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Fabry Perot / PDV Comparison

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Ralph Hodgin, Chadd May, Roy Hanks, Don Hansen,

Tony Whitworth

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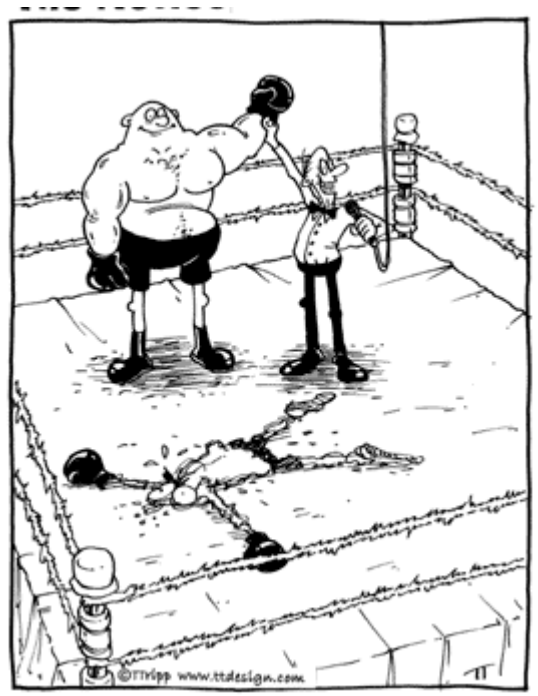
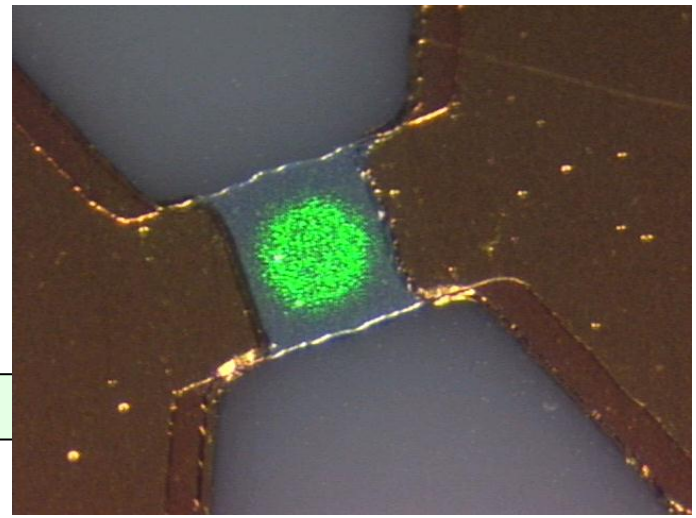
Compare Fabry-Perot to PDV

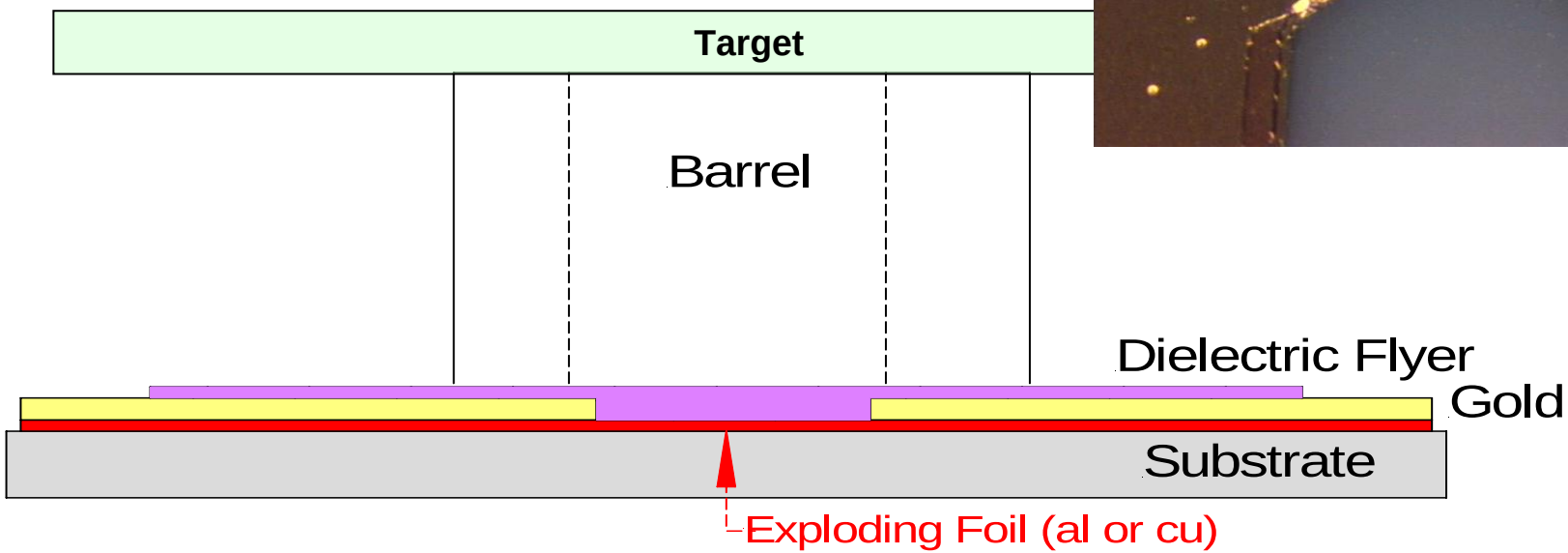
- **Objective: will PDV measure the fast pulses seen with exploding bridge flyers**
- **Each test fired under same conditions**
  - **Change probes for Fabry-Perot & PDV**
  - **1-2 shots for each setup**
- **Parylene & Spun Kapton**
- **All Shots into LiF under vacuum**
- **0.3 uF Fireset**
- **Six shots with PDV**



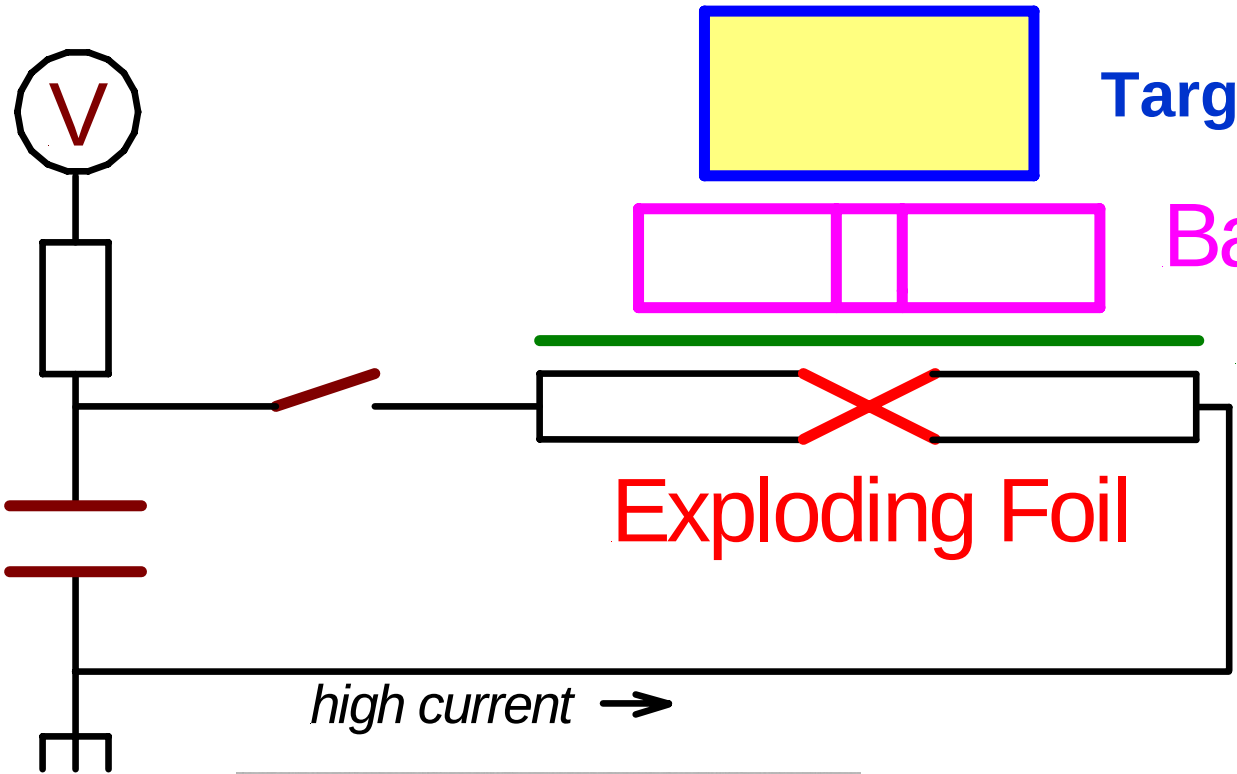
What is a Slapper

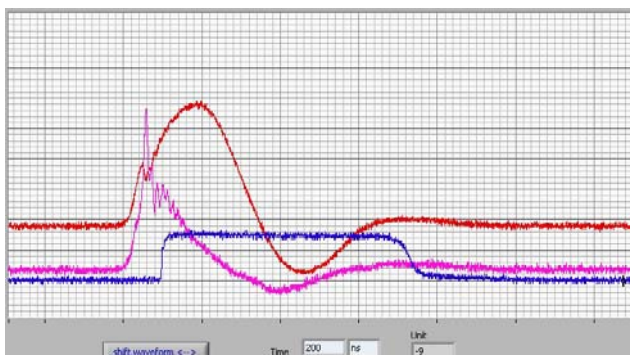
- Substrate
- Bridge Material
- Flyer Material
- Barrel Length
- Target
  - H.E.
  - LIF

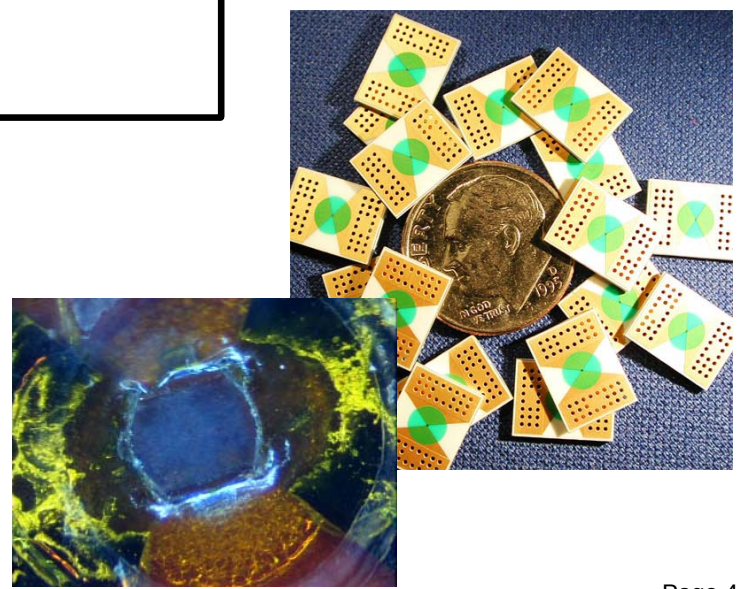




How do you fire a Slapper?







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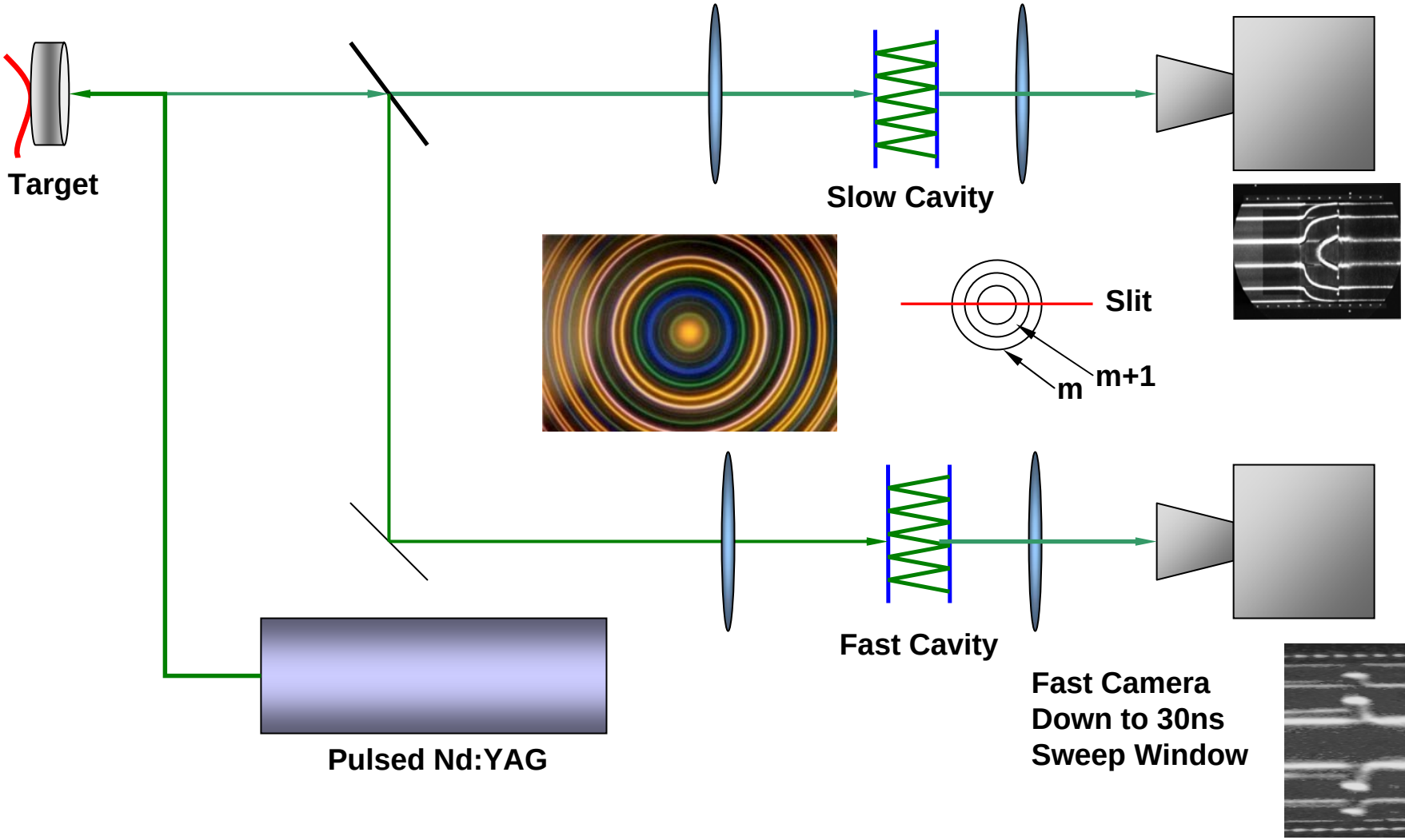
General Layout of Two-Beam Fabry-Perot System for Diagnostic Measurements on Slapper Initiators



Fabry-Perot in HEAF

- Room Size
- 2 Fabry-Perot
- 2 Streak Cameras
- Yag Laser

Photonic Doppler Velocimeter (PDV)

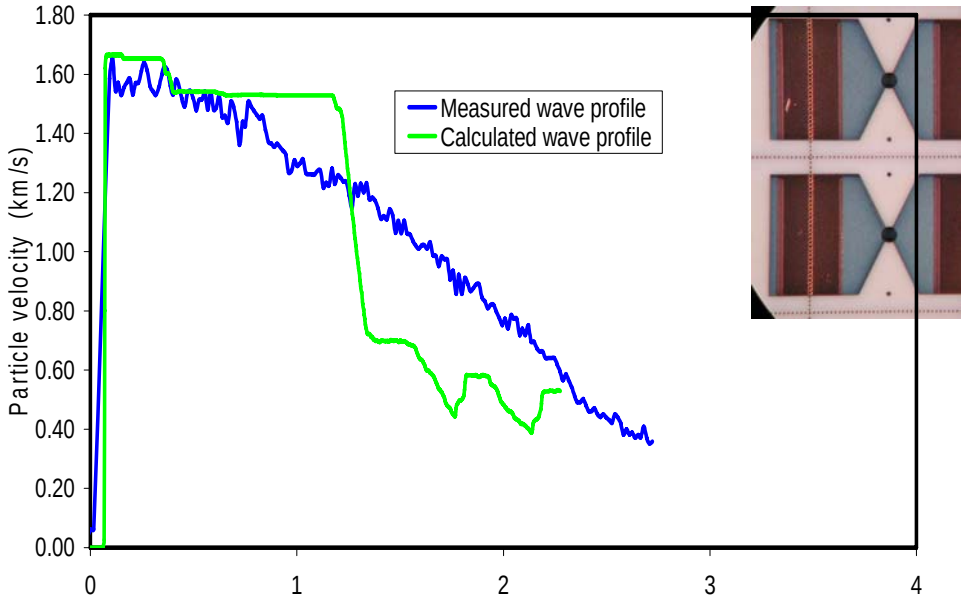
- Portable system – rack mount
- Doppler Velocimetry
- Greater than 5 mm/μsec velocity
- Limited by bandwidth only

- Room Size
- Doppler Velocimetry
- Velocity and Pulse width limited by the Fabry Cavity

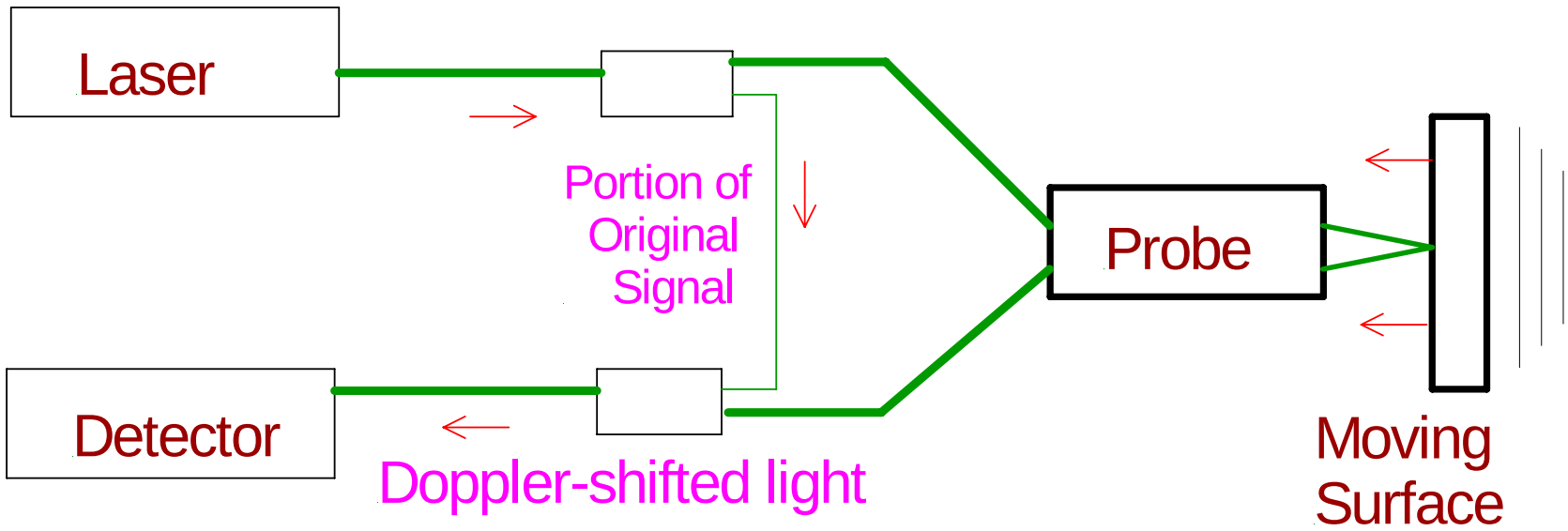
The Fill-Time of the Fabry-Perot Cavity may Filter Sub-Nanosecond Data – PDV may be a Solution

- **Fabry Results limited by the Cavity**
  - **.5ns max resolution**
- **PDV may solve this problem**

Experimental and calculated velocity wave profiles
into LiF for a 50um flight distance.



What is PDV (Photonic Doppler Velocimeter)

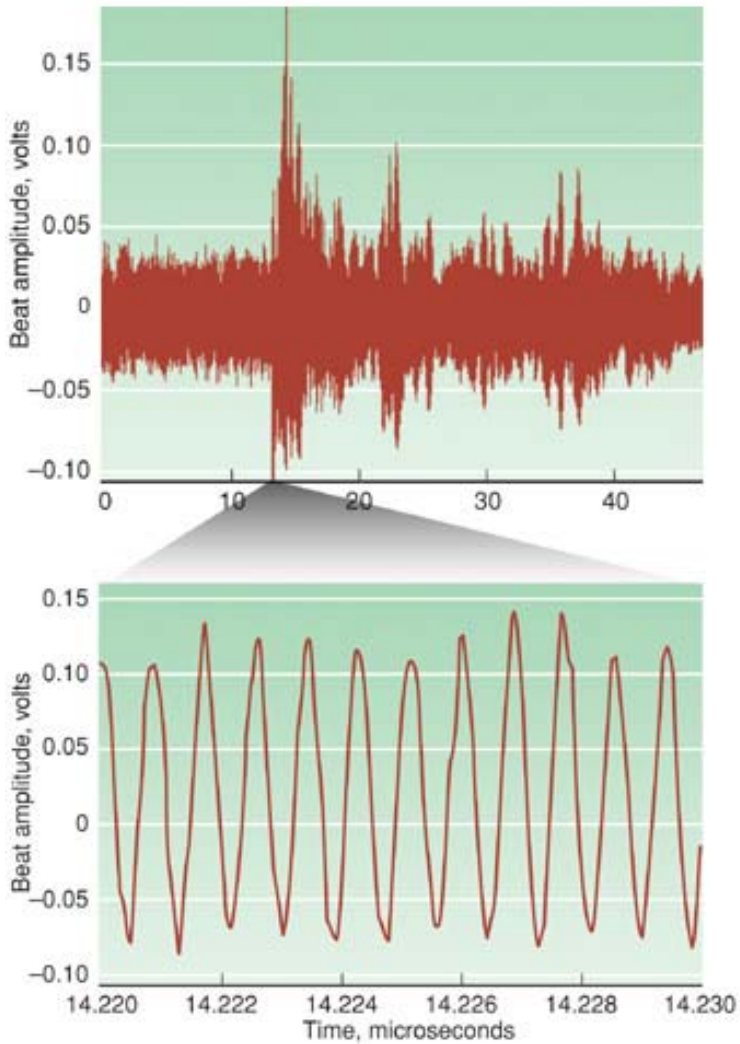


High speed detectors measure the difference in frequency, 'the Beat', between the original signal and Doppler-shifted return signal.

PDV Beat

- PDV Raw Data Output
- The ‘beat’ frequency is Proportional to Velocity
- Expanded view

- 40G sample digitizer
- 25ps/point
- 1550 nm laser wavelength



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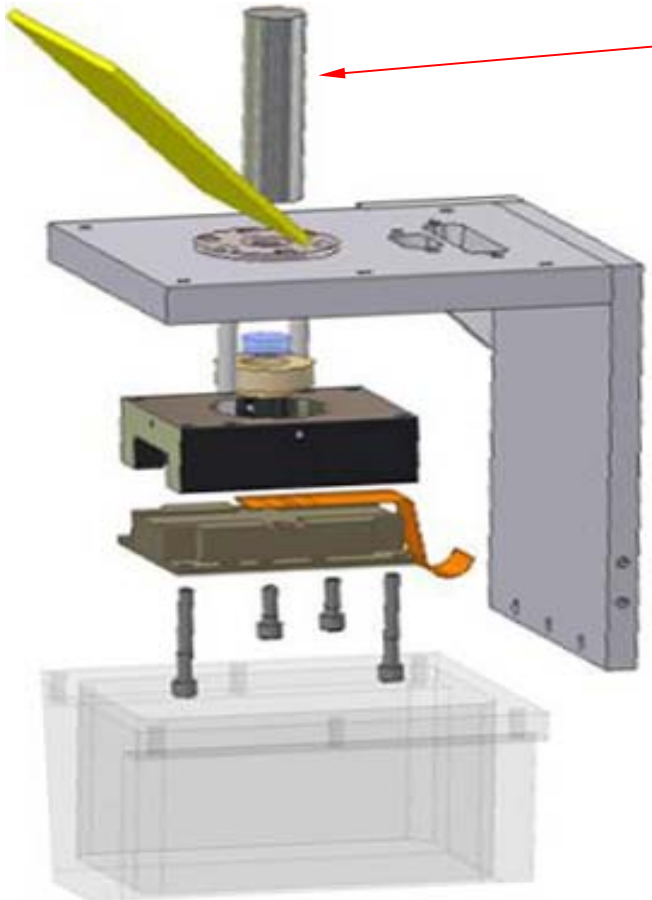
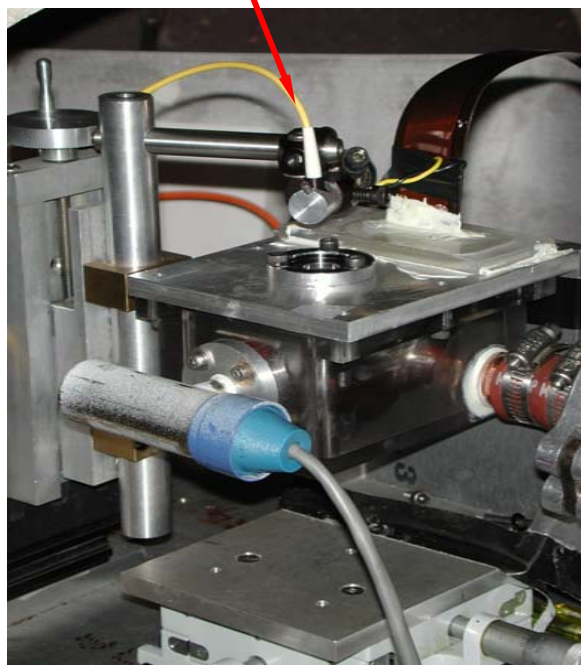
Fabry-Perot Measurements Conducted in Vacuum Provide Information on Slapper's Pulse Duration and Equation of State



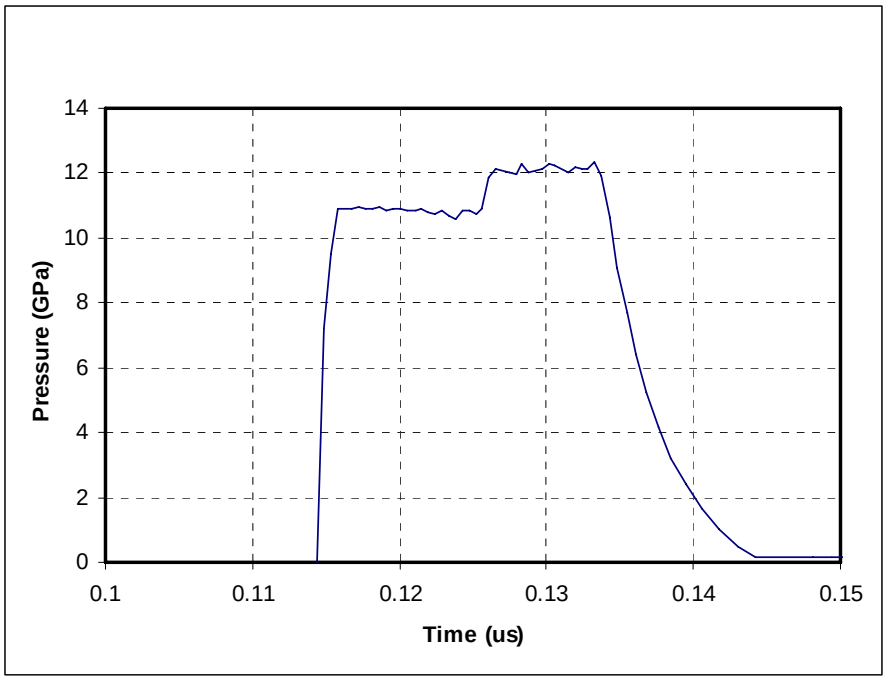
Probe for Fabry or PDV



Working in a vacuum eliminates the air cushion and the air flash at impact.

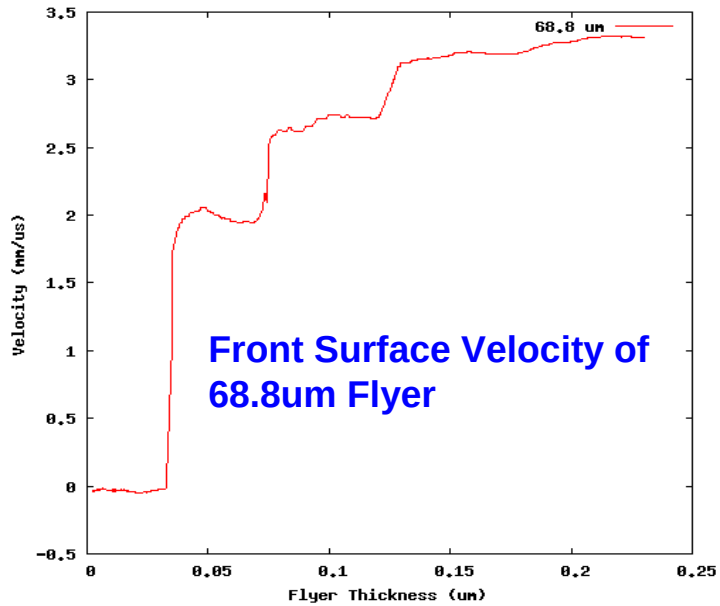
Fabry-Perot and PDV Setup

Simulation of a 60.0um Parylene-C Flyer into LiF with Strong Shock Shows Stepped-Top as Seen with Fast Fabry-Perot Diagnostic



Impact into LIF

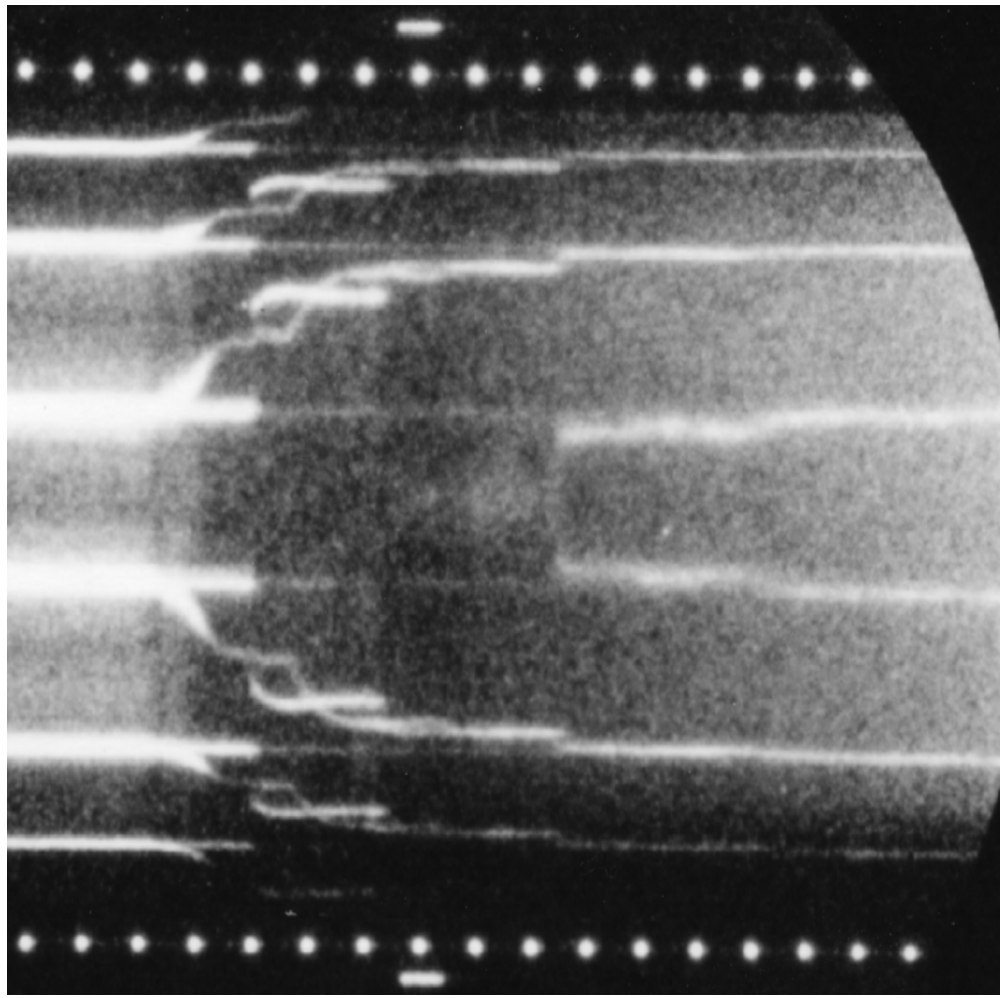
- For thick flyers (>40um) a shock wave builds in flyer material
- Shock causes a second jump in Up in LiF as shown here



Front Surface Velocity of 68.8um Flyer

68.6um Parylene - Fabry

- Complex Return
- Front & Rear flyer surface producing separate returns
- Multiple Returns are easily seen with fabry perot
- Transparent material



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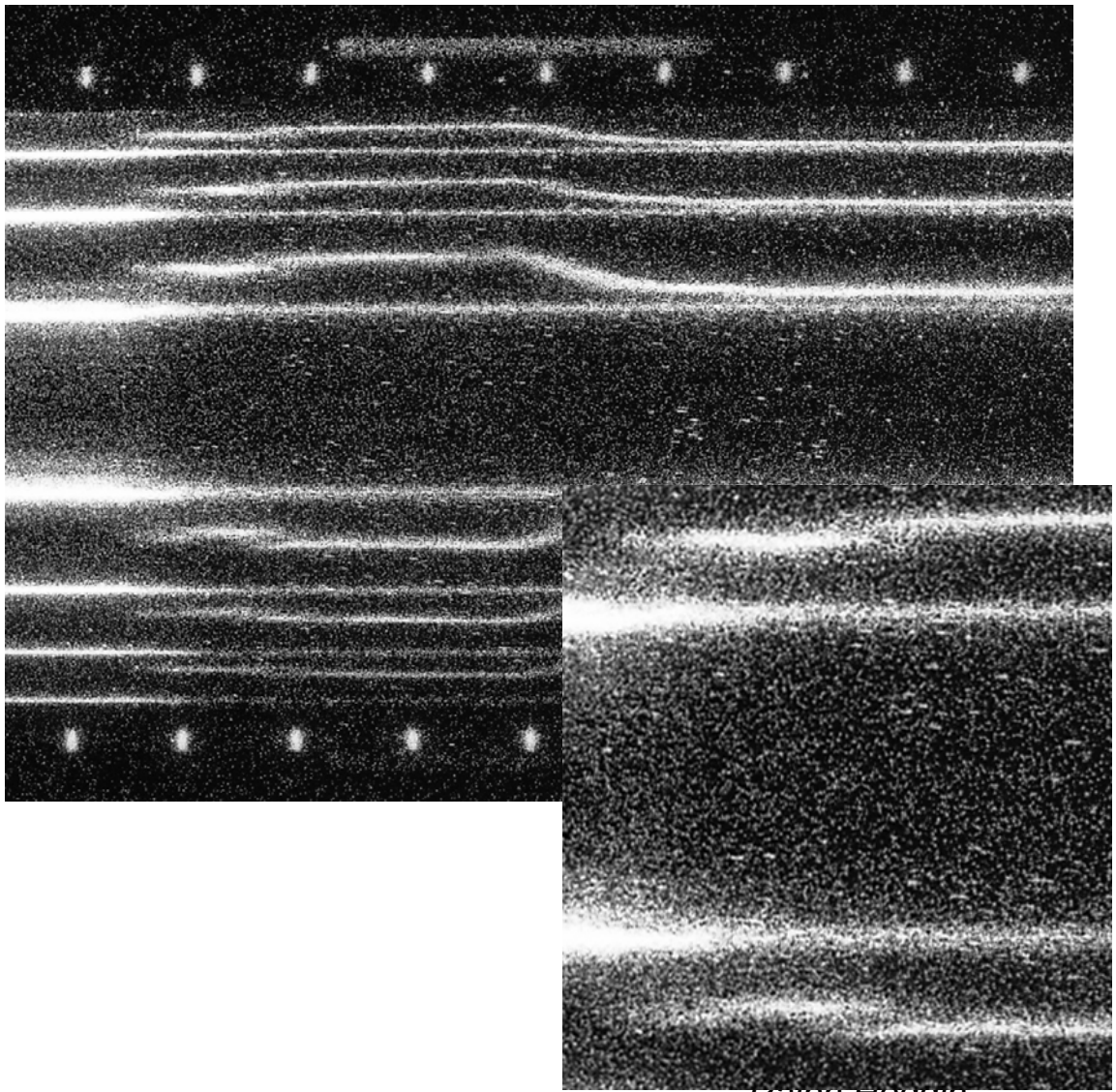
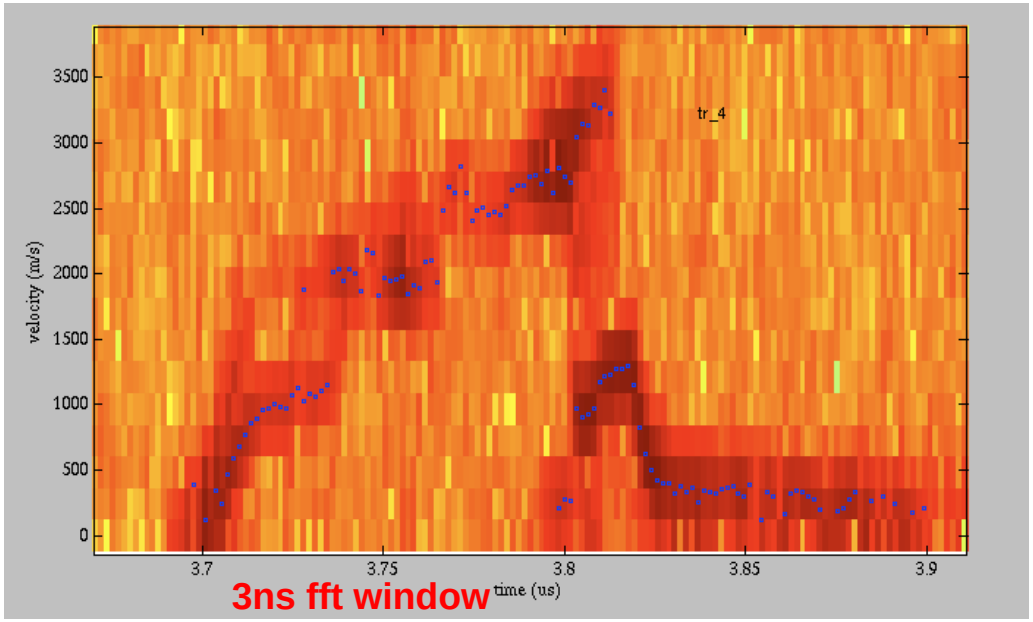
The 60um Parylene-C Flyer Impact Irregularity



- Two pressure pulses were measured with Fast Fabry-Perot System
- Originally we believed that the flyer may have spalled
- After witnessing this effect in other thick flyers we hypothesize that the second step is the result of a strong shock in the thick flyer…

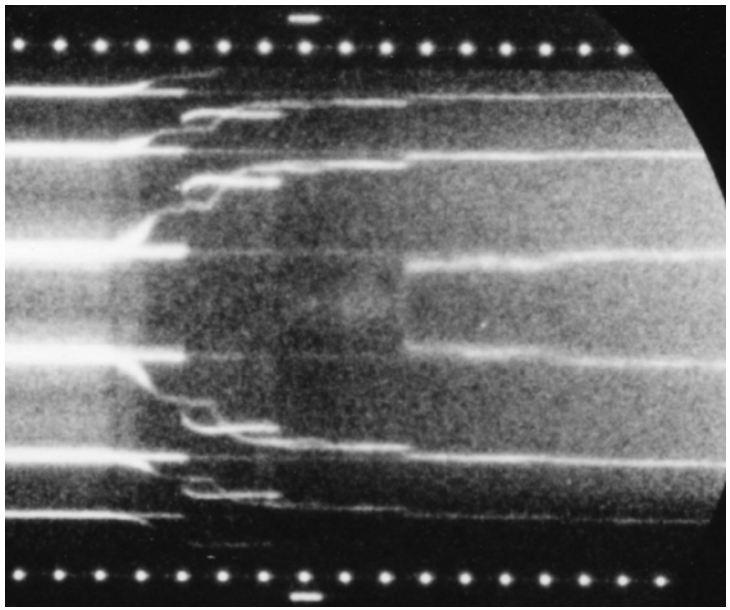
68.8u Parylene Flyer

PDV Spectrograph with 3ns window



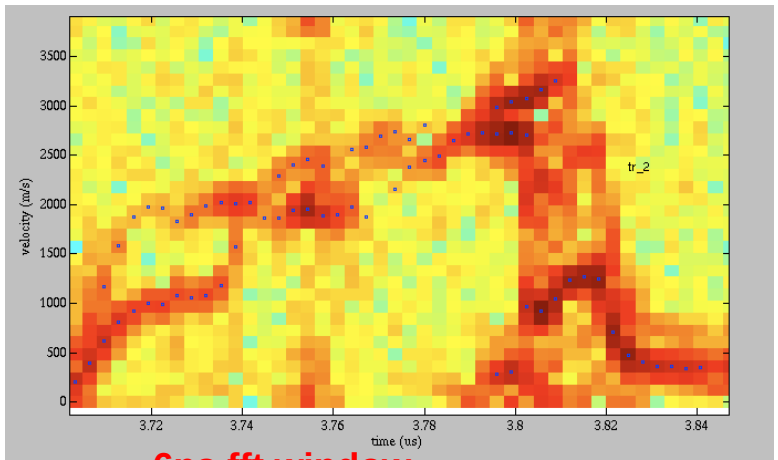
3ns fft window

Raw Fabry-Perot Data



Reanalyzed with a

6ns FFT window



6ns fft window

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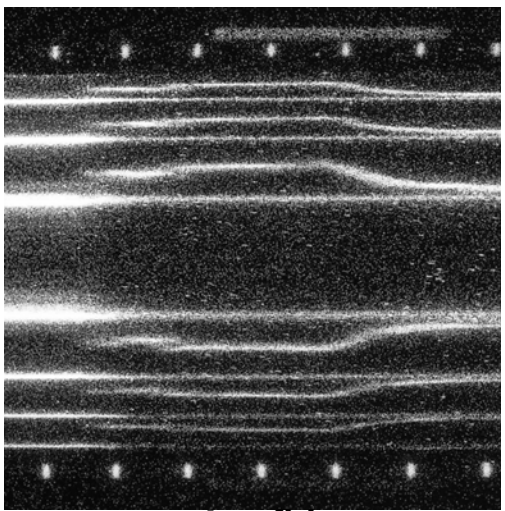
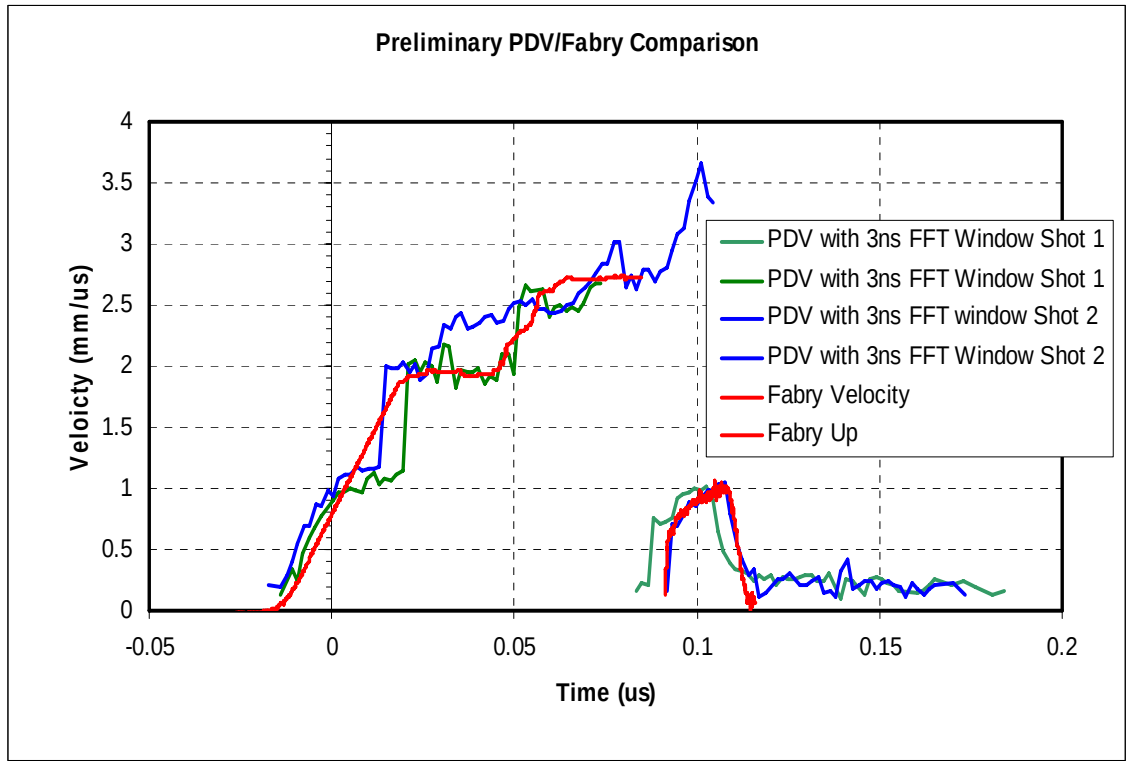
Comparison for 68.6um Parylene-C Flyer

- All PDV shots used a 3.2ns FFT Window
- Should try faster window for pressure pulse
- One of several methods for data analysis



4ns fid



The ‘step’ on the pressure pulse seen on both Fabry-Perot and PDV

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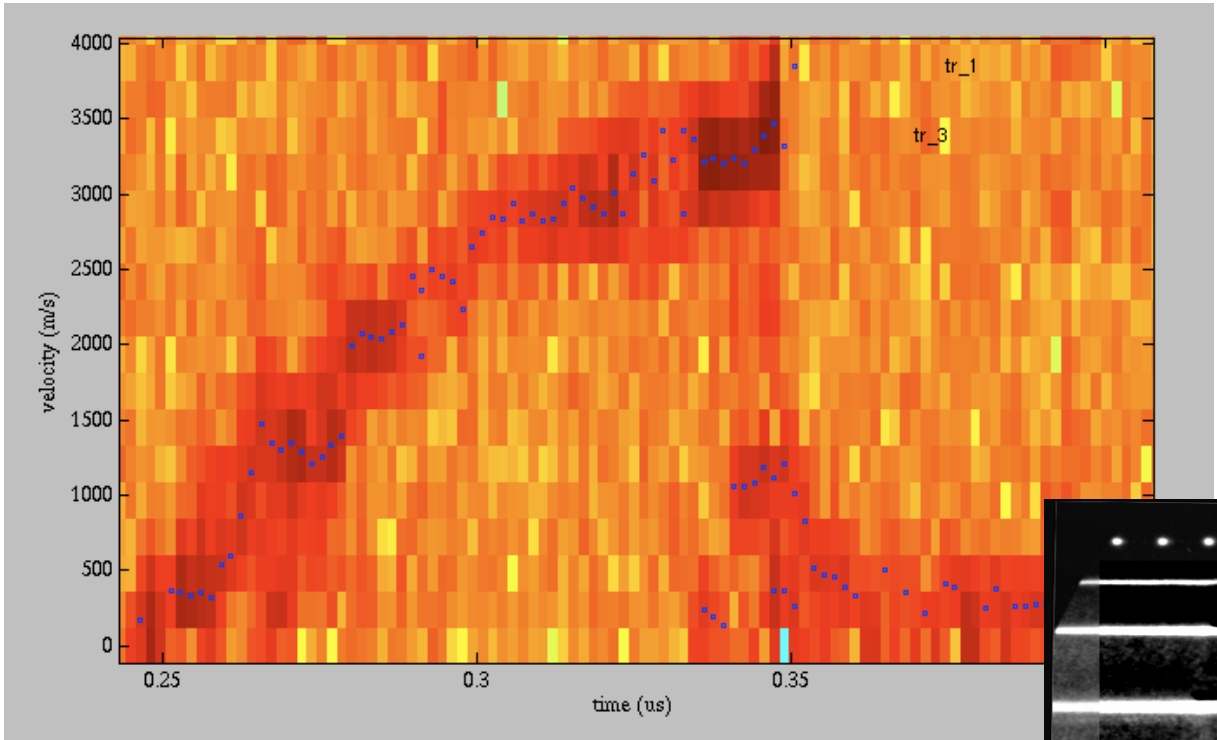
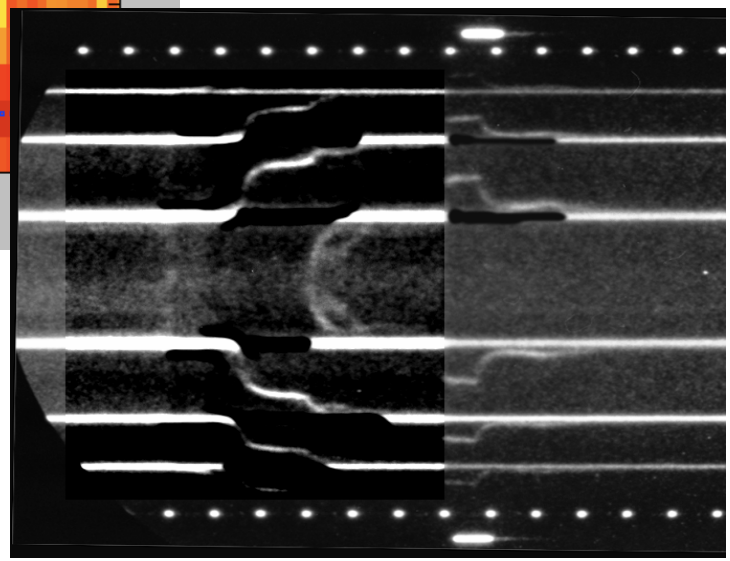
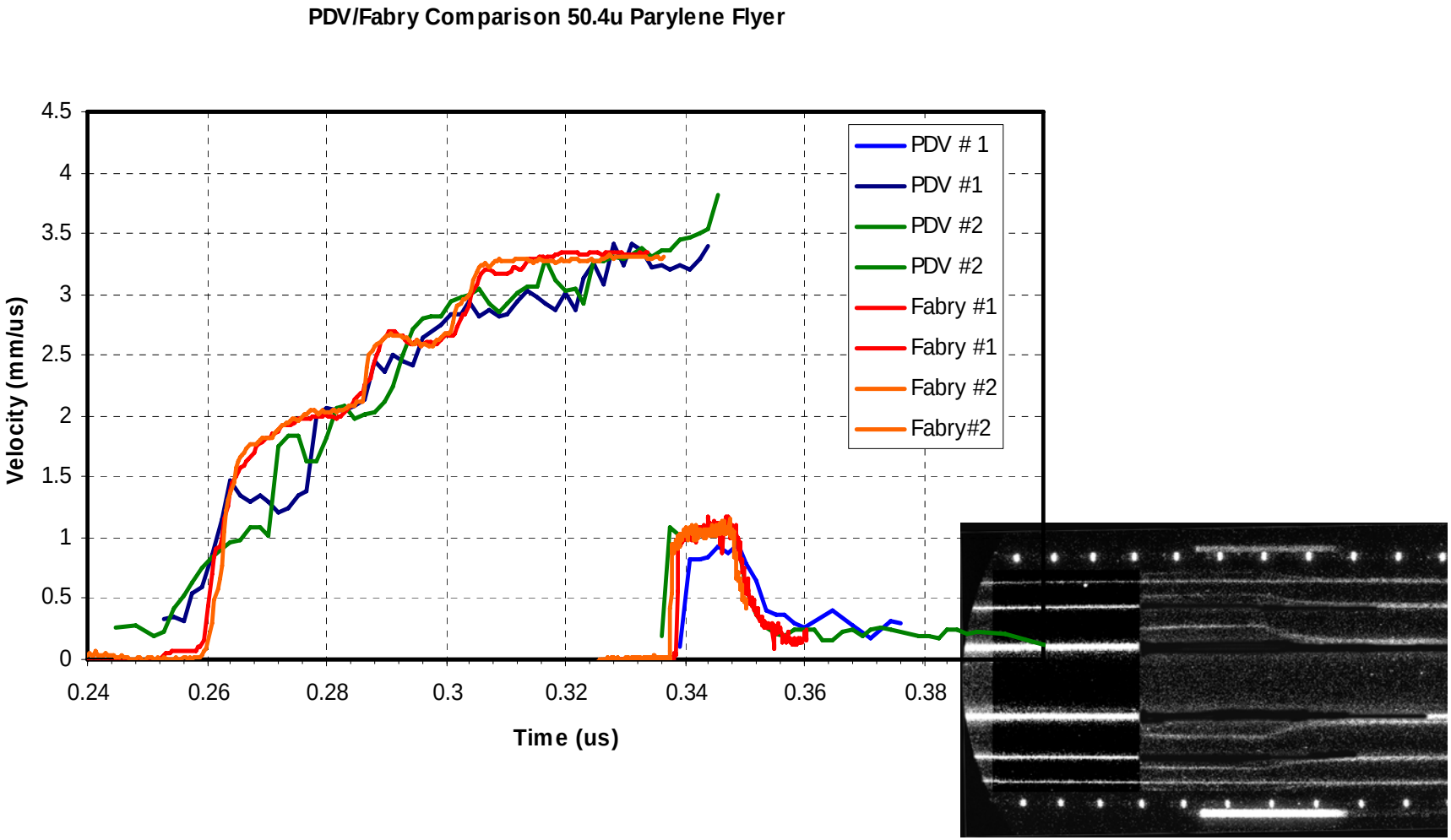
50.4u Paralyne Flyer Spectograph & Fabry-Perot

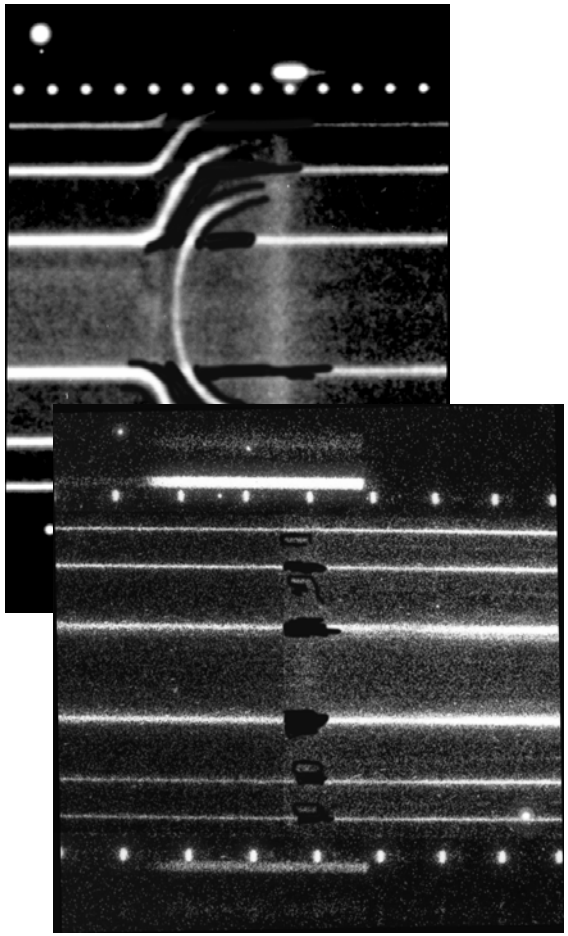


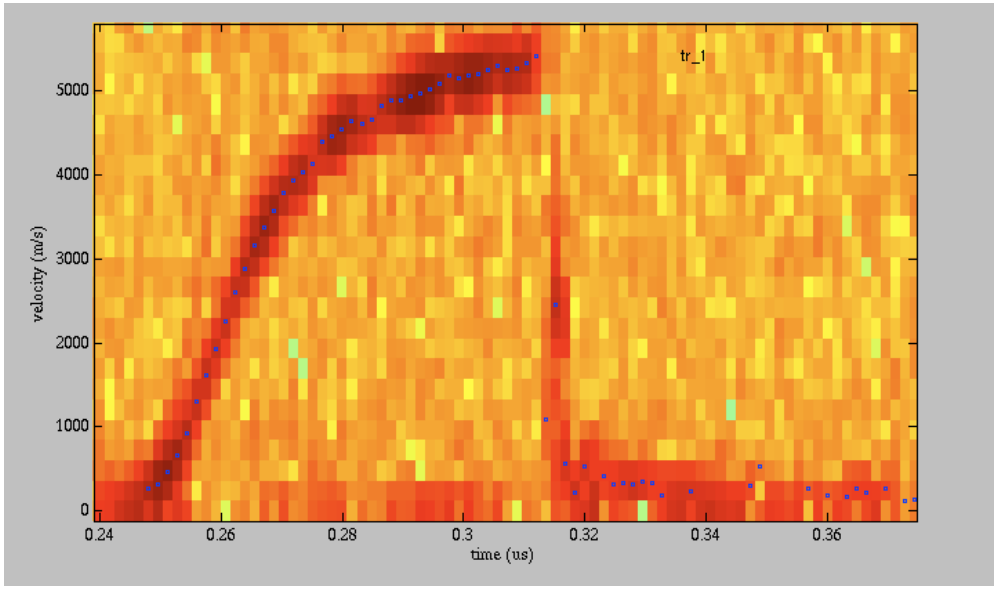


PDV/Fabry-Perot Comparison 50.4um Parylene-C



12.3u Spun Kapton Flyer





Thin flyers produce a very narrow pulse on impact

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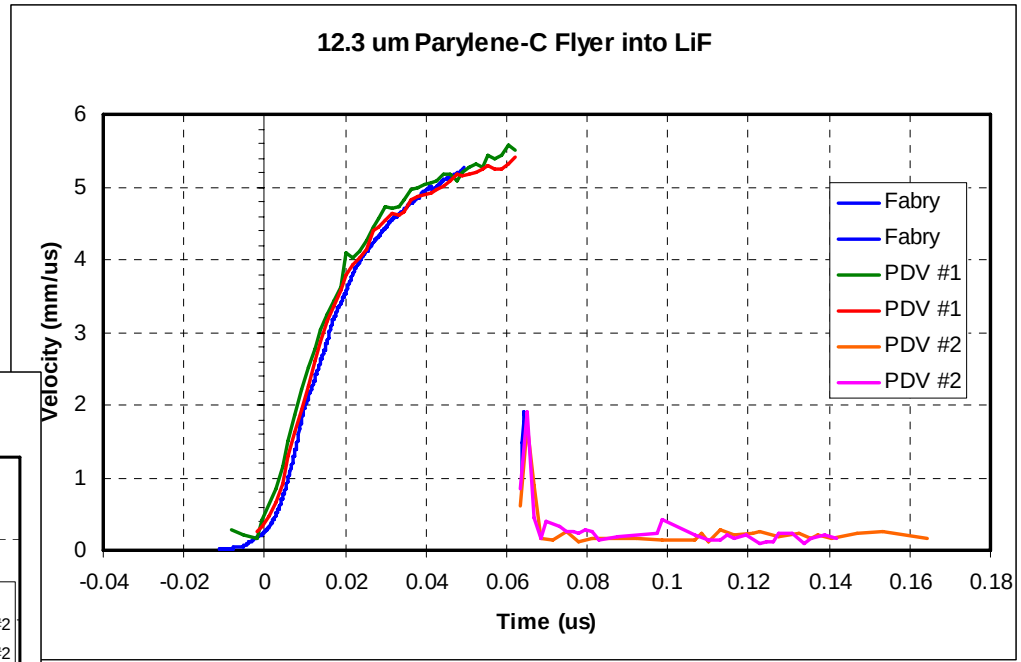
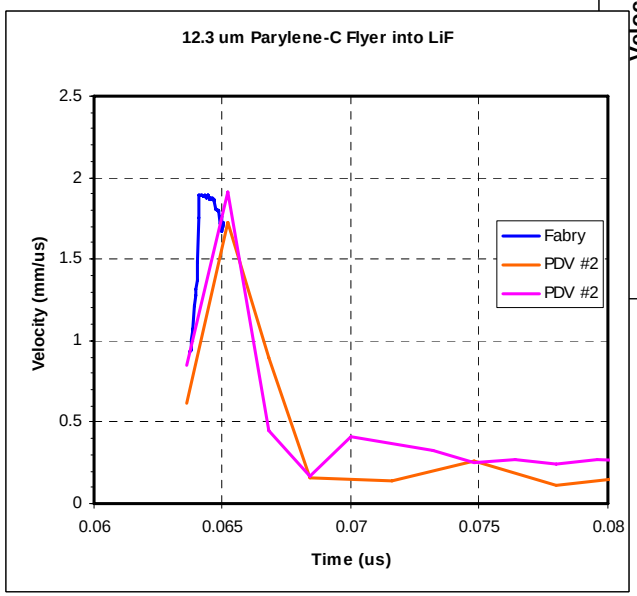
12.3um Flyer Fabry to PDV Comparison Shot

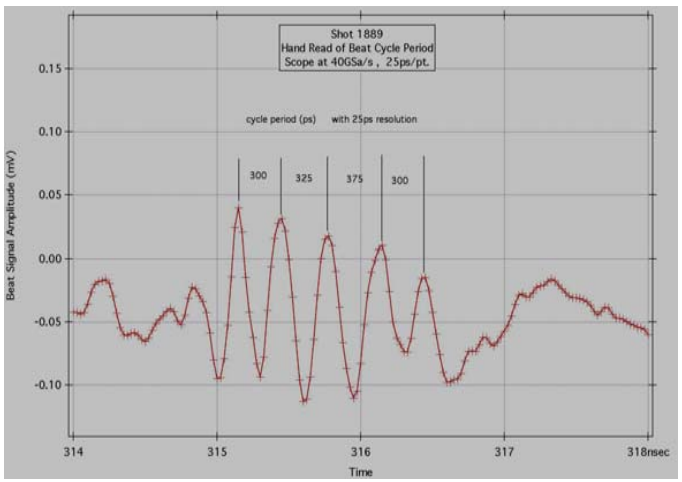
- PDV 3ns window did see the pulse
- Same Velocity profile

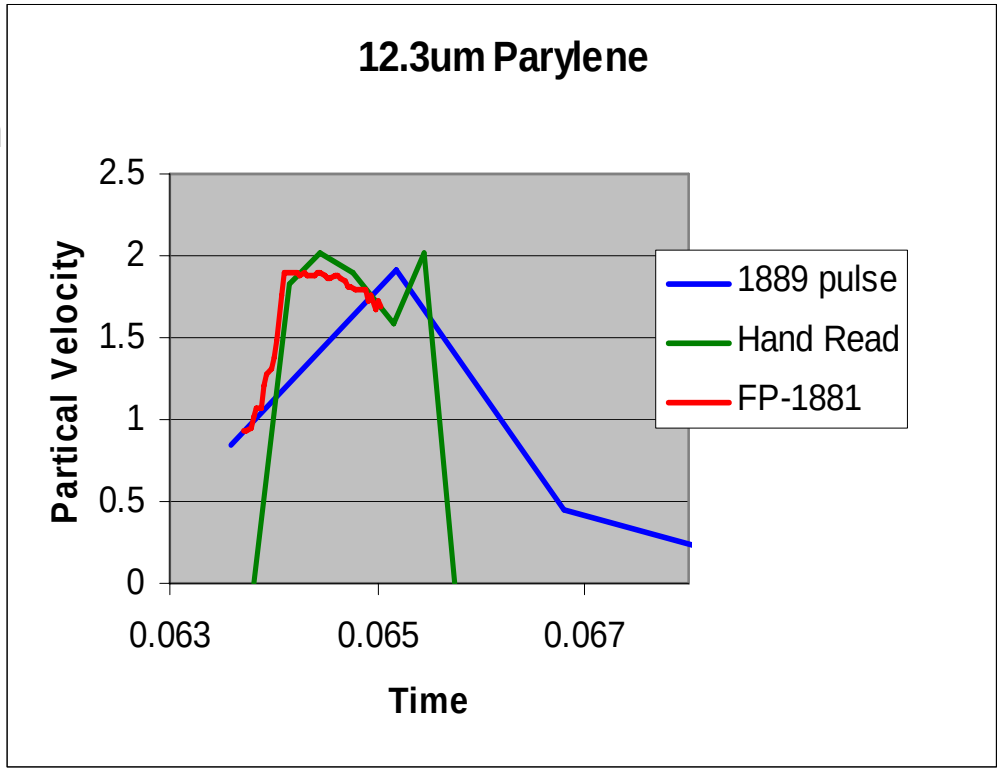




12.3um Flyer Fabry to PDV Comparison Shot

- **PDV – Hand Read of the pulse found 5 data points on this 1.2ns impact pulse**





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Conclusions

- **Fabry-Perot**
  - **Graphic – instantly see the velocity/time data**
  - **Complex returns easily seen**
  - **Speed limited by the fabry cavity (.5ns)**
  - **Expensive, Room size**
- **PDV**
  - **Must be analyzed to see the data**
  - **Complex returns are seen with additional analysis**
  - **Speed limited only by the recording digitizer**
  - **Portable, less expensive**