M3D-C1 ZOOM Meeting

06/20/2022

Upcoming meetings and deadlines

CS Issues

1. New Latex documentation
2. Mesh adaptation update -
3. NERSC Time
4. Changes to github master since last meeting
5. Regression tests
6. Segmentation error on Cori
7. SUBPC error on Perlmutter_cpu
8. 1D Hermite Finite Element test problem

Physics Studies

1. Two-fluid input parameters --
2. Status of Chen Zhao paper
3. Upgrade to impurity radiation model – Brendan Lyons

Note: **meeting minutes posted on m3dc1.pppl.gov**

In attendance

Steve Jardin
Jin Chen
Hank Strauss
Cesar Clauser
Chang Liu
Chen Zhao
Nate Ferraro
Brendan Lyons
P. Sinha
Dingyun Liu
Adam Kutkowski
Mark Shephard
Seegyoung Seol

Upcoming Meetings and Deadlines

- APS DPP abstract submission deadline is Friday July 1
- Asian Pacific Conference on Plasma Physics Oct. 9-14 2022
    - Abstracts due June 30, 2022
    - Remote only

New LaTex Documentation

From Seegyoung (6/8/2022)

A cleaned version of M3DC1 user's guide is uploaded to M3DC1/doc and this version compiles on all machines using the command "pdflatex M3DC1.tex". To generate the table of contents, please run "pdflatex M3DC1.tex" twice.

Please use this version to add your parts.

SCJ: 6/20/22

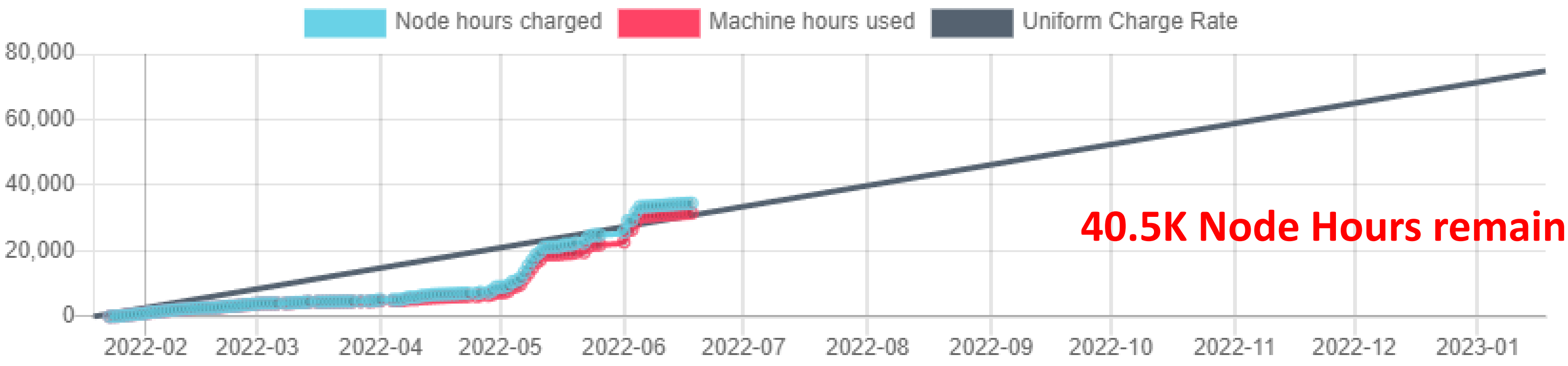
1. This is in M3DC1/doc should we get rid of M3DC1/unstructured/doc ?
2. Should I add the M3DC1.pdf to m3dc1.pppl.gov and update weekly?
3. I have started updating the C1input section.

Mesh adaptation update (and make update)

Any update?

NERSC Time

mp288



40.5K Node Hours remaining!

- All users now have access to Perlmutter and Perlmutter_cpu
- There is no charge for the year!

Changes to github master since 6/06/22

Brendan Lyons

06/06/22: Make sure pressure field always defined for KPRAD advance

06/13/22: add boron radiation and ionization data from ADAS (#50)

Add KPRAD and pellet data for boron impurity

Fix boron pellet parameters

Updated boron data with better fits to plt89_b.dat and scd89_b.dat

06/14/22: Fix boron data formatting error

06/16/22: Update Saturn makefile and regression tsts

Jin Chen

06/13/2022: add petsc_option.tex in doc directory

06/16/2022: add content in M3DC1.tex

Nate Ferraro

05/16/22: added plotting options to refine boundary.pro

Seegyoung Seol

06/08/22: Clean version of Users Guide added

06/13/22: More updates on User's guide

Local Systems

- PPPL centos7(06/17/22)
  - 7 jobs PASSED
- PPPL greene (06/17/22)
  - 5 jobs PASSED
- STELLAR (06/17/22)
  - 7 regression tests **PASSED** on stellar
- TRAVERSE_gpu(06/17/22)
  - 5 regression tests **PASSED**
  - KPRAD_2D, KPRAD_restart FAILED due to 0.001 fractional diff in C1ke

NERSC

- Cori-KNL (06/17/2022)
  7 regression tests **PASSED**

- Cori-Haswell (06/17/2022)
  7 regression tests **PASSED**

- Perlmutter (06/17/2022)
  6 regression tests **PASSED**
  NCSX **FAILED** with "PC failed due to SUBPC_ERROR"

- Perlmutter_cpu (06/17/22)
  6 regression tests **PASSED**
  NCSX failed due to small differences in C1ke file (0.00102)

Segmentation error on Cori-Haswell at end

Adelle Wright: (5/12/2022}
Currently, my stellarator runs on cori-haswell are completing but not exiting cleanly. Jin identified the issue as that mentioned below.

Jin Chen: (4/21/2022)
The segfault is caused by line
613   call MPI_Finalize(ier)

in file "newpar.f90". So you don't have to worry about it for now. I'll look into the cause of it.

SUBPC error on Perlmutter_cpu

Runs with 8 planes and 36 planes failed due to:
"PC failed due to SUBPC ERROR"

These runs did not fail immediately but after a few time steps, at which point NaN were generated. You can view one at:

/global/cfs/cdirs/mp288/Jardin/m3dnl/Perl_cpu/128-K/Run03

(I redid this today, and it failed on the 9^{th} time step)

Iterative Solver for Hermite-Cubic Elements

Sam Williams asked for a simple 1D problem using Hermite Cubic Elements so they could experiment with preconditioners:

I sent him a small F90 program I have that solves:

$$\frac{\partial \Phi}{\partial t} + V\frac{\partial \Phi}{\partial x} = \alpha\frac{\partial^2 \Phi}{\partial x^2} - \varepsilon\frac{\partial^4 \Phi}{\partial x^4}$$

Or, in finite element form:

$$\left[\mathbf{M} + \delta t\theta\left[V\mathbf{N} + \alpha\mathbf{P} + \varepsilon\mathbf{Q}\right]\right]\bullet\mathbf{Y}^{n+1} = \left[\mathbf{M} - \delta t\left(1-\theta\right)\left[V\mathbf{N} + \alpha\mathbf{P} + \varepsilon\mathbf{Q}\right]\right]\bullet\mathbf{Y}^{n}$$

I now solve this with a direct solver, but he (or one of his students) will try and solve this iteratively with a preconditioner.

2F Input Parameters

Dingyun Liu wants to do a 2F sawtooth simulation to compare with data

$$\mathbf{E} + \mathbf{V} \times \mathbf{B} = \eta \mathbf{J} + \frac{d_i}{ne}\left[\mathbf{J} \times \mathbf{B} - \nabla p_e\right]$$

1. Set itwofluid = 1 (this is the default)
2. Set ipressplit = 0 as pressure needs to be solved together with fields
3. Set itemp = 0 as it cannot be 1 when ipressplit = 0
4. Set db_fac=1, and code will define db (ion skip depth) to be physical value (.032)
5. You will need to lower the timestep dt and define harned_mikic parameter in order for the Magnetic Field Advance to converge:
6. Some experimentation showed that dt = 0.5 and harned_mikic = 0.03 were good choices for her problem

Ref: D. Harned and Z. Mikic, J. Comput. Phys **83** 1-15 (1989)

Papers in Preparation

- Chen Zhao, C. Liu, et al, “Simulation of DIII-D disruption with pellet injection and runaway electron beam”
  - ***Brendan:*** Made corrections on June 17
  - ***Chang***: Will need to go over the runaway sources section

  - ***Chen:*** Is paper ready for another read?

DIII-D Highlights…6/10/22

THEORY AND COMPUTATIONAL SCIENCE

Electrons can be accelerated to very high energies during tokamak plasma disruptions, potentially damaging the plasma facing components when they form so-called ‘runaway electrons’ and exit from the plasma. To predict the occurrence and consequences of runaway generation during disruptions, a fluid-like runaway electron module was developed in the M3D-C1 code. The module fully couples to the bulk plasma and to a pellet model, utilizing an implicit time advance scheme with sub-cycling that accurately simulates runaway velocities approaching the speed of light. Simulation of DIII-D discharge 177053, covering both the thermal and current quench phases, and including both the Dreicer and avalanche mechanisms, revealed a large electric field perturbation caused by the rapid cooling down of the plasma at the end of thermal quench that is associated with magnetic field line stochastization due to MHD instability. The runaway current reaches its highest level due to mode - runaway interactions. The instability then weakens at the current quench phase, with the magnetic field lines restored after formation of the runaway current plateau. These detailed dynamics, revealed by the M3D-C1 non-linear MHD-RE hybrid simulation, provide important insight into the plasma disruption process in tokamak experiments.

Upgrade to impurity radiation Routines

Brendan Lyons

That's All I have

Anything Else ?

Next Meeting

With LBL July 11?