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Characterizing the initiation performance of CL-20 based detonators

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U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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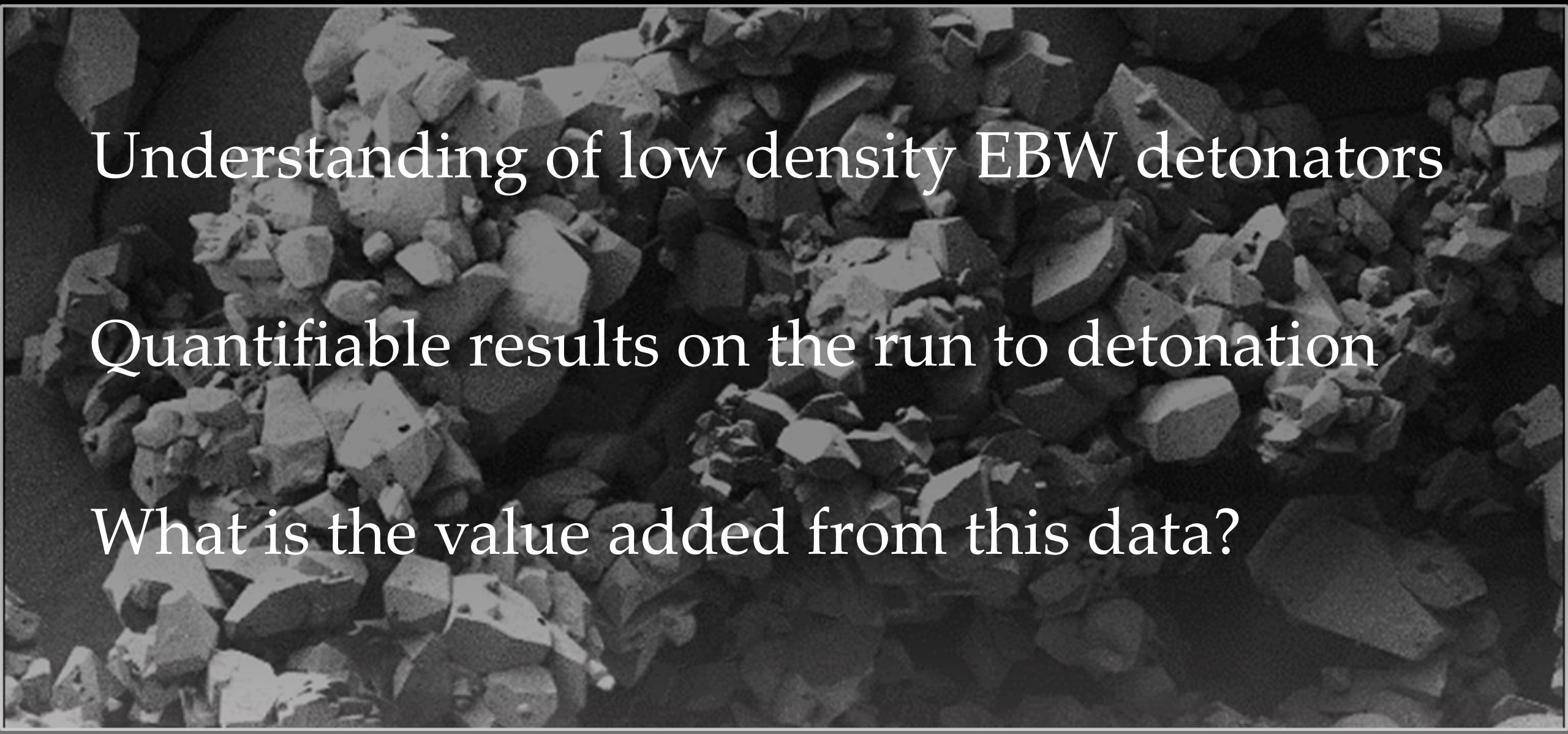
Motivation

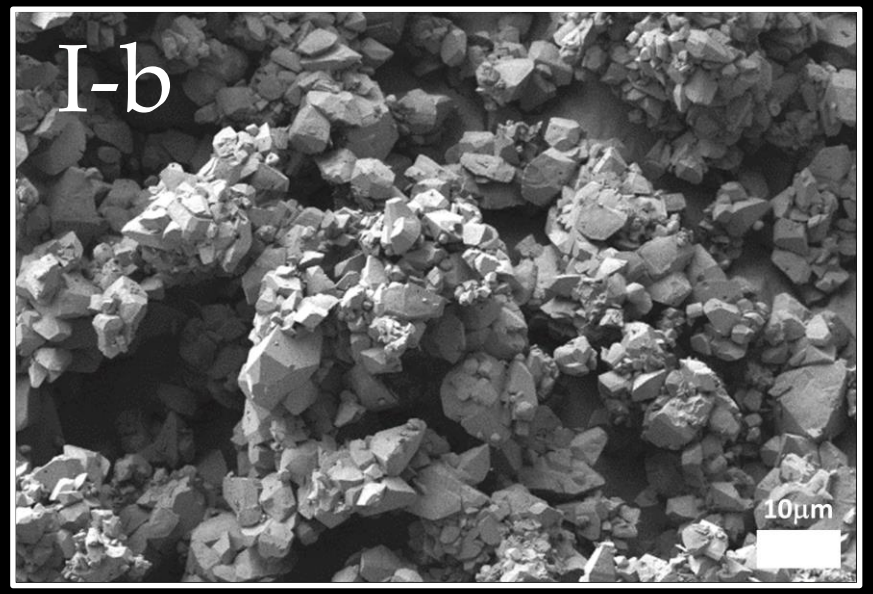


Understanding of low density EBW detonators

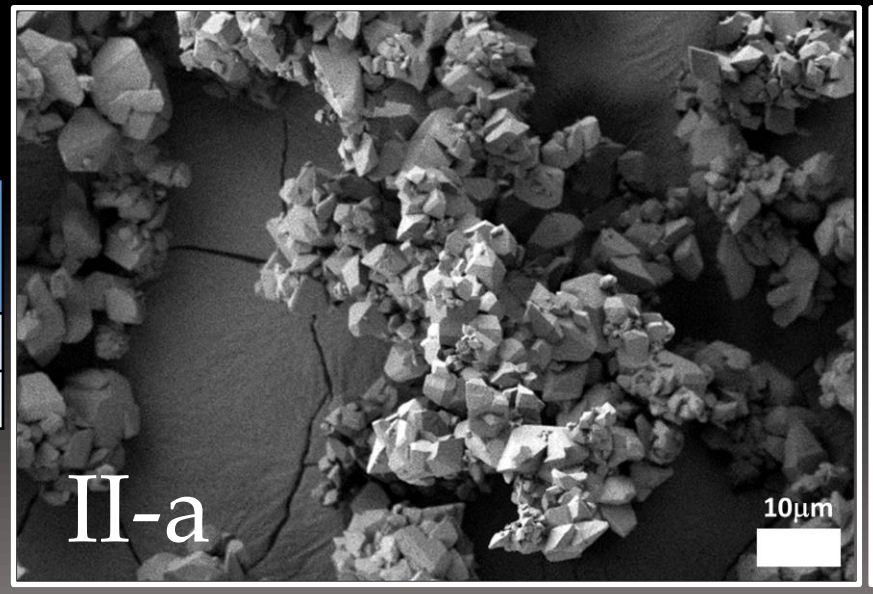
Quantifiable results on the run to detonation

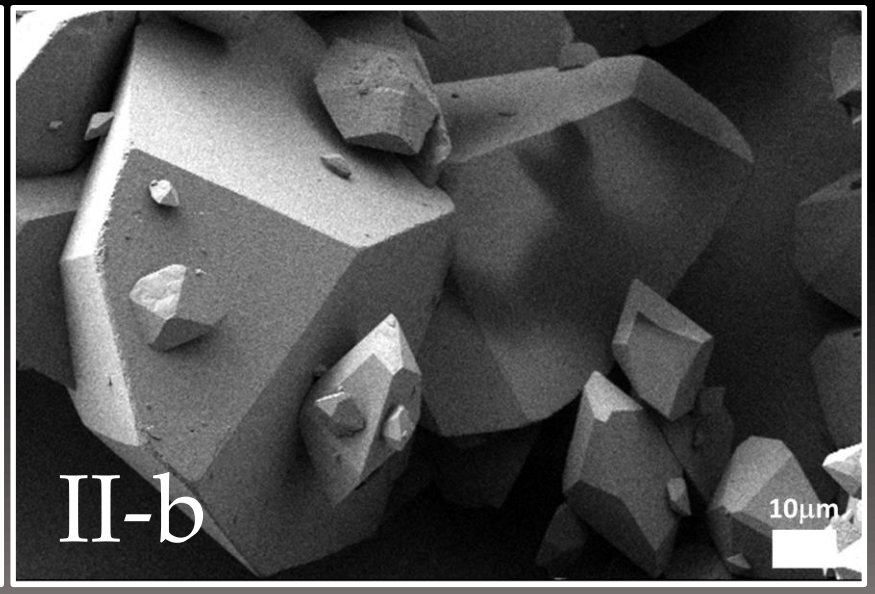
What is the value added from this data?

CL-20 Powders



Name	Process	Diameter [microns]	Surface Area [m^2/g]
I-a	Milled	8.02	1.42
I-b	Milled	15.04	0.58



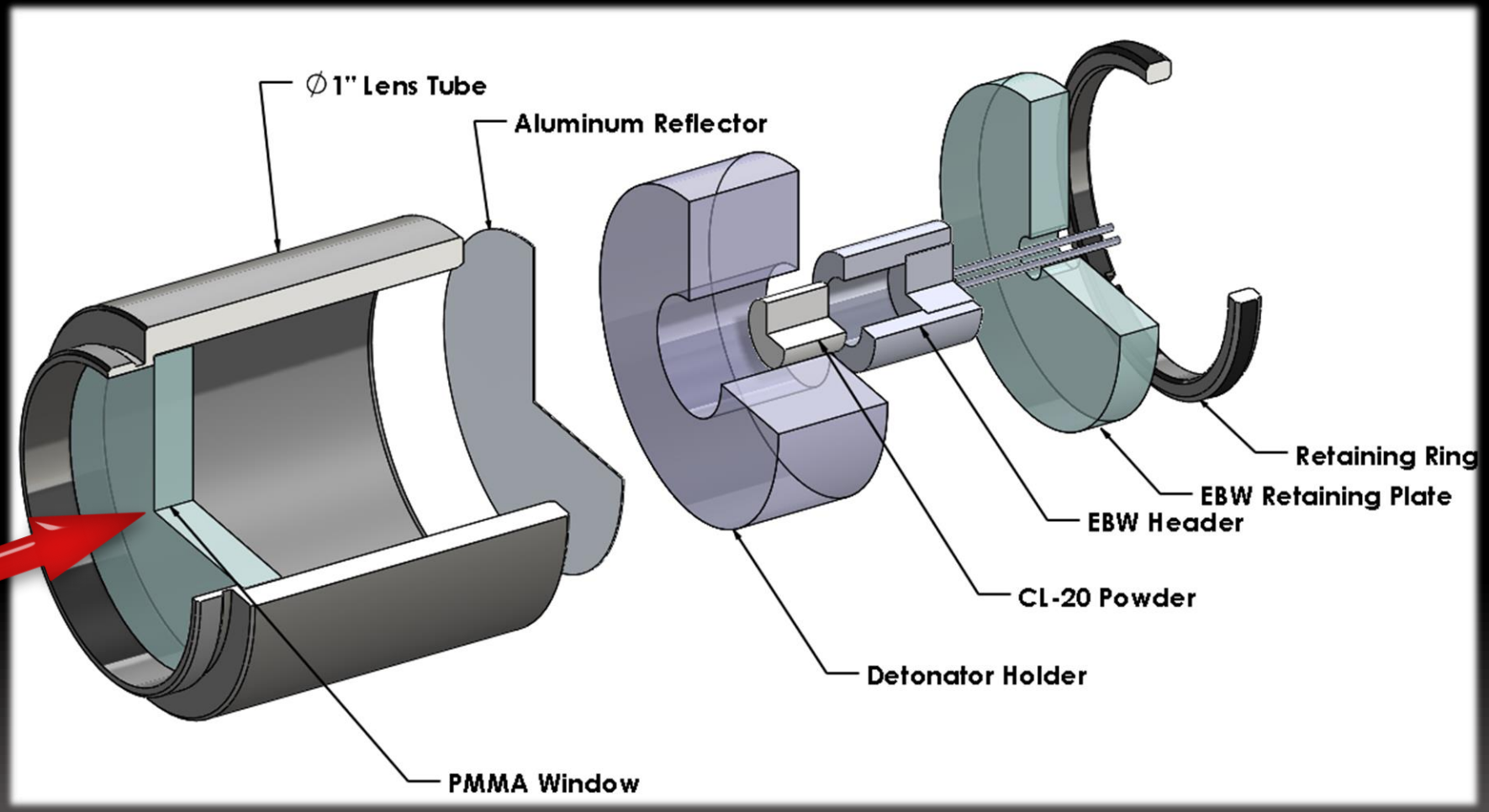


Name	Process	Diameter [microns]	Surface Area [m^2/g]
II-a	Recrystallized	13.64	0.85
II-b	Recrystallized	43.88	0.11

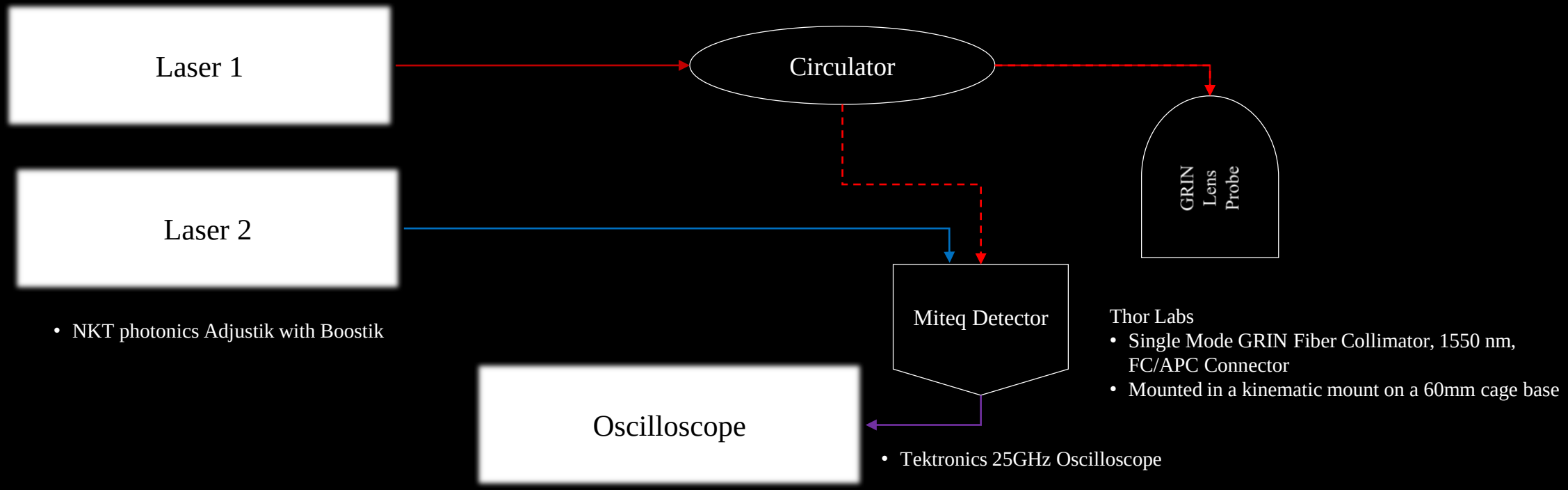
SSA determined with BET

Experimental Setup

- Standard EBW header
  - 0.001 inch dia Au wire raised 0.0014″
  - 0.020″ length
- 50%TMD CL-20
- ~1.25J pulse
- barrel heights 0.020″-0.100″ in increments of 0.020″
- PDV used to measure output velocity



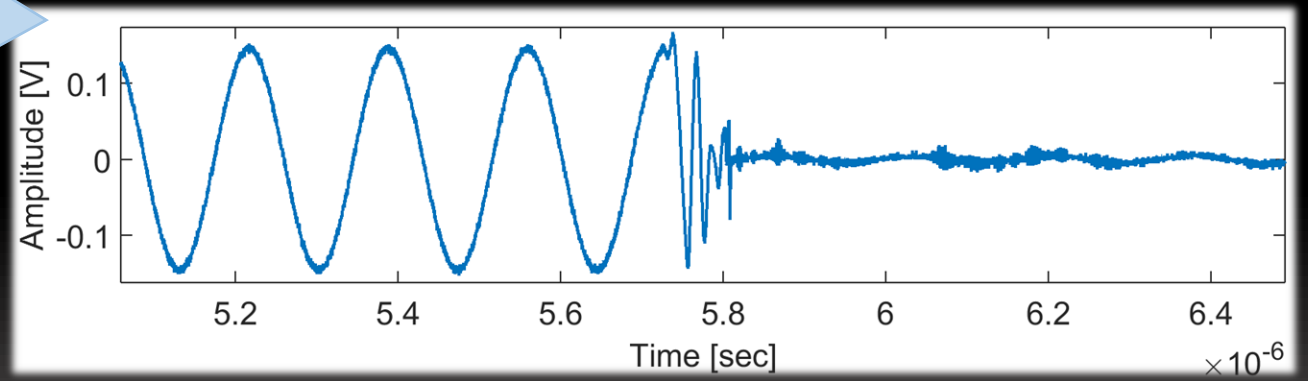
How do we measure the velocity?



Upshifted PDV (1550nm)

- One laser is used as a reference beam and the other is sent to the target, beat frequency is produced and measured with the oscilloscope

How do we measure the velocity?

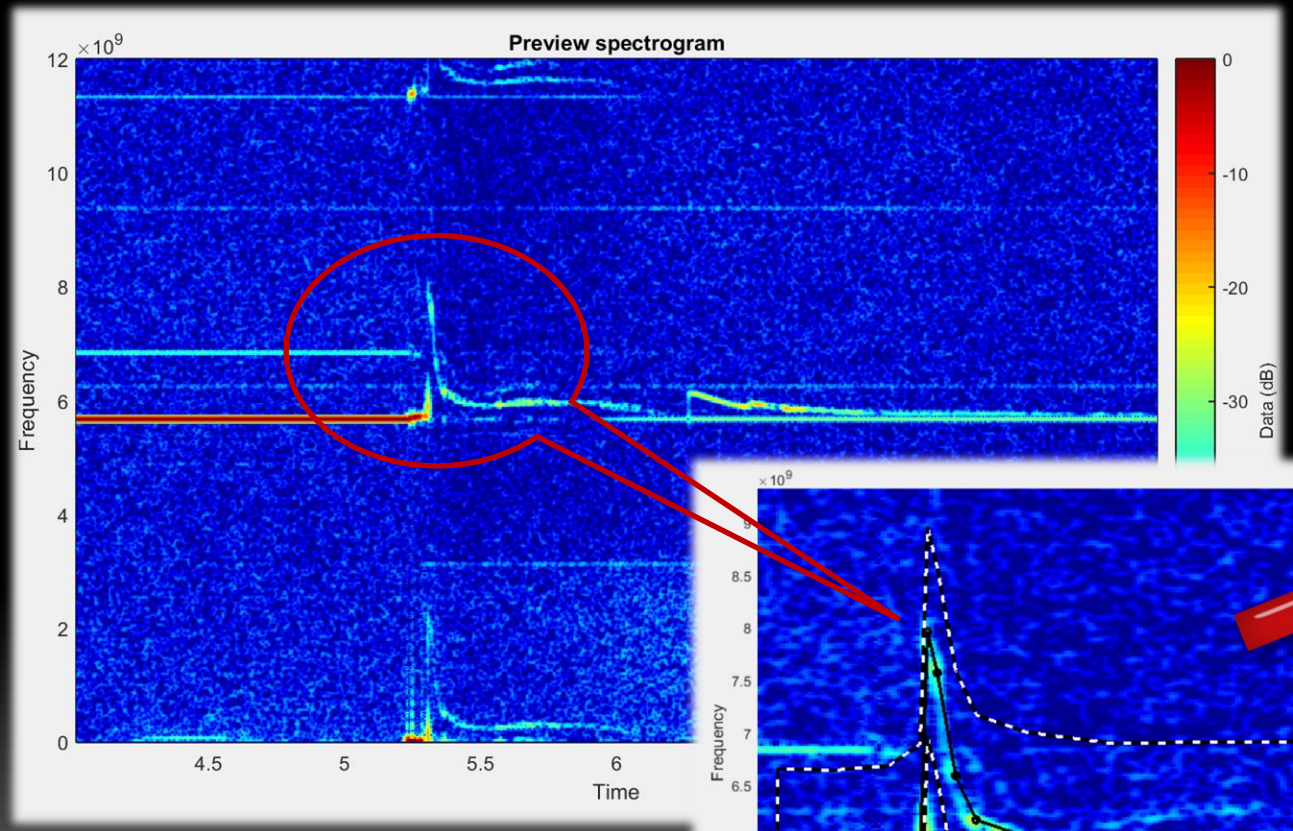


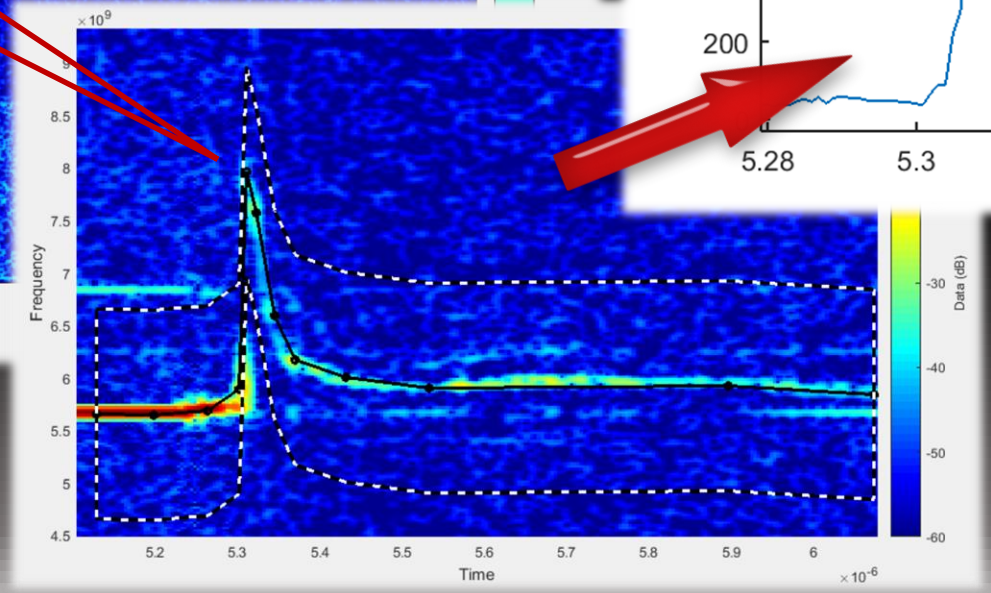
Upshifted PDV (1550nm)

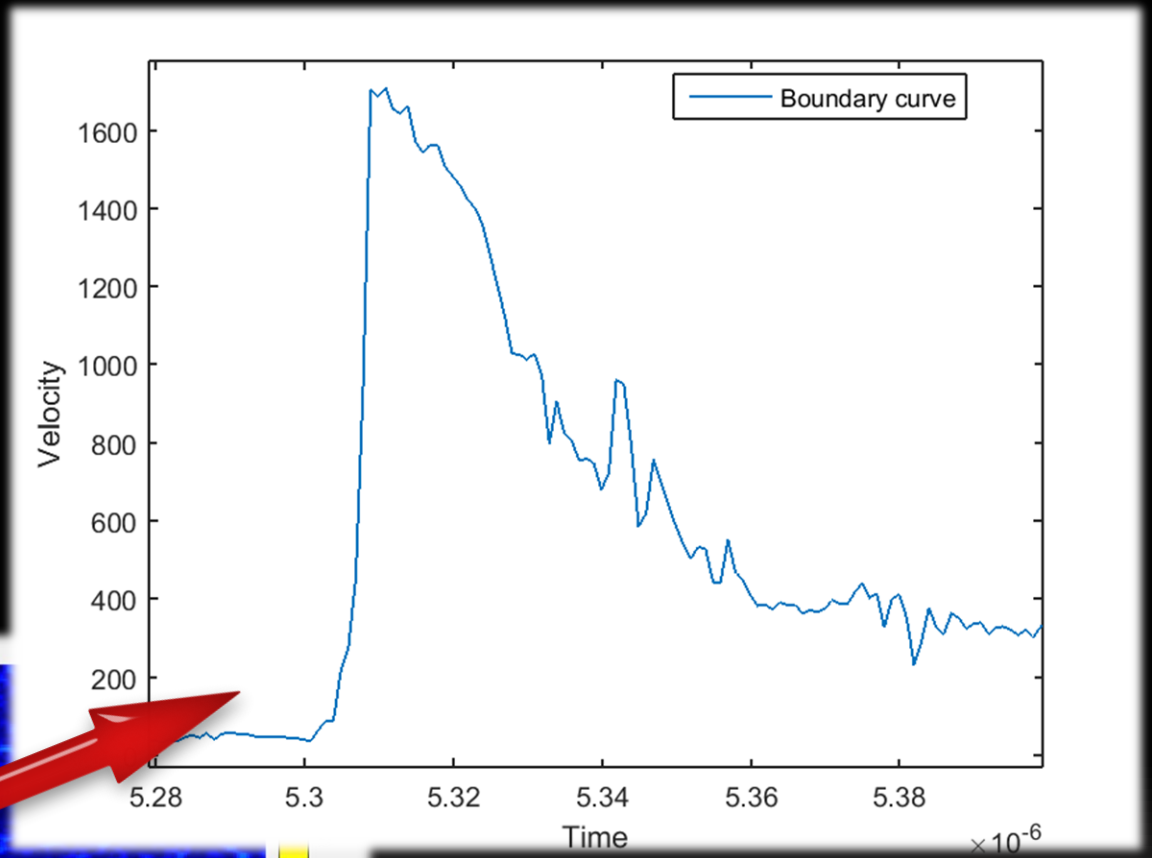
- Single mode collimated GRIN lens probe sends and receives light from target
- Post processing of signal is done using Short-time Fourier Transform (STFT)

PDV Analysis Process

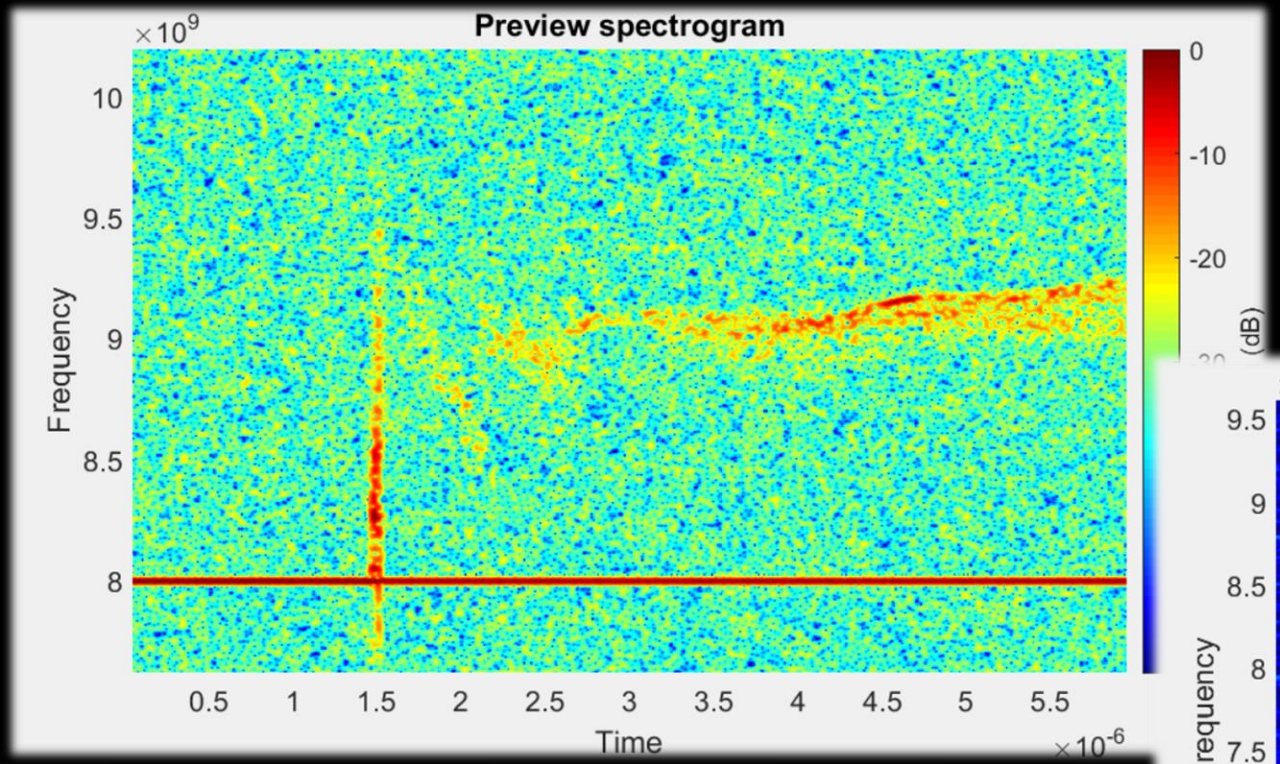
Interactive Spectrogram and Analysis





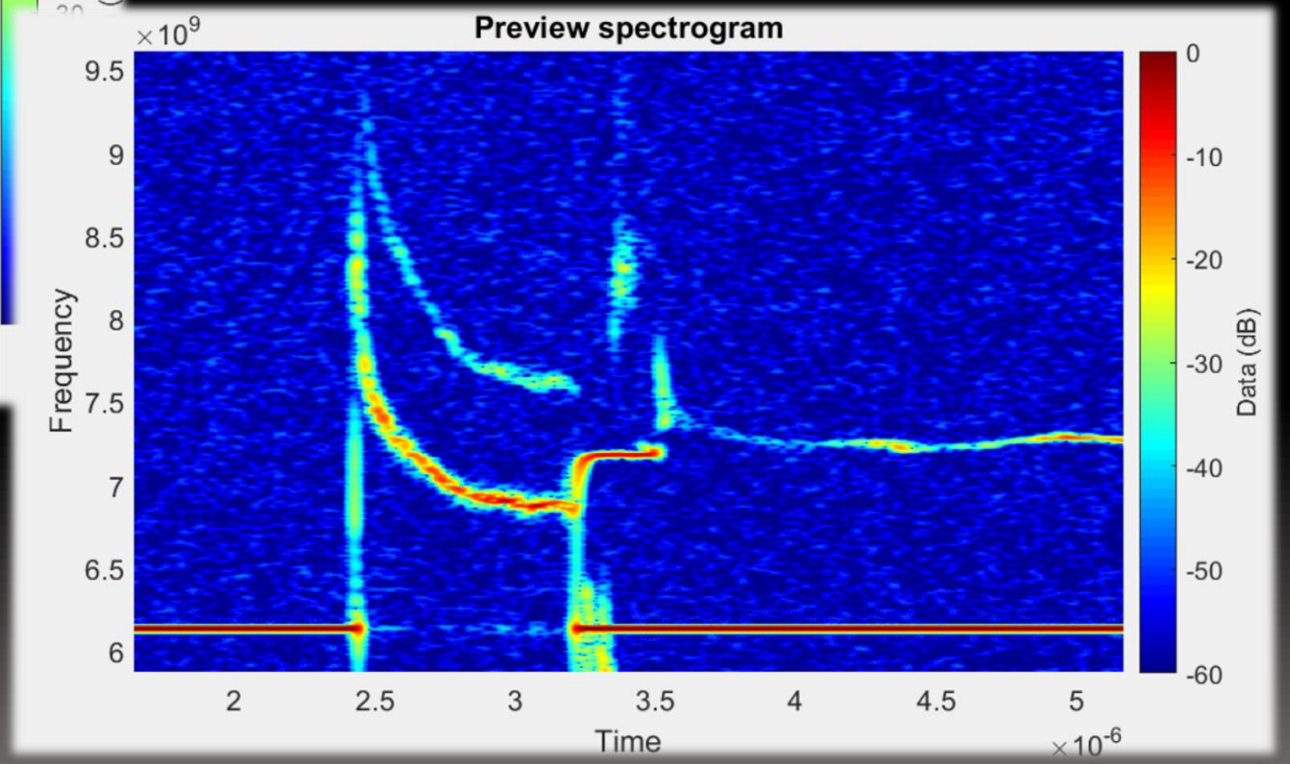


Reflective Material



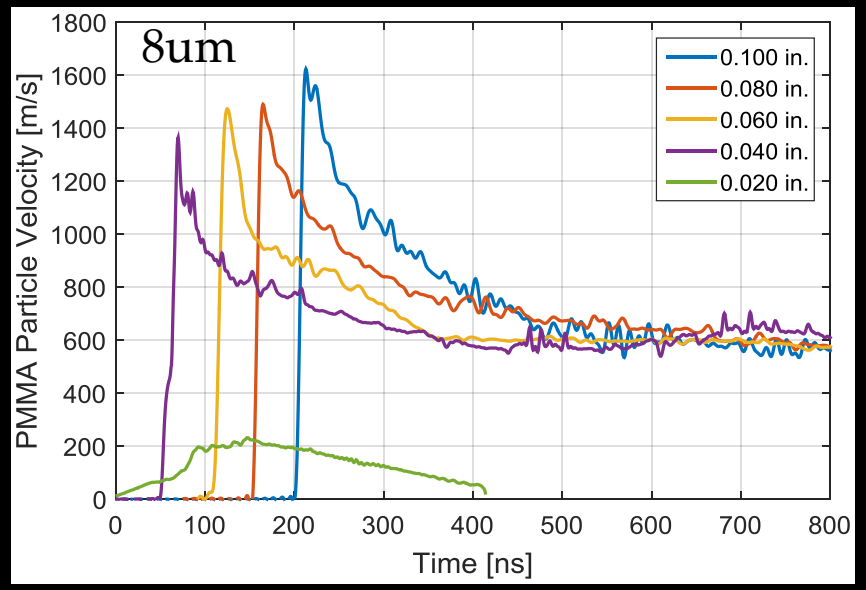
- 2um aluminized window gave poor signal return (low SNR)

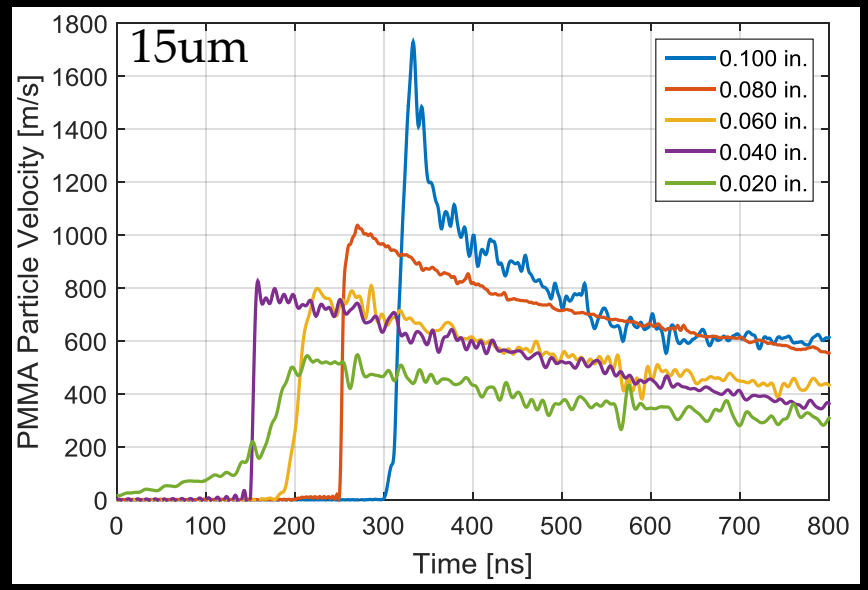
- 40um sheet attenuates the shock slightly, but gives good return

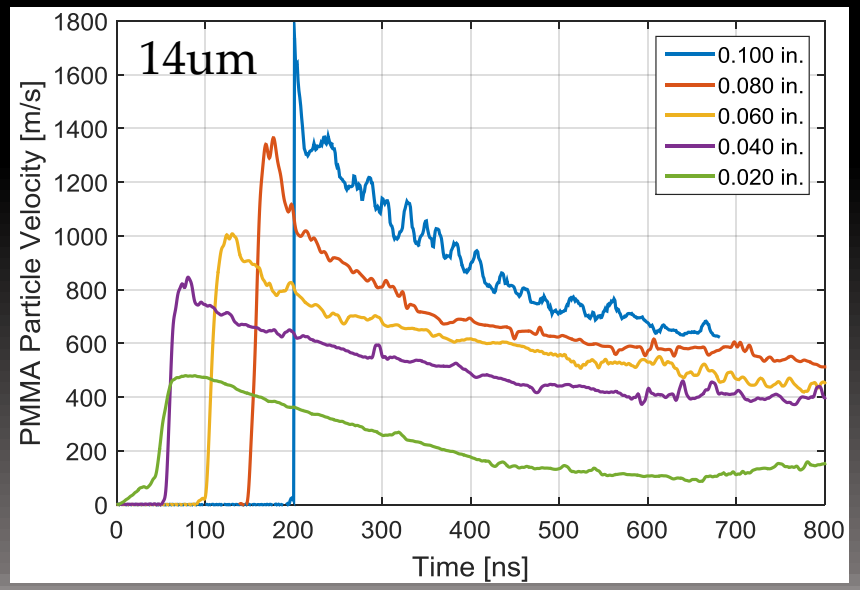


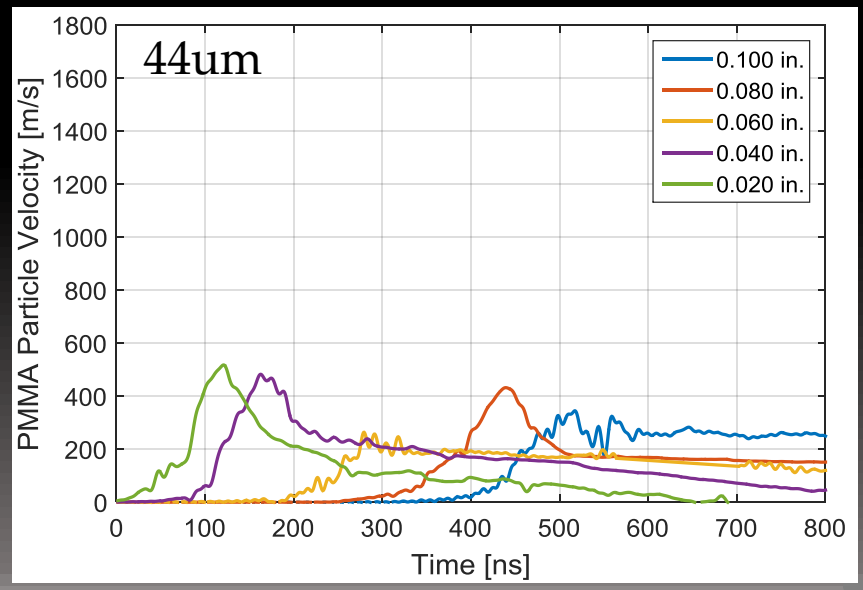
Output Velocity

- 0.020" all seem to be lower than a reaction (perhaps partial products and EBW shock)
- Larger SSA reaches steady state quicker
- Large particle seems to have spot size effects



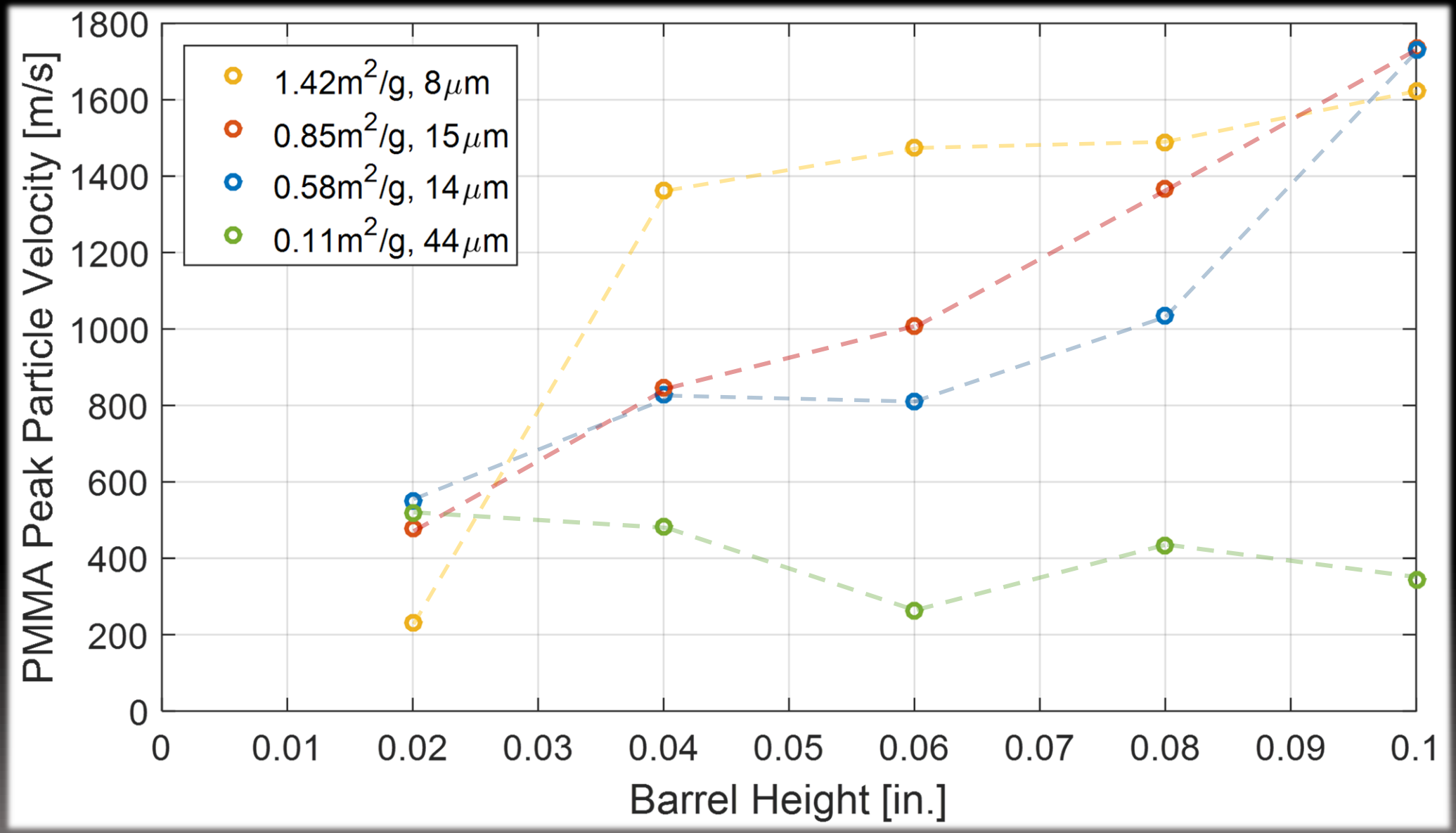




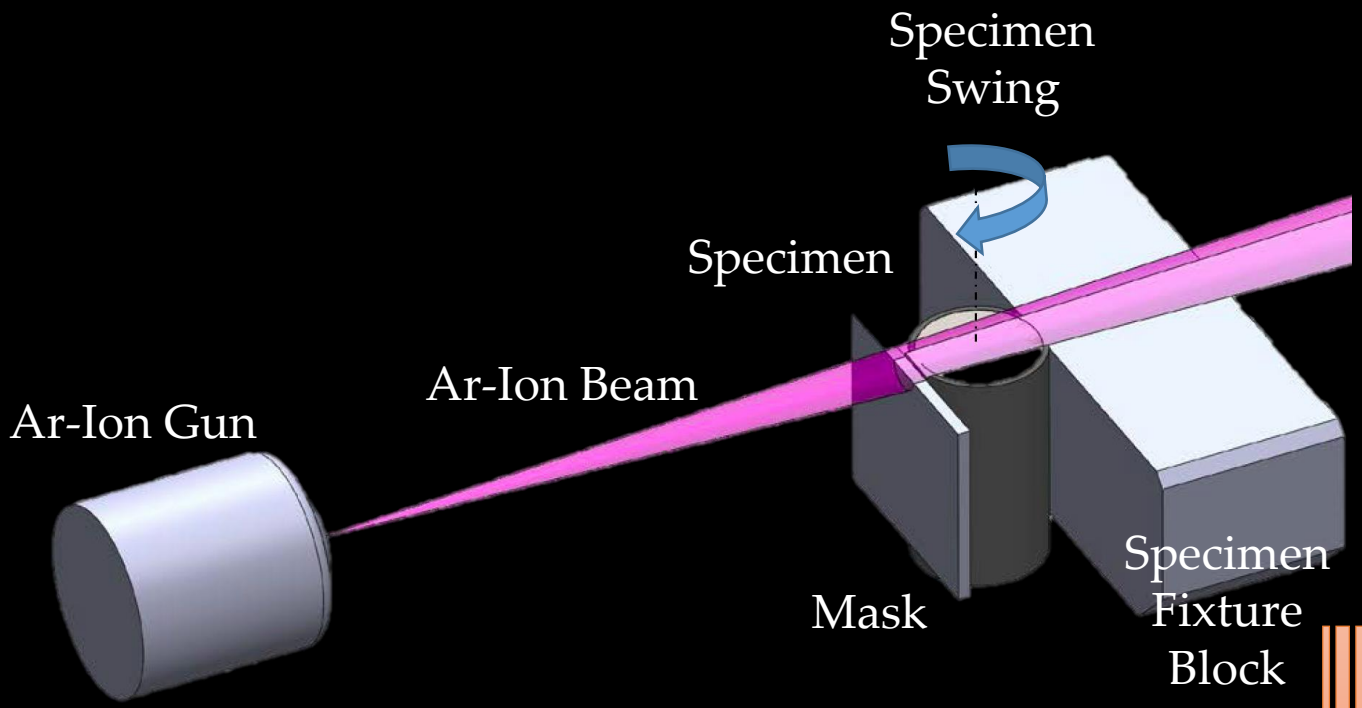


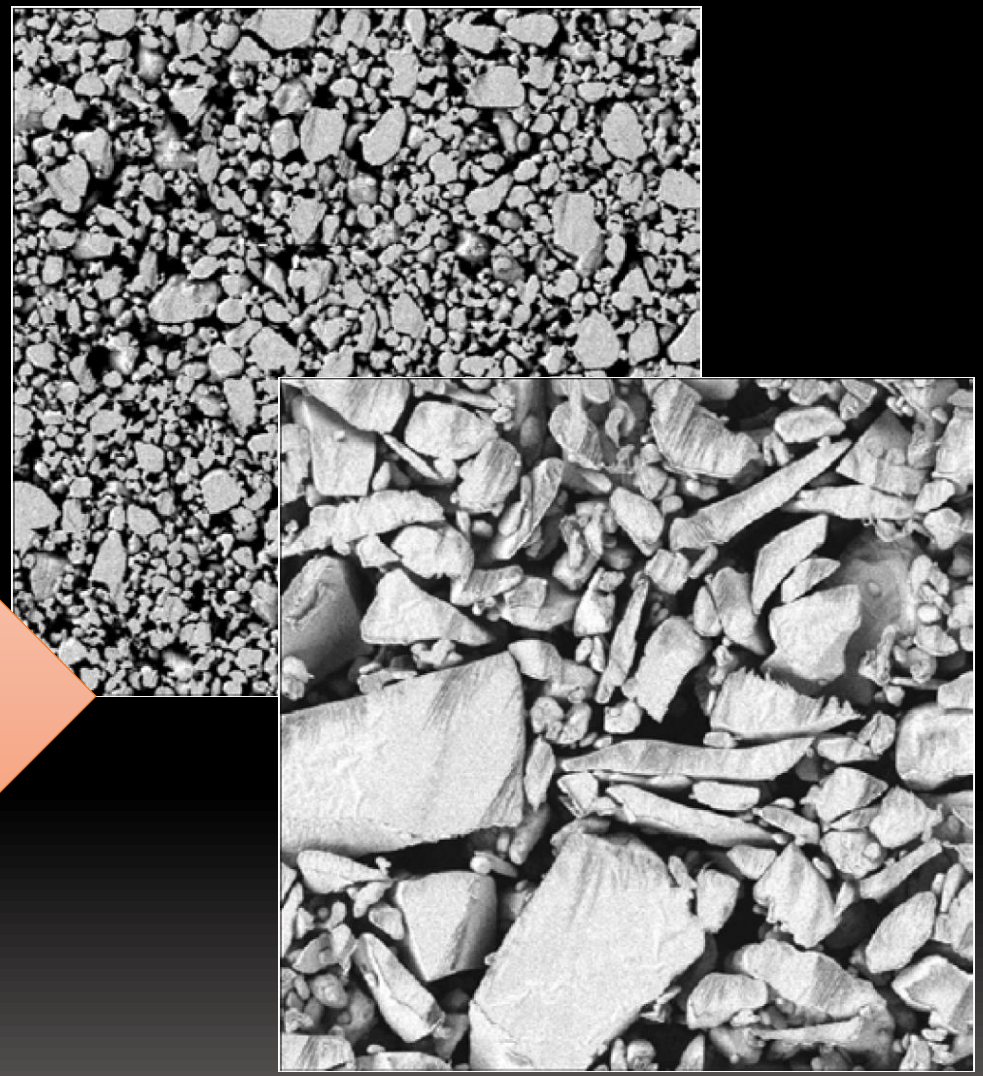
Output Velocity and Surface Area

Surface area plays a role on how quickly the charge column reaches steady state

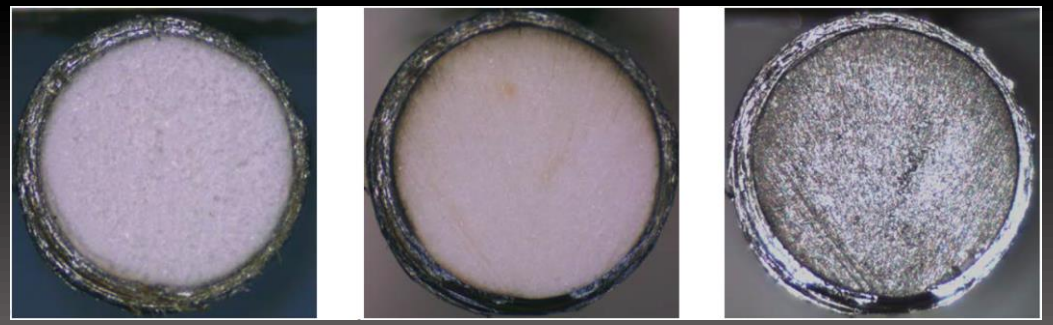


Micrograph Process



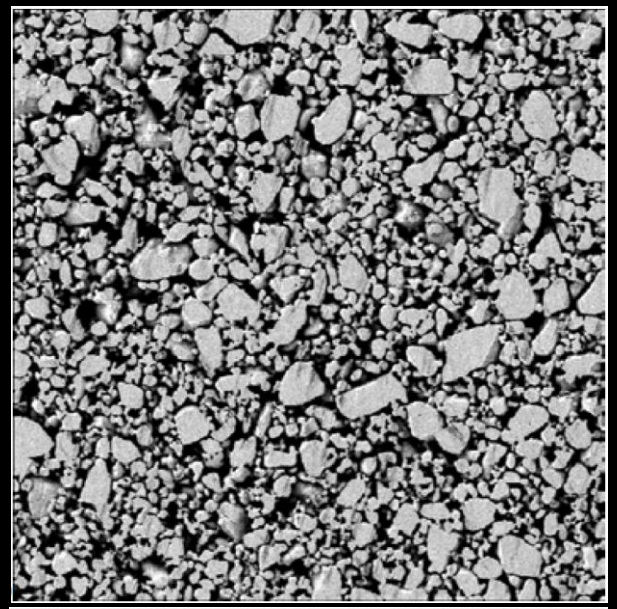


SEM Images of 50%TMD CL-20
(50μm X 50μm)



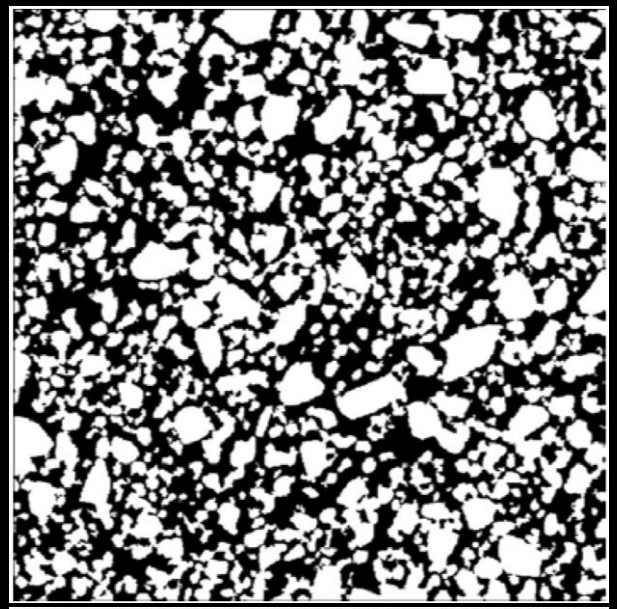
Pressed → Polished → Coated

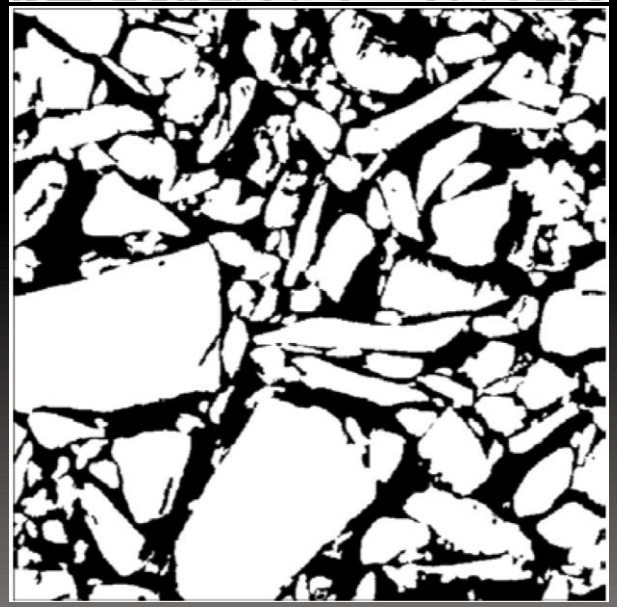
Micrograph Process



Postprocess

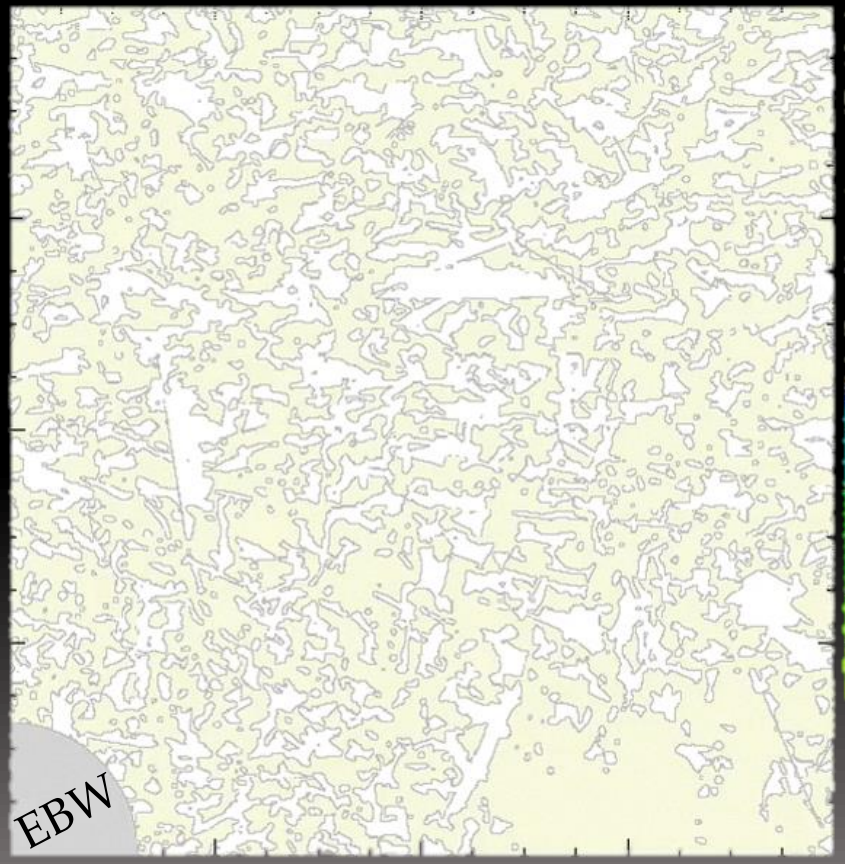
- Filter image to sharpen and denoise
- Set threshold values to give phases and surfaces that are polished

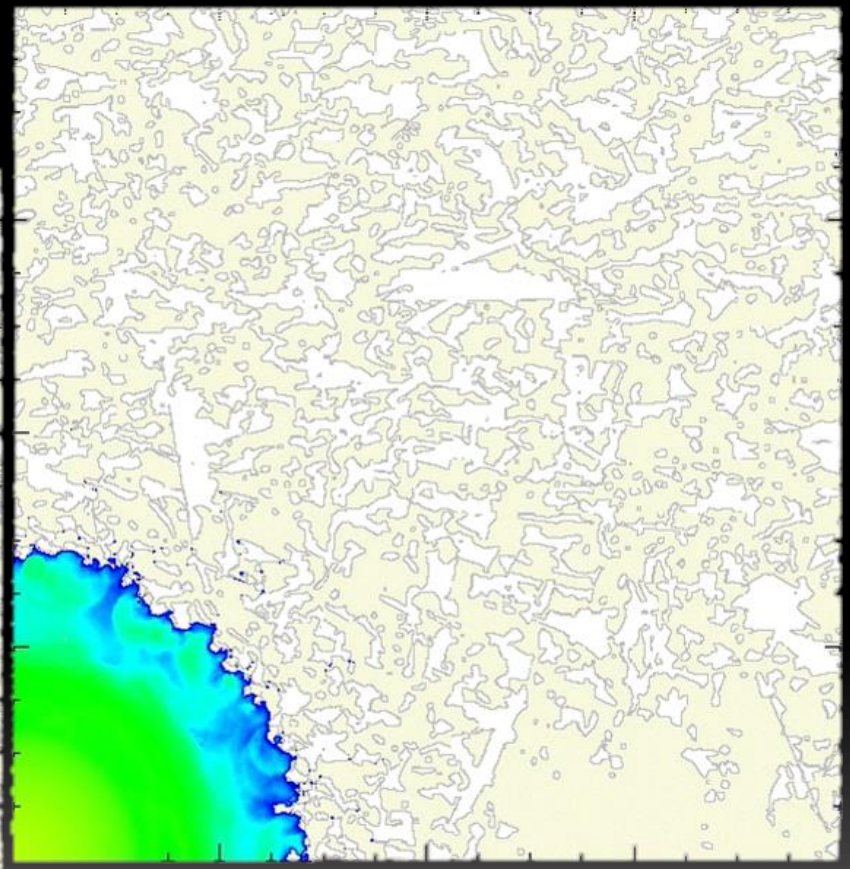


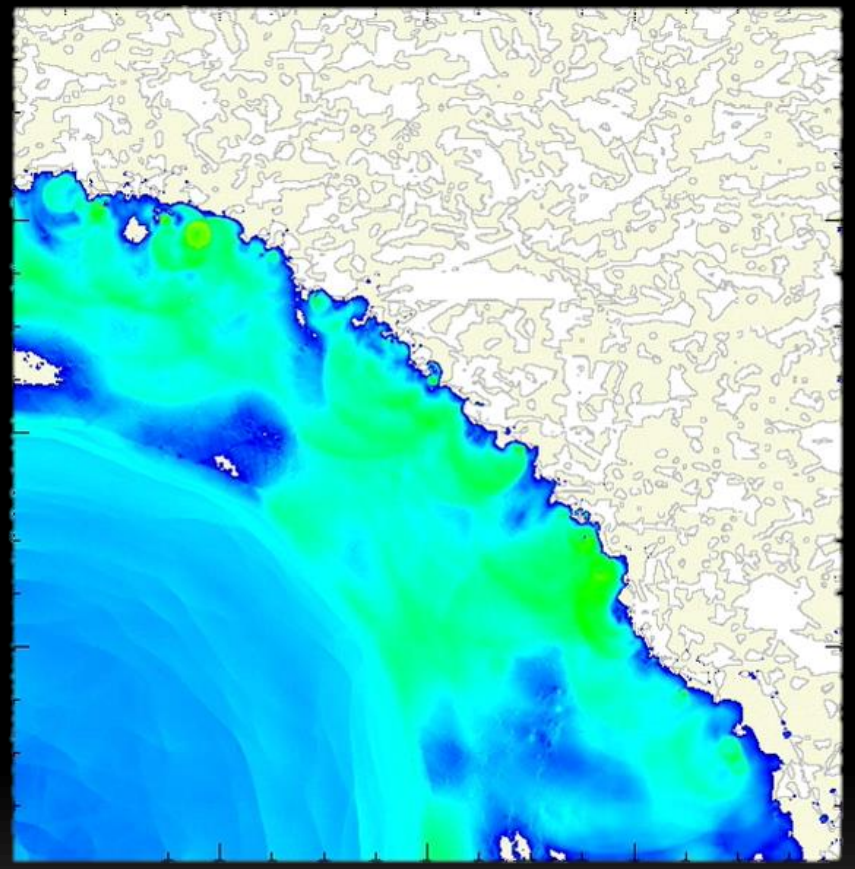


Grainscale (Mesoscale) Simulation

Pressure Field







CTH - Arrhenius Reactive Burn Model
EBW inserted with prescribed power

Summary

EBW's are still being investigated to capture all of the physics

CL-20 has a lot more to understand

Low densities (%TMD) allow for experimental capture of steady state build up

Currently tuning burn model parameters based on experimental results