M3D-C1 ZOOM Meeting

6/01/2020

Agenda

1. Announcements
2. CS Issues
   1. LBL presentation on tuning with INTEL compiler (Yank Liu)
   2. 3D Seg fault on eddy
   3. Failed dawson reg tests (error partitioning the mesh)
   4. NERSC Time
   5. Changes to GIT master since last meeting
3. Physics Studies
   1. More on 3D VDE benchmark
   2. 3D ITER VDE status
   3. JET Force status
   4. Fluid runaway electrons: stability and sources – Chen Zhao
   5. Other

Announcements

- Laboratory closed until June 22 (at least)
- CTTS Talk Series
  - 4/29 Chang Liu M3D-C1-K (posted)
  - 5/6 NIMROD CS
  - 5/13 Sovinec/Jardin 3D VDE benchmark (posted)
  - 5/20 Eric Howell NTM with NIMROD (posted)
  - 5/27 Roman Samulyak Ne and D pellet ablation rates including ∇B drift and cloud rotation(posted)
  - 6/3 Chen Zhao MHD stability with fluid RE in M3D-C1
  - 6/10 Cesar Clauser Mitigation in NSTX with EMPI
  - 6/17 Charlson Kim NIMROD SPI Simulations
  - 6/24 open
- All talks posted on ctts.pppl.gov

3D Seg Fault

When running the 3D code, I have gotten a Segmentation Violation at seemingly random time steps. When I resubmit, it either runs ok or fails at the same place but at a different timestep. The last lines of output when it fails are always the same:

```
 Advancing Temperature--end
  Advancing Fields
        -- Reuse Preconditioner
[70]PETSC ERROR: ----------------
```

This happened to me using SuperLU_dist on cori_knl, and also using mumps on eddy. Because this is not reproducible it will be hard to find, but it could have something to do with changes you made to allow reusing the preconditioner.

Jin: on eddy, copy /home/jinchen/SRC/M3DC1/unstructured/eddy.mk

Jin Chen

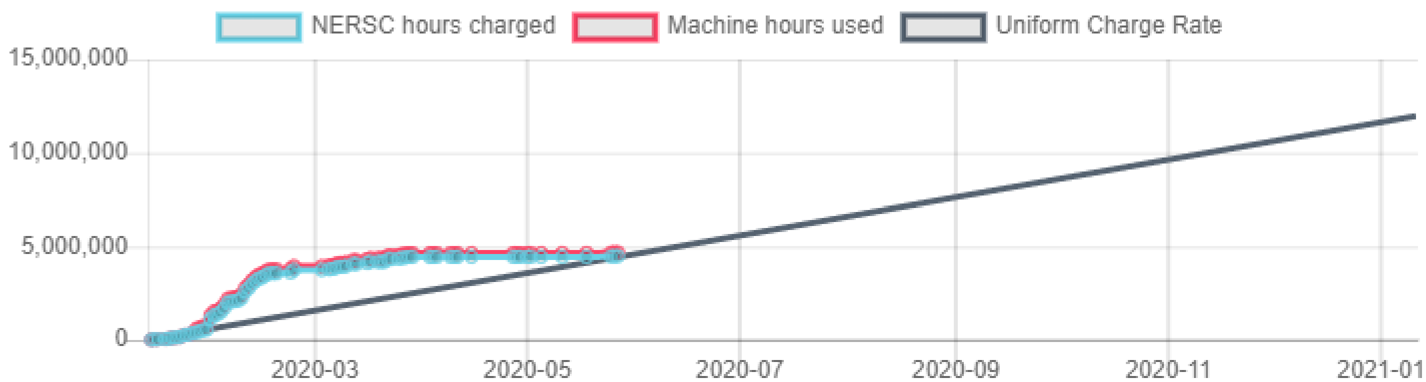
Regression Tests failed on Dawson

All regression tests failed.

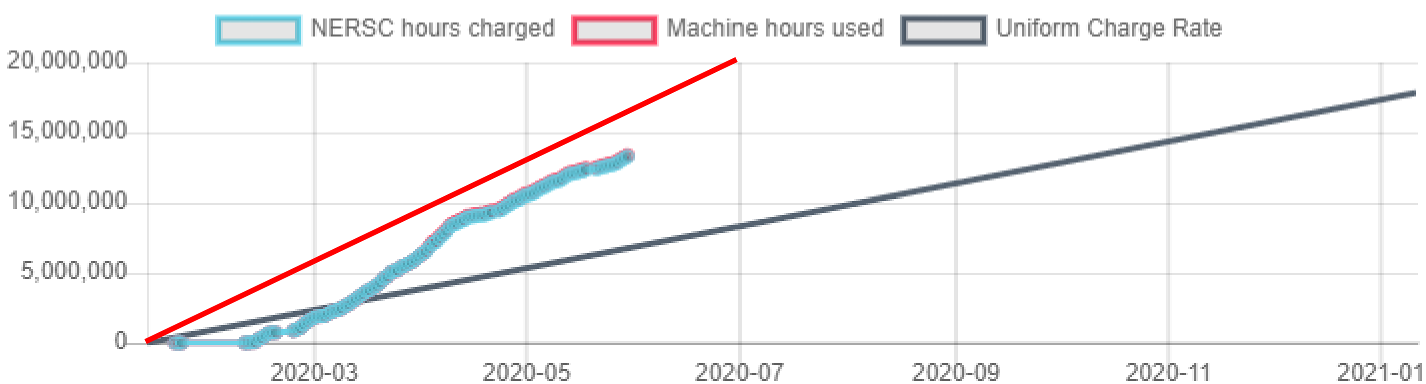
Warning: there was an error partitioning the mesh
FAILED: Job finished, but C1ke file not found

NERSC

MP288



M3163



Need to use less mp288. m3163 approaching linear usage rate

Add to batch file: #SBATCH –account=3163

(clauser, kleiner, lyons, strauss)

Changes to GIT master since last meeting

- Jardin: Temperature diagnostic plots

For itemp_plot=1, all terms in Te equation are now output (Clauser to verify)

RHS of Te equation =

= eta_jsq $(\gamma-1)\left[\eta J^2 + S_e\right]$

+ vdotgradt $-n\mathbf{V}\bullet\nabla T-(\gamma-1)nT\nabla\bullet\mathbf{V}$

+ deldotq_perp $\nabla\bullet\mathbf{q}_\perp = -\nabla\bullet\kappa_\perp\nabla T_e$

+ f3vplot $(\gamma-1)(T_i-T_e)n_e(QD)$

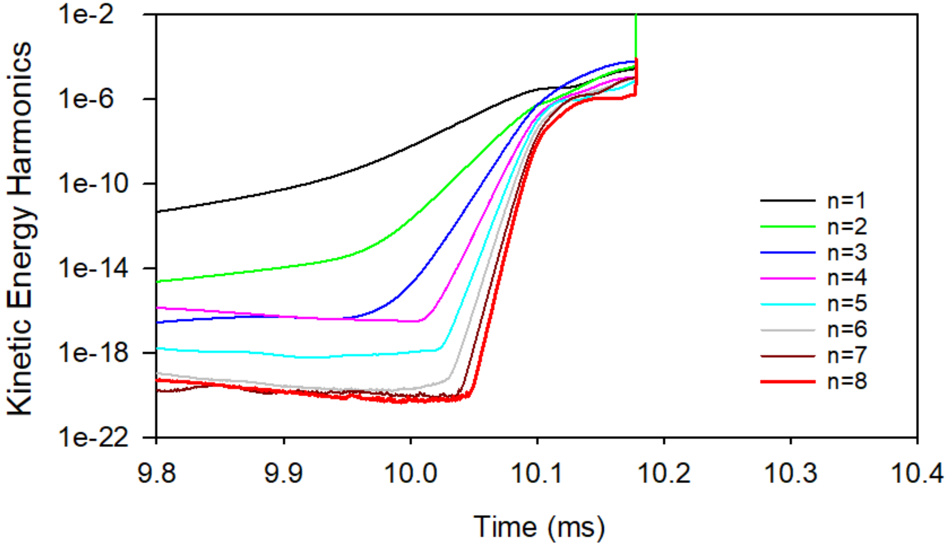
+ deldotq_par $\nabla\bullet\mathbf{q}_\parallel = -\nabla\bullet\kappa_\parallel\mathbf{bb}\bullet\nabla T_e$

+ f2eplot $-T_e\nabla\bullet D\nabla n_e - T_e S_{ne}$

- Lyons: ipellet=14 option

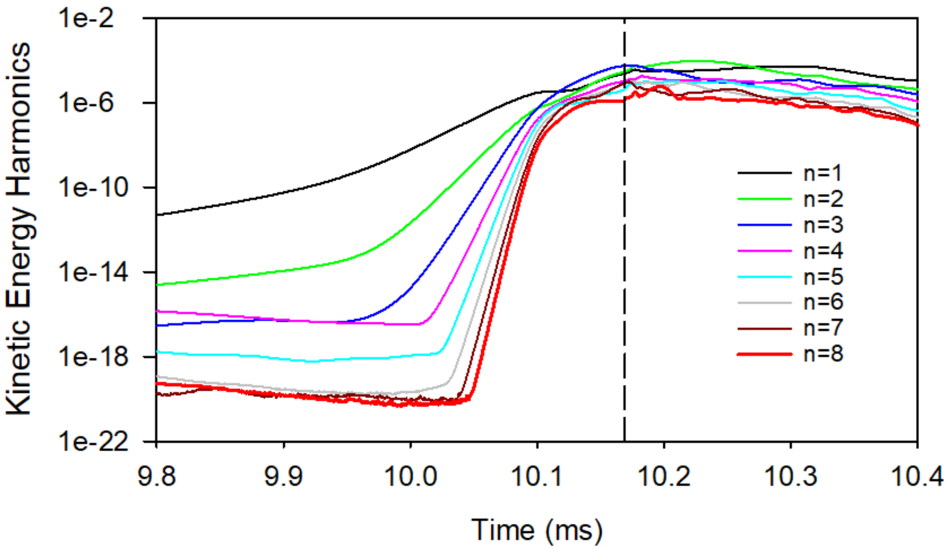
Documented changes in NEWDOC-latest: m3dc1.pppl.gov

3D VDE Benchmark -- iupstream



Original run with iupstream=0

Highest mode plotted (n=8) first to go unstable



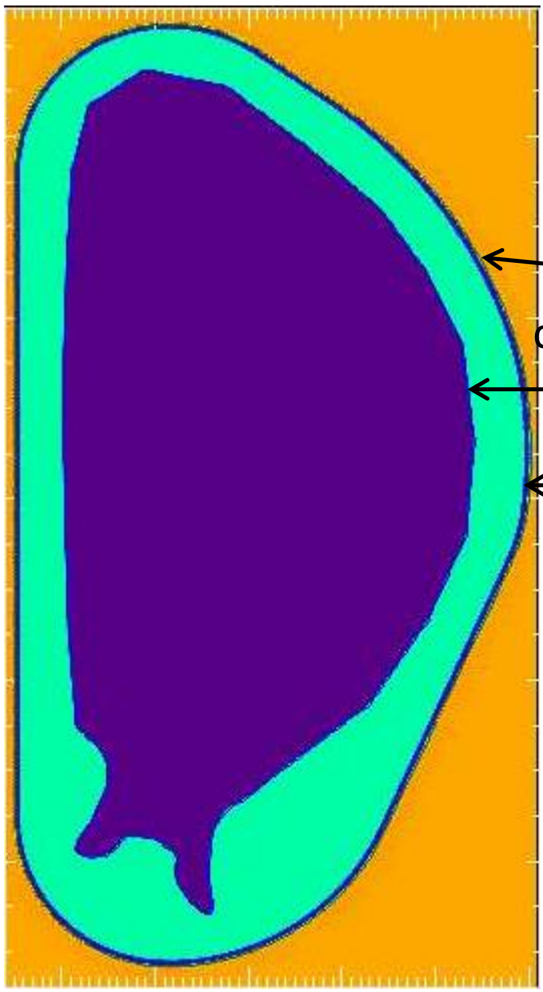
Restarted at t=10.1687 with iupstream=1 magus = .05

$$\alpha = \left\lceil V_\varphi \right\rceil \times (\text{magus}) \qquad (\ )' \equiv \partial(\ )/\partial\varphi$$

$$\dot{\rho} + \nabla \bullet (\rho \mathbf{V}) = D_\rho \nabla^2 \rho + \frac{\alpha}{R^2}\rho''$$

Similar term added to equations for: p, ψ, F

3D ITER VDE – coupling to CARIDDI



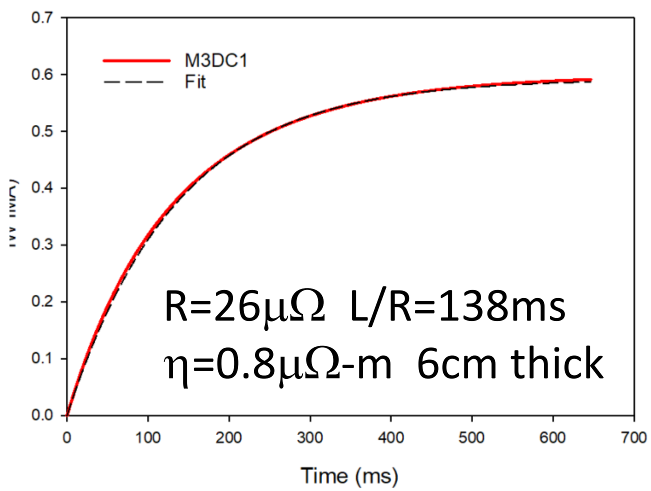
$$\frac{1}{R^2}(\nu_i,\dot{\psi}) = -\frac{\eta_T}{R^2}\Delta^*\nu_i\Delta^*\psi + \frac{\eta_P}{R^2}\left[\frac{1}{R^2}(\nu_i,\psi'') + [\nu_i, f'''] + [\nu_i, F']\right]$$
$$+\frac{\eta_P'}{R^2}\left[\frac{1}{R^2}(\nu_i,\psi') + [\nu_i, f''] + [\nu_i, F]\right]$$

contour 1

contour 3

$$\frac{\nu_i}{R^2}\dot{F} = -\frac{\eta_P}{R^2}(\nu_i, F) - \frac{\eta_P}{R^2}(\nu_i, f'') + \frac{\eta_P}{R^2}[\nu_i, \psi']$$

contour 2



L/R test with no plasma

New variables for poloidal resistivity of wall

eta_wallRZ
wall_region_etaRZ

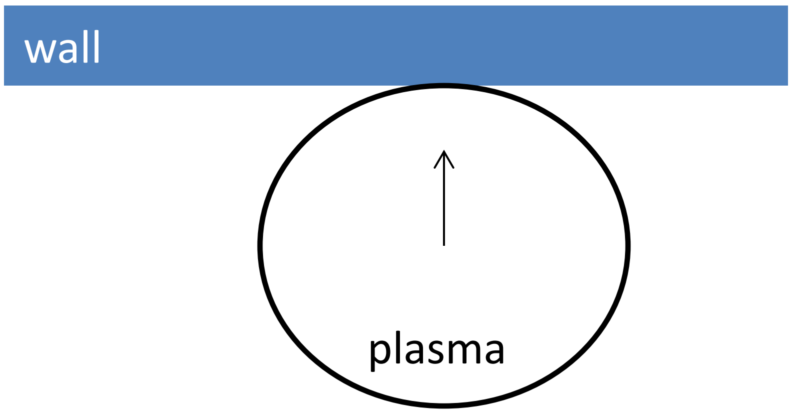
Defaulted to eta_wall and wall_region_eta

Ratio of VDE time to current quench time matters

$$q(a) \cong 2\pi \frac{B_T a^2}{R \mu_0 I_p}$$

$$Z_p = Z_0 e^{\gamma_{VDE} t}$$

$$I_p = I_{p0} e^{-\gamma_{CD} t}$$



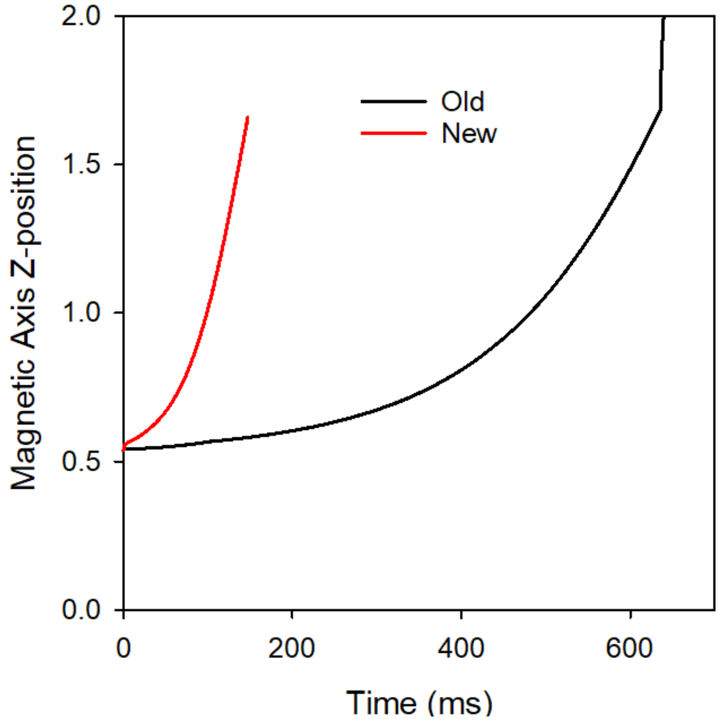
q(a) will decrease durring the current quench

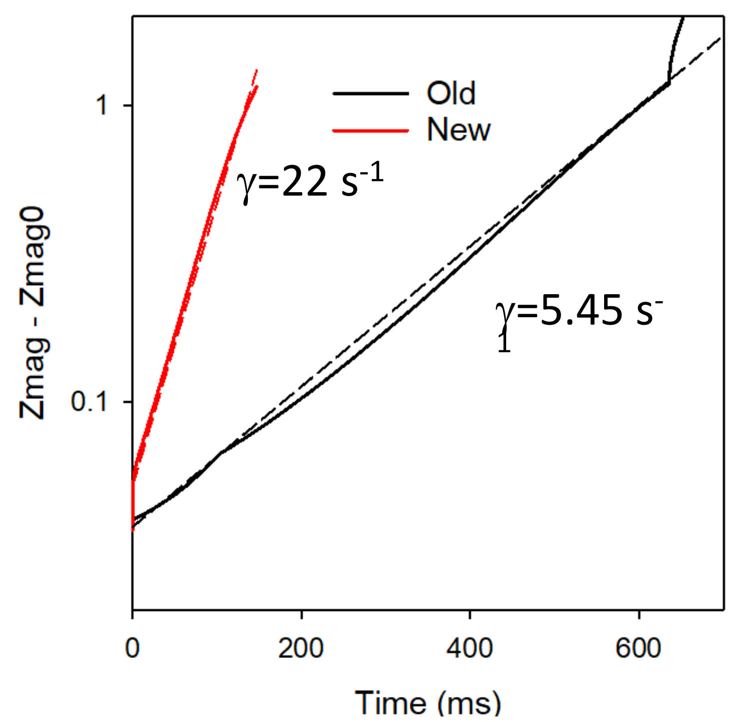
only if $\gamma_{VDE} > \frac{1}{2}\gamma_{CD}$

if q(a) doesn't decrease during the current quench,

there will be very little MHD activity and sideways force

Z-motion of magnetic axis is much faster



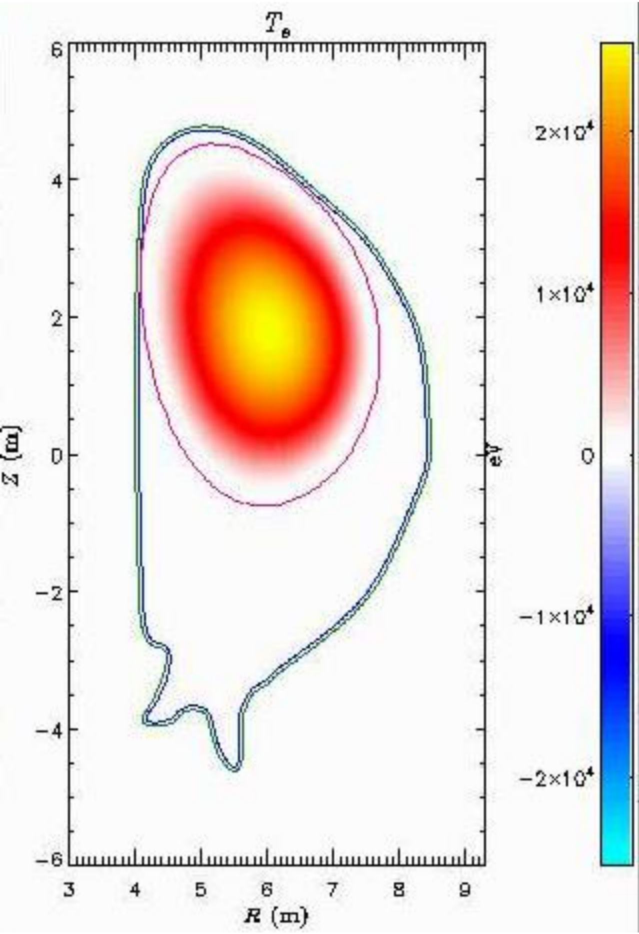


Old: γ x L/R = 1.28

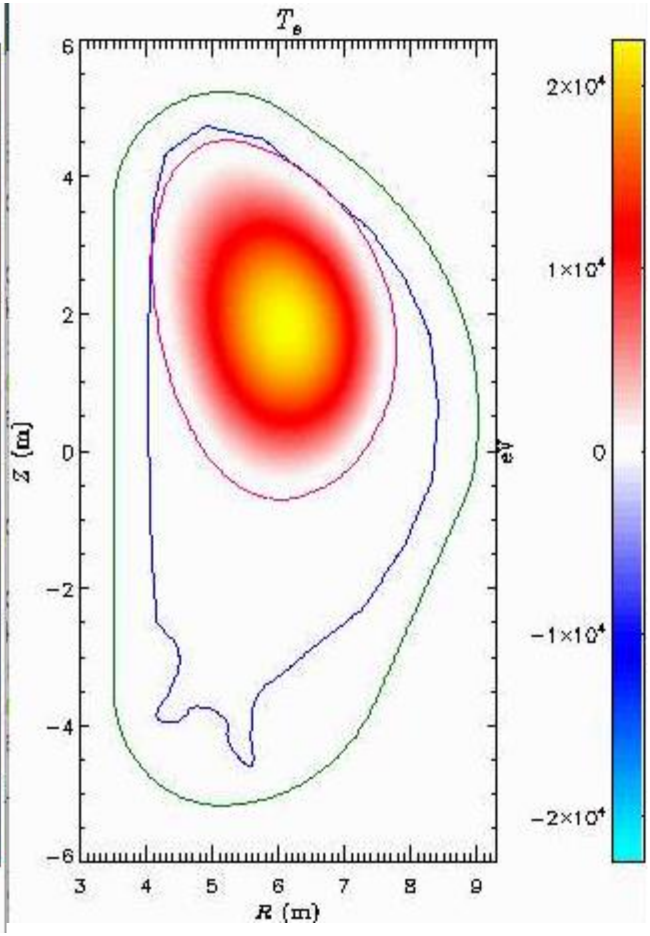
New: γ x L/R = 3.03

Starting new 3D run to compare with old structure run

Old structure



New structure

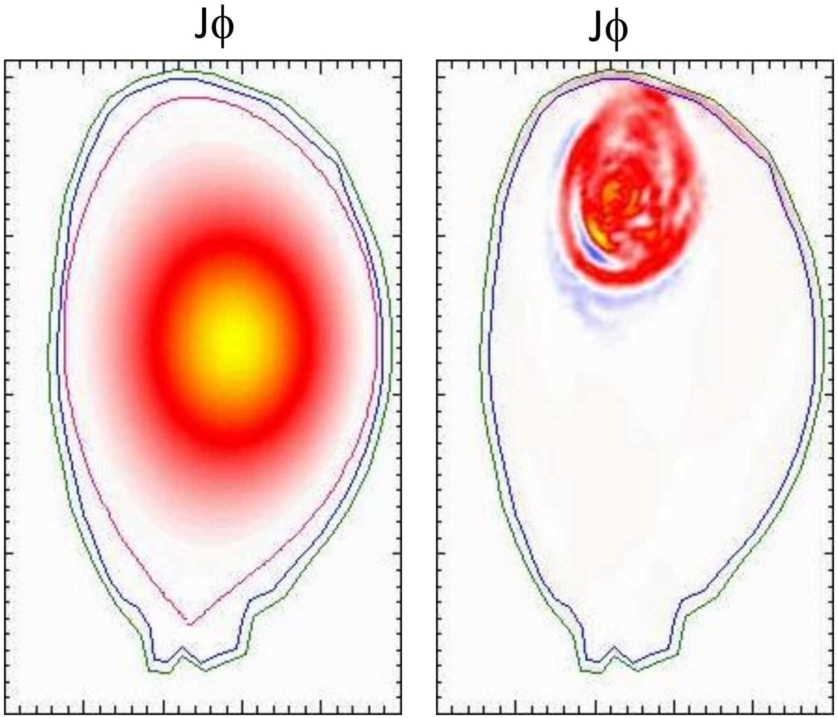


New run has:

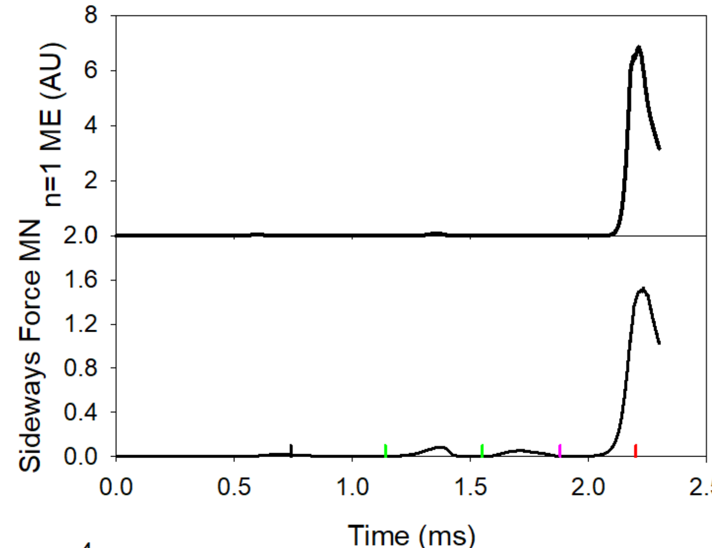
- Same initial zmag
- Same initial q(a) ~2.0
- Same transport coefs

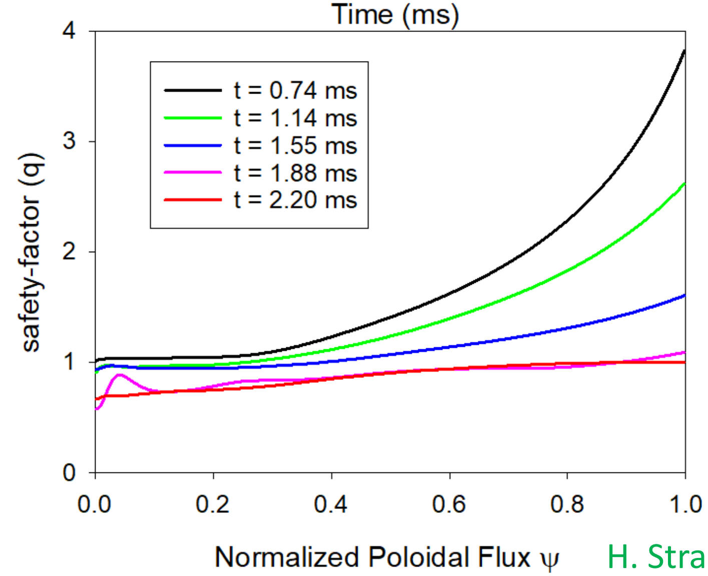
- Several runs with different nskip & pskip to look for cost savings

M3D-C[1] simulation of JET VDE shows origin and magnitude of sideways force



t = 0.0 ms　　t = 2.2 ms





- Plasma drifts upward and scrapes off
- Sideways force arises when q(a) < 1 and large (1,1) mode develops

H. Strauss

MHD Stability with Runaway Electrons

Simulation of MHD instabilities with fluid runaway electron model in M3D-C^1

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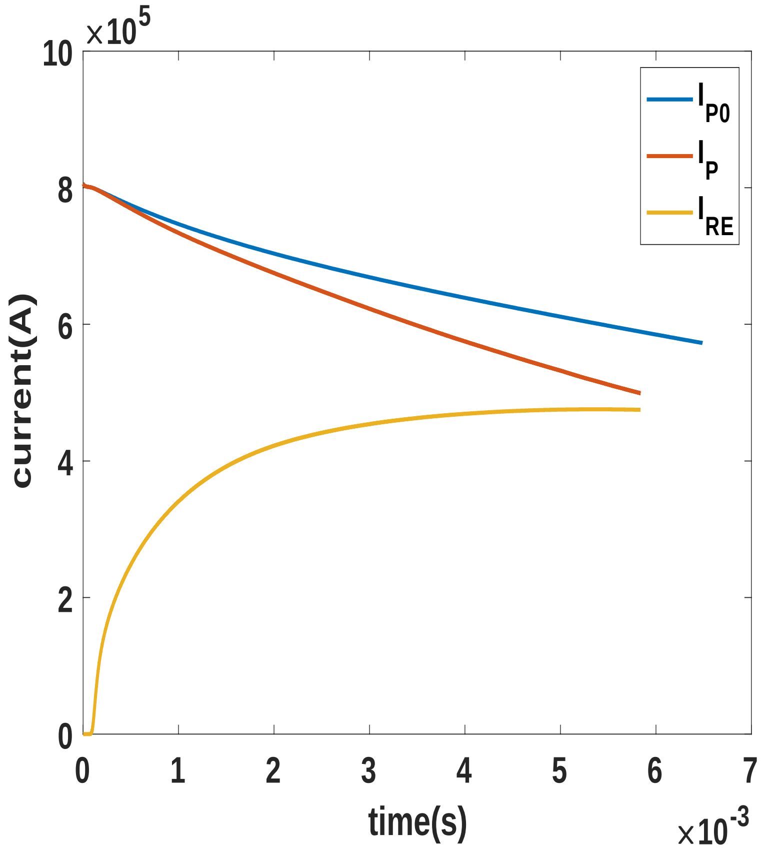
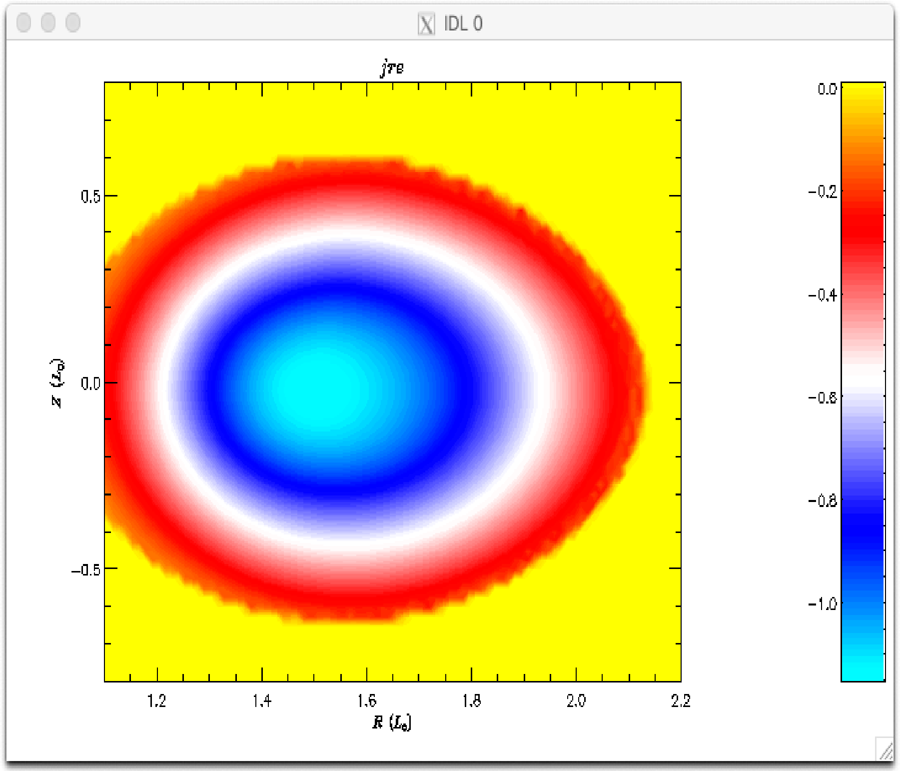
(Dated: 9 May 2020)

Runaway electrons may be generated in a tokamak during the start up, during normal operation and during a plasma disruption. During a disruption, runaway electrons can be accelerated to high energies, potentially damaging the first wall. To predict the consequences of runaway generation during a disruption, it is necessary to consider resonant interactions of runaways with the bulk plasma. Here we consider the interactions of runaways on low mode number tearing modes. We have developed a fluid runaway electron model for the 3D MHD code M3D-C^1[Jardin,et al. J Comput. Sci Discovery 6 014002 (2012)]. To benchmark, we have reproduced the MHD linear tearing mode results (with runaway electrons) in a circular cylinder presented in previous analytic studies[[Helander, P., et al, Phys. Plasmas 14 144102 (2007)] and have extended them here with a numerical eigenvalue calculation. We find that the low mode number tearing mode has a rotation caused by the MHD - runaways interaction, and the perturbed toroidal current scale length is much smaller with runaways than without and decreases as the runaway speed increases.

- Chen’s NF submission has now been published in Nuclear Fusion

Runaway generation during disruption





- The plasma current dropped faster with runaways than without
- The runaway current becomes uniform when it saturate at about 6ms.

Chen Zhao

That’s All I have

Anything Else ?