

# Field Experiments Leveraging Multichannel PDV at URI

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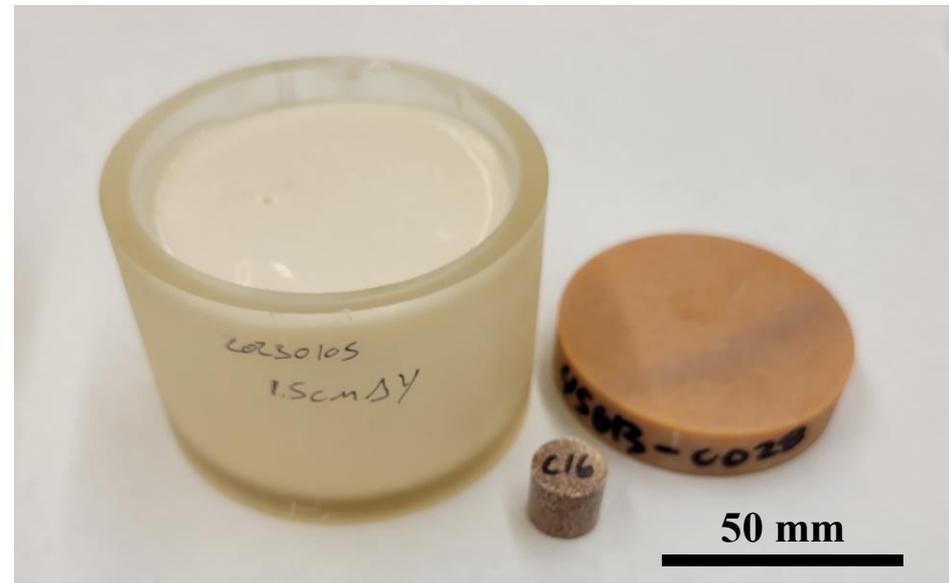
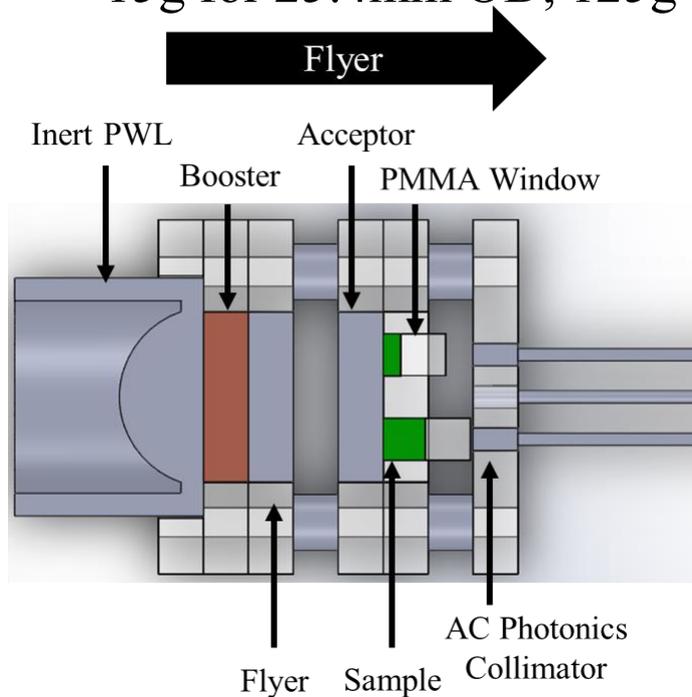
# Motivation

- Design cast-cure plane wave lenses for DEVCOM & Brown-URI MURI
- Deliver planar shocks without the need for a gas gun, machining explosives, or pressing large charges
- Enabling wedge tests, gap tests, flyer plate impact



# Inert Plane Wave Lenses

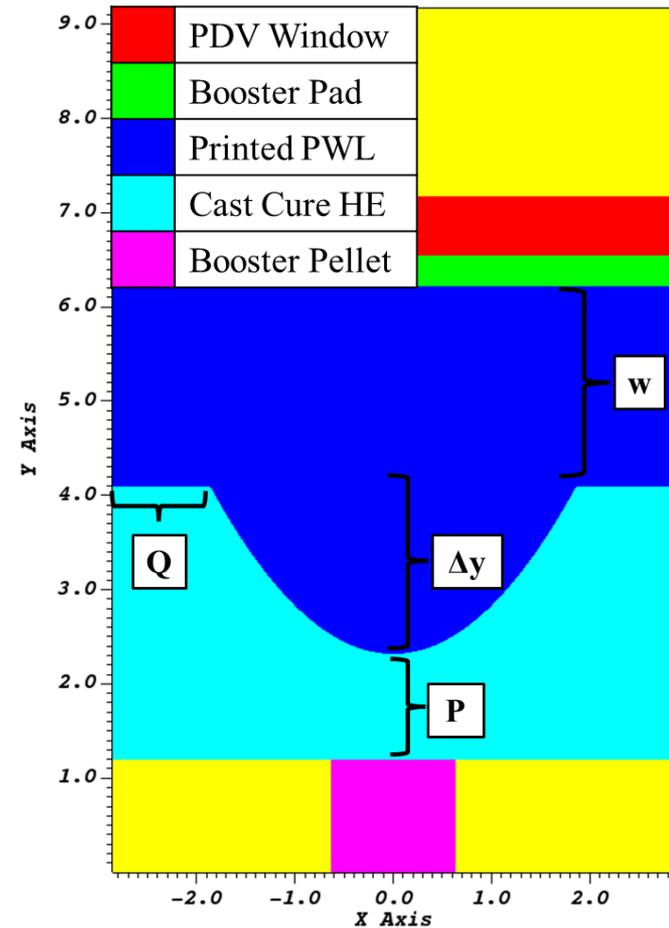
- Fritz<sup>1</sup> inert attenuator lenses slow the center of the wave
- Additive manufacturing allows for rapid prototyping & production
- Lenses have low NEW
  - 15g for 25.4mm OD, 125g for 50.8mm



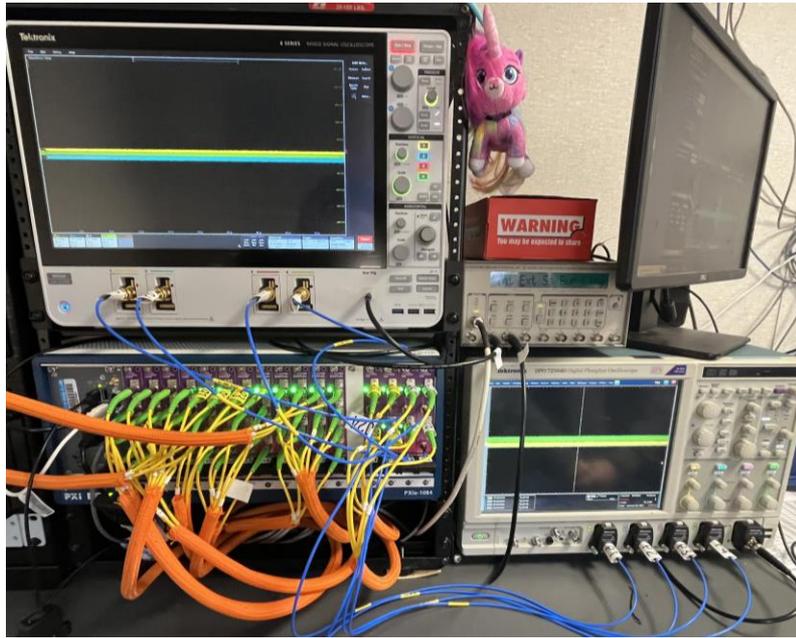
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# Leveraging PDV

- Output pressures from Fritz lenses are heavily dependent on HE & attenuator
- Pressures need to be consistent & sufficiently high to initiate a booster pad uniformly
- Booster pads need to retain uniform pressure at output



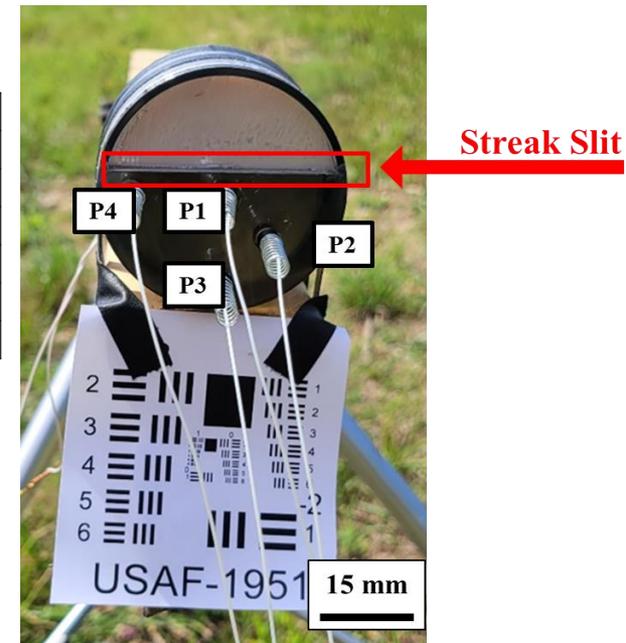
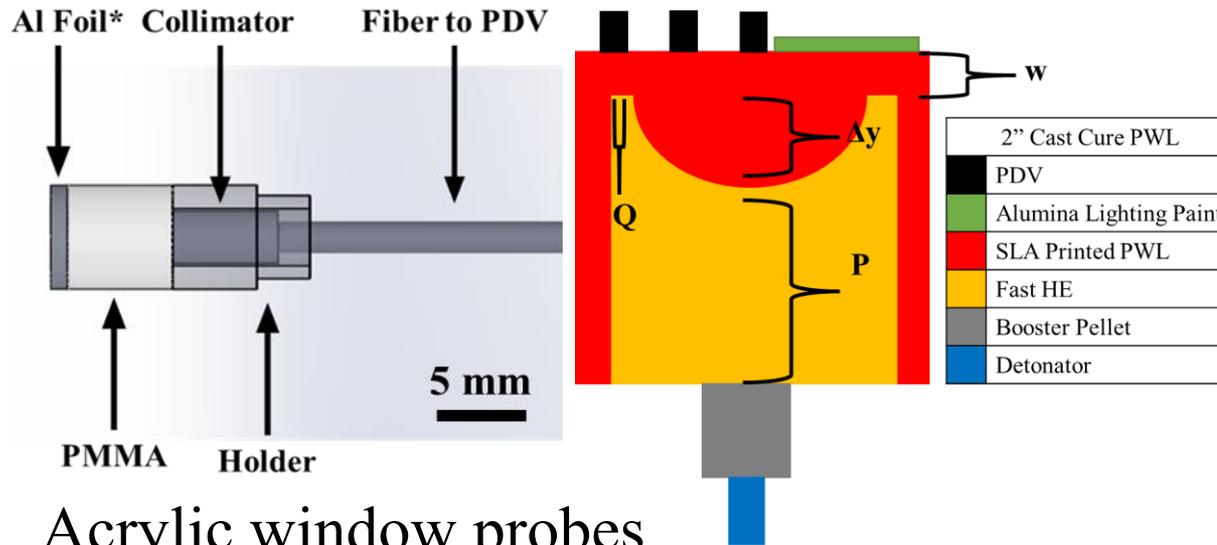
# PDV at URI



- Quantifi Photonics 8-Channel Heterodyne
- Allows quick fielding of multiple probes
- Luna 4600 OBR used for timing corrections
- DURIP Award Funded
  - FOA-AFRL-AFOSR-2021-0002, N00014-21-S-F002

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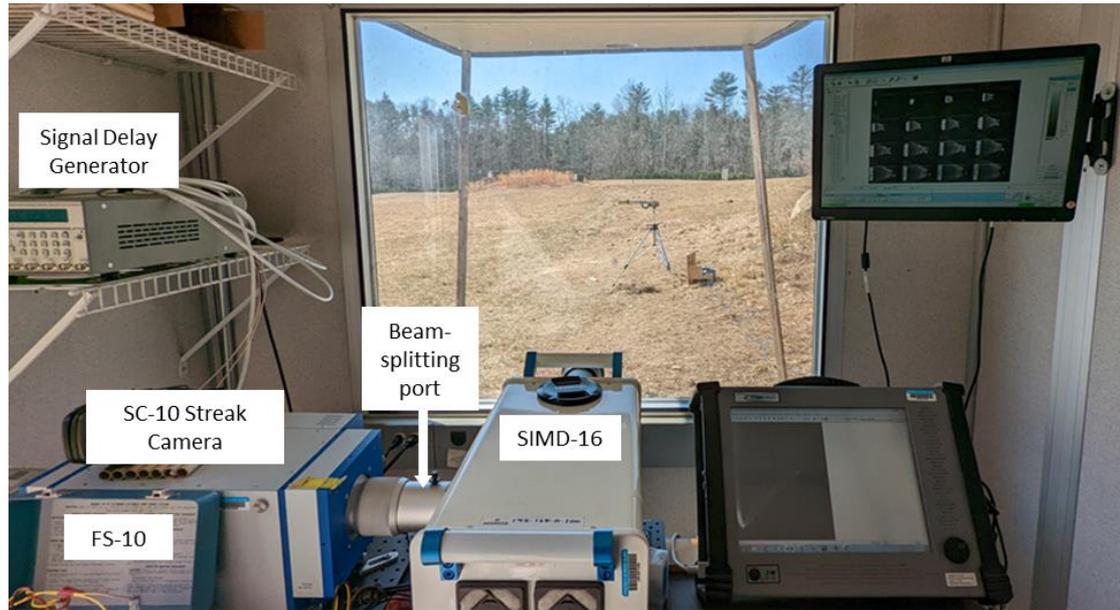
# Lens Geometry & Booster Pad Experiments



- Acrylic window probes
  - 6.35 mm cast acrylic
  - AC Photonics CL1A5525B26301
- Streak camera, measuring breakout by lighting by either:
  - Alumina lighting paint, across half the lens
  - Booster pad (Comp-B or PBXN-5)

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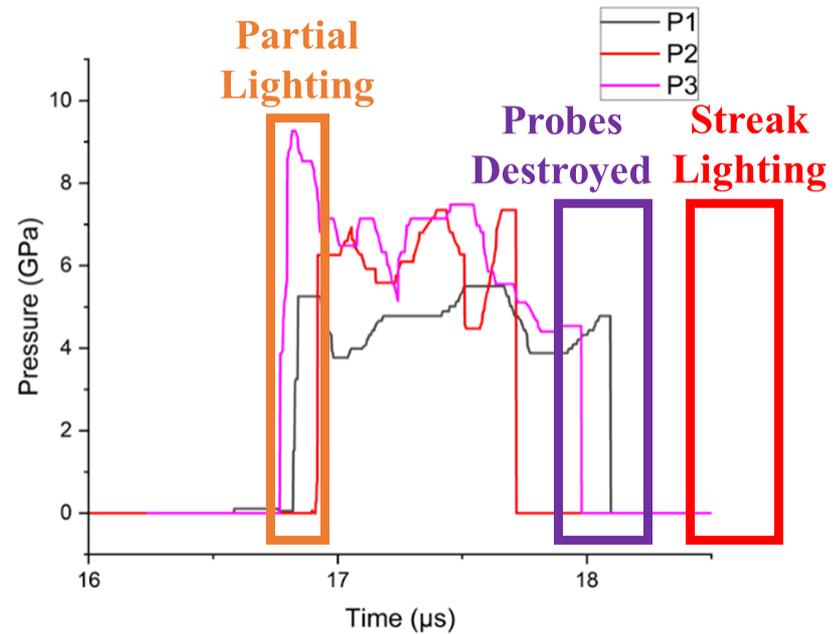
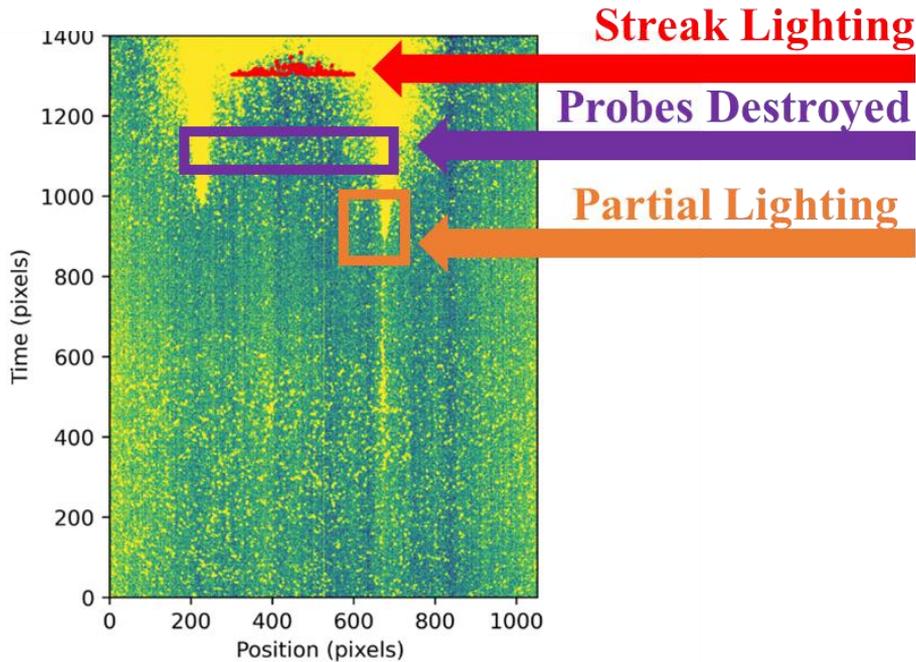
# Camera System



- SIMD-16 coupled to an Optronis SC-10
- Framing camera imaging at 3,030,303 fps
- Streak camera imaging at 1.95 & 0.79 ns/pix

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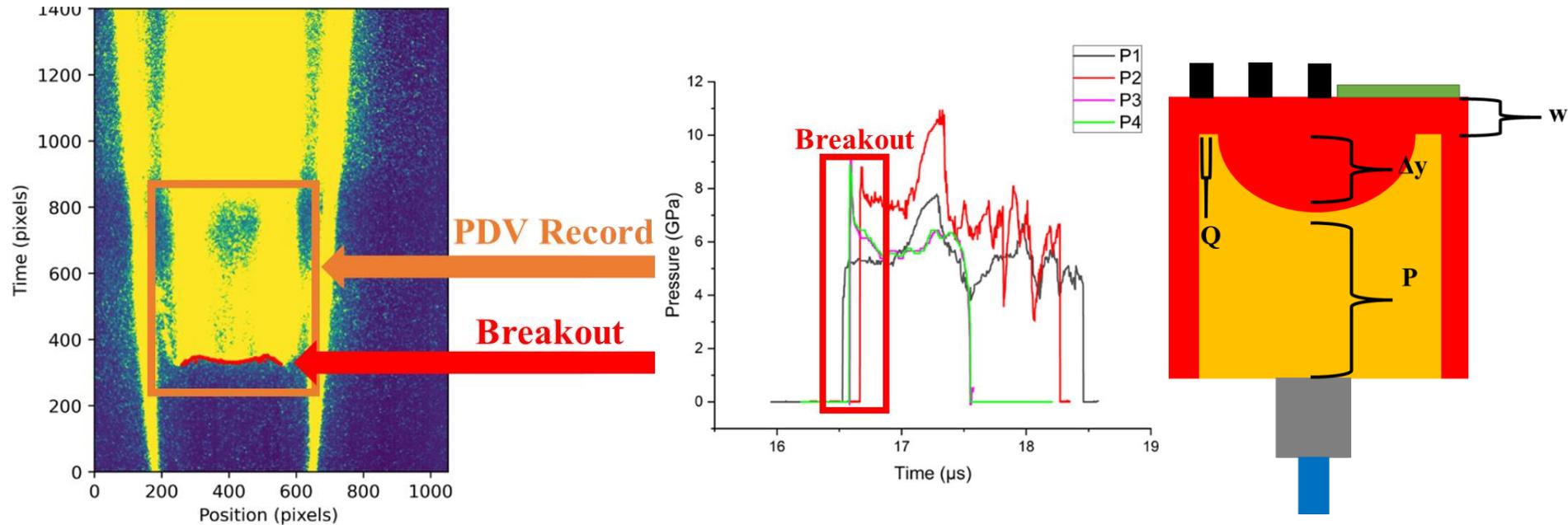
# Insight into Lighting Experiments



- On first inspection it appeared that our streak camera was early, contrary to initial calculations
- PDV suggested that our shock front arrived during the streak record

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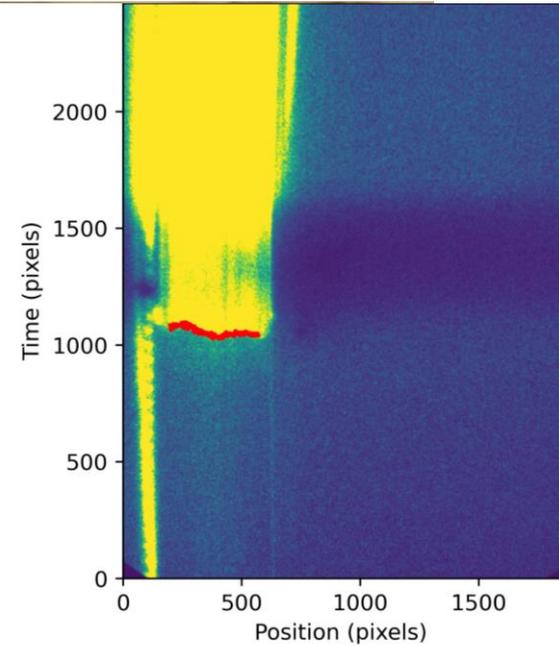
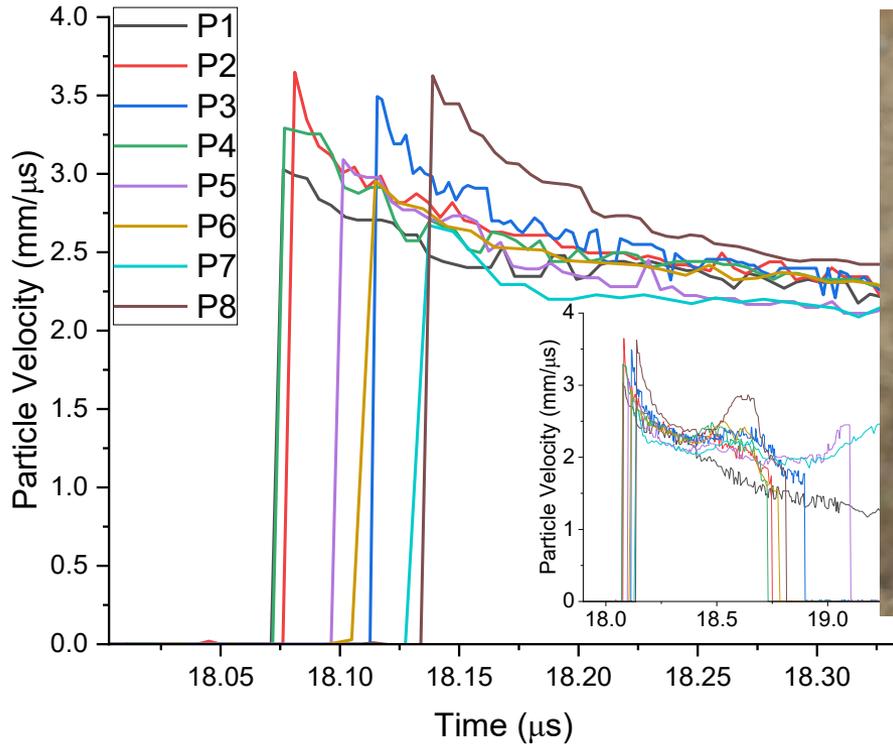
# Higher Pressure Shot



- $\Delta y$  was reduced by 1.0 cm
- High pressure lens design resulted in lighting
  - Paint requires threshold pressure  $\sim 7\text{-}8$  GPa

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# Comp B Booster



- Comp-B used as received 1.713 g/cc, 55.9 mm OD x 12.7 mm thick
- 60.7 ns measured by PDV
- 54 ns measured by streak camera
  - Streaked at 0.79 ns/pixel

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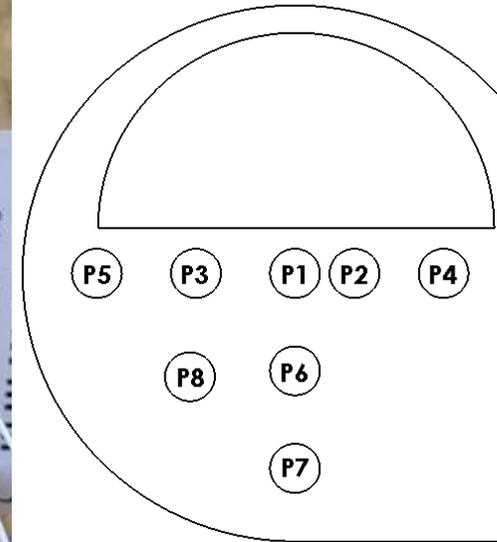
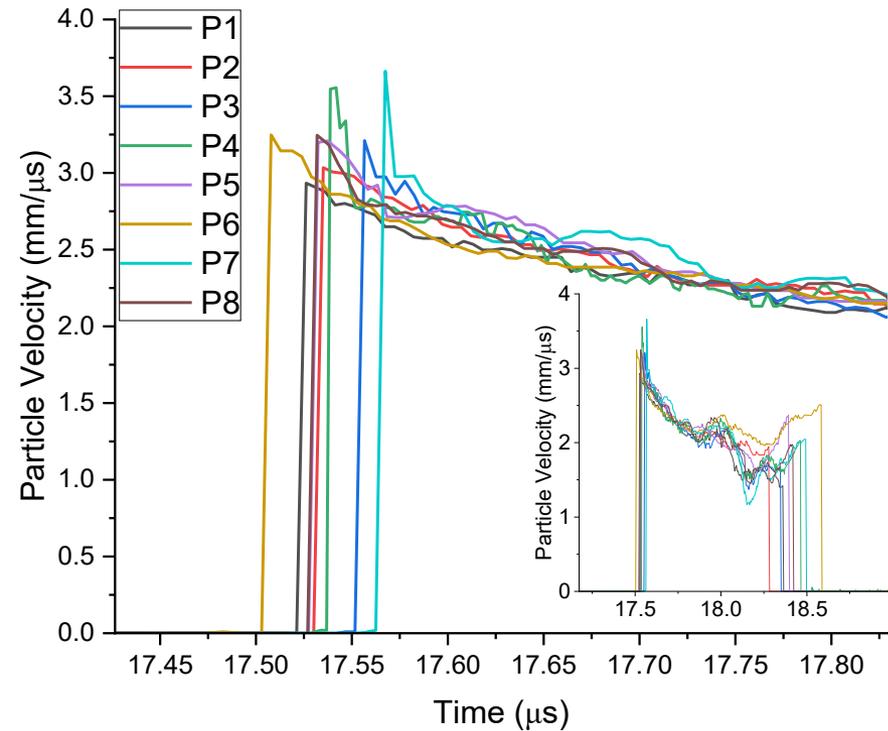
# Maybe Time to Press Pads in House



- Comp B booster pads and P22 lenses of unknown provenience
- Pads and lenses appear to be from different lots based on markings
- Came to us from Florida, maybe survived Katrina?

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# PBXN-5 Booster Pad

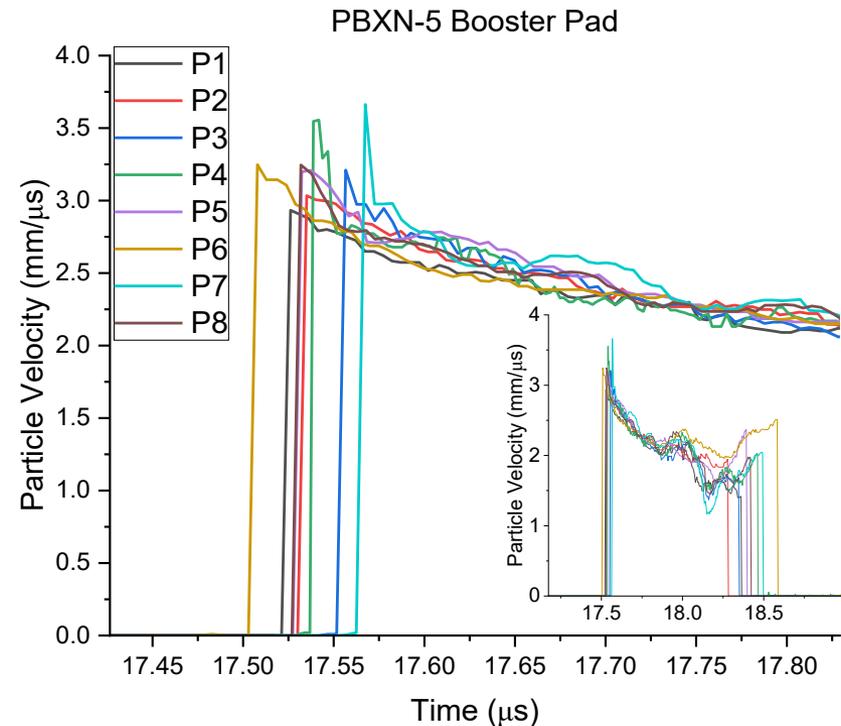
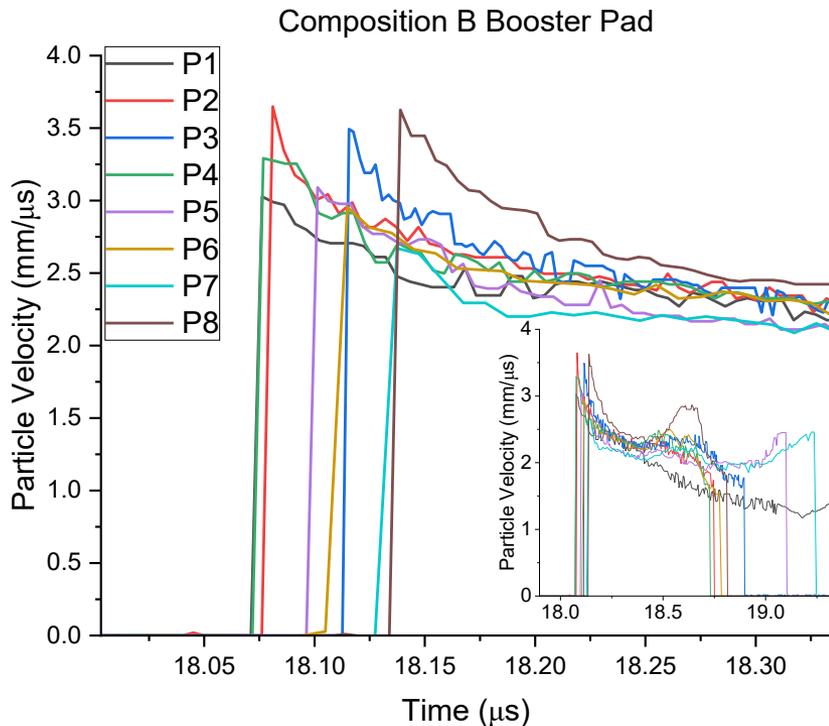


- PBXN-5 pressed to 1.777 g/cc, 50 mm OD x 6.35 mm thick
- 59.5 ns measured by PDV
- Pressure at charge center is lower than expected

\*Streak camera suffered a coms issue

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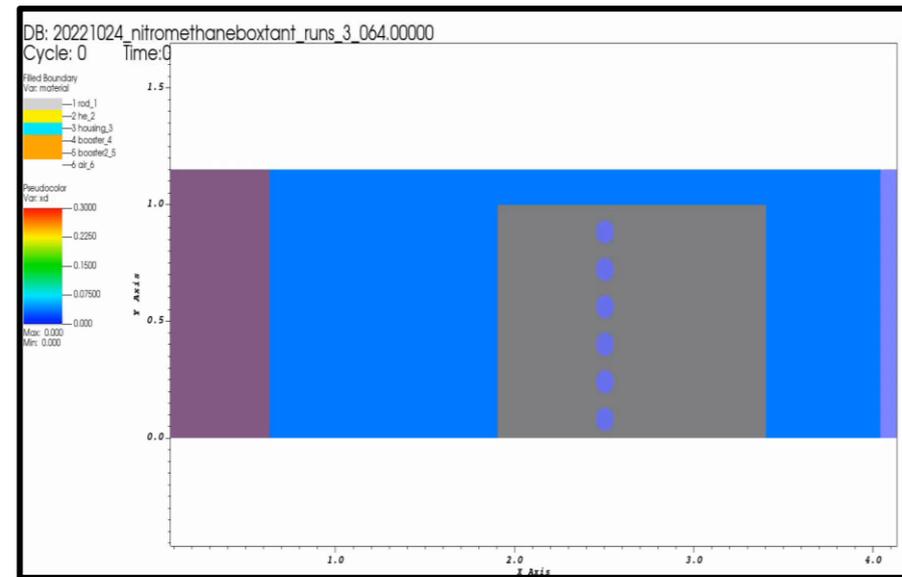
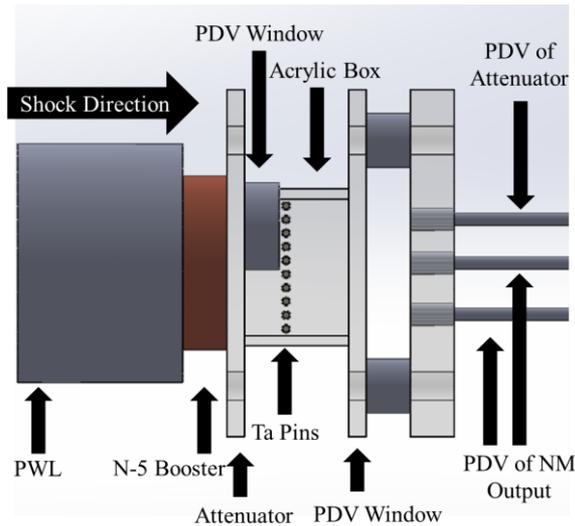
# Booster Pad Comparison



- Detonation out of Comp B & N-5 pads appears to not be uniform at 12.7 & 6.35 mm thick, respectively
- N-5 pad thickness will be increased to reach steady detonation

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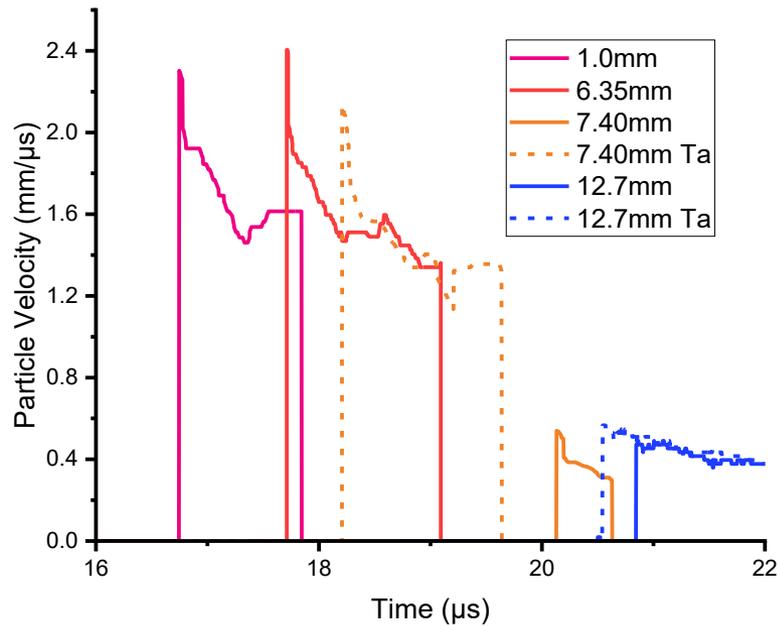
# Nitromethane SDT Modification



- Measured SDT in pure nitromethane with 25.4 mm inert PWL's
- 1.00 mm OD Tantalum pins
  - Supported by ALE3D modeling done by Stewart<sup>1</sup> and internally at URI<sup>2,3</sup>
- Various acrylic attenuators, 1.0 mm to 12.7 mm

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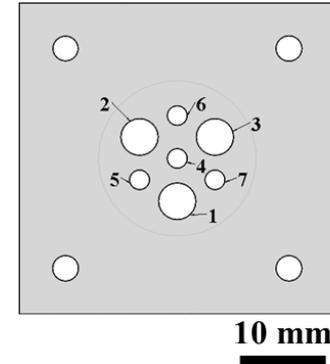
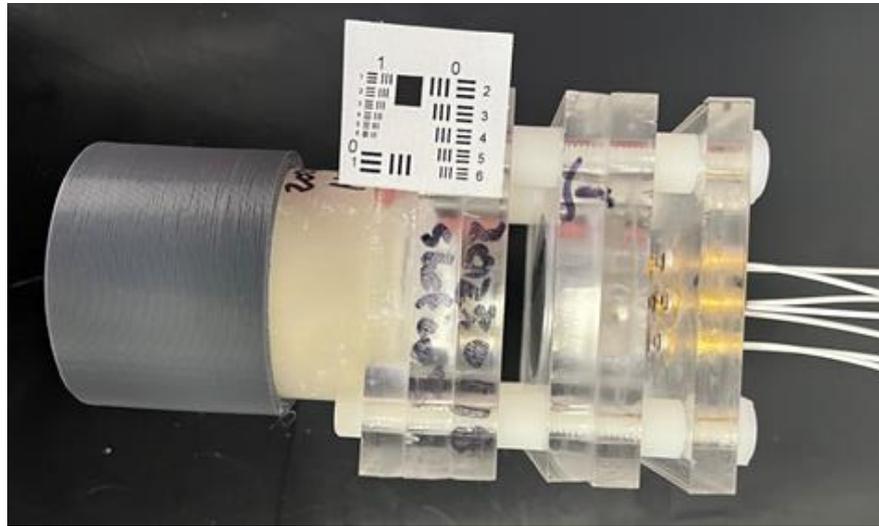
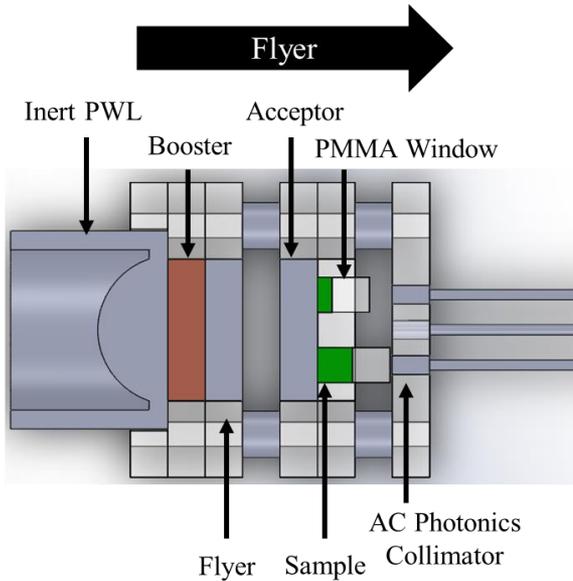
# Enhanced Shock Sensitivity



- Without rods nitromethane with 1.0 mm or 6.35 mm attenuators show normal detonation
- But at 7.40 mm detonation fails to propagate without rods

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# PBXN-5 Plate Impact



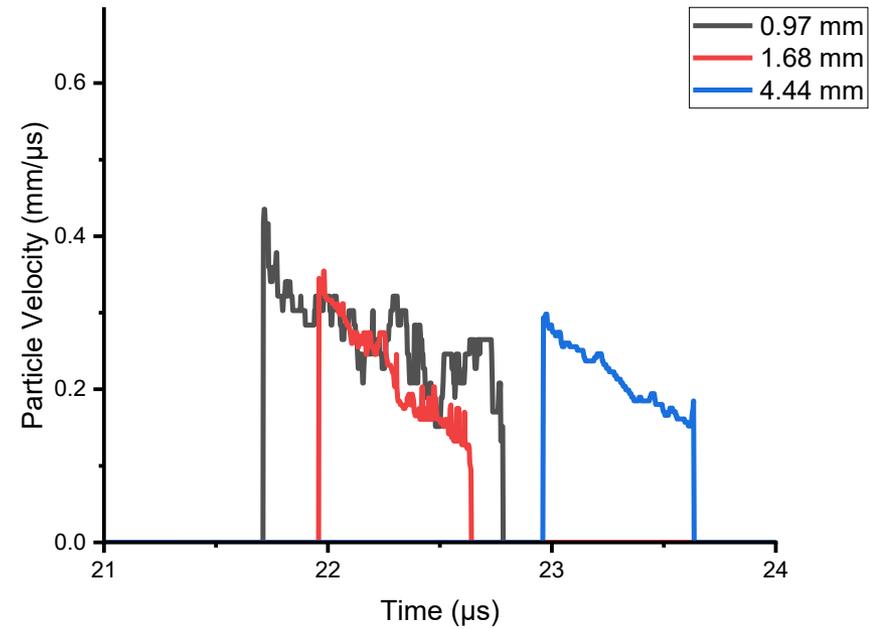
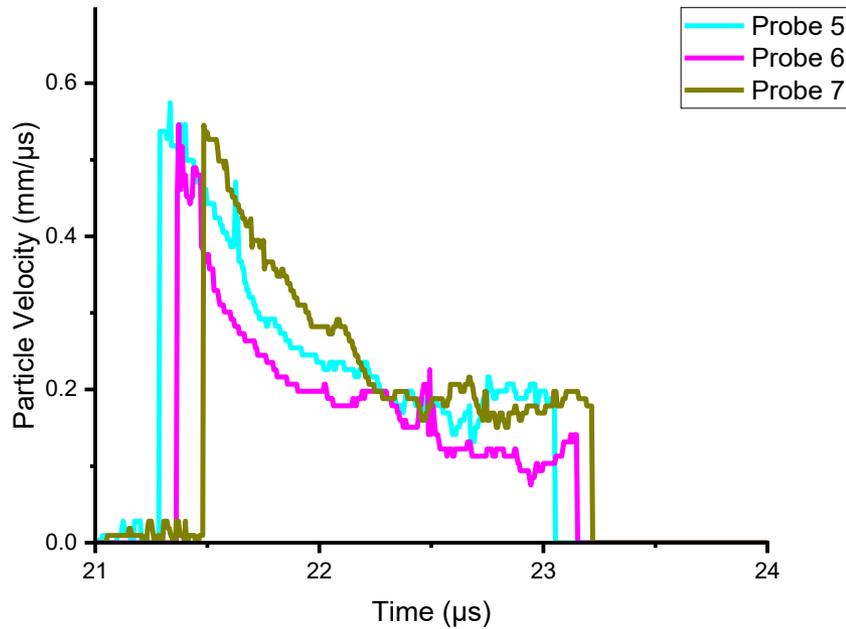
- 7 PDV Probes
- 3 Samples of pressed PBXN-5  
1.800 g/cc

- 4 Plate Impact Probes  
– Measuring tilt and bow
- Similar to SPIFFY<sup>1</sup>

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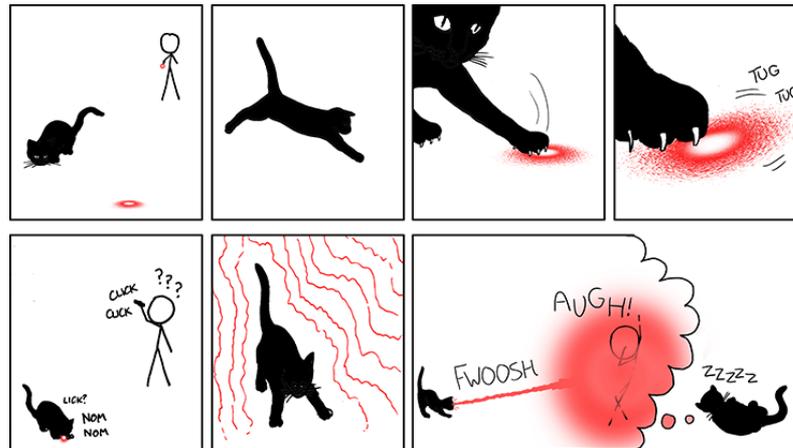
# Small Plate Impact Shots

- Acceptor plate output
  - 190 ns spread
  - 7.5 mrad of tilt across the plate
- PBXN-5 is unreacted
- Exploring higher pressures & various microstructures



# Summary

- We have fielded a wide range of PDV experiments in various field conditions
  - $< 0^{\circ}\text{C}$  to  $35^{\circ}\text{C}$ , moderate winds (5-15 knots)
    - Warm gloves and rigging tape are must haves
- PDV was vital in designing inert PWL's
  - Uniform lighting for imaging not always the best metric for a good PWL
  - Booster pad material and sizing selection will vary based on lens design
- Even without a gas gun it is possible for us to field both gap and plate impact tests thanks to PDV



- And remember when in the field avoid cats<sup>1</sup>

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# Acknowledgments

- Dr. Jimmie Oxley, PI
- Noah Scarpelli, Graduate Student
- Maddy Stanisha, Graduate Student with small hands<sup>1</sup>
- Alan Valliere, Site Manager & Ordinance Technician
- DURIP Awards from AFOSR & ONR
- Dr. Paul Anderson, DEVCOM for funding PWL research

<sup>1</sup> Very important for close or small probes

