Shock Compression of Argon Gas: Experiment and Analysis of PDV Data

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Outline

- Experimental setup
- Typical results
- Interpretation of results (analysis of PDV data)
- Summary

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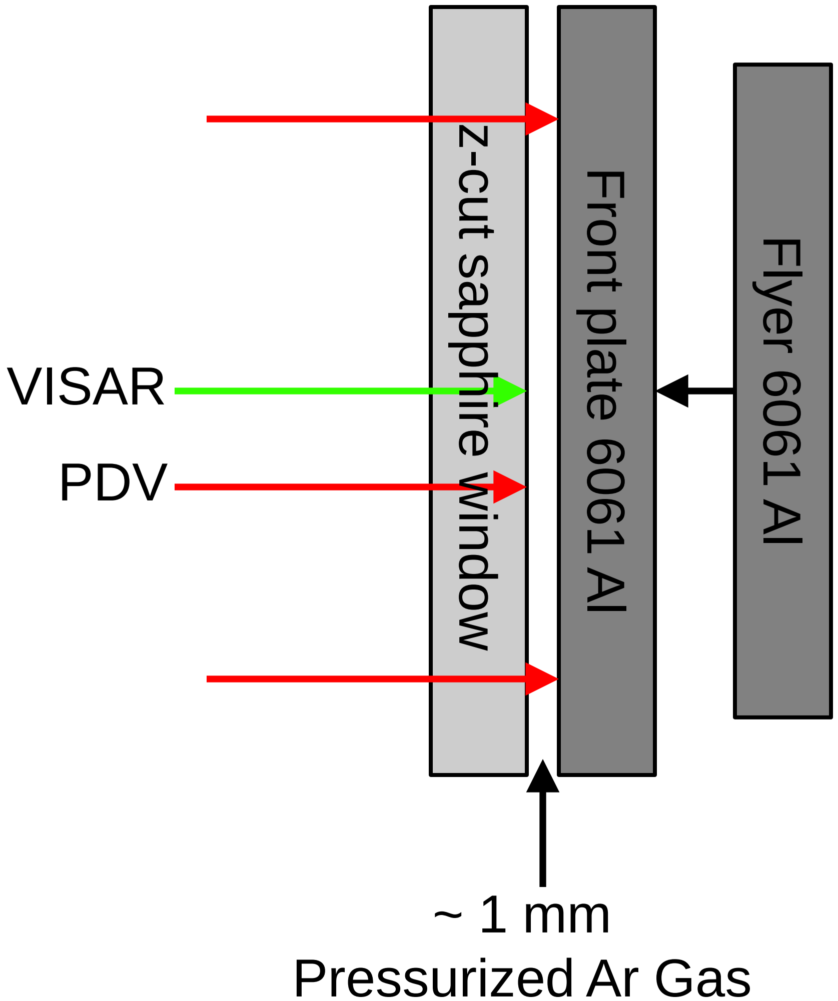
Experimental setup (simple view)

- u_P to be estimated as ~ flyer velocity with correction for isentropic release.
- U_s to be estimated from $\Delta x/\Delta t$.
- ring up measured at sapphire window provides off Hugoniot constraints on EOS, high pressures.



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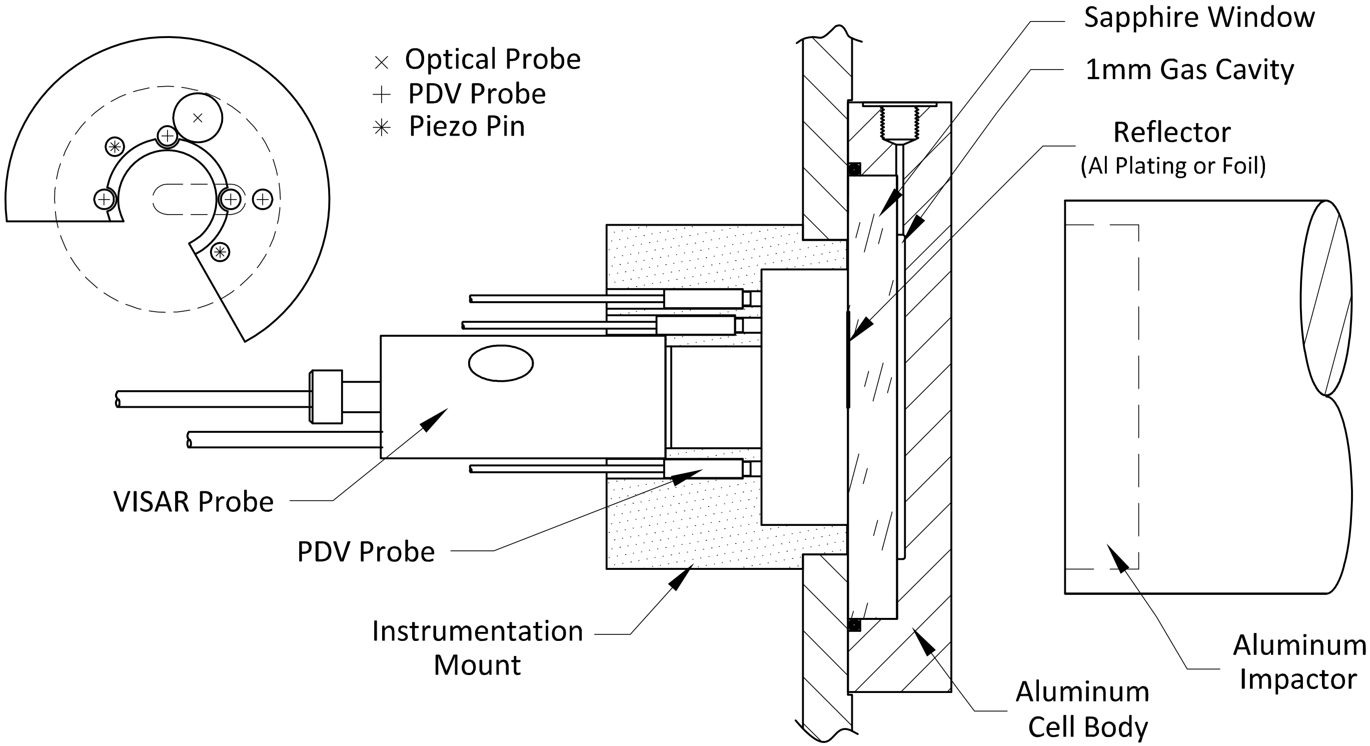
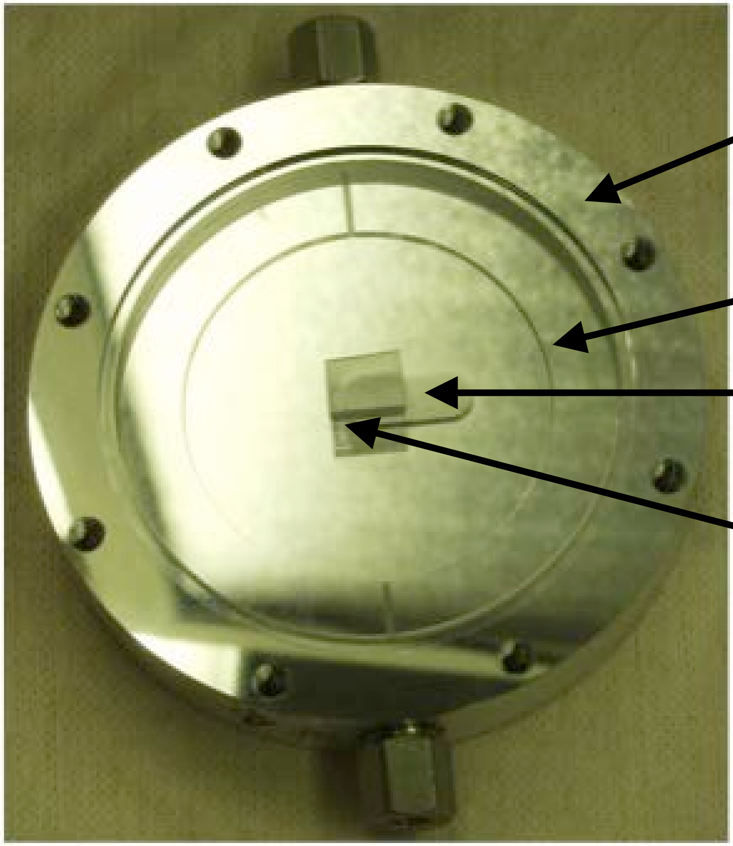
x-t diagram (MACRAME) goes here

Experimental setup (detailed view)



Cell from sapphire window side



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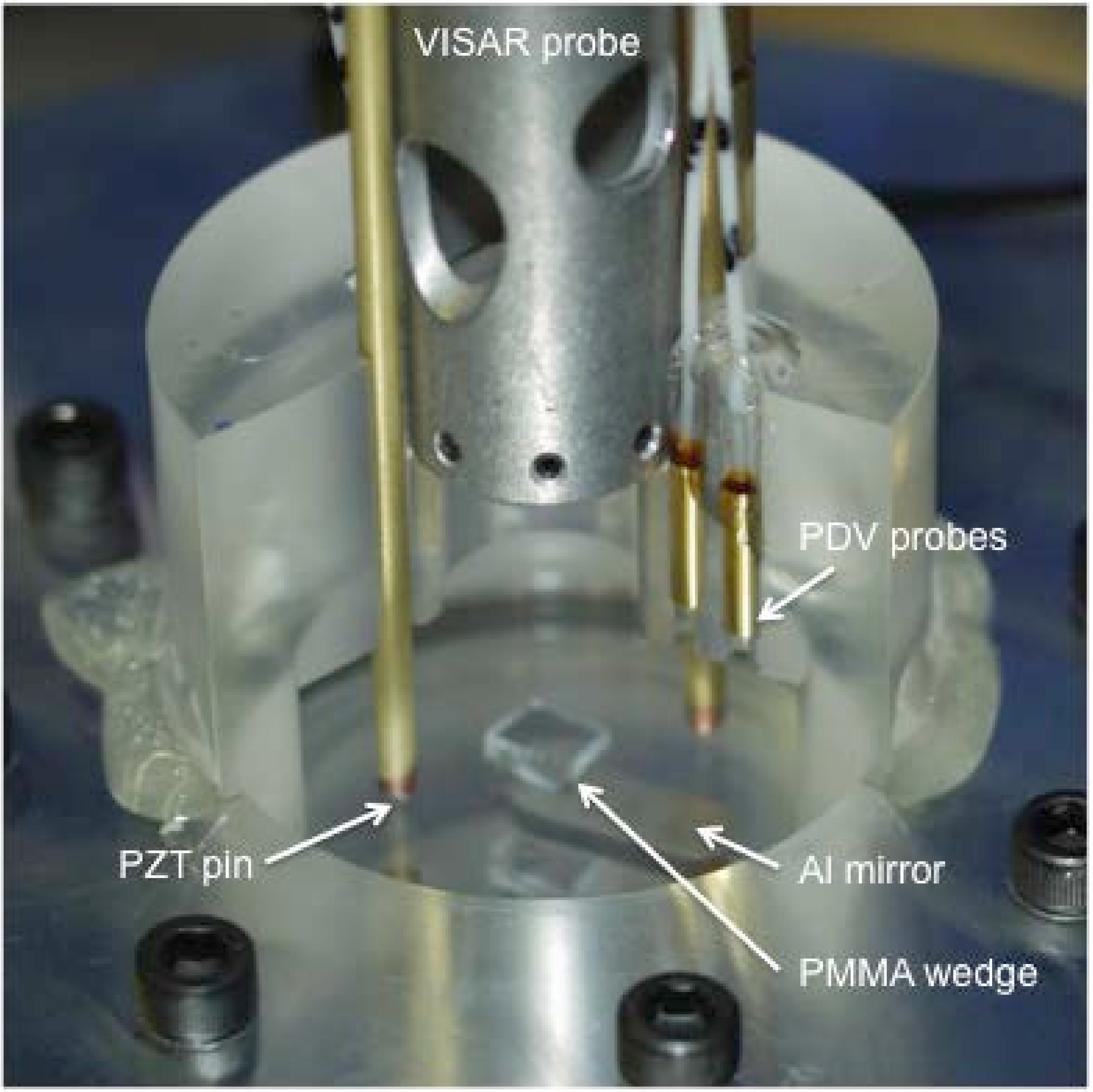
Instrumentation mount



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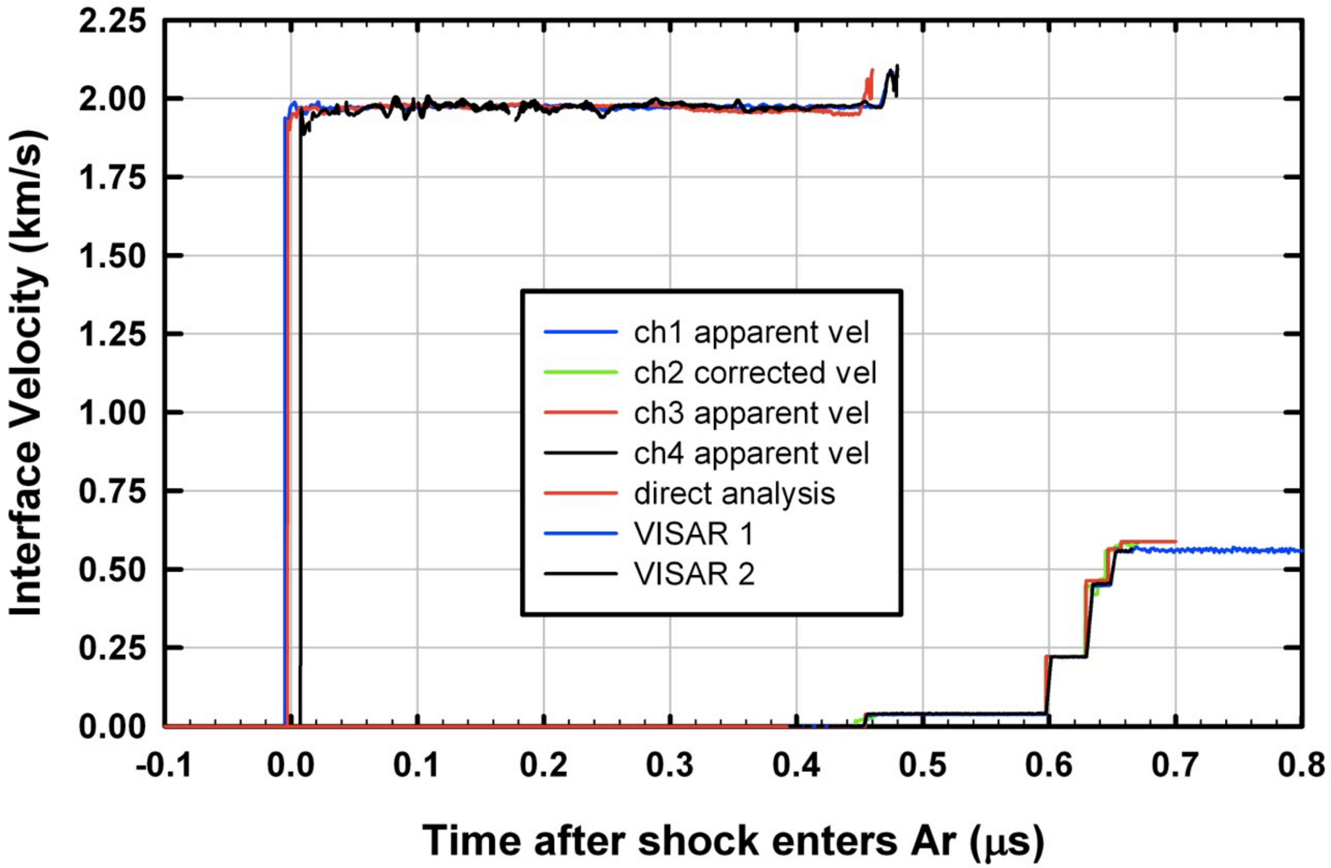
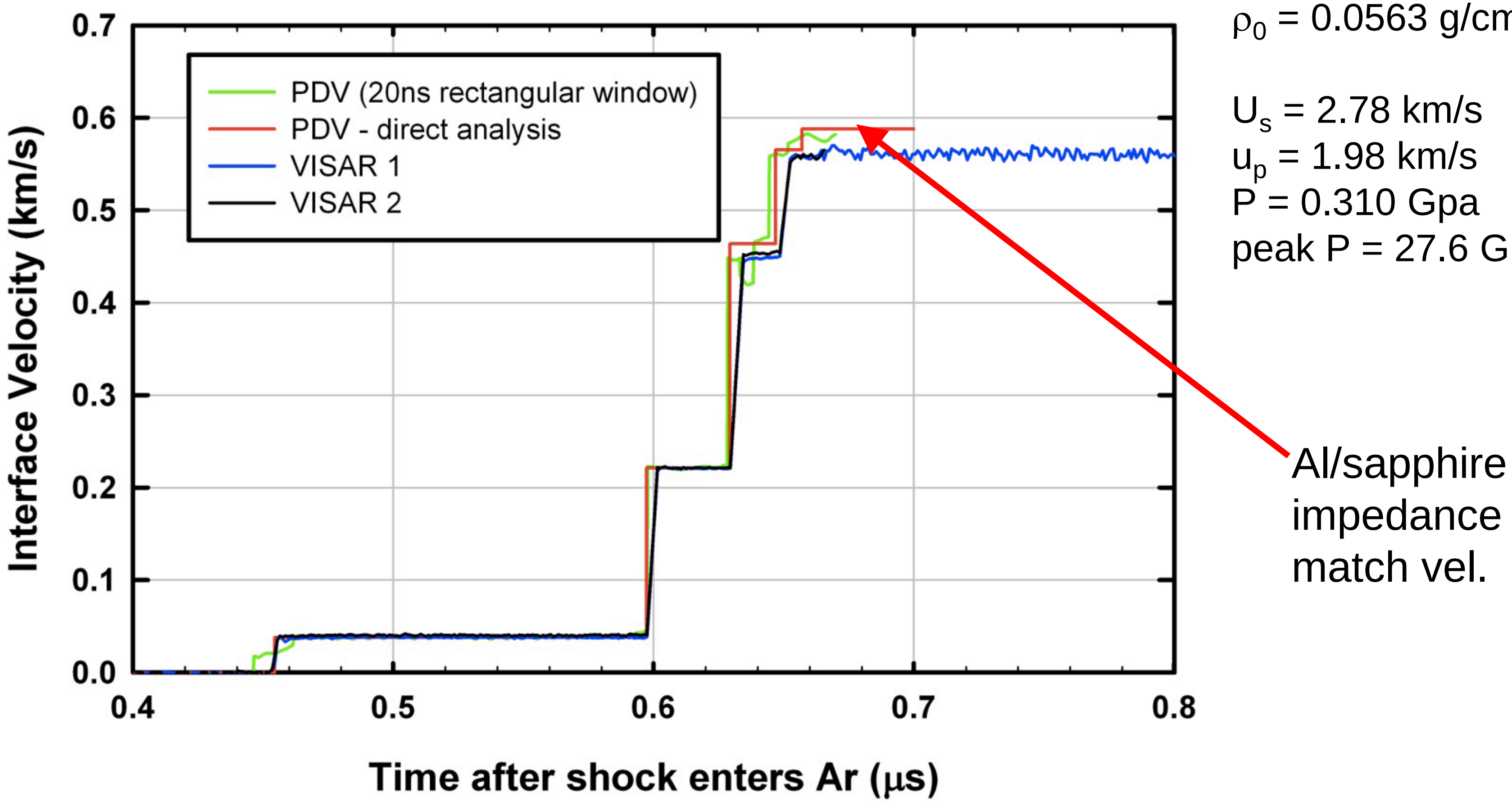
Results – 2s-568: all extracted traces



V_{proj} = 2.003 ± 0.002 km/s
500 psig, 20.8 °C
ρ_0 = 0.0563 g/cm^3

U_s = 2.78 km/s
u_p = 1.98 km/s
P = 0.310 Gpa
peak P = 27.6 GPa

Results – 2s-568: ring up at sapphire window



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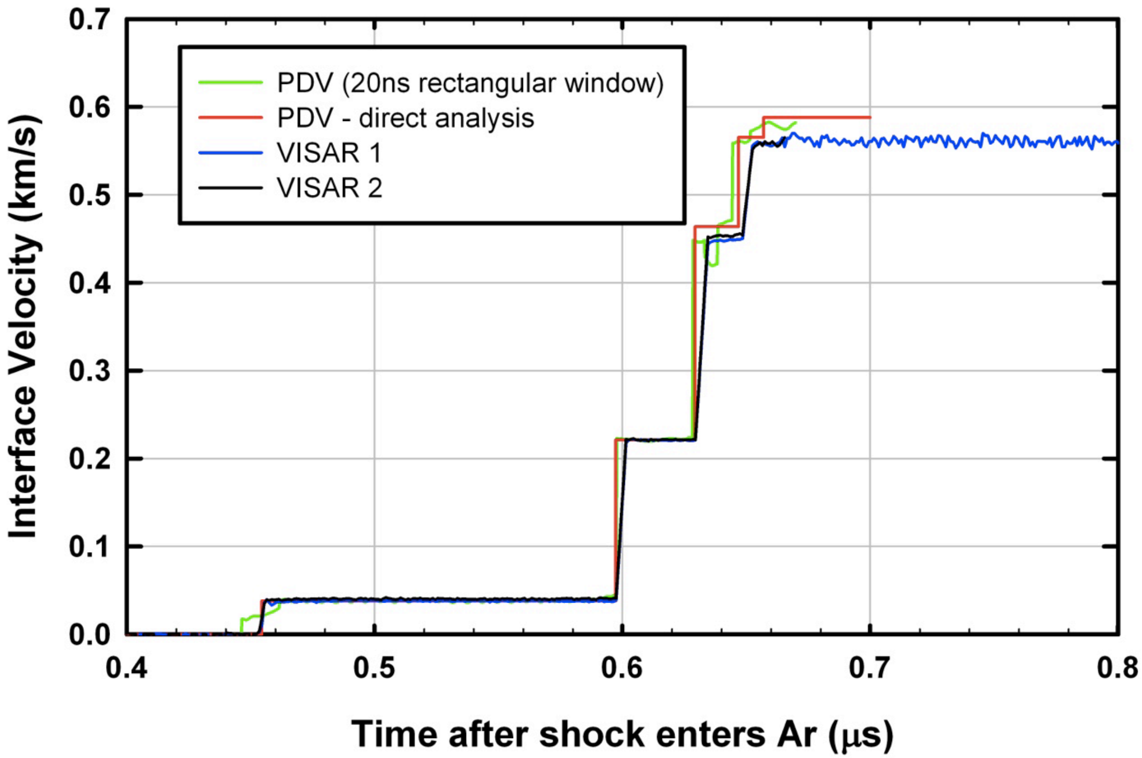

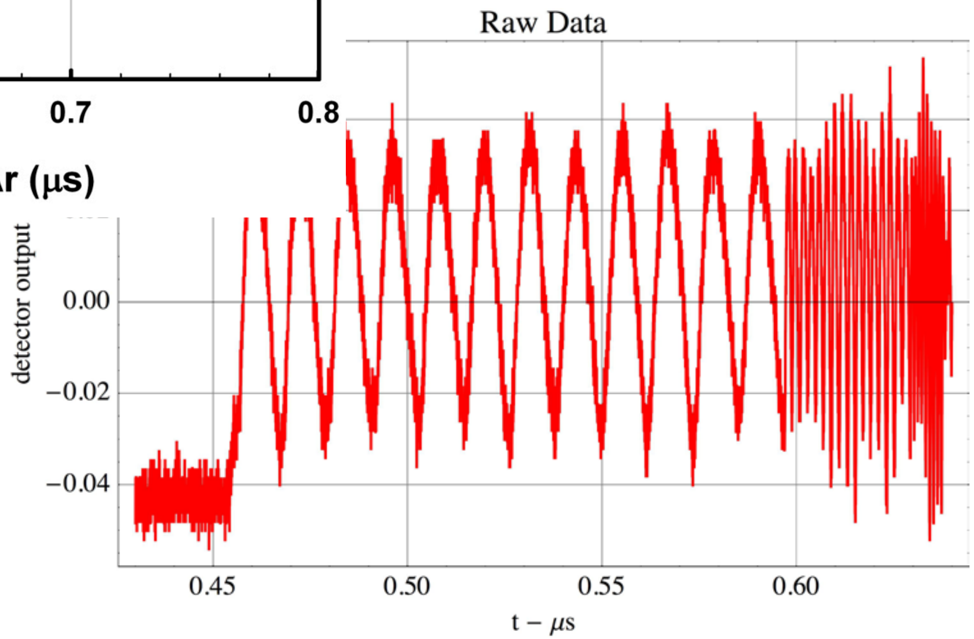

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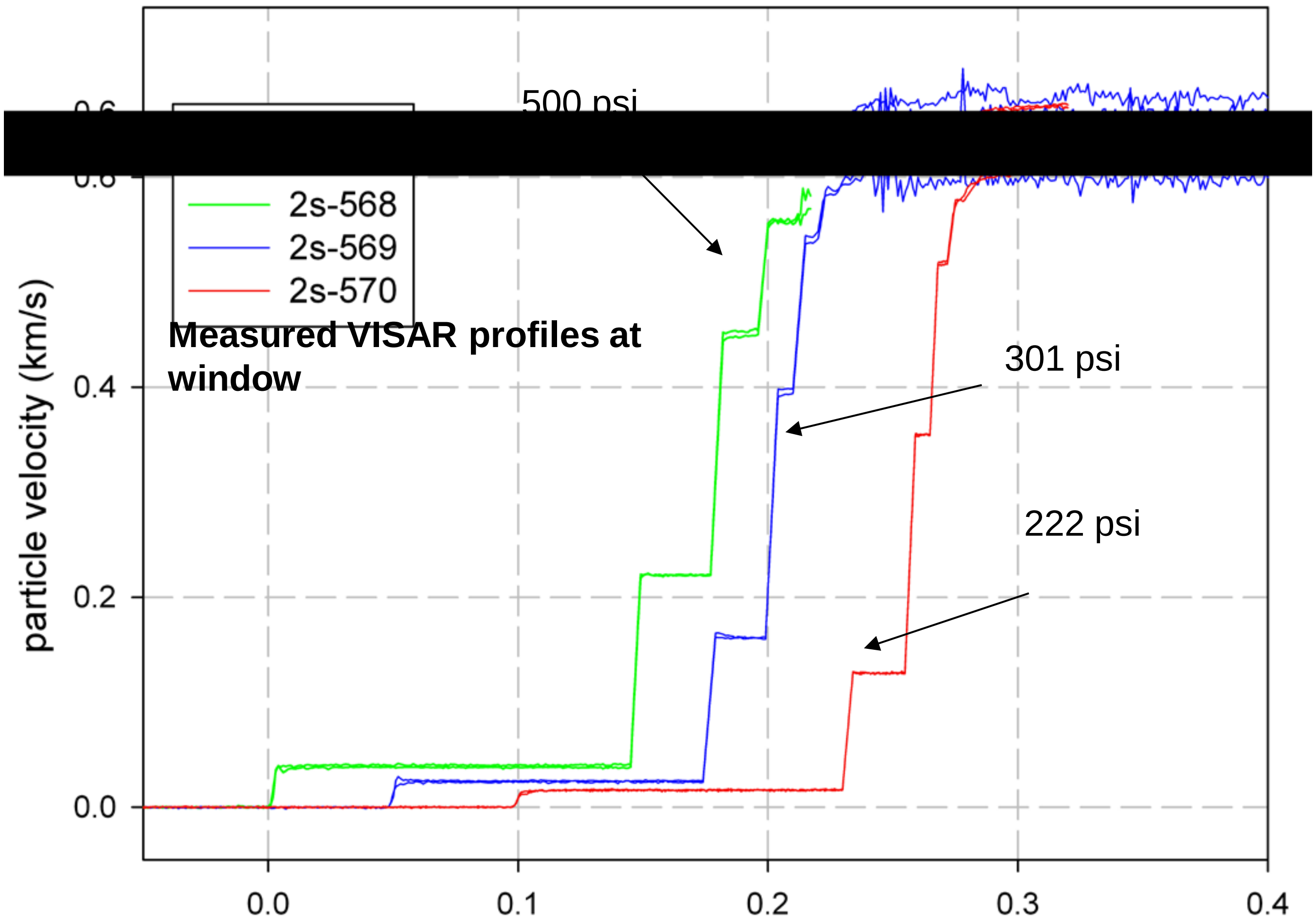
Several experiments with different Ar gas pressures



increasing initial gas pressure increases U_s, u_p and P states. Ring up states are higher as well.

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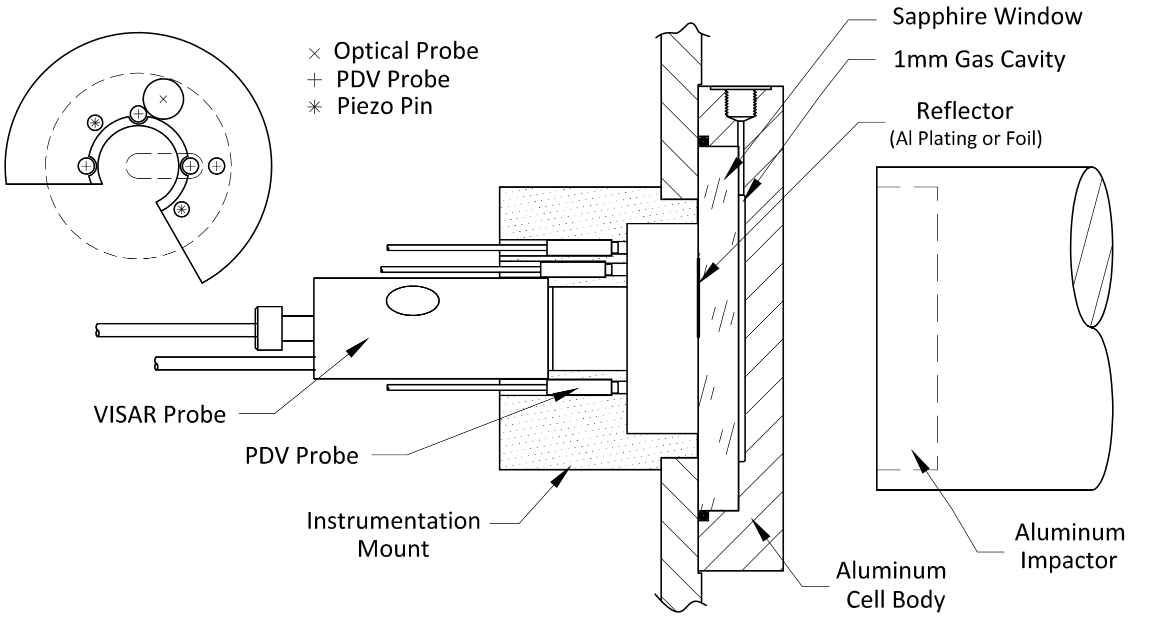
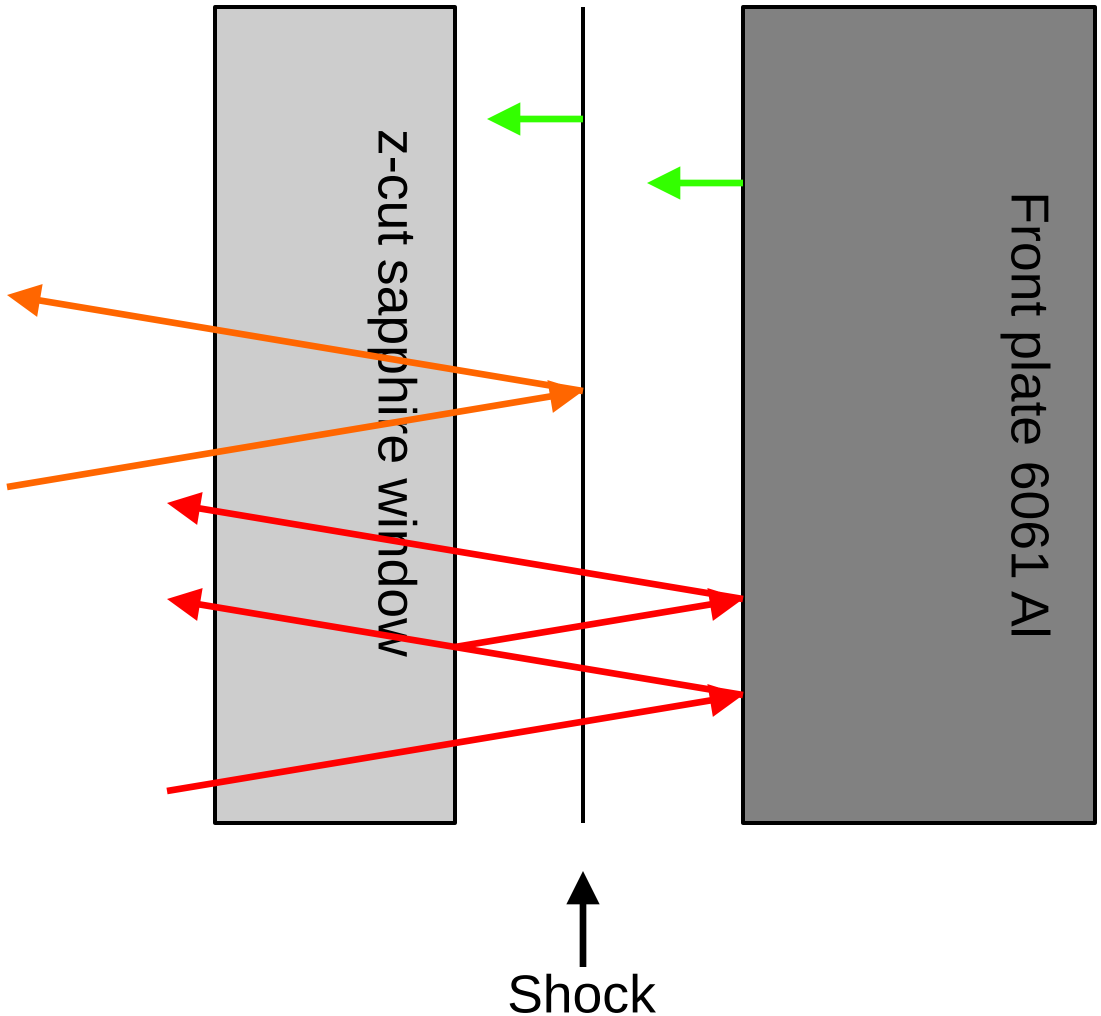
Difficulties

- u_P to be estimated as ~ projectile velocity with correction due to isentropic release.
- U_s to be estimated from $\Delta x/\Delta t$.
- u_p to be corrected using impedance match methods – Al standard.
- But "measured" EOS points didn't fit any model.

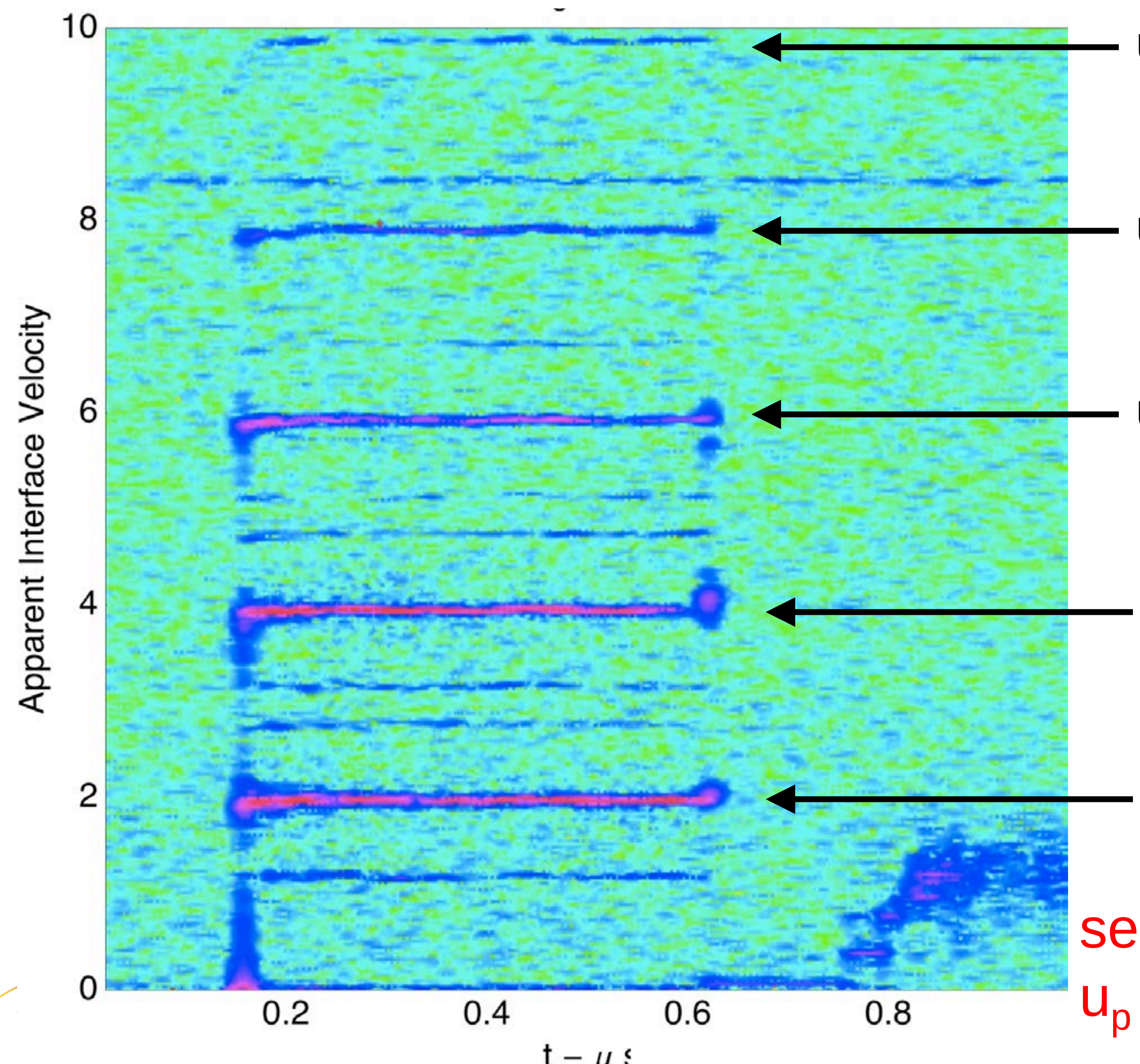
- Suspected culprit – cell thickness at pressure. U_s is rubbish.
- Can the experiments be "salvaged?"



Consider where reflections can come from:



A careful look at the data (2s-568 ch4)



u_{P5} = 9.88 km/s

u_{P4} = 7.89 km/s

u_{P3} = 5.93 km/s

u_{P2} = 3.95 km/s

u_{P1} = 1.98 km/s

self consistent

$u_p = 1.98 \pm 0.01$ km/s

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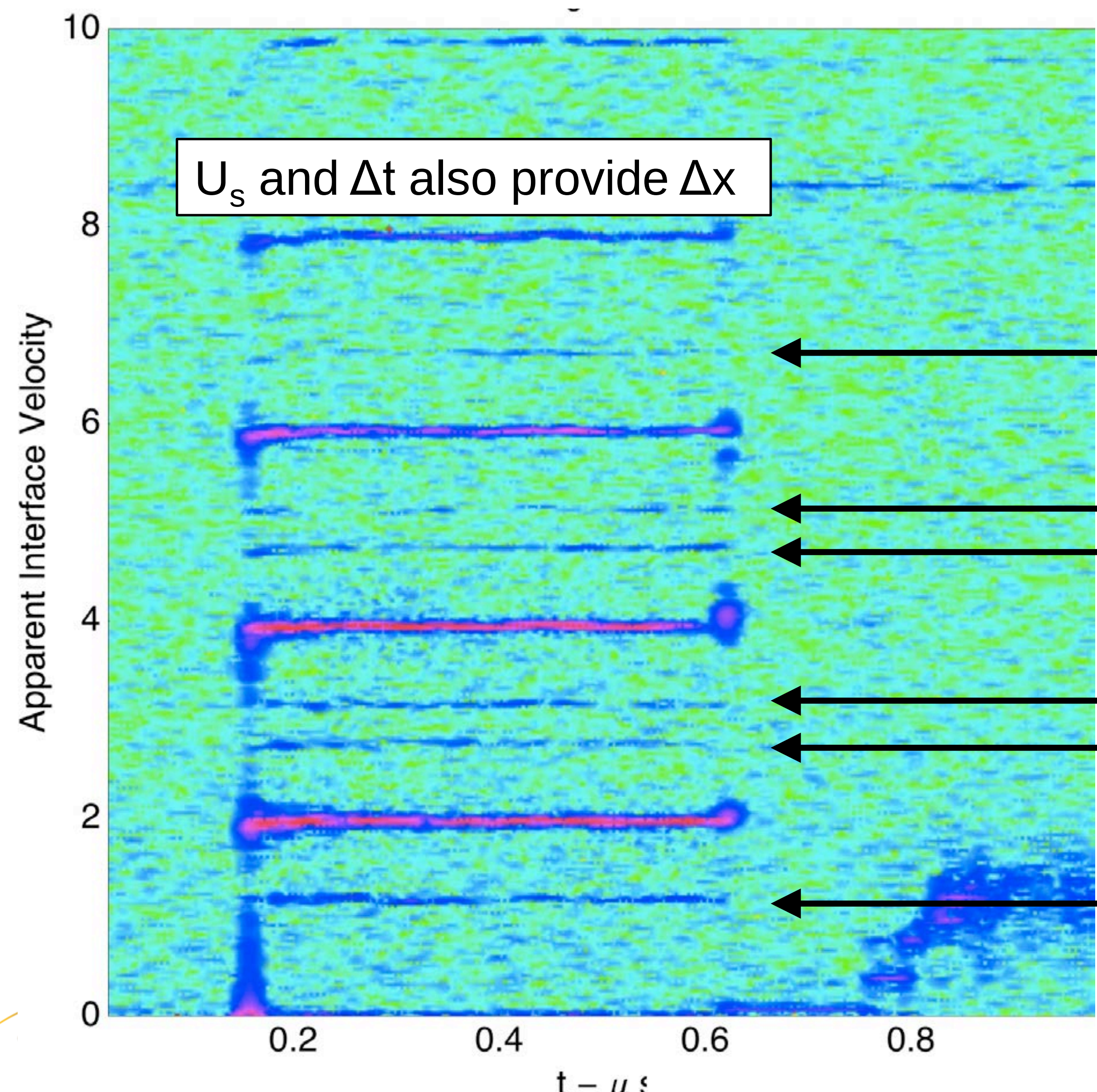


self consistent

$U_s = 2.77 \pm 0.03$ km/s

$u_{P2} + U_{s1} = 6.72$ km/s

$u_{P4} - U_{s1} = 5.11$ km/s

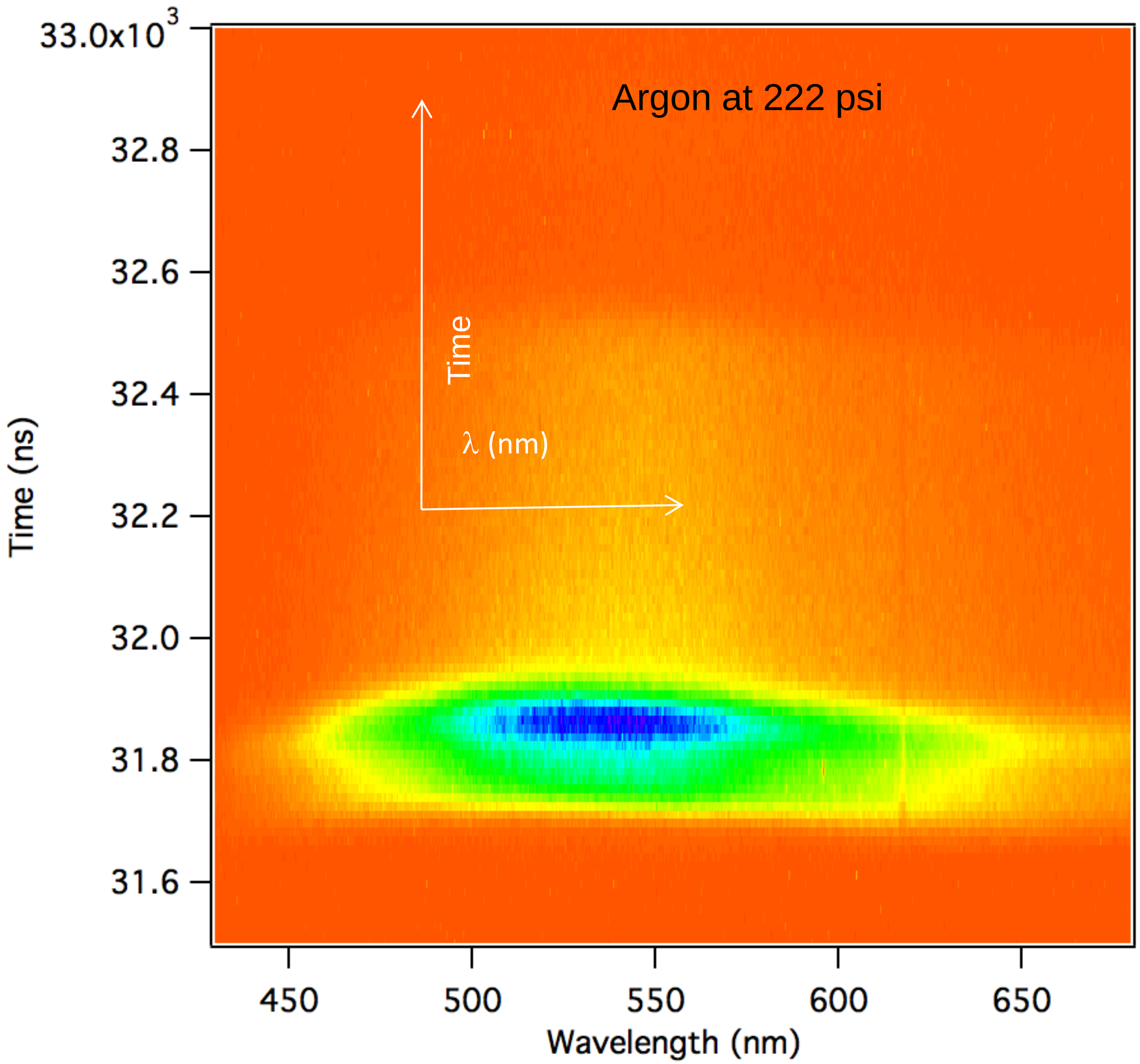
$u_{P1} + U_{s1} = 4.75$ km/s

$u_{P3} - U_{s1} = 3.15$ km/s

$U_{s1} = 2.75$ km/s

$u_{P2} - U_{s1} = 1.18$ km/s

Intense broadband emission from shocked Argon is responsible for reflection from shock front.



Temperatures
~ 5,000K first shock
~ 10,000K peak

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Summary

- A method for measuring EOS data for shocked gasses is shown.
- Particle velocity is measured, via PDV, from the free surface of the aluminum driver.
- Weak reflection from the shock front of shocked Argon gas allows a direct measurement, via PDV, of the shock velocity.
- Other shocked gasses provide much stronger reflections making it more difficult to determine the “free surface” velocity of the aluminum driver.
- Off Hugoniot states are achieved via ring up between the aluminum driver and the sapphire anvil. Measurements are made with both PDV and VISAR.

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