

M3D-C1 ZOOM Meeting

09/20/2021

Announcements

CS Issues

1. Mesh adaptation update
2. NERSC Time
3. Changes to github master since last meeting
4. Regression tests
5. GPU update

Physics Studies

1. New ikappafunc=1 now available
2. M3D-C1 LP Coupling status – Samulyak, Lyons
3. 1/1 mode with negative loop voltage on EAST – Liqing Xu
4. Poloidal Velocity Boundary Conditions – Lyons
5. DIII Pellet Injection without RE goes unstable – Chen Zhao

Note: [meeting minutes posted on m3dc1.pppl.gov](https://m3dc1.pppl.gov)

In attendance

Steve Jardin

Andreas Kleiner

Jin Chen

Adelle Wright

Nate Ferraro

Chen Zhao

Brendan Lyons

Chang Liu

Andreas Kleiner

Mark Shephard

Seegyong Seol

Usman Riaz

Morteza Siboni

Announcements

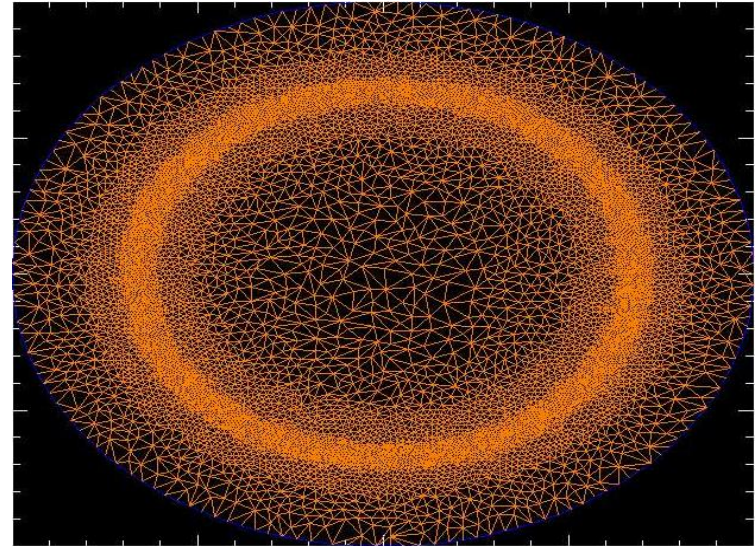
- NERSC ERCAP requests due Oct 4
 - Separate requests for CPU (cori and Perlmutter) and GPU(Perlmutter)
- /p/tsc to be upgraded during Sept. maintenance period
 - 20 times faster and greatly expanded size
- John Mandrekas requested a 90 min presentation from all SciDACs
 - Progress over last 4 years
 - Plans for next year
 - Synergy between Physics and CS teams
 - Most important unsolved problems in our area
- APS Nov 8-12
 - Meeting will be IN PERSON with virtual option
 - M3D-C1 Invited talks by C. Liu, A. Wingen
 - CTTS meeting? Will DOE allow travel?
- EPS 6/27 – 7/1 2022 in Maastricht, Netherlands
 - Nominate invited speakers by 29 October 2021

Mesh Adaptation Update

Jardin and Strauss prepared request for capability for refinement at rational surface and wall.

$$h^{-1} = \tilde{h}^{-1} + \frac{1}{l_c} \left[\frac{1}{1 + \left(\frac{\tilde{\psi} - \psi_c}{W_c} \right)^2} \right]$$

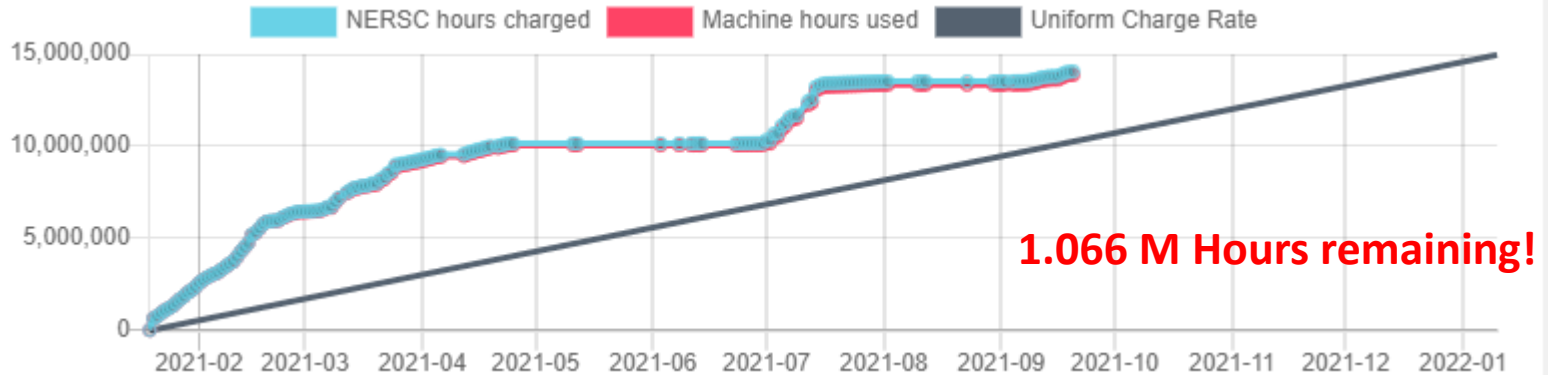
Nate recommended waiting until Brendan develops capability for arbitrary size field.



RPI?

NERSC Time

mp288



- mp288 received 10M Hrs for CY 2021, + 5M Hrs additional
- Pearlmuter time will not be charged for this FY
- We are NESAP Tier 2. Machine not yet ready. Phase-I w GPUs
- FY2022 ERCAP now open, due 10/4/12 (Lyons: include DE-SC0020299 for analysis of JET/KSTAR mitigation experiments)

Changes to github master since 09/12/21

S. Jardin:

9/17/21: Changes for ikapparfunc=1

Seegyung Seol:

9/13/21: fixing m3dc1_scorec compilation error

Nate Ferraro:

9/16/21: Updates to allow plot_br.pro and associated IDL routines work properly for nonlinear calculations

9/17/21: Merged stellarator branch into master

Local Systems

- PPPL centos7(09/12/21)
 - 4 regression tests **PASSED** on centos7:
 - RMP_nonlin **failed**
 - ADAPT **failed**
- PPPL greene (09/12/21)
 - 3 regression tests **PASSED** on greene (m3dc1)
 - No batch file found for pellet
 - RMP_nonlin **failed** (almost same way as in centos2)
 - ADAPT **failed** (in same way as on centos7)
- STELLAR (09/19/21)
 - 4 regression tests **PASSED** on stellar
 - RMP_nonlin **failed**
 - ADAPT **failed**
- TRAVERSE(09/12/21)
 - Code compiles
 - Regression test failed: split_smb not found in PATH

Other Systems

- Cori-KNL (9/19/2021)
 - 4 regression tests **PASSED** on KNL
 - RMP_nonlin **failed**
 - ADAPT **failed**
- Cori-Haswell (9/19/2021)
 - 4 regression tests **PASSED** on cori
 - RMP_nonlin **failed** in same way as on knl
 - ADAPT **failed** in same way as on knl
- MARCONI
 - All regression tests PASSED on MARCONI (J. Chen, 9/04/20)
- **ADAPT and RMP_nonlin fail in same way on all machines**

Difference in RMP_nonlin

KE

<	1	2.0000E+01	<u>6.8302E-06</u>	1.4052E-02	2.6177E-06	4.2039E-06	8.6268E-09	4.1017E-01	1.2798E+03	5.3552E-01	1.28070E+03
<	2	4.0000E+01	5.4228E-06	-5.7429E-03	2.0945E-07	5.2093E-06	4.1356E-09	4.1004E-01	1.2798E+03	5.3544E-01	1.28070E+03
<	3	6.0000E+01	6.6955E-06	5.2510E-03	2.1988E-08	6.6720E-06	1.5442E-09	4.0997E-01	1.2798E+03	5.3543E-01	1.28070E+03
<	4	8.0000E+01	8.5336E-06	6.0348E-03	1.4872E-08	8.5166E-06	2.1278E-09	4.0993E-01	1.2798E+03	5.3543E-01	1.28070E+03
<	5	1.0000E+02	<u>1.0689E-05</u>	5.6070E-03	1.5061E-08	1.0671E-05	3.1740E-09	4.0992E-01	1.2798E+03	5.3543E-01	1.28070E+03

>	1	2.0000E+01	<u>6.8288E-06</u>	1.4048E-02	2.6163E-06	4.2038E-06	8.6249E-09	4.1018E-01	1.2798E+03	5.3552E-01	1.28070E+03
>	2	4.0000E+01	5.4225E-06	-5.7391E-03	2.0960E-07	5.2088E-06	4.1364E-09	4.1004E-01	1.2798E+03	5.3544E-01	1.28070E+03
>	3	6.0000E+01	6.6941E-06	5.2473E-03	2.2017E-08	6.6706E-06	1.5453E-09	4.0997E-01	1.2798E+03	5.3543E-01	1.28070E+03
>	4	8.0000E+01	8.5310E-06	6.0324E-03	1.4879E-08	8.5140E-06	2.1274E-09	4.0993E-01	1.2798E+03	5.3543E-01	1.28070E+03
>	5	1.0000E+02	<u>1.0685E-05</u>	5.6050E-03	1.5062E-08	1.0667E-05	3.1726E-09	4.0992E-01	1.2798E+03	5.3543E-01	1.28070E+03

Same results on all machines: Differences grow slowly in time

Cycle 1: 6.8302E-06 vs 6.8288E-06 (0.020%)

Cycle 5: 1.0689E-05 vs 1.0685E-05 (0.037%)

Changes likely due to more accurate parabolization term when stellarator version was merged. Rebaseline?

Difference in C1ke files for adapt

Unchanged from 9/13/21

```
< 0 0.0000E+00 1.6085E-01 1.5011E-10 0.0000E+00 1.6085E-01 0.0000E+00 4.5714E+00 3.2116E+04 5.9487E+00 3.21267E+04  
---  
> 0 0.0000E+00 1.6085E-01 3.6410E-11 0.0000E+00 1.6085E-01 0.0000E+00 4.5726E+00 3.2125E+04 5.9487E+00 3.21360E+04
```

1.5011E-10
3.6410E-11

gamma_gr

4.5714E+00
4.5726E+00

emagp

3.2116E+04
3.2125E+04

emagt

gamma_gr does not have any meaning for the 0 time step ... can ignore
emagp is the integrated energy in the poloidal field
emagt is the integrated energy in the toroidal field

GPU update

From Chang Liu 9/13/21:

I have finished the first version GPU matrix assembling and uploaded to the "traverse-gpu" branch. It can now run on traverse. I wonder if you can help me test this code on traverse, doing some regression tests, and let me know if it works as expected. If it works well, I will merge this to the master branch.

Additional 9/20/21:

- Working with Jin Chen, PETSc group, and Sherry Li to get a version of the solvers to work on GPUs.

S. Jardin will post Chang's instructions on how to access, compile, and run TRAVERSE GPU version

New ikapparfunc=1 now available

$$\text{ikapparfunc}=0 \quad \chi_{\parallel} = \text{kappar} \quad (\text{default})$$

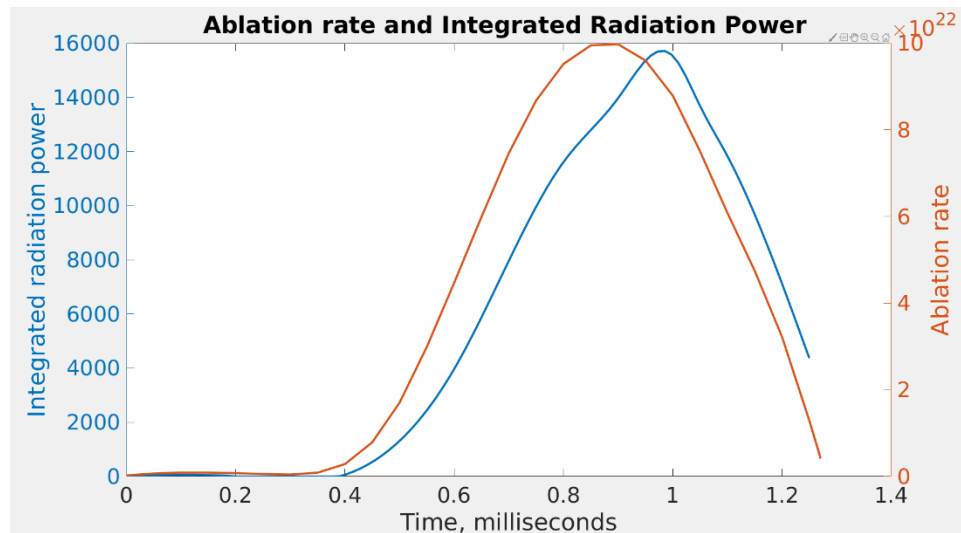
$$\text{ikapparfunc}=1 \quad \chi_{\parallel} = \text{kappar} \times \left[\left(T_c / T \right)^{5/2} + 1 \right]^{-1}$$

$$T_c = \text{tcrit} \quad (\text{internal units})$$

Parallel thermal conductivity can now be plotted with IDL routine:
`plot_field,'kappar',file='...../C1.h5',nslice`

M3D-C1 – LP Code coupling

- Brendan wrote to Daisuke on 9/10/2021 requesting more experimental information
- Daisuke sent vgs from 3/18/21 on 9/15/21. Will be posted with meeting minutes.
- Roman produced plot of integrated radiated power vs time
- Roman anxious to publish sensitivity of ablation rate to the plasma state input.



1/1 mode with negative vloop on EAST

Email from Liqing Xu on 8/31/21

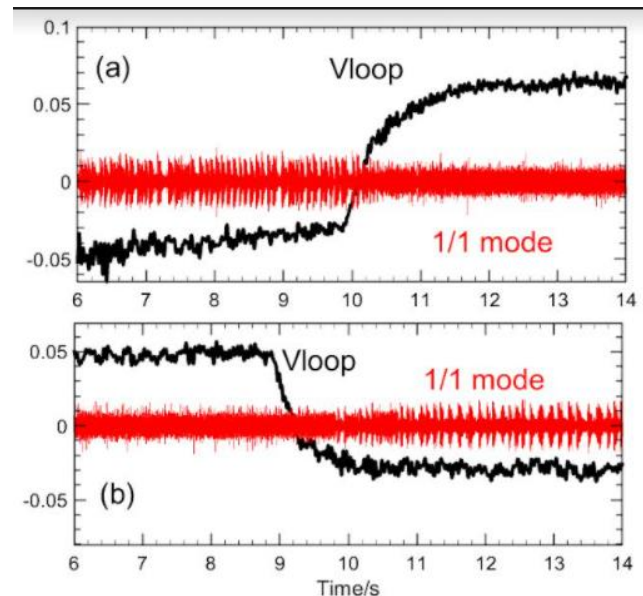
- Recently, we found some interesting data in EAST toroidal loop voltage feedback control experiment.
- The target plasma has a very strong central electron heating by LHW and ECRH. $R/L_{Te} \sim 10$ in the core. The plasma current is almost non-inductive, say $I_{ohmic} \sim 0$.
- In Vloop FB experiment, a 1/1 mode is present when Vloop slightly below zero, and disappear when Vloop above zero, as shown in the attached figure.

Email updates: 9/3 and 9/6 and

- The total current 500kA is feedback controlled. q_{95} is about 5.6-5.7;
- Both the plasma current and loop voltage are controlled by together of 4.6G lower hybrid waves and Ohmic current.

Email update 9/18/21

- From the equilibrium reconstructions with EFIT+POINT, the q_0 in negative loop voltage is closer to unity than the value in positive case. The current profile more peaked in positive Vloop, and $q_0 \ll 1$. We do not have MSE, but have 11 channels of polarimeter-interferometer (POINT) for q_0 measurements.



Yao Zhou wrote on 9/17 that he will visit ASIPP in a few weeks and will talk with Liqing and request additional data!

Poloidal Velocity Boundary Conditions

No normal flow

should be

$$R^2 \nabla U \times \nabla \phi \cdot \hat{n} + R^{-2} \nabla_{\perp} \chi \cdot \hat{n} = 0$$

we now have

$$R^2 \nabla U \times \nabla \phi \cdot \hat{n} = 0$$

$$R^{-2} \nabla_{\perp} \chi \cdot \hat{n} = 0$$

No slip

should be

$$R^2 \nabla U \times \nabla \phi \cdot \hat{t} + R^{-2} \nabla_{\perp} \chi \cdot \hat{t} = 0$$

we now have

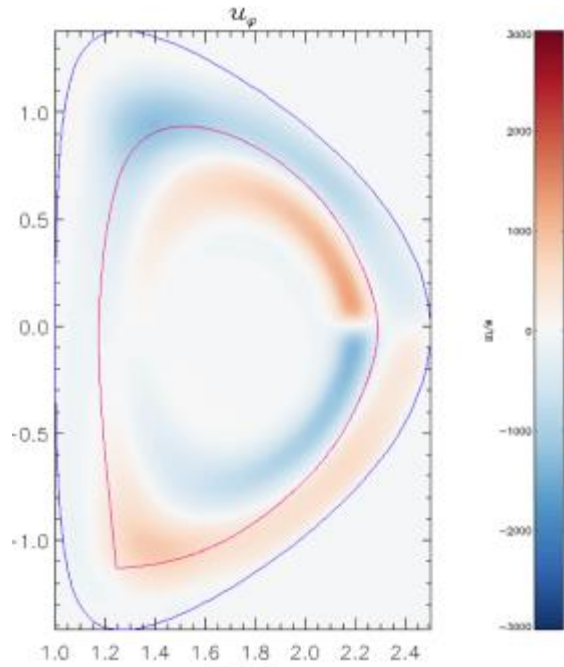
$$R^2 \nabla U \times \nabla \phi \cdot \hat{t} = 0$$

$$R^{-2} \nabla_{\perp} \chi \cdot \hat{t} = 0$$

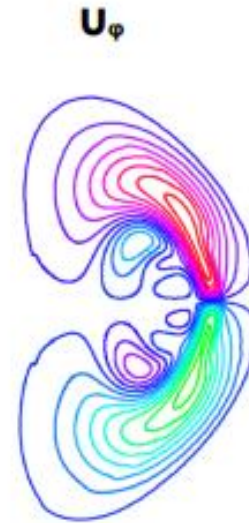
Brendan has implemented a new inoslip_pol=2 boundary condition that imposes only the sum...seems to fix the problem (not yet committed to master)

(old) Toroidal flow with density source

M3D-C1

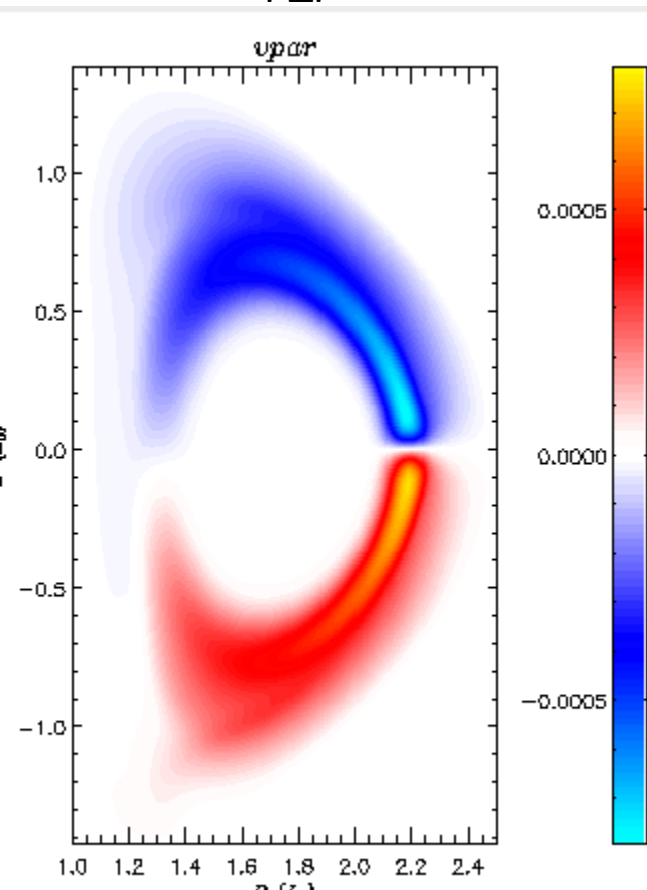


NIMROD

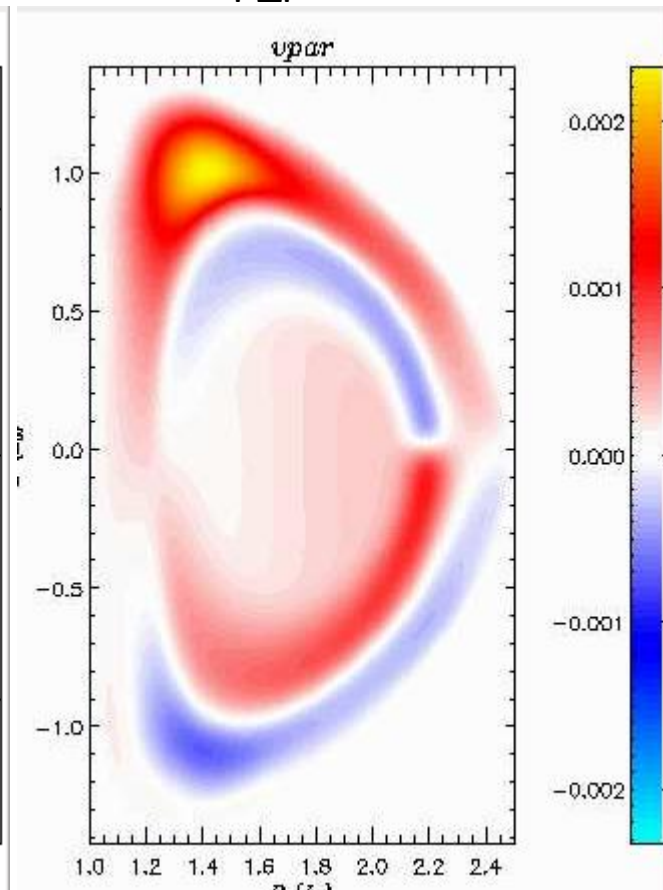


Comparison of inoslip_pol=0,1,2 for problem with density source

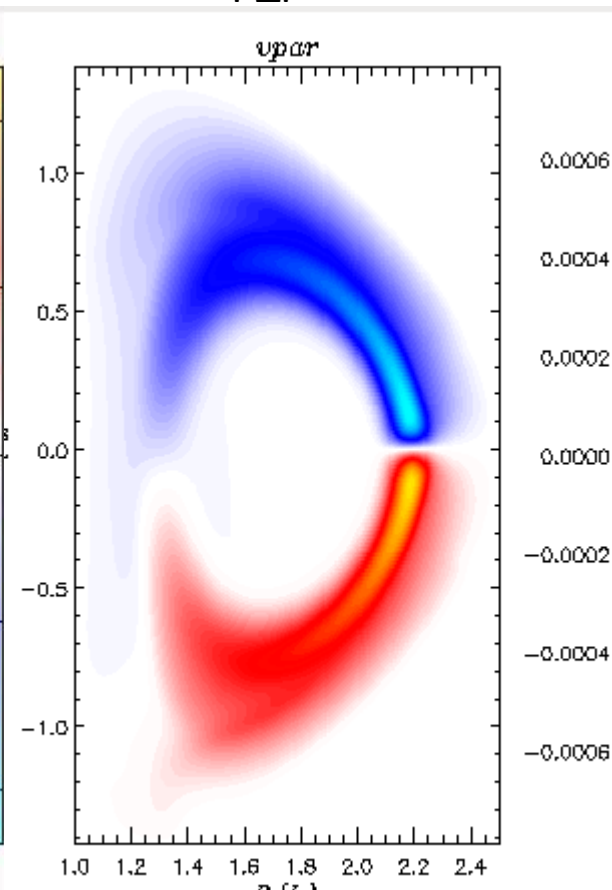
inoslip_pol=0



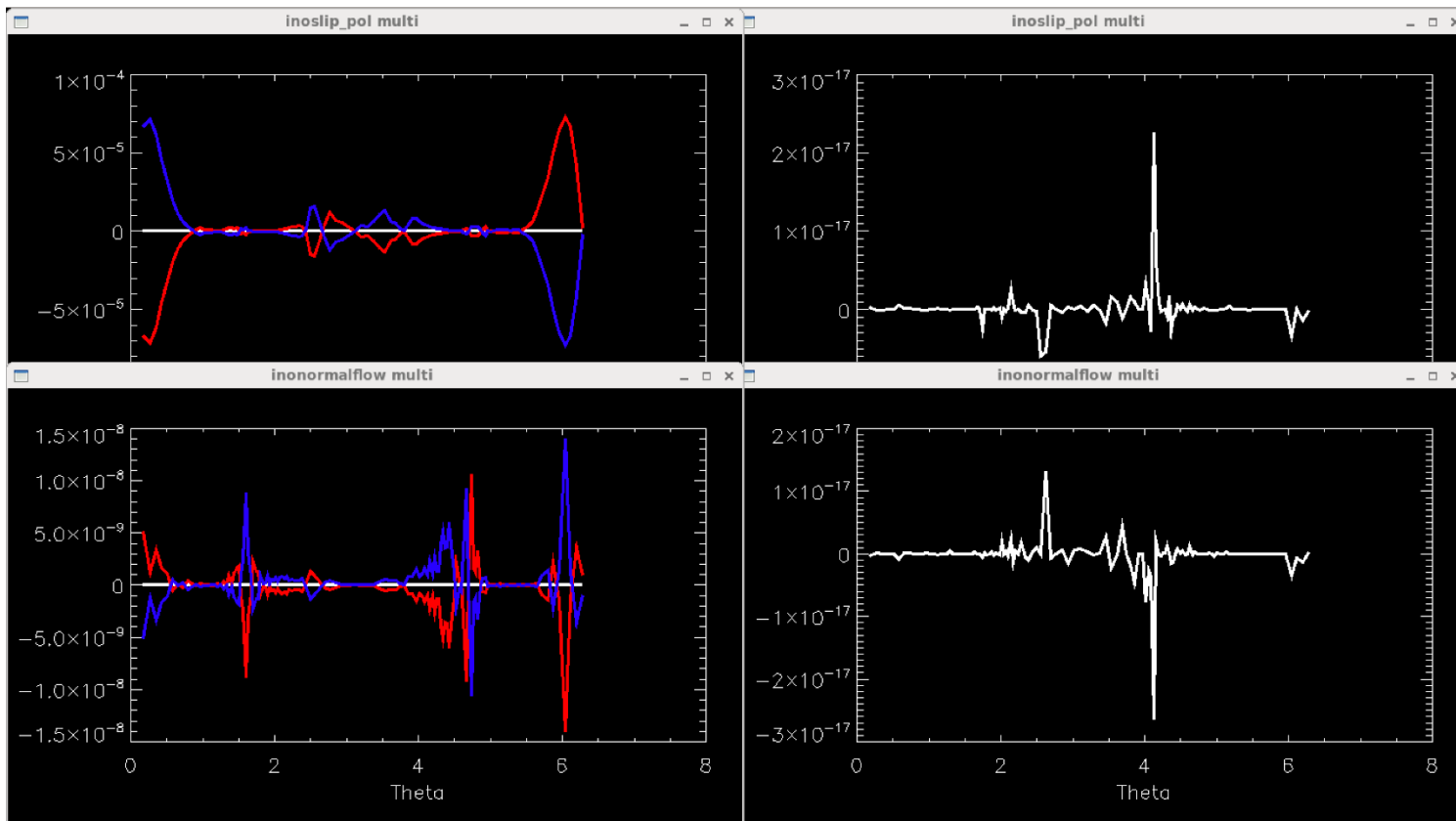
inoslip_pol=1



inoslip_pol=2



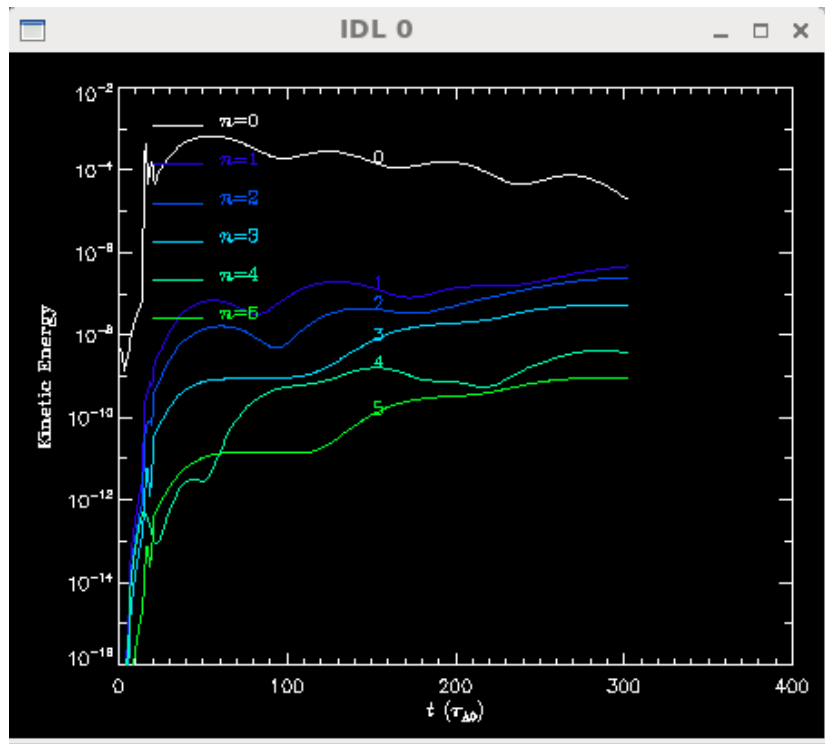
New Boundary plots by Brendan confirm inoslip_pol=2



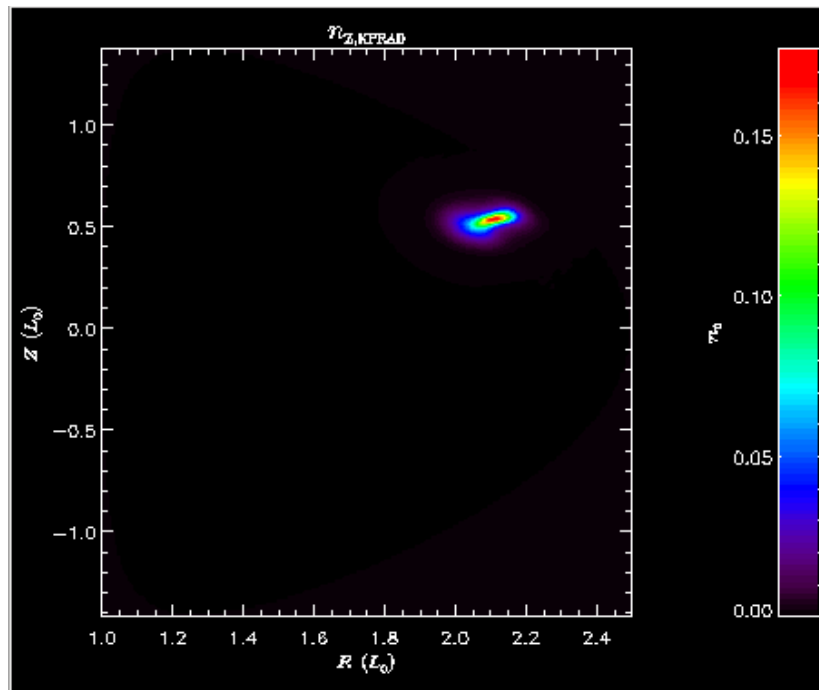
Red and blue are individual velocity terms on boundary due to U and χ ; white is sum.

DIII-D Pellet injection case goes unstable (without RE)

plot_hmn



plot_field, 'kprad_totden'



Could the impurity density be going negative?
See /scratch/gpfs/cz12/kprad2_test

Chen Zhao

That's All I have

Anything Else ?