Idaho National Engineering and Environmental Laboratory

Aerosol Production in Lead-protected and Flibe-protected Chambers

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Discussion Topics

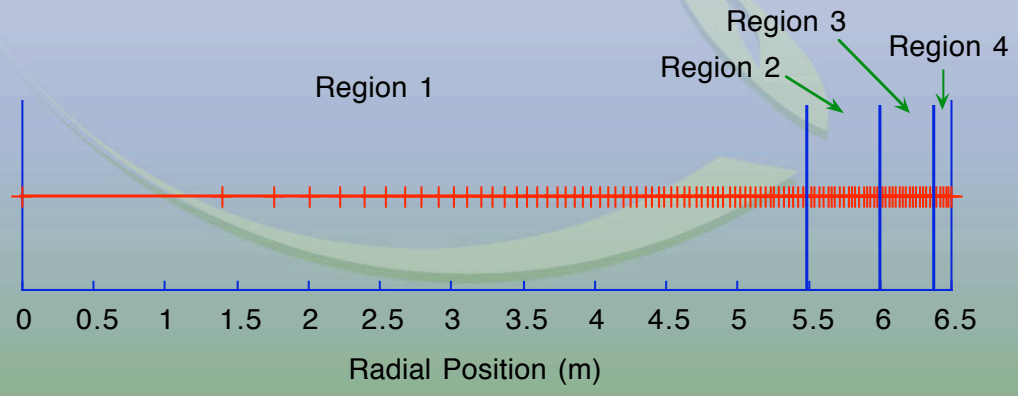
- Improvements to Models
- Comparison of Lead and Initial Flibe Results
- What's Next? (to pass the Continuing Resolution!!!)

Model Improvements:

- Wall thermal response model (including volumetric heating from penetrating x-rays) is now fully incorporated into the code; surface vaporization and condensation are solved consistently with other parts of code
- Flibe bulk properties added to perform initial look at flibe nucleation; calculations for dissociation of flibe and condensation of component species has NOT been performed

Analysis:

- Average values of aerosol properties in four chamber regions were determined; a spherical chamber with a 6.5 m radius was used
- Values of interest are mass concentration and particle size distribution in Region 1; these quantities are important for their impact on beam and target propagation

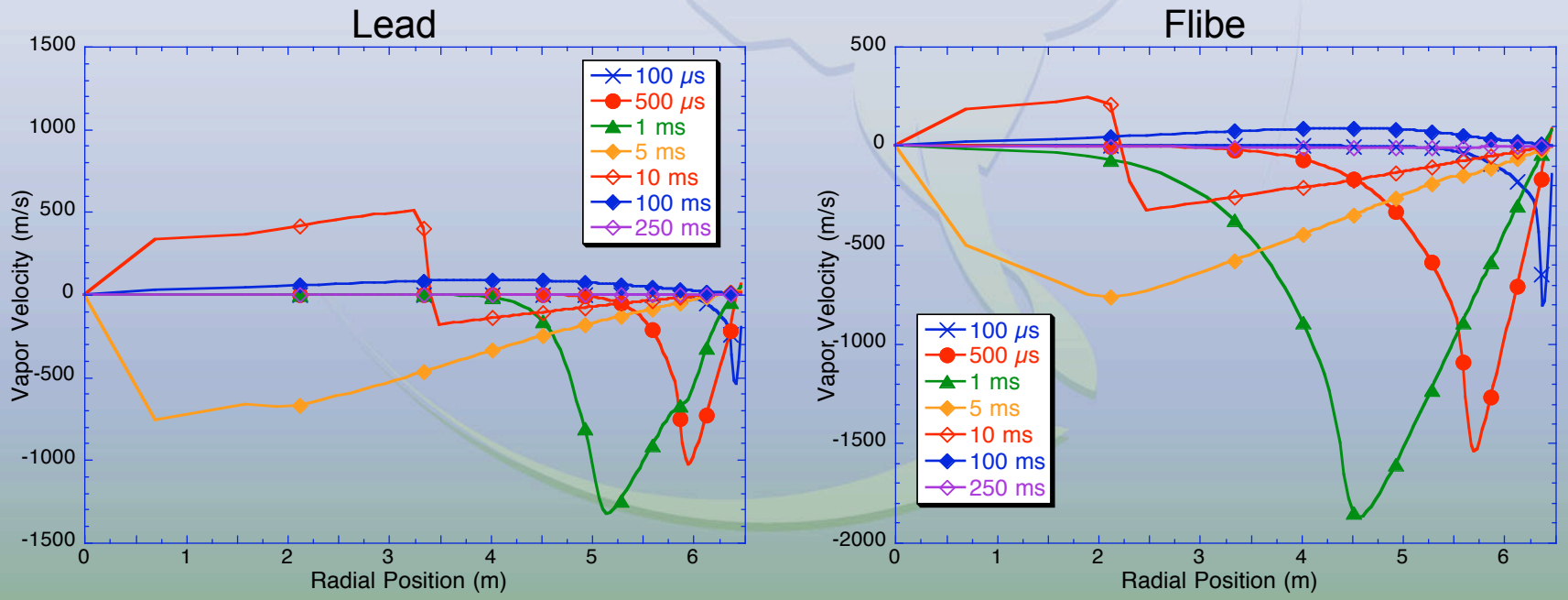


Model Results: Liquid Wall Chambers

Simulations were performed for liquid-covered walls exposed to the energy from a 458 MJ indirect-drive target. X-rays carry 115 MJ for this target; only the x-ray flux was considered to deposit energy on the wall surface.

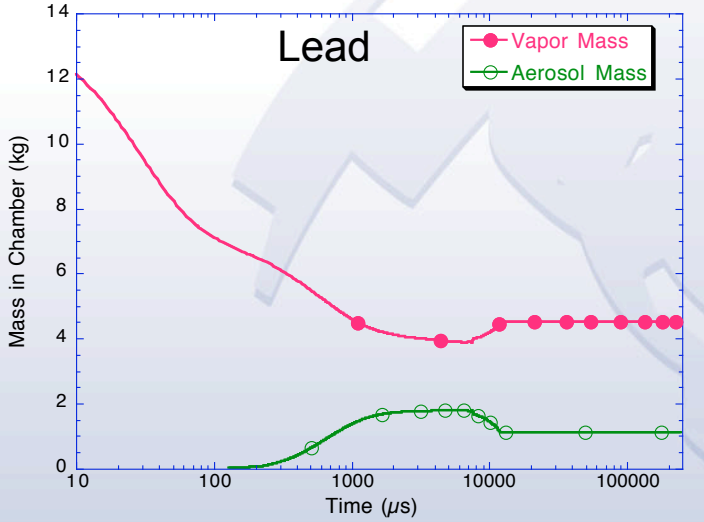
Initial chamber conditions for both cases: T_{wall} = 800 K, and the chamber pressure equal to the material's equilibrium vapor pressure at the wall temperature. Chamber radius is 6.5 m.

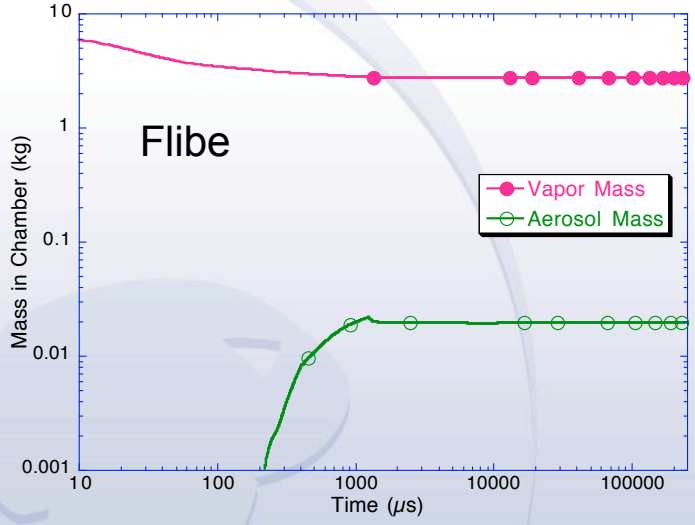
Flow Model Results: Vapor Velocity



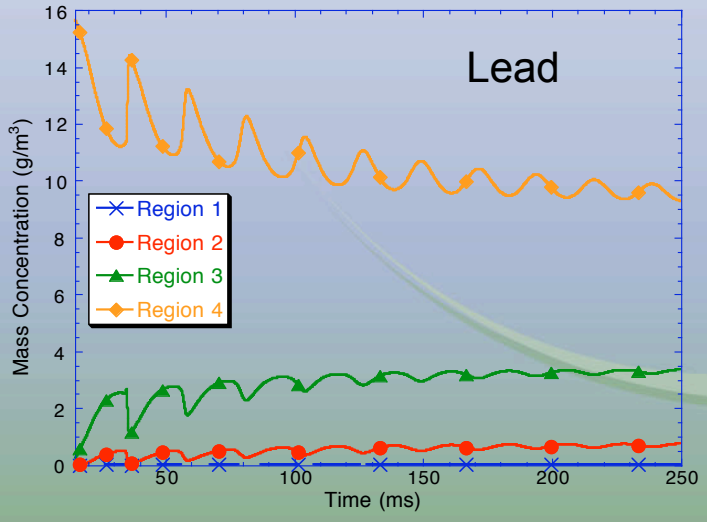
Model Results: Liquid Wall Chambers, cont.

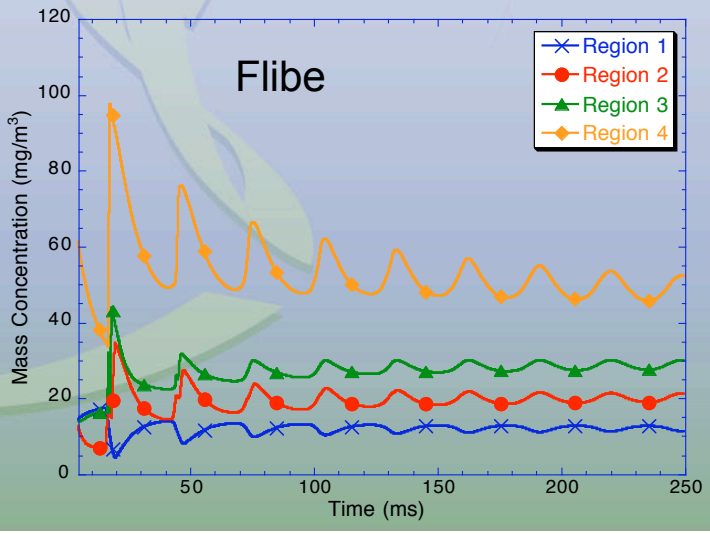
Aerosol Model Results- Total Vapor and Aerosol Masses:





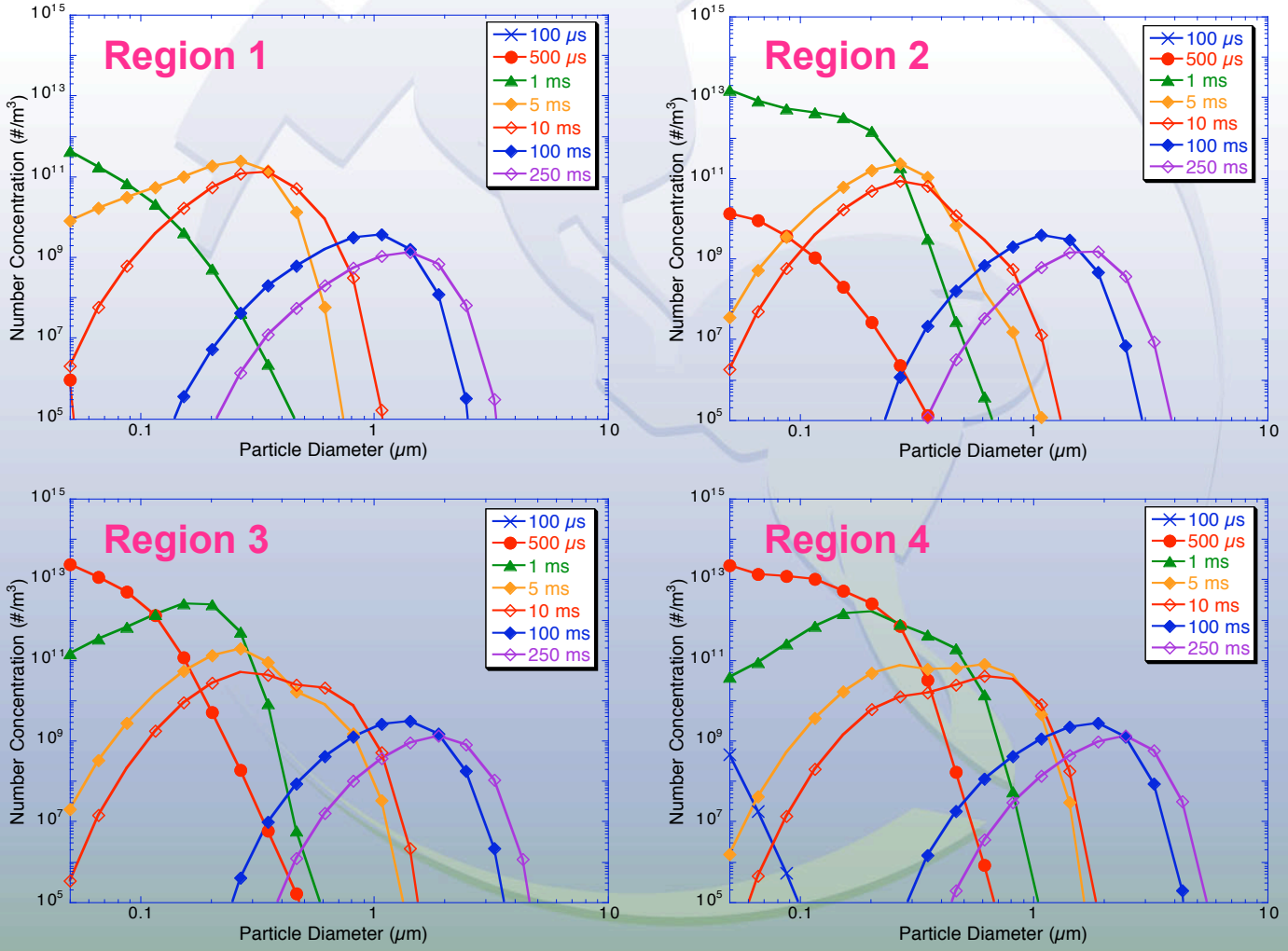
Regional Mass Concentrations:





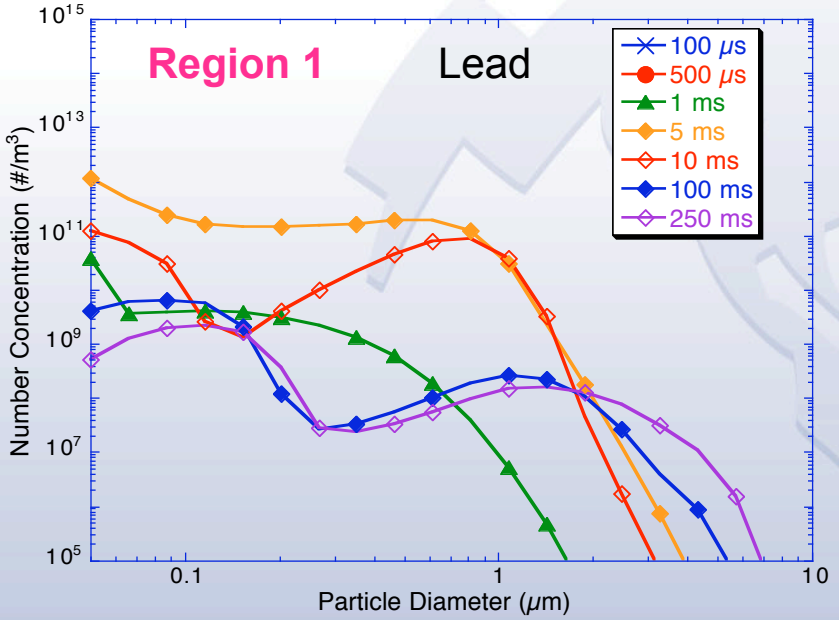
Model Results: Liquid Wall Chambers, cont.

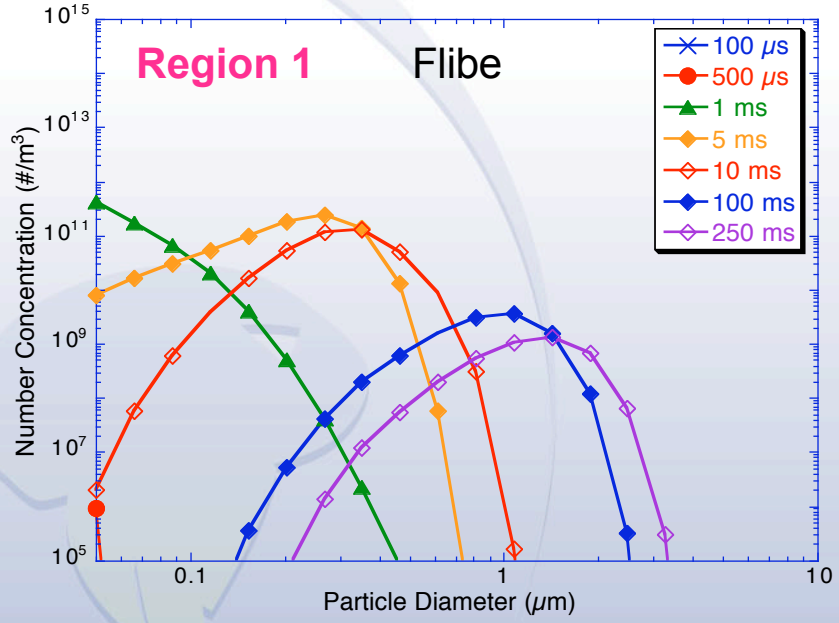
Regional Particle Size Distributions (for flibe only):



Model Results: Liquid Wall Chambers, cont.

Region 1 Particle Size Distributions:





Results indicate that flibe gives a smaller mass concentration near the chamber center (10 mg/m^3 versus 20 mg/m^3 for lead). The size distribution of flibe is more narrow.

Summary of results:

Material	Total Evaporated Mass	Evaporated Thickness	At End of Simulation: 250 ms Total Aerosol Mass	Region 1 Mass Concentration	Average Particle Size	Number Concentration at Average Size
Liquid Walls: 142 MJ from x-rays of indirect-drive target						
Pb	13.1 kg	2.46 μm	1.2 kg	20 mg/m^3	~ 2 μm	~1x10^9 #/m^3
Flibe	5.86 kg	5.52 μm	20 g	10 mg/m^3	1.2 μm	1x10^9 #/m^3
Solid Walls: 43 MJ from ions of direct-drive target*						
W	57 g	0.0045 μm	0.5 g	0.4 mg/m^3	< 0.3 μm	~1x10^9 #/m^3
Steel	2.2 kg	0.53 μm	123 mg	90 mg/m^3	1 μm	1x10^{10} #/m^3

*- solid wall results are given for comparison

What's Next???

- add other particle sources to model (e.g. melt-layer ejection and spry droplet injection)
- fix radiative/plasma part of gas-dynamic model to better simulate the behavior of evaporated vapor (e.g. ion heating)
- extend to model to multi-component aerosols to allow more realistic simulation of Flibe condensation