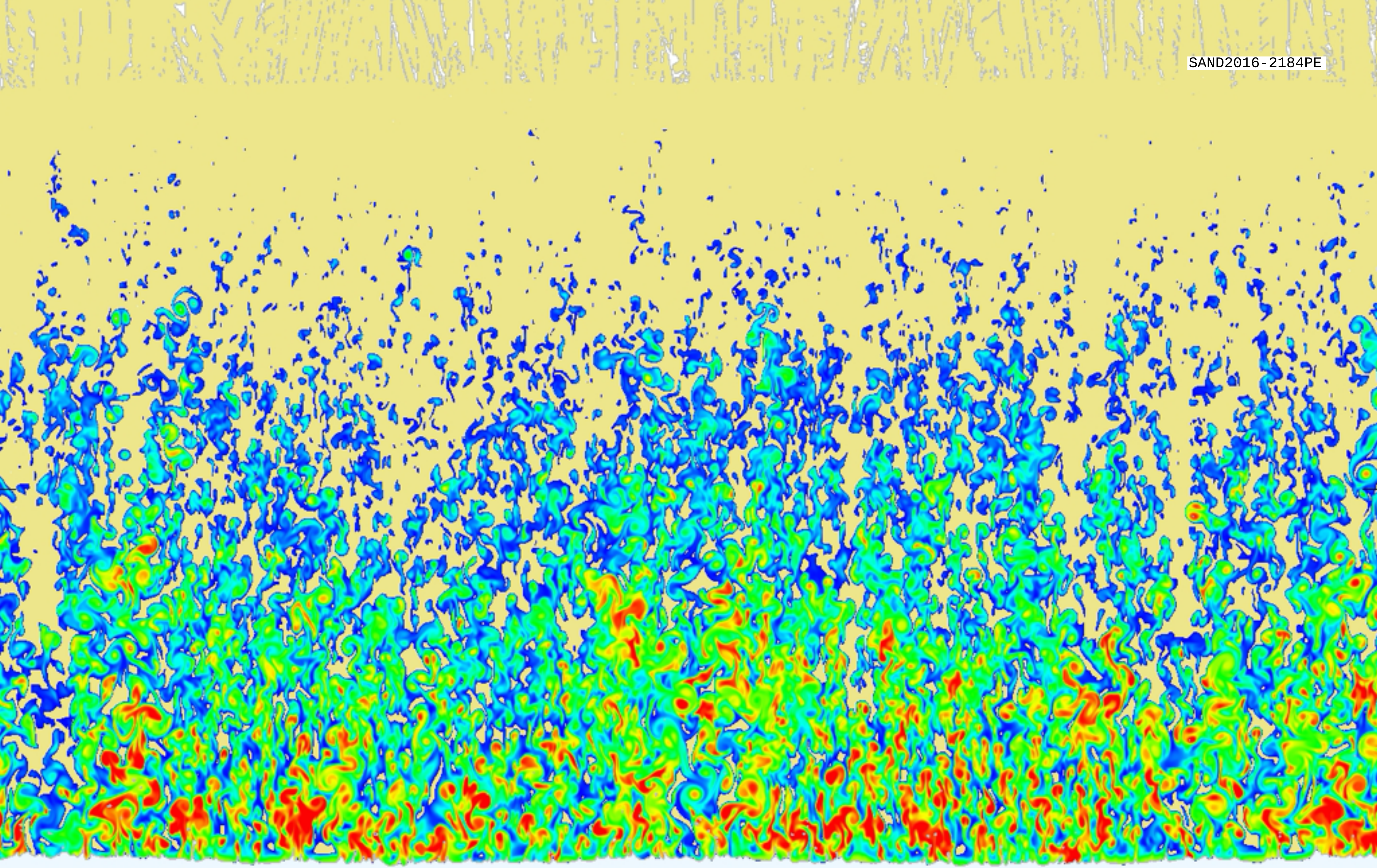
SAND2016-2184PE



RYAN R. WIXOM

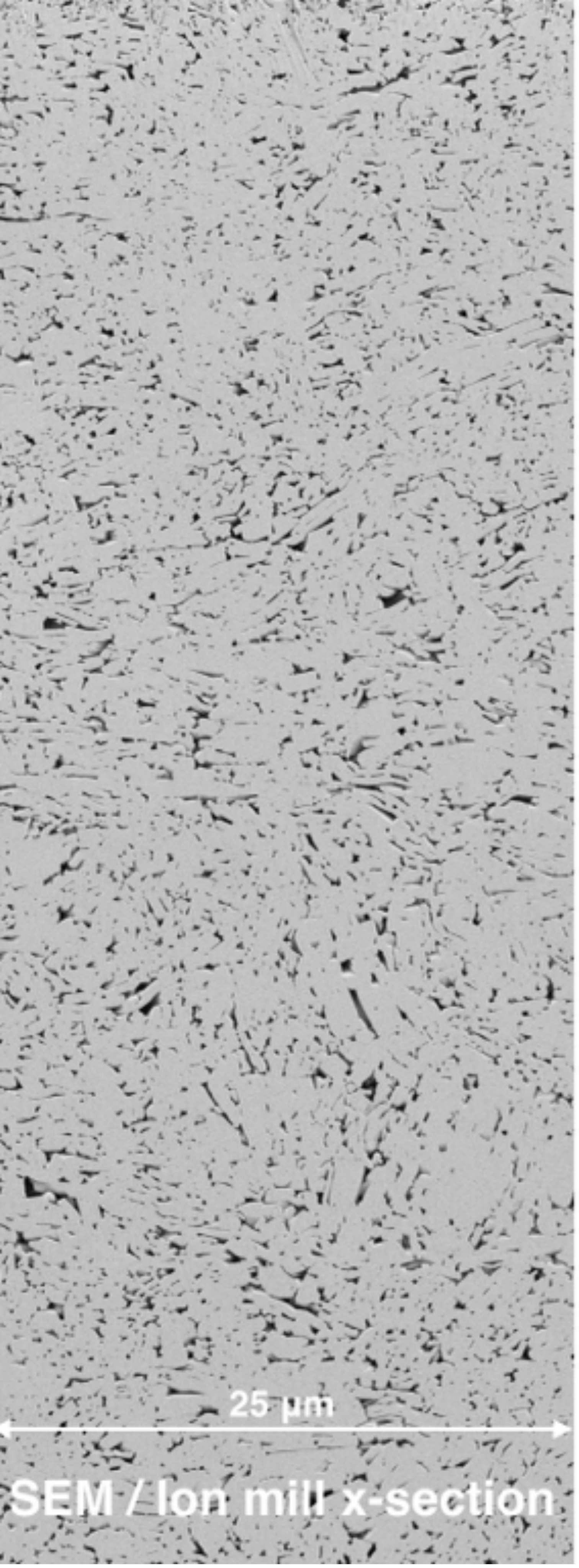
BUILD-UP TO DETONATION IN HNS

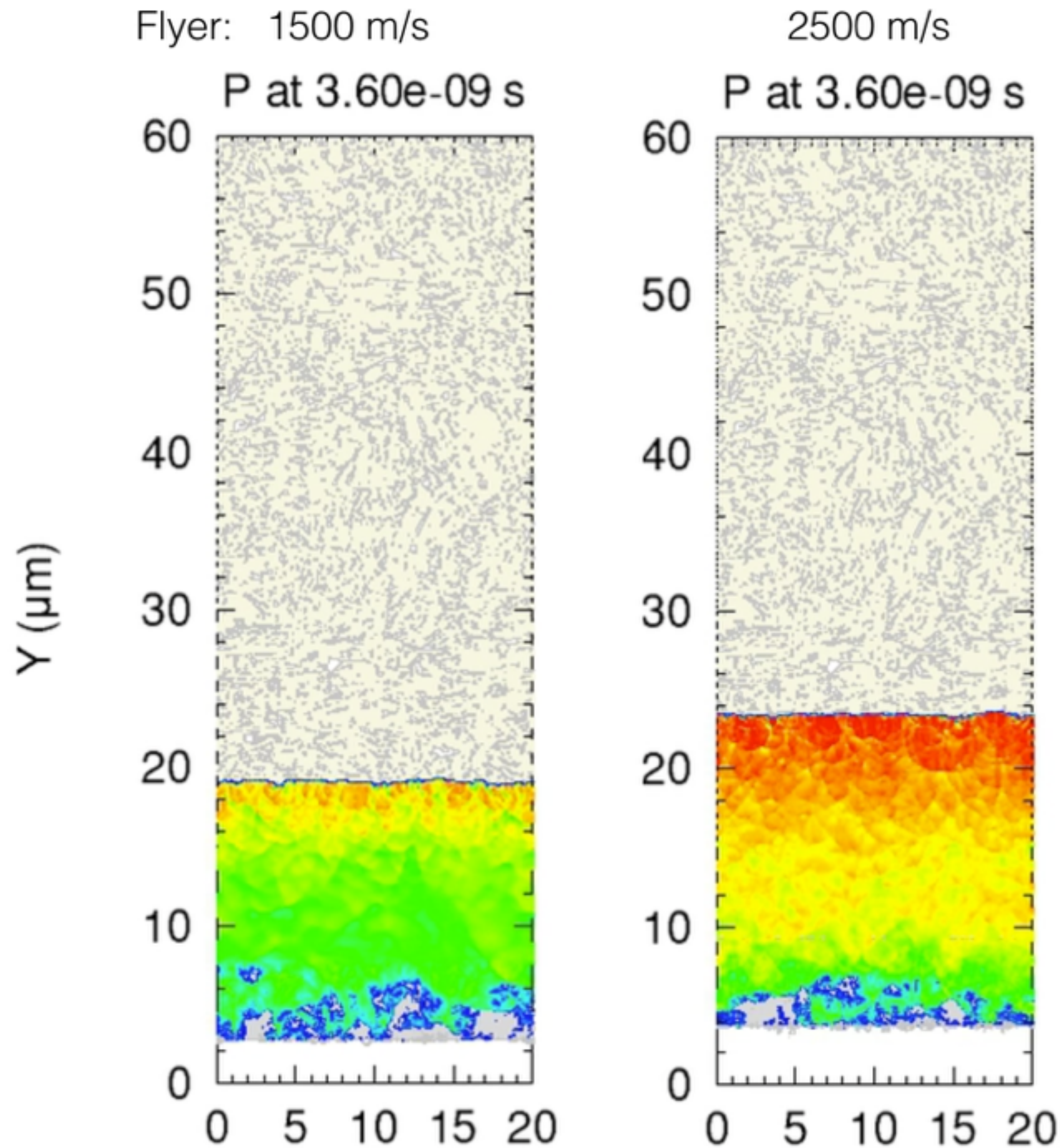
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Collaborators:

- David Damm
- Joseph Olles
- Cole Yarrington
- David Kittel
- Alex Tappan
- Robert Knepper
- Eric Welle
- Barry Ritchey
- Pat Ball

Mesoscale simulation of HNS initiation

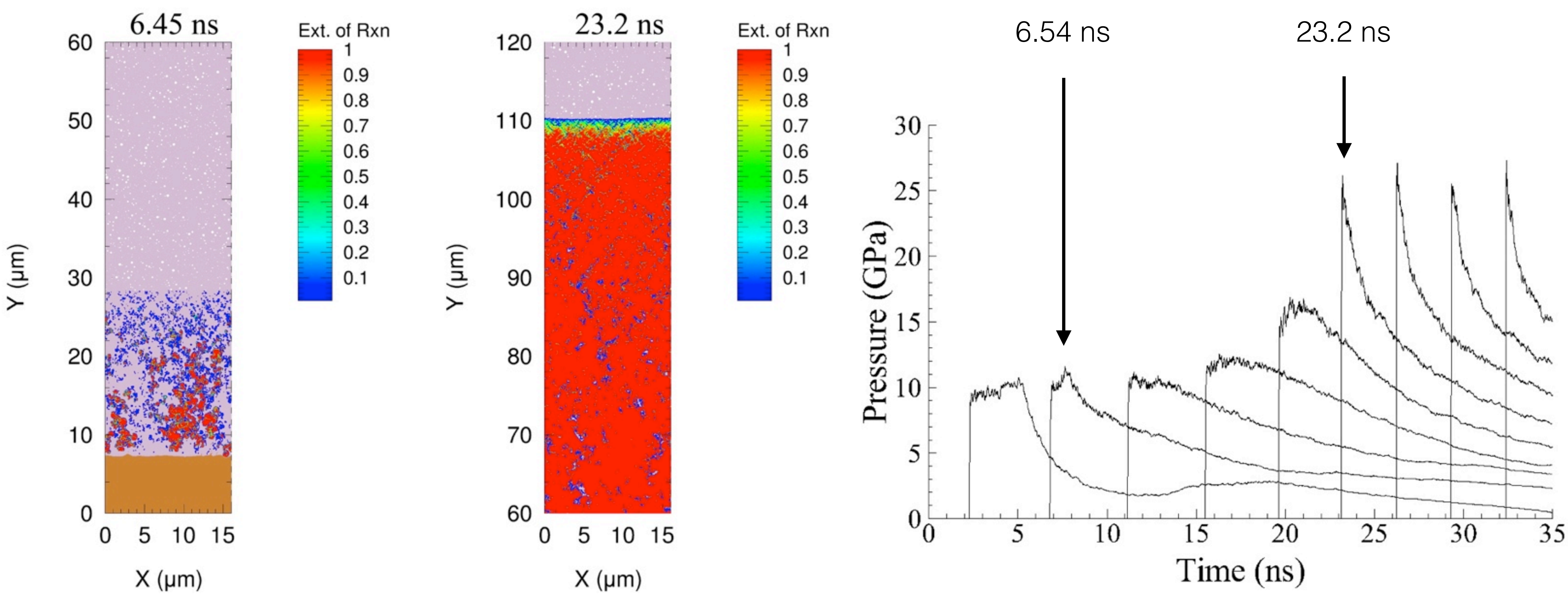




How do we validibrate our simulation?

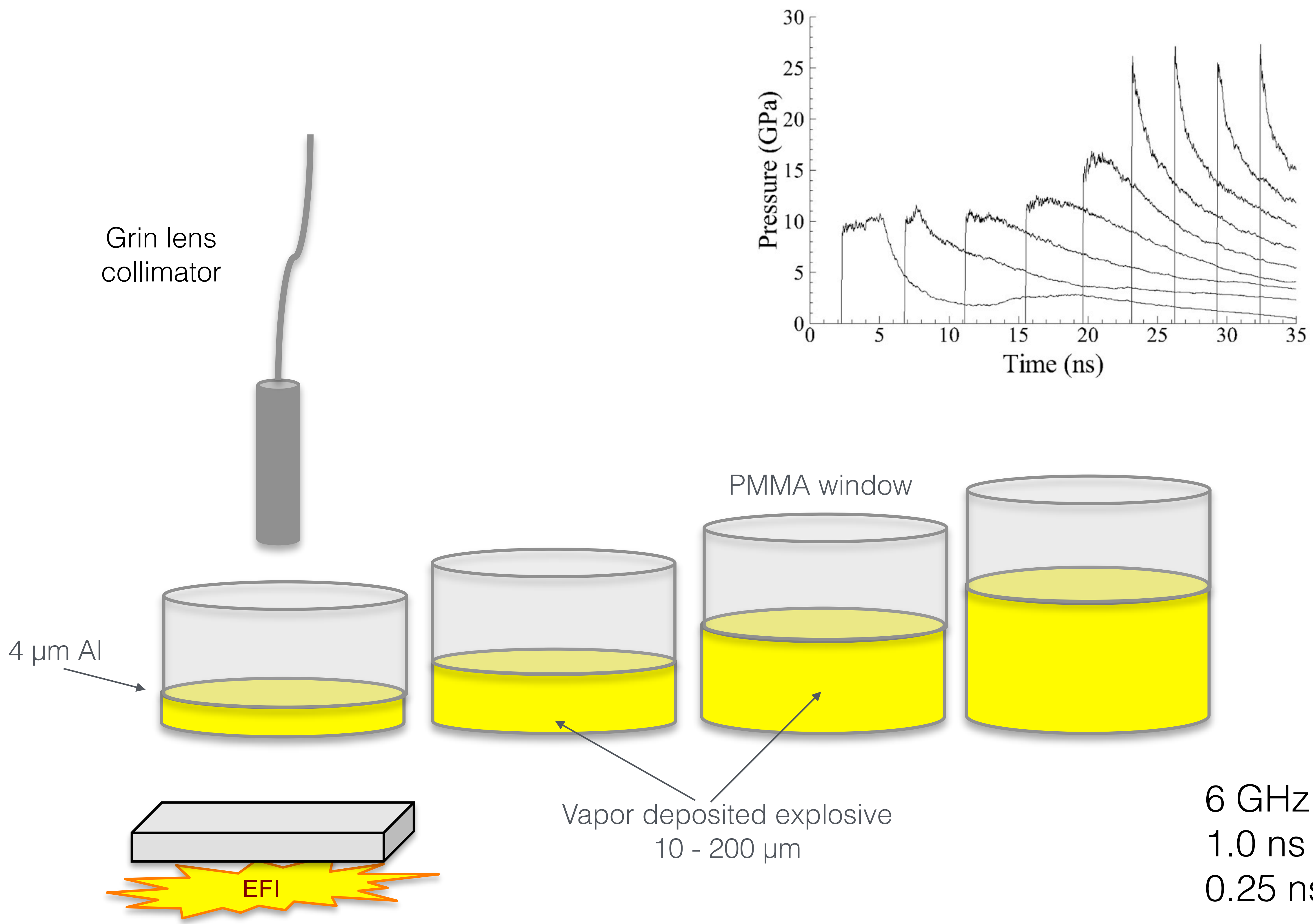
Mesoscale simulation was used to predict a shift in run-distance and threshold with increasing pore diameter.

Particle velocity histories from simulation



This type of data (velocity histories) has not been collected for detonator materials where run-up is 10s ns and 10s-100s µm.

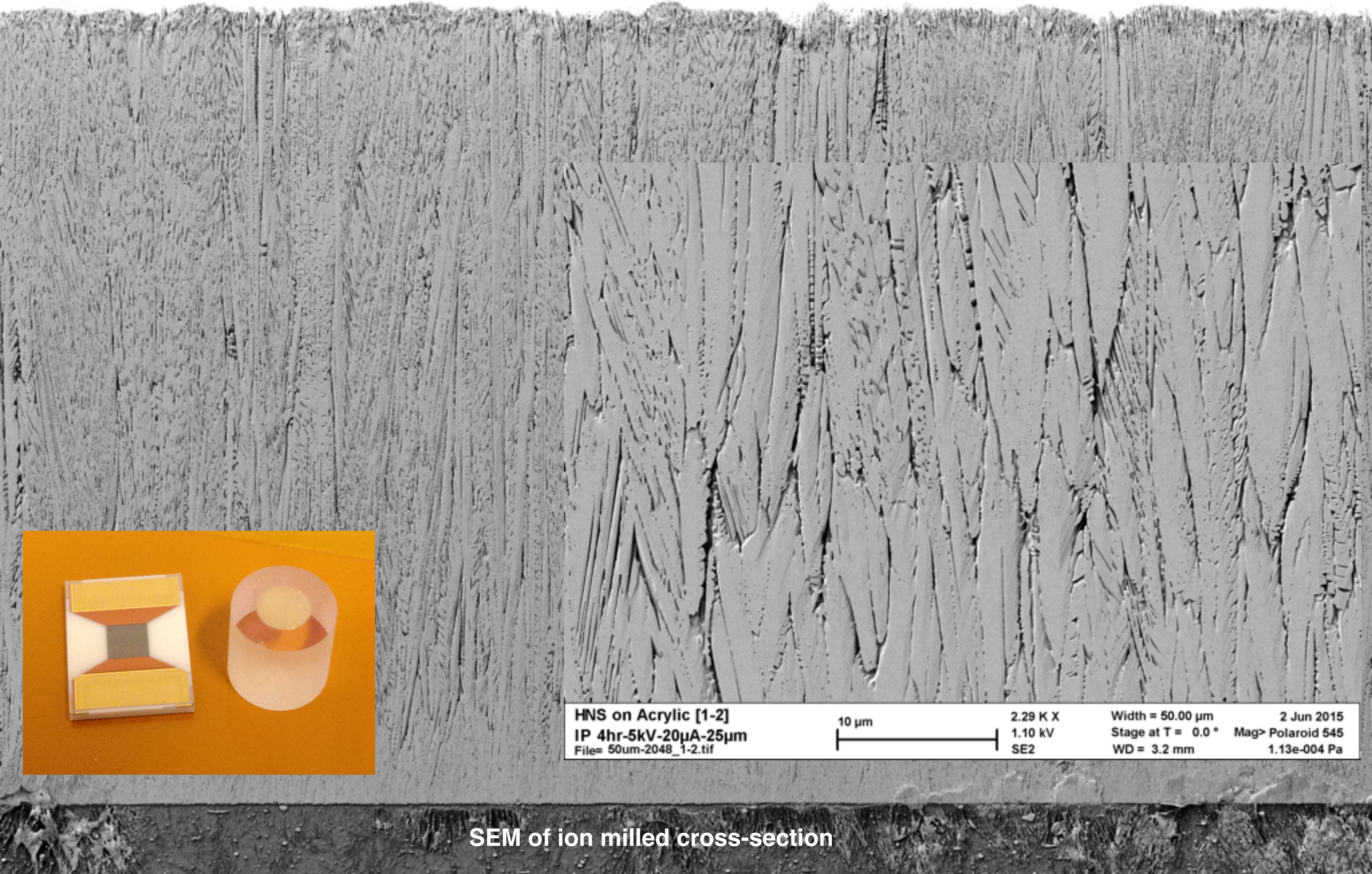
The experiment: small scale "cutback"



6 GHz upshift
1.0 ns window
0.25 ns advance

Samples: Vapor-deposited HNS (50-200um thick)

These samples are extremely cool



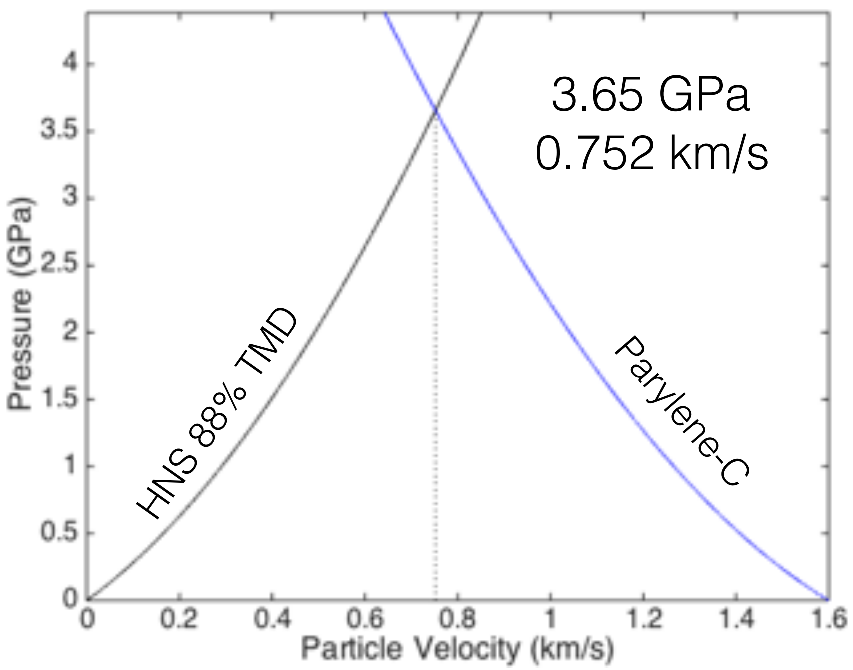
SEM of ion milled cross-section

What should we expect to see?

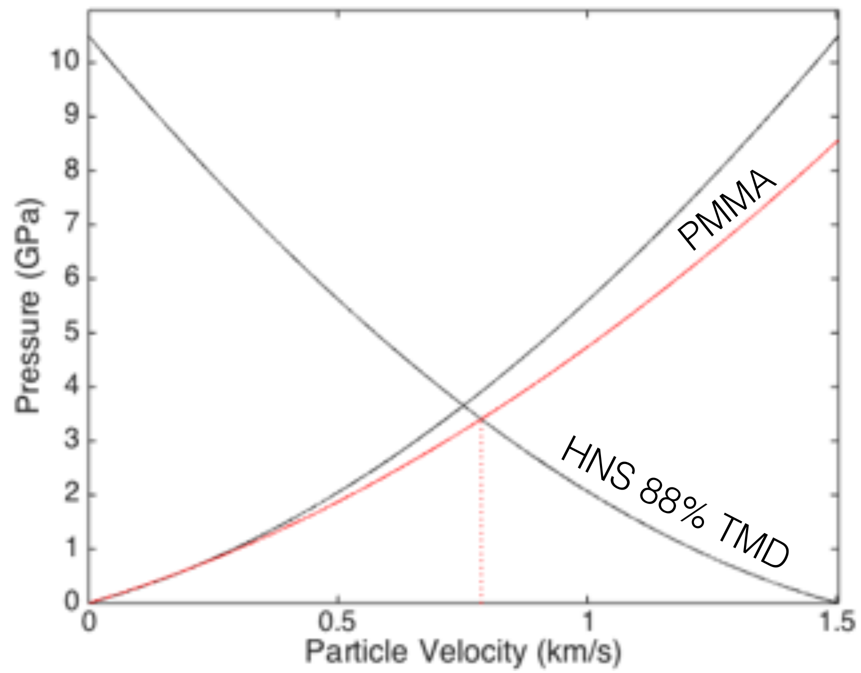
1d CTH
50 um P-C flyer
60 um HNS film
- 88% TMD, DFT-MD EOS
PMMA window

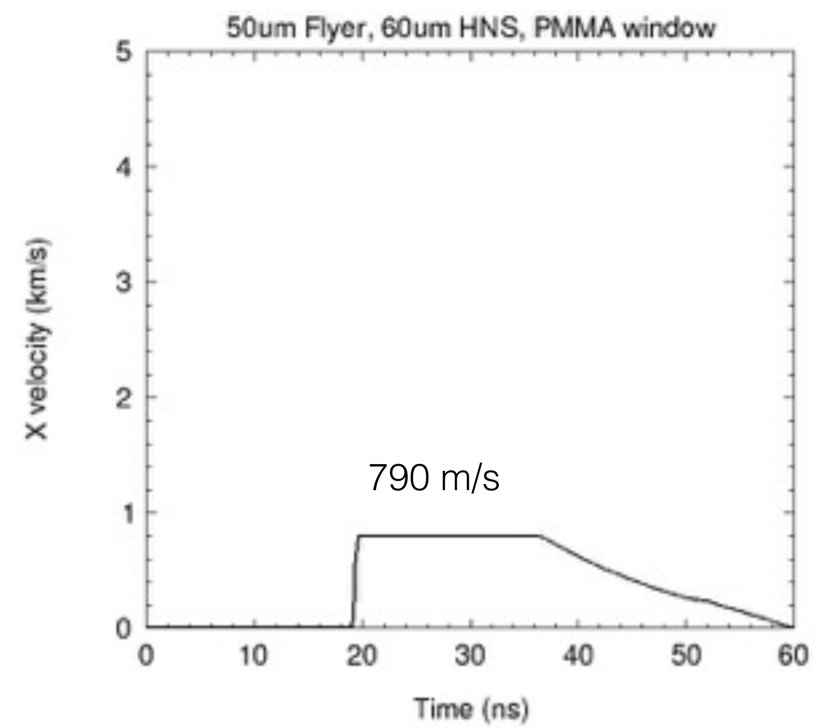
Inert shock imparted by 1600 m/s flyer

Flyer Impact



Window Interface





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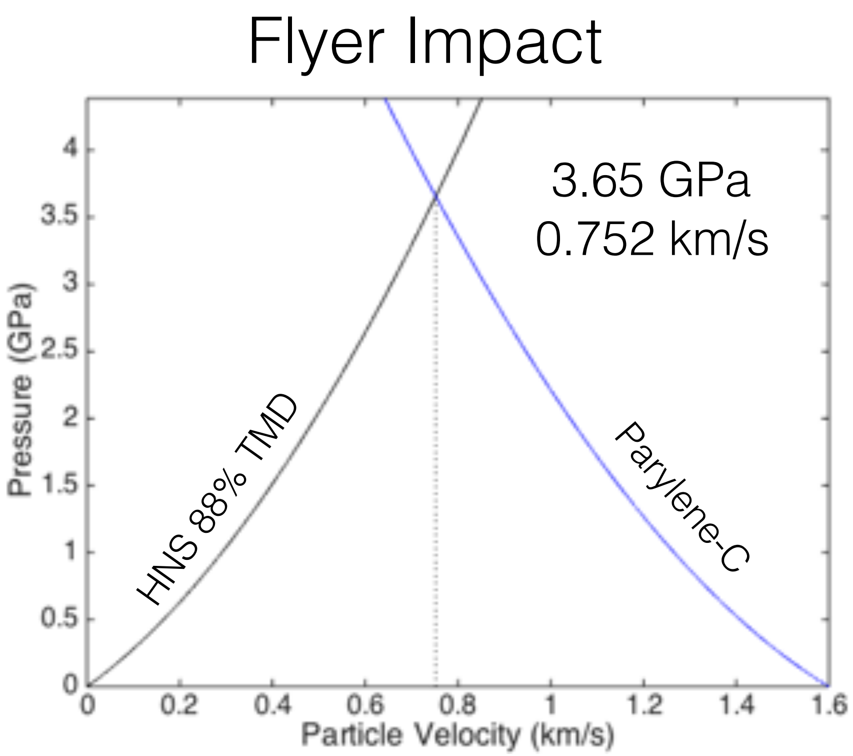
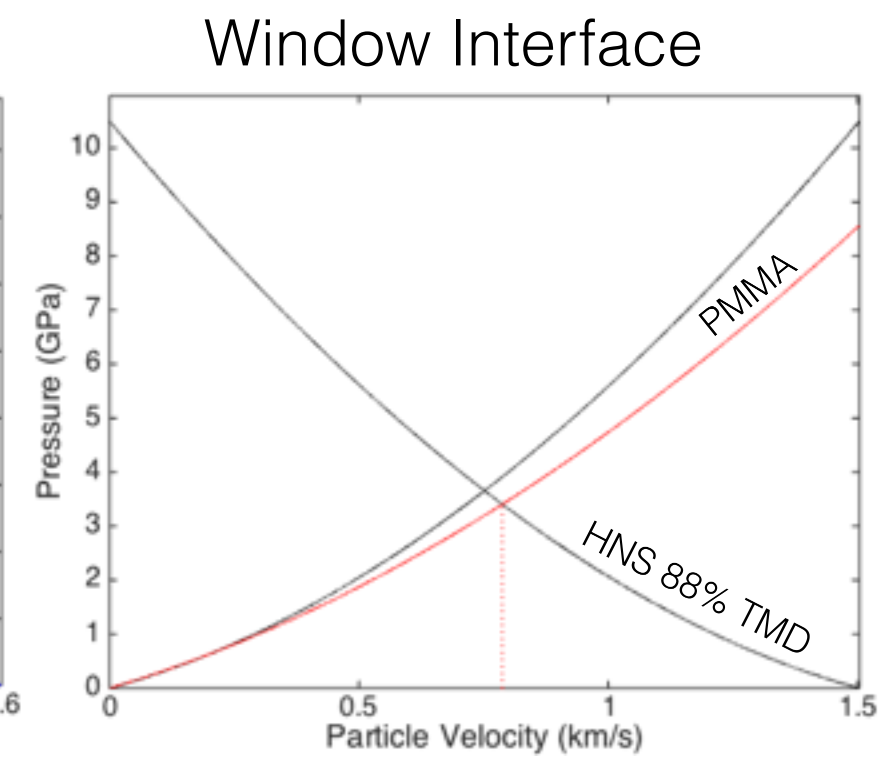
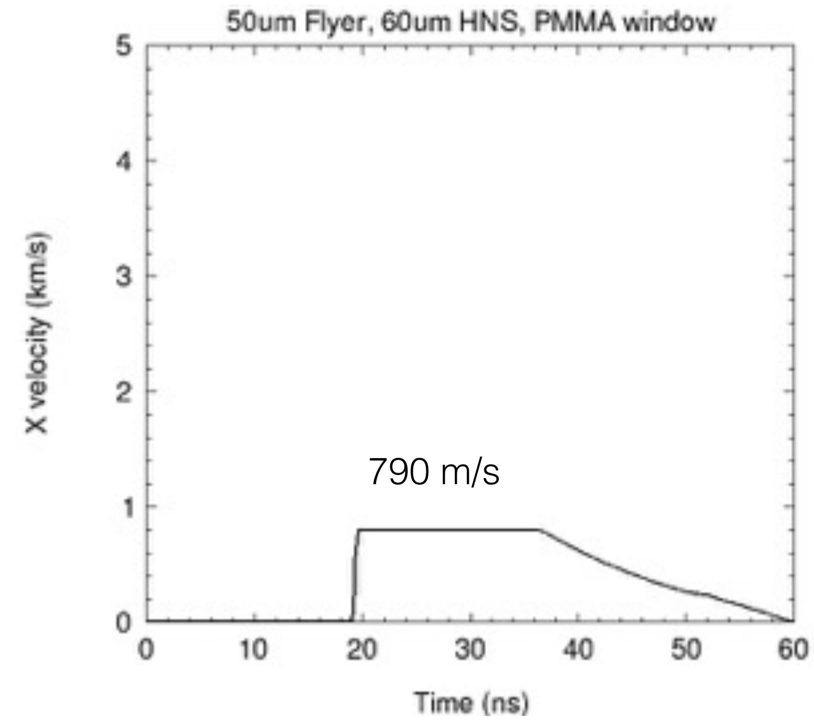
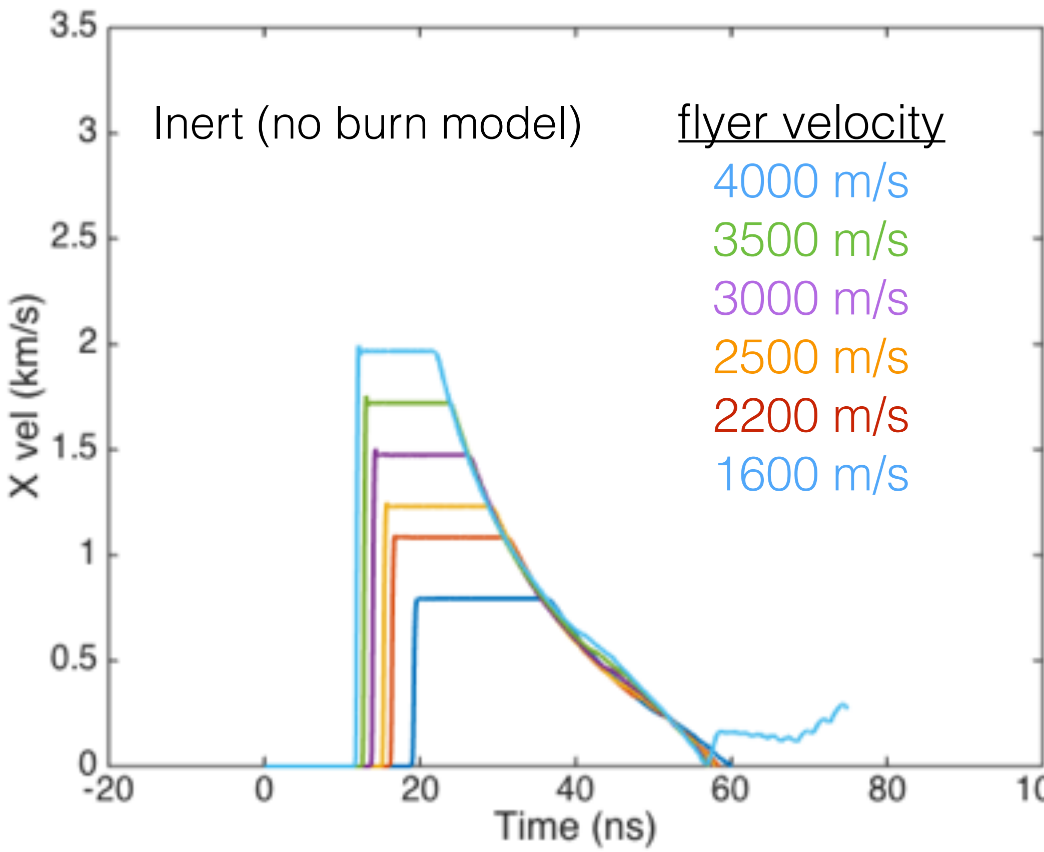
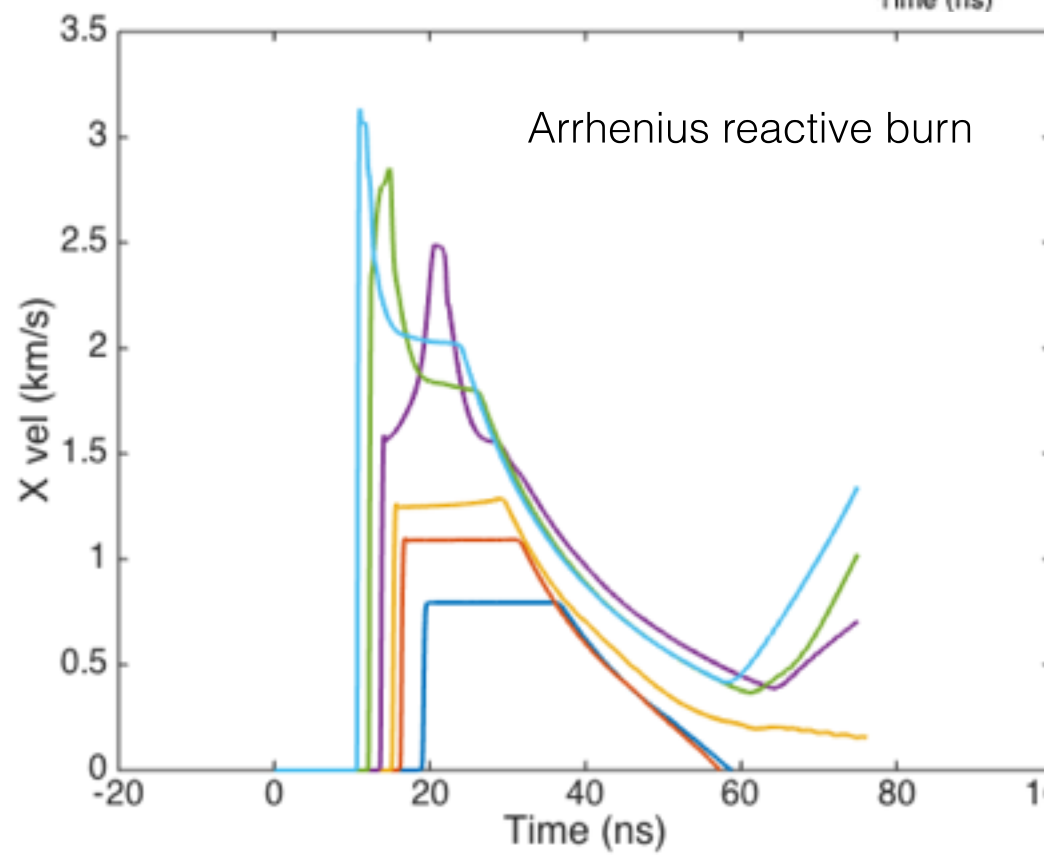


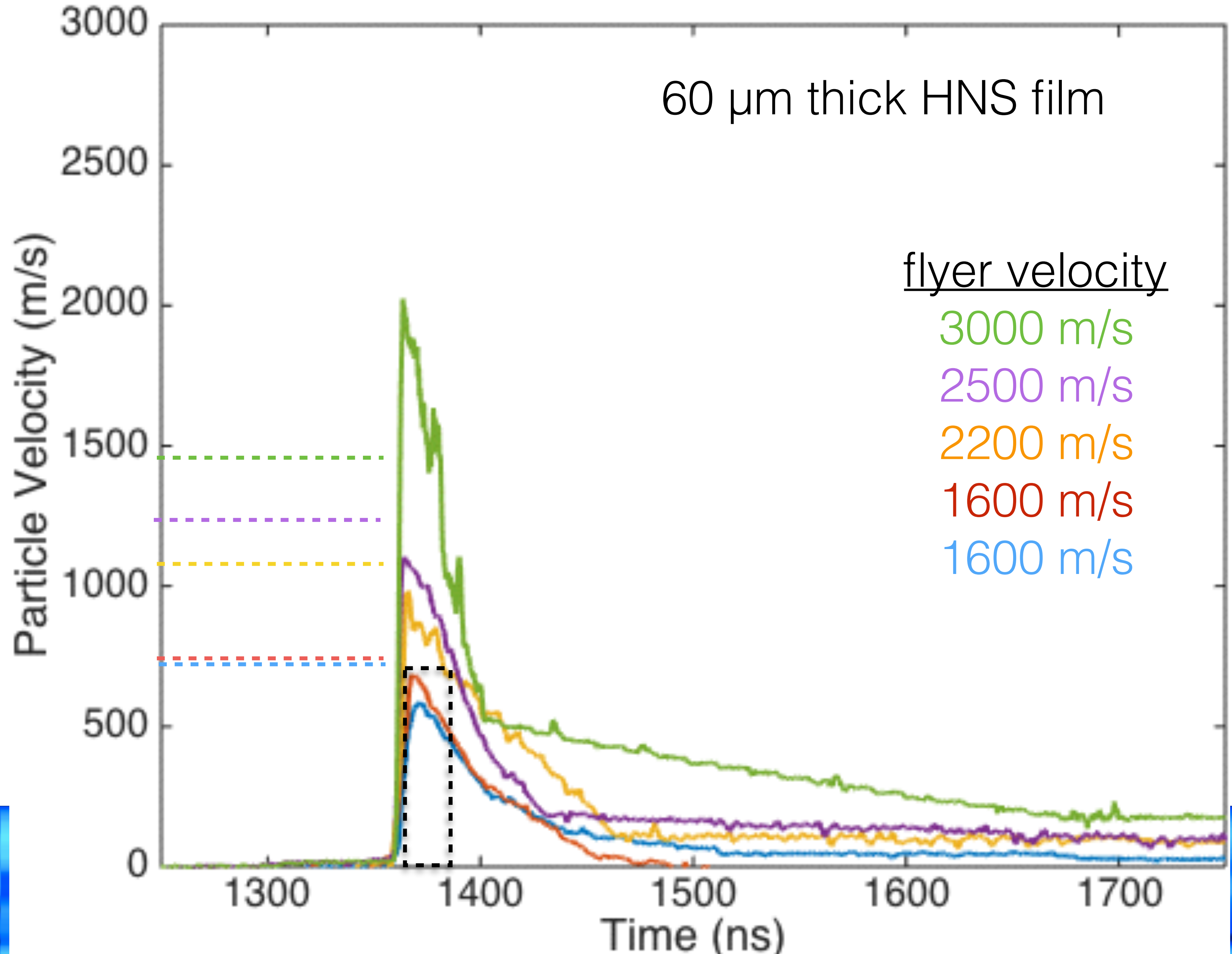


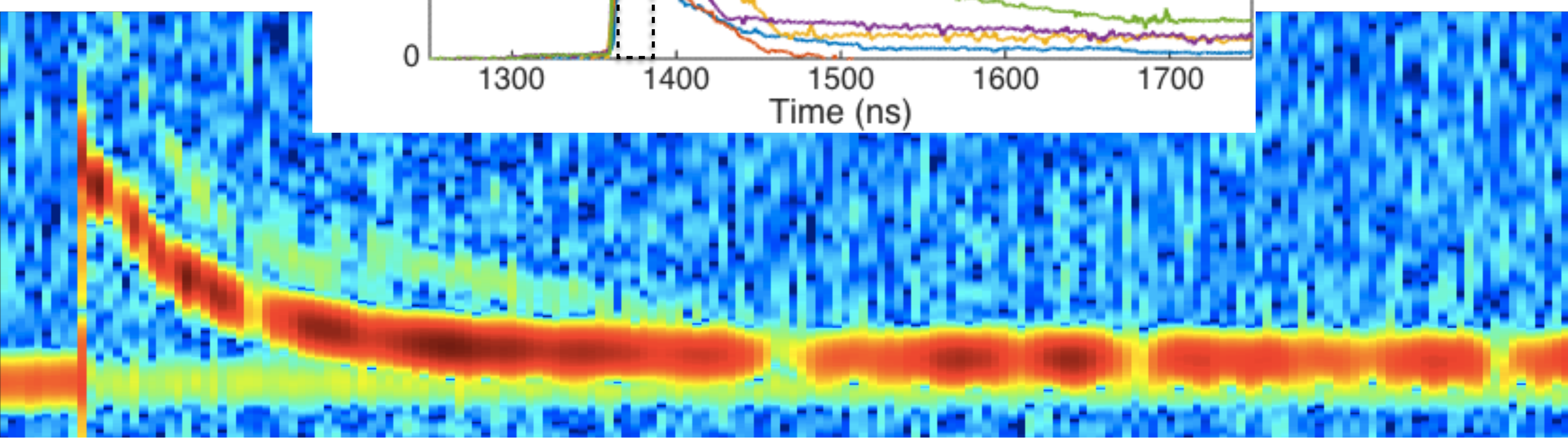




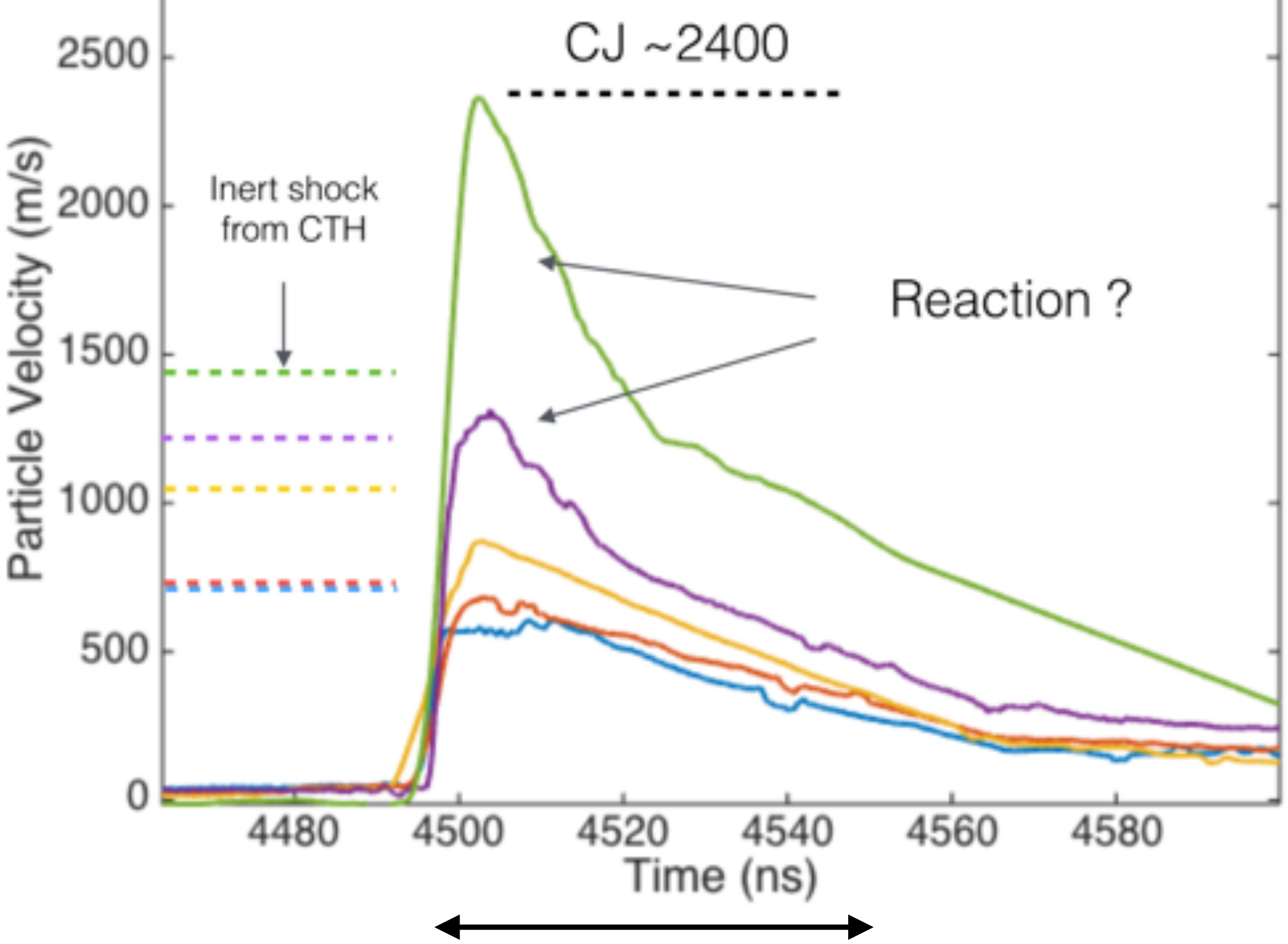


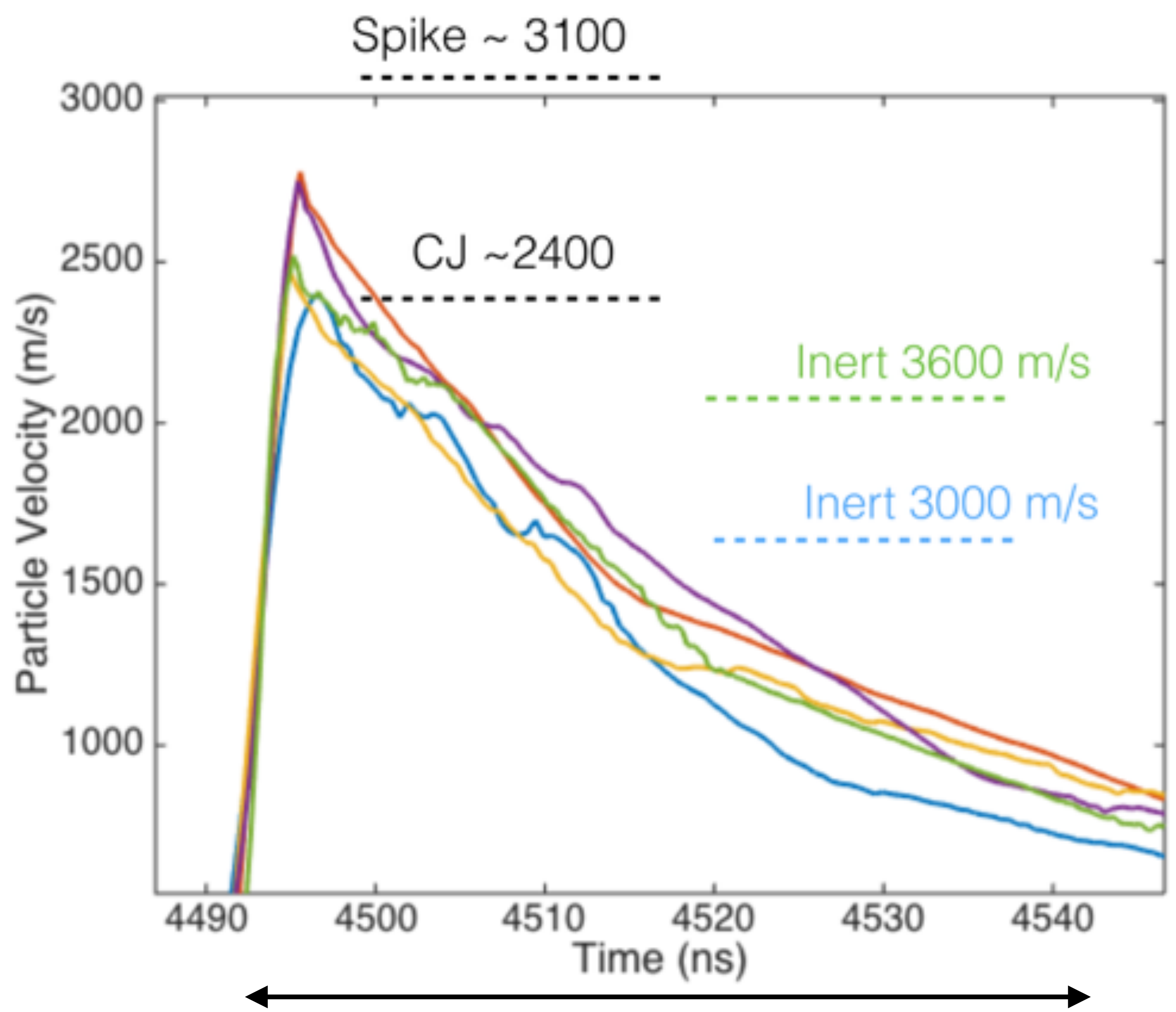
Velocity histories from HNS films (60 µm thick)

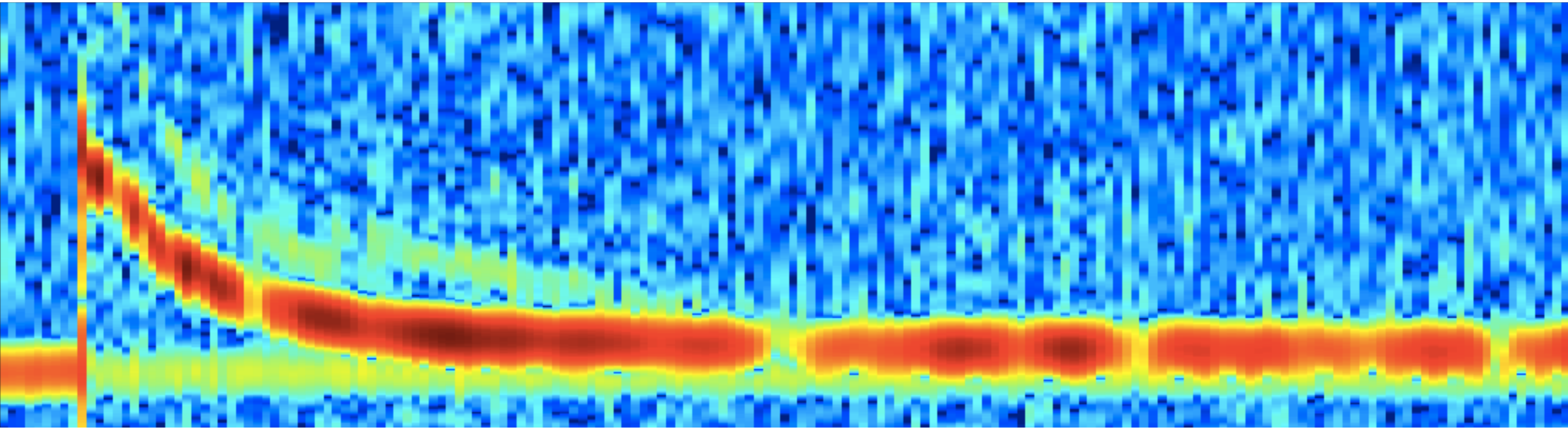




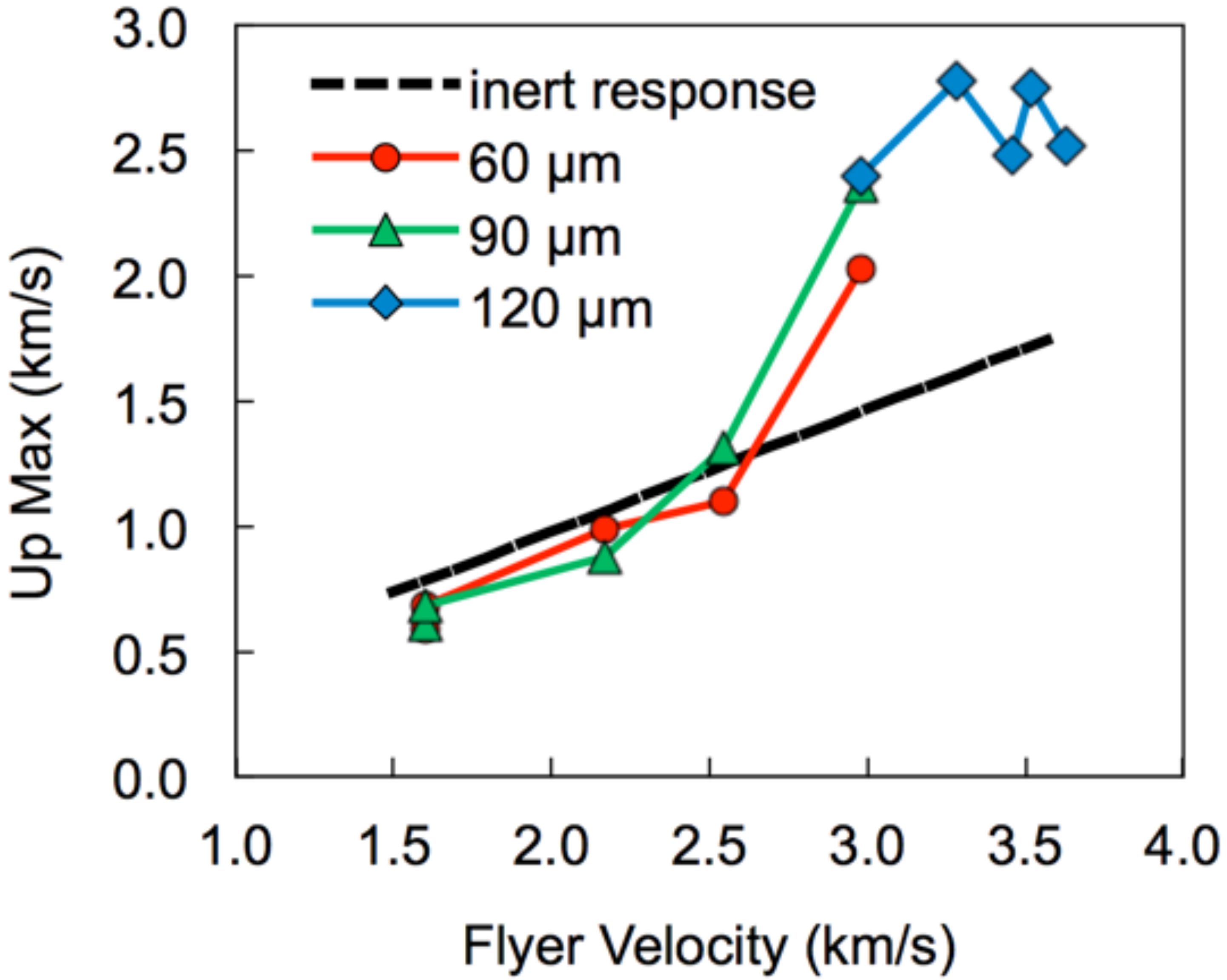
PDV HNS (90 µm thick) (120 µm thick)



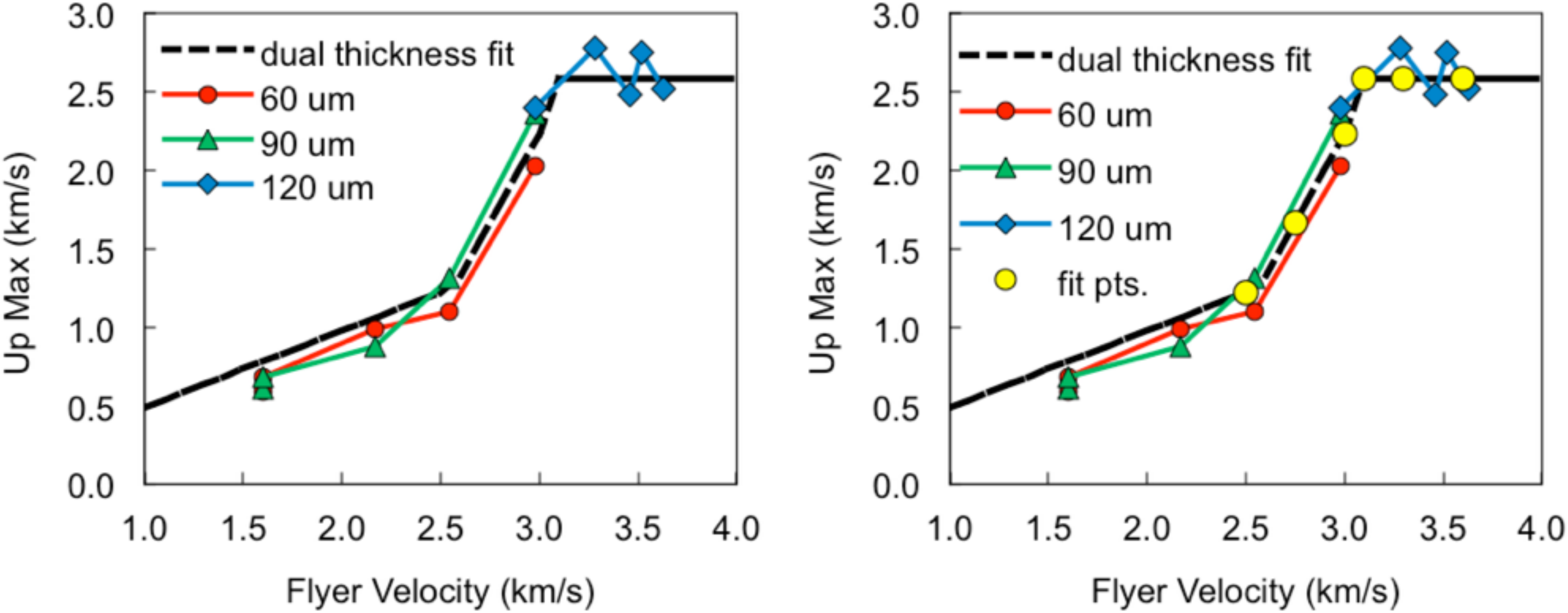




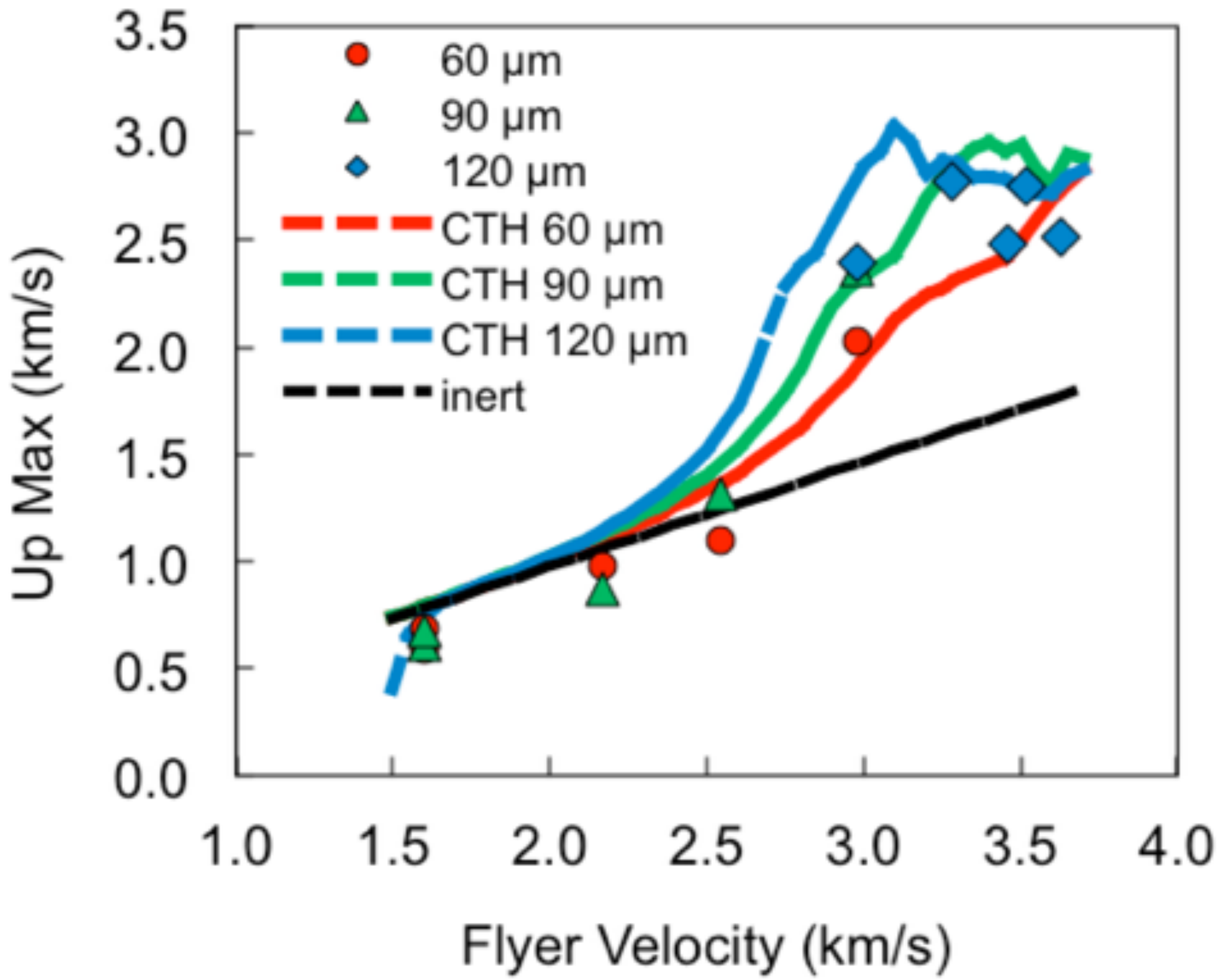
Experimental results



Proposed optimization



CTH optimization HVRB model



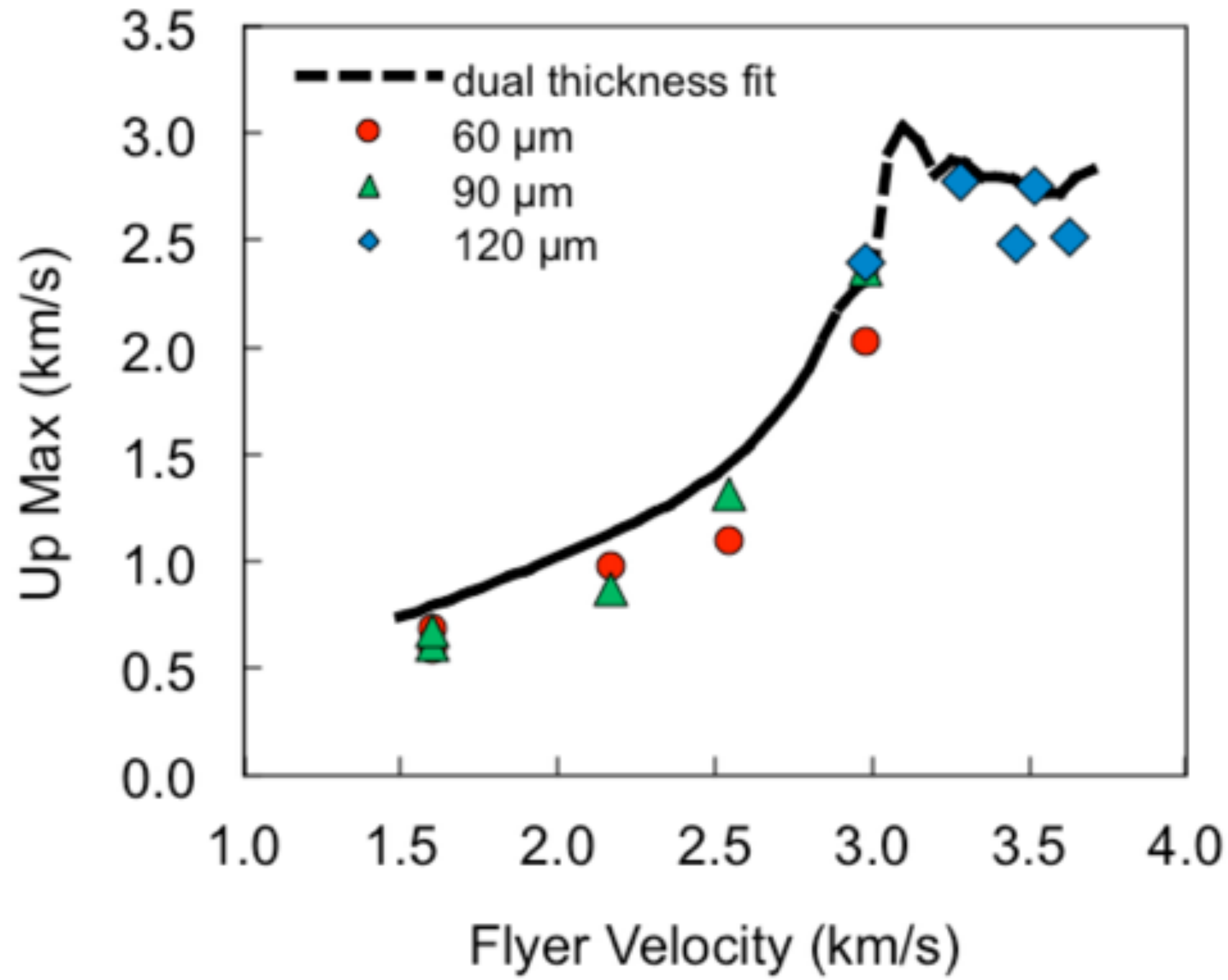
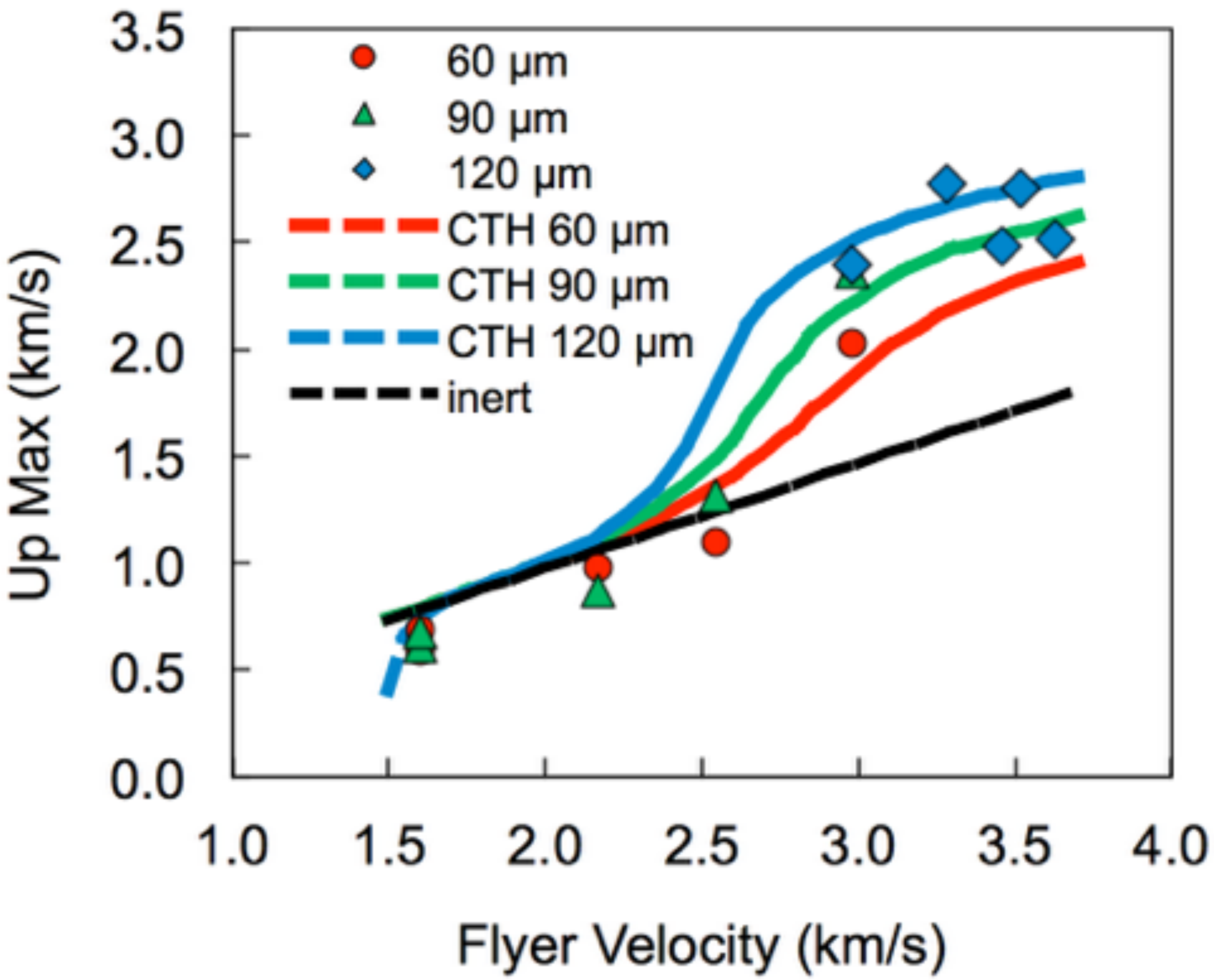


Table 1. HVRB model and Dakota optimization details for fd_gradient_step_size=1e-4.

Parameter	PR	ZR	MR	XR	PI
Lower Bound	1e10	1	1	0.1	1e9
Initial Guess	3e10	3	1.5	1	3e9
Best Parameters	3e10	3.0131	1.4687	0.9291	3e9
Upper Bound	50e10	10	2	2	3e10

Gradient based optimization, “personally frustrating.”

CTH optimization ARB model



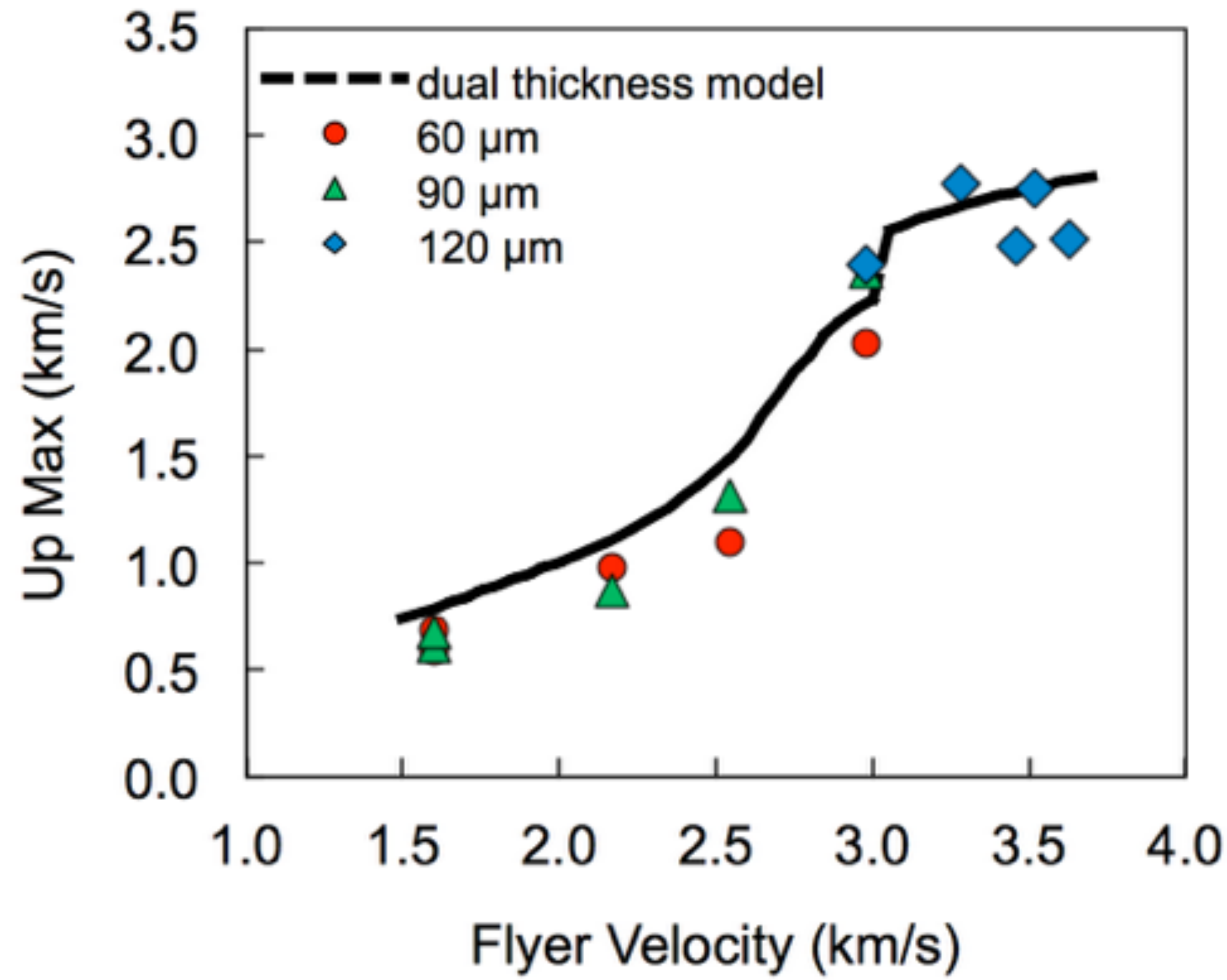
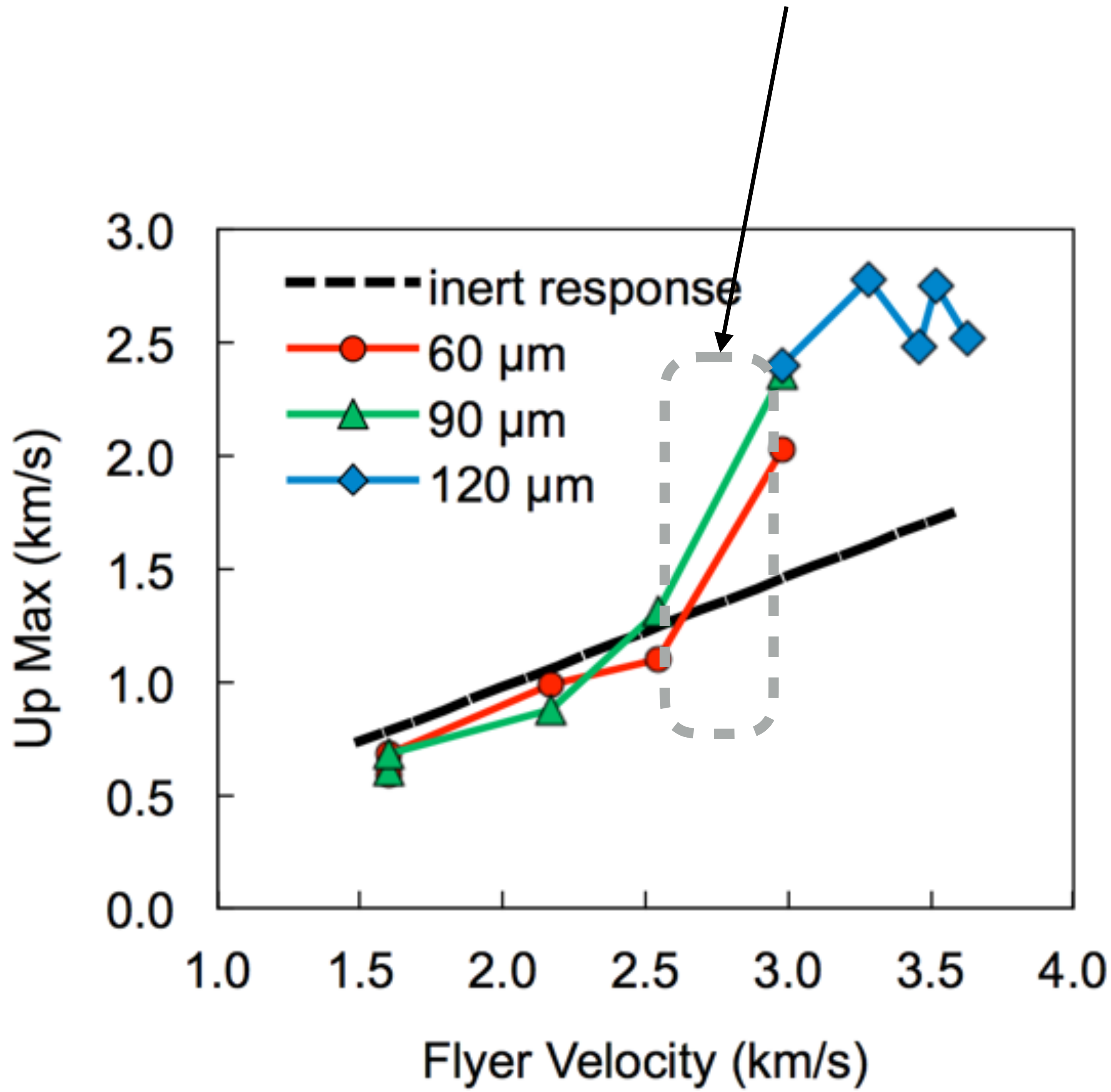


Table 1. ARB model parameters and Dakota optimization.

Parameter	FF	AT
Lower Bound	1e9	0.01
Best Parameters	2.0156e9	0.43236
Upper Bound	1e10	0.7

Evolutionary algorithm with a population size of 16.

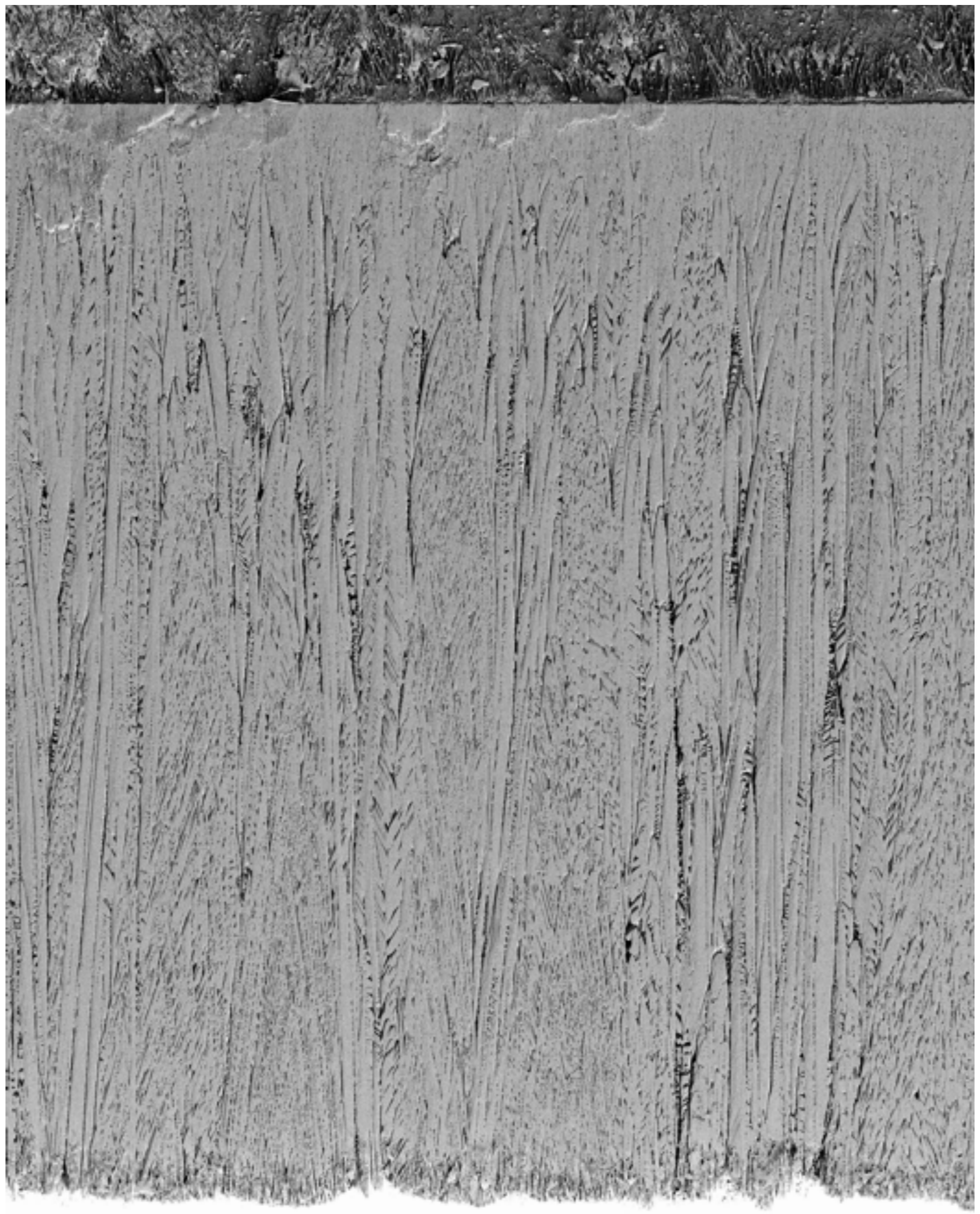
Experimental results (NEW)

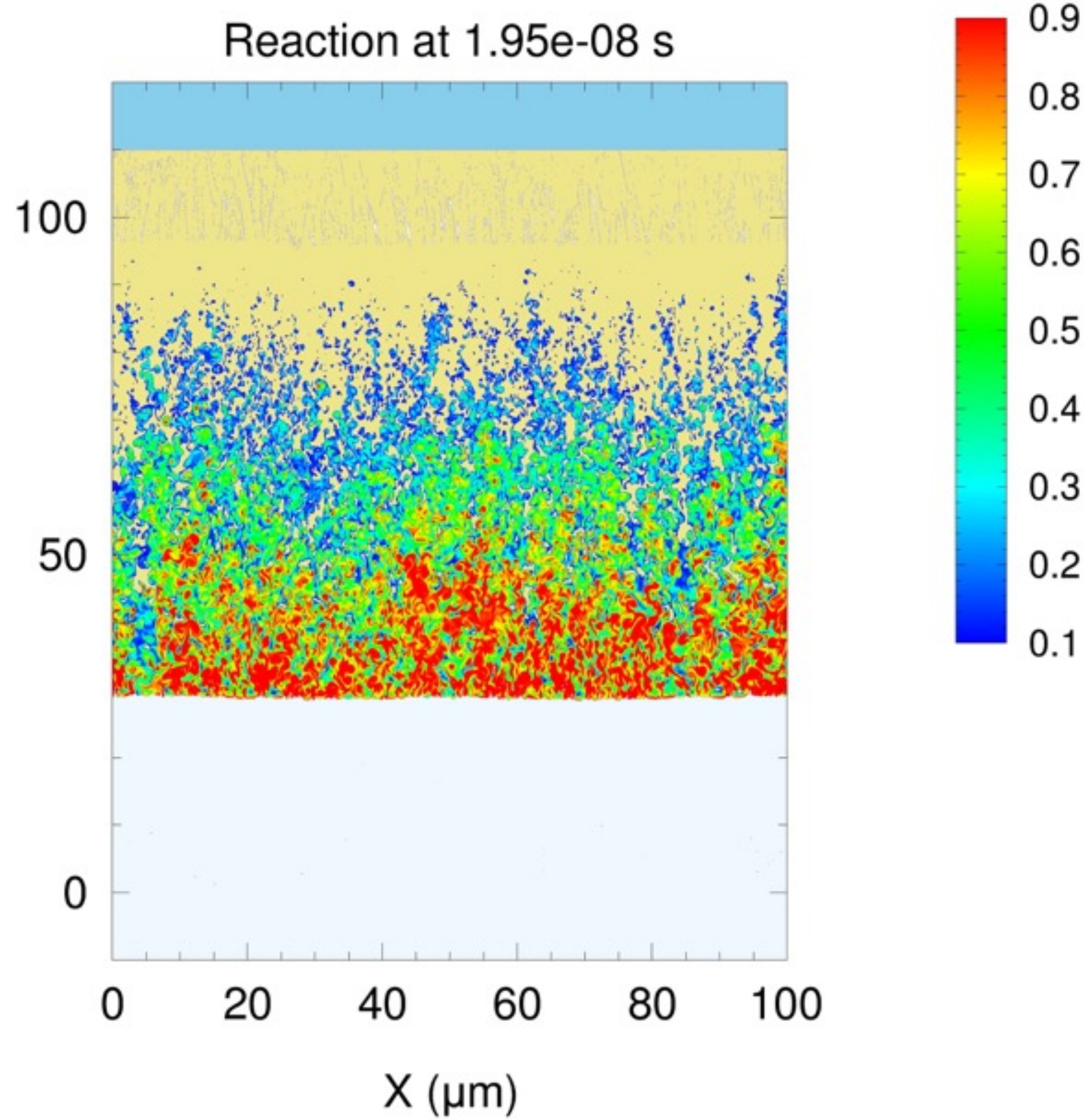


Plan to collect data at one velocity for 4 thicknesses (60, 90, 120, 150 µm)

Transition seems to be more abrupt than we assumed.

Grain-Scale (mesoscale) simulation





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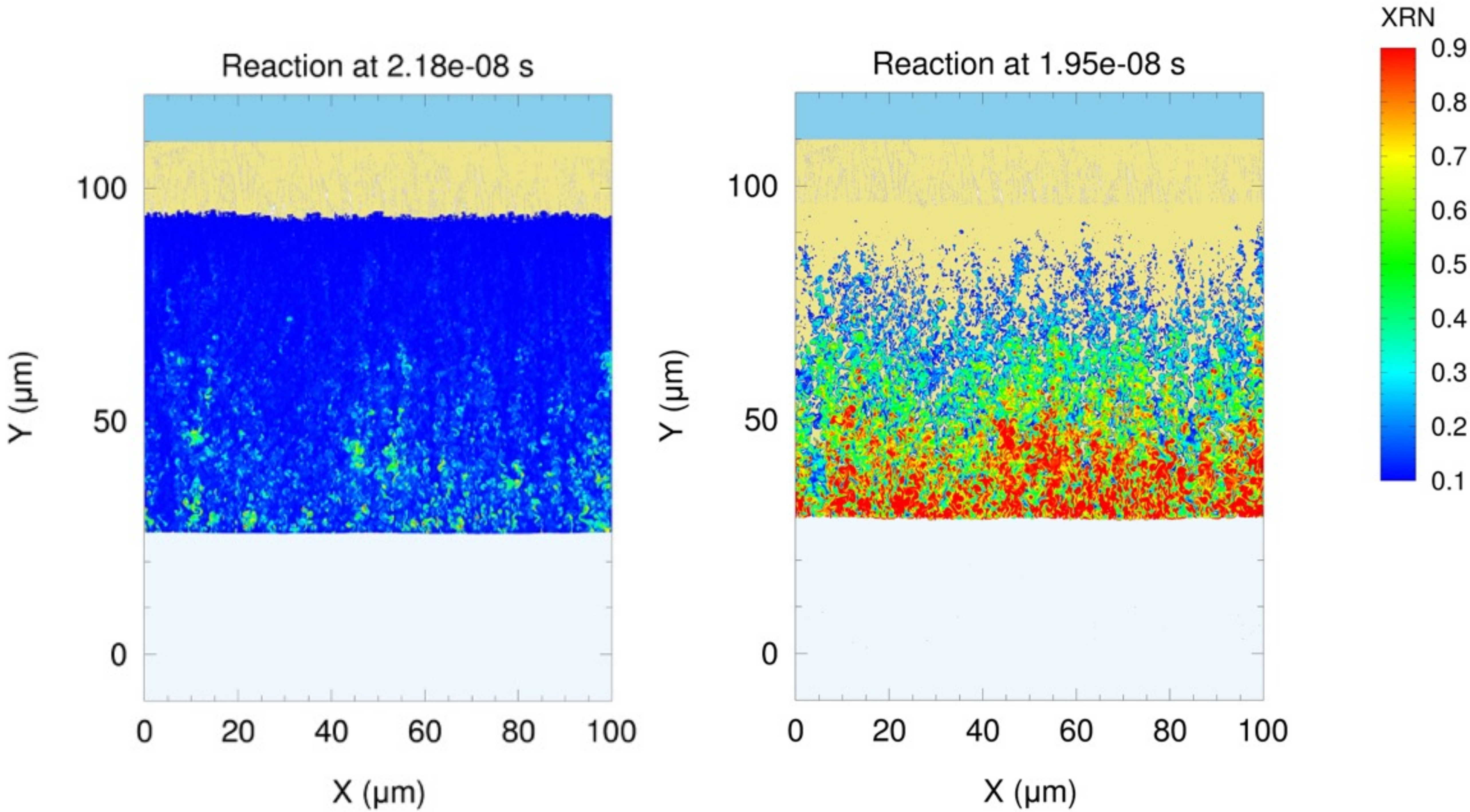
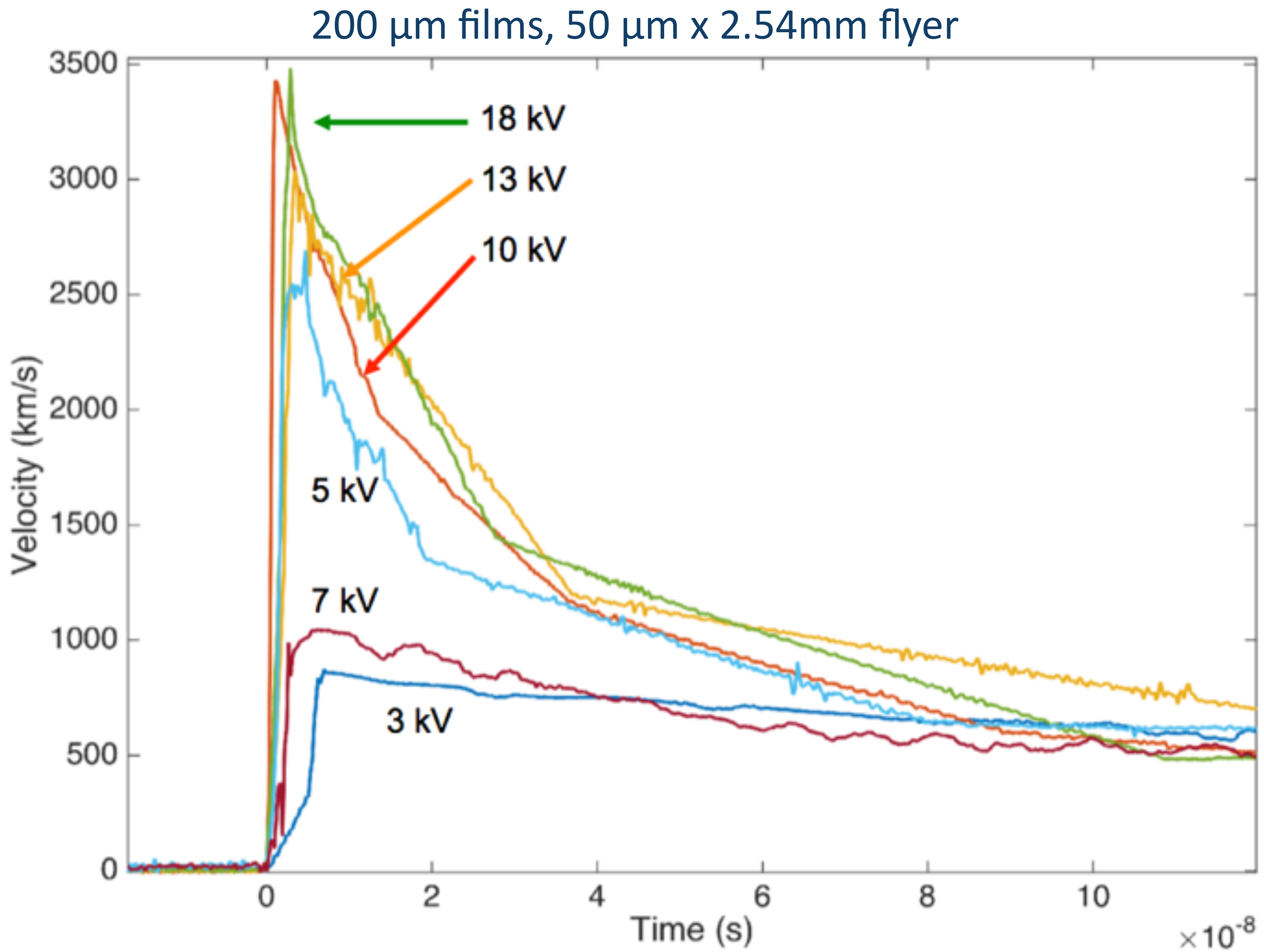


First-principles based reactants EOS (tabular)
Sesame table product EOS (historical)
Arrhenius reactive burn (ARB) with new and old parameters

Preliminary PETN results



Summary

We used PDV to capture the the build-up to detonation in flyer initiated HNS and PETN at the micron/nanosecond scale.

These data will be used to evaluate the appropriateness of currently available reactive-burn models for hydrocode simulation.

PDV from lower velocity flyer impacts show transit of an inert shock, which might be used to evaluate the unreacted equations of state used to model these materials.

We plan to optimize the experiments and collect more data.

- window treatment, statistics, probes, analysis (jump off), …

We plan to change flyer thickness, sample thickness and density.

Can we determine where reactions are starting and when?

- homogeneous or heterogeneous