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Using PDV to determine the shape of an impacting object

PDV Workshop



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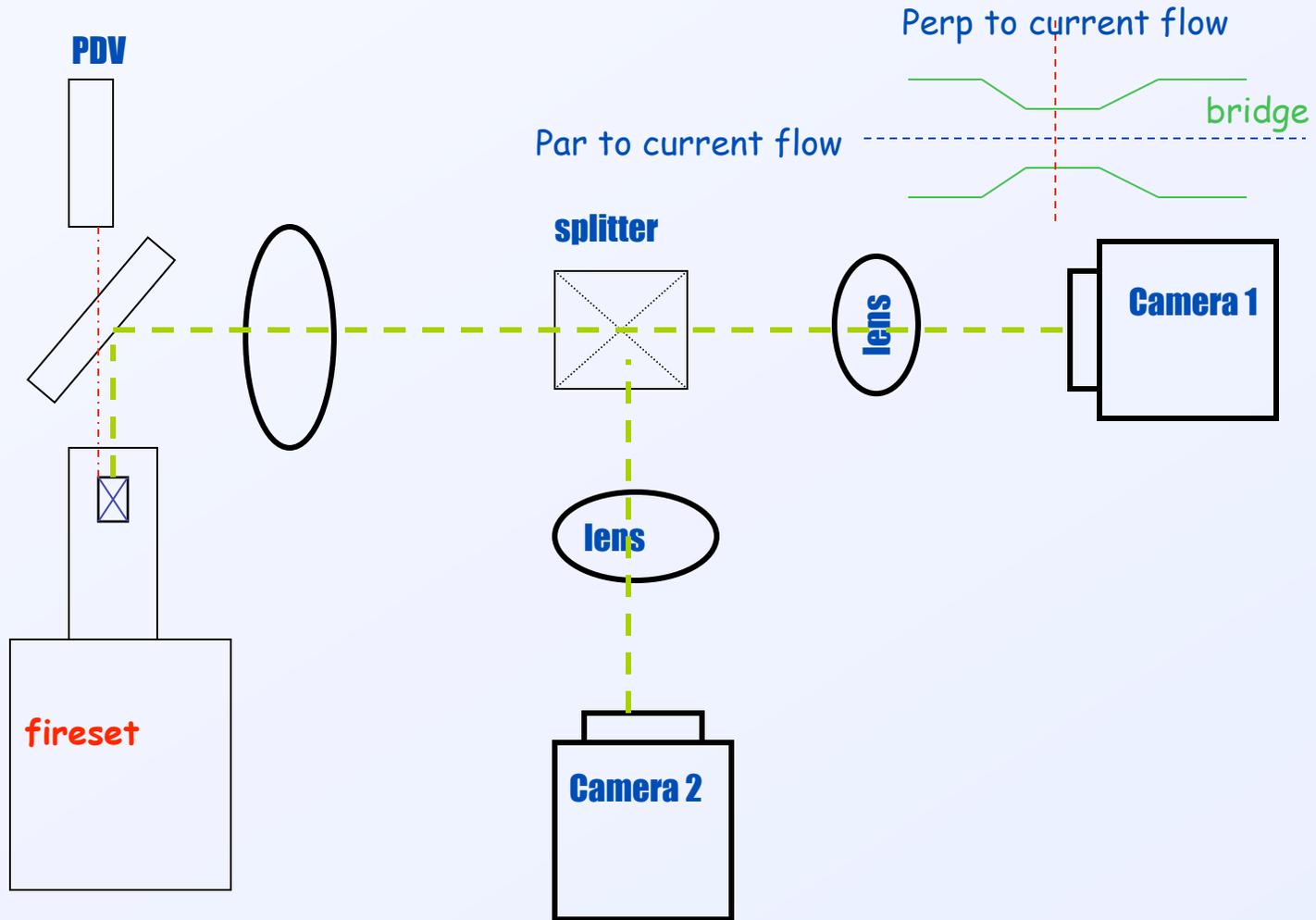
LLNL-PRES-419025

Objective

- Determine the Shape and thickness of Explosively driven Flyers
 - We can determine the Evolution of flyer shape using multiple probes
 - Velocity & Impact Pressure at each probe
 - We use Streak Cameras to record impact shape by recording the nitrogen light flash produced on impact
- Currently we use the multi-channel PDV to record discrete spatial locations, but this has limited implementation due to channel constraints. So, we are developing the Multiplexed PDV

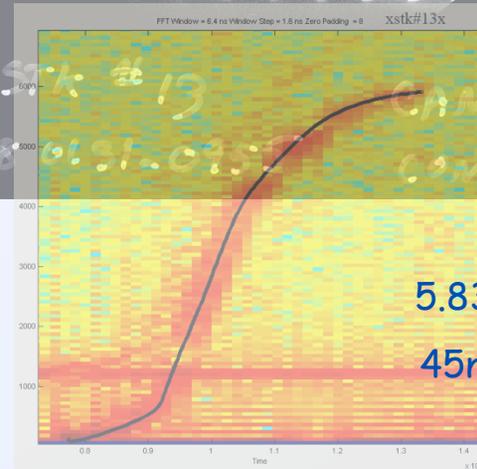
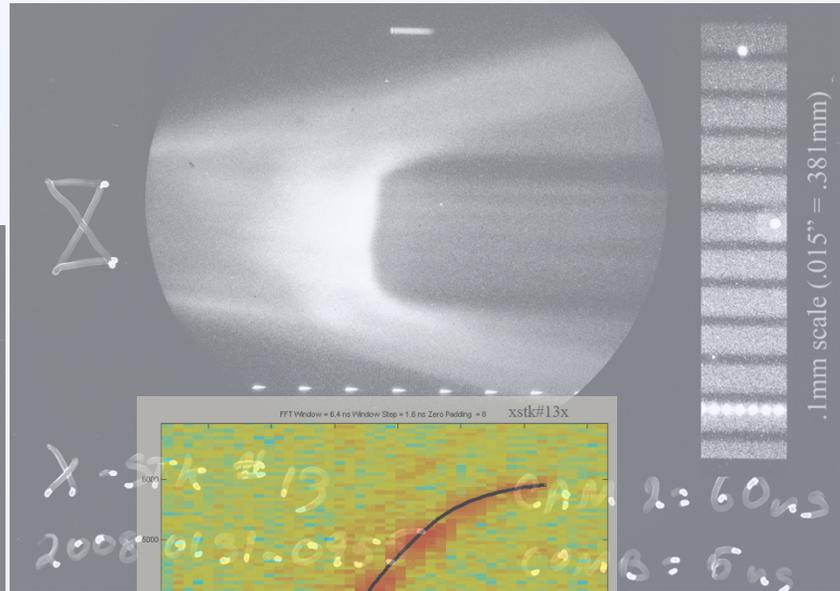
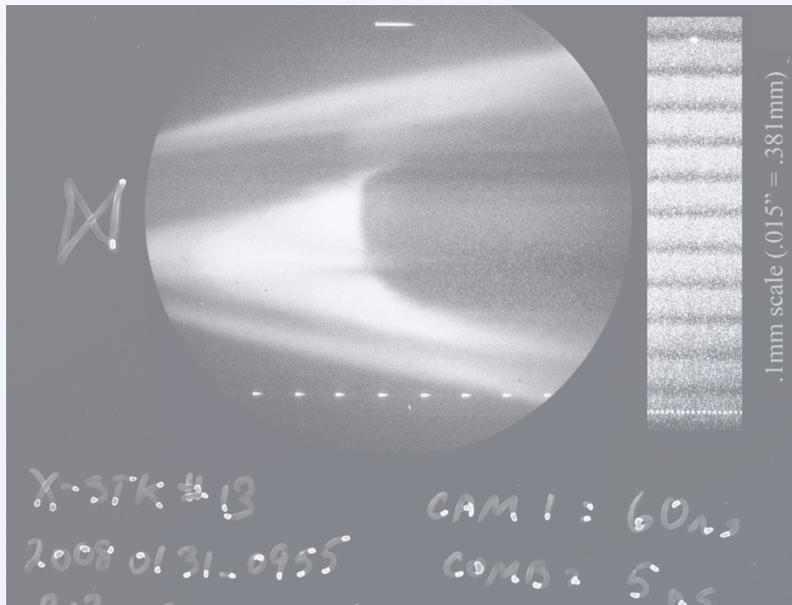


The Streak Camera Setup



Cross-Streak Results with PDV

- Streak Cameras
 - Multiple Cameras can record the impact shape
- PDV
 - velocity



Developing a Multiplexed PDV system

A cleaved fiber will record velocity & impact into a window

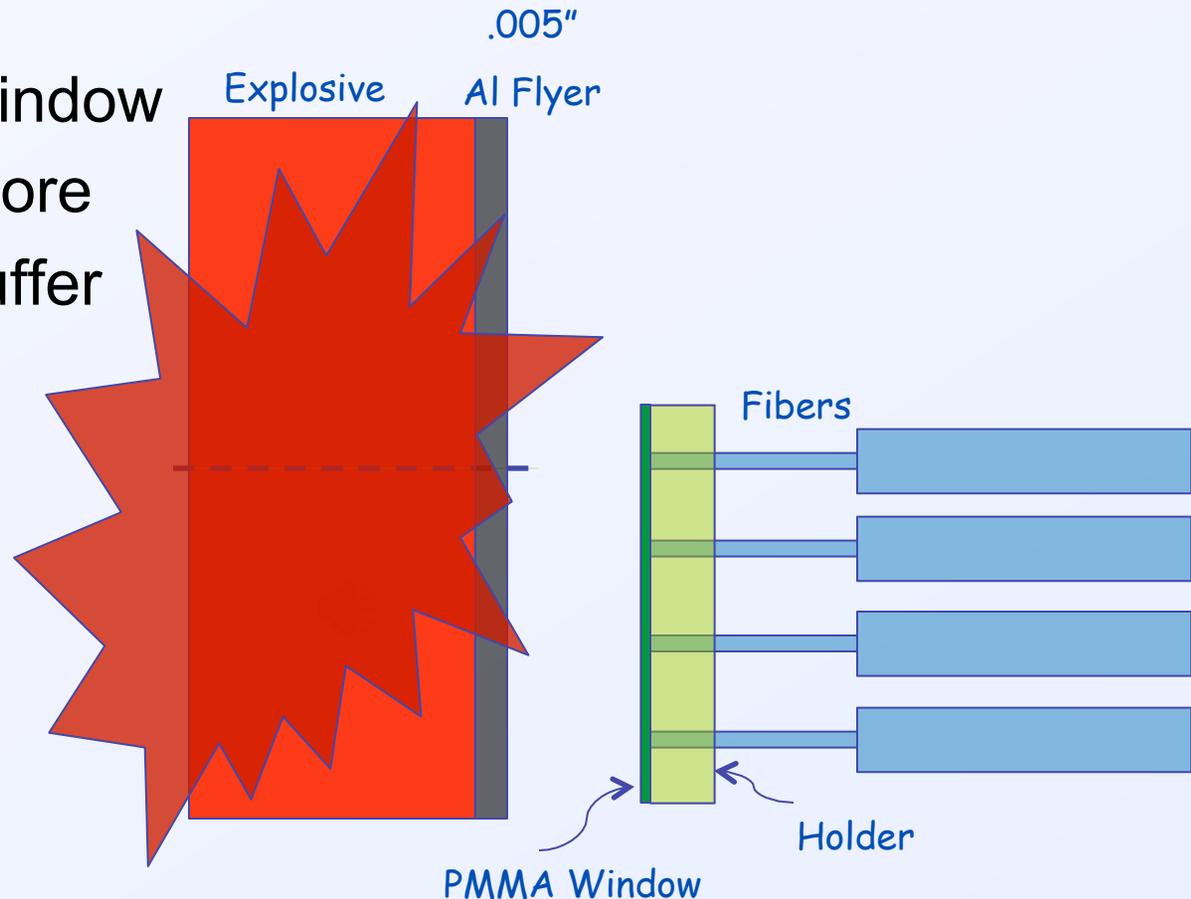
- No lens
- A -20db cleaved fiber
- Closely spaced fibers
 - How close?
 - Shape determined by integrating velocity between each probe
 - Flyer velocity and particle velocity at each point

 The particle velocity in the window and the impact velocity allows us to determine impactor thickness



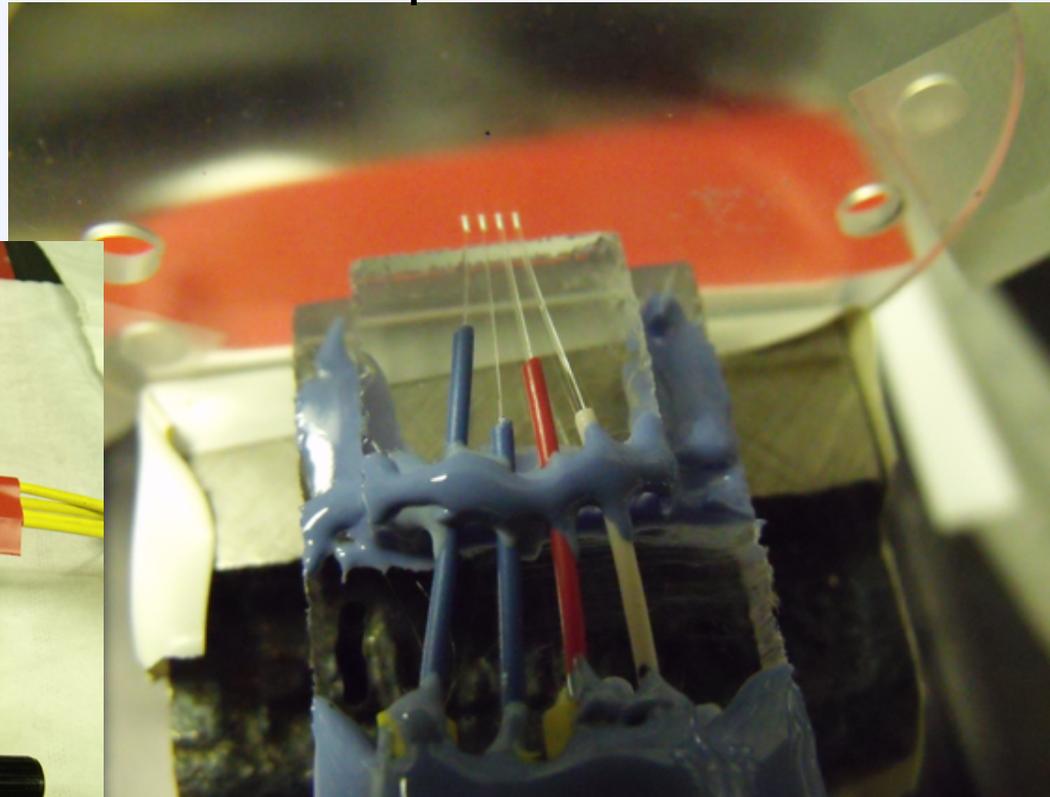
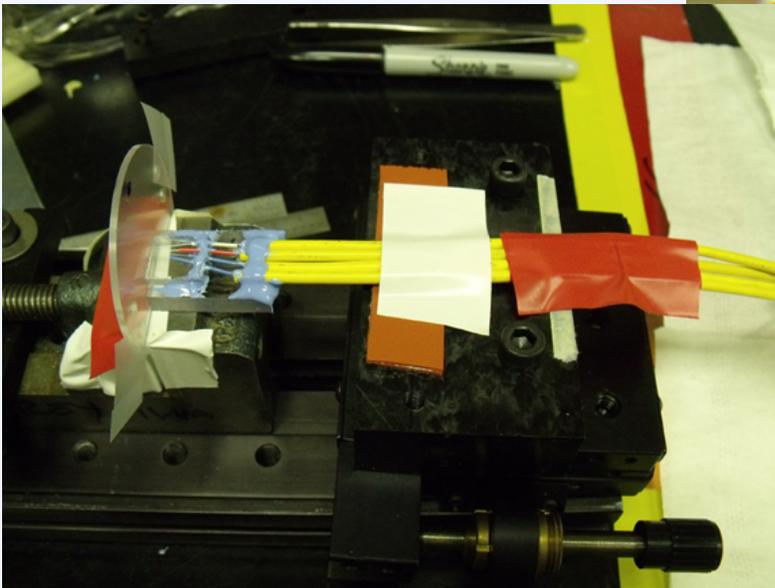
Multi-Fiber PDV experiment Setup

- Fibers in contact with PMMA window
- .020" PMMA window
- 125um Fiber Core
 - 250um w/buffer



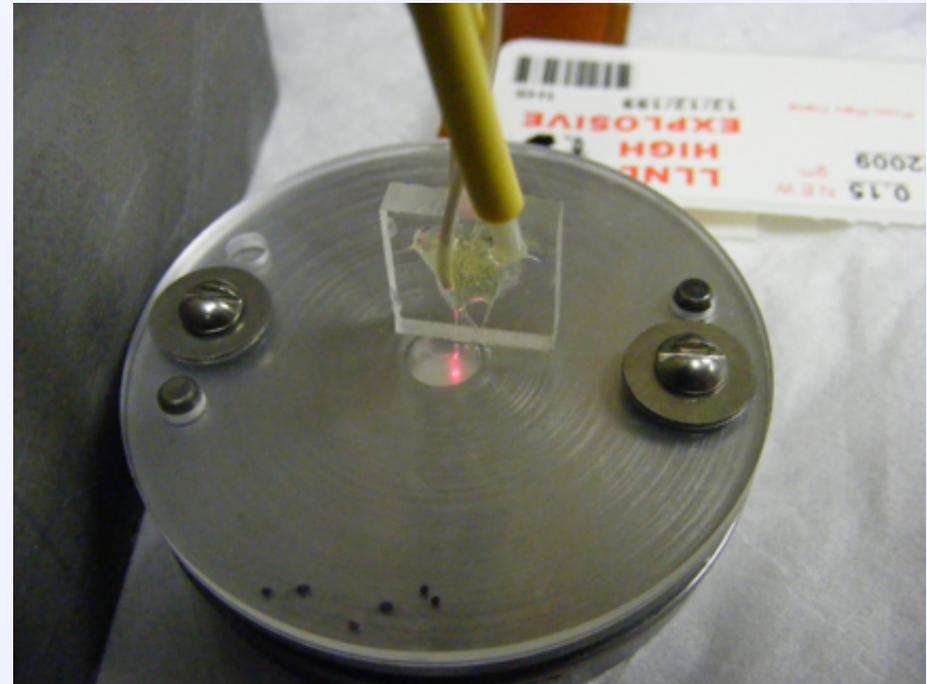
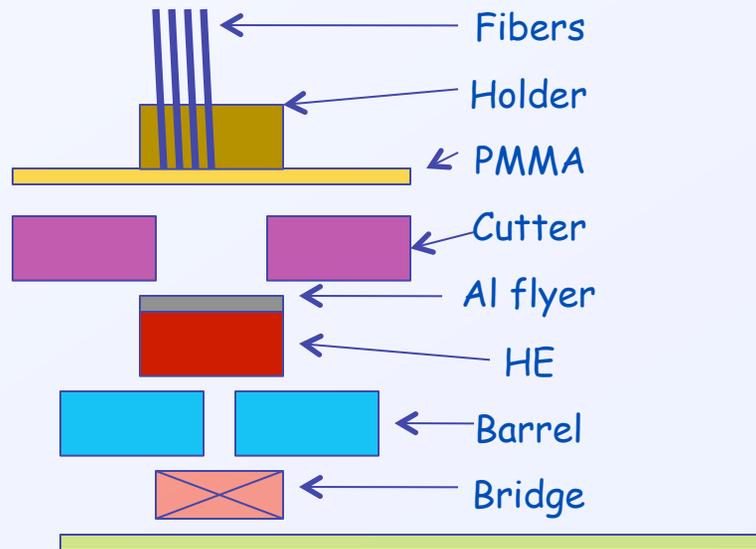
Building the Multi-Fiber PDV test

- 4 single mode fibers
- Fibers inserted flush with back of pmma holder
- Spaced at .030"

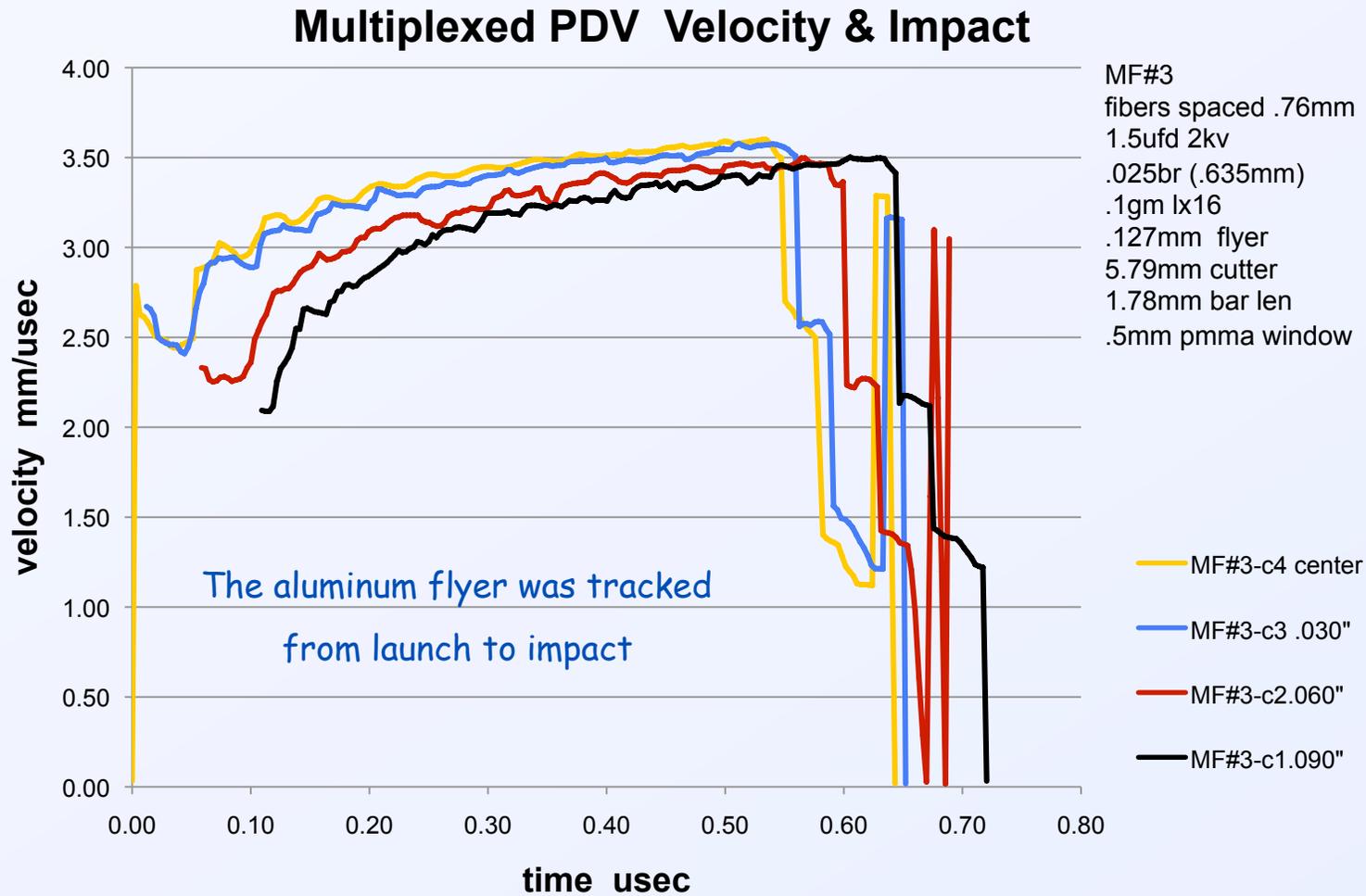


Assembly of the experiment

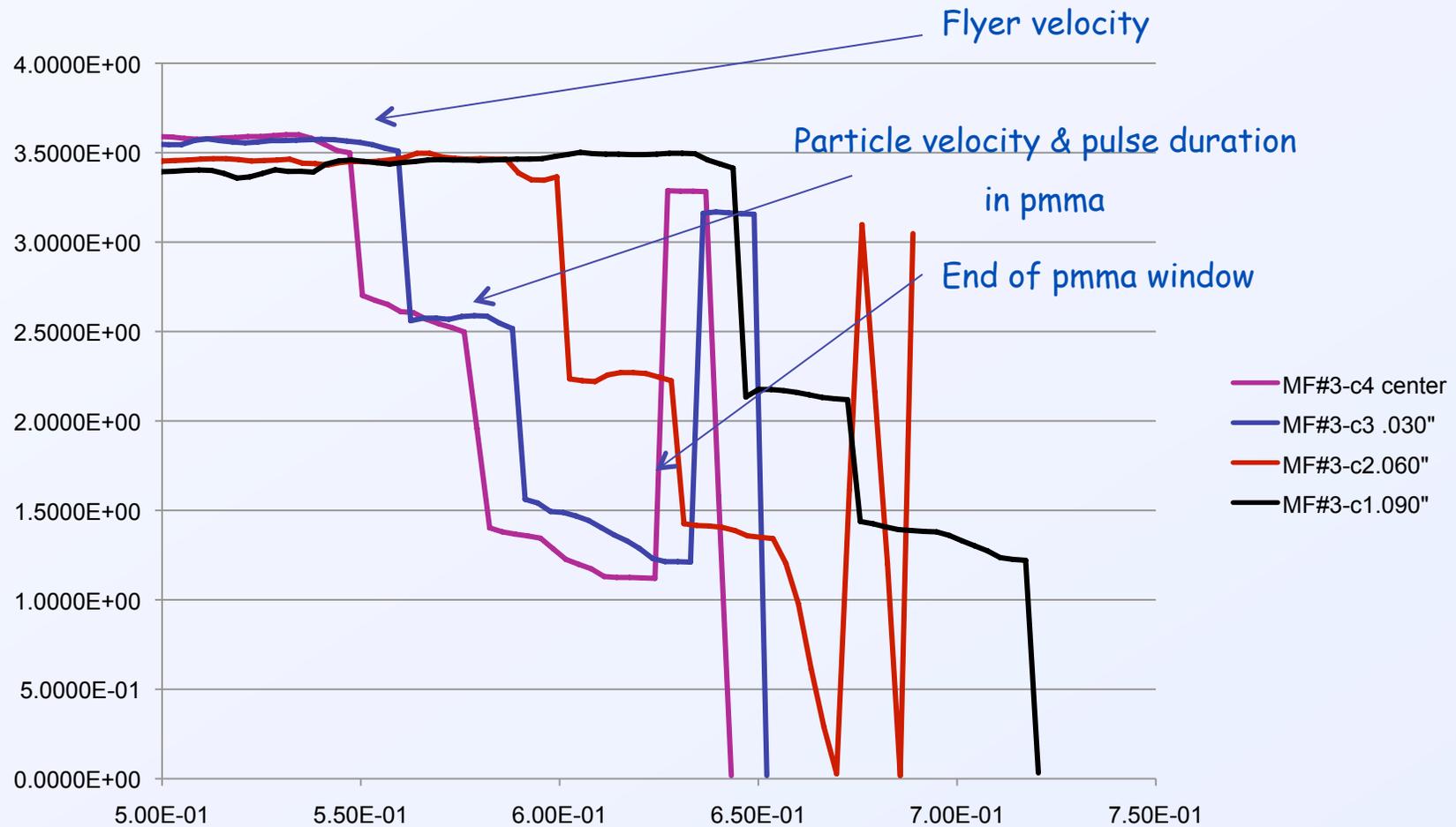
- Shot assembly
 - Pins align parts accurately



Multi-Fiber PDV Signals

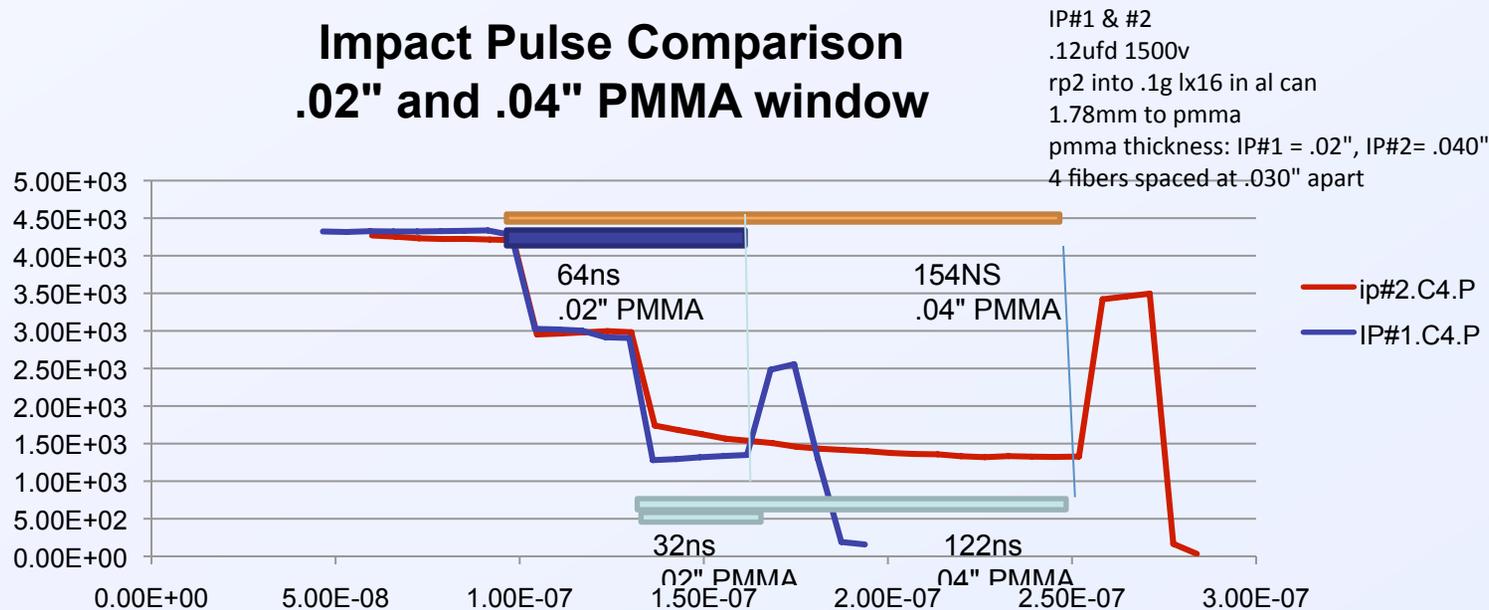


At impact, the particle velocity in the PMMA window is measured



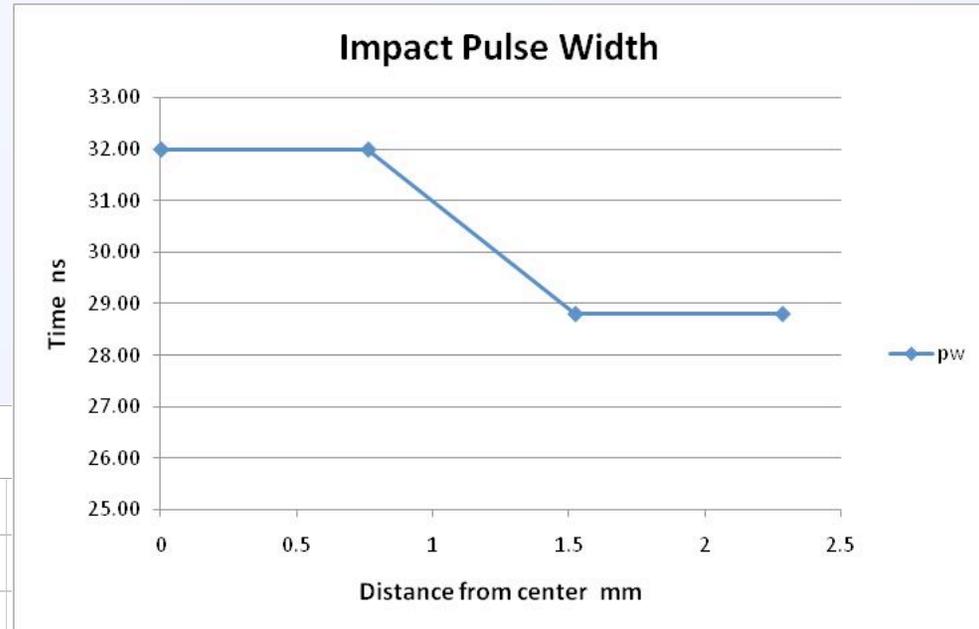
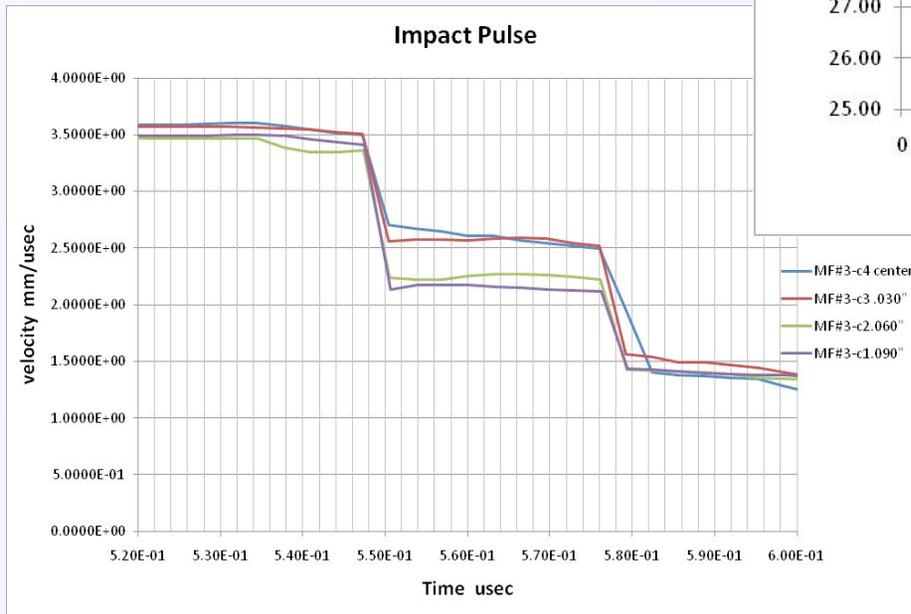
A comparison of two window thicknesses

- PDV fibers have a short focal length, but we the flyer for the complete flight of 1.78mm
- Thicker windows could have crosstalk with the adjacent channels, no crosstalk detected



The flyer impact into the pmma window

- Particle Velocity and Impact Velocity allows the flyer thickness to be determined



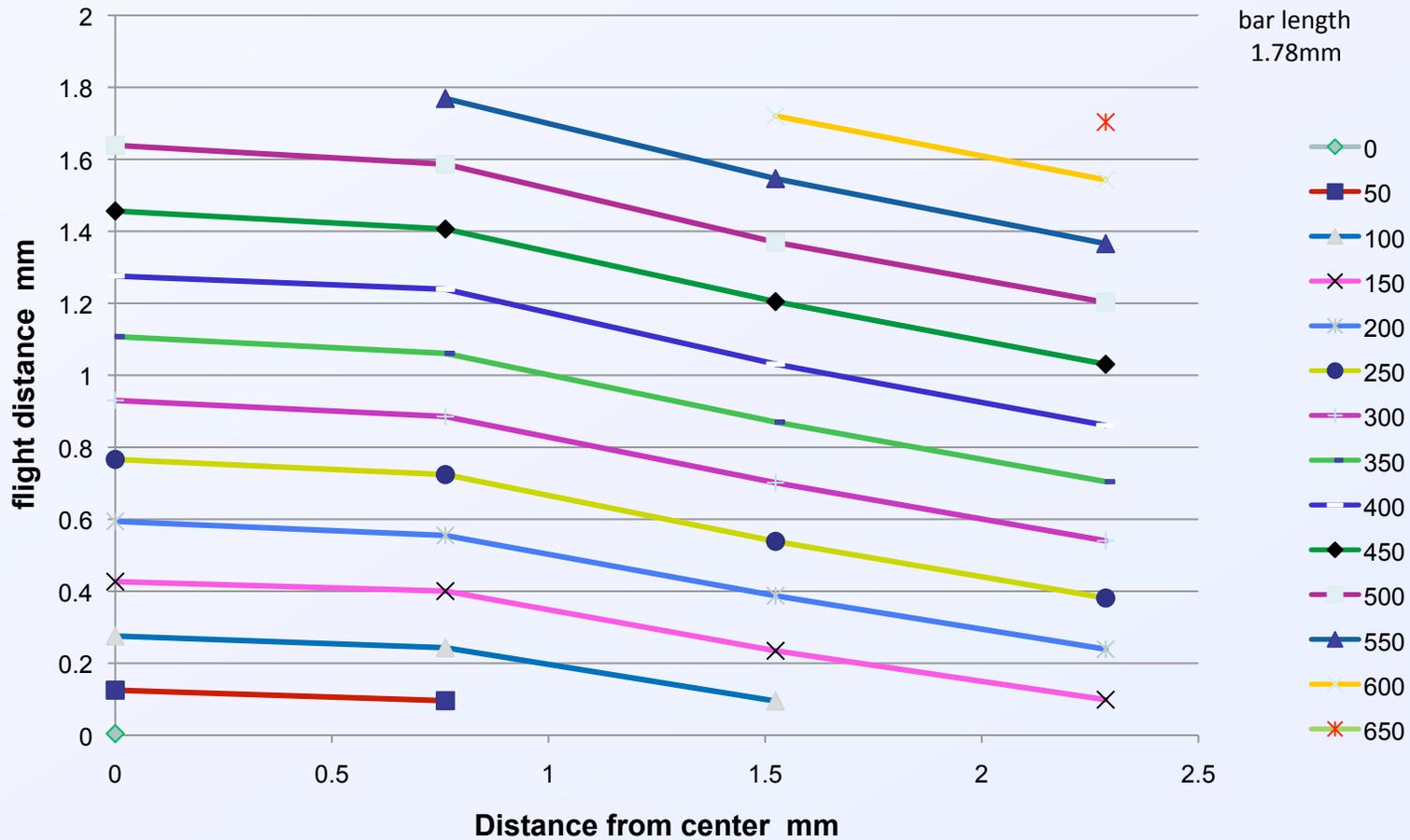
- It looks like the flyer is thinner off the center line, more work is needed



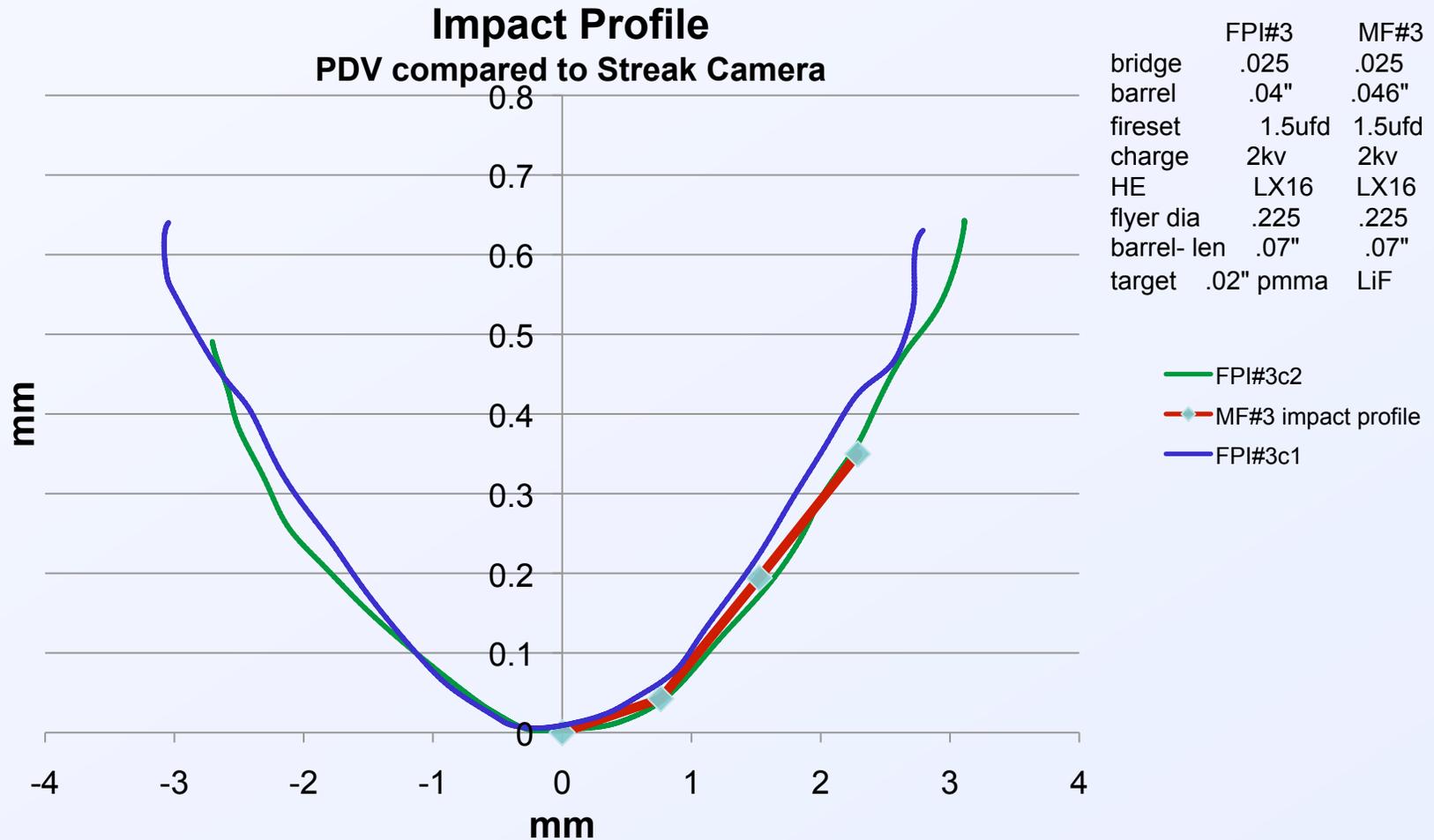
Evolution of the Flyer Shape

Flyer Shape at 50ns Intervals MF#3

probe spacing
.762mm (.03")
flyer cutter dia
5.79mm
bar length
1.78mm



Comparing the Impact Profile with streak camera results



Conclusion

- This test of Multiple PDV Fibers equally spaced across an object was successful
 - No lens is required for the PDV probe
 - Determine shape of an impactor
 -  Compares favorably to streak camera records
 - The pressure pulse time duration at impact was measured and favorably compares with single point measurements
- Resolution
 - Determined by size & spacing of fibers
 - Type and size of the optical window



Future Plans

- Time Domain Multiplexed PDV
 - PDV signals mixed together
 -  Time delays for each signal
 - 4 PDV signals for one detector
 - 16 channels per scope
- Off the shelf fiber optic connectors
 - Fiber spacing = 250um
 - Row spacing = 500um
 - 12 fibers / row



Shot FPI#3

