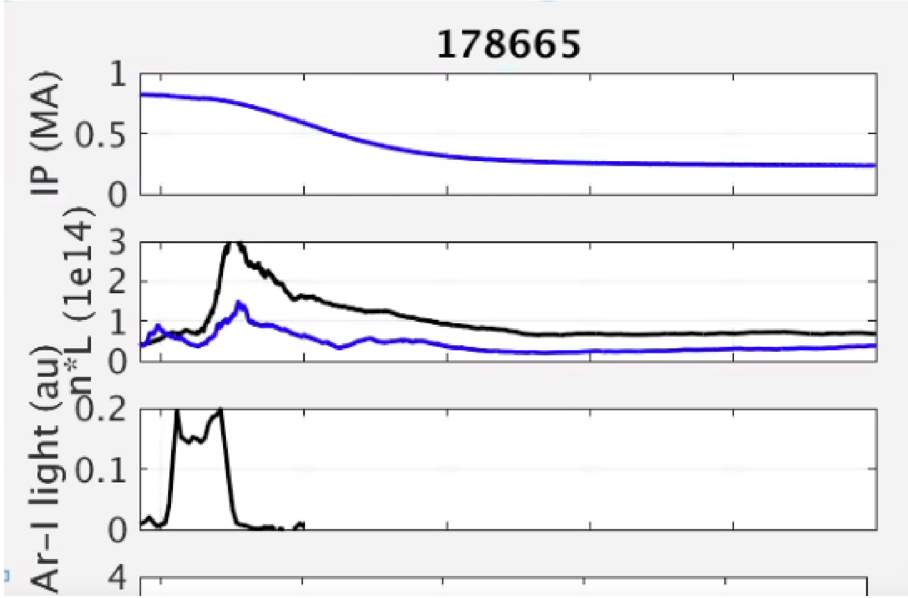
1) Vinodh and Matthias will look further into defining the setup for the AUG based benchmark case that was looked at with ASTRA-STRAHL and contact the M3D-C1 team as soon as they have something ready.

2) Chen will look into modeling the DIII-D discharge 178665 and will let JOREK team know when there are any interesting observations.

3) The two teams will meet again in a few weeks as soon as there is something new to look at for 1) or 2).

In attendance: Matthias Hoelzl, Vinodh Bandaru, Chen Zhao, Stephen Jardin

DIII-D RE generation with Ar shot 178665



Carlos suggested this shot:

<ne>, Te(r,t), IP(t), AR-1 (R,Z,t)

Eric Hollman studied this shot in detail in an upcoming paper so we may want to write to him

Use equilibria from 177053. You might want to look at matching the pre-TQ density integral to 665

That’s All I have

Anything Else ?

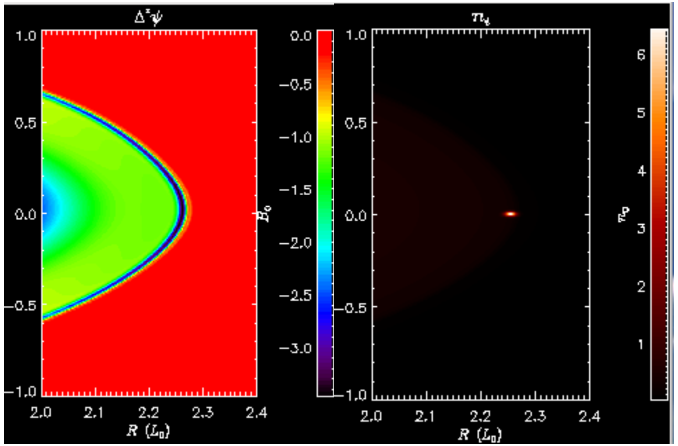
That's All I have

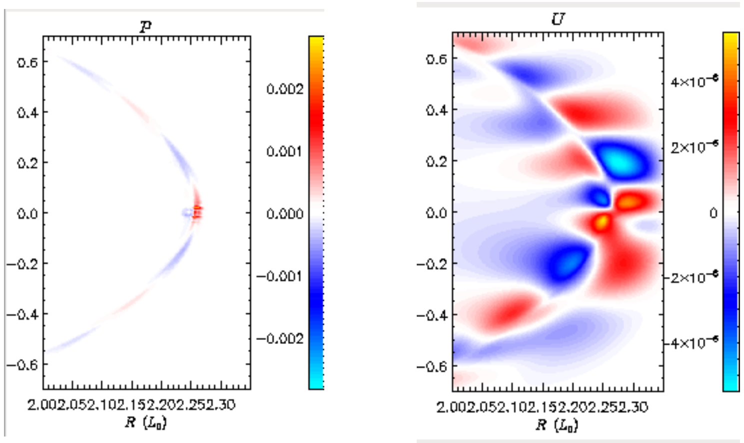
Anything Else ?

M3D-C1 modeling of pellet ELM triggering in low-collisionality discharges

- Preprint by A. Wingen (ORNL), Linear and non-linear simulations
- Linear simulation with ipellet=1 perturbs only the density profile.   Large enough perturbation excites an unstable mode

Q: How does a density perturbation excite a MHD mode?

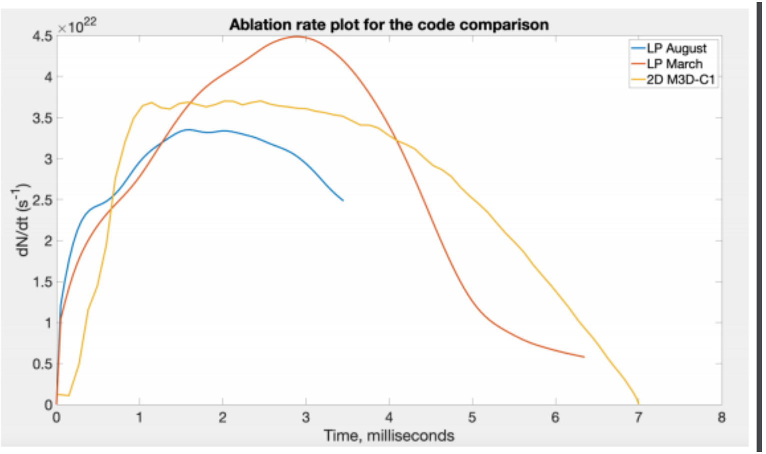




Density perturbation causes decreased Te at one location on flux surface.   Thermal conduction during linear phase causes pressure to increase there.   Gives an unstable mode for ntor=9 only if kappar .ne. 0

Interfacing M3D-C1 and LPC

- Zoom meeting was held 04/08/21 with Roman Samulyak and students
- Presentation posted on m3dc1.pppl.gov
- Small differences between m3dc1 pellet model and LPC local model
- Brendan to see what data is available for single neon pellet ablation test
- **Daisuke Shiraki will address this in a special call set for Tuesday at 2:00 ET. Lyons, Samulyak, Jardin, ….. (assuming Samulyak availability)**



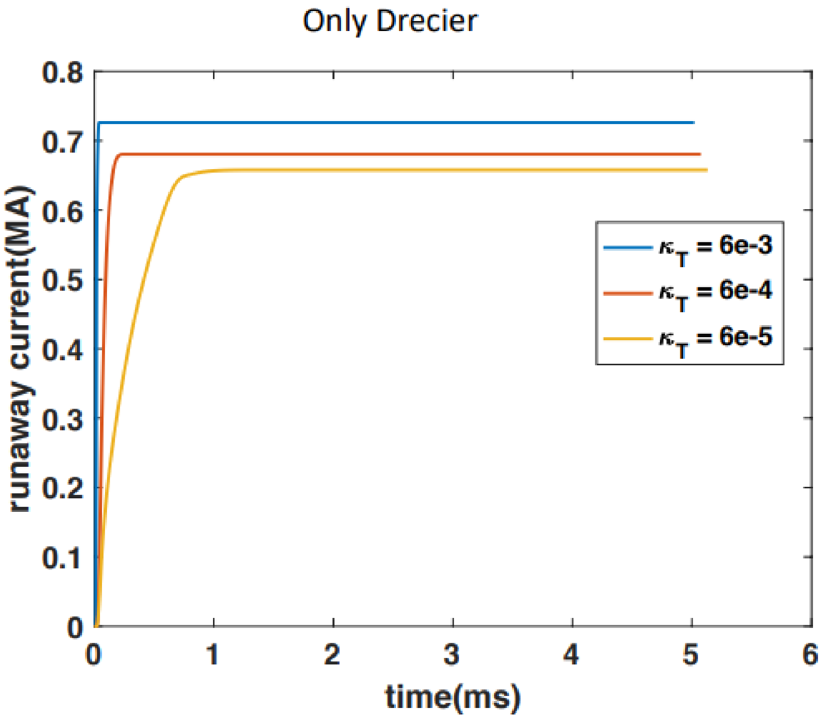
Approach to nonlinear MHD simulations in stellarator geometry

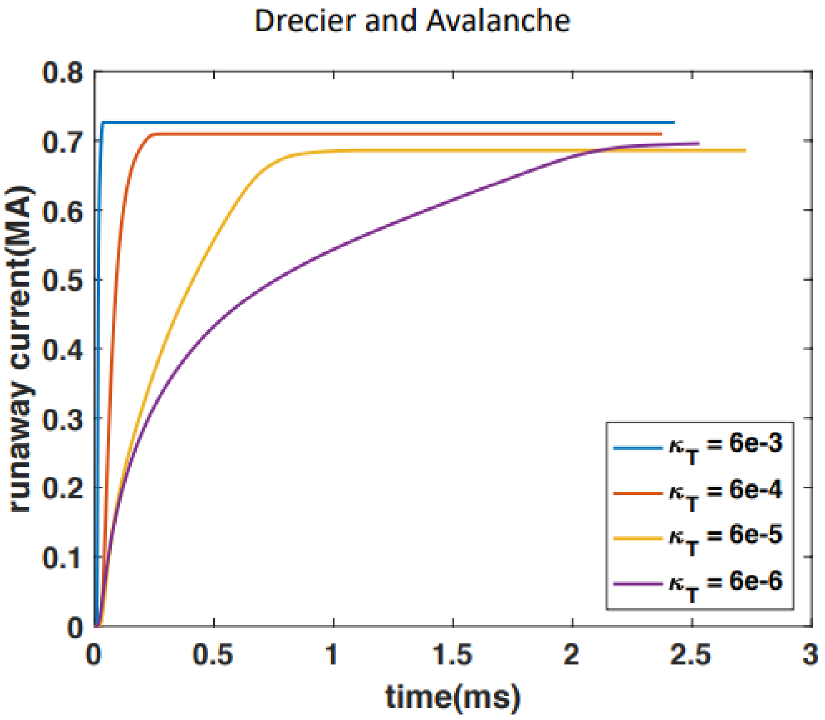
- Yao Zhou has an excellent preprint he plans to submit to Nuclear Fusion

Self-consistent simulation of resistive kink instabilities with runaway electrons

- Chang Liu, et al manuscript submitted to Plasma Physics and Controlled Fusion 04/21/2021

Effect of Avalanche term on DIII-D 177053





Chen Zhao

Next Steps

- Chen Zhao should consider writing a paper on the incorporation of the runaway source term in M3D-C1 and include the DIII-D result

- NIMROD is interested in doing a benchmark of the runaway source calculations.   I gave them Chen's equilibrium and results. This could be included in paper if done sufficiently fast.

- I asked Carlos Paz-Soldan to help us identify a series of DIII-D shots where runaways are generated and there are good diagnostics.   Still waiting to hear. (he did indicate that he's working on it)

- We had a zoom call with the JOREK group this morning.   They will also check with ASDEX-U to see if there is a series of experiments that we could model

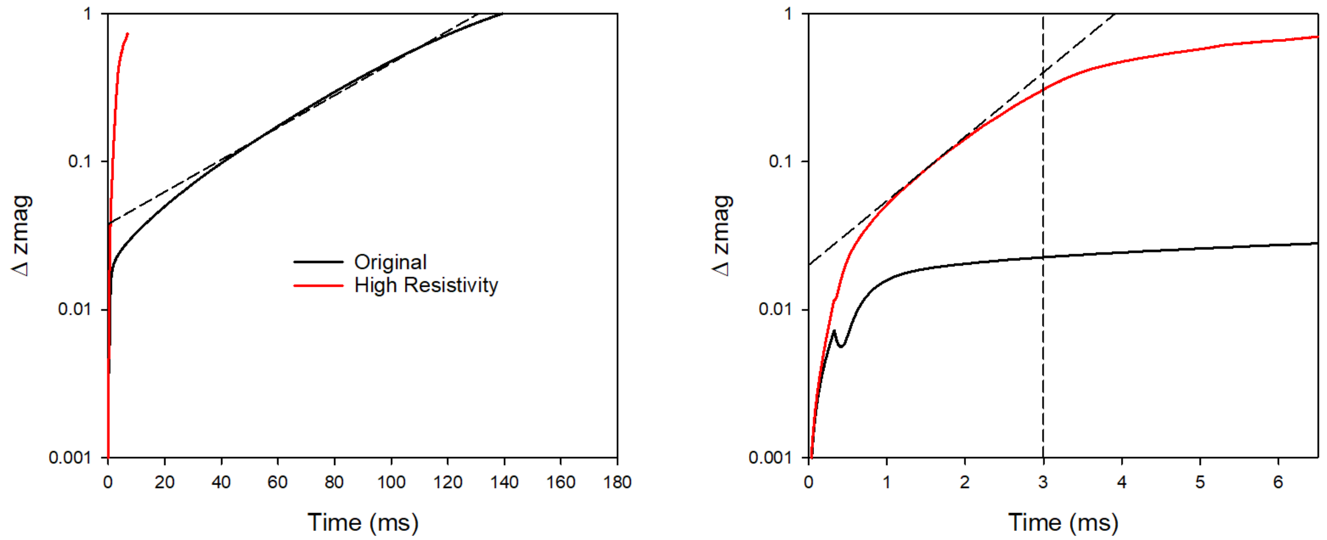
Effect of resistive wall on the thermal quench

- Hank Strauss requested an EFIT equilibrium for shot 154576 at 3312ms, just before it disrupts
- This was studied in the paper: R. Sweeney, et al, "Relationship between locked modes and thermal quenches in DIII-D"
- Focus of paper is that sometimes overlapping locked modes just flatten the temperature around the q=2 surface (q=3/2 to edge) whereas sometimes they also cause a collapse of the core temperature
- NIMROD simulations were initialized with islands of the size and phase of the experiment: 3/2, 2/1, 3/1, and 4/1
- In the simulation, the 2/1 island decays in time, unlike in the experiment. Also, the experiment shows a wider region of Te collapse. Can M3DC1 improve on this?

Current coupling scheme of fishbone simulation in M3D-C1

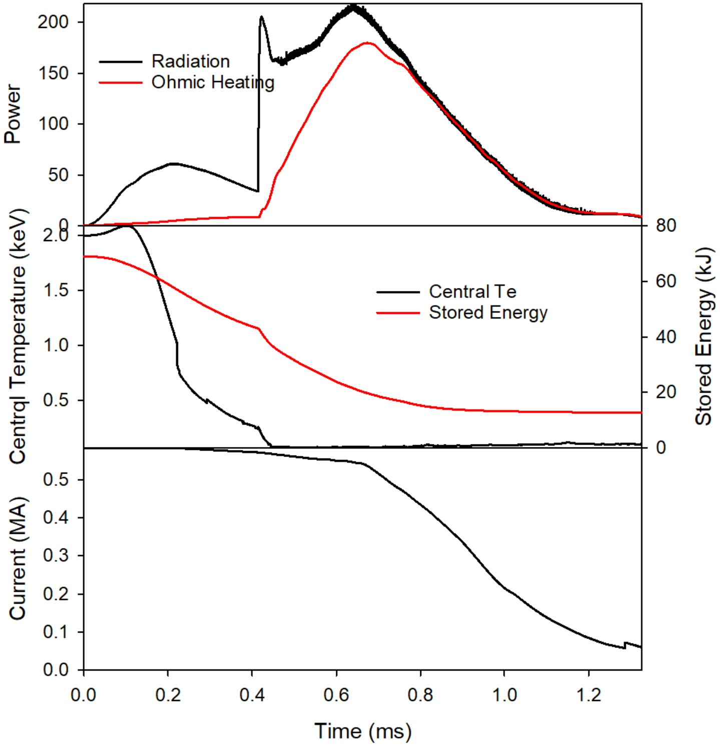
- Chang Liu to present

ITER disruption with more resistive vessel



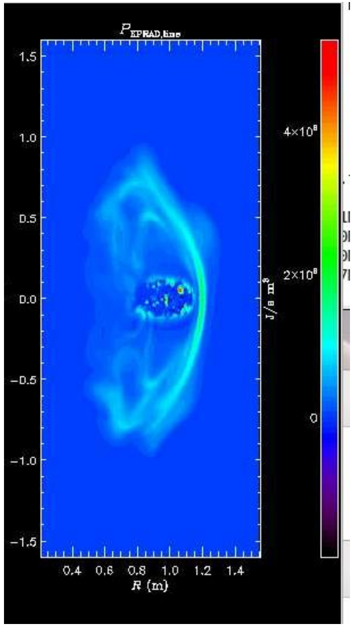
- Increased all vessel resistivities by 100
- Growth rate went from .025 ms^{-1} to 2.0 ms^{-1}
- New case greatly slows down after contact with wall is made

Carbon Mitigation in NSTX-U (shell pellet)



Shell carbon pellet in NSTX (now running)

Radiation
t = 0.73 ms

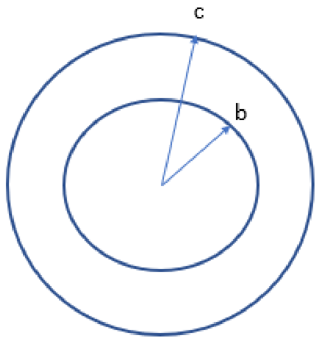


This run is essentially done and can be incorporated into Cesar's paper

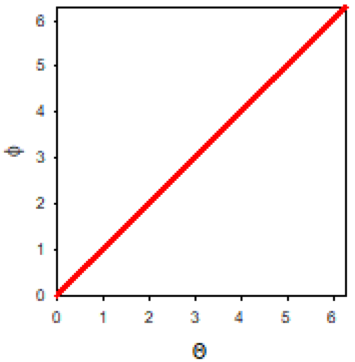
Cesar Clauser

Helical Band to remove runaway electrons

- Brendan Lyons performed a calculation last year with a conducting helical band that did not show large helical currents
- Want to try and reproduce, first in circular cylindrical geometry.



Circular cylindrical geometry.
Conductor in region b < r < c



3D helical band of good conductivity at |Θ-ϕ| < δ

#1. Will a purely toroidal voltage from the plasma current decaying drive a helical current in this geometry?

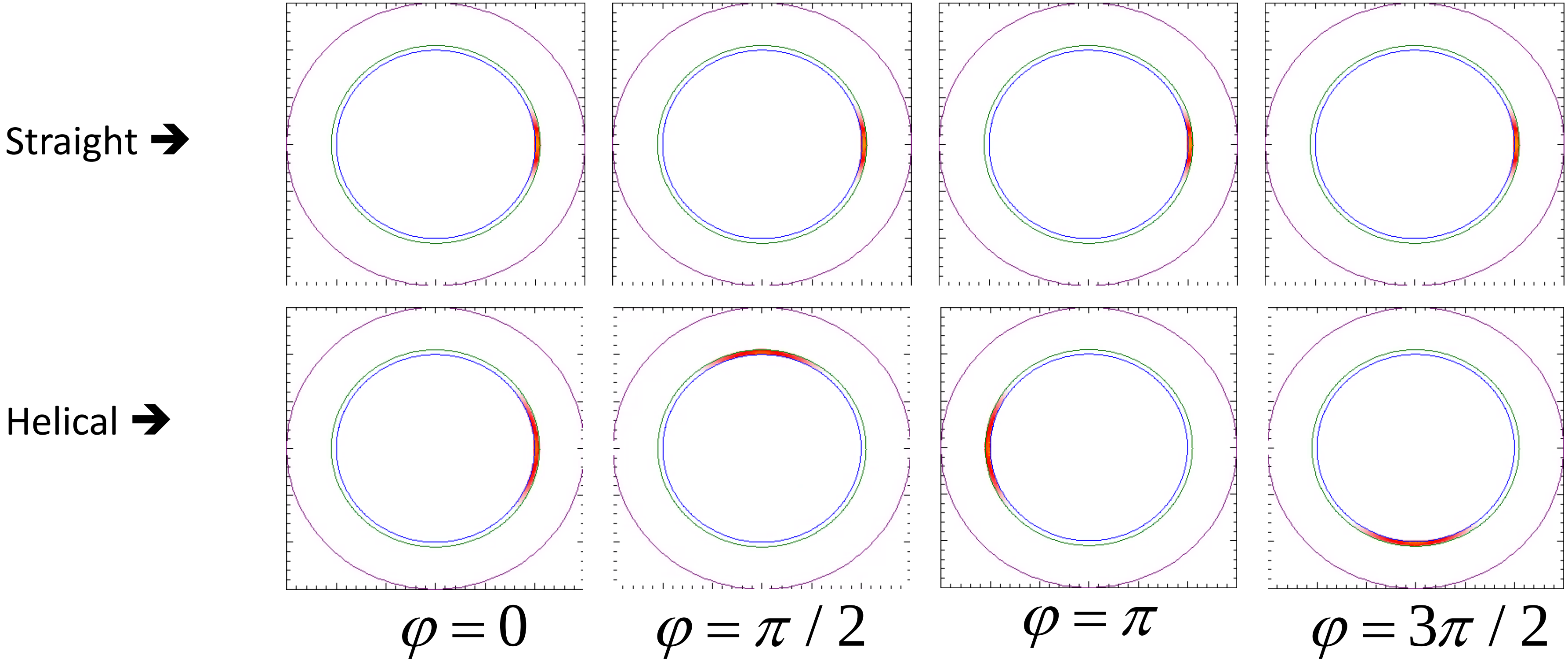
$$\nabla \times \mathbf{E} = 0 \quad \Rightarrow \quad \mathbf{E} = -\nabla\Phi + \frac{V_L}{2\pi}\nabla\phi$$

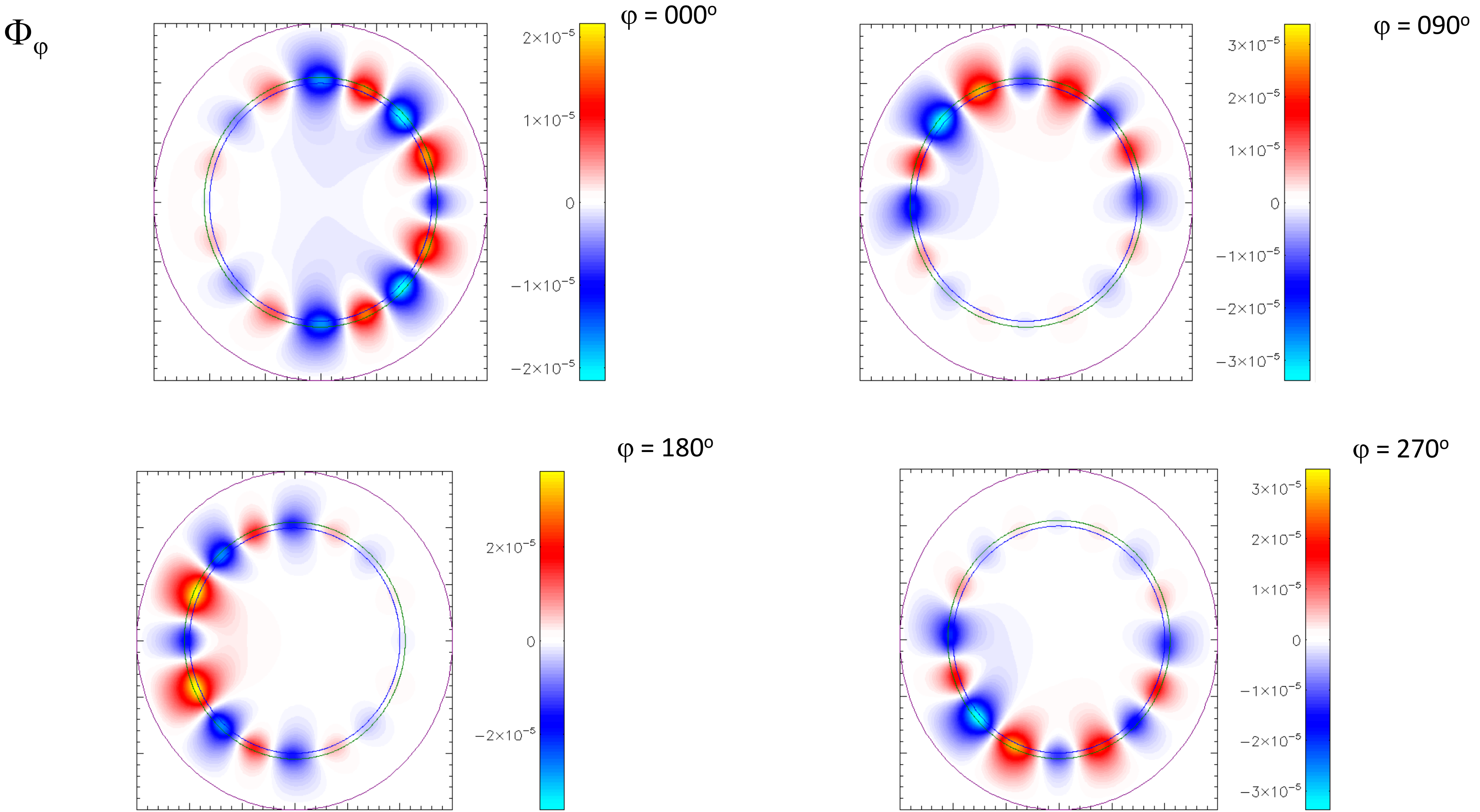
$$\mathbf{J} = \sigma\mathbf{E}$$

What is driving the current in the θ direction? It can't be Φ unless

$$\int_0^{2\pi} \sigma^{-1} J_\theta d\theta = \int_0^{2\pi} \frac{d\Phi}{d\theta} d\theta = 0$$

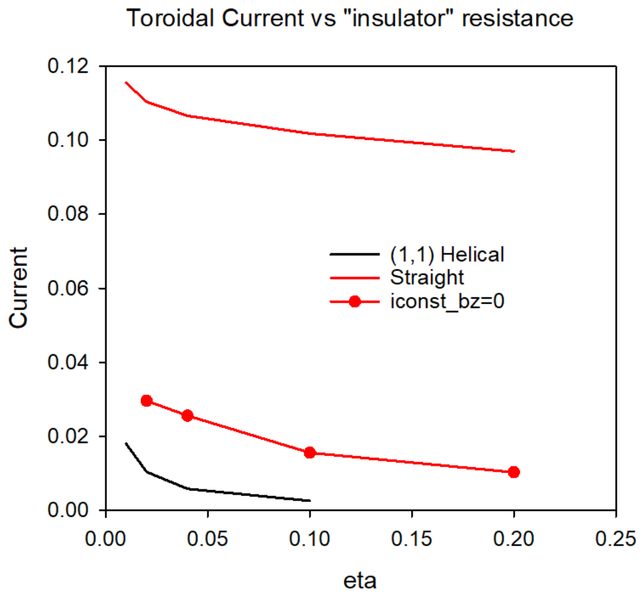
Comparison between Straight and helical band





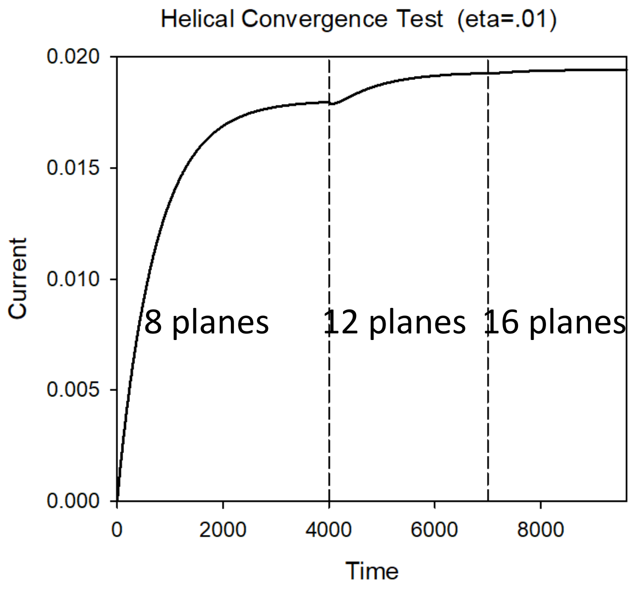
Φφ
φ = 000º
2×10⁻⁵
1×10⁻⁵
0
−1×10⁻⁵
−2×10⁻⁵
φ = 090º
3×10⁻⁵
2×10⁻⁵
1×10⁻⁵
0
−1×10⁻⁵
−2×10⁻⁵
−3×10⁻⁵
φ = 180º
2×10⁻⁵
0
−2×10⁻⁵
φ = 270º
3×10⁻⁵
2×10⁻⁵
1×10⁻⁵
0
−1×10⁻⁵
−2×10⁻⁵
−3×10⁻⁵

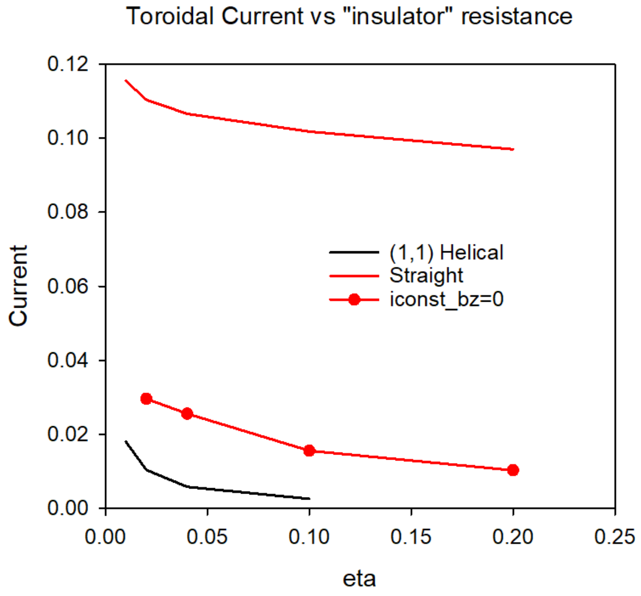
Helical resistive band to suppress runaways



- I have asked Matthias Hoelzl if he could try and reproduce this with the STARWALL code. He seems interested

Some Convergence Tests

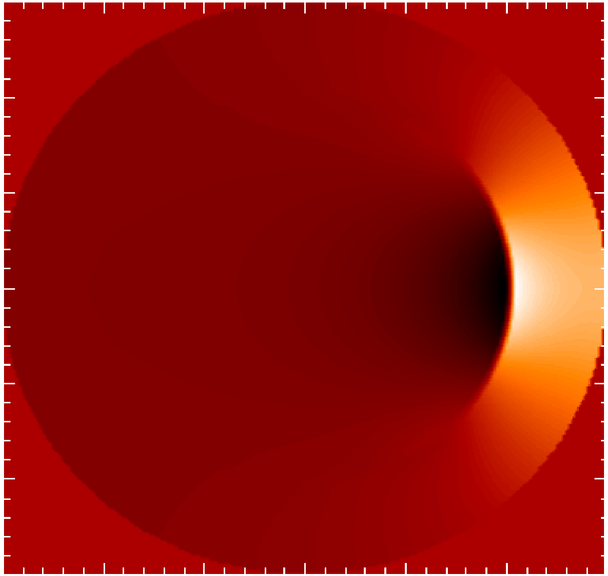


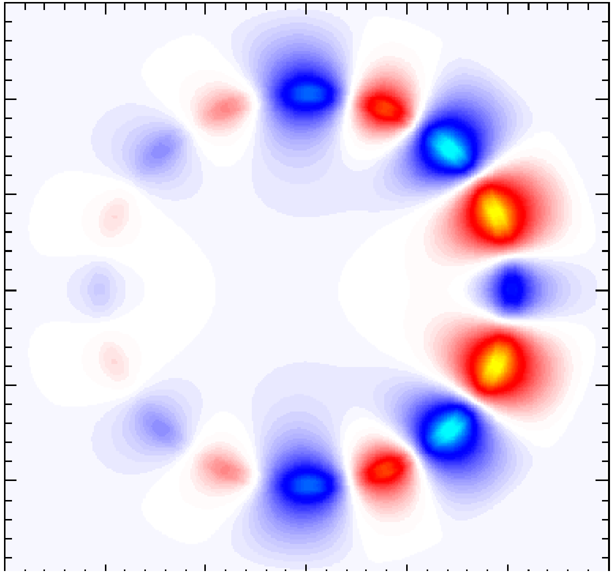


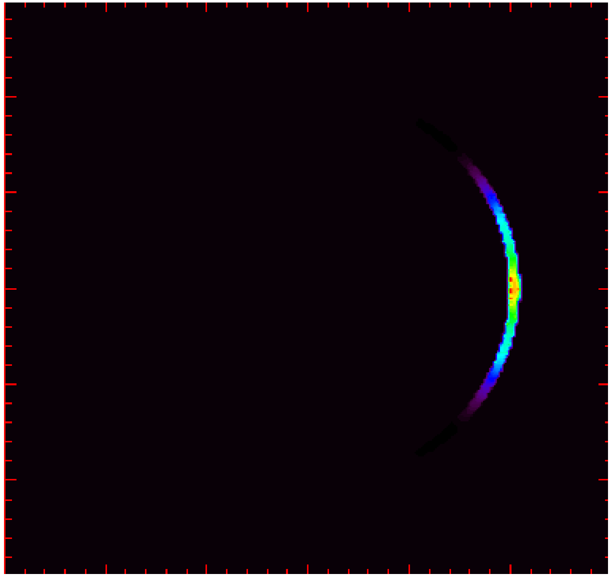
- Wall current appears to be converged in # of planes
- Helical wall current tending towards zero for large values of insulator resistance
- Now testing dependence on boundary conditions (location of ideal wall)
- Helical (1,2) case gives less than half the current of helical (1,1) case
- Iconst_bz=0 increases current, but still far below straight case

Plots for iconst_bz=0

I $\frac{\partial \Phi}{\partial \varphi}$ J_φ







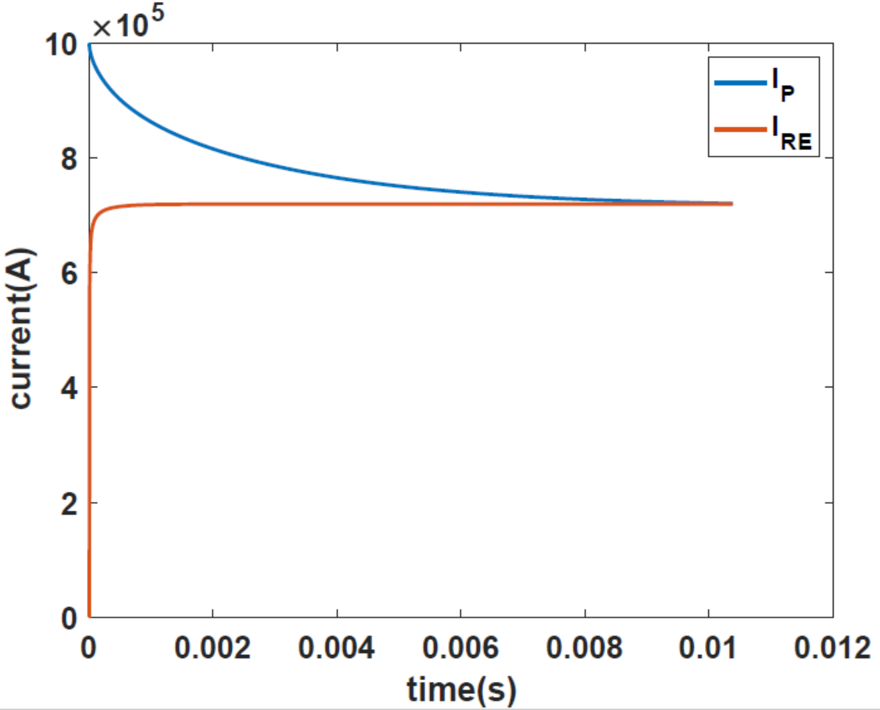
$$\nabla_\perp \bullet \frac{1}{R^2} \nabla \Phi = \nabla_\perp \cdot \eta \left[-\frac{1}{R^2} \nabla F \times \nabla \varphi - \frac{1}{R^2} \nabla f'' \times \nabla \varphi - \frac{1}{R^4} \nabla_\perp \psi' \right]$$

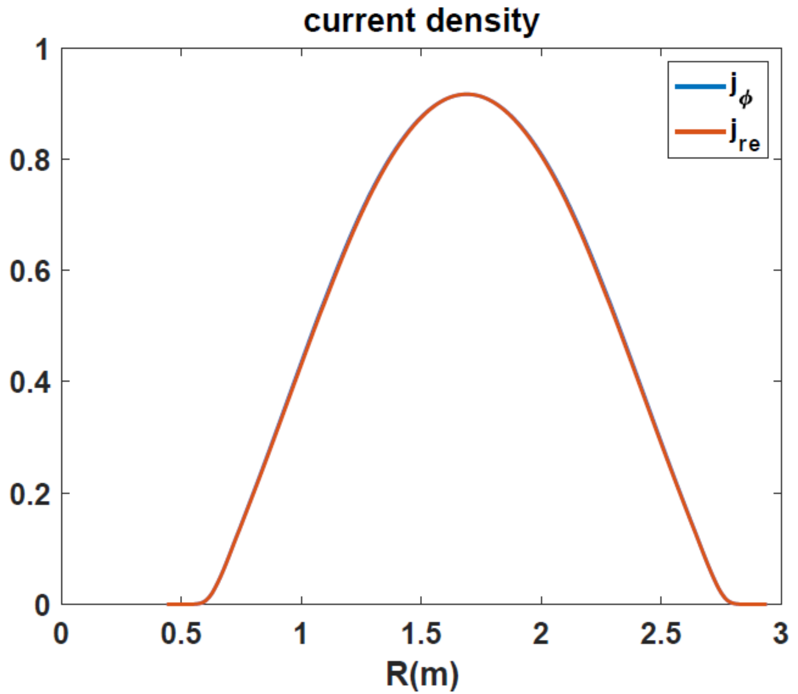
Local Systems

- PPPL centos7(02/22/21)
  - 6 regression tests PASSED on centos7:

- PPPL greene (02/15/21)
  - 4 regression tests PASSED
  - RMP_nonlin timed out (but gave correct results)
  - No batch file found for pellet
- EDDY (2/15/21)
  - 6 regression tests PASSED
- TRAVERSE(1/4/21)
  - Code compiles
  - Regression test failed: split_smb not found in PATH
  - Have not yet tried shipping .smb files from another machine

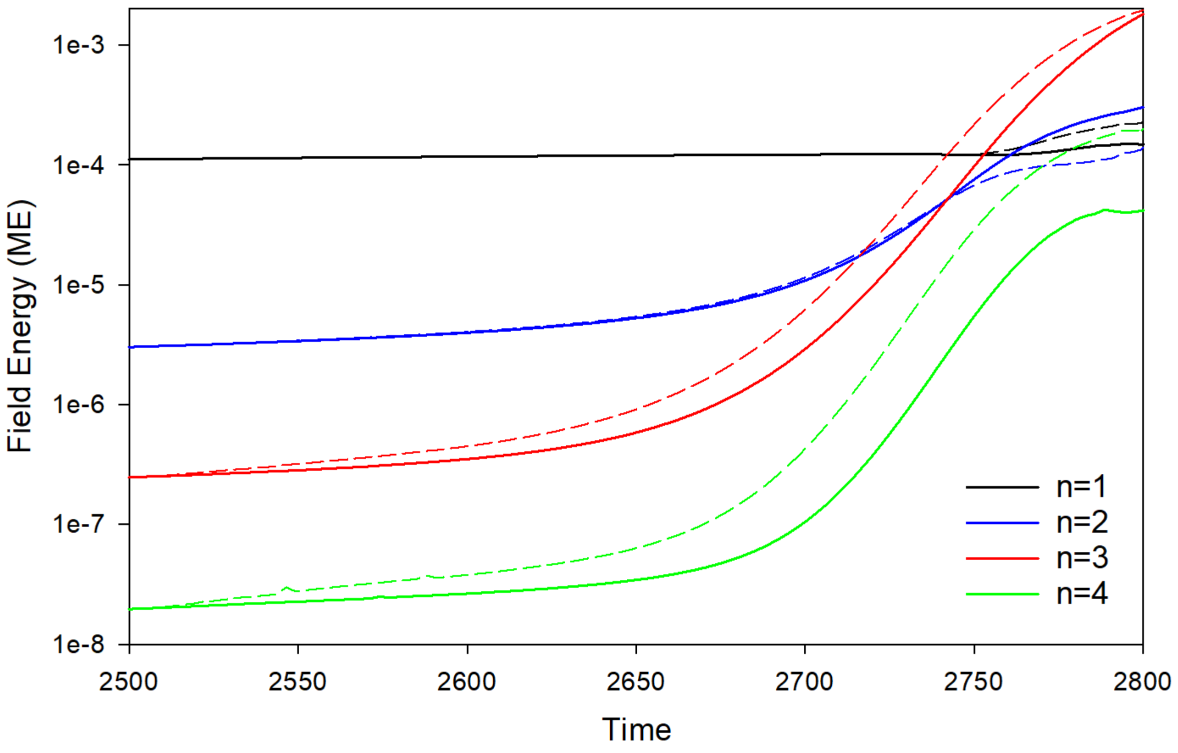
2D (cylindrical) RE with sources (12/19/2020)



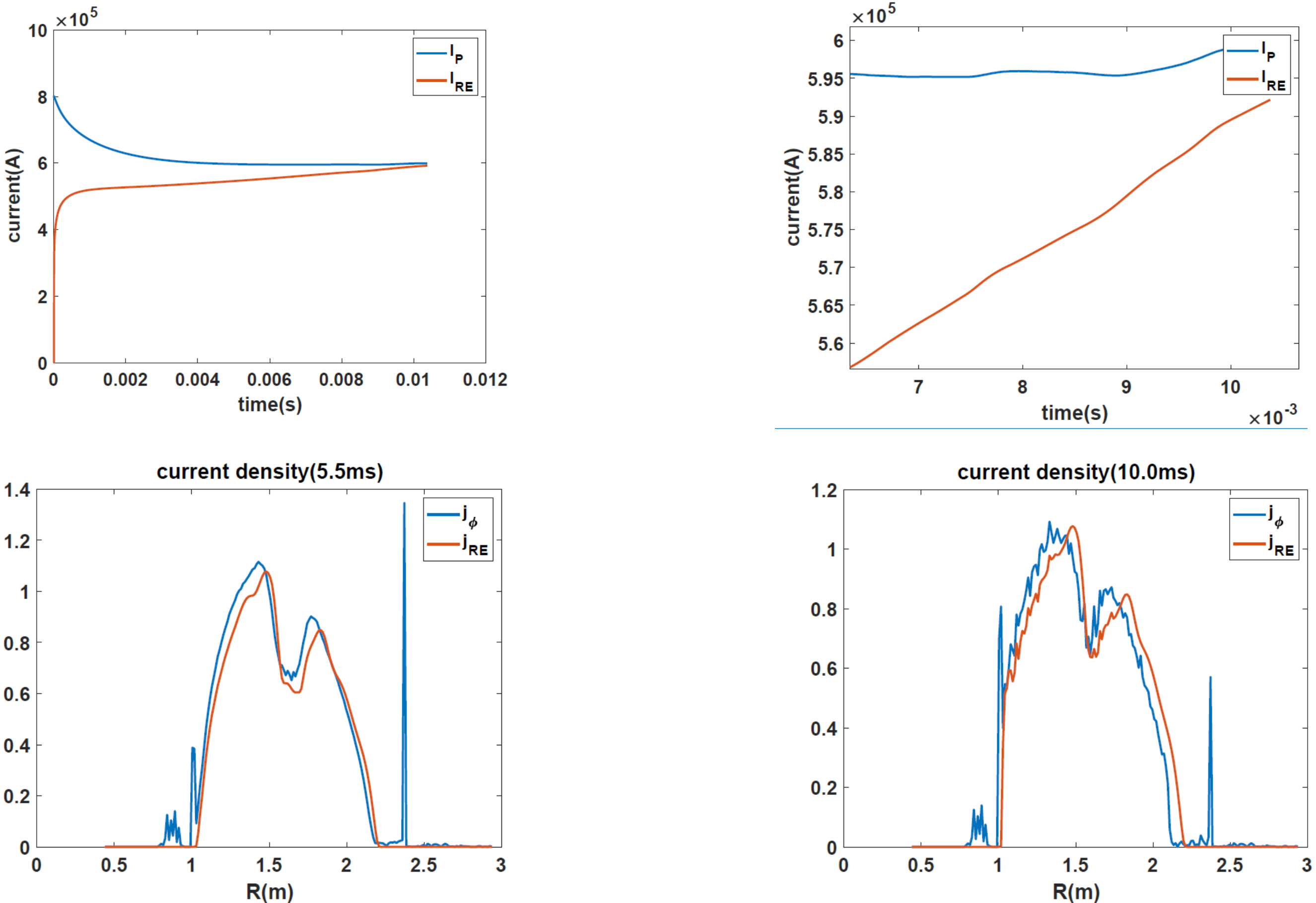


Chen Zhao

Energy in base case 36742317 (solid) and 16 plane case 37248033 (dashed)



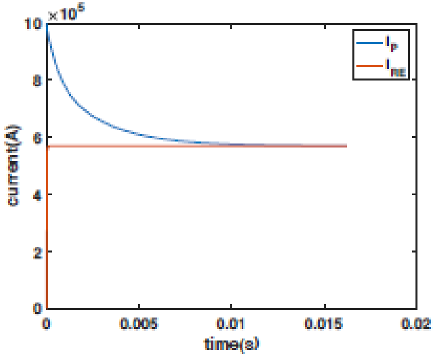
DIII-D 177053 with Argon

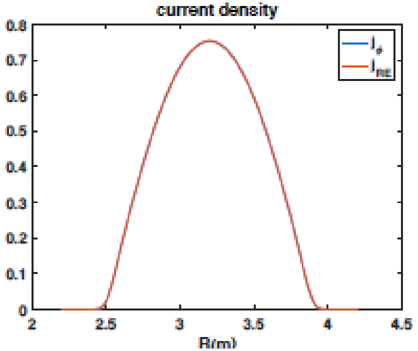


Chen Zhao

Same calculation in a Cylinder

M3D-C1 runaway generation with cylinder geometry





- Parameters:

$$\beta_0 = 0.15$$

$$a = 0.65m$$
$$\mathrm{R} = 1.7m$$
$$B_0 = 1.9T$$
$$\eta = 1.0\times10^{-4}$$
$$n_0 = 1.0\times10^{20}m^{-3}$$
$$c = 150v_A$$
$$N_{elements} = 12261$$
$$\Delta t = 1.0\tau_A$$

- The plasma current was equal with plasma current by the runaway current at about 12ms.
- The radial profile of runaway current profile are exactly same when the plasma current equal to runaway current.

Progress on other shots?

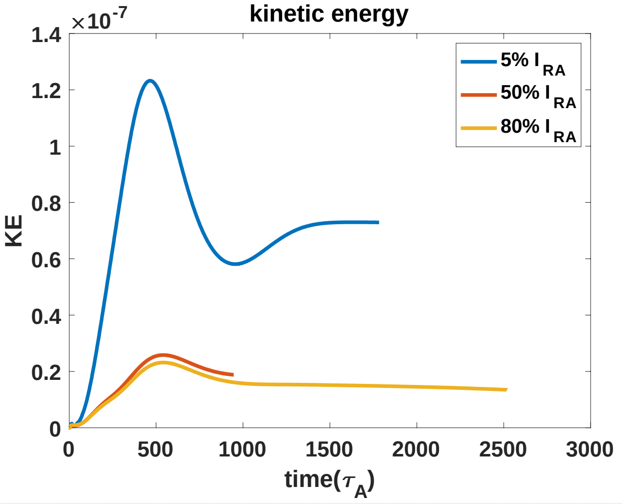
- M3D-C1/NIMROD 3D Benchmark

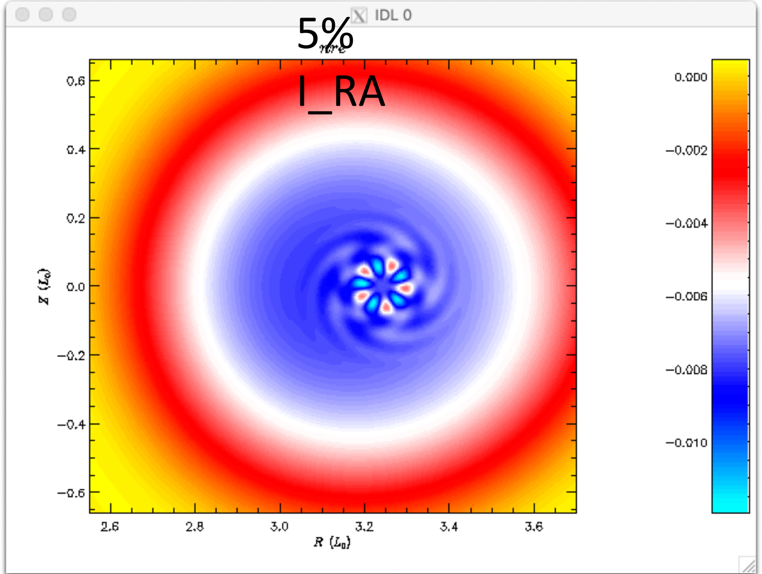
NSTX shot 1224020 – Fast ion transport with coupled kink and tearing modes
Chang Liu

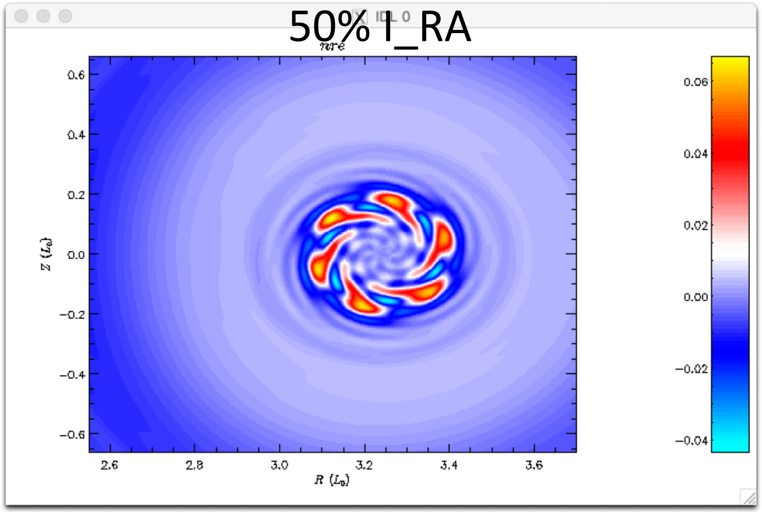
DIII-D Neon pellet mitigation simulation for KORC

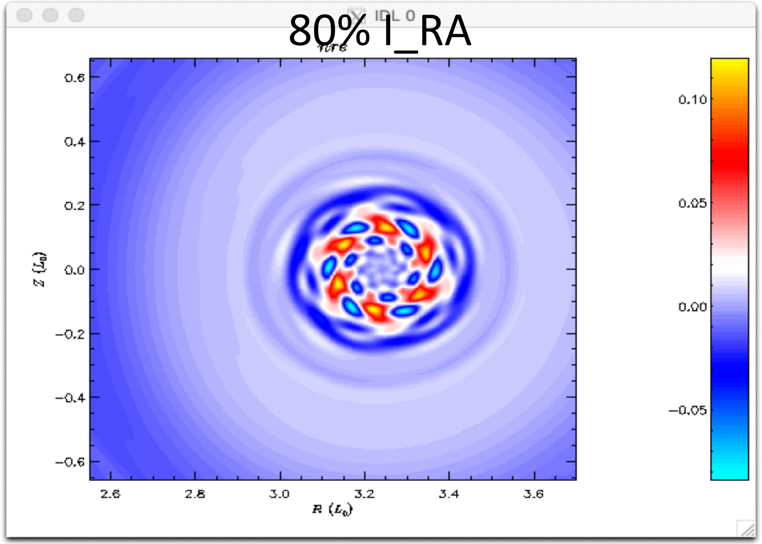
- Brendan Lyons trying to extend 8 plane case to 32 planes

SPARK ?   Do we need to do anything?

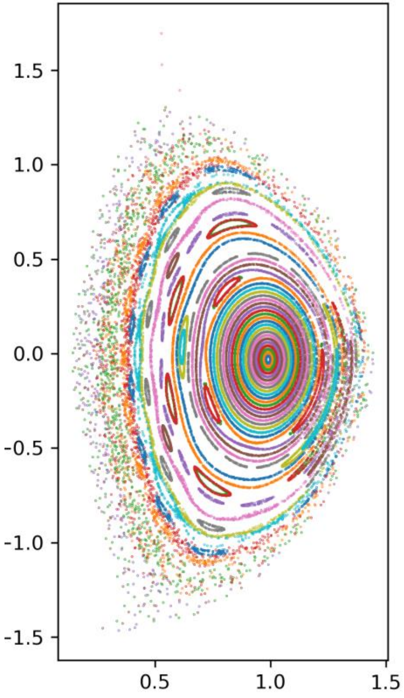

kinetic energy
×10^-7
KE
time(τ_A)
5% I_RA
50% I_RA
80% I_RA
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
500
1000
1500
2000
2500
3000


IDL 0
5% I_RA
Z (L0)
R (L0)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
2.6
2.8
3.0
3.2
3.4
3.6
0.000
−0.002
−0.004
−0.006
−0.008
−0.010


IDL 0
50% I_RA
Z (L0)
R (L0)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
2.6
2.8
3.0
3.2
3.4
3.6
0.06
0.04
0.02
0.00
−0.02
−0.04


IDL 0
80% I_RA
Z (L0)
R (L0)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
2.6
2.8
3.0
3.2
3.4
3.6
0.10
0.05
0.00
−0.05

NSTX shot 1224020 – Fast ion transport with coupled kink and tearing modes Chang Liu



- In the original geqdsk file, the equilibrium was poorly converged. New one is much better. Has q(0) = 1.3

- Chang has analyzed new equilibrium (left)

- No ideal (1,1) mode, several tearing modes

- If goal is to get unstable (1,1) mode, likely need to lower q(0)
- Adding sheared toroidal rotation should help stabilize resistive modes.

Grad-B drift in M3D-C1—HF side

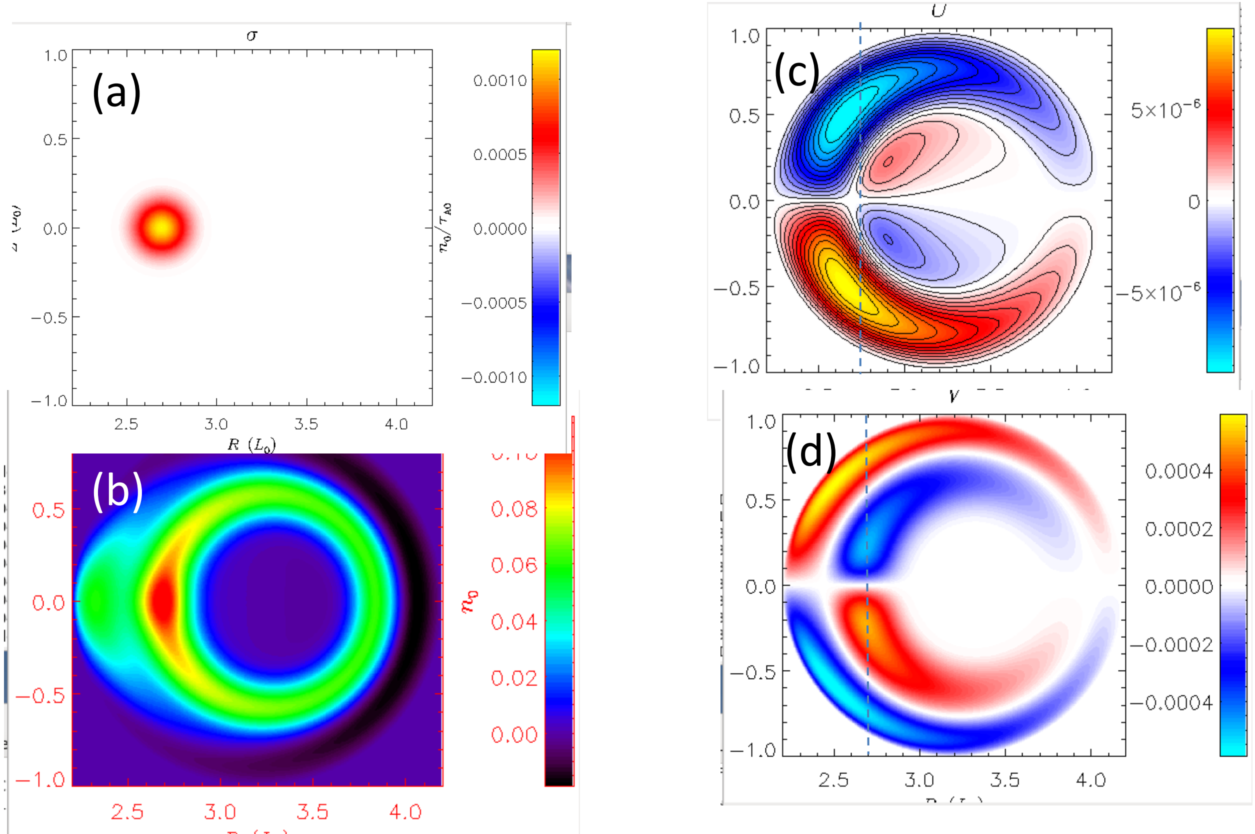
Request to calculate grad-B drift in M3D-C1 and to compare with that being put into the LP Code

(a) Density source in 1F toroidal equilibrium

(b) Change in density after $10^3\ \tau_A$

(c) Poloidal velocity stream function

(d) Toroidal velocity contours



Grad-B drift in M3D-C1– LF source

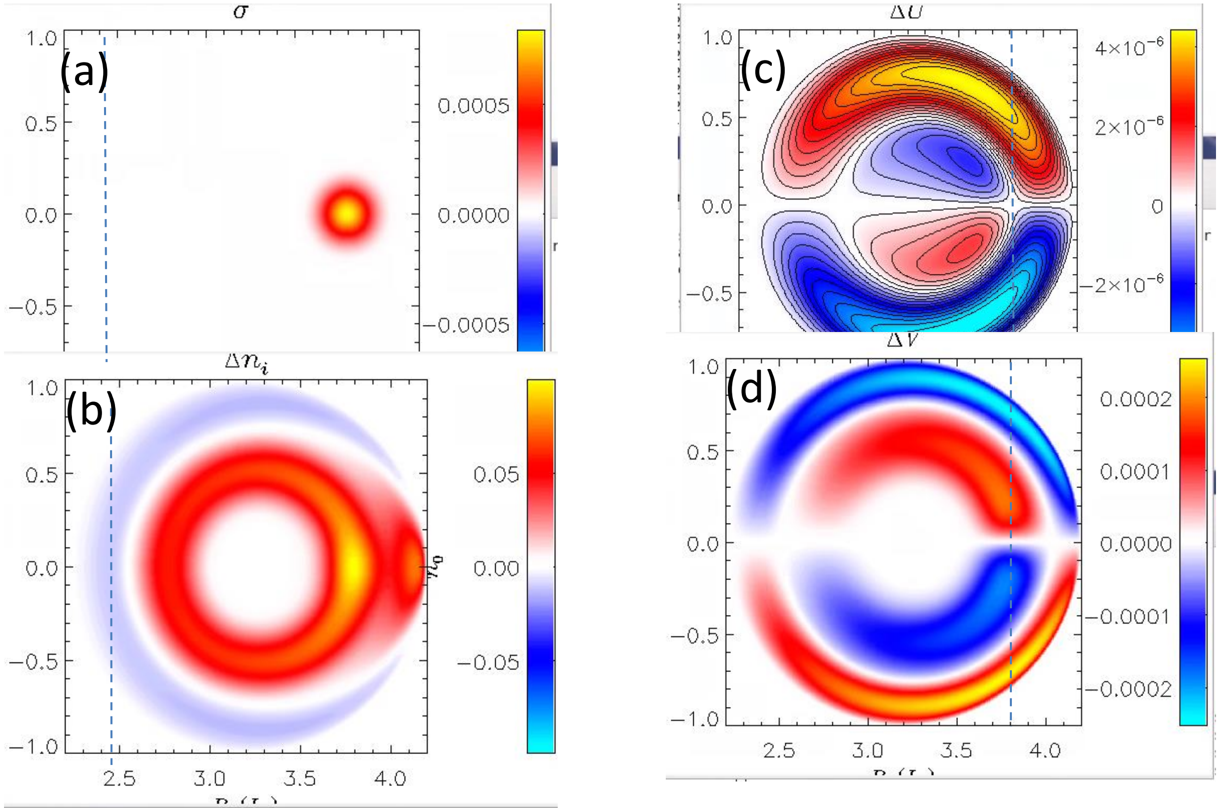
Request to calculate grad-B drift in M3D-C1 and to compare with that being put into the LP Code

(a) Density source in 1F toroidal equilibrium

(b) Change in density after $10^3\ \tau_A$

(c) Poloidal velocity stream function

(d) Toroidal velocity contours



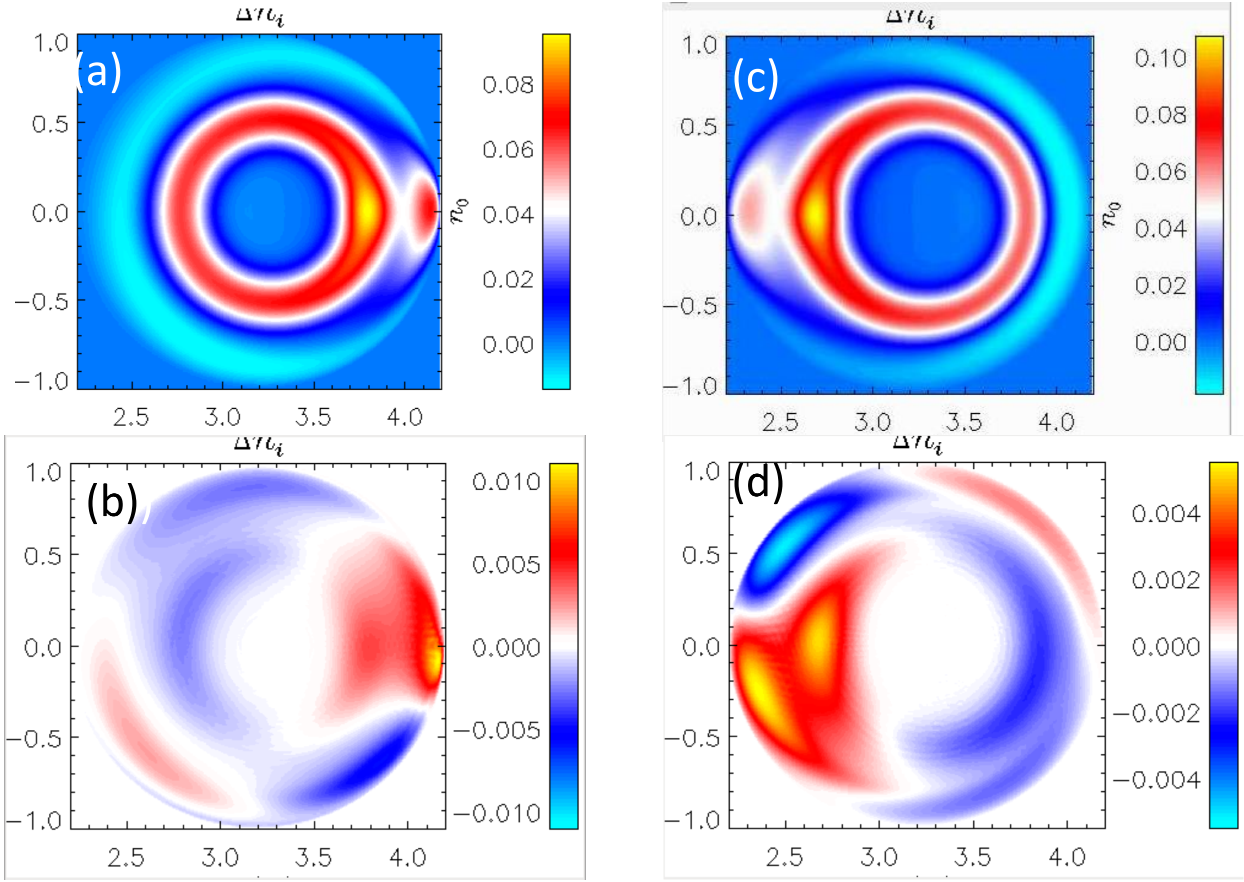
Grad-B drift in M3D-C1—2F effects

(a) 2F density change after 10^3 τ_A for LF side source

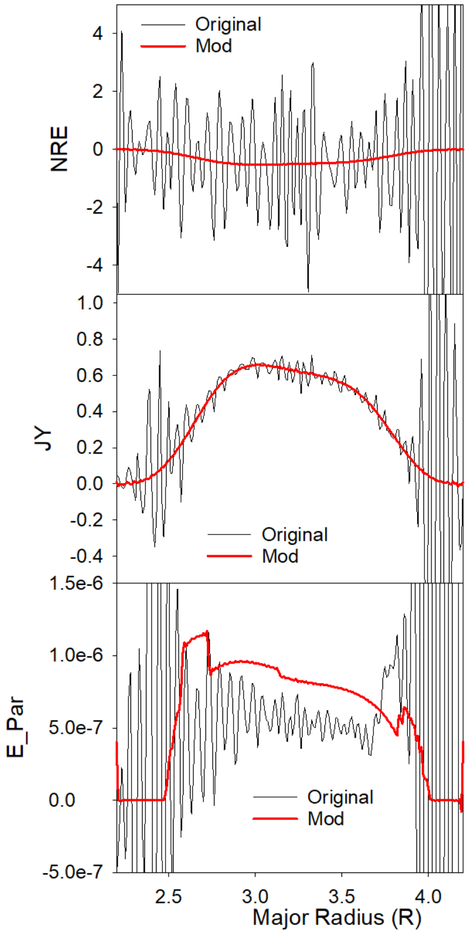
(b) Difference in 1F and 2F density (LF)

(c) 2Fdensity change after 10^3 τ_A for HF side source

(d) Differencein 1F and 2F density (HF)



Sawtoothing discharge with runaway electrons

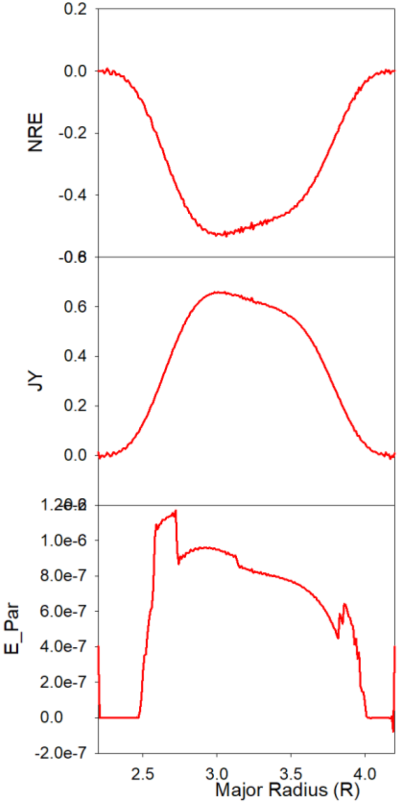


Profiles of nre, jy, and E_par after 30 timesteps

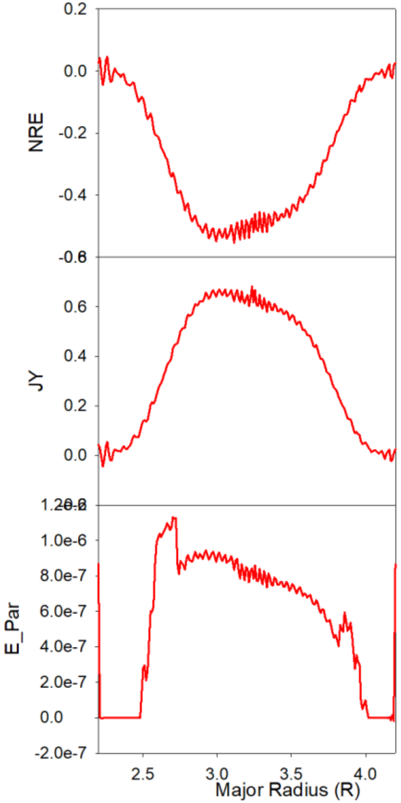
Original: /p/tsc/m3dnl/Isabel/Chen2D
Mod: /p/tsc/m3dnl/Isabel/Chen2D-mod1

Changed:
mesh size
"regular"
"integration points"
ipres=1
cre
pedge
viscosity
denm
equilibrium density

Longer times develops oscillations



Change from t=6 to t=100



- Short wavelength oscillations occur first in nre and then in other quantities (jy, e_par)
- Could we add some smoothing?