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# Fabry-Perot / PDV Comparison

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51st Annual Fuze Conference  
Nashville, TN, United States  
May 22, 2007 through May 24, 2007

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## **Fabry Perot / PDV Comparison**

**51<sup>st</sup> Annual FUZE Conference**

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**May 24, 2007**

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**Ralph Hodgkin, Chadd May, Roy Hanks, Don Hansen,**

**Tony Whitworth**

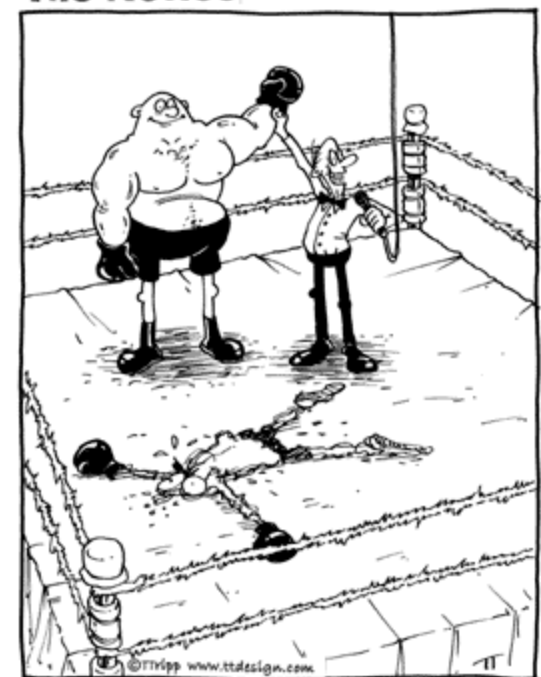
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# Compare Fabry-Perot to PDV

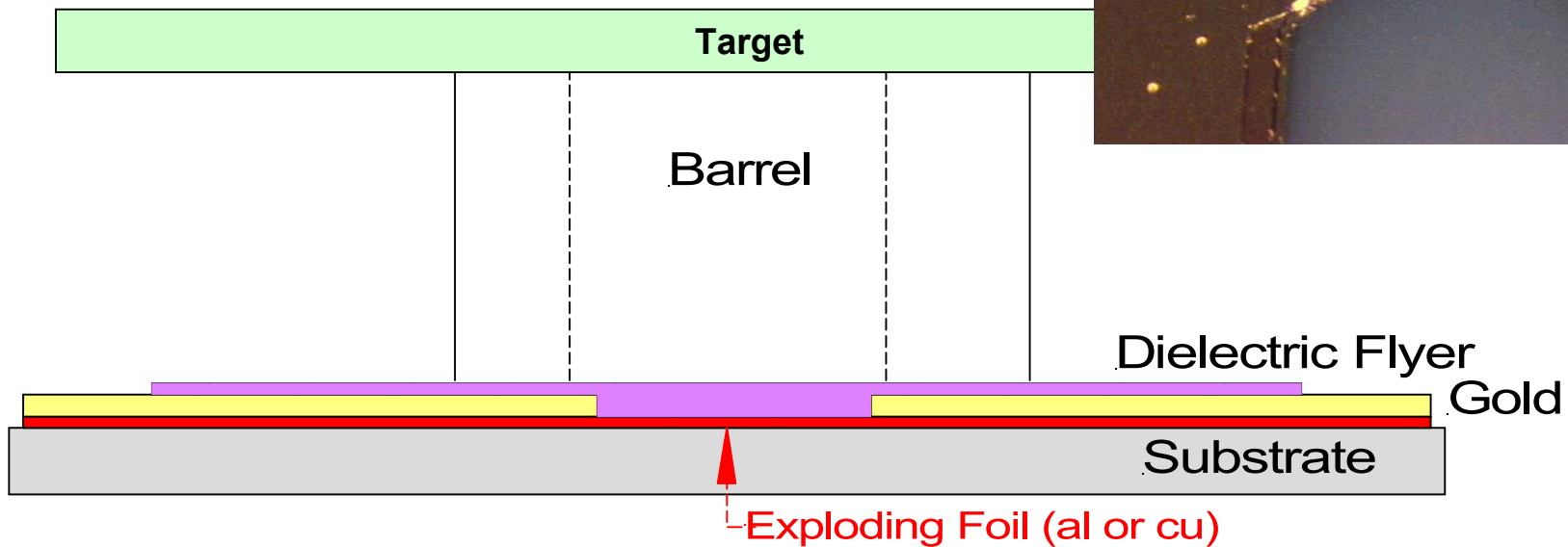
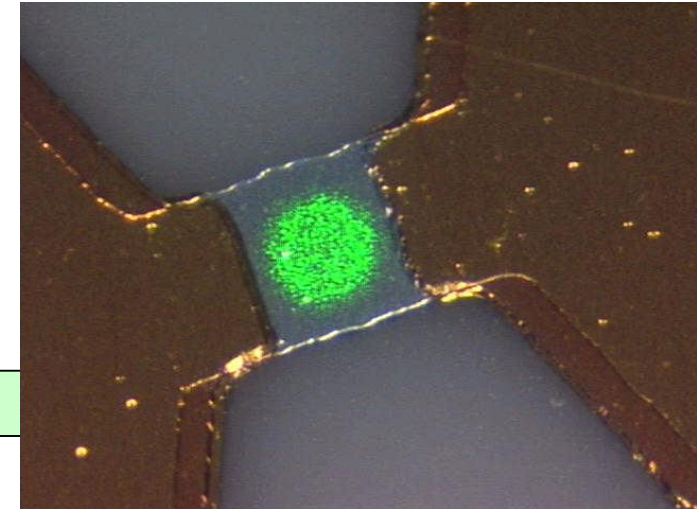
- **Objective: will PDV measure the fast pulses seen with exploding bridge flyers**
- **Each test fired under same conditions**
  - Change probes for Fabry-Perot & PDV
  - 1-2 shots for each setup
- **Parylene & Spun Kapton**
- **All Shots into LiF under vacuum**
- **0.3 uF Fireset**
- **Six shots with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





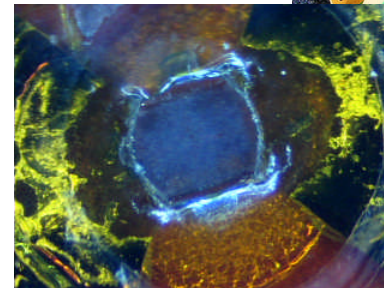
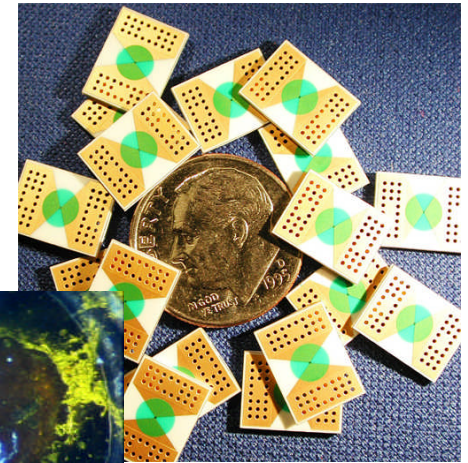
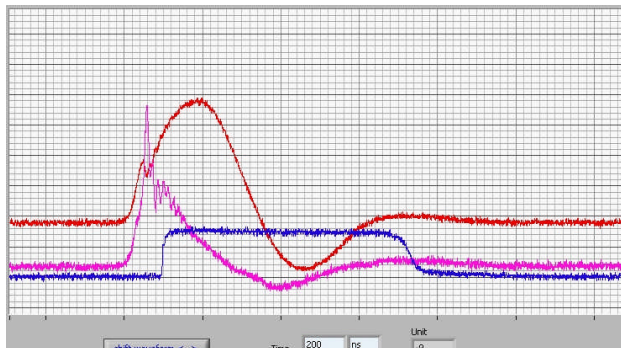
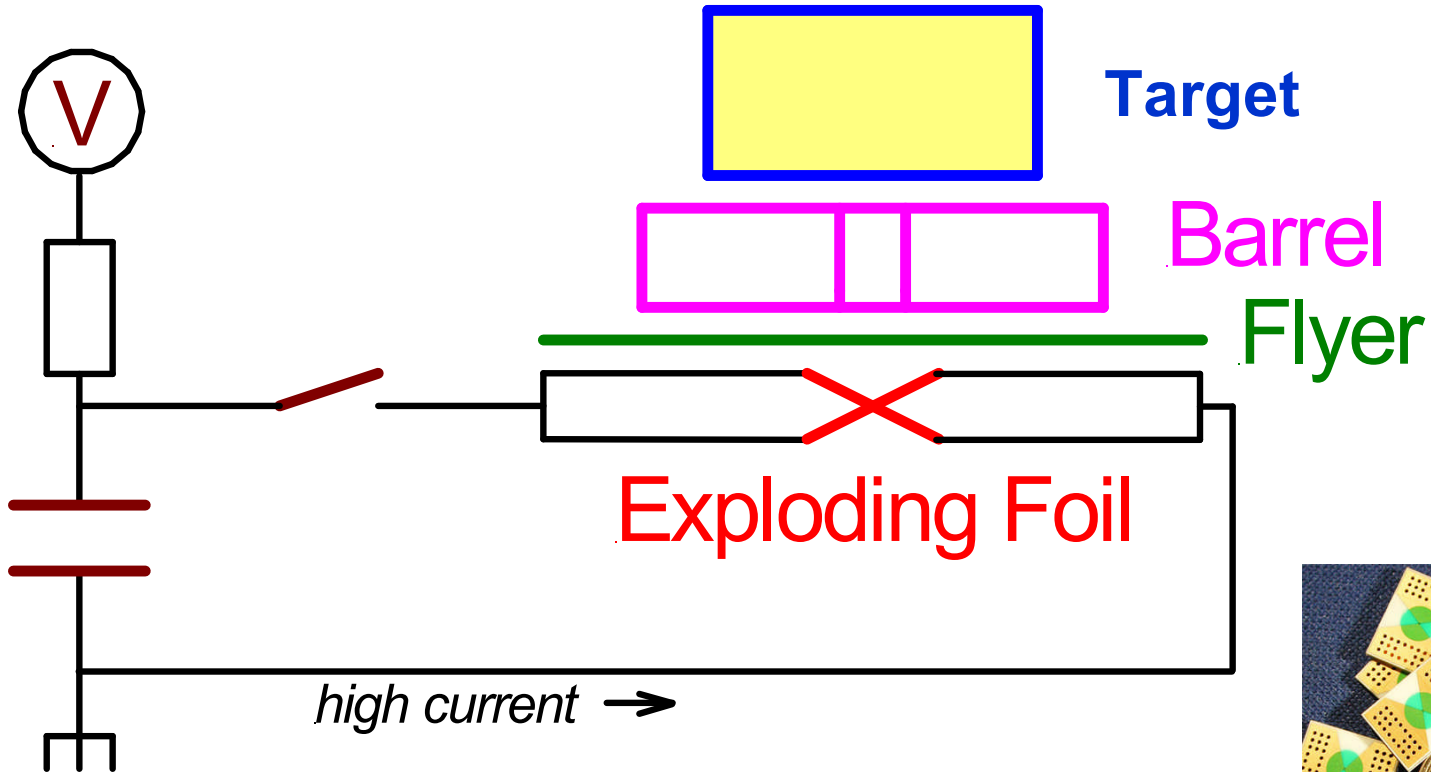
# What is a Slapper

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



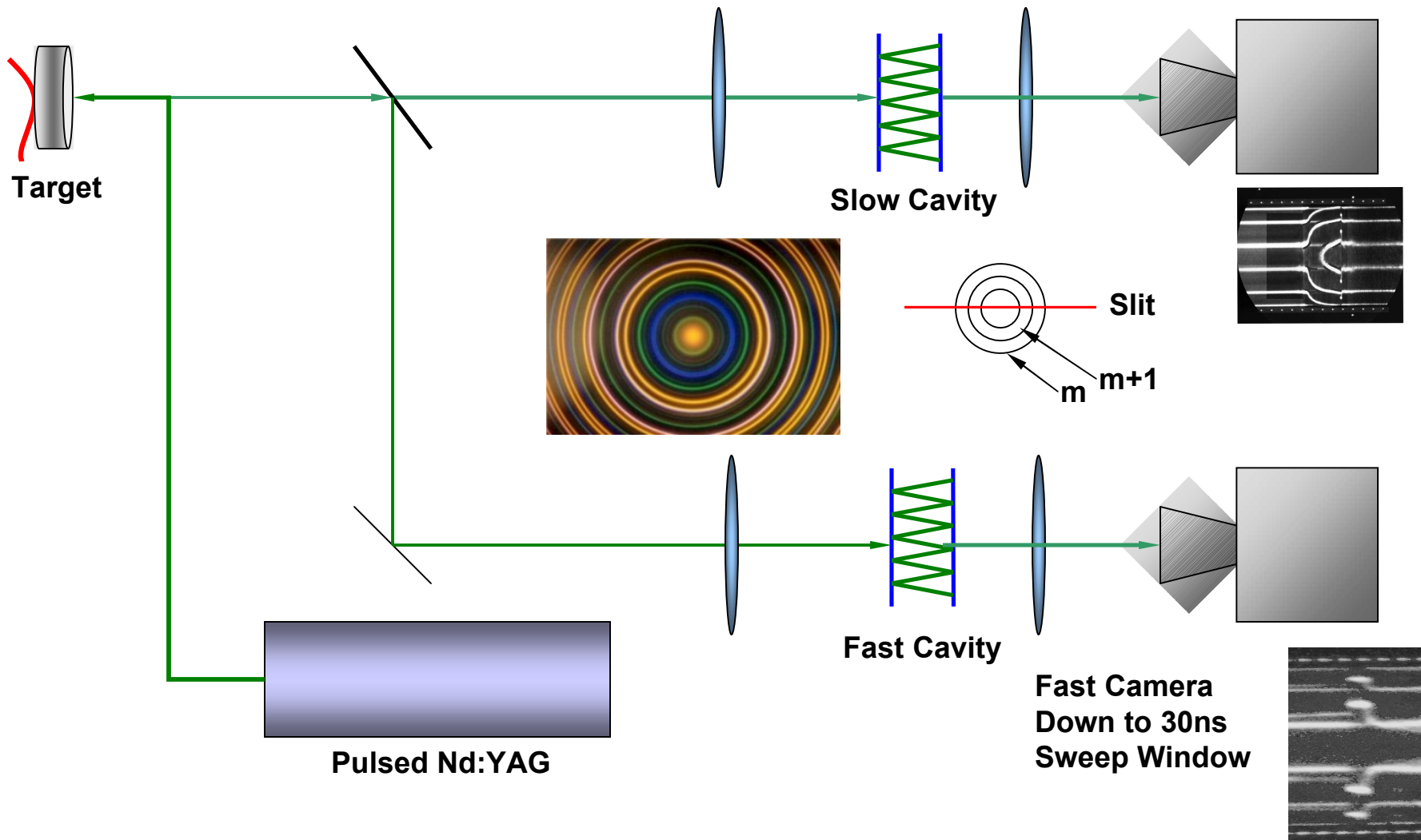


# How do you fire a Slapper?



Ralph Hodgins

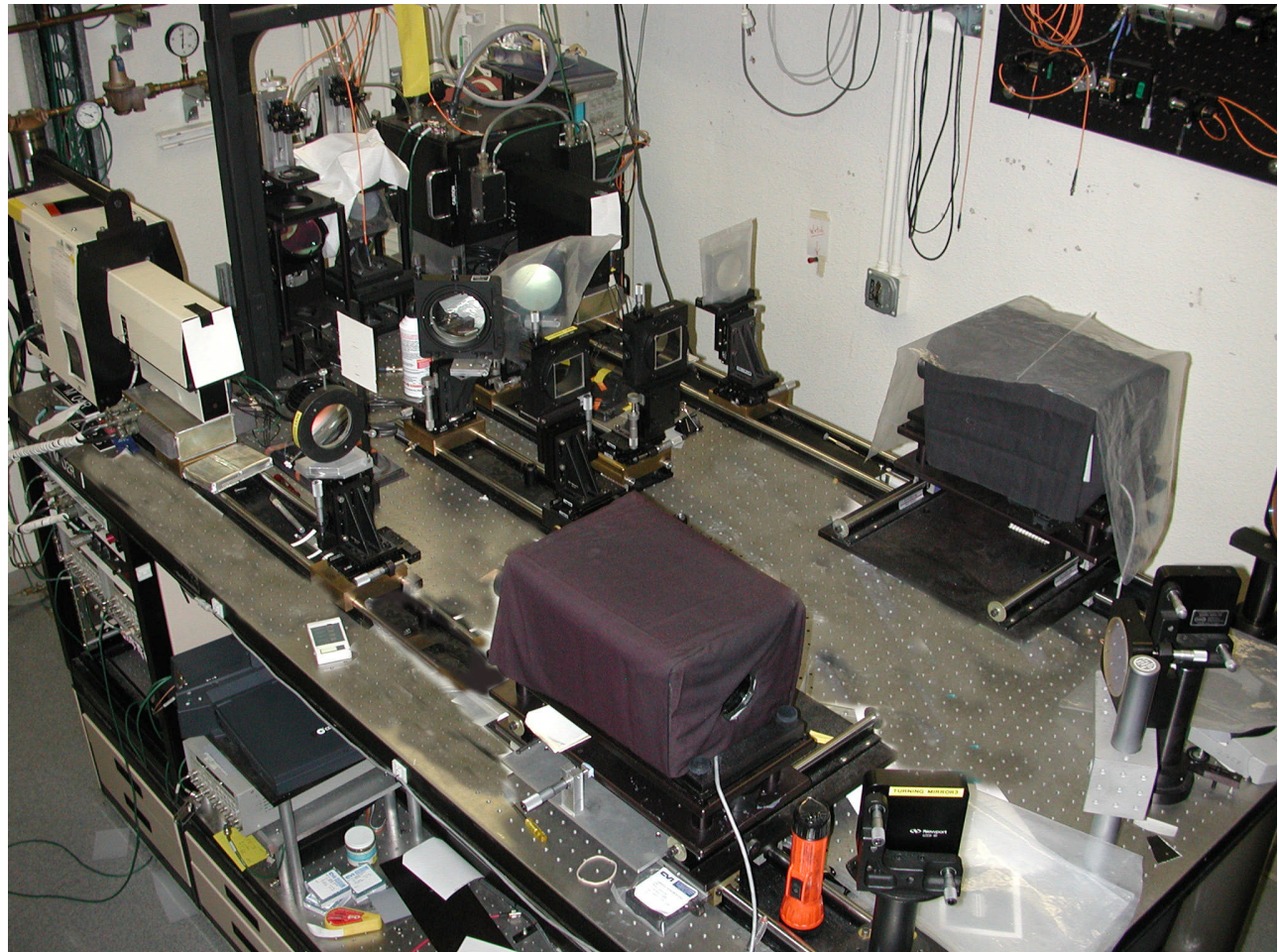
# General Layout of Two-Beam Fabry-Perot System for Diagnostic Measurements on Slapper Initiators



# Fabry-Perot in HEAF



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





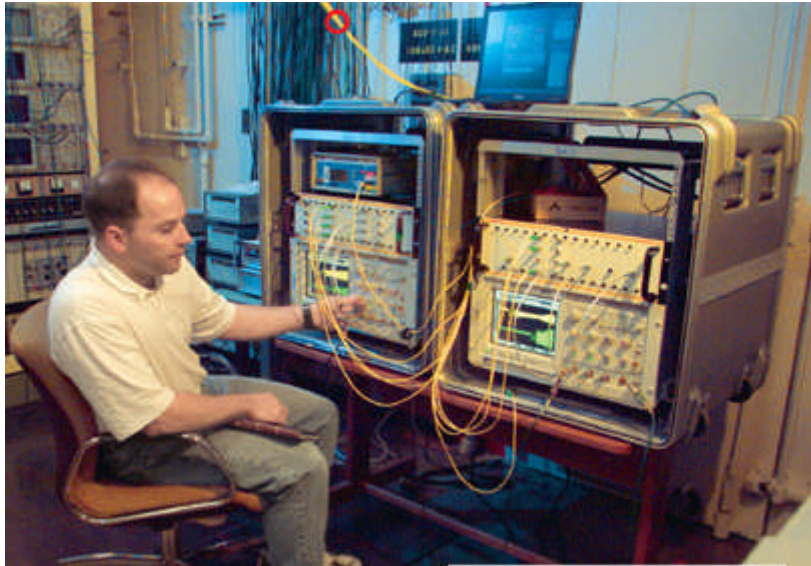


## Photonic Doppler Velocimeter (PDV)

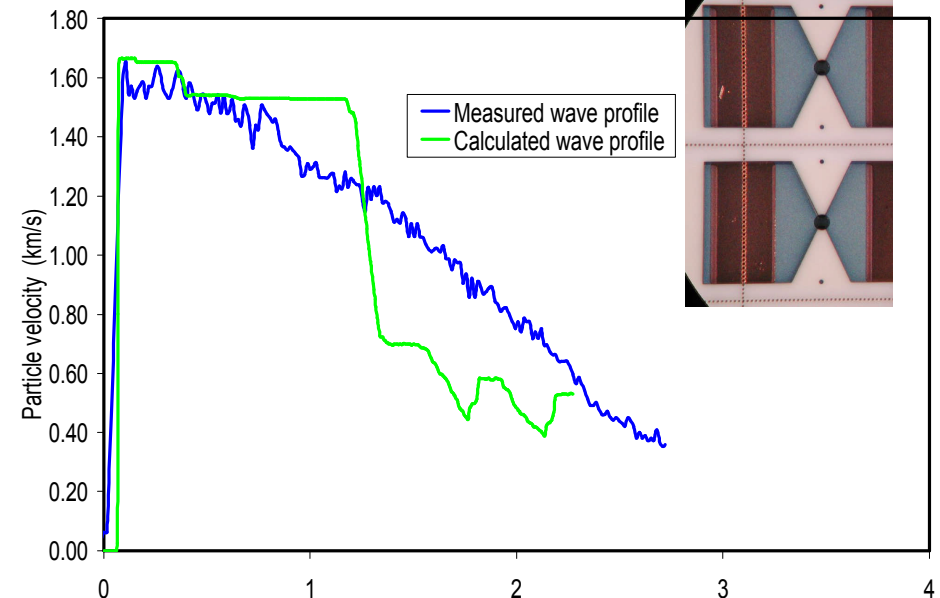


- Portable system – rack mount
- Doppler Velocimetry
- Greater than 5 mm/ $\mu$ sec velocity
- Limited by bandwidth only

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



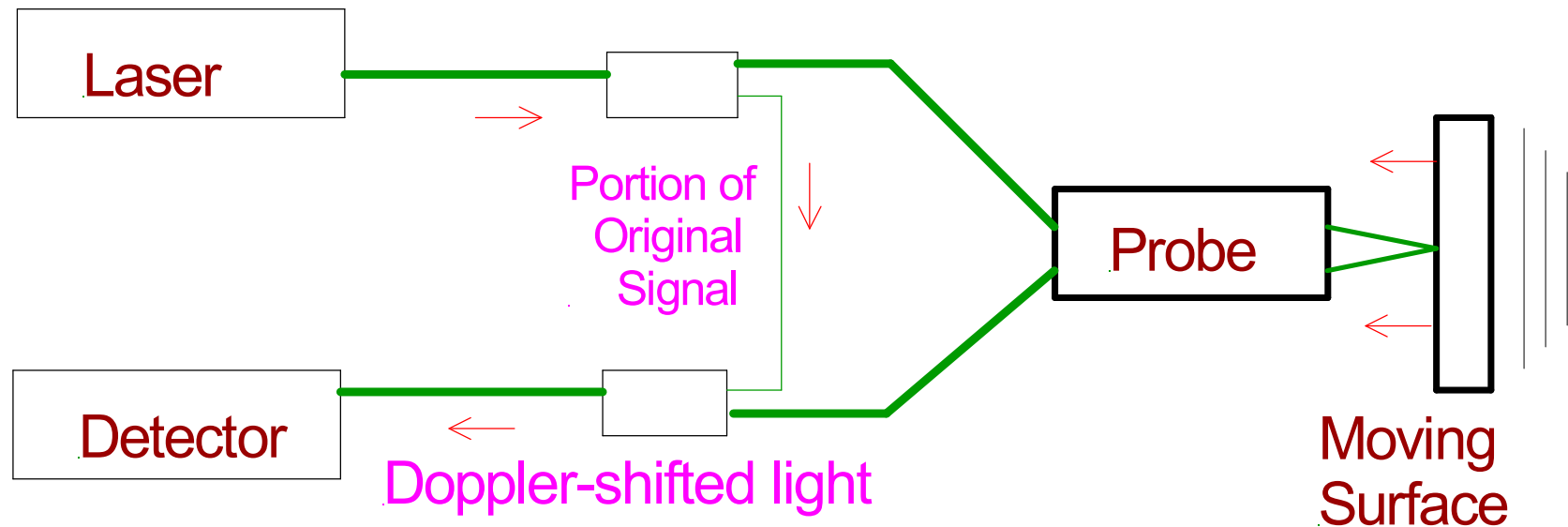
Experimental and calculated velocity wave profiles into LiF for a 50 $\mu$ m flight distance.



- Portable system – rack mount
- Doppler Velocimetry
- Greater than 5 mm/ $\mu$ sec velocity
- Limited by bandwidth only



# 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.

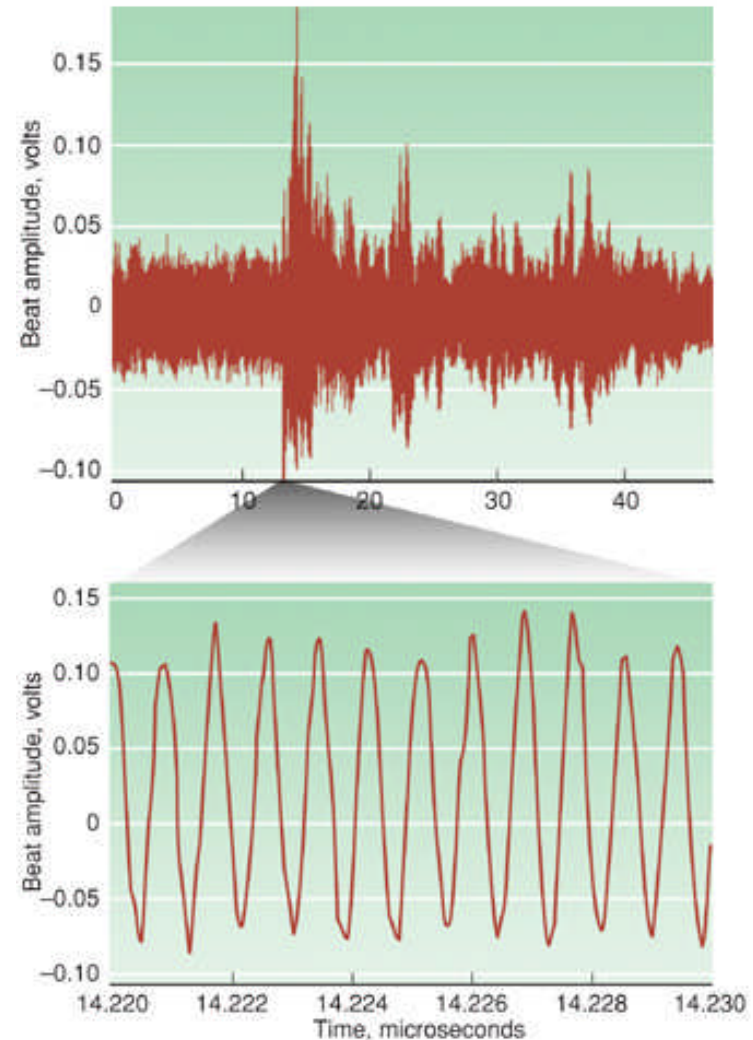


## PDV

- The 'beat' frequency is converted to amplitude

- Expanded view

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

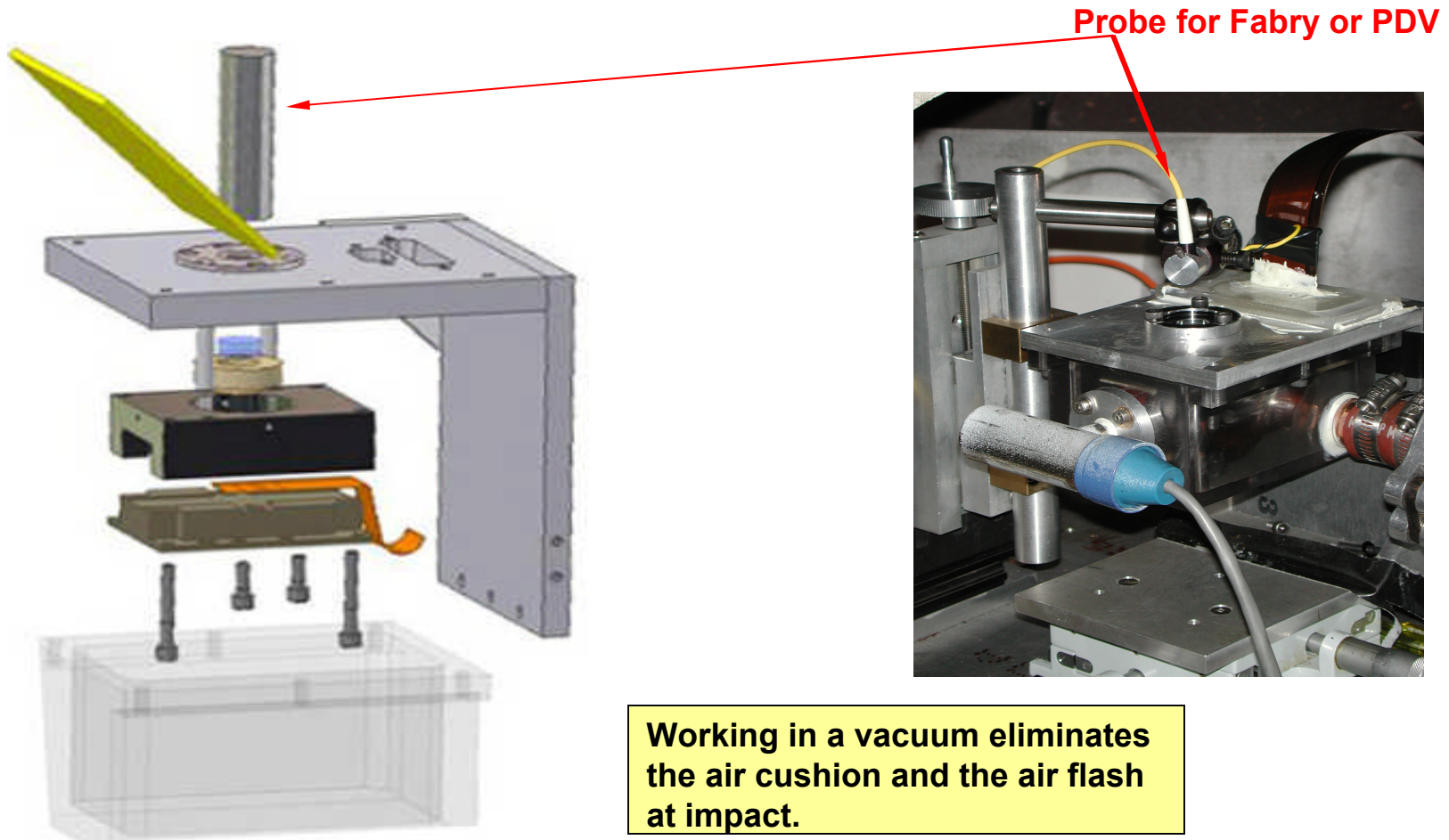


*Ted Strand*

*Ralph Hodgkin*

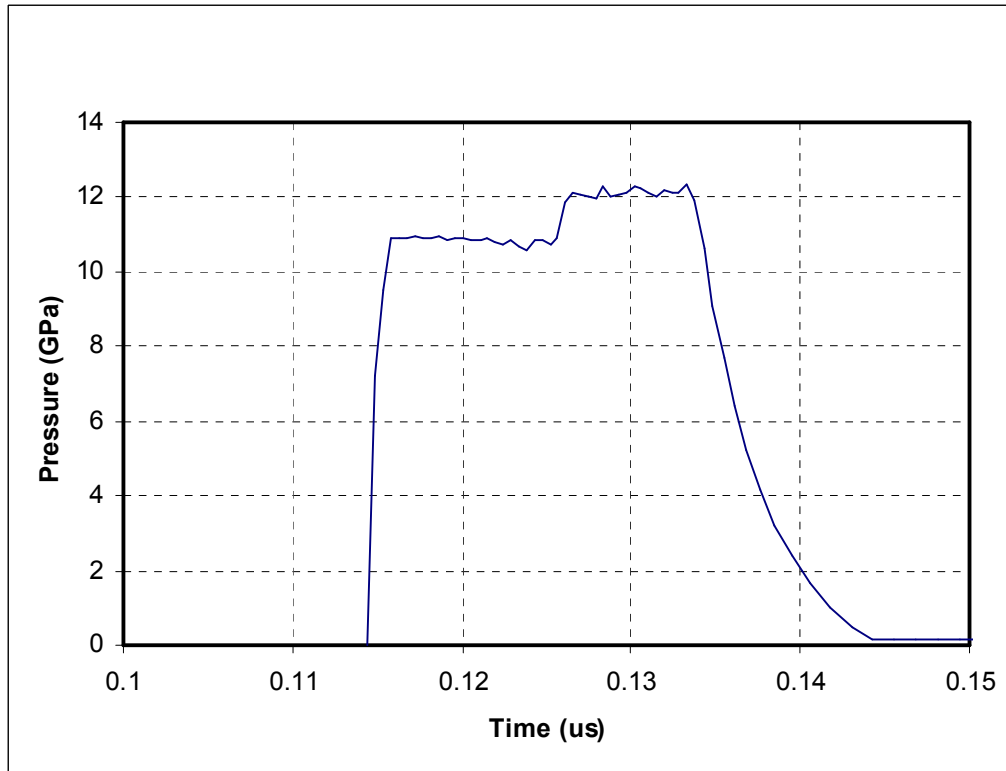


## Fabry-Perot Measurements Conducted in Vacuum Provide Information on Slapper's Pulse Duration and Equation of State



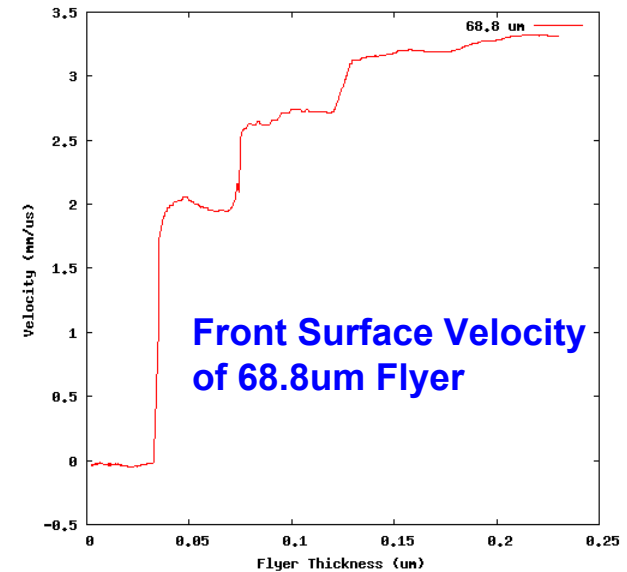
### Fabry-Perot and PDV Setup

# Kowin 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  $U_p$  in LiF as shown here

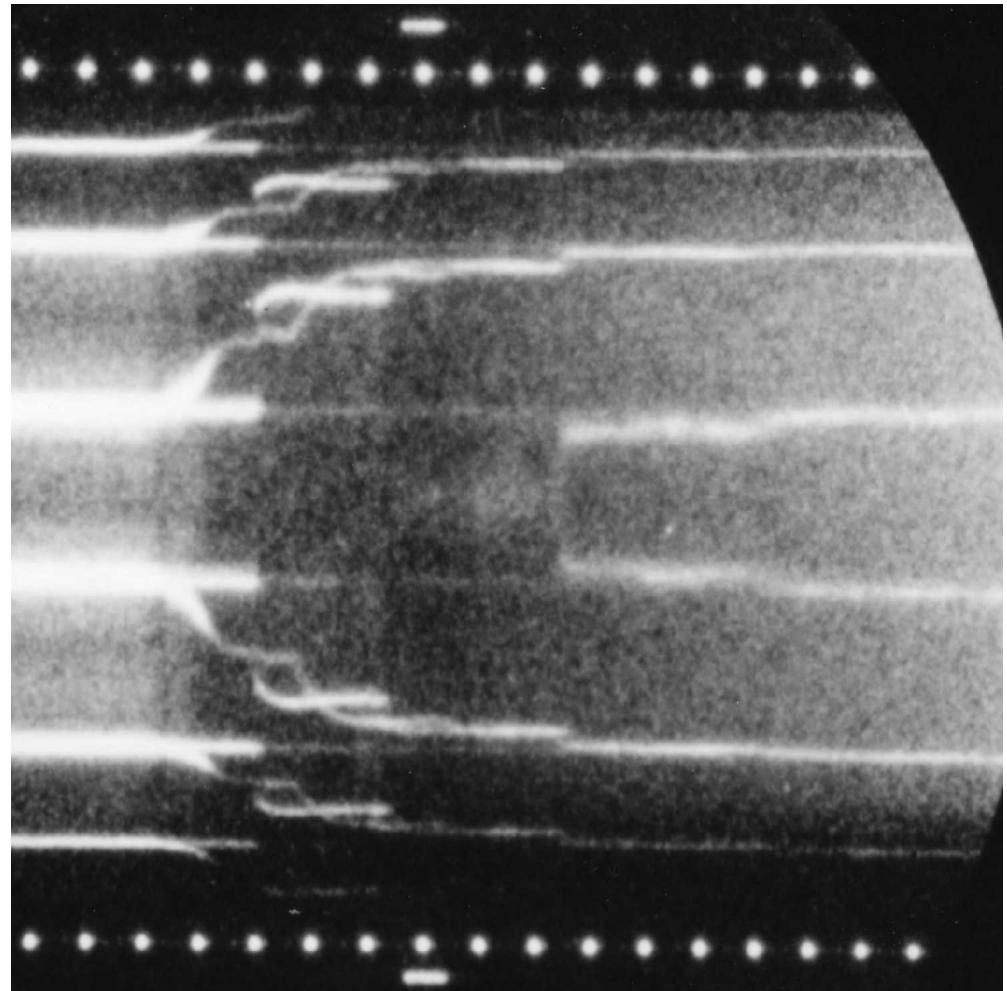


Front Surface Velocity of 68.8um Flyer



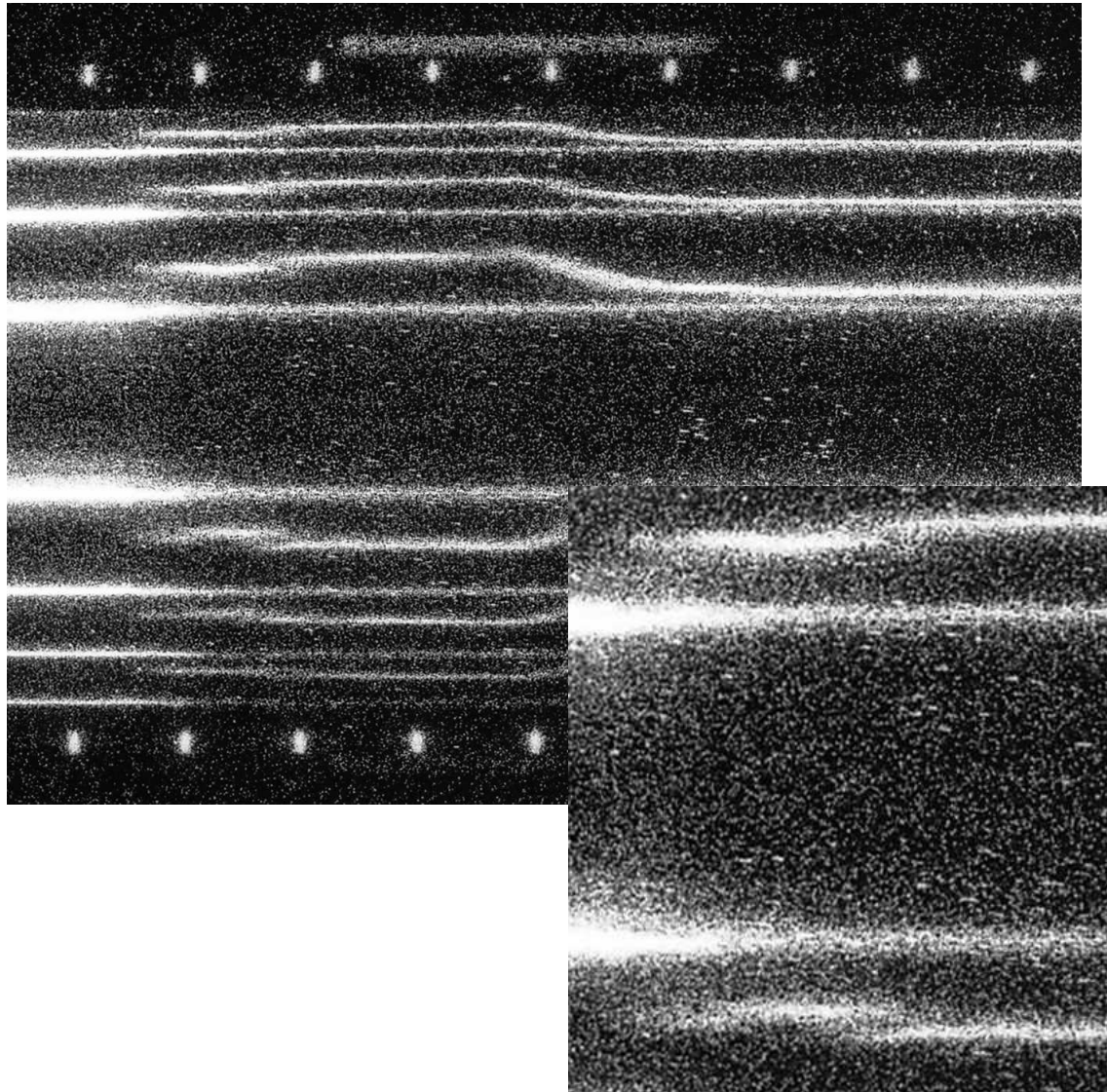
## 68.6um Parylene - Fabry

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





## 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...

*Ralph Hough*

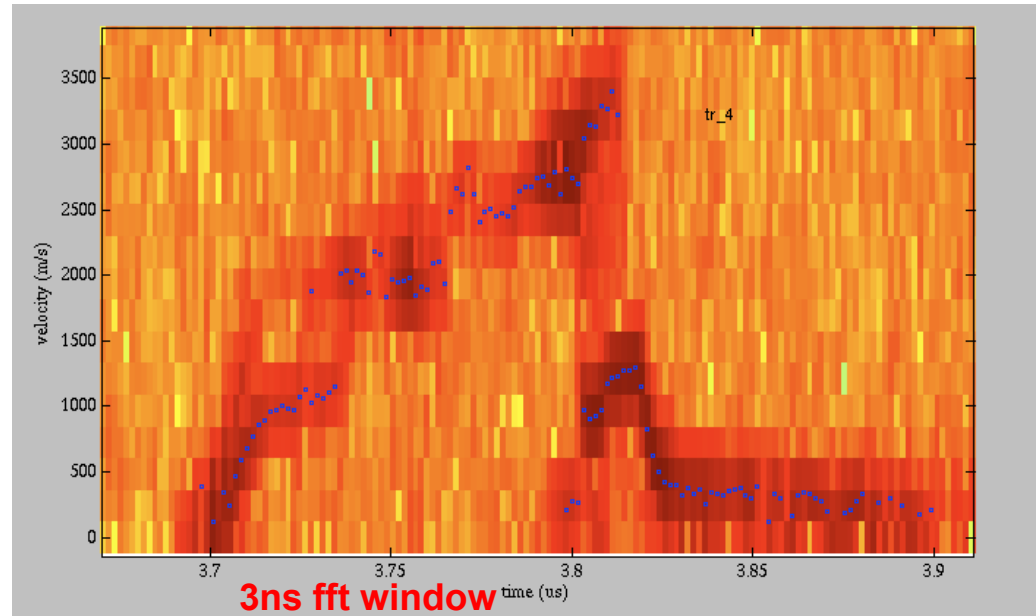
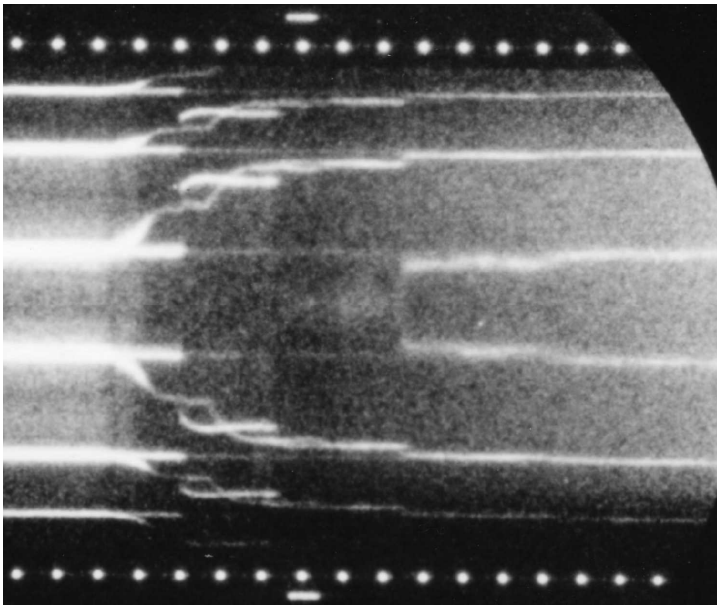




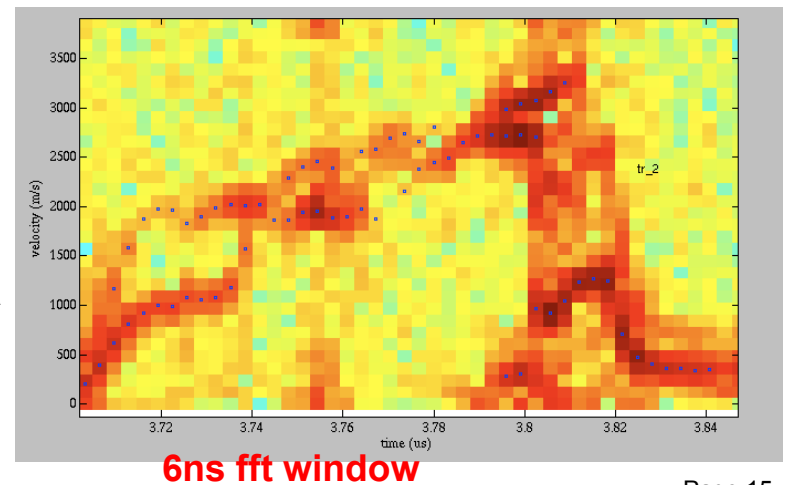
# 68.8u Parylene Flyer

## PDV Spectrograph with 3ns window

### Raw Fabry-Perot Data



### Reanalyzed with a 6ns FFT window

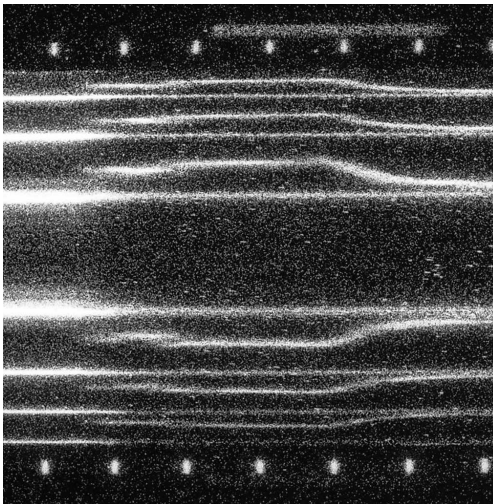


Ralph Hodgkin

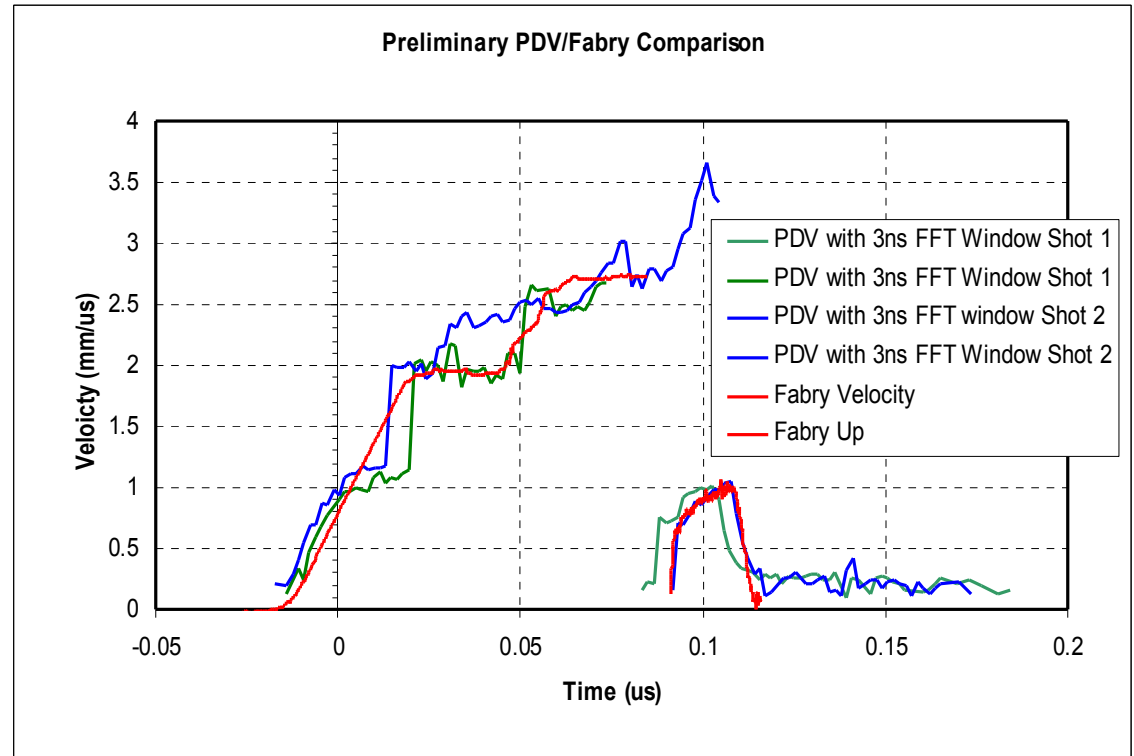


## Comparison for 68.6um Parylene-C Flyer

- 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

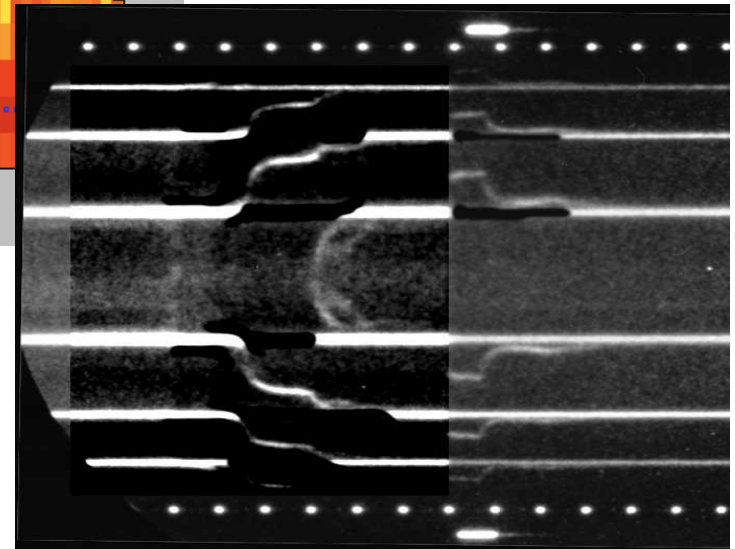
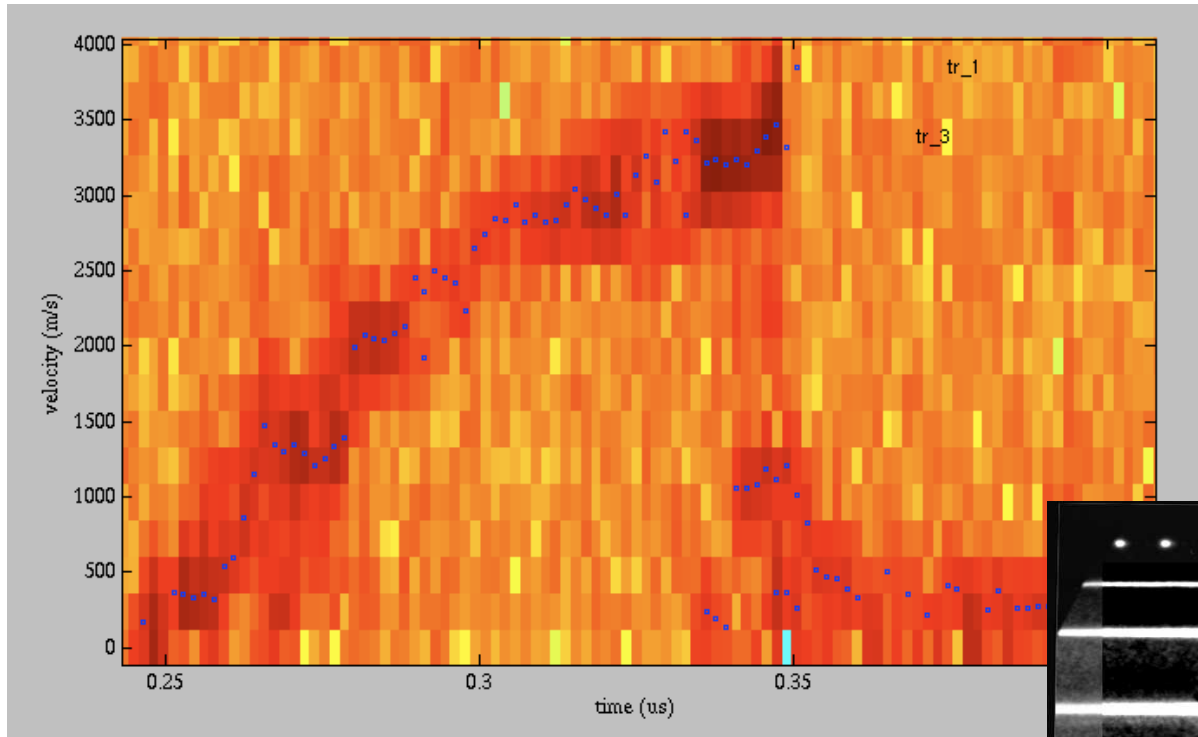


The 'step' on the pressure pulse seen on both Fabry-Perot and PDV

Ralph Hodgkin

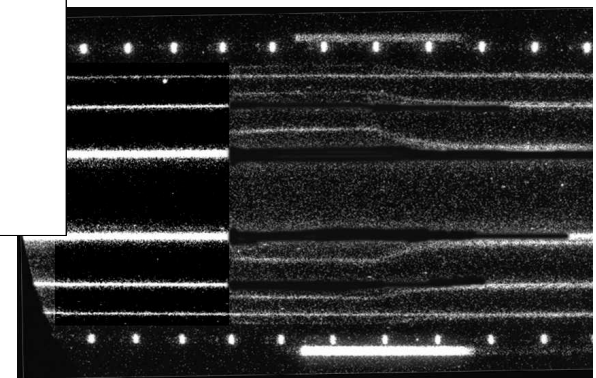
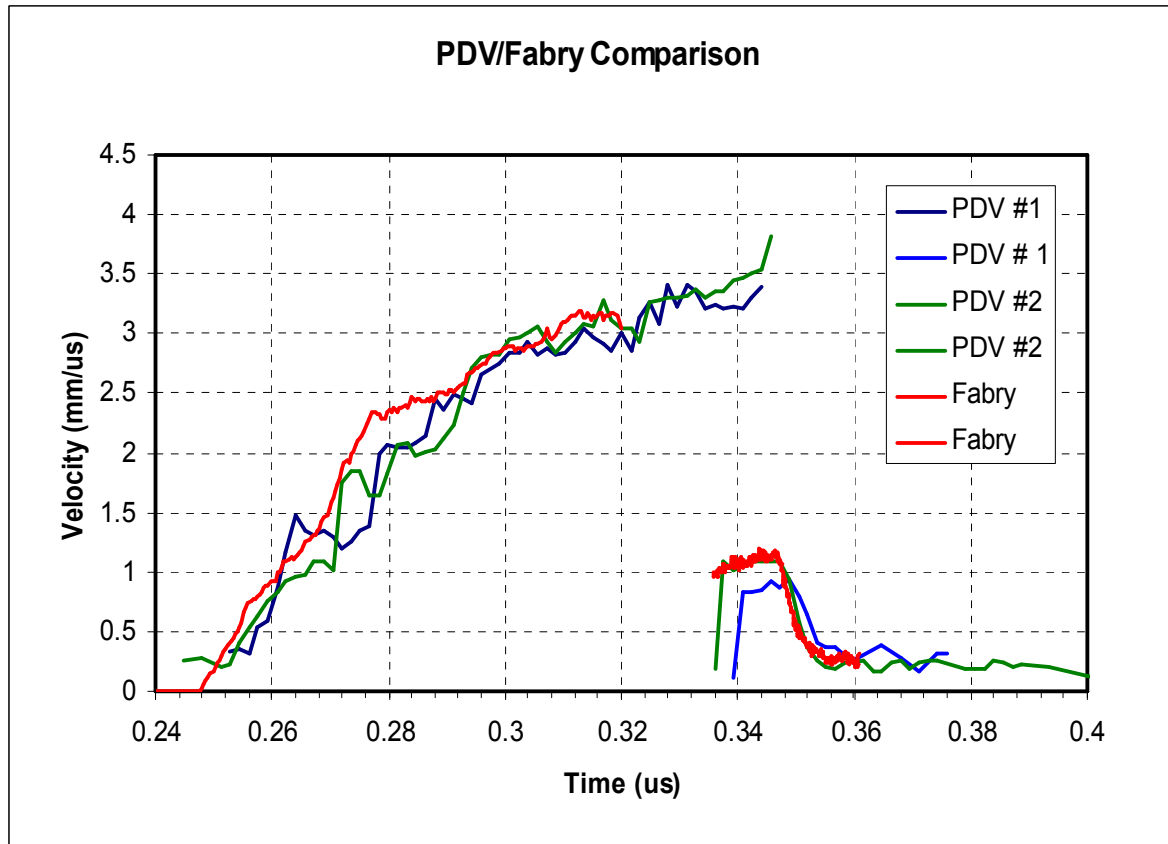


## 50.4u Paralyne Flyer Spectrograph & Fabry-Perot



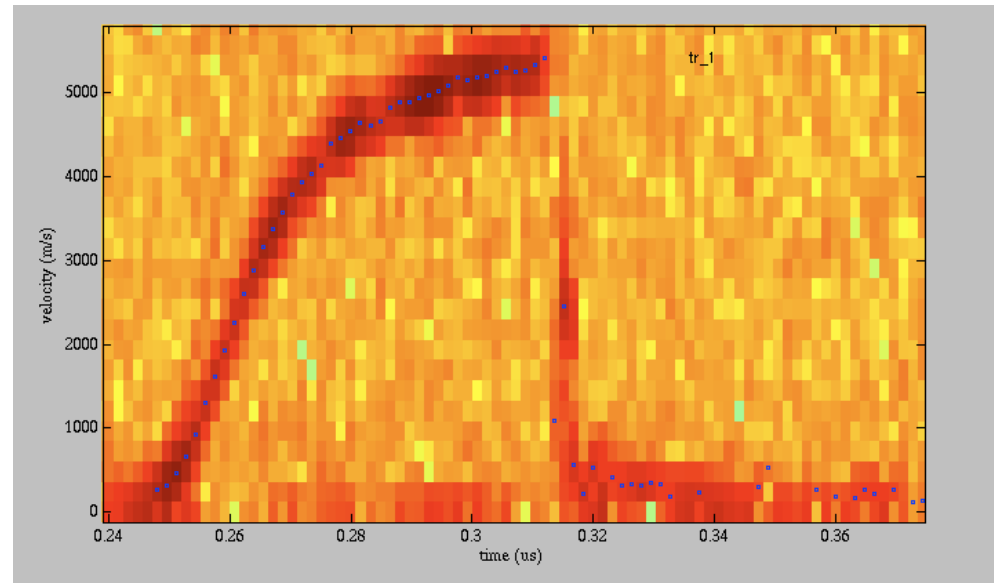
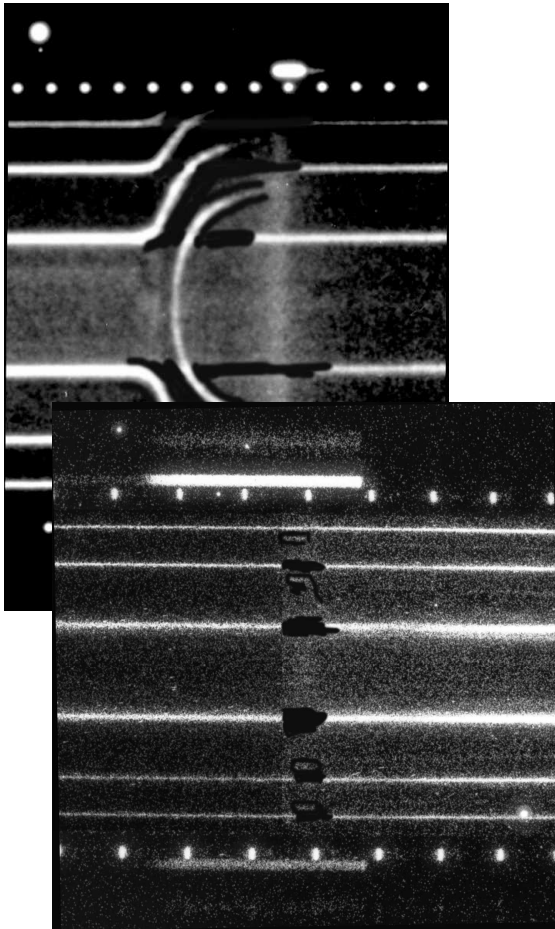


# PDV/Fabry-Perot Comparison 50.4um Parylene-C





## 12.3u Spun Kapton Flyer

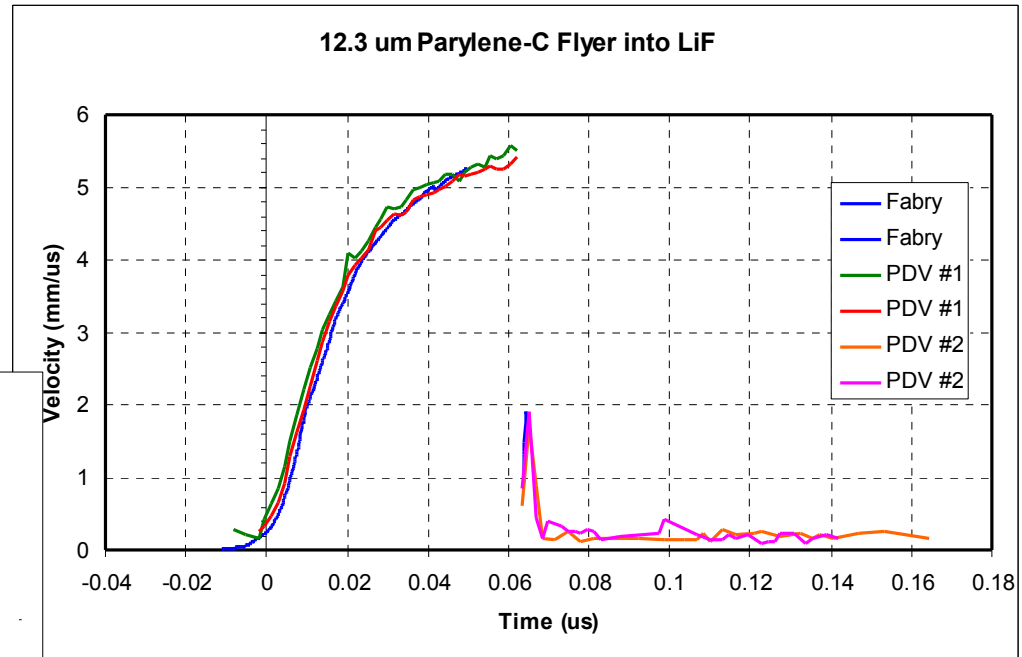


Thin flyers produce a very narrow pulse on impact



## 12.3um Flyer Fabry to PDV Comparison Shot

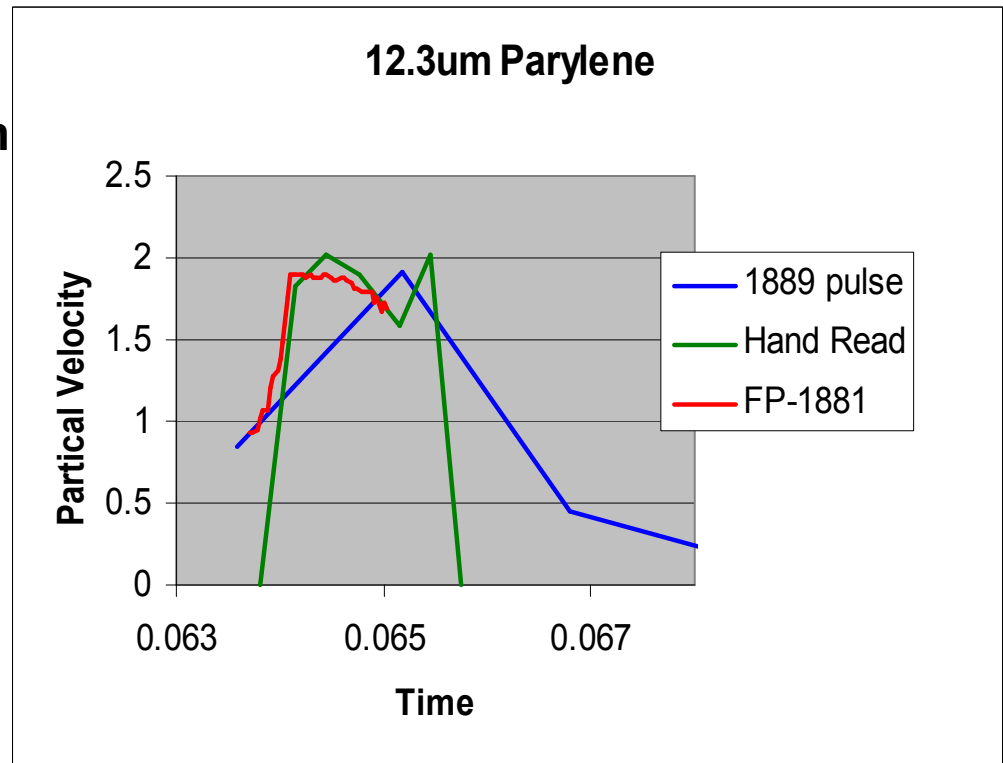
- PDV 3ns window did see the pulse
- Same Velocity profile





## 12.3um Flyer Fabry to PDV Comparison Shot

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





## Conclusions

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### - 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

