M3D-C1 ZOOM Meeting

11/16/2020

Agenda

1. CS Issues
    1. GPU solve status
    2. Local systems
    3. Other systems
    4. NERSC Time
    5. Changes to github master since last meeting
    6. C. Clauser proposal for reading pellet info
    7. Qsolver to m3D-C1 documented
2. Physics Studies
    1. M3D-C1 involvement in 2021 Theory Performance Target
    2. Status of first coupled M3D-C1/LP Simulation .. Lyons/Samulyak
    3. DIII-D shot 177053 progress
    4. Chen Zhao Update on sawtooth with runaways
    5. NSTX shot 1224020
    6. Status of other simulations
    7. Other?

GPU solve status

Update from Jin Chen on 11/16/2020 Re: Traverse

We have fixed the seg fault error for 2 mpi-tasks run. We thought it should work for any multi-tasks run, but actually not. The 4 or more than 4 mpi-tasks runs still failed due to the same error at the same location. The Superlu group are working on it.

Local Systems

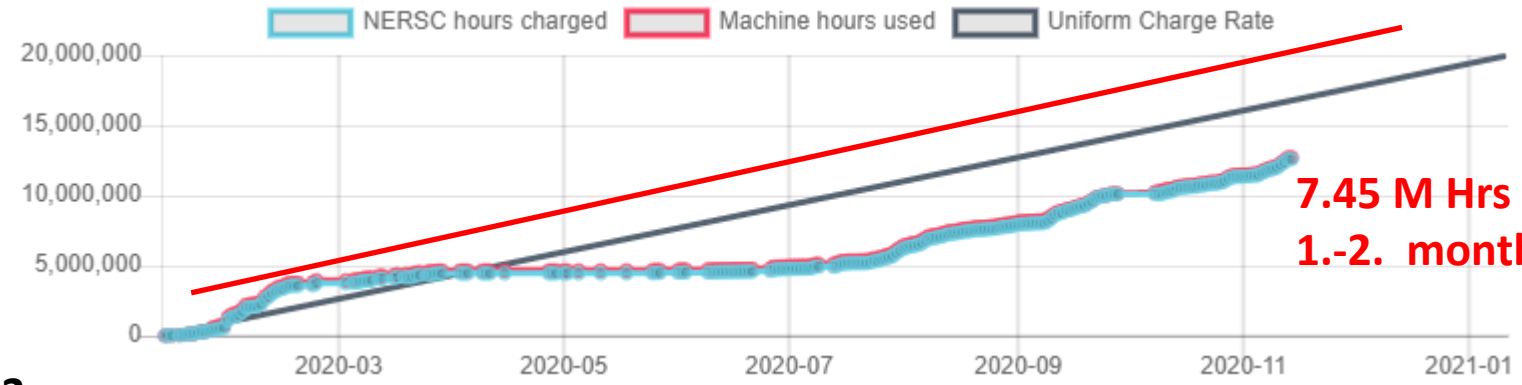
- PPPL centos7(11/16)
  - All 6 regression tests PASSED on centos7:
- PPPL greene (11/16)
  - 5 regression tests PASSED
  - No batch file found for pellet
- EDDY (11/16)
  - All 6 regression tests PASSED
- TRAVERSE(11/16)
  - Code compiles
  - Regression test failed: split_smb not found in PATH
  - Have not yet tried shipping .smb files from another machine

Other Systems

- Cori-KNL (11/16)
  - 6 regression tests passed on KNL
- Cori-Haswell (11/16)
  - 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
- 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)
  - ??

NERSC Time

mp288



7.45 M Hrs left
1.-2. months

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 Dec 15 (New estimated arrival date)
- New NERSC allocations start Jan 15 2021

Changes to github master since last meeting

- N. Ferraro
  - 11/4/20: Added check to only read toroidal angle data if restarting from a 3D case. Removed condition that nplanes only changes by an integer multiple on restart
- Usman Riaz
  - 11/2/20: 2D anisotropic Mesh Adaptation case has been added. A function to create dummy size field is added for testing. Anisotropic function for frames and size vectors for the proposed API is updated
- Seegyoung Seol
  - 11/2/20: global 2nd order adjacency operator added

C. Clauser proposal for reading pellet info

- Cesar wants to change some pellet parameters at restart time. So, he suggests that the following pellet variables only be read from the restart file if iread_pellet.ge.1:
- pellet_var, pellet_var_tor, pellet_verr, pellet_velphi, pellet_velz, pellet_vx, pellet,vy, cloud_pel, pellet_mix

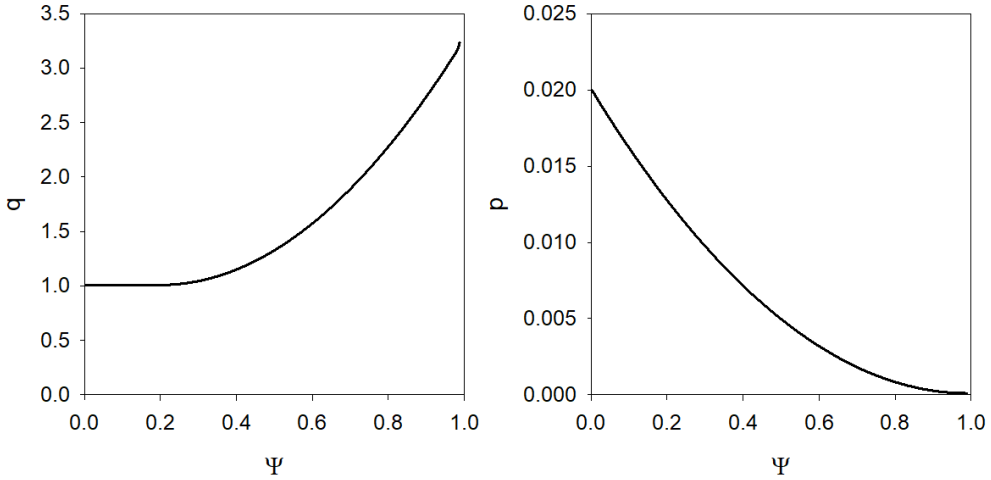
(note: pellet_vx and pellet_vy are auxialliary variables)

So, if iread_pellet .eq. 0 (default) the values of these in the C1input file at the restart time will be used, allowing them to be changed

In addition, he is adding a new ablation model which sets the ablation rate to a constant. He is using the input variable “pellet_rate” for this

Counter proposal made by Brendan at 1:44 today involving adding new input variable irestart_pellet which defaults to what we have now. The new constant ablation model is fine with Brendan.

qsolver to M3D-C1 documented



- You can use the qsolver code to calculate a toroidal equilibrium with a specified shape, q(ψ), p(ψ), profiles
- The output profiles-p and profiles-g files can be read into m3dc1 with inumgs=1
- This is now documented in the new Section 20 of the newdoc.pdf at m3dc1.pppl.gov

M3D-C1 involvement in 2021 Theory Performance Target

Q1: Perform a disruption mitigation simulation to provide data for iRFP and NORSE codes to simulate hot tail formation and for KORC to simulate RE transport in stochastic magnetic fields

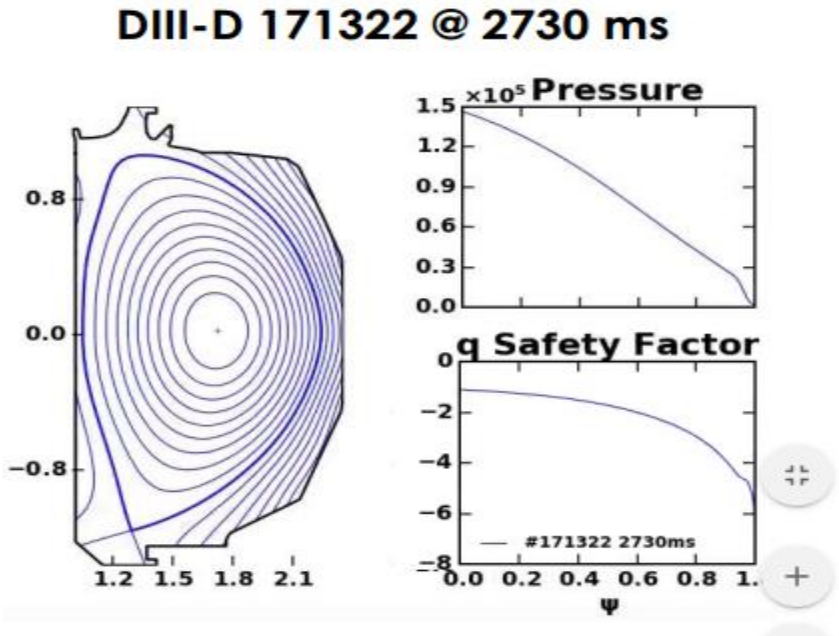
Q2: MHD simulations using M3D-C1 and NIMROD will be conducted to investigate the time dynamics of the thermal collapse rate and effect of MHD instabilities and stochastic fields on seed formation.

Q3: Run KORC and CQL3D with impurity profiles from M3D-C1 and NIMROD MHD simulations to study effect in 3D impurity fields.

Q4: Self-consistent simulations including thermal quench with impurities injection, RE-MHD coupling, and MHD instabilities will be conducted using M3D-C1 and NIMROD

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



8/10/20 – proposed

10/5/20 – Brendan sent data from a 2D run

10/7/20 – Roman requested more concise data from around pellet vs time

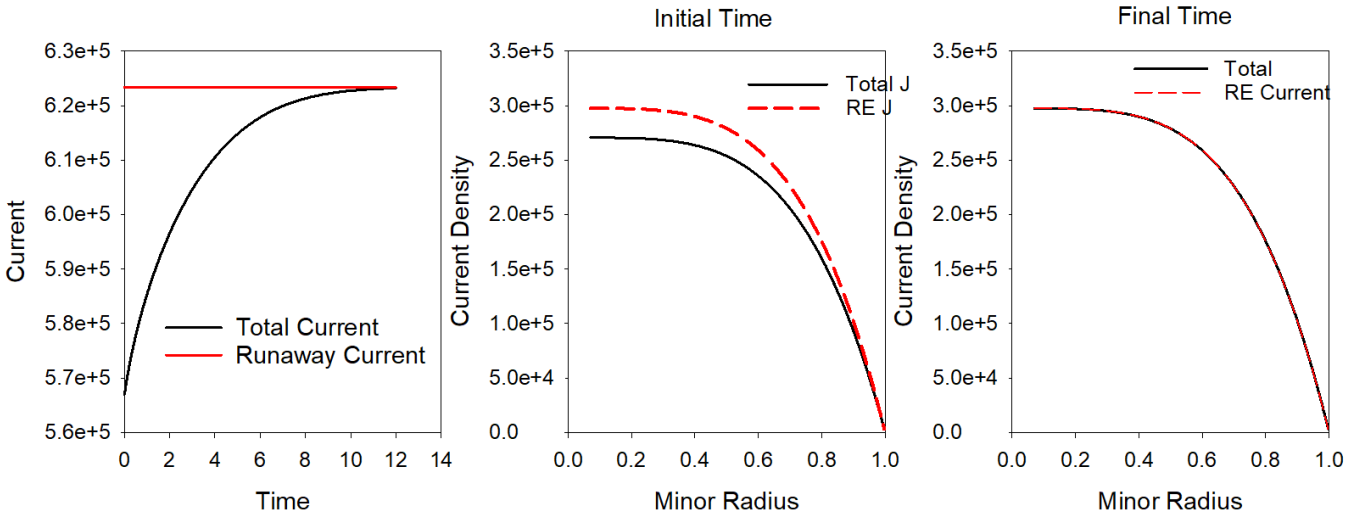
10/20/20 – Brendan developed and documented postprocessor for LP ablation code.

11/2/20 – Roman said they will use Brendan's data this week and then schedule a ZOOM

11/16/20 – Roman requested a zoom next week

DIII-D shot 177053 – Runaway generation with Ar injection

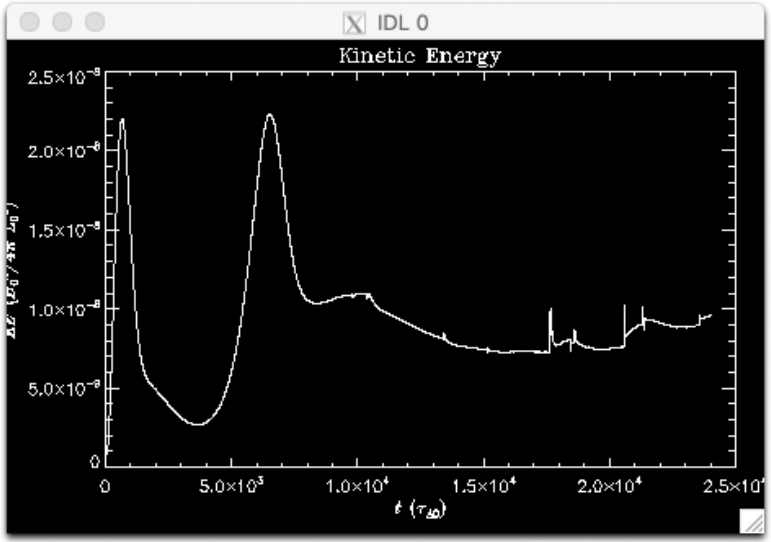
- Chen was concerned that when the runaway current exceeded the total current, η (J – J_{RA}) would reverse sign and code would be unphysical and numerically unstable
- I set up a case like this in my 1D stand-alone code, and it worked fine. Negative (J – JRA) just means the bulk current has reversed
- He has sense also verified this in his stand-alone code

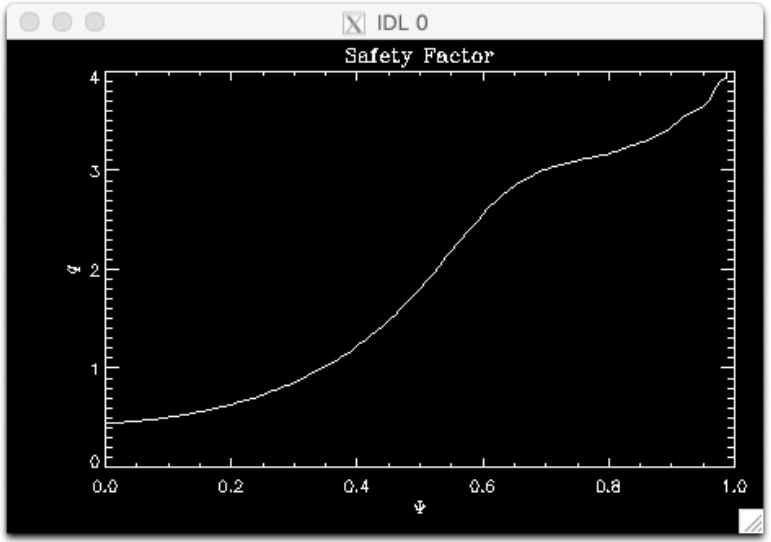


Chen Zhao on Sawteeth with RE

11/16/20

2d result with 50% runaway current



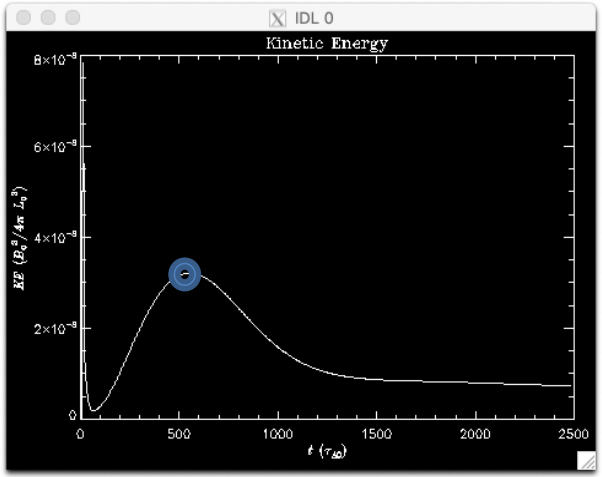


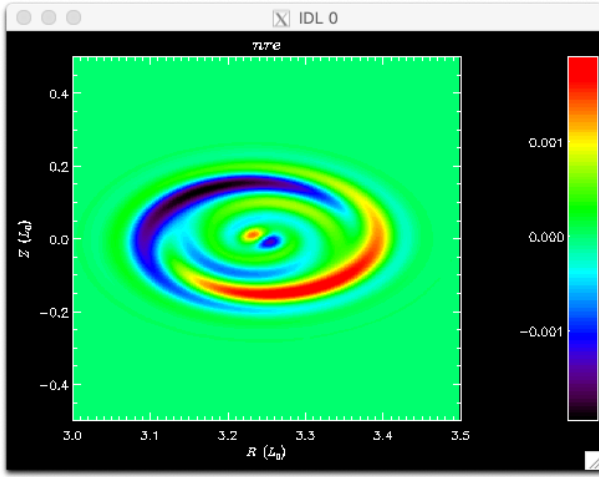
There is no sawtooth after t ~ 10000tau_A

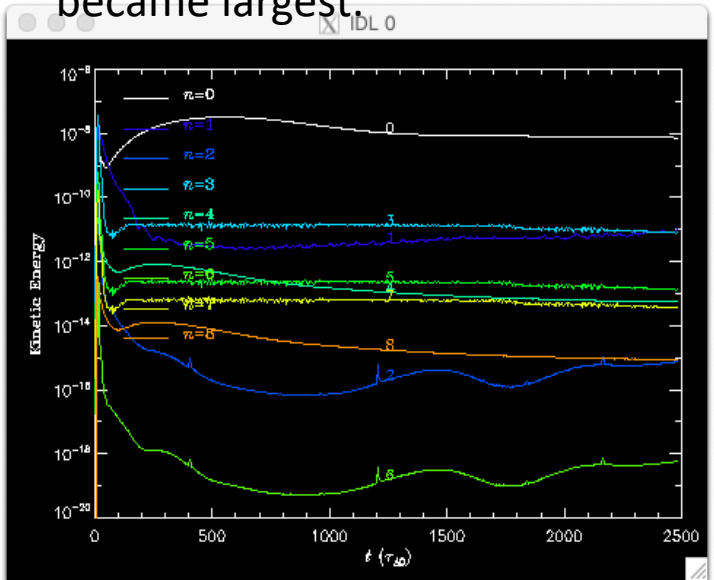
q was much lower than 1(~0.5) at the center in 2nd sawteeth phase

3d result with 50% runaway current

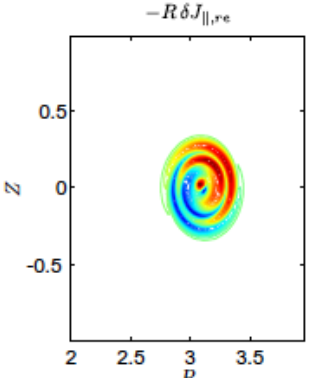
The HMN plot shows that n=1 harmonic was largest before t = 100tau_A, and after that n=0 harmonic became largest.





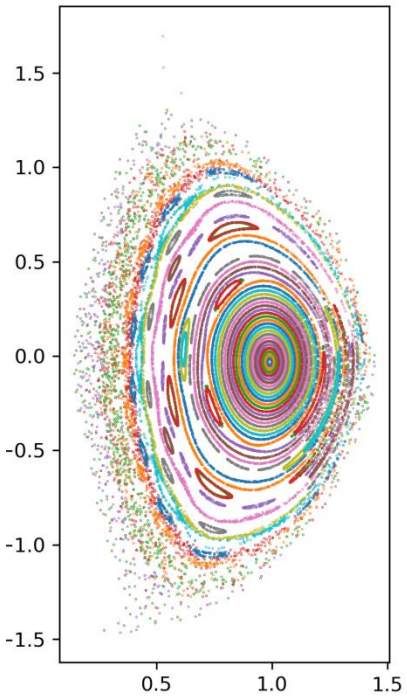


The runaway current profile t=500tau_A(blue circle in the left figure) at the center looks similar with Cai & Fu's paper.



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.

Progress on other shots?

DIII-D shot 177040 – saturated mode amplitude of (2,1) mode with runaways

- Chang Liu, Chen Zhao

DIII-D Neon pellet mitigation simulation for KORC

- Brendan Lyons

SPARK ?

That’s All I have

Anything Else ?

Grad-B drift in M3D-C1—HF side

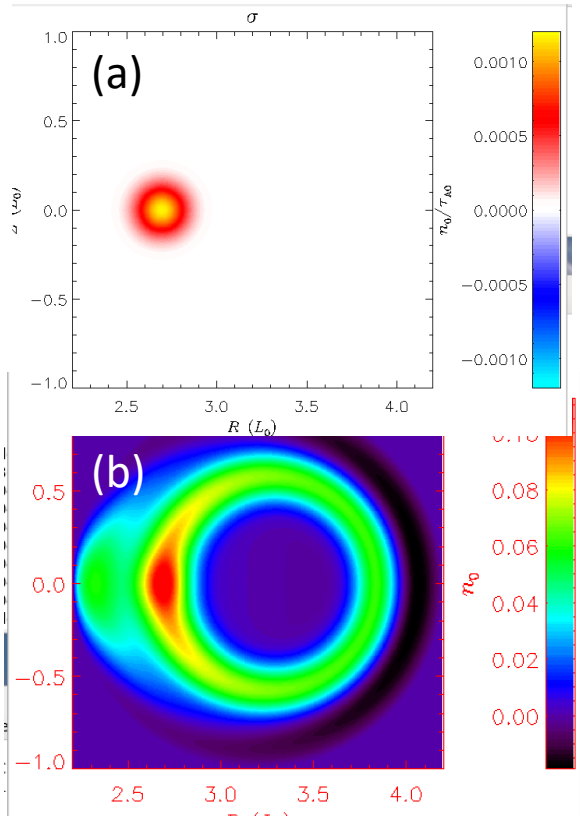
Request to calculate grad-B drift in M3D-C1 and to compare with that being put into the LP Code

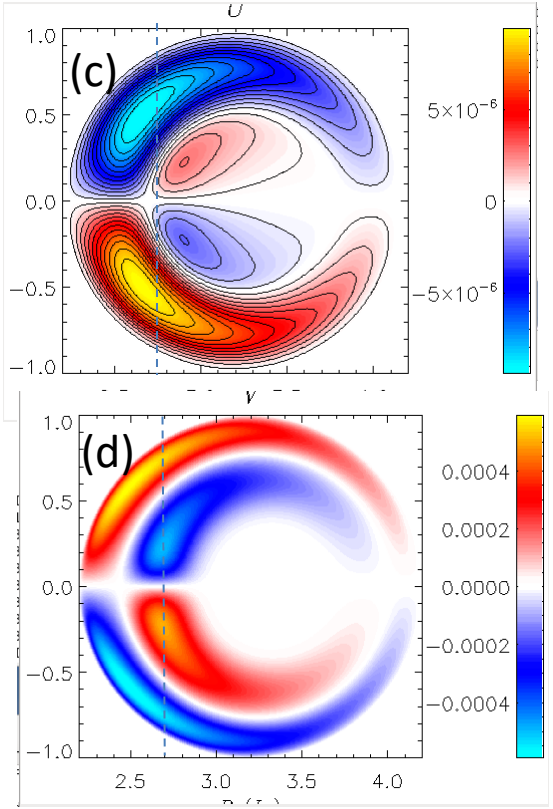
(a) Density source in 1F toroidal equilibrium

(b) Change in density after 10^3 τ_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 τ_A

(c) Poloidal velocity stream function

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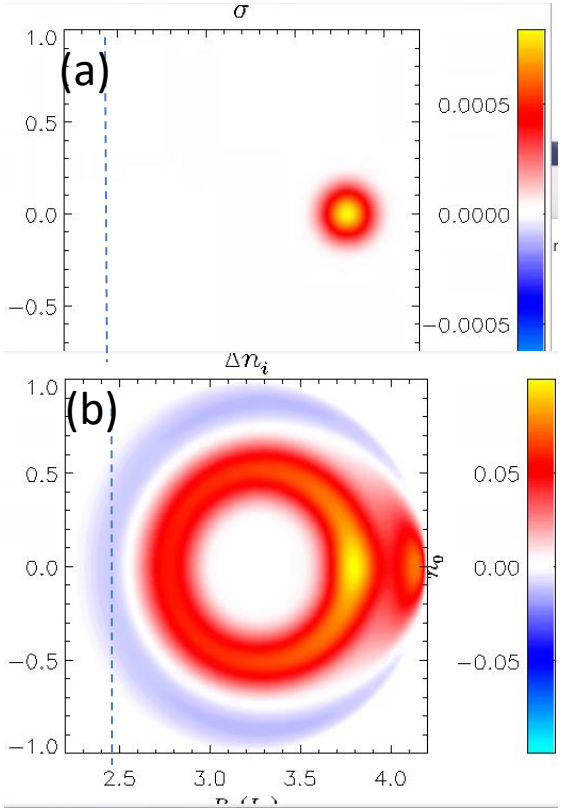
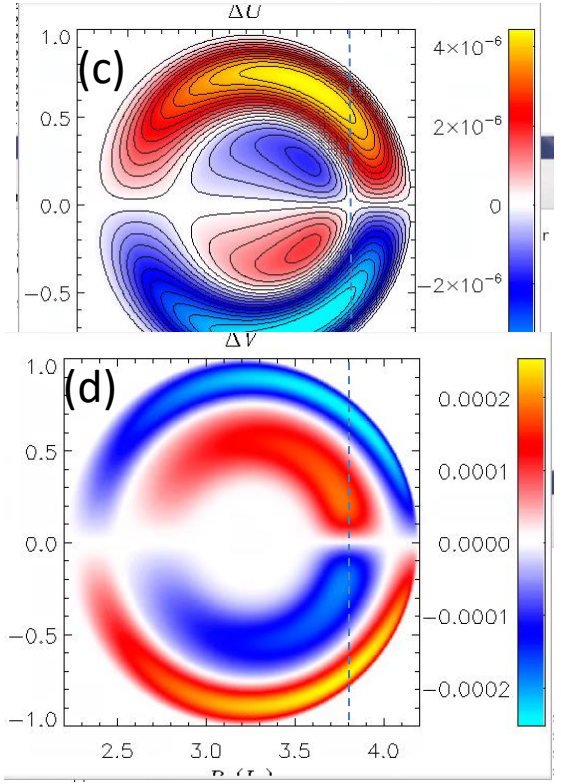




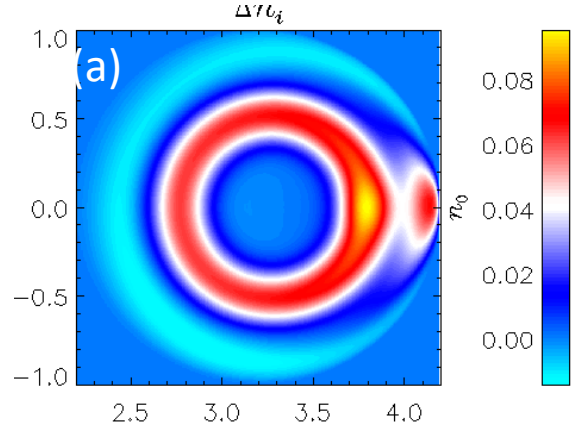
Grad-B drift in M3D-C1—2F effects

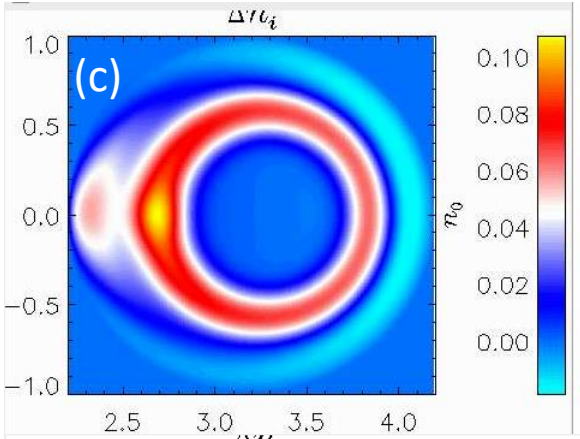
(a) 2F density change after 10^3 τ_A for LF side source

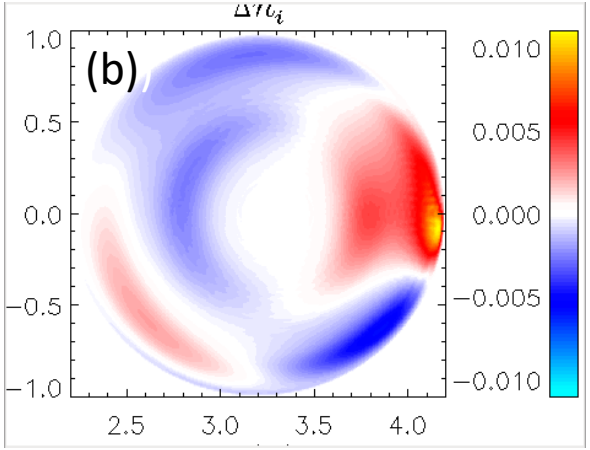
(b) Difference in 1F and 2F density (LF)

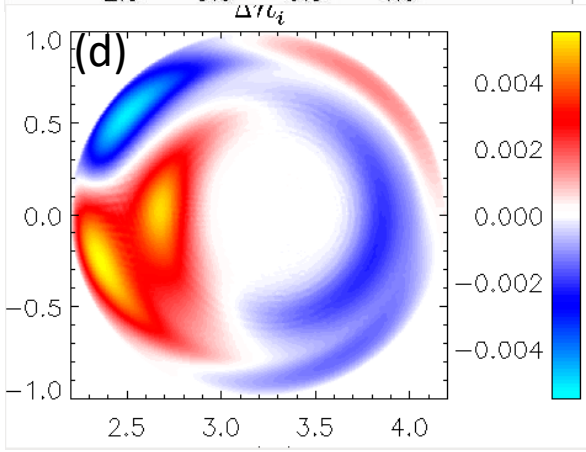
(c) 2Fdensity change after 10^3 τ_A for HF side source

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

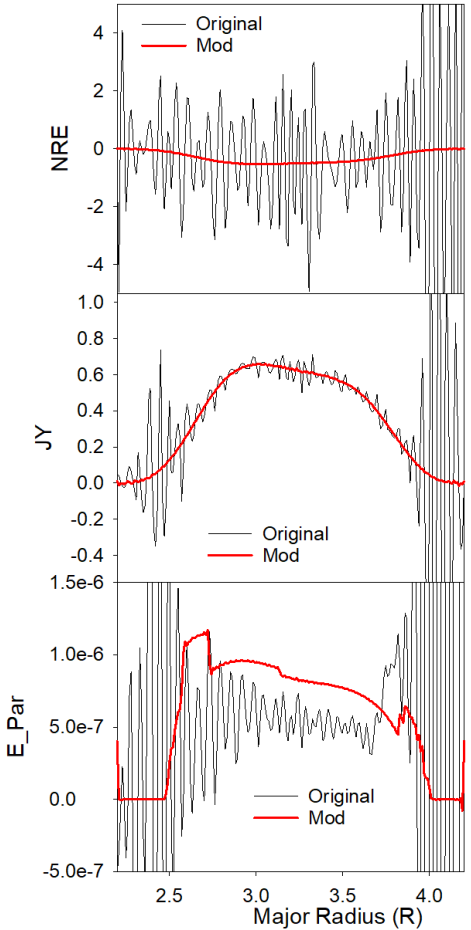








Sawtoothing discharge with runaway electrons

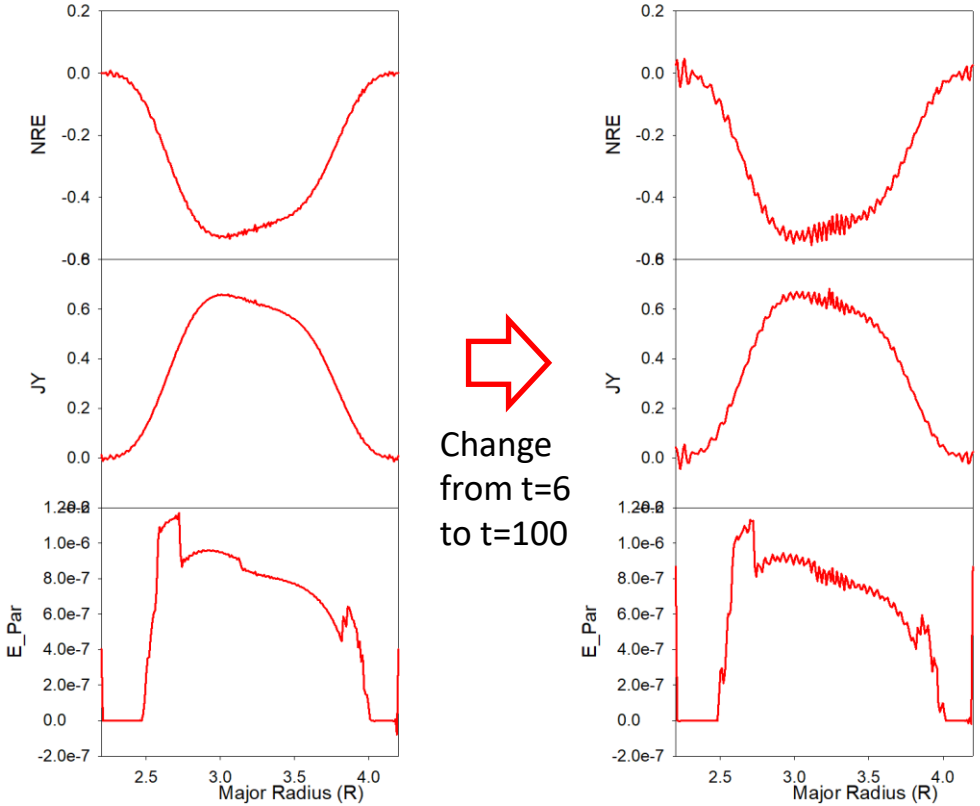


Profiles of nre, jy, and E_par after 30 timesteps

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



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