

M3D-C1 ZOOM Meeting

8/24/2020

Agenda

1. Announcements
2. CS Issues
 1. Local systems
 2. Update on new cluster – J. Chen
 3. NERSC Time
 4. Changes to github master since last meeting
 5. PETSC/SuperLU bug for complex solves
 6. Status of GPU solves on cori-GPU
 7. Summary of NUG meeting
3. Physics Studies
 1. Conservation laws and energy conservation
 2. Use of GS equation when runaways are present
 3. M3D-C1 coupling to RE code KORC
 4. RE Fluid Modeling of DIII-D Experiments
 5. Runaways with sources
 6. Other

Announcements

- Laboratory closed unless authorized
 - New procedure for occasional access....see www-local.pppl.gov
 - No need to get 1-time password
- ITPA MHD Meeting October 14-16 2020
 - Fully Remote
- APS-DPP Meeting Nov 9-13, 2020
 - Fully Remote
- IAEA Fusion Energy Conference postponed to May 2021

Local Systems

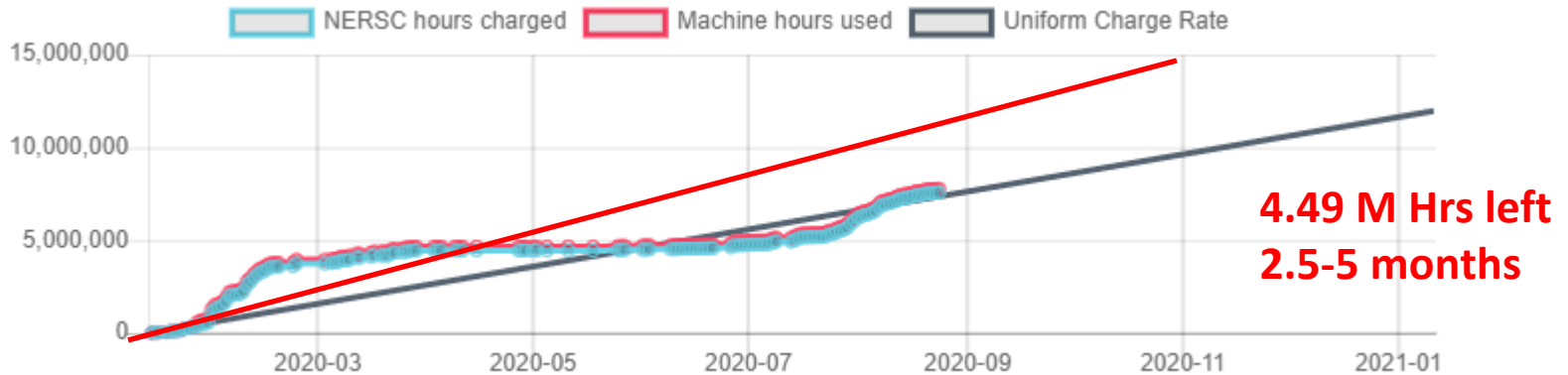
- PPPL
 - Centos7 documentation updated: m3dc1.pppl.gov
 - All 6 regression tests PASSED on centos7
 - 5 PASSED on greene (pellet batch file not found for greene)
- EDDY
 - All 6 regression tests PASSED on eddy
- TRAVERSE
 - Updated to RHEL8
 - Problem compiling this morning: needed to change PETSc version
 - Jin and Seegyong still installing consistent libraries
 - Do regression tests run on Traverse?

Update on New Cluster

- Status from Jin Chen?
 - Has Memory/core been settled?
 - Need more info on storage?

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

- N. Ferraro
 - 08-12 Limited size of Newton step in flux_coordinates.pro to make it more robust
- B. Lyons
 - 08-10 correct sign of isotropic heat flux diagnostic
- S. Seol
 - 08-10 updating libraries and binaries on Sdumont using openmpi/icc/4.04
 - 08-17 cori_knl.mk updated to support matrix-reuse debugging

Complex SuperLU_dist bug fixed (~ 8/17)

- Kudos to Chang for identifying this bug and pointing the way on how to fix it
- Fix involved changing data type in SuperLU_dist.
 - Change has been committed to SuperLU git/master
 - Instructions on how to build PETSc with new SuperLU
 - Chang verified that it now works
 - Jin is rebuilding PETSc on all platforms with the new SuperLU

Status of GPU solves on cori-gpu

- Could we get a short summary of the status of m3dc1 on cori-gpu with the PETSc solves?
 - Are both SuperLU and GMRES using the GPUs?
 - Including the triangular solves?

Summary of NERSC Users Group Meeting 8/17/20

- Community File System:
 - \$CFS/m3163 has 19 TB of disk storage available
 - \$CFS/mp288 has 13.5 TB “ “ “ “
- Push towards GPUs is primarily for energy efficiency
 - GPUs are 10 time more energy efficient for same flop rate
- Perlmutter
 - Phase 1 (GPU only) available ~ April 2021
 - 4 NVIDIA A100 GPUs/node with 40 GB memory/GPU
 - Phase 2 (CPU) ~ 6 months later
 - 3000 CPU nodes, each with 64 cores and 512 GB memory
 - No INTEL compilers: PGI and GNU
 - No charge for use in 2021

Energy Conservation

$$\mathbf{B} \cdot \left[\frac{\partial \mathbf{B}}{\partial t} = -\nabla \times \mathbf{E} \right] \Rightarrow \frac{\partial}{\partial t} \frac{1}{2} B^2 = -\mathbf{E} \cdot \mathbf{J} - \nabla \cdot (\mathbf{E} \times \mathbf{B})$$

$$\left. \begin{aligned} \frac{\partial p}{\partial t} &= -\nabla \cdot (p\mathbf{V}) - (\gamma - 1)p\nabla \cdot \mathbf{V} + (\gamma - 1) \left[\eta J^2 - \nabla \cdot \mathbf{q} - \mathbf{V} \cdot \nabla \cdot \mathbf{\Pi} + S_E \right] \\ \mathbf{E} + \mathbf{V} \times \mathbf{B} &= \eta \mathbf{J} \Rightarrow \eta J^2 = \mathbf{J} \cdot \mathbf{E} - \mathbf{V} \cdot \mathbf{J} \times \mathbf{B} \end{aligned} \right\} \Rightarrow$$

$$\frac{1}{(\gamma-1)} \frac{\partial p}{\partial t} = -\frac{\gamma}{(\gamma-1)} \nabla \cdot (p\mathbf{V}) + \mathbf{V} \cdot \nabla p + \mathbf{J} \cdot \mathbf{E} - \mathbf{V} \cdot \mathbf{J} \times \mathbf{B} - \nabla \cdot \mathbf{q} - \mathbf{V} \cdot \nabla \cdot \mathbf{\Pi} + S_E$$

$$\mathbf{V} \cdot \left[nM_i \left(\frac{\partial \mathbf{V}}{\partial t} + \mathbf{V} \cdot \nabla \mathbf{V} \right) + \nabla p = \mathbf{J} \times \mathbf{B} - \nabla \cdot \mathbf{\Pi} - \frac{1}{2} M_i \mathbf{V} \cdot (D_\rho \nabla n + S_n) \right] \Rightarrow$$

$$\frac{1}{2} nM_i \frac{\partial}{\partial t} V^2 = -\frac{1}{2} nM_i \nabla \cdot (\mathbf{V} V^2) + \frac{1}{2} nM_i V^2 \nabla \cdot \mathbf{V} - \mathbf{V} \cdot \nabla p + \mathbf{V} \cdot \mathbf{J} \times \mathbf{B} - \nabla \cdot [\mathbf{\Pi} \cdot \mathbf{V}] + \nabla \mathbf{V} : \mathbf{\Pi} - \frac{1}{2} M_i V^2 \cdot (D_\rho \nabla n + S_n)$$

$$\frac{1}{2} M_i V^2 \left[\frac{\partial n}{\partial t} + \nabla \cdot (n\mathbf{V}) = \nabla \cdot D_\rho \nabla n + S_n \cdot \right] \Rightarrow$$

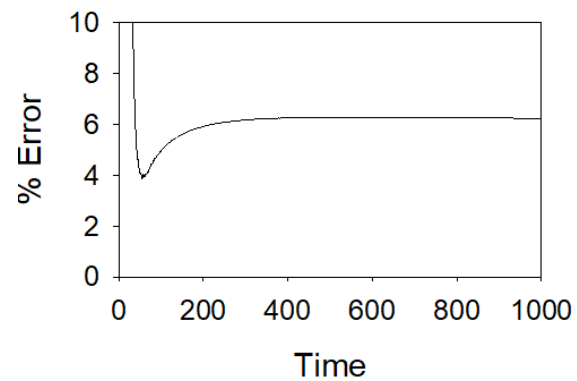
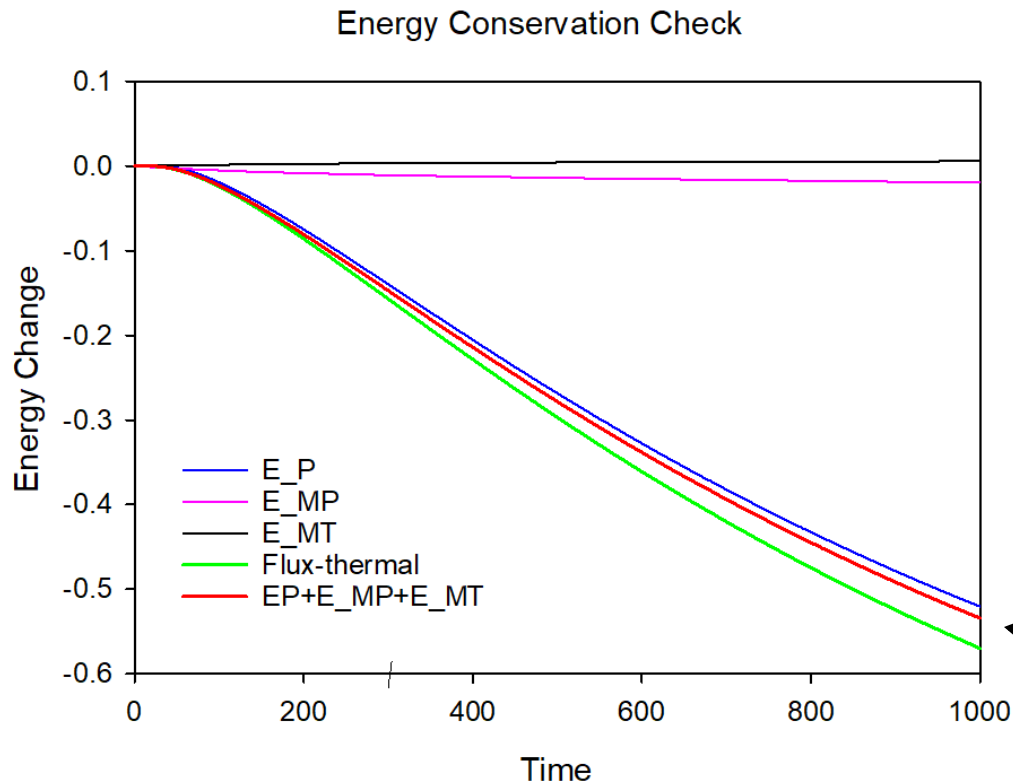
$$\frac{1}{2} M_i V^2 \frac{\partial n}{\partial t} = -\frac{1}{2} M_i n V^2 \nabla \cdot \mathbf{V} - \frac{1}{2} M_i V^2 \mathbf{V} \cdot \nabla n + \frac{1}{2} M_i V^2 \nabla \cdot D_\rho \nabla n + \frac{1}{2} M_i V^2 S_n$$

$$\frac{\partial}{\partial t} \left[\frac{1}{2} B^2 + \frac{p}{(\gamma-1)} + \frac{1}{2} nM_i V^2 \right] + \nabla \cdot \left[\left(\frac{\gamma}{(\gamma-1)} p + \frac{1}{2} M_i n V^2 \right) \mathbf{V} + \mathbf{E} \times \mathbf{B} + \mathbf{q}_e + \mathbf{\Pi} \cdot \mathbf{V} \right] = S_E$$

$E_P + E_{MT} + E_{MP}$

Flux_thermal


Energy conservation(2)



GREEN and RED curves should overlay ~ 6% error

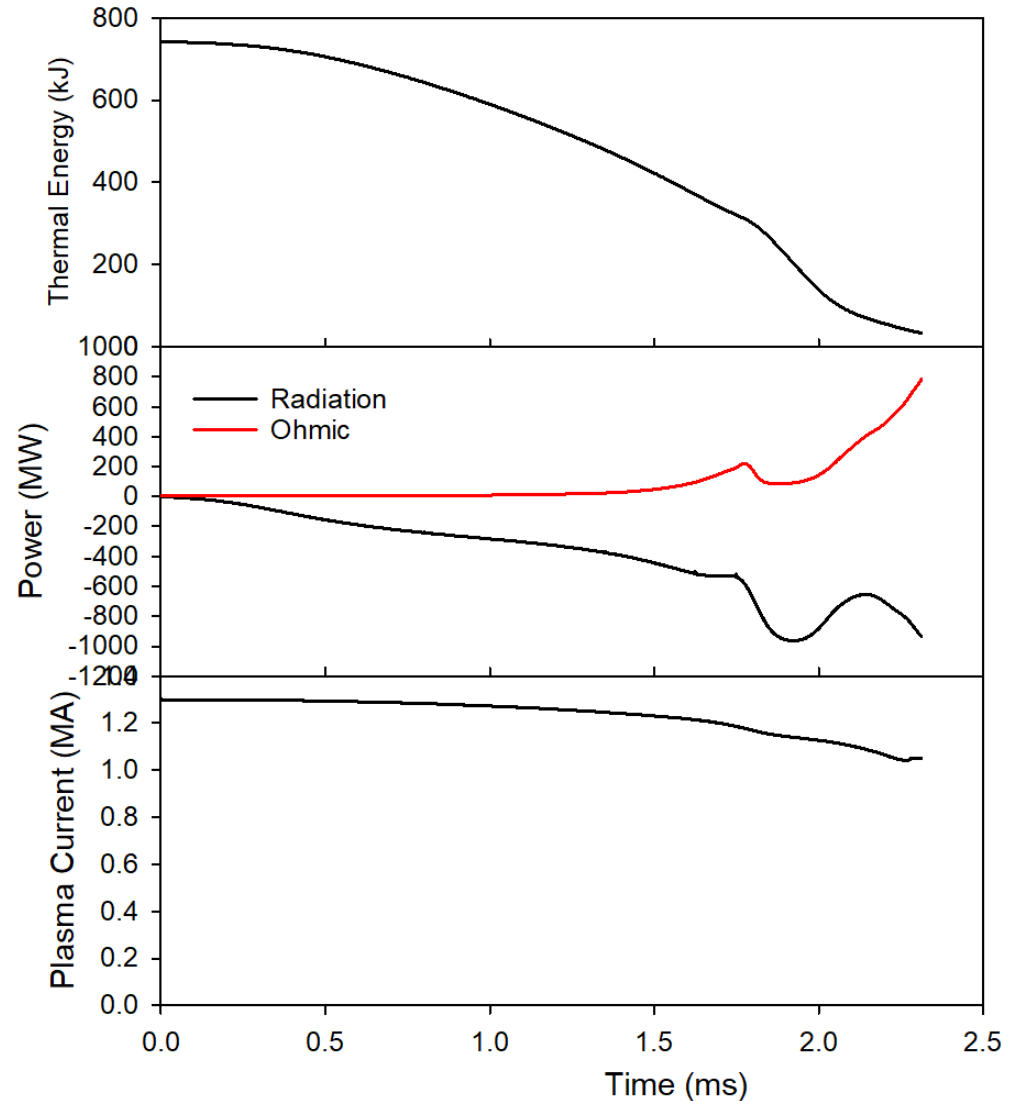
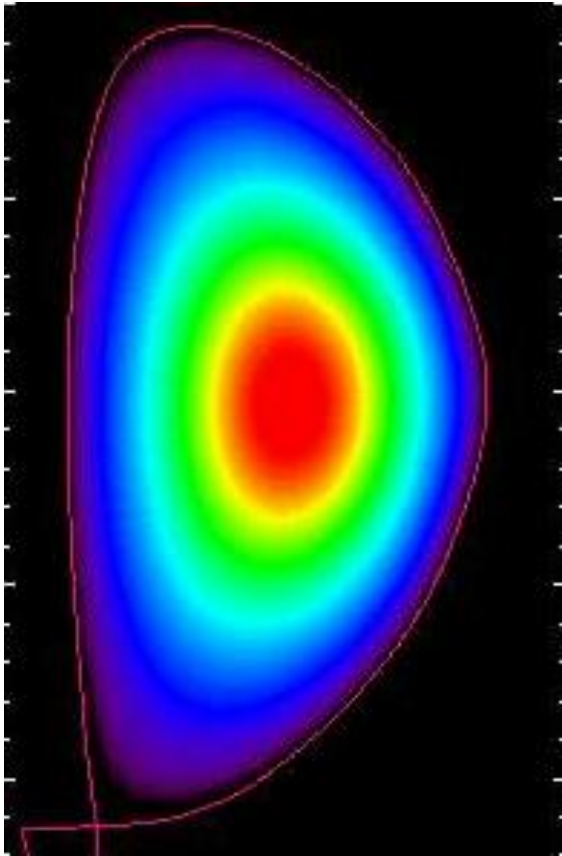
bclions file/knegt_ohmic/kr_0 with:
iconst_bz = 0

Use of Grad Shafranov equation when runaways are present

$$\Delta^* \psi = -\mu_0 R^2 p'_{\text{th}} - FF' + e\mu_0 \left[uF' + \frac{n_r}{\gamma^m} (A + e\psi) \right]$$


This term is due to the curvature drift and is neglected in our present treatment

M3D-C1 coupling to RE code KORC

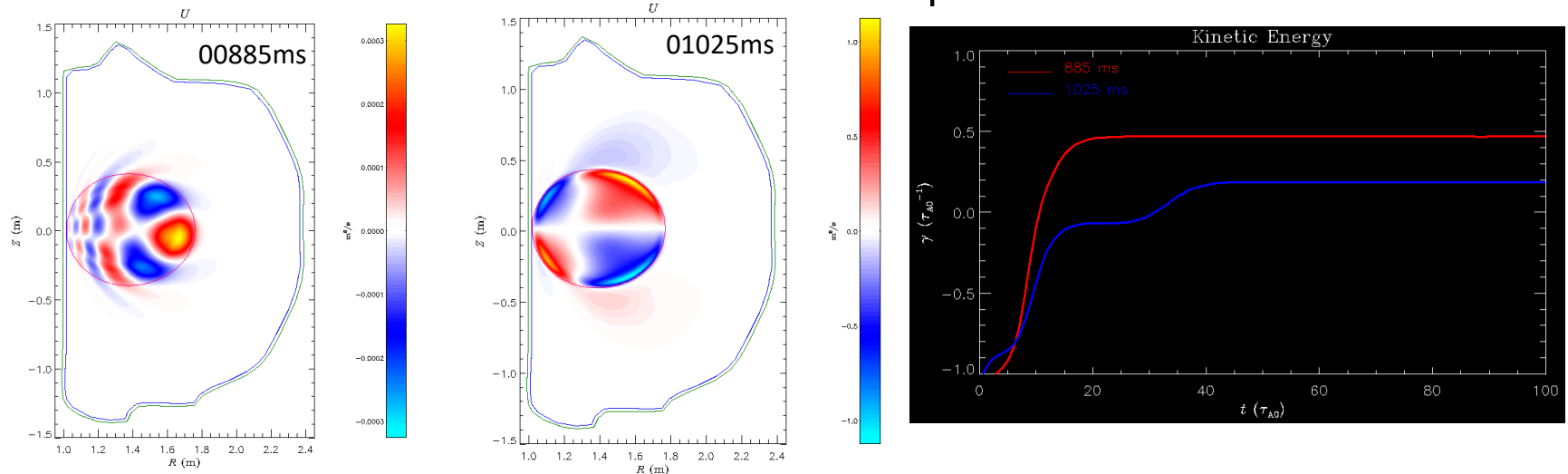


Has this case been run to longer times for the current quench?
Any word from ORNL?

Time Traces of Thermal Energy, Power Radiated, and Plasma Current

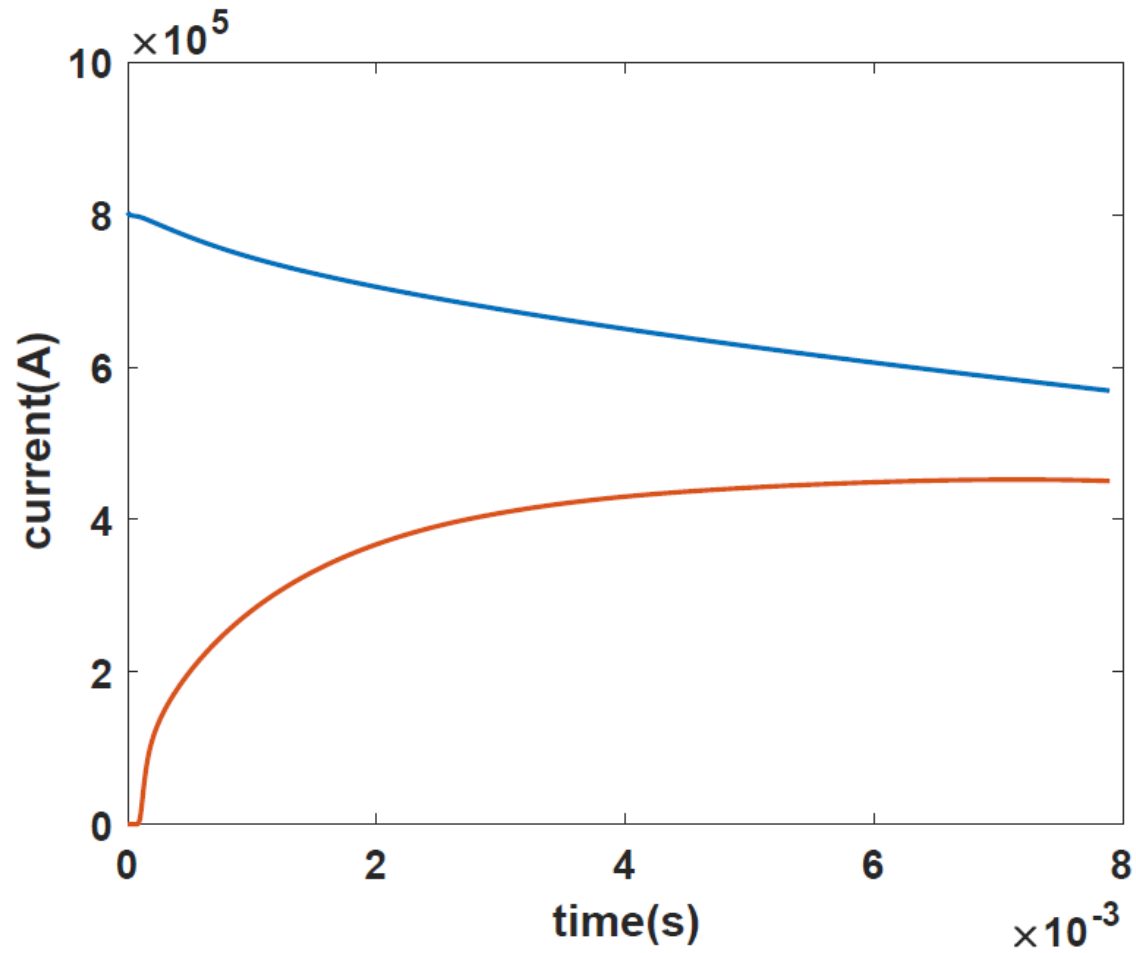
RE Fluid Modeling of DIII-D Experiments

- Carlos Paz-Soldan and Yueqiang Liu (GA) are interested in having M3D-C1 perform some nonlinear runs on shots where kink-modes de-confined Res
- Brendan Lyons suggested shot 177040. These have been looked at by Liu with the (linear) MARS code
- ZOOM call held Tuesday July 28 @ 1:00 PM ET
 - Chang Liu, Chen Zhao, Steve Jardin, Yueqiang Liu, Carlos Paz-Soldan
- Brendan sent around initial free-boundary equilibrium & results:



- Chang Liu to compare with MARS results, extend to non-linear

Runaways with Sources



Test of Boozer Theory for Cold VDE

- Have we been able to run a 2D VDE case with an ideal wall where the current is decreasing on the midplane until it goes vertically unstable?

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

That's All I have

Anything Else ?