Target threat spectra

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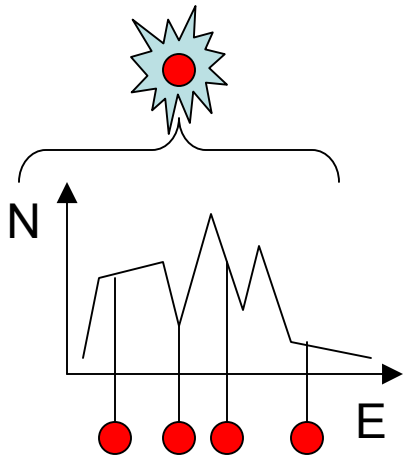
Outline

- Target debris transport to wall modeling
  - Monte Carlo “splitting” algorithm implemented
- Bounding threat spectra calculations
  - NRL meeting on December 9, 2004
  - Pure hydro calculation
  - Long mean free path calculation
- BUCKY explosion simulations

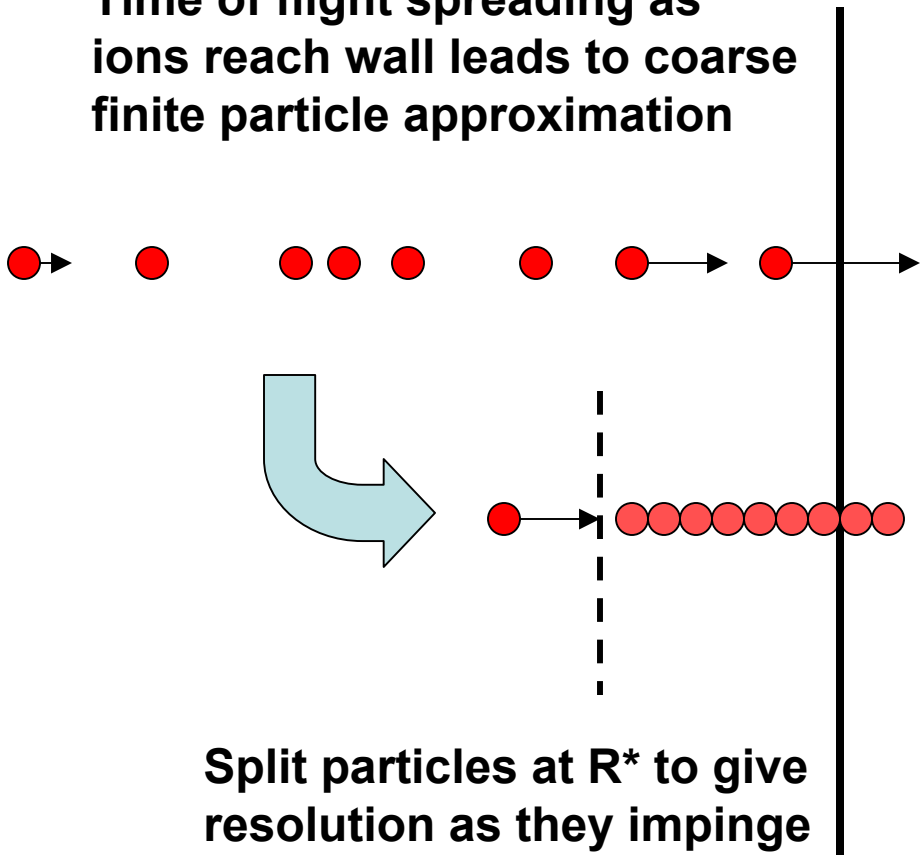
“Conventional” target chamber simulation

Target explosion



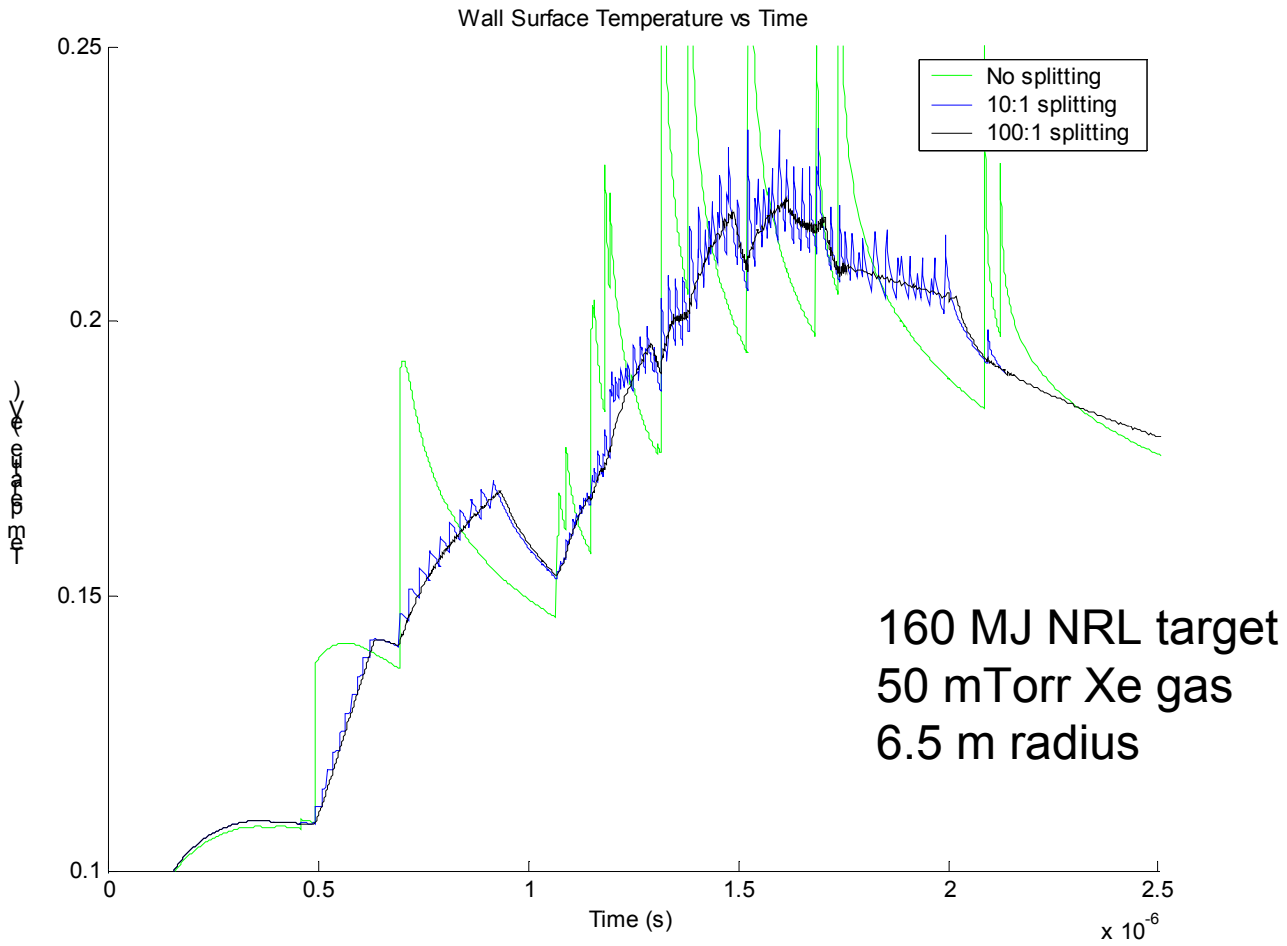
Ion energy distribution sampled at discrete energies E_i

Time of flight spreading as ions reach wall leads to coarse finite particle approximation



Split particles at R* to give resolution as they impinge on first wall

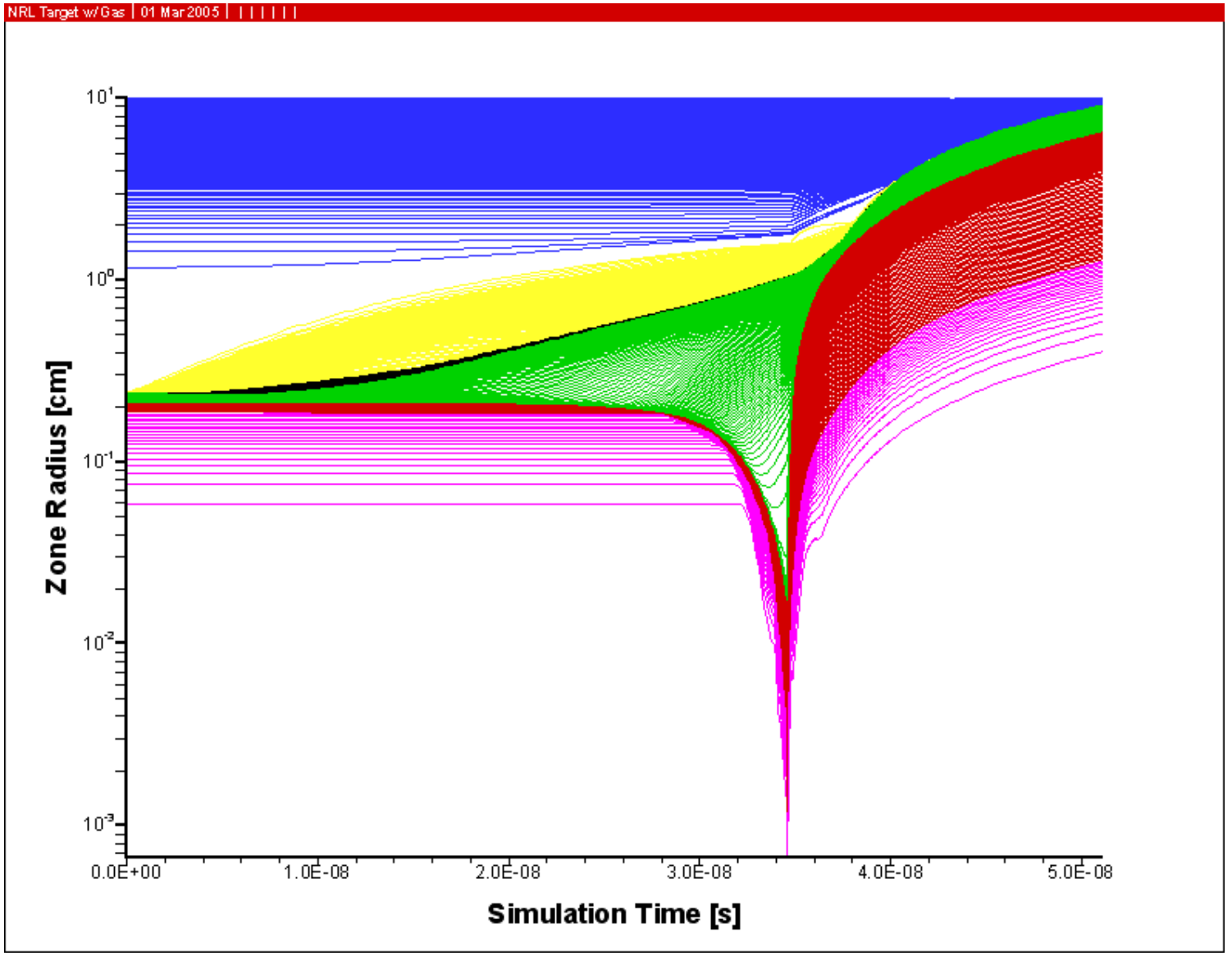
Target debris transport to wall: wall surface temperature for different splitting parameters



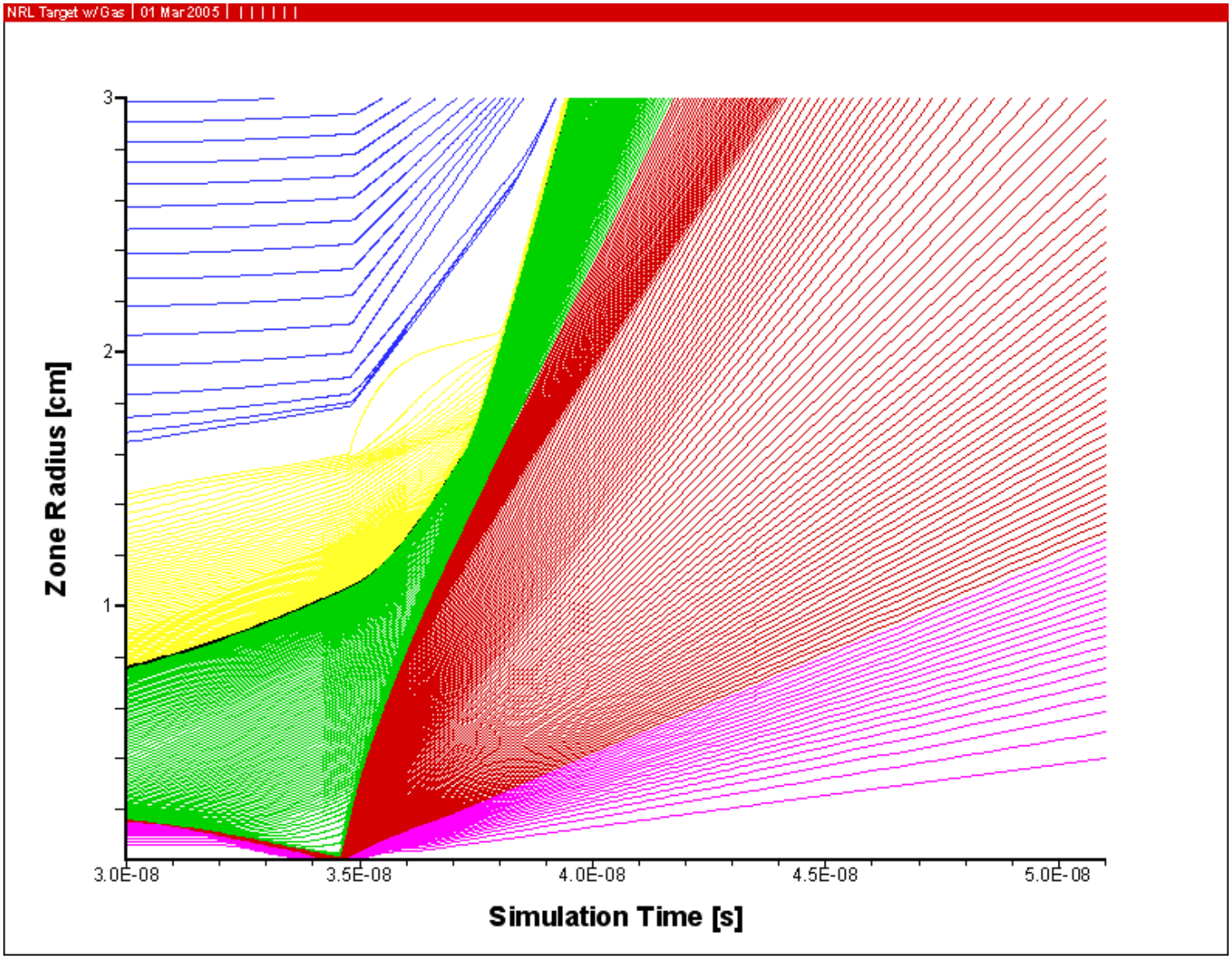
Bounding threat spectra calculations

- Meeting at NRL on Dec 9, 2004
  - Post-burn exploding target has ion mean free path “issues” that potentially reduce the shock acceleration of the plasma debris.
  - HANE experiments and theory are relevant to these issues. Instabilities could produce effective collisionality that “re-validates” hydrodynamics model. (Ref: R. Clark, et. al.)
  - First step: bounding calculations with models currently in BUCKY.

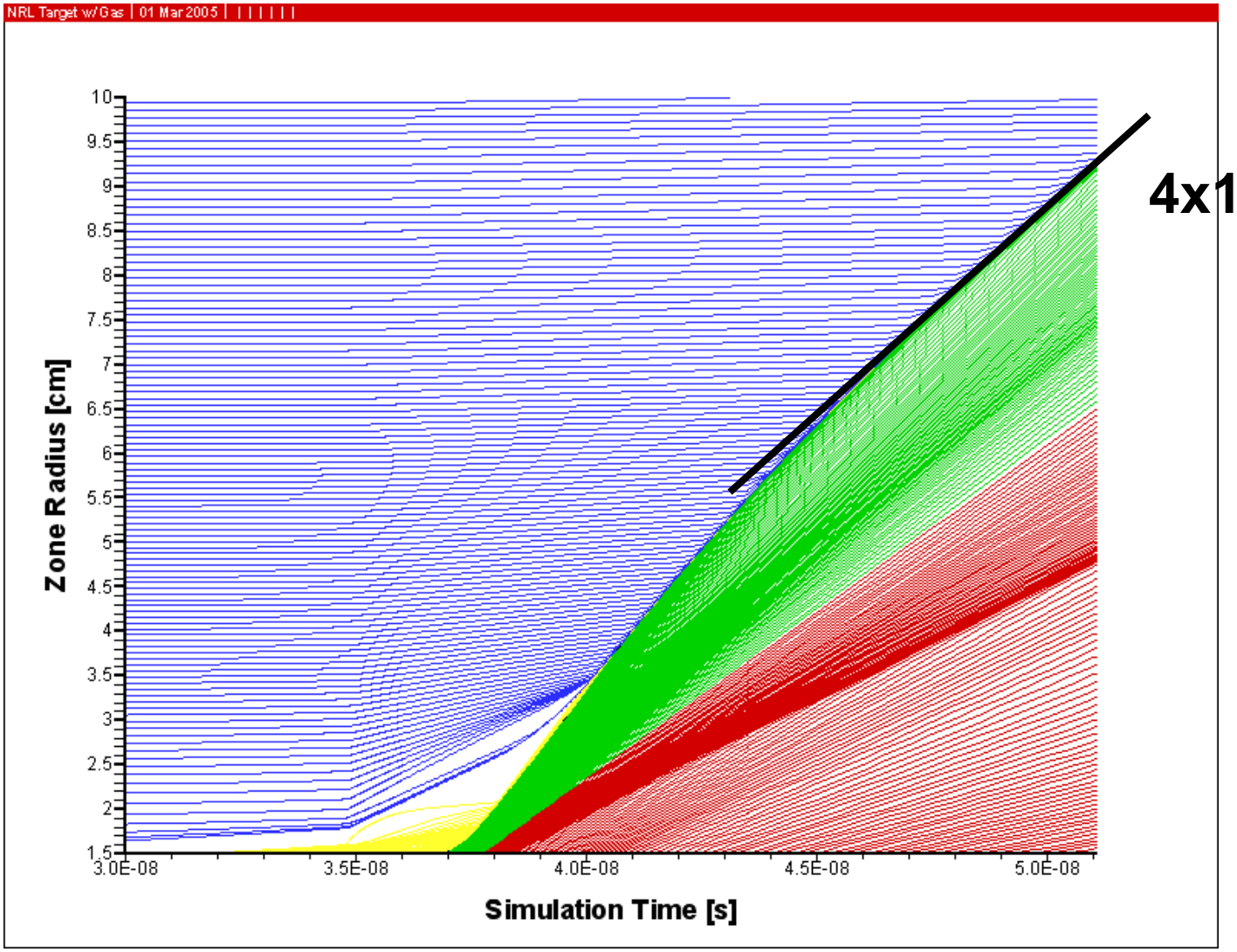
Bounding threat spectra calculations
High collisionality – pure hydrodynamic



Bounding threat spectra calculations
High collisionality – pure hydrodynamic



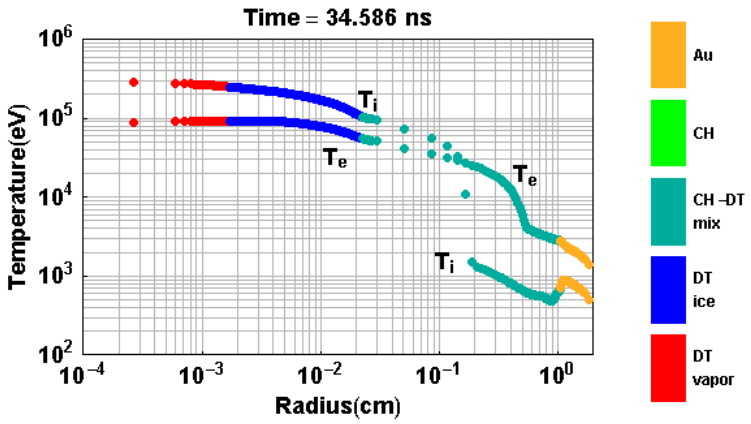
Bounding threat spectra calculations
High collisionality – pure hydrodynamic

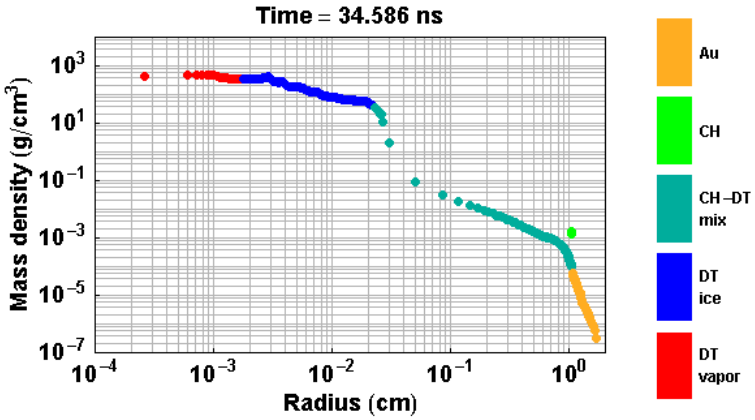


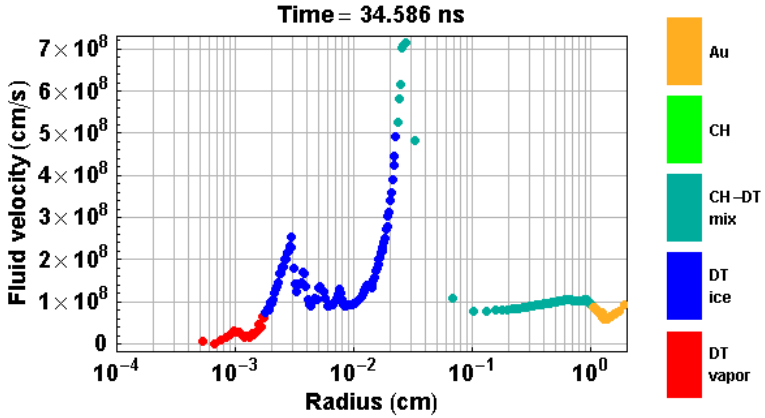
Wave-Particle Interactions May Cause the Hydrodynamic Approximation to Remain Valid

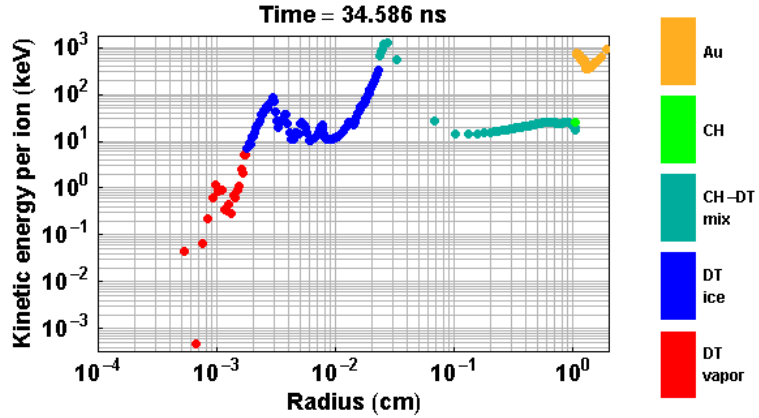
- This mechanism was pointed out by NRL during the NRL/UW physics meeting on Dec. 9.
- Instabilities and wave-particle interactions caused hydrodynamics to be a good approximation for the HANE experiments.
- Bob Clark's poster at this meeting, based on HANE program research during the 1970's, very nicely summarizes the potential instabilities and coupling mechanisms.
- Work has begun on this mechanism for HAPL.
  - Caveat: Devil is in the details, and the problem is very difficult.

Shock Parameters at 34.586 ns (Ignition Plus ~20 ps) Show That the Shock Has Reached r = 0.02-0.03 cm





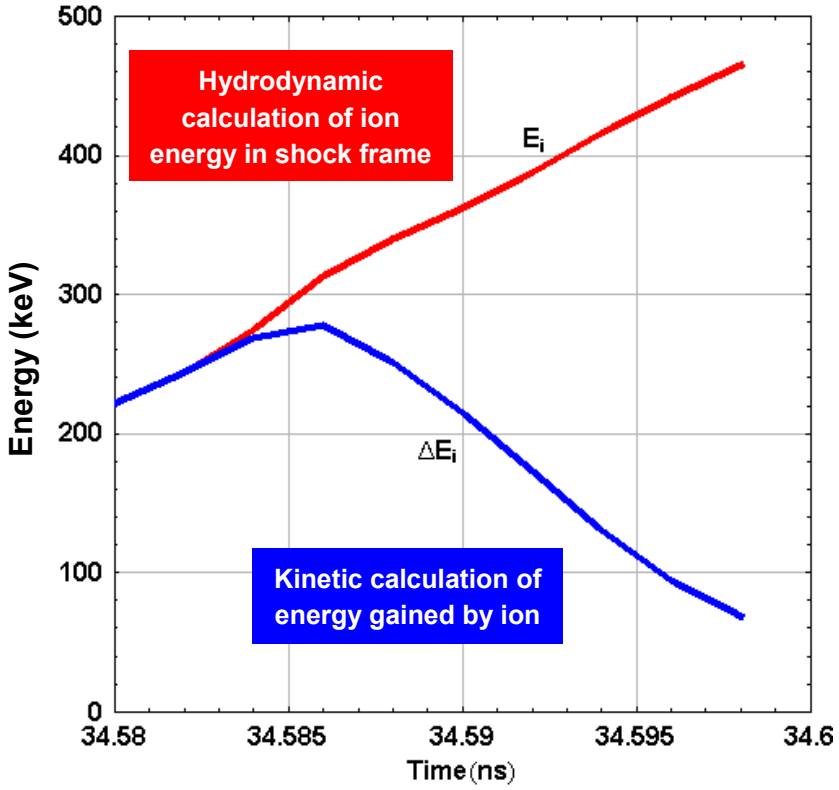




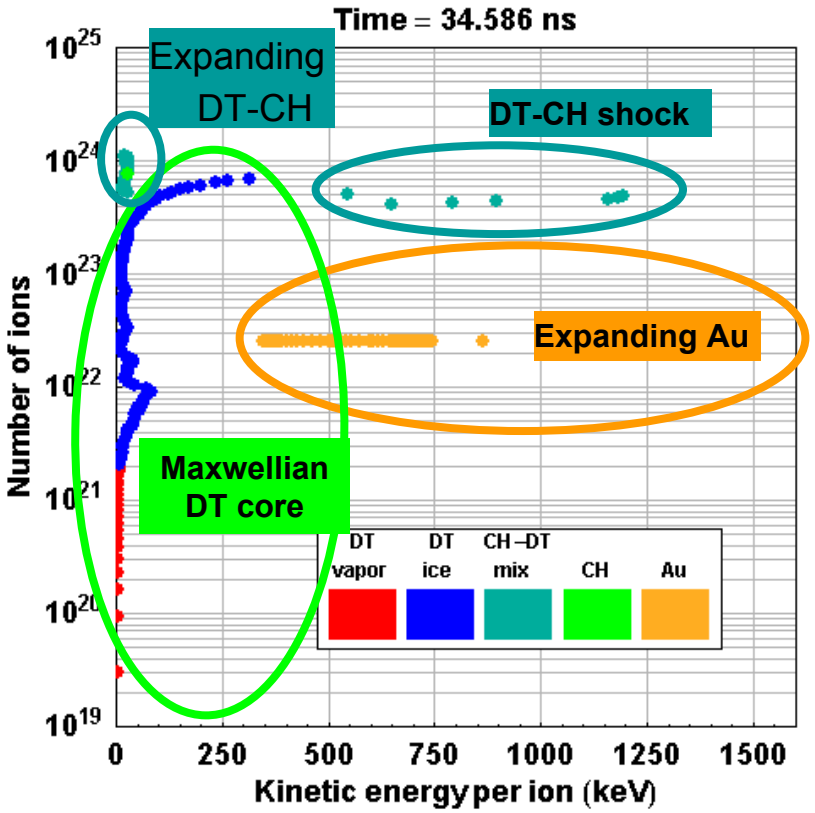
- Each point represents a Lagrangian zone of constant mass.

Bounding threat spectra calculations
Low collisionality – kinetic fast ions

- At ~34.586 ns, hydrodynamic and kinetic energy deposition calculations begin to diverge.



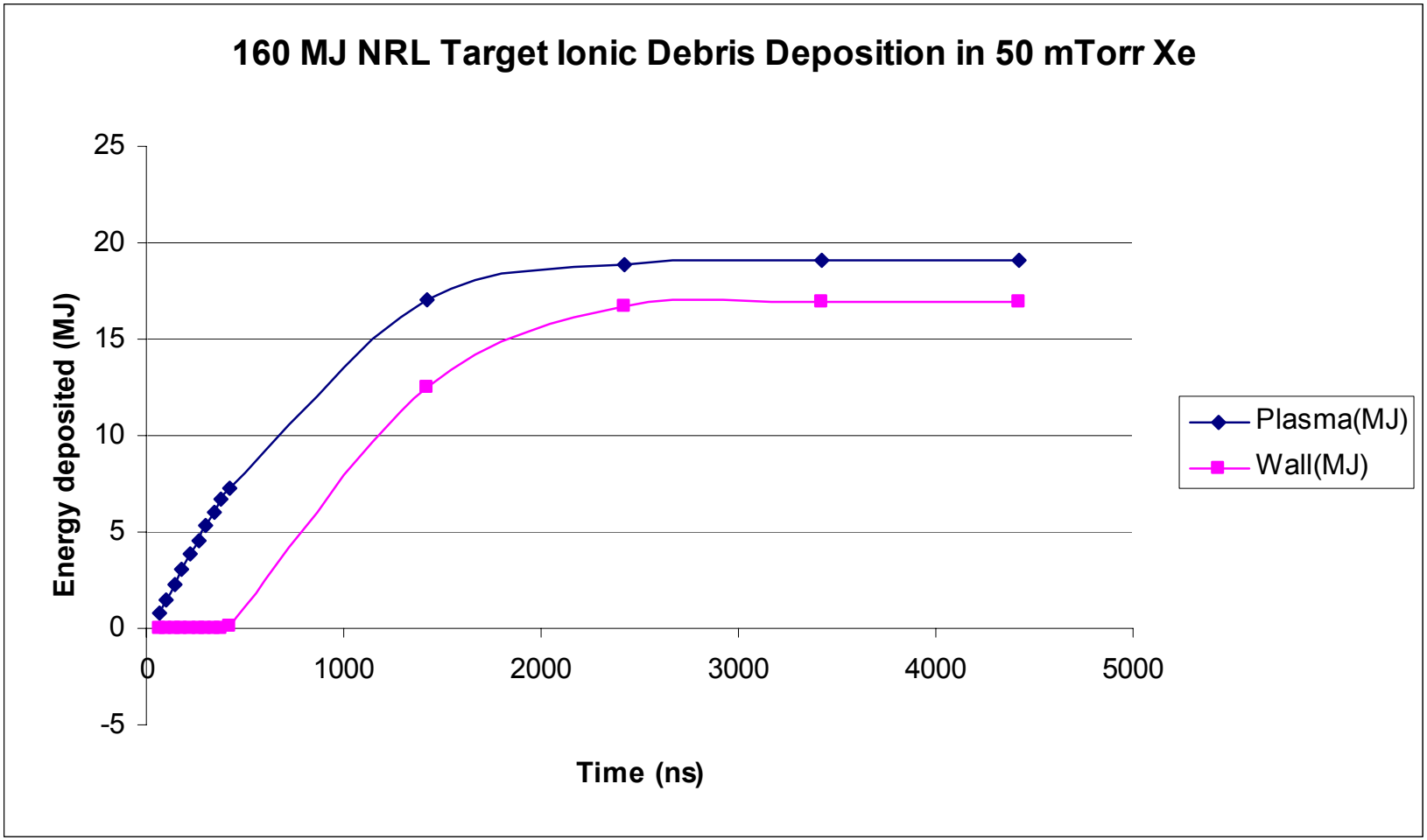
- A separate BUCKY calculation will stream the shock ions through the ambient plasma.



“Conventional” chamber simulations

- For low Xe pressure the gas volumetrically heats, there is little hydrodynamic motion
  - 50-50% split between plasma deposition and wall deposition for target debris at 50 mTorr.
- The wall temperature response is most sensitive to ion stopping models and Xe opacity in 10-1,000 eV range.
  - Ion stopping model determines prompt heat input
  - Opacity determines gas re-radiation time

BUCKY explosion simulations



Summary

- New debris transport model developed and working. Next step:
  - Review ion-stopping model and opacity theory
  - Do simulations
    - Spartan initial conditions
    - Xe vs. Ar
- Bounding calculations
  - Pure hydrodynamic calculation working
  - Kinetic calculation in progress
  - Next step: Evaluate HANE literature