Embedded PDV in Cast Explosives

PDV Workshop

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Motivations

•Develop and validate model simulations

•Gain as much knowledge about a "device" (in this case, a melted and cast material) found in the field by experimental means on the range.

•Previously used embedded diagnostics such as carbon resistor gauges, have been moderately successful. Why not try PDV?

•PDV seems to be a more "elegant" approach.

Questions

?- Will the PDV and optical components survive the melt / pour temperature of Composition-B (≈80°C)?

?- If we embedded fibers inside a cast material, and send a shock wave through the material, could we accurately measure it?

?- Because of the inherent voids left behind during the cooling process (TNT shrinkage of 12%), would we simply recover only very local conditions? Will the probes survive?

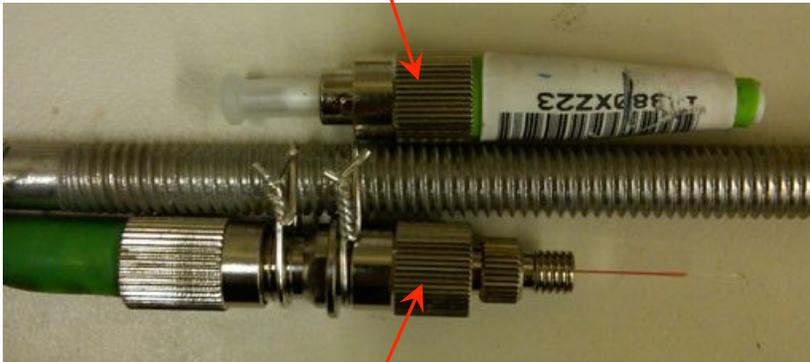?- Will the difference in sound speeds in the various materials used in the experiment effect the PDV data?
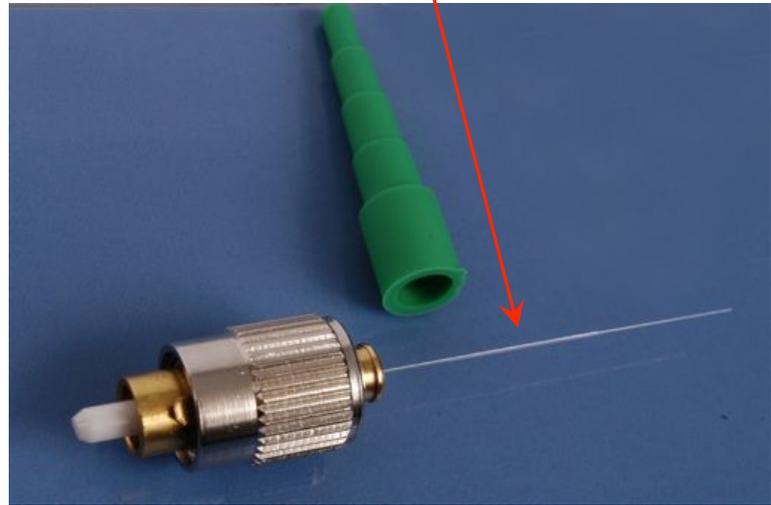
PDV Probe Considerations
Mirrored fiber reflector vs. bare, cleaved fiber

Mirrored fiber reflector

Bare, Cleaved fiber

With boot removed

Would either of these probes survive the melt / pour temperature of composition-B (80°C)?
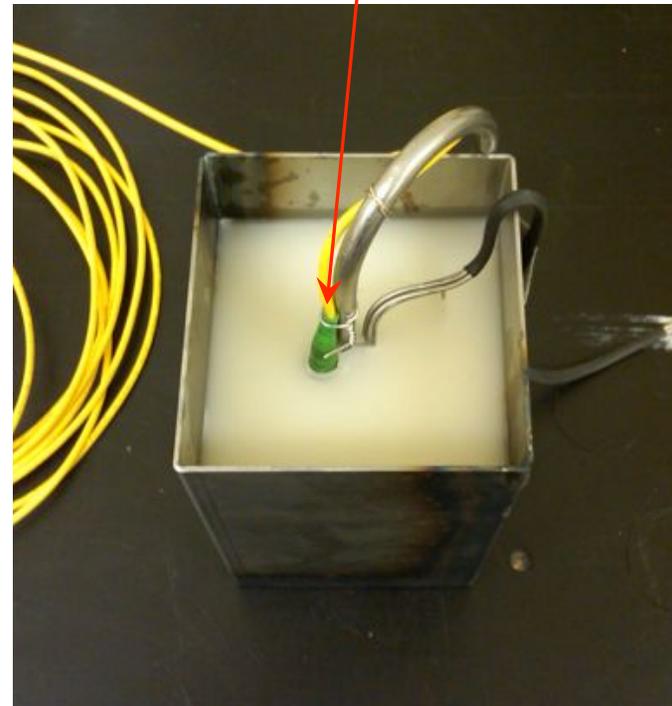
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PDV Thermal Test / Wax Test Shot
Will the PDV Components even survive?

PDV Probe in Boiling
Water (100°C)
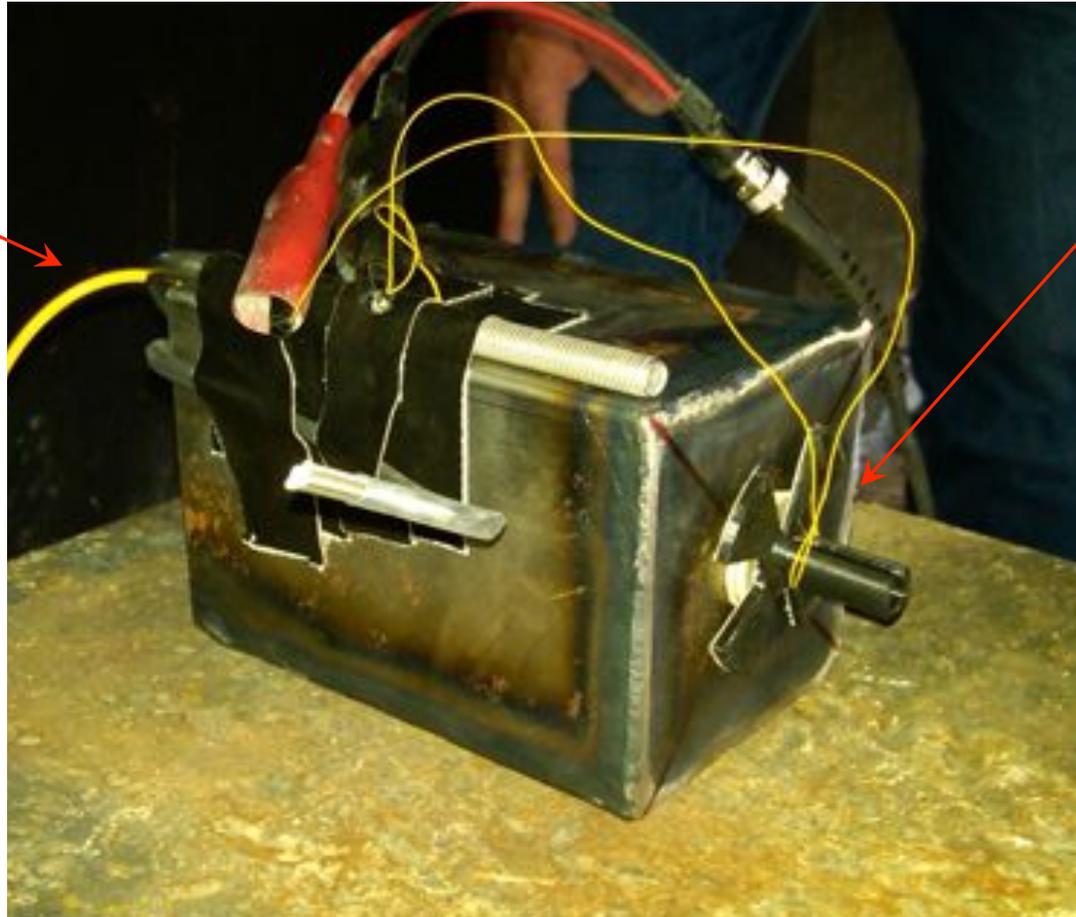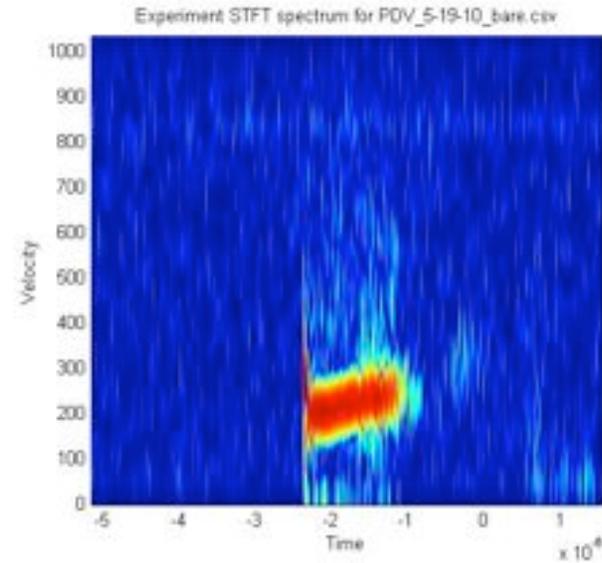
PDV Probe
embedded in wax
melted @ ≈ 70°C

PDV Thermal Test / Wax Test Shot
What kind of data will we get?

PDV Probe

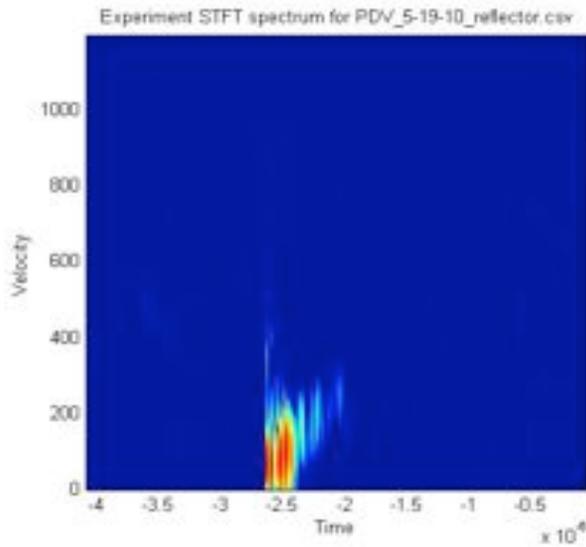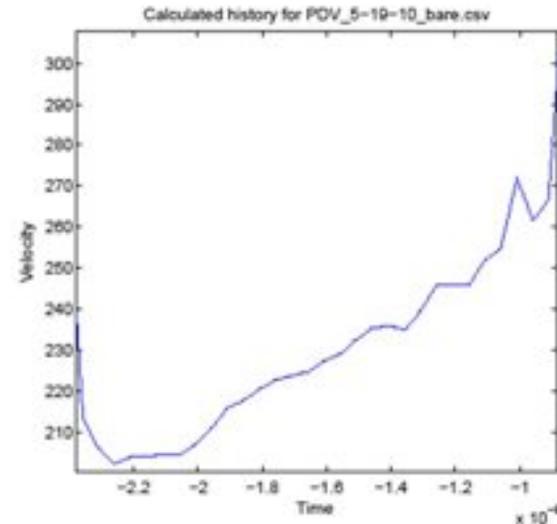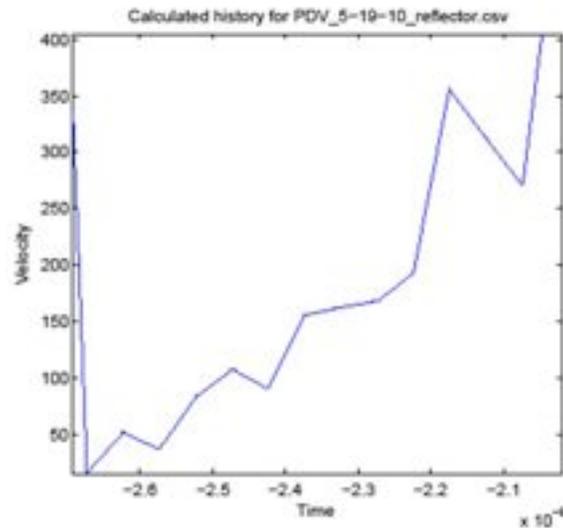C12 Load with standard M16 Detonator

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PDV Thermal Test / Wax Test Shot
Expected velocity ≈ 200 m/sec

Mirrored Probe Data

Cleaved Fiber Data

Drum Instrumentation
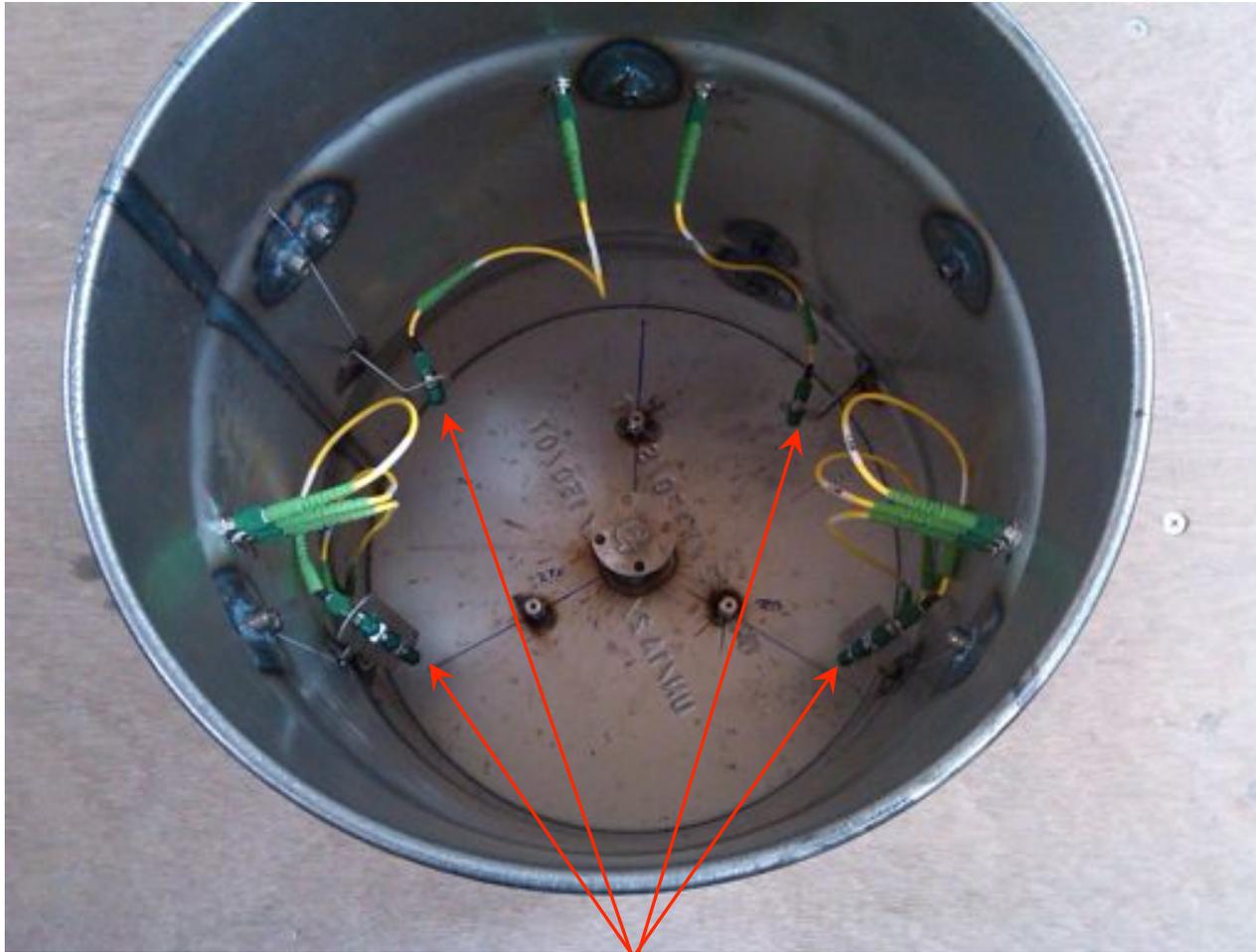*Experimental Measurements for Model Development/Validation*

Thermocouples

Aluminum housing
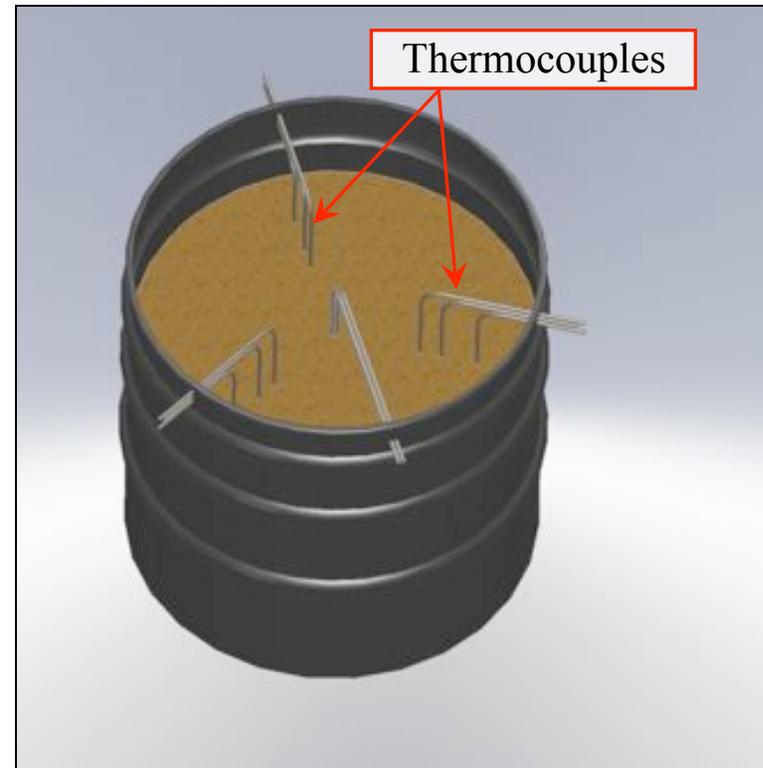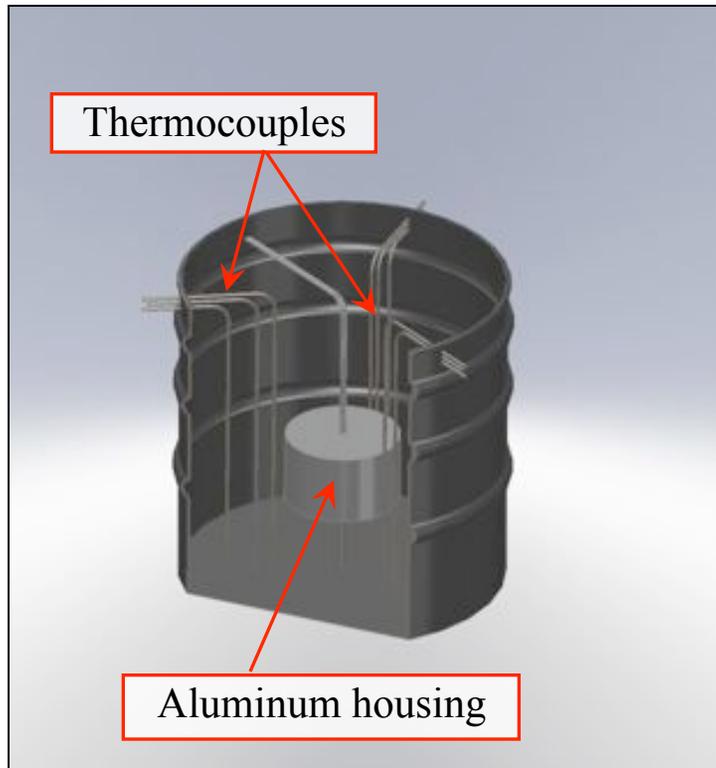
Thermocouples

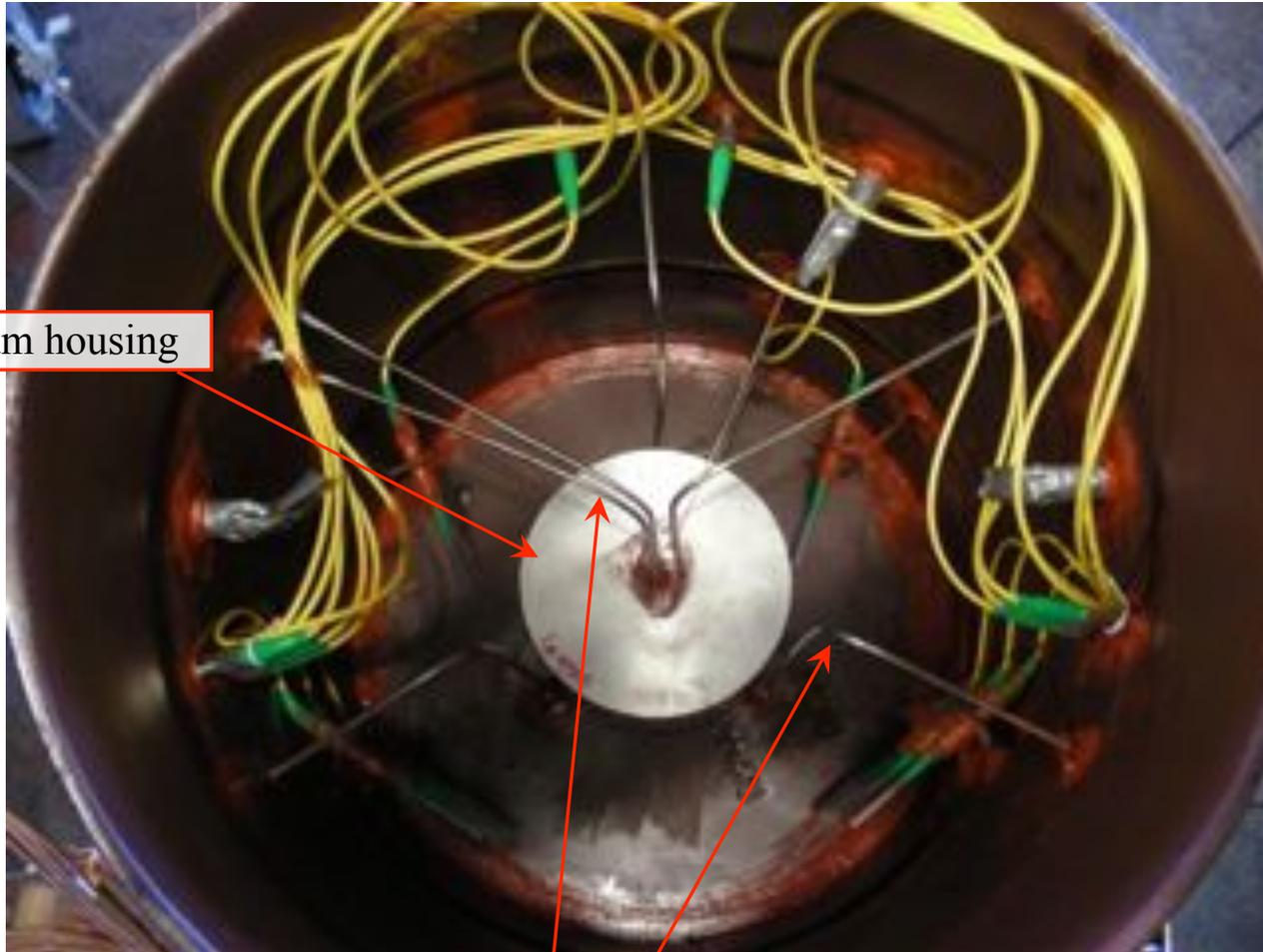# Drum Instrumentation
PDV Probe Locations

PDV Probe
Locations

Drum Instrumentation
PDV probes alone just not enough!
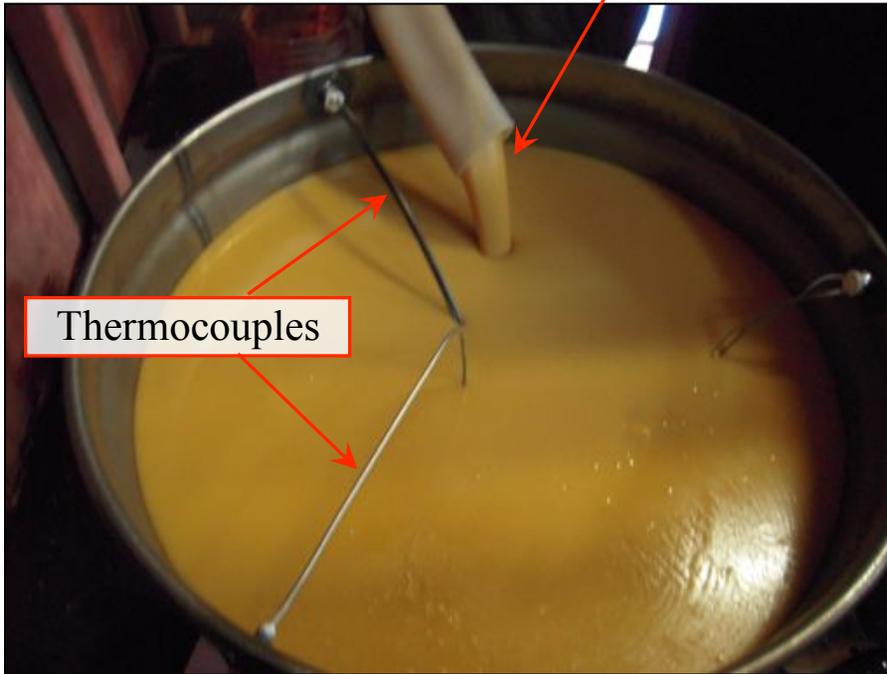

Aluminum housing

Thermocouples

Drum Instrumentation
A note on the finished product…not what we embedded PDV probes into!
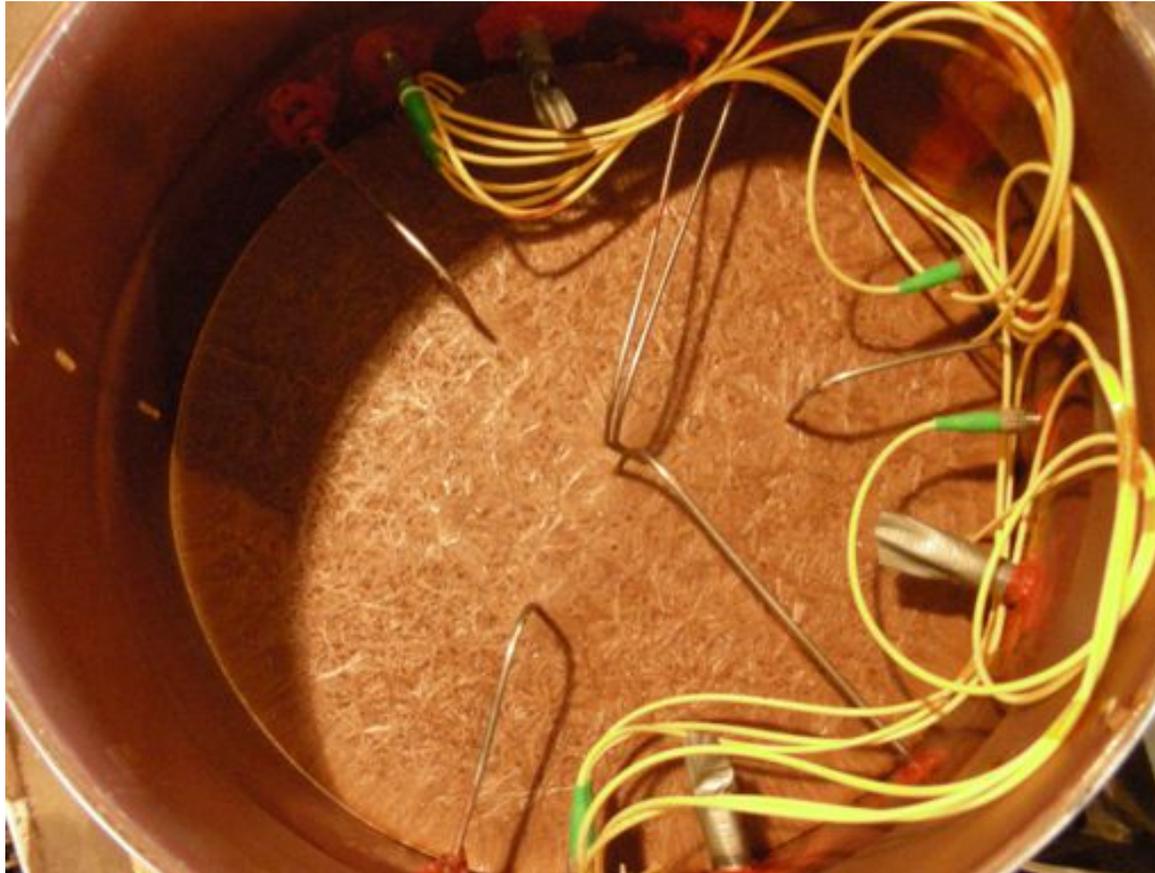

Melt cast explosive

Bummer!

Thermocouples

NOTE: A single-stage pour does not yield a desirable finish

Drum Instrumentation
This IS what we embedded probes into!

Much better!

NOTE: Day and Zimmerman Inc. have a MUCH higher quality explosive casting process.
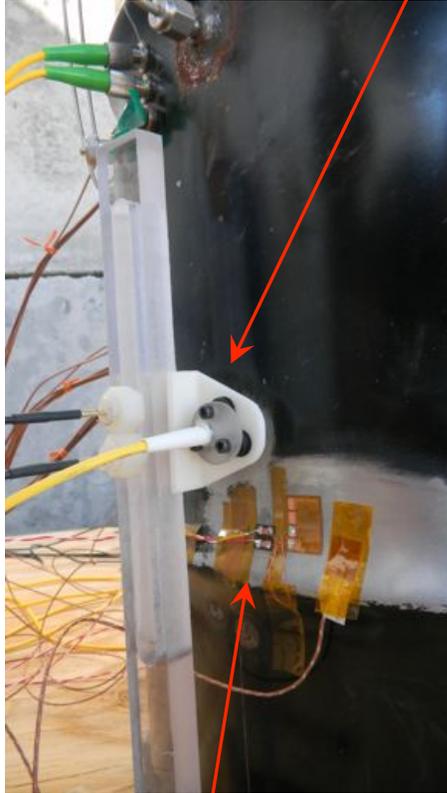
Test Set-up
Non-detonation desired

Test Drum

Water Disrupter Tool
(1.4 km/sec insult)

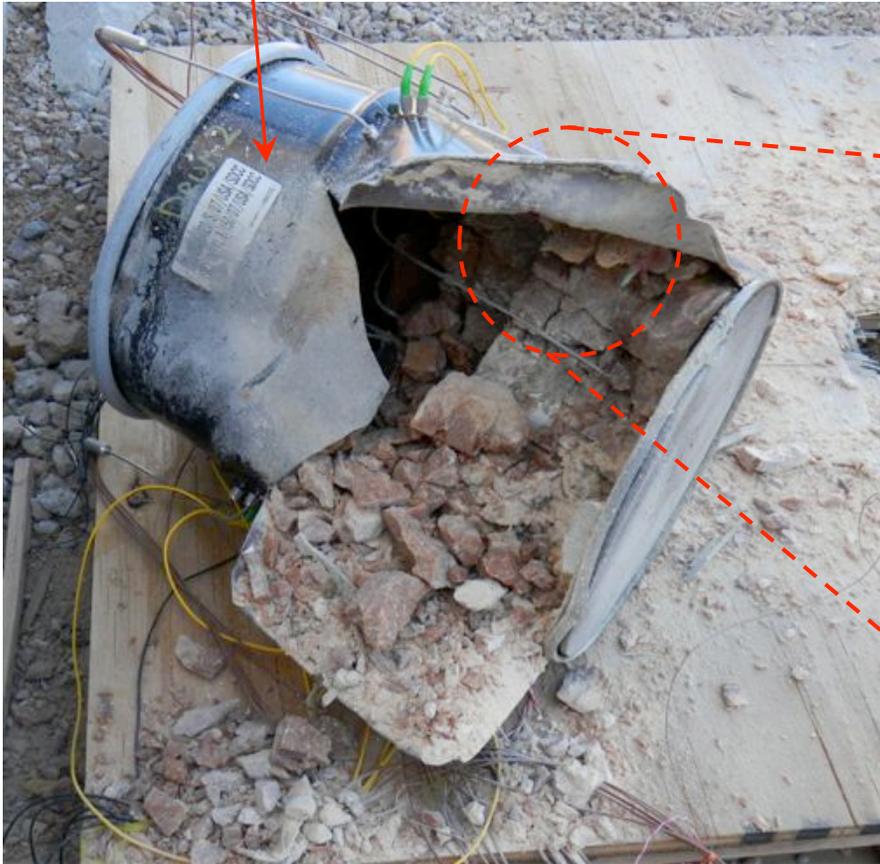PDV Probe with
TOAD pins

Strain Gauge and
thermocouple

Test Set-up
Non-detonation achieved!

Test Drum

PDV Probes not destroyed!

Bare Fiber not broken!

Shot Day
"Clean-up" shot…not a good time for flying!
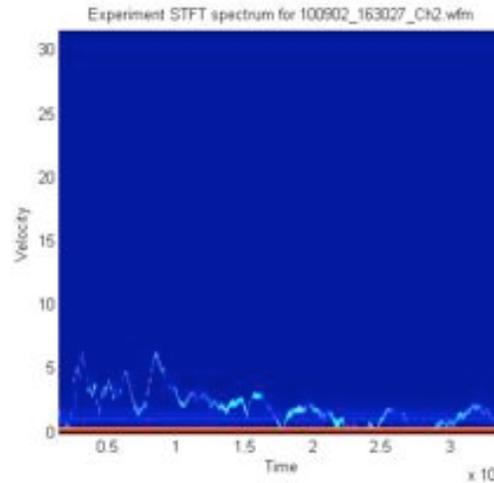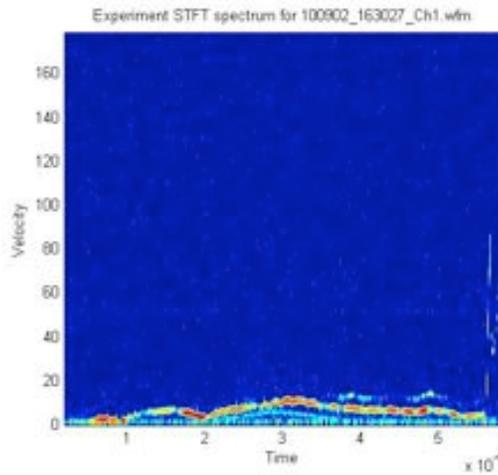

9-2-10 real time clean up shot.asf

PDV Data Results
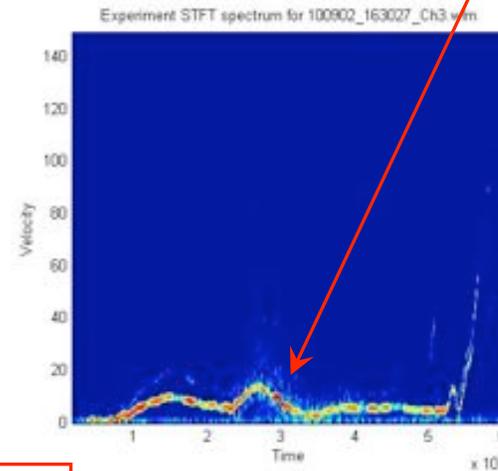### *Front outside probes agree as wave travels around drum*

- Predicted TOA between front and rear probes 1.5 msec.

- Front probes impacted at 560 μsec

- No "impact" seen by rear PDV; probe still attached to drum post-shot.

Experiment STFT spectrum for 100902_163027_Ch2.wfm

- Slow (<20 m/sec) drum wall movement noticed?

- Will this couple into the internal PDV measurements?

Experiment STFT spectrum for 100902_163027_Ch1.wfm
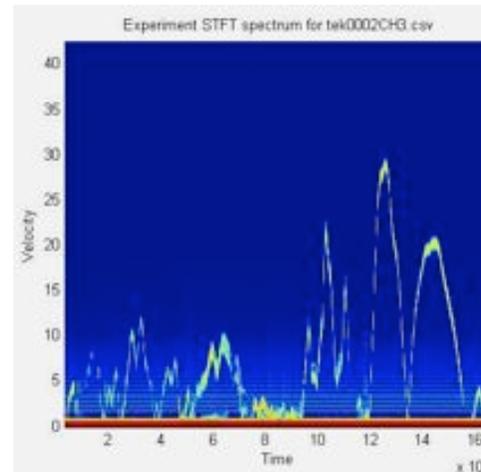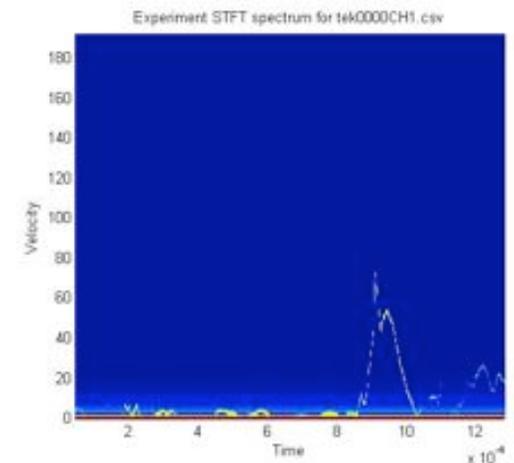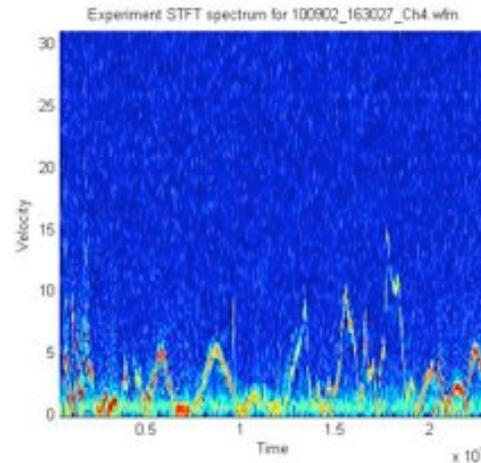
Experiment STFT spectrum for 100902_163027_Ch3.wfm

Insult

PDV Data Results
Internal probes

•Expected ≈0.9 msec to hit the first probes.

•PDV channels see faster "peaks" between 0.9 and 1.5 msec.

•LOTS of low velocity components.

•Sees first "data" at 61, 42, 42, and 57 μsec respectively. Is this caused by the sound speed in steel coupling into fibers?

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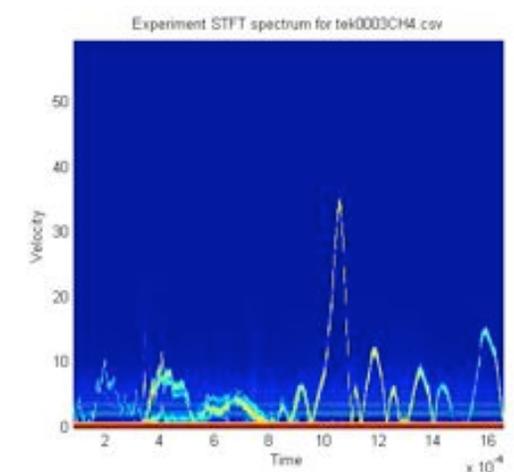
Summary

- PDV diagnostics did survive the melt/pour process, and were embedded inside of a cast explosive (one small success).

- It is believed that the steel drum coupled vibration into the internal probes prior to "real" data. Any thoughts on how to isolate this effect?

- Data, while rather ambiguous, does exhibit "events" happening at the expected times.

- Has anyone else done anything like this before? Are we going about this process all wrong?