Pellet-Ablation Code-Camp Debrief

by

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Presented at the
M3D-C1 Developers & Users Meeting
August 10th, 2020

GENERAL ATOMICS

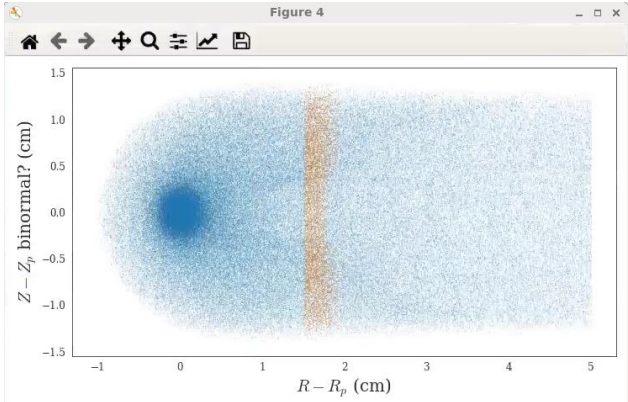
Code Camp Held August 3-6, 2020 on Coupling MHD Codes to Lagrangian-Particle Ablation Code

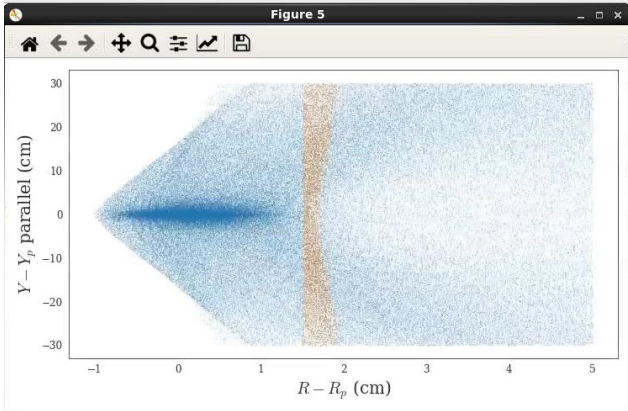
- **Different physical models at disparate scales**
  - MHD codes (M3D-C1 & NIMROD) describe macroscopic dynamics
    - Evolution of the plasma equilibrium
    - Rapid global instabilities
    - Ionization, recombination, and radiation of diffuse impurities
  - LP code describes local dynamics
    - Ablation of solid mass from pellet
    - Impurity dynamics in dense cloud
- **Output of the week**
  - Finalized file-based data-exchange format
  - Finished M3D-C1 implementation to read file (directly or redistributed)
  - Made plan for predictor-corrector modeling of DIII-D

State of Each LP Written to Single File, Either for Full Cloud or Grad-B Drifted Material

- **First line has total time of simulation & mass of each LP**
  - Each LP has same total mass, so volume effectively changes
  - These are used to give the rate of deposition
- **Each line is a separate LP, with position and densities of each charge state**

```
All units are cgs except Temperature is in eV
Line 1: time interval, s,  particle mass, g
Columns are

1  x, transverse coordinate, cm
2  y, transverse coordinate, cm
3  z, longitudinal coordinate, cm

4  Vx, transverse velocity, cm/s
5  Vy, transverse velocity, cm/s
6  Vz, transverse velocity, cm/s

7  T [eV]
8  rho, density, g/cm^3
9  P, pressure, g/(cm s^2)

10  electron heat deposition power density,

11 radiation power density, g/(cm s^3)

12 number density of neutral atoms, 1/cm^3

13 1+: number density of 1+ ions, 1/cm^3
14 2+: number density of 2+ ions, 1/cm^3
15 3+
16 4+
17 5+   ....
18 6+
19 7+
20 8+
21 9+
22 10+ number density of fully ionized ions, 1/cm^3

23 e number density of electrons, 1/cm^3

24 averaged ionization
```

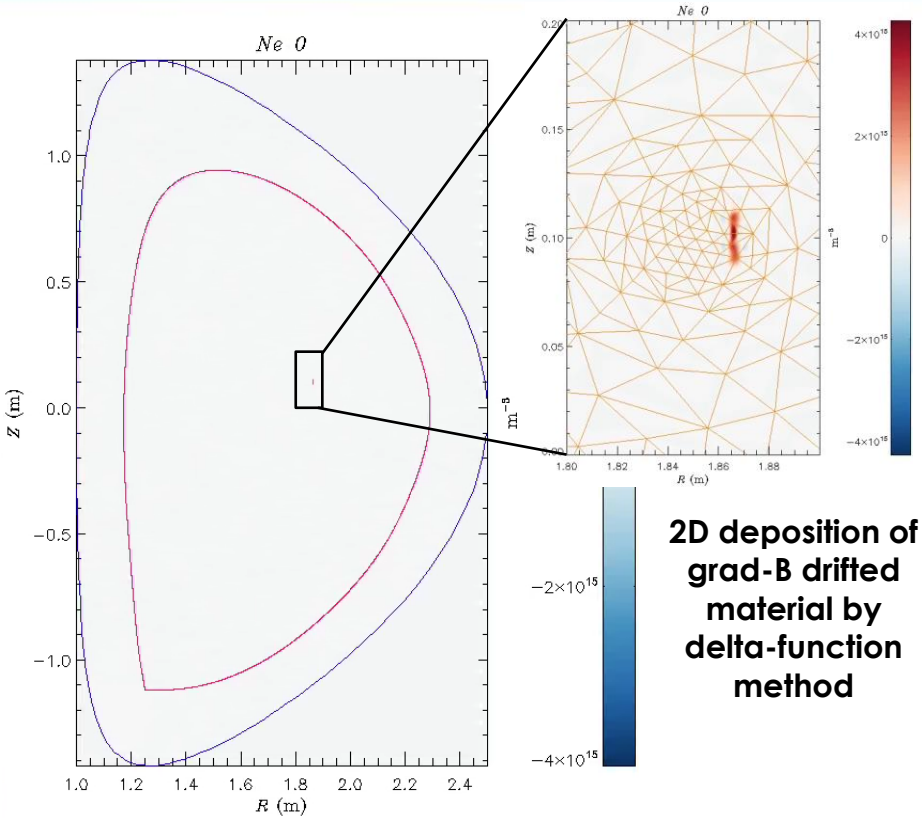




GENERAL ATOMICS

M3D-C1 Can Read This File and Interpret in Two Ways

- **`iread_lp_source=1`**
  - Each LP is considered a delta-function particle source, deposited on finite elements directly
  - Need sufficient resolution, both of LPs and FEs, to get smooth source (seems okay in 2D, but 3D noisy)
  - To-do: deposited toroidally, but cloud should be field-aligned
- **`iread_lp_souce=2`**
  - Total number of particles of each charge state tabulated from file
  - Redeposited as source for each charge state on `ipellet` distributions



2D deposition of grad-B drifted material by delta-function method

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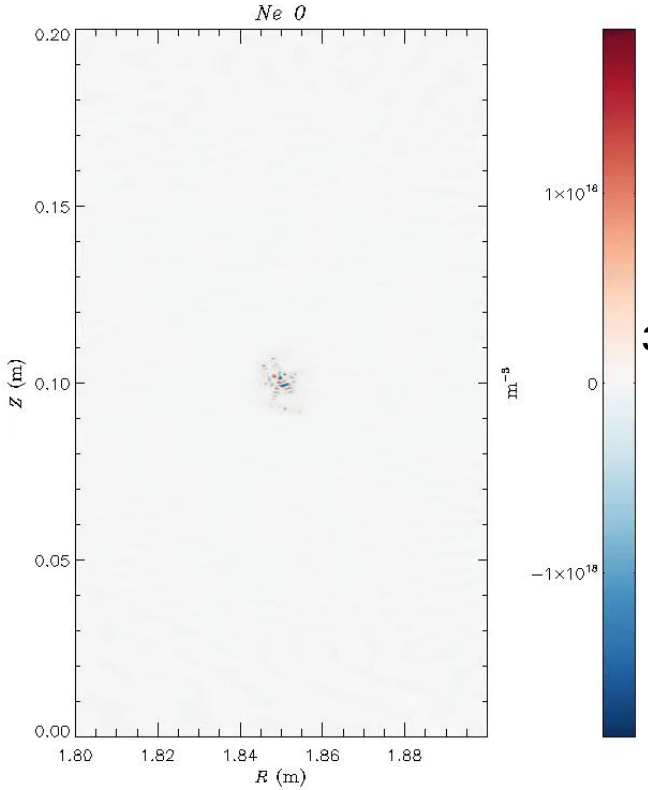

3D deposition of full cloud by delta-function method

First Coupled Simulations will Use Predictor-Corrector Method

- **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

DIII-D 171322 @ 2730 ms