



Effects of Surface Preparation in Consolidated Aluminum Particles and Copper Cylinder Expansion Tests

Presented to:

PDV Workshop 2023

**By: Keith Tukes Jr., Dr. Joseph Olles,
Paul Giannuzzi, & Joshua Felts
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POC: Keith Tukes Jr., 757-714-8532

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Outline

- Introduction to the copper test setup
 - Probe alignment
 - Introduction to the PDV system
 - Effect of surface finish on measurements
 - Results from both surfaces of copper tubes
- Introduction of consolidated Al articles
 - Optical properties of material
 - Introduction to system
 - Focusing probes
 - Fixed frequency AOFS
 - Measurements
- Conclusions

Copper Cylinder Expansion

- CYLEX/DAX Tests
 - Used to determine product equations of state
 - CJ-pressure
- Probe Alignment
 - Measured probe height on holder and case (vertical)
 - **Scored line along side of case (horizontal)**
 - **Should have used kinematic mounts**



PDV System

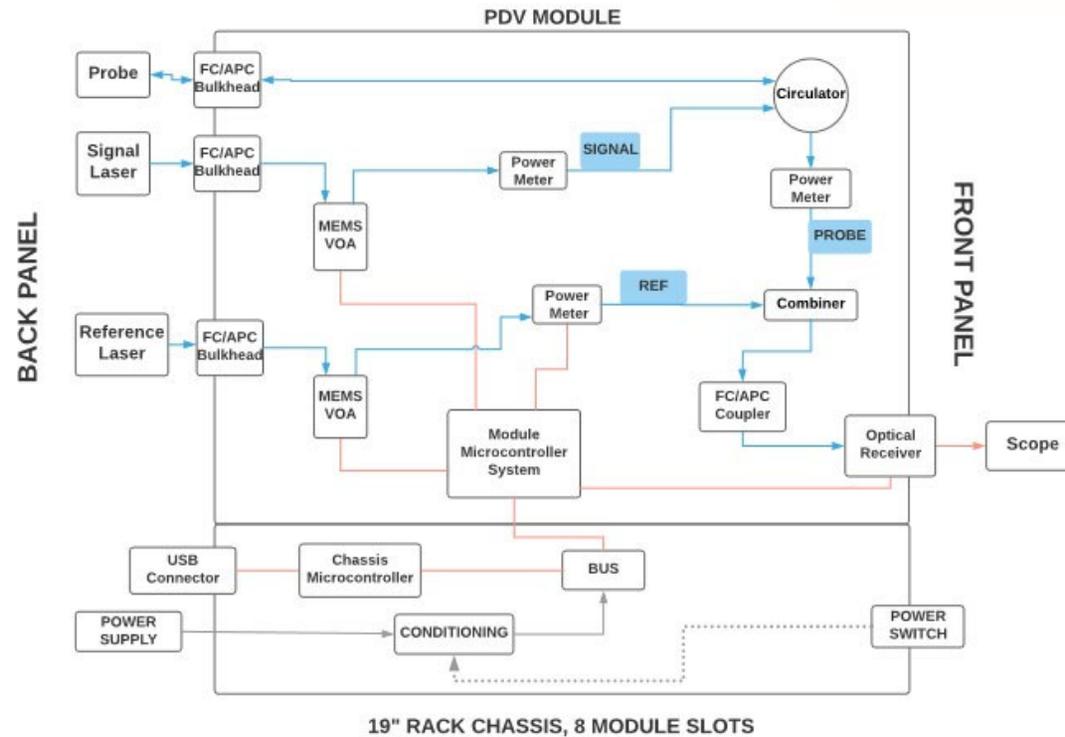
- Traverse Solutions and Instrumentation (TSI)
- 8 ch. Heterodyne System
 - 5 μ s time multiplexing on 4 channels
 - Uses NKT Photonics: Koheras Basik (40mW) and BOOSTIK (2W) modules
 - MEMS VOAs and laser power levels are controlled via TSI & NKT software respectively,
 - Attenuators use to adjust the probe and reference power levels
 - Koheras Basik lasers use thermal tuning
 - <https://www.sevensix.co.jp/wp-content/uploads/NKT-Photonics-App-notes.pdf>
 - 20 GHz Detectors and oscilloscope
- Collimated probes
 - Thorlabs 50-1550A-APC
 - AR Coated Lens
 - 300 mW power handling
 - 1.8mm GRIN lens
 - 0.5mm beam dia.



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PDV System Schematic

MODULAR PDV SYSTEM SCHEMATIC

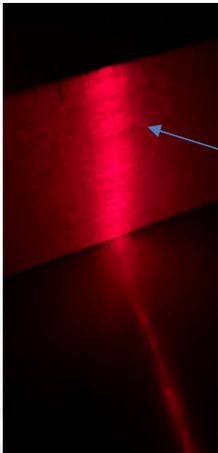
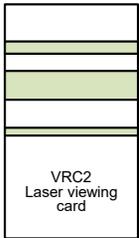


*From TSI PDV System Manual

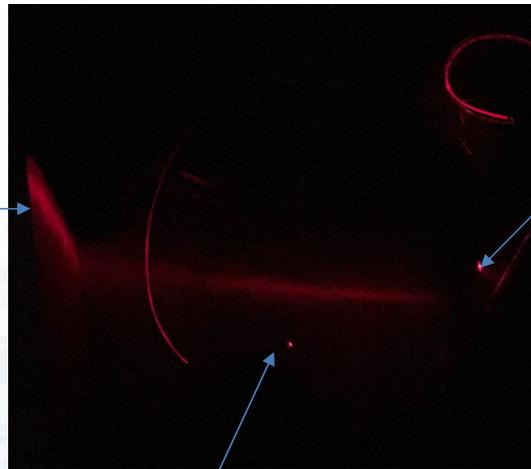
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Measurements on Machined Surfaces

- Measurements were on round, machined surfaces
 - Horizontal alignment is critical
 - Difficult to obtain good vertical alignment because of “fringes” made by machining marks.
 - Some relief is granted by sanding the surface

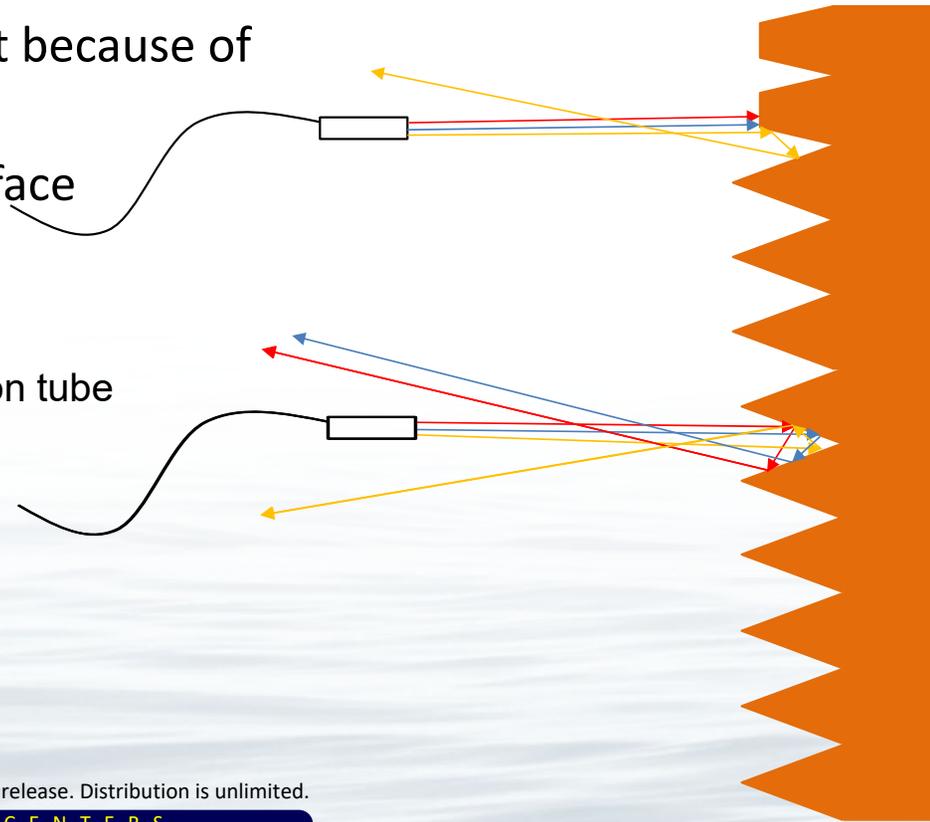


Reflection
from
tube



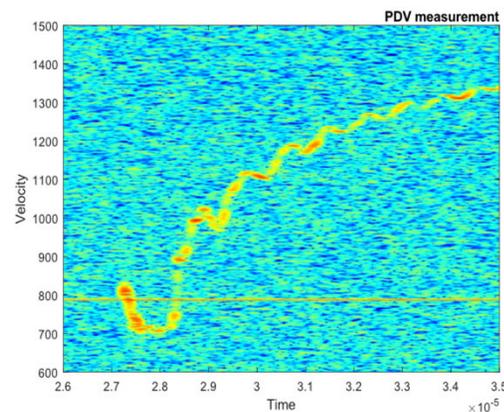
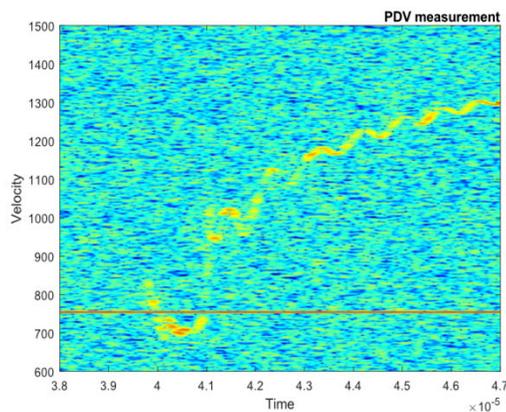
Probe

Spot on tube



Measurements on Machined Surfaces

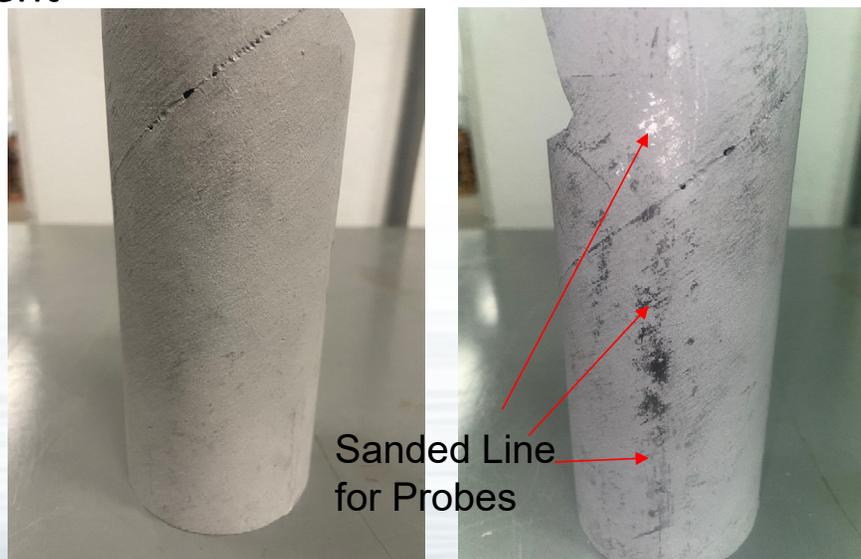
- Loss of signal early in tube expansion without intervention
- Slightly better when using fine-grade sandpaper
- Signal improving at late time may be due to “melting” of copper at high pressure/temperature



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Consolidated Al Particle Tests

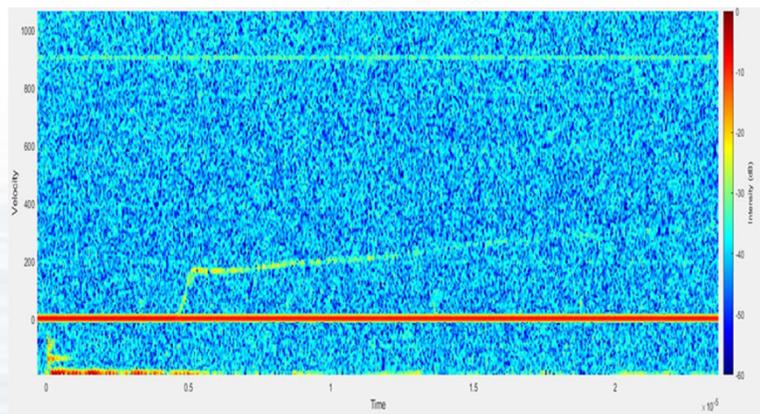
- Material initially appeared very dull
- This inspired us to conduct some initial floret-like tests.
- We saw results from initial tests indicating Al dispersion due to shock loading
- Wanted to improve chances of return signal + use initial signal intensity to determine alignment



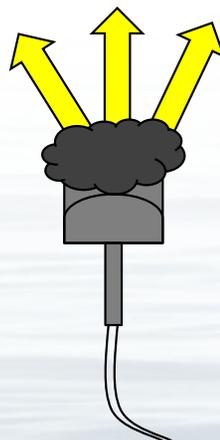
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Consolidated Al Particle Initial Tests

- Didn't know if we would get good return after seeing the (full-up) test articles
- Initial Test articles gave hints on how to get better return
- Unpolished sample got decent return
 - Needed a way to align probes



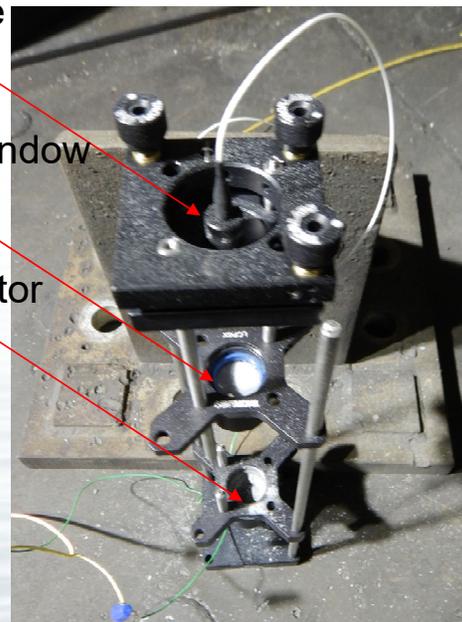
Al Particle Spray



Thorlabs Probe

Angled PMMA window

Sample/Detonator Location

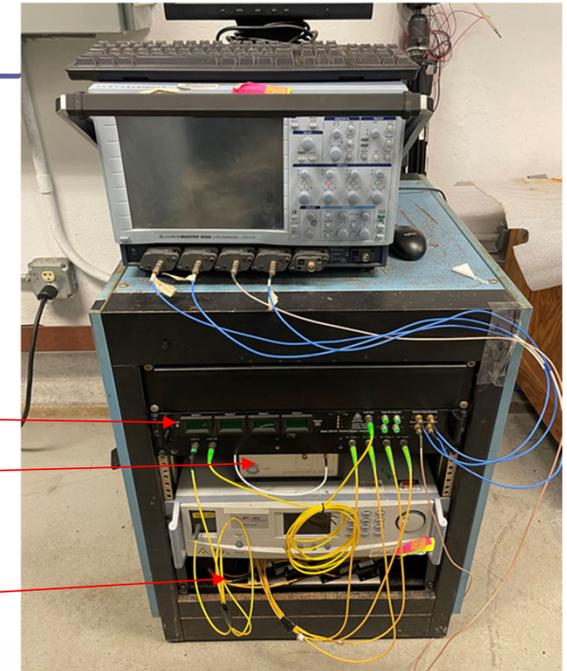


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PDV System

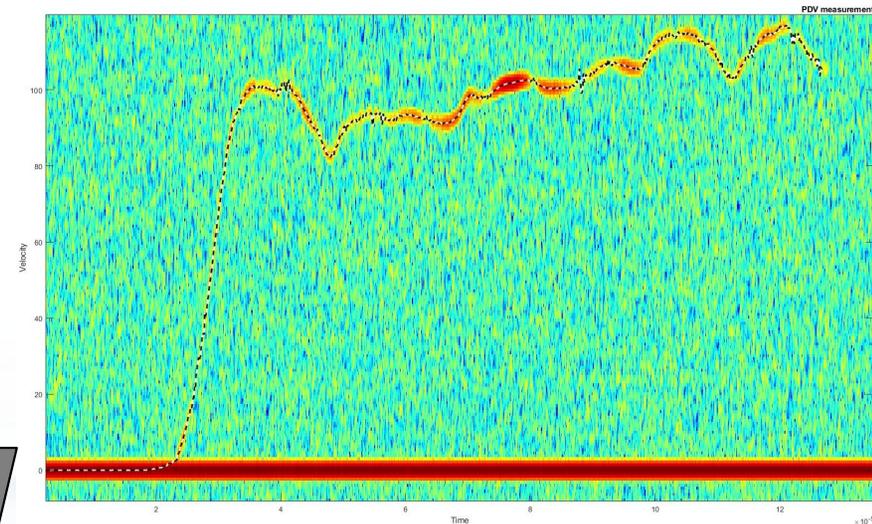
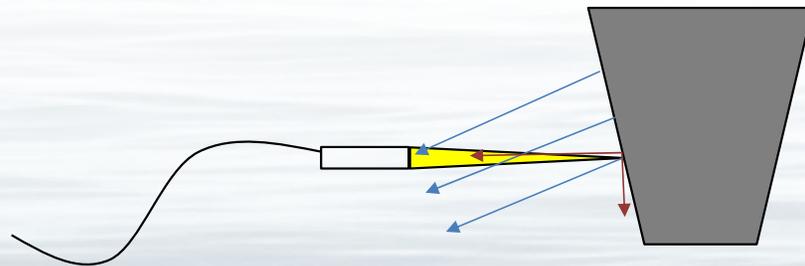
- 8GHz scope
- Original System is:
 - Third Millennium Engineering Part #: 1CF41A1
 - LPG Laser: ELR 1 1550 SF
 - 1W divided amongst 4 ch
- Many fixes on this system
 - Ripped out power meters
 - Inserted a AOFS & RF Driver
 - Brimrose 250 MHz Fixed Frequency AOFS
 - Driver: FFF-250-B2-F1.5
 - AOFS: TEF-250-1550-2FP
 - Replaced VOAs
 - Thorlabs VOA50-APC
 - Replaced Detectors
 - Thorlabs PDA8GS Detectors, 9.5 GHz bandwidth
 - Probes
 - OZ Optics LPF-01-1550-9/125-S-4-25-5AS-60-3A-1-5
 - f=5mm aspheric lens
 - ~45mm spot size @ ~1in probe distance



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Consolidated Al Particle Test

- Focusing probes used hoping to see Al particle spread
 - Didn't exactly work out how we wanted
 - Large changes in spread due to focusing probes
 - Probably caught a combination of velocity components through focusing probe cone
 - Large changes in velocity spread
 - Material becomes powdered, non-consolidated





Conclusions

- Copper Tube Tests:
 - Best case: use flat finished articles if testing cylindrical metal tubes
 - Worst case: You can polish it
 - You NEED to know the probe angle (if any) to account for multiple velocity vector components
 - USE KINEMATIC MOUNTS
- Consolidated Al Particle Tests:
 - Always consider how to ensure probe alignment
 - We polished the side and looked at the return signal
 - Maybe shouldn't have gone with focusing probes
 - Just complicated the measurement unnecessarily



Questions?

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