M3D-C1 ZOOM Meeting 07/12/2021

Announcements

CS Issues

- 1. GPU solves update
- 2. Mesh adaptation
- 3. stellar.Princeton.edu and cori anomalies
- 4. NERSC Time
- 5. Changes to github master since last meeting
- 6. New section in Newdoc
- 7. Regression tests

Physics Studies

1. Magnetic boundary conditions

Note: meeting minutes posted on m3dc1.pppl.gov

In attendance

Steve Jardin Hank Strauss Chen Zhao Andreas Kleiner Adelle Wright Brendan Lyons Mark Shephard Usman Seegyoung Seol Chang Liu Jin Chen Priyanjana Sinha

Announcements

- No meeting next week (TSDW)
- 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
 - 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
- Nuclear Fusion ITPA special Issue "on the path to burning plasma operation"
 - To include published material only
 - Will be submitted to NF by July 2022

Nuclear Fusion ITPA Special Issue

1. Introduction			
2. MHD stability			
2.1 Sawtooth oscillations	V. Igochine,		
2.2 Neoclassical tearing modes	E. Kolemen,		
2.3 Resistive wall modes	<u>S. Sabbagh</u> , Y. Liu,		
2.4 Error fields	JK. Park, N. Logan,		
3. Disruptions			
3.1 Disruption Consequences	F. Villone, V. Yanovskiy, R. Granetz, V. Pustovitov, I. Bandyopadhyay, M. Lehnen,		
3.2 Disruption Avoidance	M. Maraschek, D. Humphreys,		
3.3 Disruption Mitigation and Control	N. Eidietis, C. Paz-Soldan, R. Sweeney,		
3.4 Disruption Prediction	<u>G. Pautasso</u> , C. Rea, R. Granetz,		
3.5 Disruption Modeling	S. Jardin, I. Bandyopadhyay, E. Nardon, V. Lukash, A. Matsuyama,		
4. Plasma magnetic control in ITER			
4.1 Plasma vertical stabilization by in-vessel coils	s Y. Gribov, <u>M. Dubrov</u> , (DINA Team)		
4.2 Low frequency noise in plasma vertical	D. Humphrova		

GPU Solve Status

Mesh Adaptation

Seegyoung Seol Brendan Lyons

Stellar Bug report

6/2/21 Slowdown on stellar-k08n13. Regression tests: Compute 2 x slower, solve 4 time slower

CSES response:

NICE!!!! Can we use that code? What a great job at detecting this. I'd like to run it on every node.

Taking k08n13 offline.

Bill

Brendan Lyons

Stellar.Princeton.edu



2D run. 96 p, 1 node

Switched to mumps

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

stellar.princeton.edu



Adelle 7/12/21

stellar.princeton.edu



Jardin 07/12/21 Job 36070

From Jin Chen (7/12/21)

I rebuilt PETSc and scorec libs using intel-mpi using different levels of optimization: O1, O2, O3. And here is what I have found so far:

1- for the code itself

1) code runs for MUMPS if using O1 optimization

2) code runs for MUMPS when "-mat_mumps_icntl_14 100" is added if using O2 and O3 optimizations

3) code runs for superlu_dist for all O1, O2, O3 optimizations and does not hang anymore when code finishes. superlu_dist option "-mat_superlu_dist_rowperm norowperm" can be used to get speedup.

Jin Chen-2 –file C1ke related

1) The code was set to restart at every 1,000 timesteps. The discrepancy for the 4th variable "gamma_gr" was found at restart in both MUMPS and superlu_dist:

MUMPS:

1-1000 run:

1000 5.0000E+03 2.9696E-07 -1.1929E-05 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 1000-2000 run:

1000 5.0000E+03 2.9696E-07 2.0000E-01 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 superlu_dist:

1-1000 run:

1000 5.0000E+03 2.9696E-07 -1.1838E-05 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 1000-2000 run:

1000 5.0000E+03 2.9696E-07 2.0000E-01 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04

2) the 4th variable "gamma_gr" differs in MUMPS O1 run and MUMPS O3 run

O1: 1000 5.0000E+03 2.9696E-07 -1.1929E-05 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 O2: 1000 5.0000E+03 2.9696E-07 -1.1708E-05 2.8646E-08 2.6800E-07 3.1624E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 3) the 4th variable "gamma gr" differs in superlu dist O1 run and superlu dist O3 run

O1: 1000 5.0000E+03 2.9697E-07 -1.1791E-05 2.8647E-08 2.6800E-07 3.1624E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04 O2: 1000 5.0000E+03 2.9696E-07 -1.1838E-05 2.8646E-08 2.6800E-07 3.1622E-10 5.2899E+02 1.7171E+04 4.9465E+02 1.81951E+04

Jin Chen -3 Solve Time Issue

The solve time is smooth. Not be able to repeat the wedge pattern. The plot from 2 superlu_dist restart runs is attached. The solve time dropped due to using "-mat_superlu_dist_rowperm".



cori.nersc.gov



Resubmit Same files



NERSC Time

mp288



- 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

- Nate Ferraro:
 - 07/07/21
 - For itor=0, reverted definition of "jy" and "jy_plasma" in read_field.pro and the current diagnostics in: to be the actual current density rather than scaled by rzero
 - For itor=0, changed definition of vloop to have dimensions of voltage
 - For itor=0, changed definition of "flux" scalar in read_scalars.pro to have dimensions of flux
 - Updated RMP nonlin regtest to reflect these changes
 - Incremented output "version" number to account for change to vloop definition
 - Added coding to automatically scale vloop on restart to account for recently changed definition in itor=0
- Brendan Lyons
 - 06/29/21: Change idenmfunc=1 to evaluate based on 1/Te without field (#37)
 - 06/30/21: (Co-authored by Seegyoung Seol)
 - Store itri for magaxis & te_max as global variables
 - Calling reset_itris after adaptation
 - Use diagnostics module in adapt_mesh
 - 07/02/21: Prevent pellet ablation and deposition if Lorentzian volume is zero
- S. Jardin
 - **06/29/21**: Chen Zhao's RE changes: new variables ra_cyc, radiff, rjra

New Section in newdoc

9.0 Relation between itor=1 and itor=0

The vector fields for itor=1 and itor=0 are defined as follows:

itor=1	itor=0
$\mathbf{B} = \nabla \psi \times \nabla \varphi - \nabla_{\perp} f' + F \nabla \varphi$	$\mathbf{B} = \nabla \boldsymbol{\psi} \times \hat{\boldsymbol{y}} - \nabla_{\perp} \boldsymbol{f}' + \boldsymbol{F} \hat{\boldsymbol{y}}$
$\mathbf{V} = R^2 \nabla U \times \nabla \varphi + \omega R^2 \nabla \varphi + R^{-2} \nabla_\perp \chi$	$\mathbf{V} = \nabla U \times \hat{y} + \omega \hat{y} + \nabla_{\perp} \chi$

Note that this implies that when comparing a itor=1 run with major radius R₀ with a itor=0 run with rzero:

- When applying a loop voltage to a configuration with a given resistivity, the voltage is applied in such a way that the total plasma current and wall current 'IP,IW' and current density 'jy' should be comparable for itor=0,1 if the cross section is the same and rzero=R₀
- 2. The IDL quantity "jphi" (itor=1) should be compared with jphi*rzero (itor=0)
- 3. The velocity variables U, ω, χ (itor=1) should be compared with $U/rzero, \omega/rzero, \chi \times (rzero)^2$

Local Systems

- PPPL centos7(07/12/21)
 - 6 regression tests **PASSED** on centos7:
- PPPL greene (07/12/21)
 - 5 regression tests PASSED on greene (m3dc1)
- STELLAR (07/12/21)
 - 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 (6/29/2021)
 - 6 regression tests passed
- 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)
 - ??

Magnetic boundary conditions

I = RB _T		default
iconst_bz = 1	Dirichlet	0
inocurrent_pol = 1	Neumann	0
Ψ		
iconst_bn = 1	Dirichlet	1
inocurrent_norm=1	Neumann (only in 3D)	0
f		
ifbound=1	Dirichlet	1 (real)
ifbound=2	Neumann	2 (complex)

Note that if iconst_bz and inocurrent_pol not set, there is no boundary condition being applied to the I solve

That's All I have

Anything Else ?

ITER Sideways Force



tedge = 1.01010e-3

ITER Sideways Force



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. Porcelli¹, and R. Fitzpatrick³ ¹DISAT, Polytechnic University of Turin, Torino 10129, Italy ²KTX Laboratory, School of Nuclear Science and Technology, University of Science and Technology of China, Hefei, 230022, China ³Institute 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

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

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



plot_field,'i',19,/lines,/lcfs,/bound



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

/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.

Typical Tearing Mode



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



Chen Zhao paper on RE with sources

Simulation of the runaway electron plateau formation during current quench

C. Zhao¹, C. Liu¹, S. C. Jardin¹, N. M. Ferraro¹, B. C. Lyons² V. Bandaru³, M. Hoelzl³

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) J_RA



0.002 0.004 0.006 0.008 0.01 0.012 0.014 time(s)

0.2

0 0

Runaway current during 2nd ST phase

3.4

3.5

-0.13

-0.14

-0.15

-0,16

-0.17





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)

10002.7500E+033.0076E-013.6364E-012.8914E-022.7081E-011.0371E-036.3888E+022.1293E+043.2050E+022.22524E+0410012.7528E+03**3.0125E-012.9180E-04**2.9007E-02**2.7121E-01**1.0298E-036.3882E+022.1293E+043.2028E+022.22521E+0410022.7555E+03**3.0170E-012.7516E-042.9101E-02**2.7157E-01**1.0278E-03**6.3875E+022.1293E+043.2005E+022.22518E+0410032.7582E+033.0214E-01**2.6496E-042.9189E-022.7193E-011.0246E-03**6.3869E+022.1293E+043.1982E+022.22515E+04

-2 slurm18516 died 1088 SEGV (SuperLU)

1000 2.7500F+03 3.0076F-01 3.6364F-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** 2.9188F-02 2.7192F-01 1.0250F-03 6.3869E+02 2.1293E+04 3.1982E+02 2.22515E+04

-3 slurm18607 died 1049 SEGV (SuperLU)

10002.7500E+033.0076E-013.6364E-012.8914E-022.7081E-011.0371E-036.3888E+022.1293E+043.2050E+022.22524E+0410012.7528E+03**3.0124E-012.9007E-022.7121E-01**1.0298E-036.3882E+022.1293E+043.2028E+022.22521E+0410022.7555E+03**3.0170E-012.7414E-042.9101E-02**2.7157E-01**1.0278E-03**6.3875E+022.1293E+043.2005E+022.22518E+0410032.7582E+033.0214E-01**2.6593E-042.9189E-022.7193E-011.0248E-03**6.3869E+022.1293E+043.1982E+022.22515E+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 1½ 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



Drecier and Avalanche

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)

Radiation

t = 0.73 ms



Shell carbon pellet in NSTX (now running)



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 $|\Theta - \phi| < \delta$

#1. Will a purely toroidal voltage from the plasma current decaying drive a helical current in this geometry? $\nabla \times \mathbf{E} = 0 \implies \mathbf{E} = -\nabla \Phi + \frac{V_L}{2\pi} \nabla \phi$

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

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









φ = 090°



 Φ_{ϕ}







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



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

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)





Chen Zhao

Same calculation in a Cylinder

M3D-C1 runaway generation with cylinder geometry



Parameters: β₀ = 0.15

 $\begin{array}{l} a = 0.65m \\ R = 1.7m \\ B_0 = 1.9T \\ \eta = 1.0 \times 10^{-4} \\ n_0 = 1.0 \times 10^{20} m^{-3} \\ c = 150 v_A \\ N_{elements} = 12261 \\ \Delta t = 1.0 \tau_A \end{array}$

- 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?








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 in1F toroidalequilibrium
- (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 intothe LP Codeσ

- (a) Density source in 1F toroidal equilibrium
- (b) Change in density after 10³ τ_{A}
- (c) Poloidal velocity stream function
- (d) Toroidal velocity contours





Grad-B drift in M3D-C1—2F effects

- (a) 2F density change after $10^3 \tau_A$ for LF side source
- (b) Difference in 1F and 2F density (LF)
- (c) 2Fdensity change after $10^3 \tau_A$ 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



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