Fabry-Perot / PDV Comparison

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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

![Diagram of Slapper components]

Ralph Hodgin
How do you fire a Slapper?

[Diagram with labeled parts: Target, Barrel, Flyer, Exploding Foil, high current, and Voltage (V).]
General Layout of Two-Beam Fabry-Perot System for Diagnostic Measurements on Slapper Initiators

- Target
- Pulsed Nd:YAG
- Slow Cavity
- Fast Cavity
- Fast Camera
- Sweep Window

Down to 30ns
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

Ralph Hodgin
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 50um flight distance.

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

Ralph Hodgin
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.
The ‘beat’ frequency is converted to amplitude

Expanded view

- 40G sample digitizer
- 25ps/point
- 1550 nm laser wavelength
Fabry-Perot Measurements Conducted in Vacuum Provide Information on Slapper’s Pulse Duration and Equation of State

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

Fabry-Perot and PDV Setup

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

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

Impact into LiF

Front Surface Velocity of 68.8um Flyer

Ralph Hodgin
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...
68.8u Parylene Flyer

Raw Fabry-Perot Data

PDV Spectrograph with 3ns window

Reanalyzed with a 6ns FFT window

Ralph Hodgin
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

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

_Ralph Hodgin_
50.4u Paralyne Flyer Spectograph & Fabry-Perot

Ralph Hodgin
PDV/Fabry-Perot Comparison 50.4um Parylene-C

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Thin flyers produce a very narrow pulse on impact

*Ralph Hodgin*
12.3um Flyer Fabry to PDV Comparison Shot

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

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**12.3 um Parylene-C Flyer into LiF**

- Fabry
- PDV #1
- PDV #2

**Time (us)**

-0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18

**Velocity (mm/μs)**

0 0.04 0.06 0.065 0.07 0.075 0.08

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

- **Fabry-Perot**
  - Graphic – instantly see the velocity/time data
  - Complex returns easily seen
  - Speed limited by the fabry cavity (0.5ns)
  - 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