Effects of Long Mean-Free-Path Ions on Shock Breakout

John Santarius and Greg Moses

University of Wisconsin

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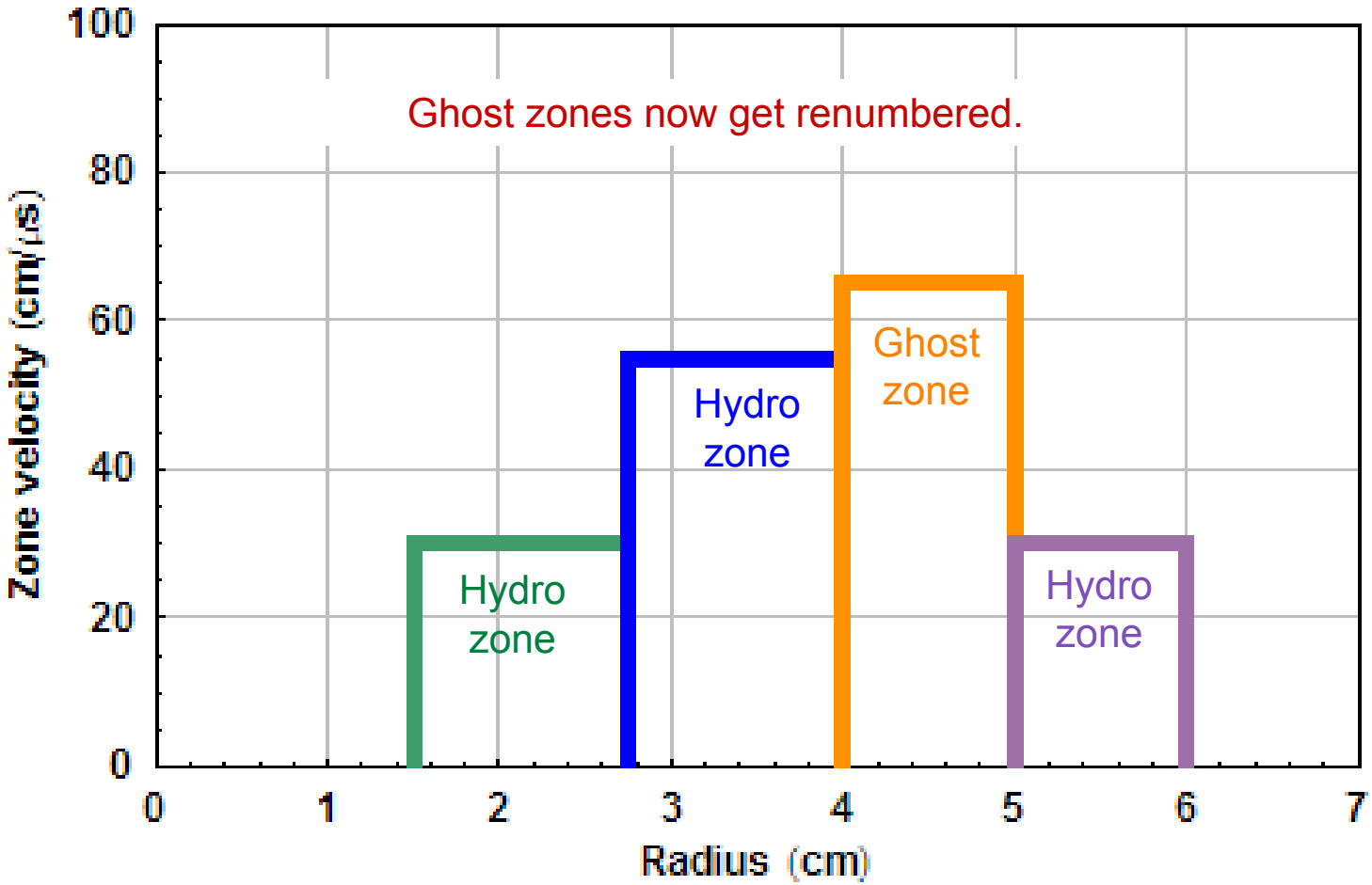
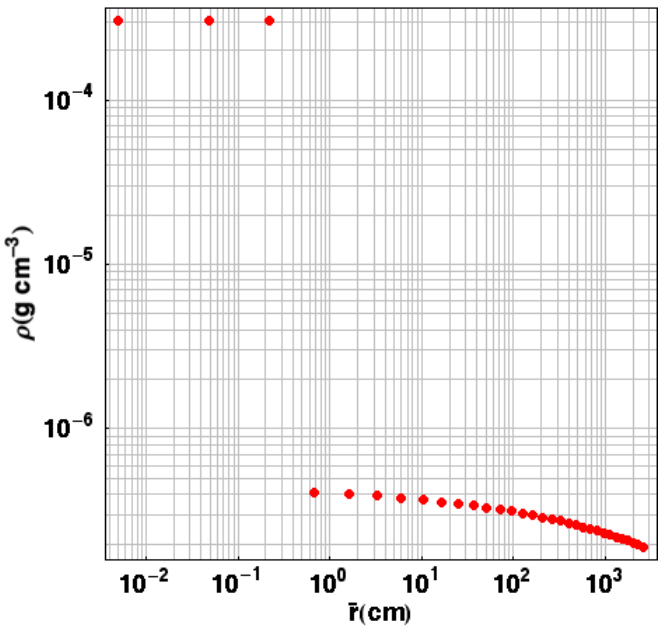
In the Original Conceptual Picture, Long Mean-Free Path "Ghost" Zones Move through Hydro Zones

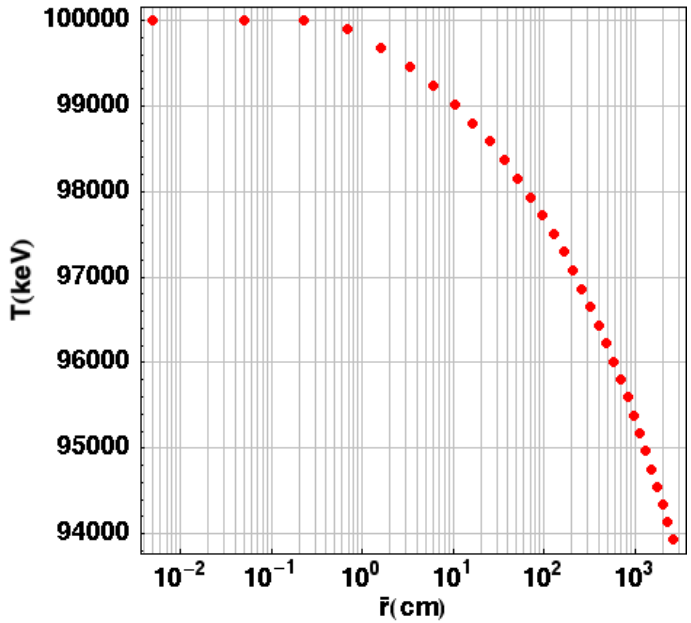
- Ghost zones transfer momentum with those hydro zones through which they pass.



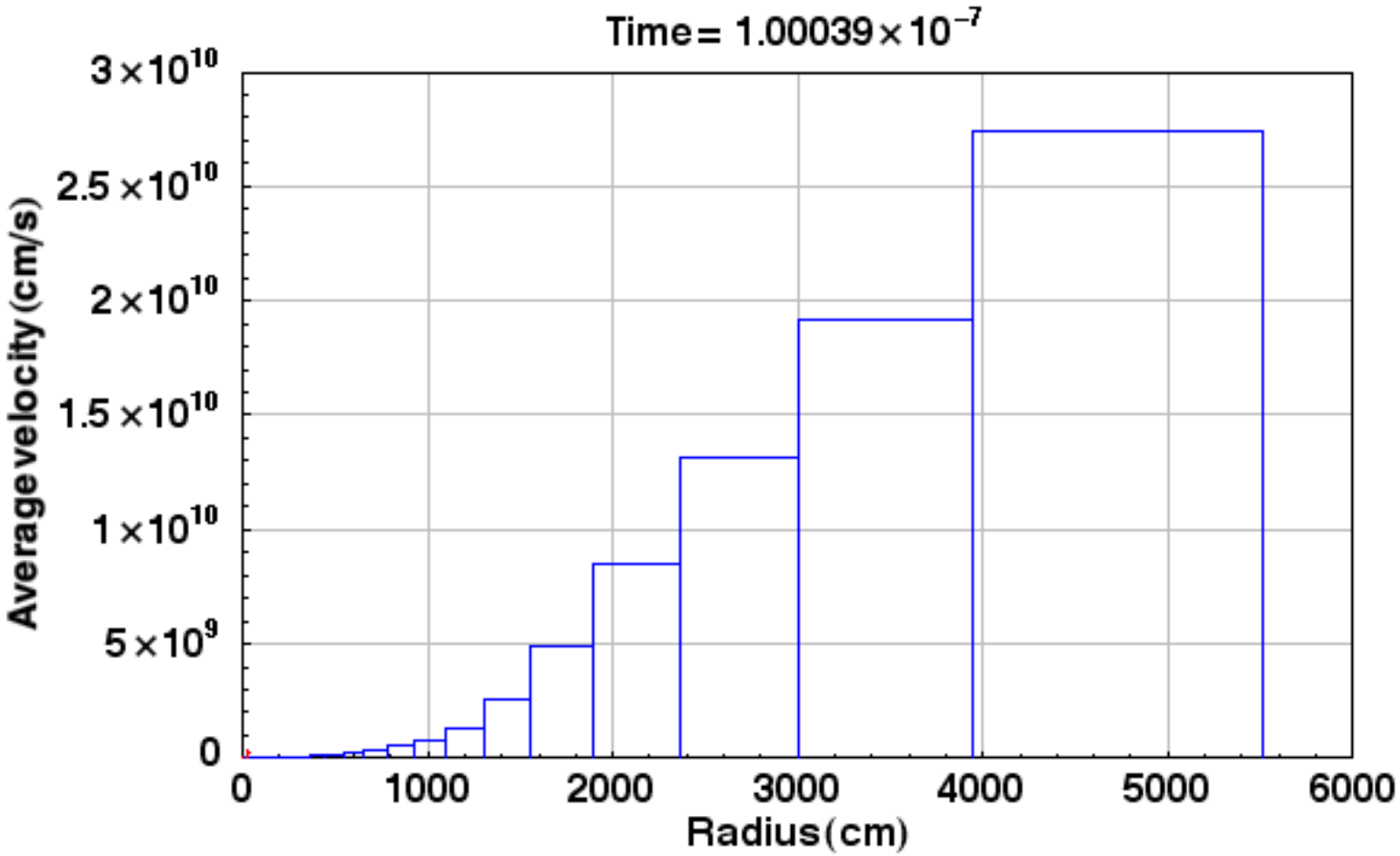
Zel'dovich & Raizer Shock-Breakout Problem Chosen for Code Development

- Zel'dovich & Raizer, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, Chapter 25.
- Strong, spherical shock propagating through an exponentially falling density gradient.
  - Analogous to ICF shock propagating through the blow-off plasma.
- Initial velocities equal zero; mass density and temperature shown below.



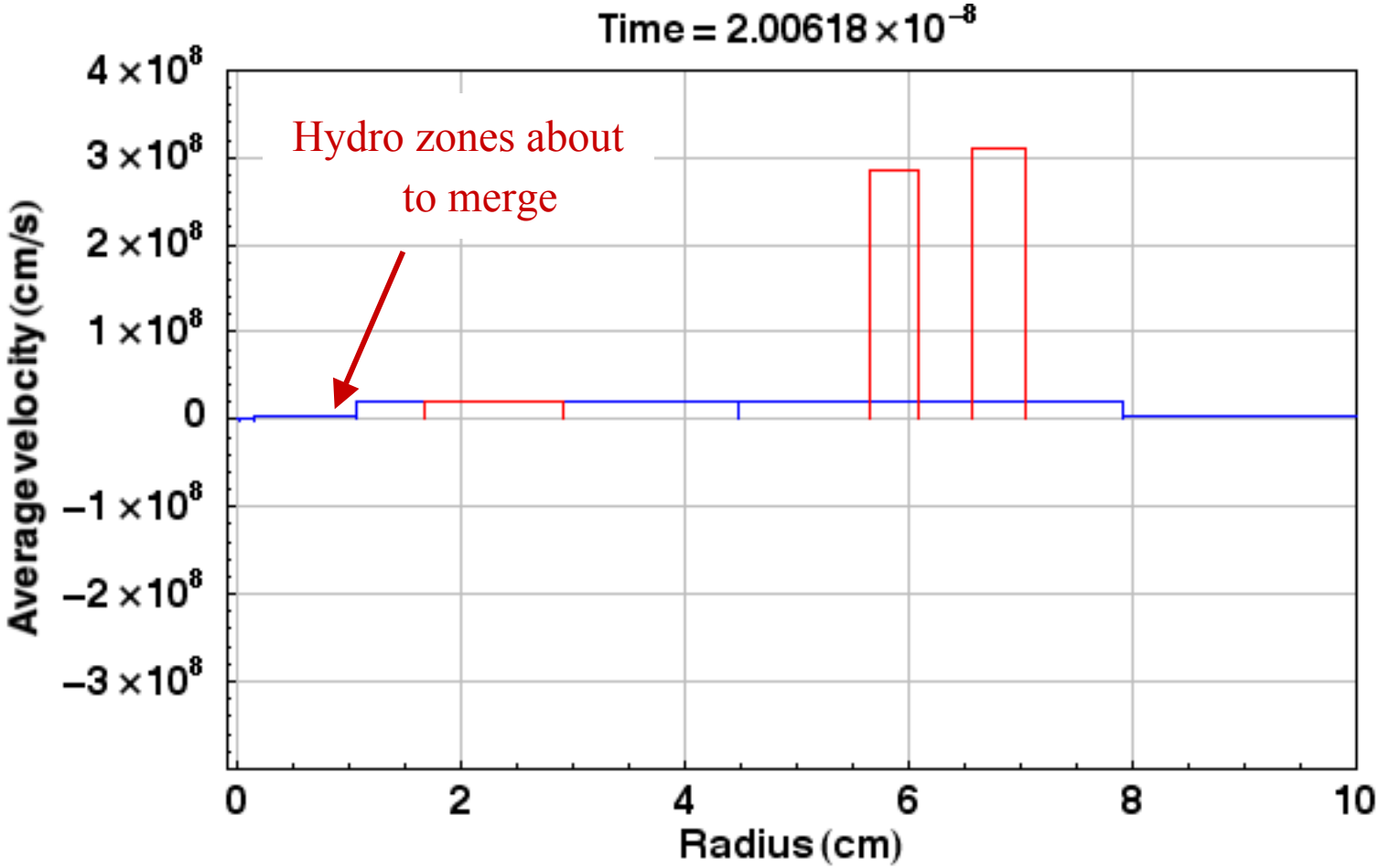


For Pure Hydro Motion, Velocities Get Unphysically High

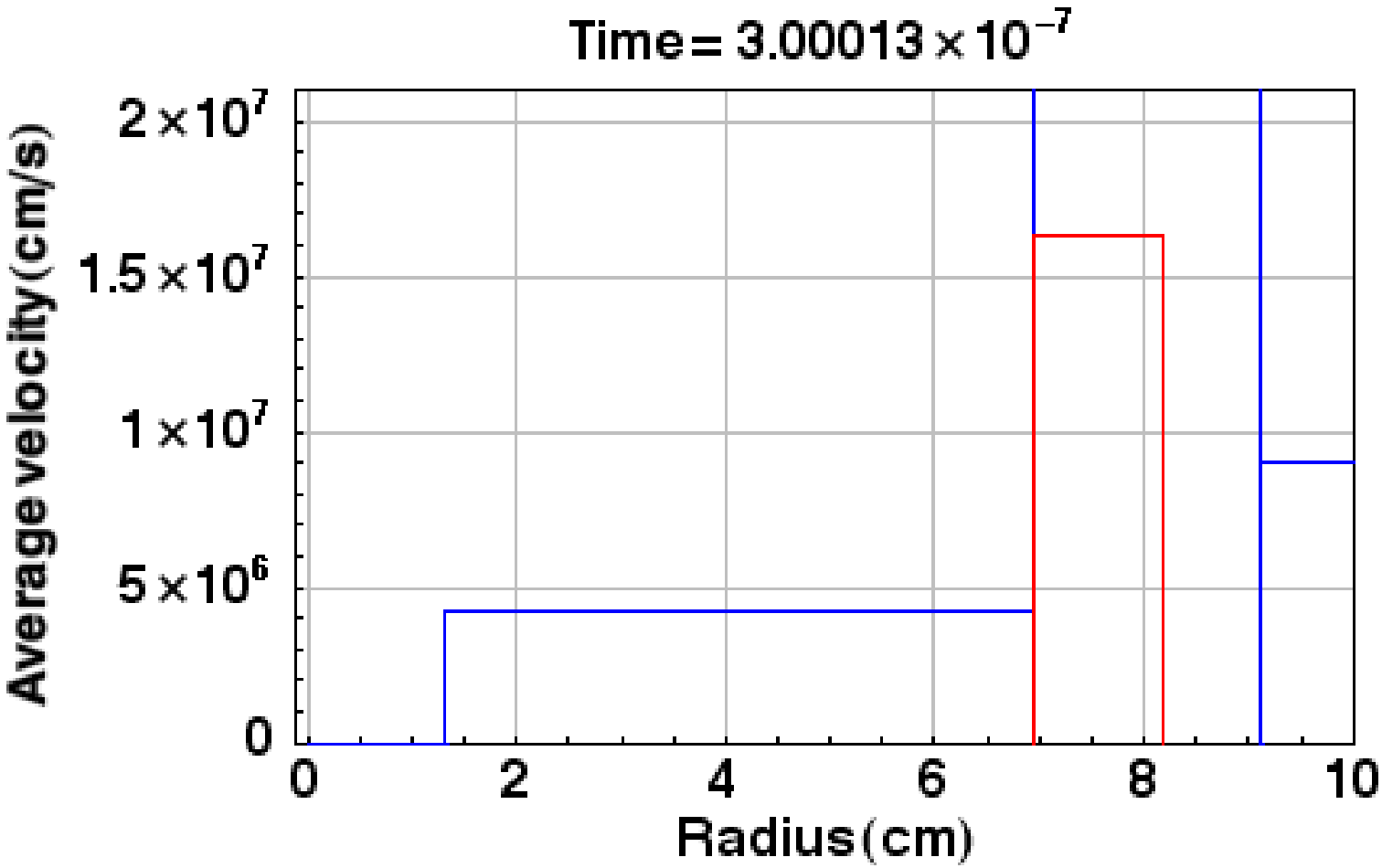


Gap (Null Zone) between Hydro Zones Fills Quickly because of Internal Pressure

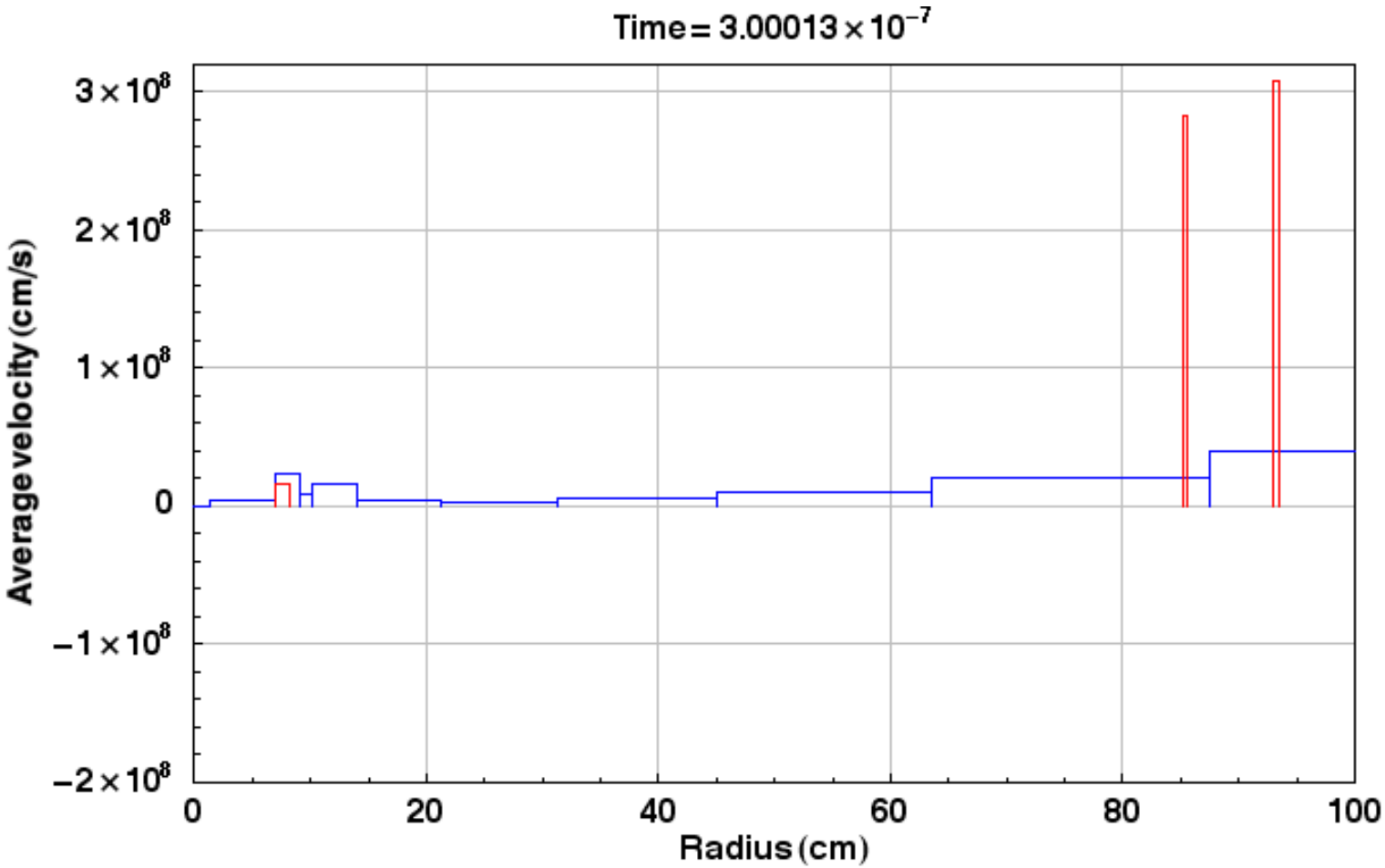
- Ghost zones drag hydro zones upward in energy (and velocity).



Slowest Ghost Zone Fades after a Short Time



After a Short Time, Ghost Zones Nearly Free-Stream



Status and Summary

- Mathematica® code appears to move hydro and long mean-free path (ghost) zones properly for the simple Zel'dovich and Raizer test case.
- Momentum transfer between zones also appears to be working.
- A minor zone renumbering problem remains to be addressed.
- Next step is to use initial conditions from a HAPL test problem.

Reserve Slides

At 34.592 ns, the DT-CH Shock Thickness and Incoming Ion Mean Free Paths Become Comparable

	DT Core	DT-CH Shock	CH-Au Shock
r_{shock} (cm)	< 0.001	0.026	
Δr_{shock} (cm)	< 0.001	0.02	0.004
v_{shock} (cm/s)	6.6×10^{6}	5.5×10^{8}	8.6×10^{7}
n (cm^{-3})	1.5×10^{26}	5.1×10^{24}	
T (keV)	276	86	2.8
T_e (keV)	72	47	0.69
Ave. charge state	1	DT 1 CH 1	CH 1 Au 36
Δr_{shock} / mfp	> 1000	1.1	0.001

Qualitative Motion of Ghost and Hydro Zones Appears Reasonable