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Velocimetry used to determine growth to detonation in hexanitrostilbene (HNS)

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Motivation

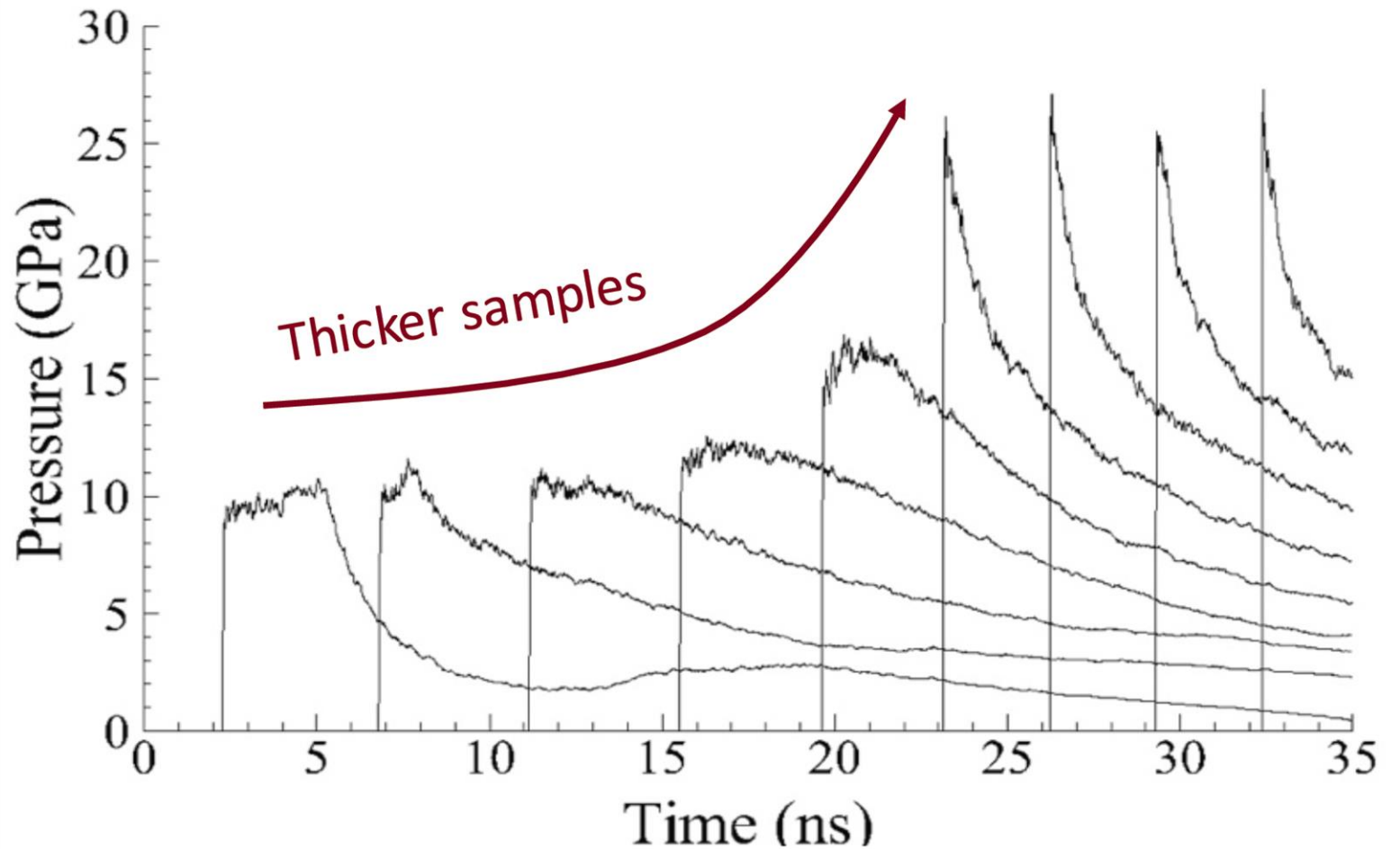Why are we interested in run to detonation?

How can we measure the run to detonation in explosives?
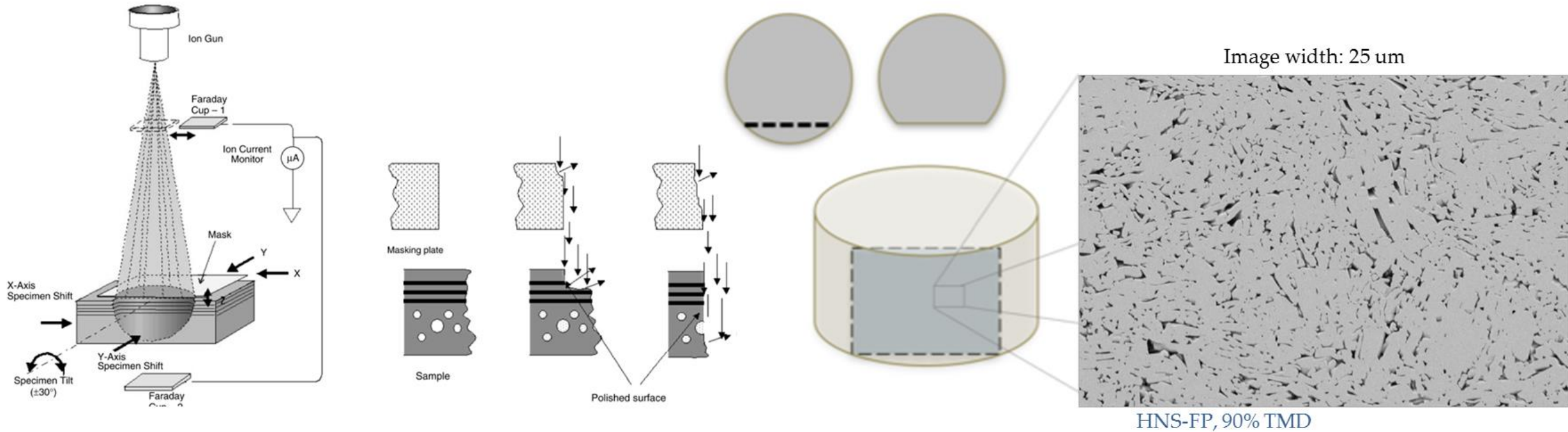
What is the value from this data?

Run to detonation

Design parameter

Needed for validation
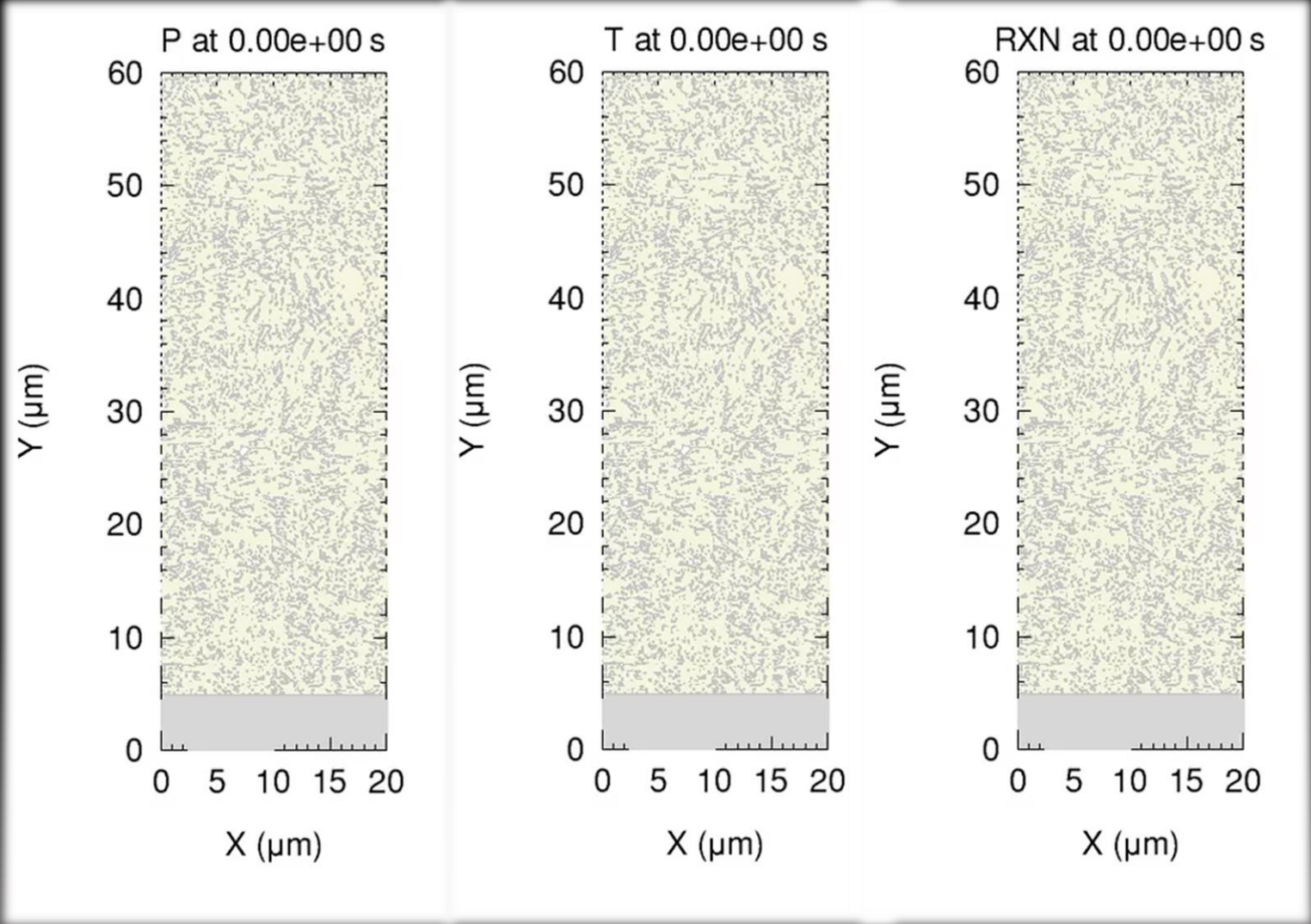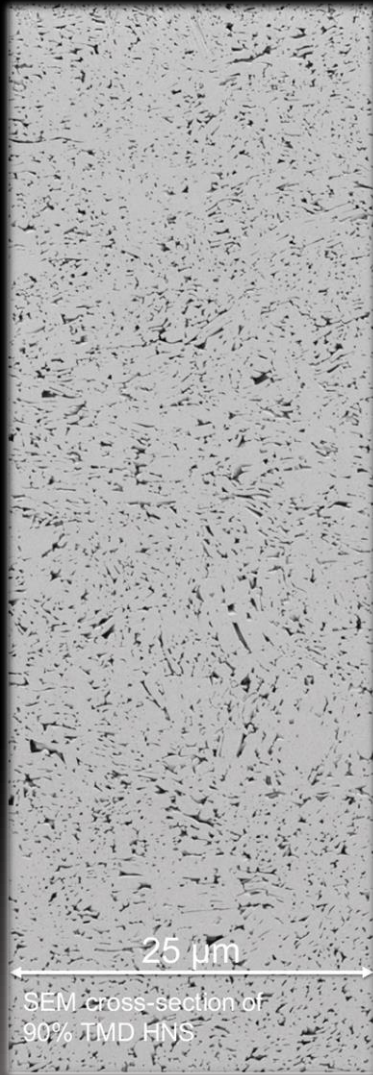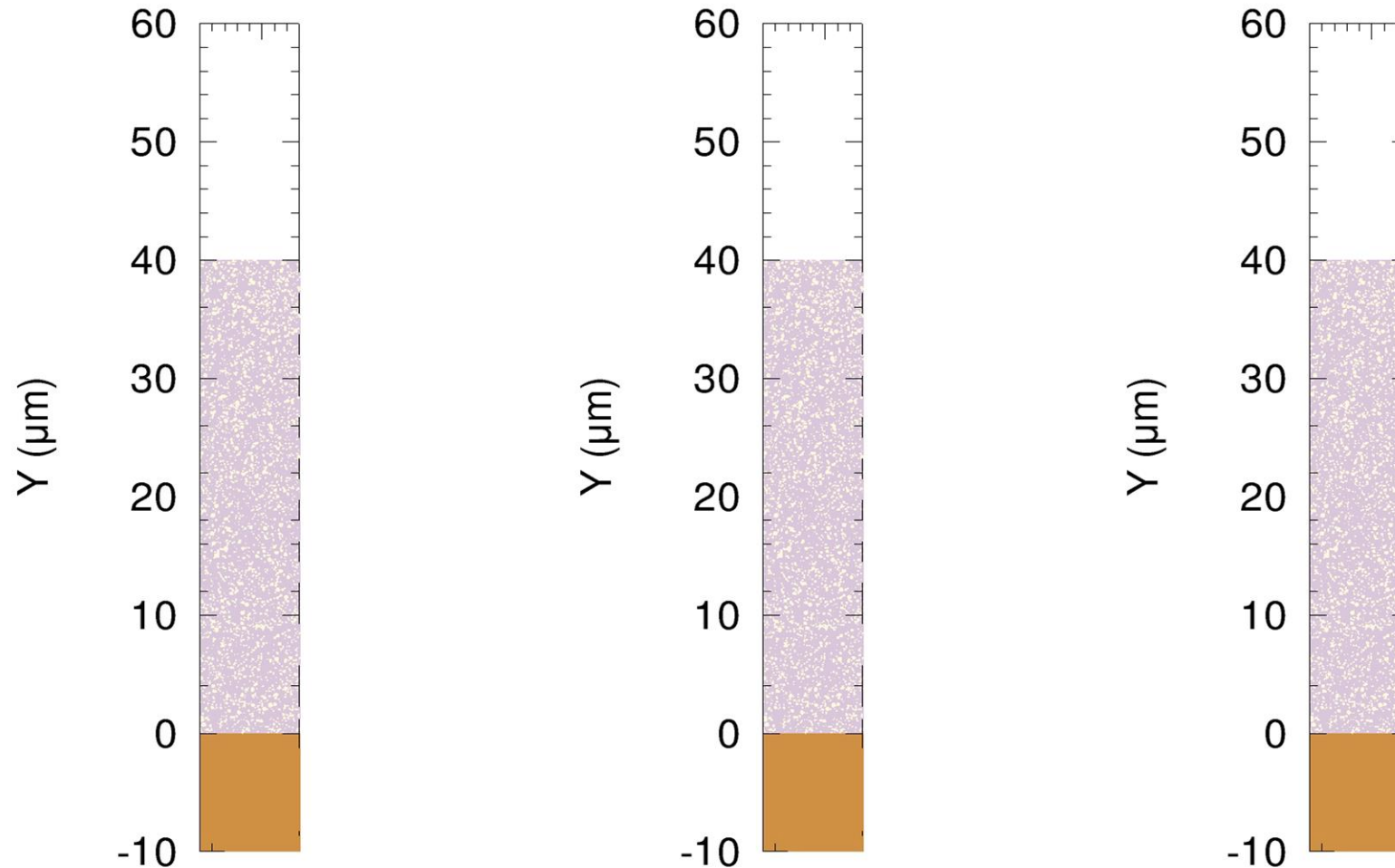of predictive modeling

Capturing porosity

Image width: 25 um

HNS-FP, 90% TMD

Cross-sectioned pellets, Ar-Ion beam milling technique

Grainscale modeling

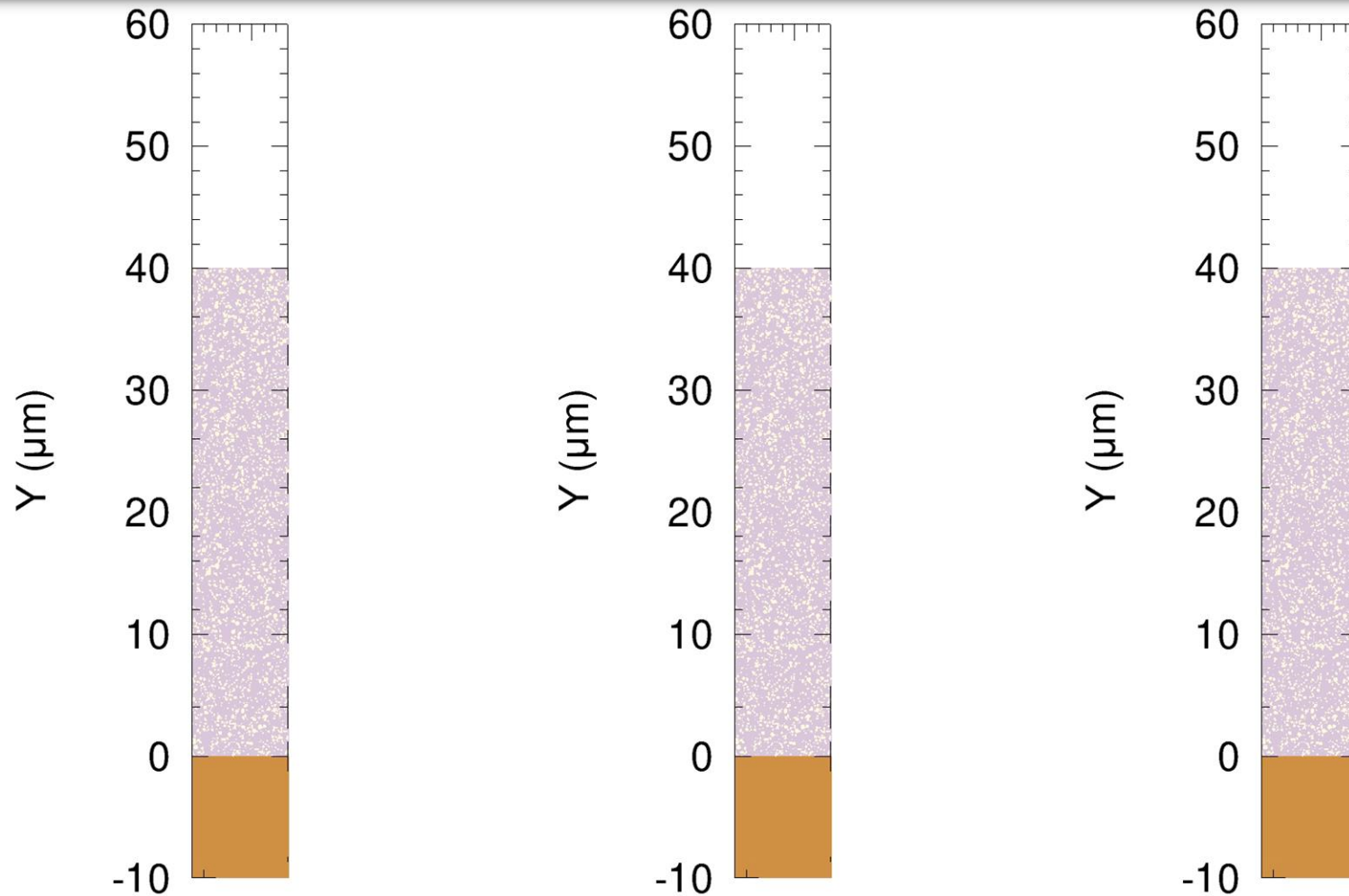HNS simulations show build up to detonation ~100μm scale

Simulation of un-successful initiation

HNS, 3100 m/s, Parylene-C flyer

P, T, & Rxn at 0.000000e+00

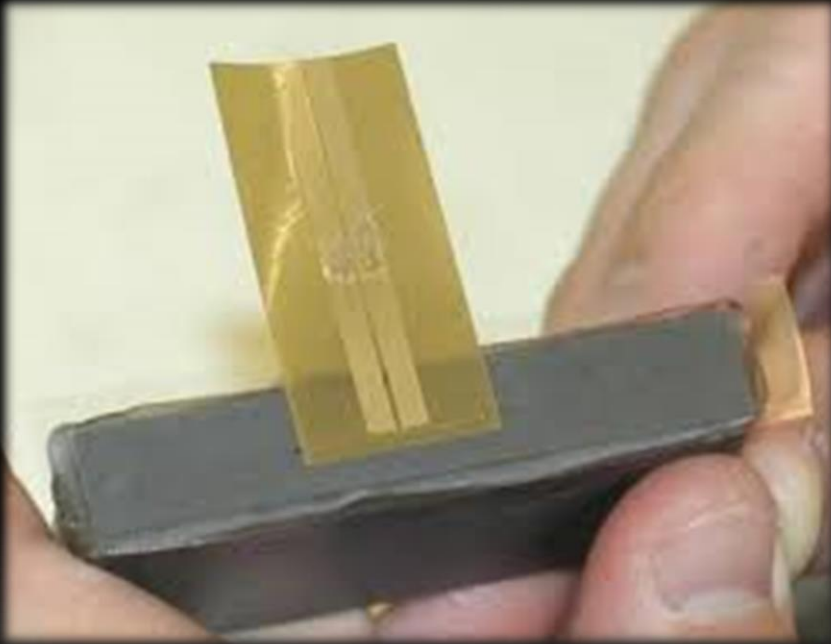# Simulation of successful initiation

HNS, 3200 m/s, Parylene-C flyer

P, T, & Rxn at 0.000000e+00

Measurement techniques

- Typical gauges (wedge tests, PVDF, Manganin, etc.)
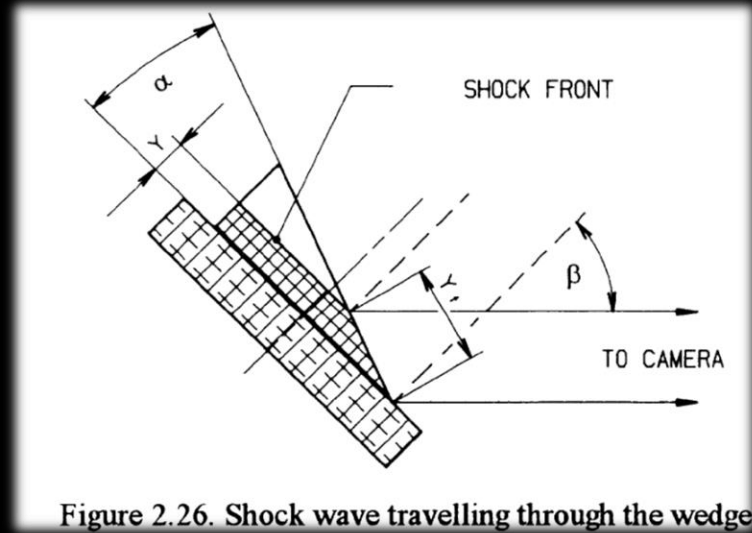

Lateral Gauge Response in Polymers
Gareth Appleby-Thomas, 2010

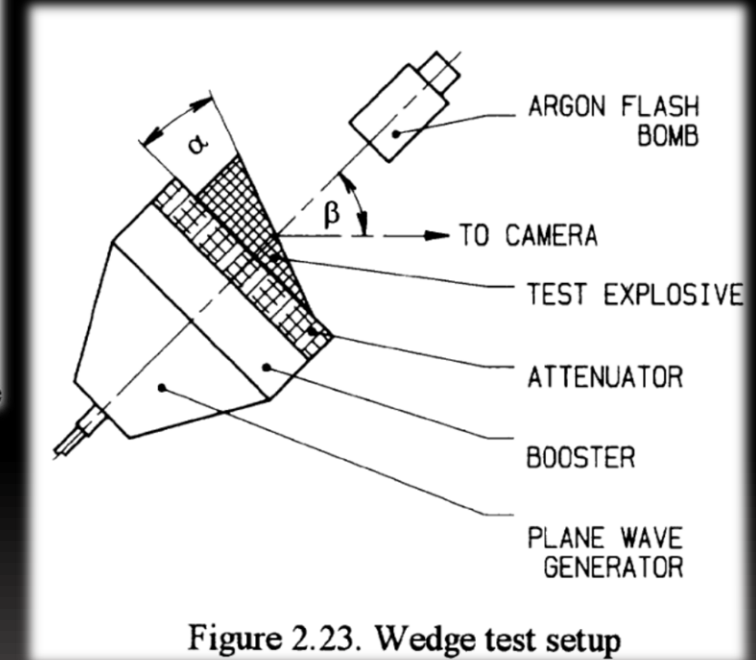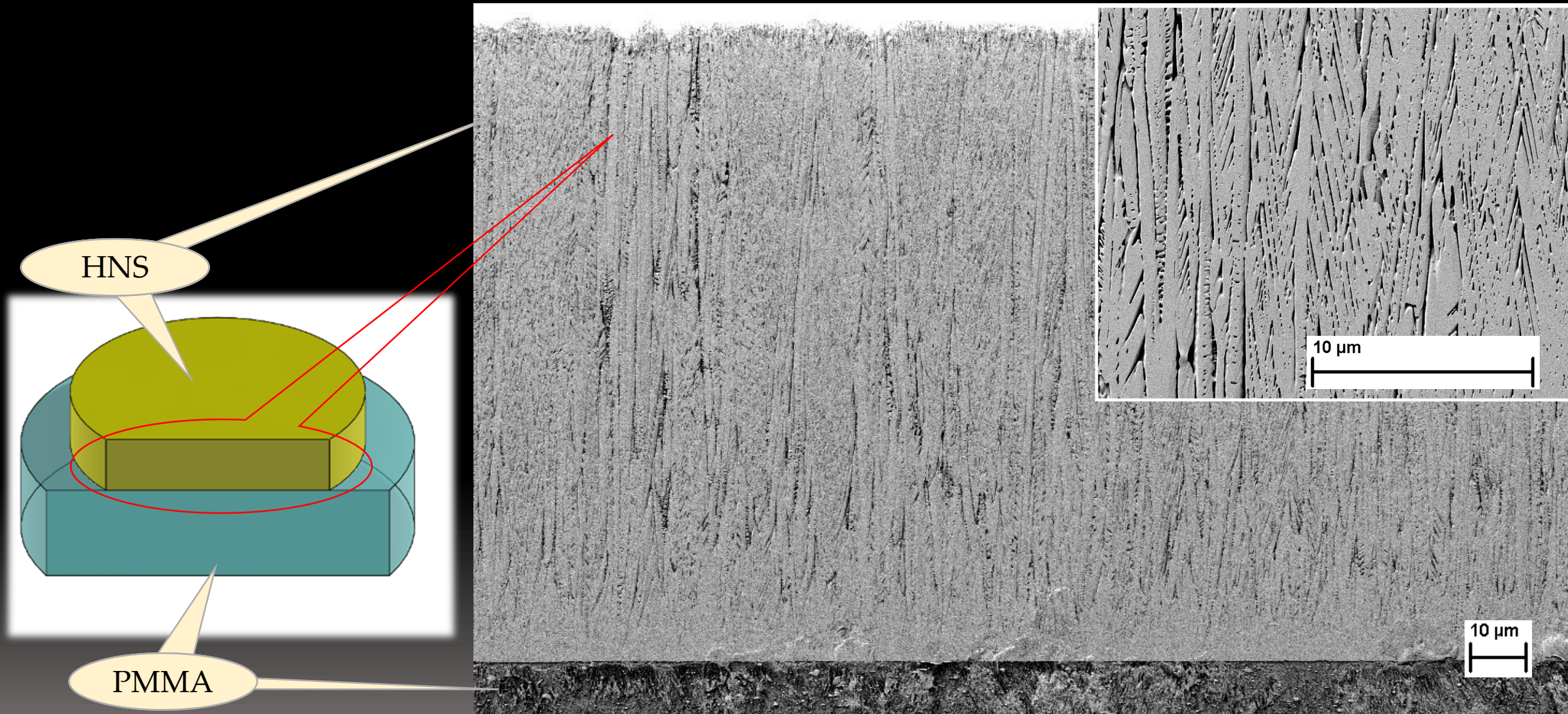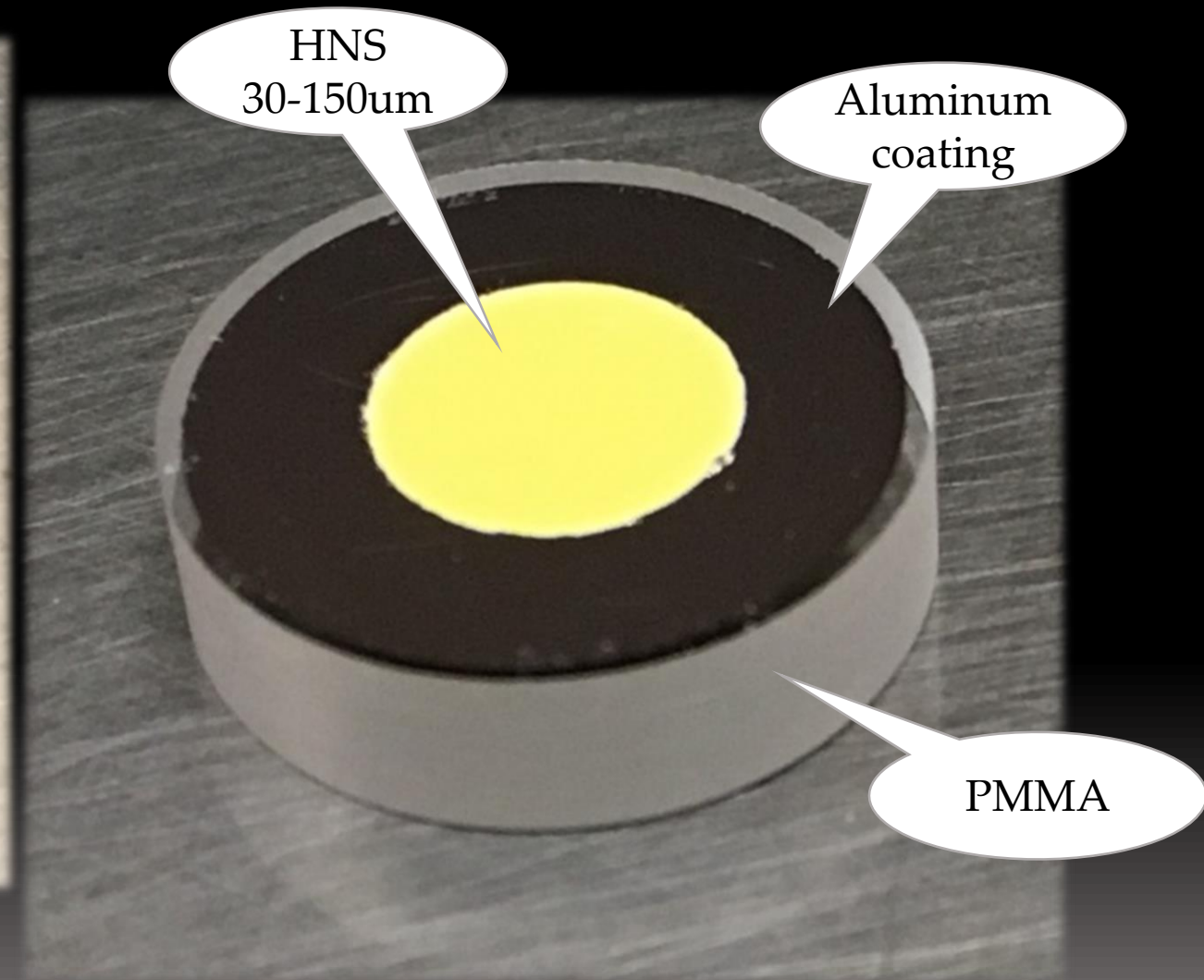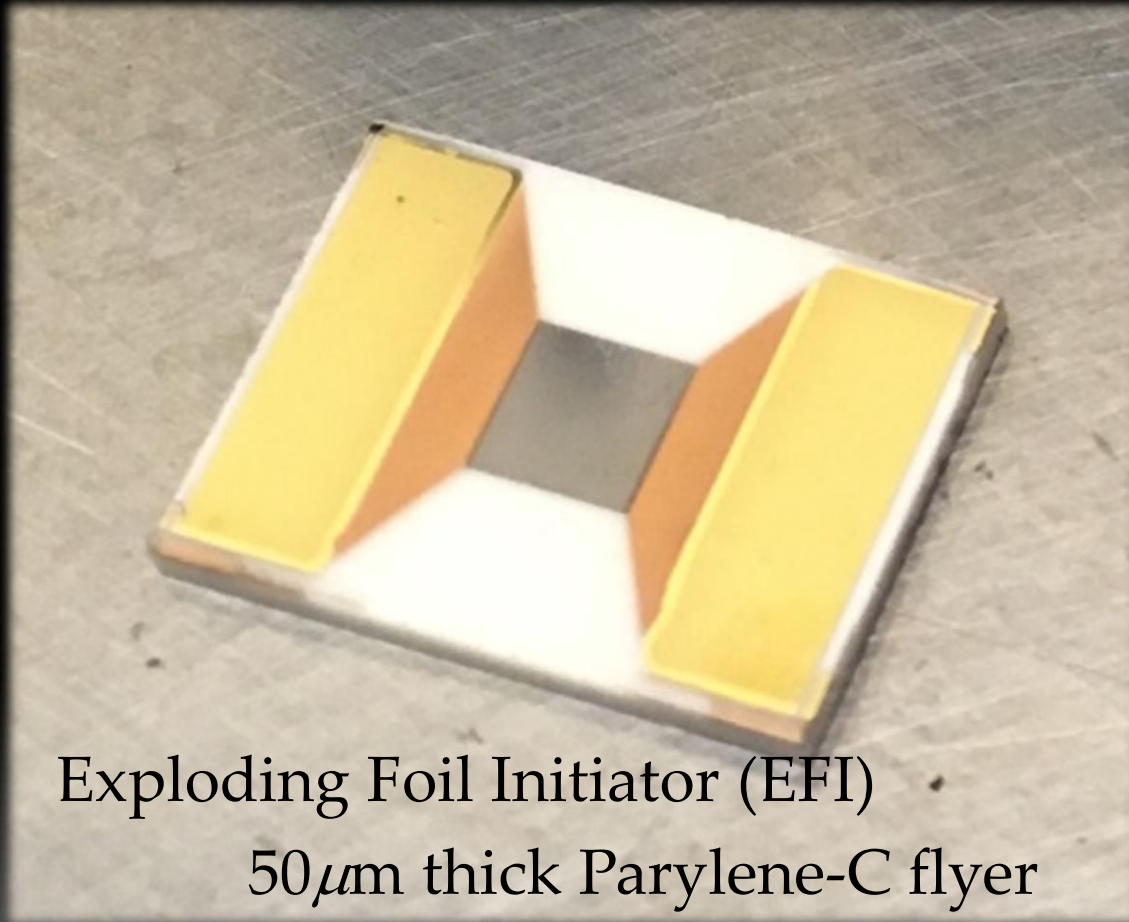Figure 2.26. Shock wave travelling through the wedge

Figure 2.23. Wedge test setup

Suceska, Muhamed. *Test methods for explosives*.
Springer Science & Business Media, 2012.

Vapor deposition of energetics
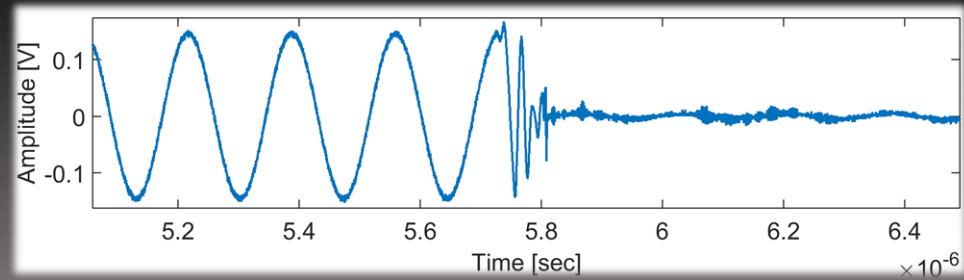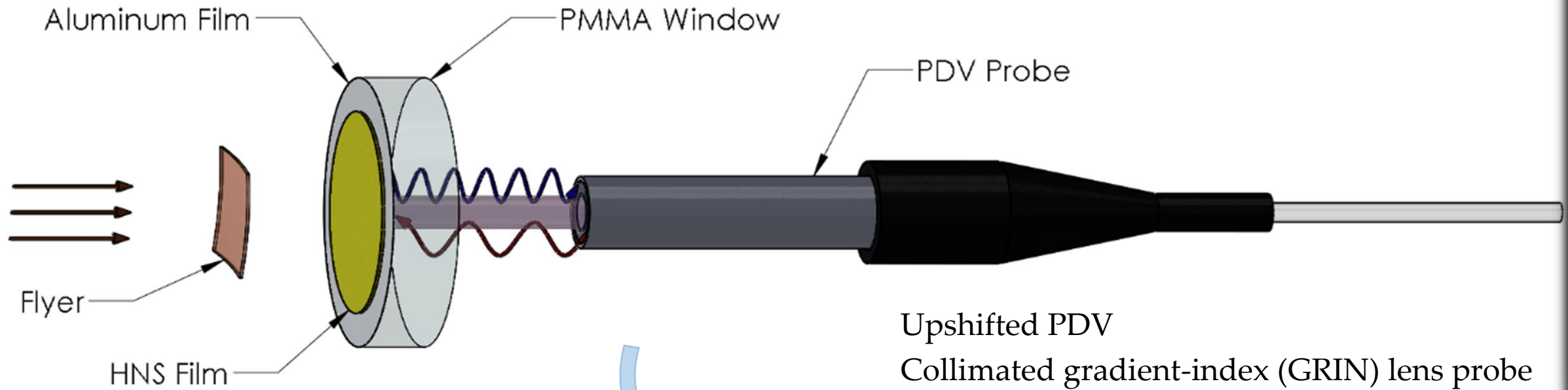

HNS

PMMA

10 μm

10 μm

Measuring the run distance

Exploding Foil Initiator (EFI)
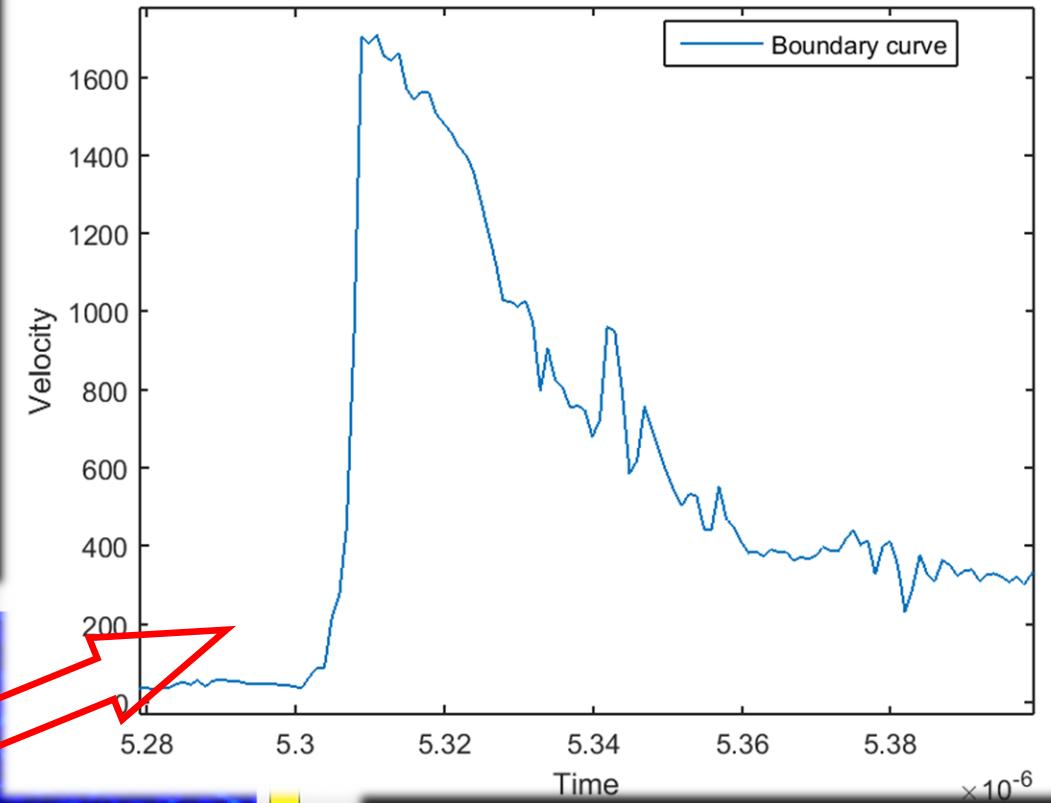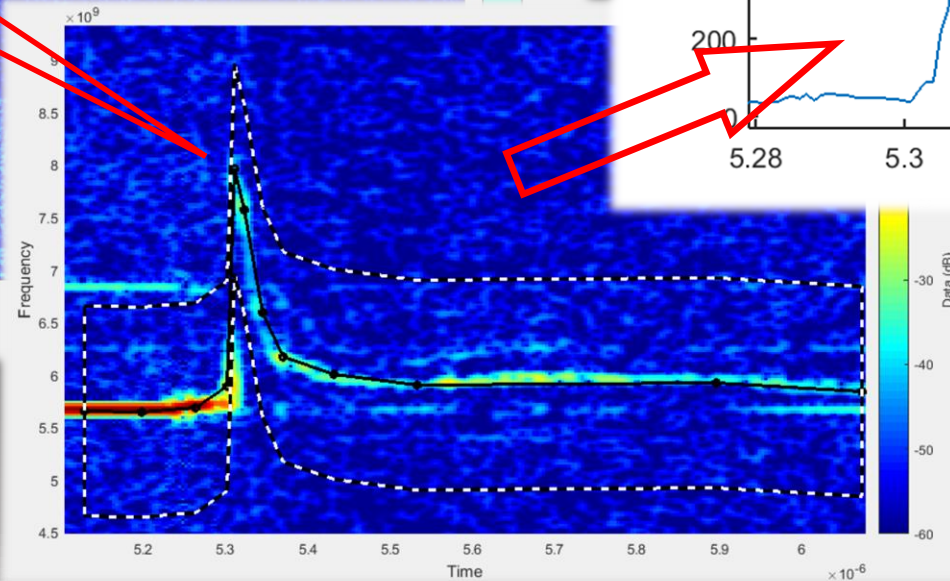50μm thick Parylene-C flyer

HNS
30-150um

Aluminum
coating

PMMA

Experiment and measurement

Upshifted PDV
Collimated gradient-index (GRIN) lens probe
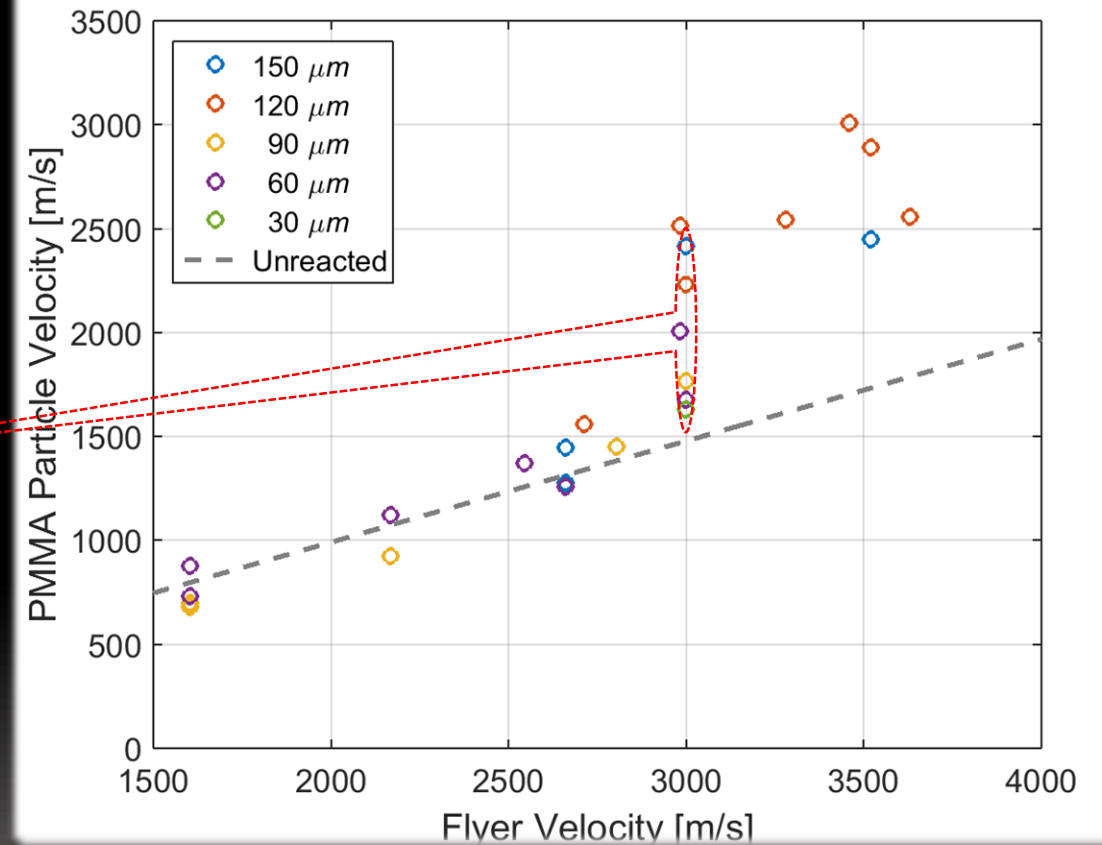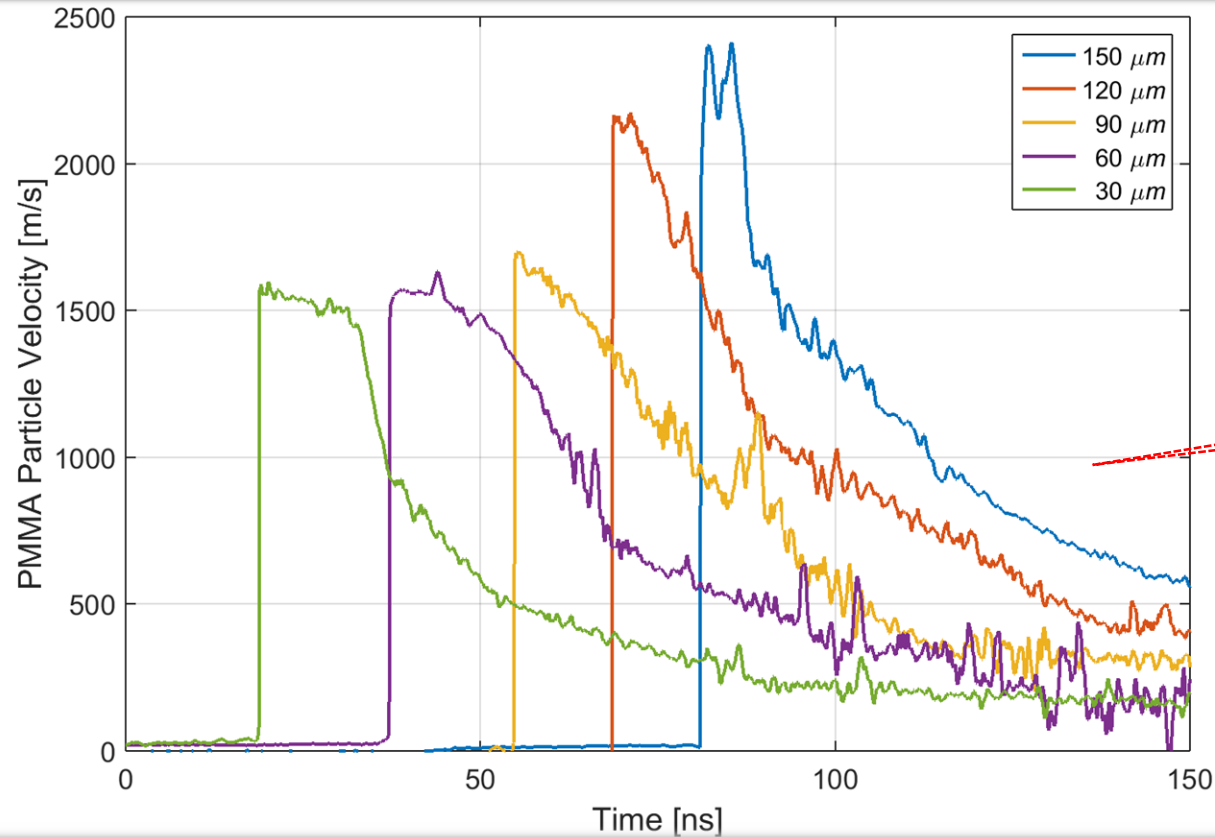
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PDV analysis
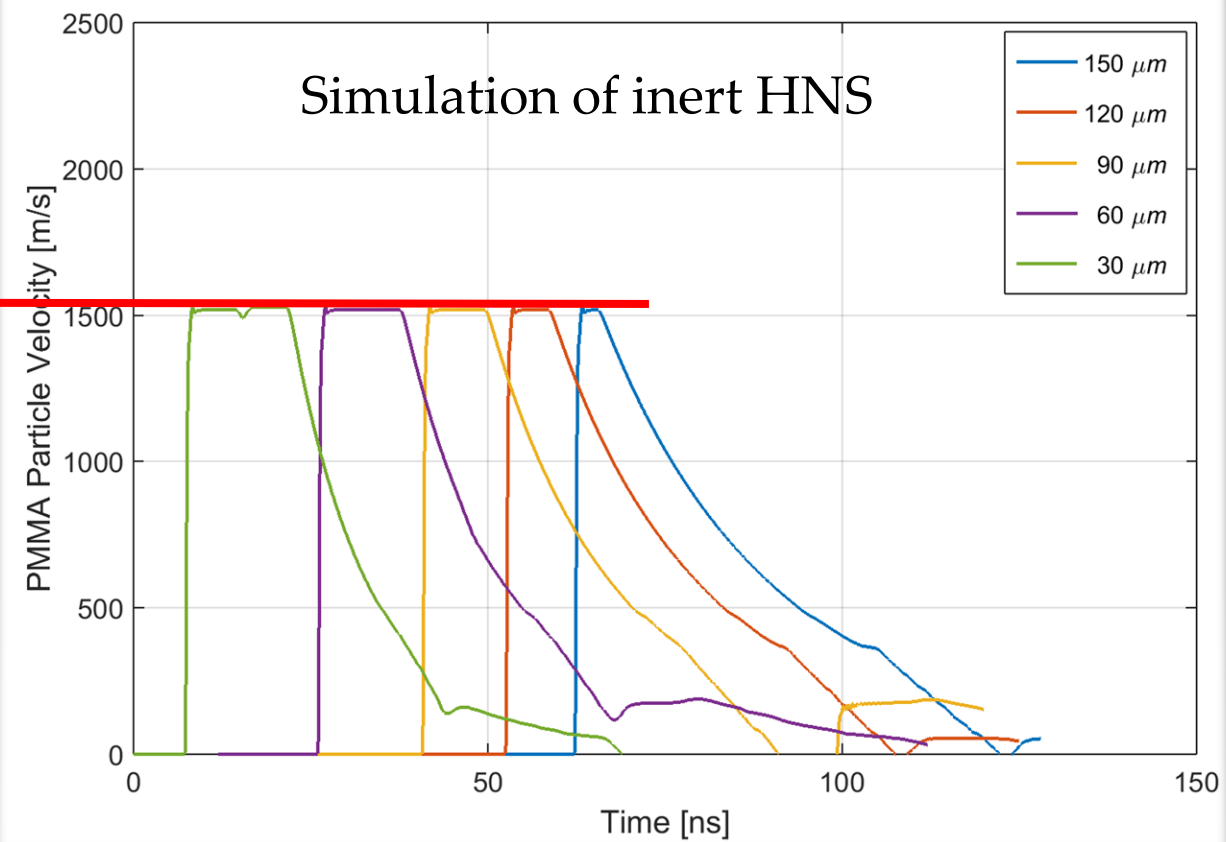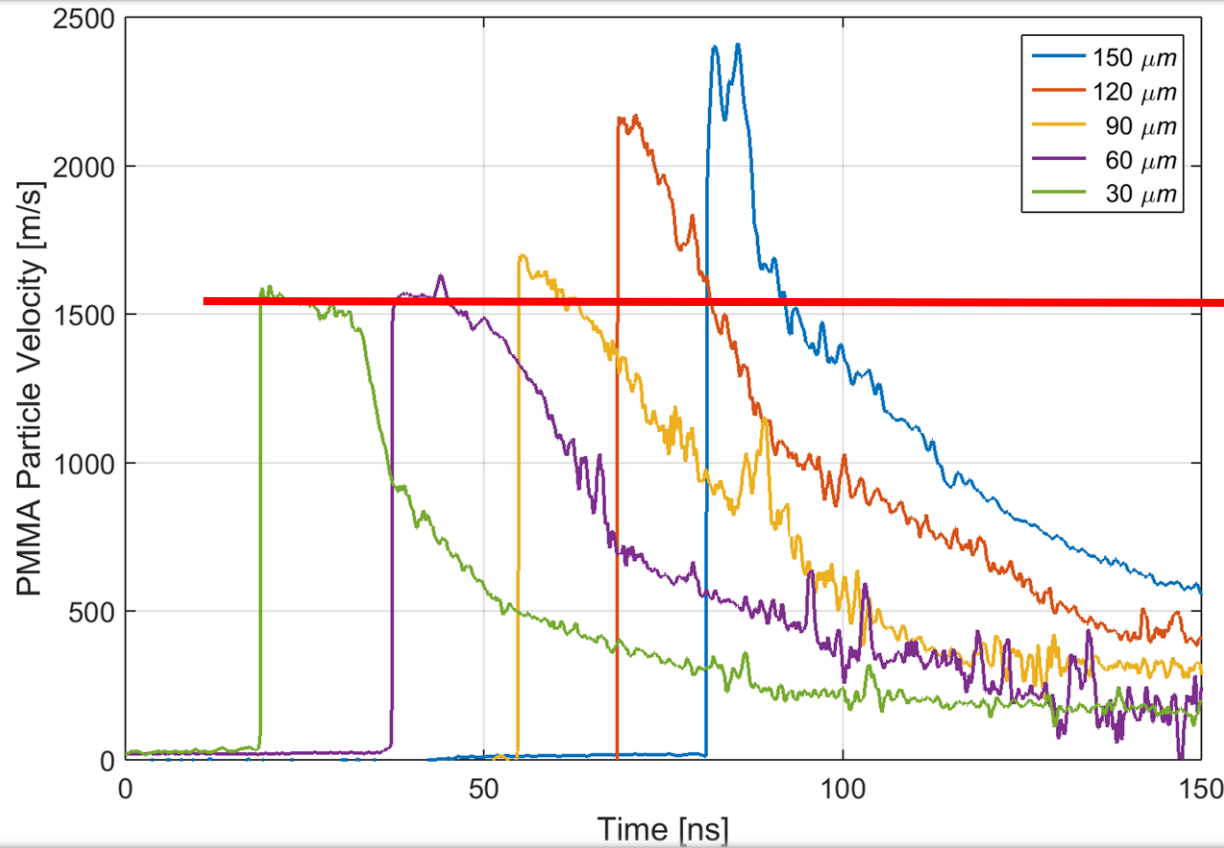
Spectrogram and analysis

Acquired run to detonation

Experimental results for HNS films

Comparison with inert

Experimental results versus inert simulations of HNS films

Summary

First time the run distance has been measured in HNS

Great tool when run to detonation distances are small

This is a special case where experiments can be fully modeled with grainscale detail

Currently tuning burn model parameters based on experimental results