SHOCK INITIATION MEASUREMENTS USING MULTIPLE SAMPLES & INSTRUMENTED WITH PDV

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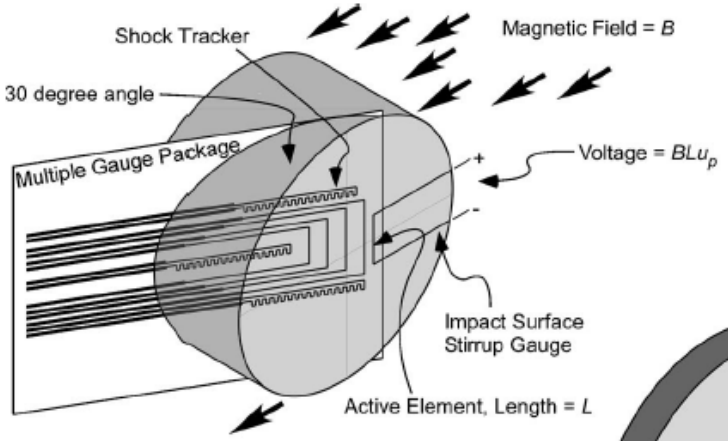
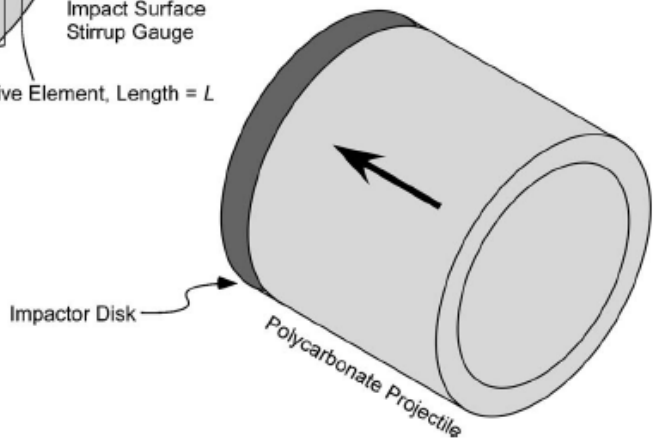
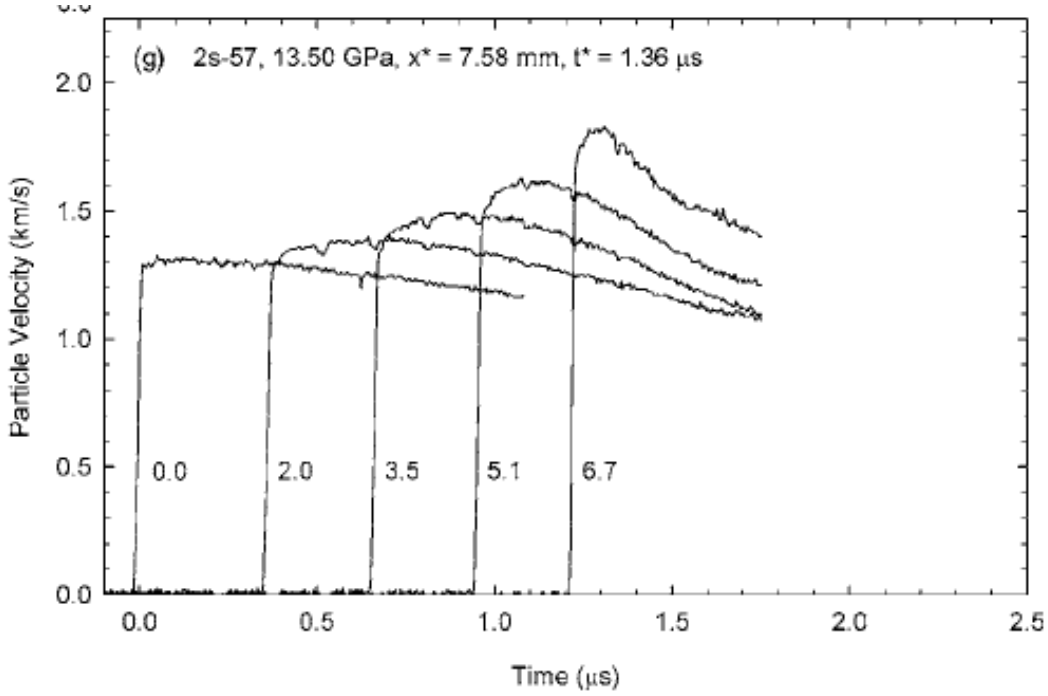
Experiment we hoped to replicate using PDV



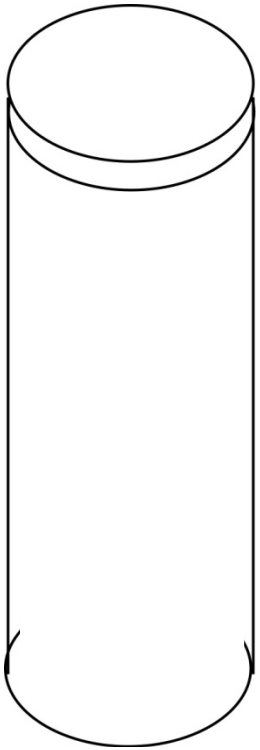




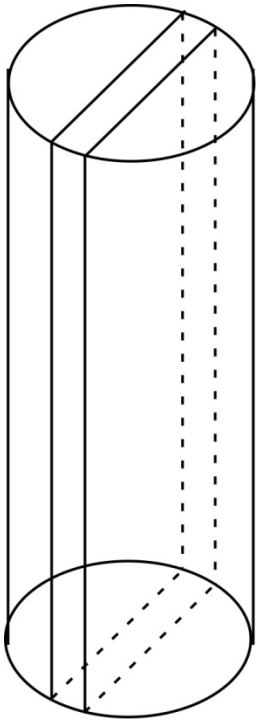
Gustavsen, Sheffield, and Alcon, J. Appl. Phys., 99, 114907 (2006)

Why PDV?

Disks



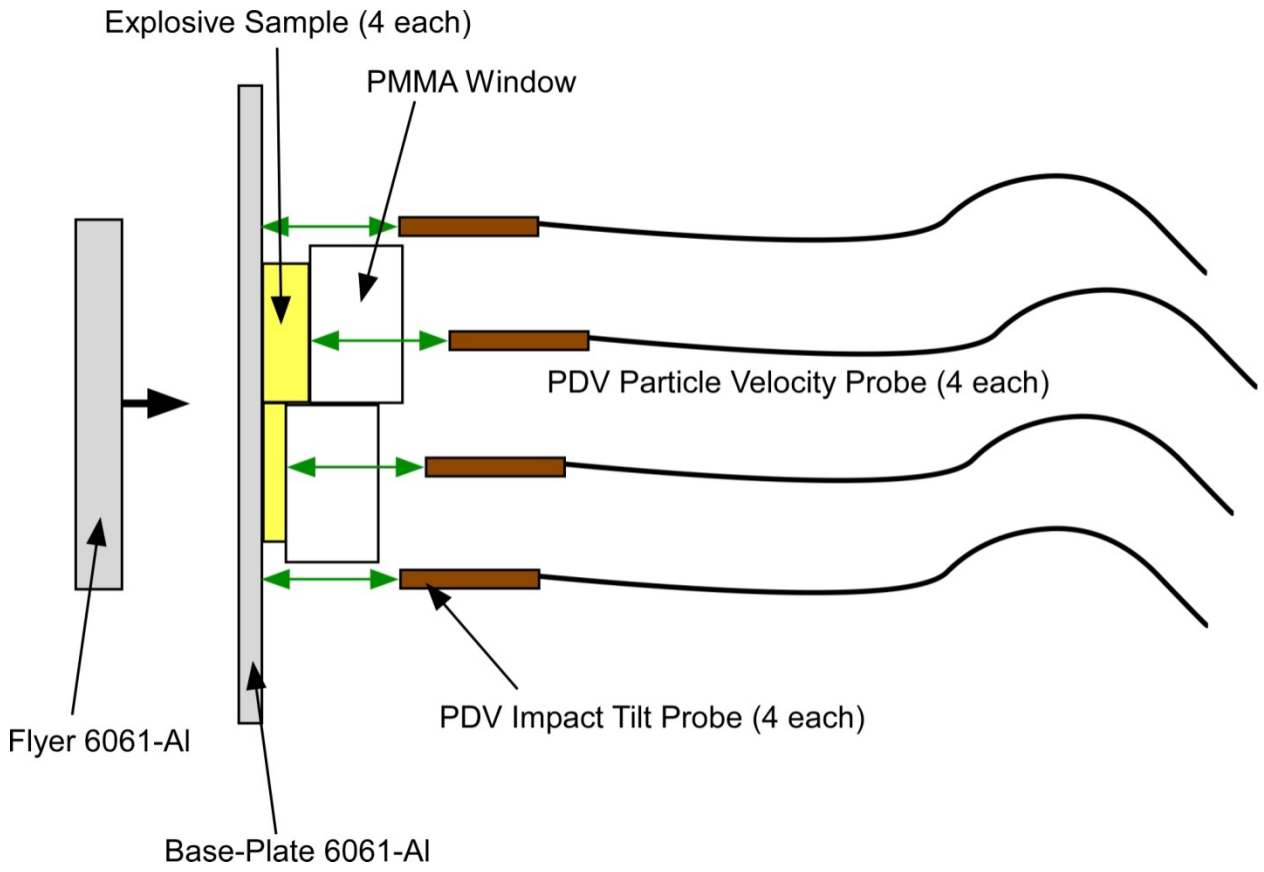
Samples came in form of 25 mm diameter rods. Magnetic gauge experiments require 50 mm diameter cylinders. We still wanted measurements at multiple depths.



Slabs

Samples were cut as shown to look for possible orientation effects

Plate impact experiment



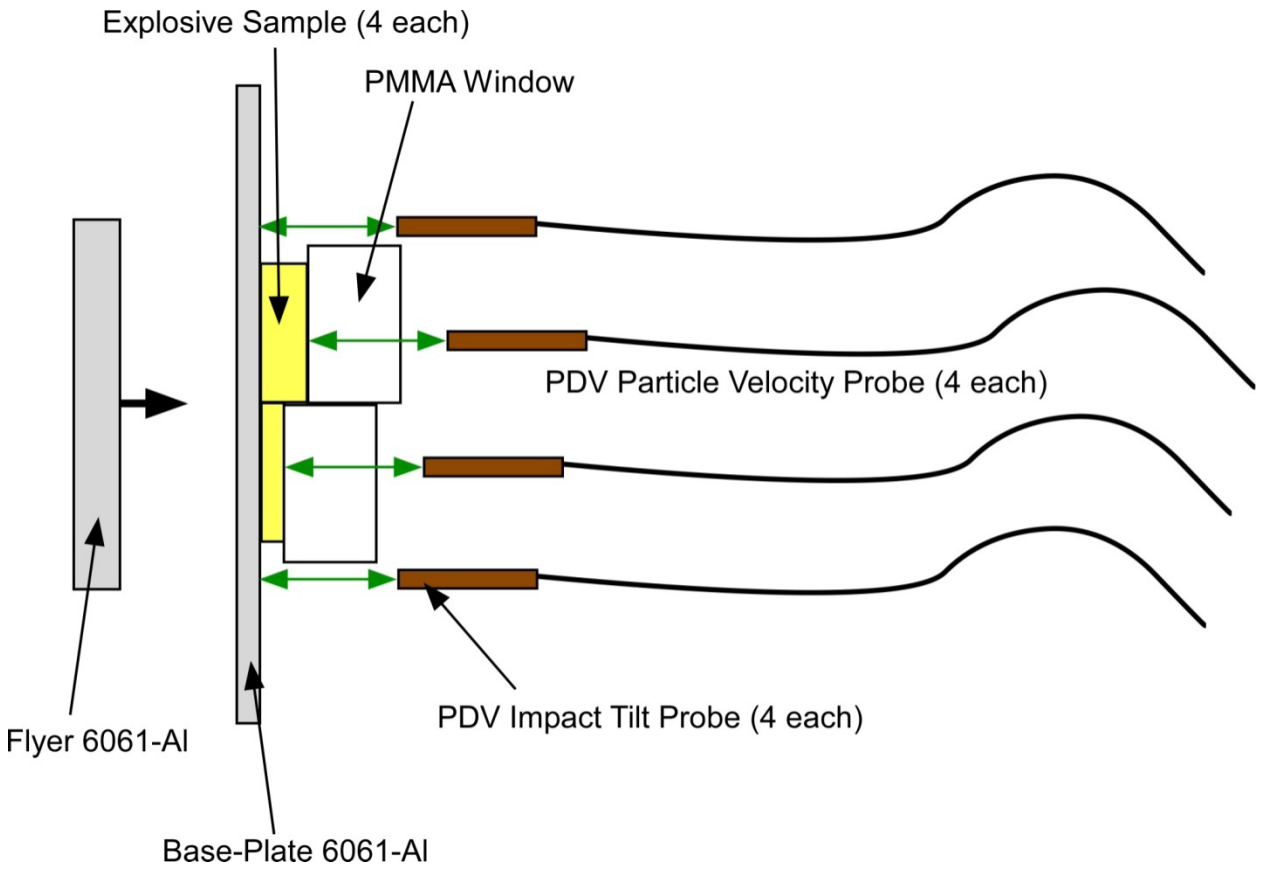
1550 nm PMMA window correction factor. (I used 1.00)

Shot #	Apparent Velocity (km/s)	True Velocity (km/s)	Correction factor
2s-401	1.584(7)	1.572(8)	1.008
AWE-1	0.2059	0.2192	0.94
AWE-2	0.2121	0.2179	0.97
AWE-3	0.4457	0.456	0.977

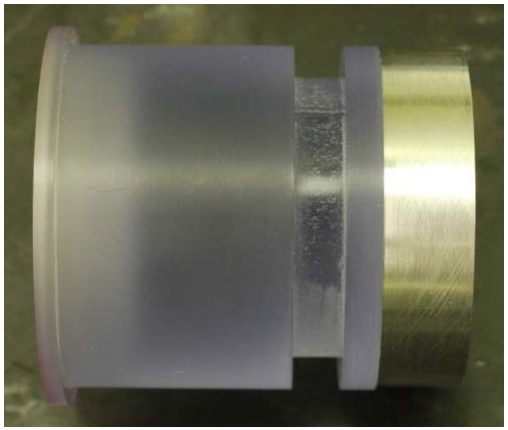
AWE data from Pete Keightley

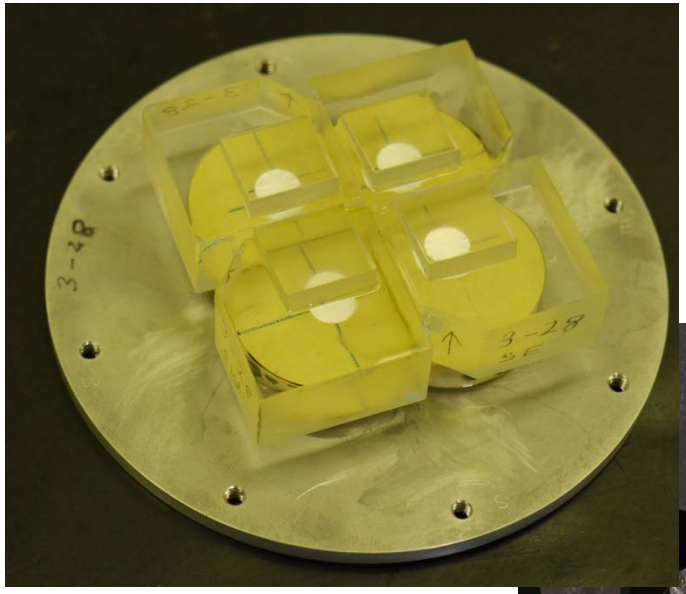
Correction factors for 514 nm 1.00, J. Wackerle, SPIE (1987)
Correction factor 532 nm 0.99, L. Barker, supplied with VALYN VISAR

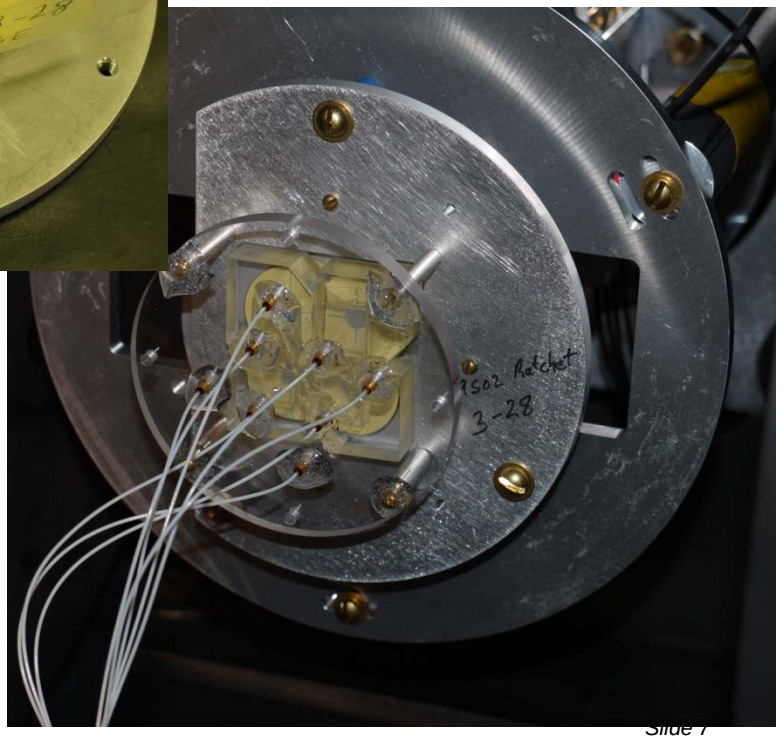
Plate impact experiment

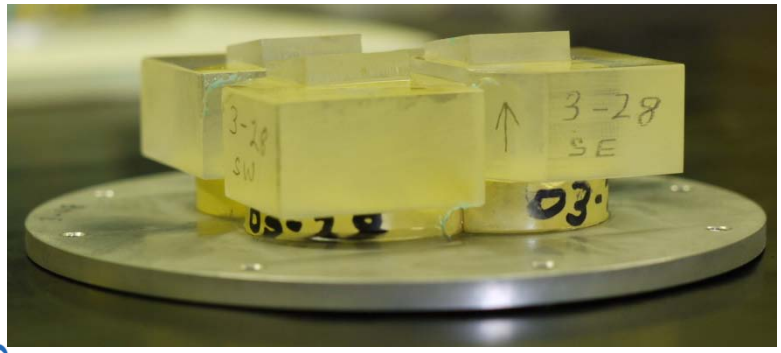


Impact Experiment – Photos (shot 2s-405)
Note – AC Photonics collimating probes, 8˚ wedges

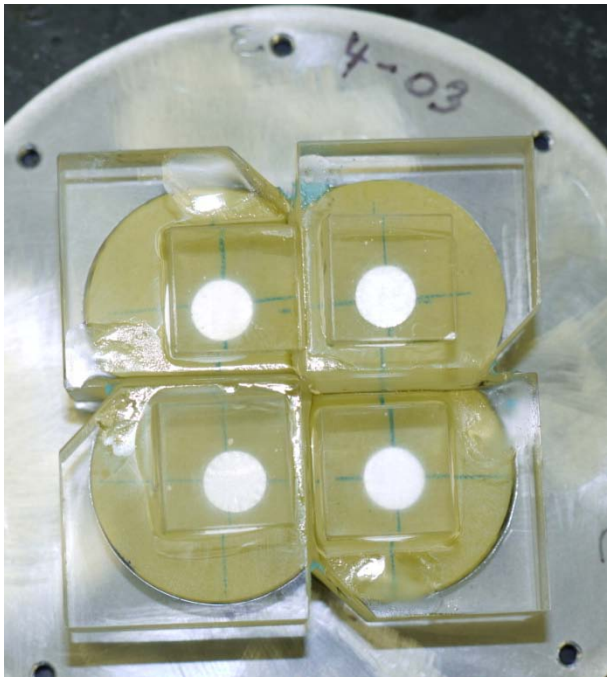


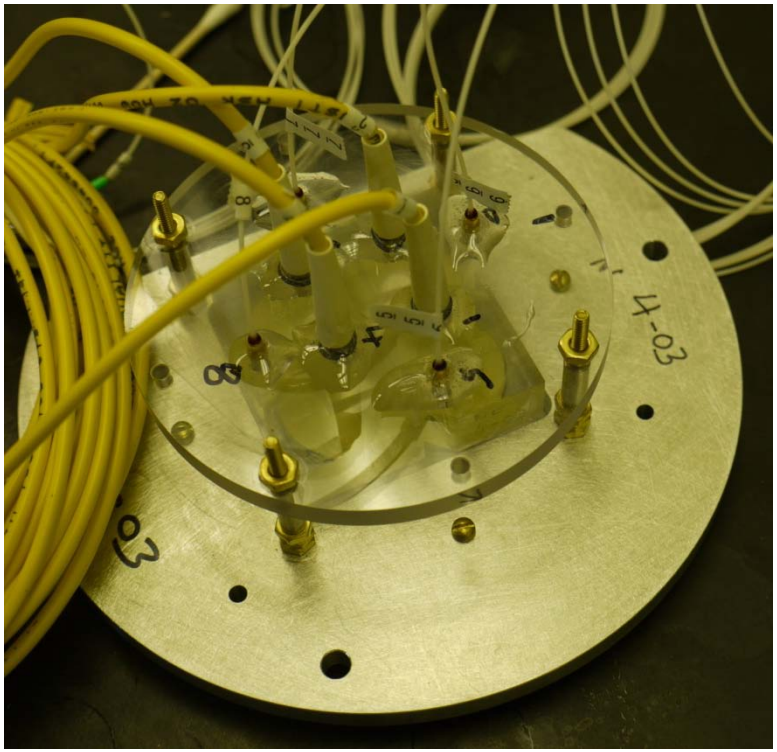


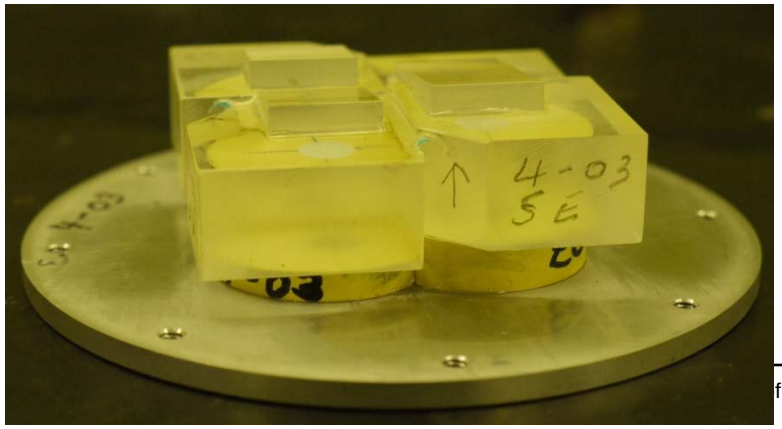




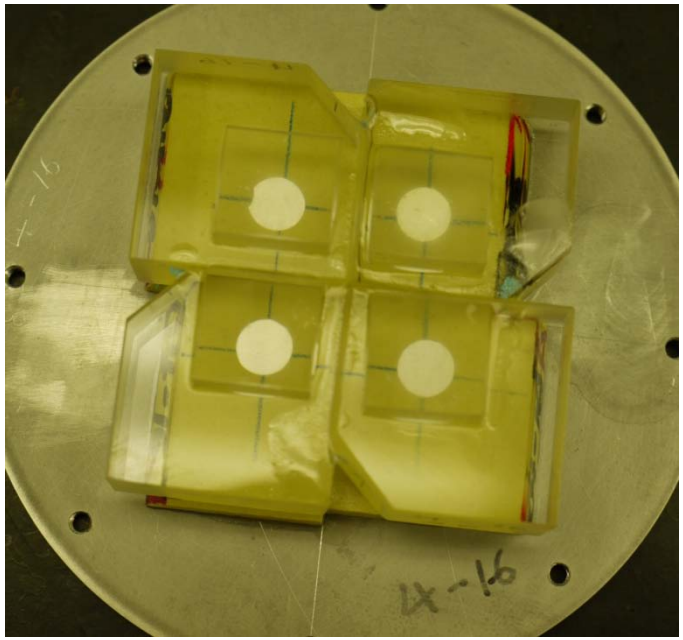
Impact Experiment – Photos (Shot 2s-412)
Note Oz-optics 21 mm focusing probe

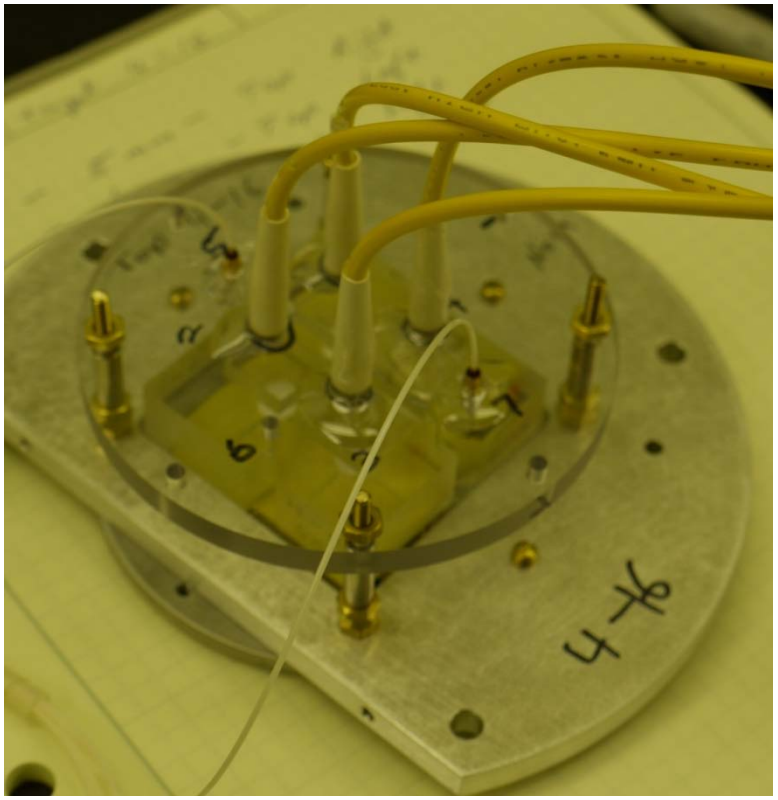


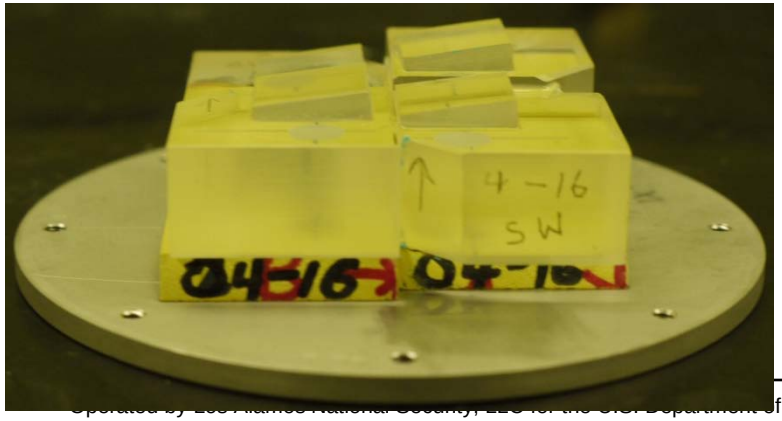




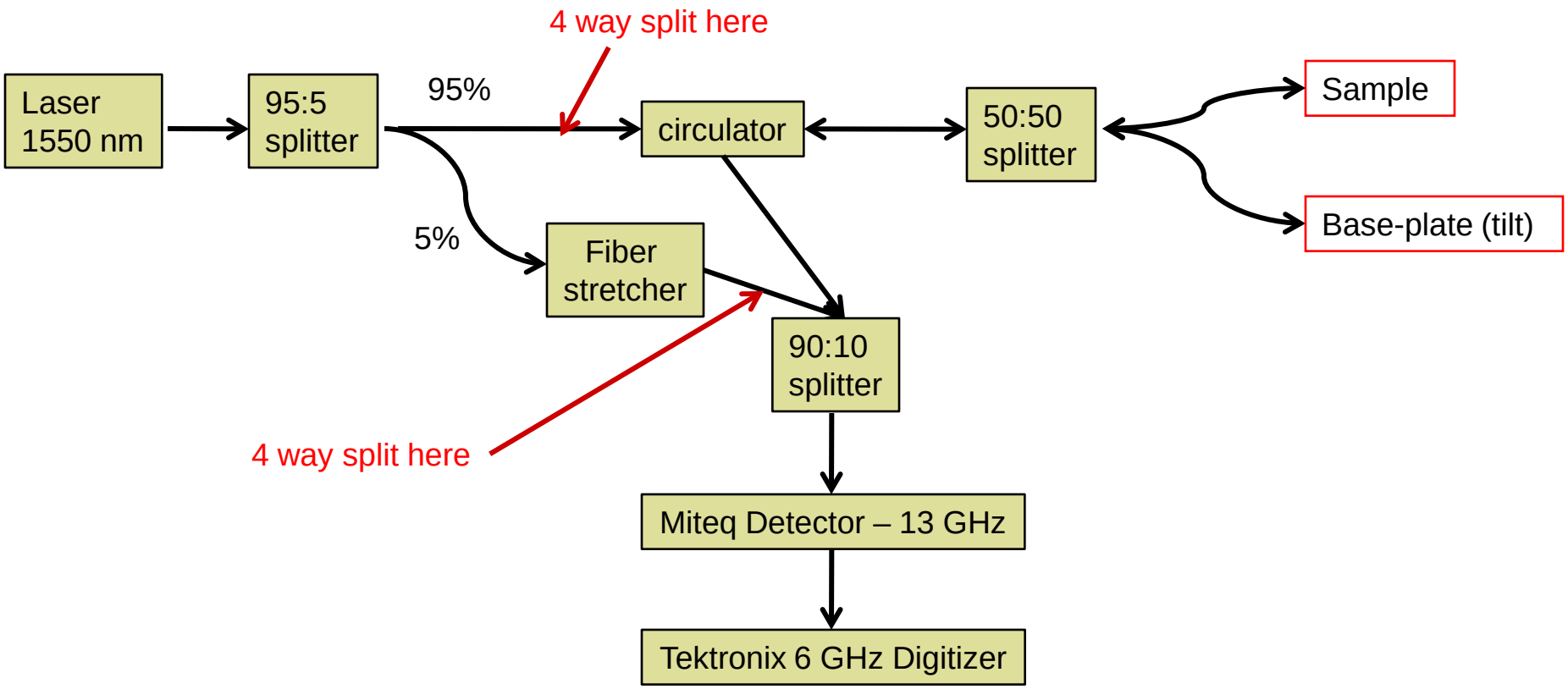
Impact Experiment – Photos (Shot 2s-413)
The samples were cut as slabs, parallel to the axis of the rod.



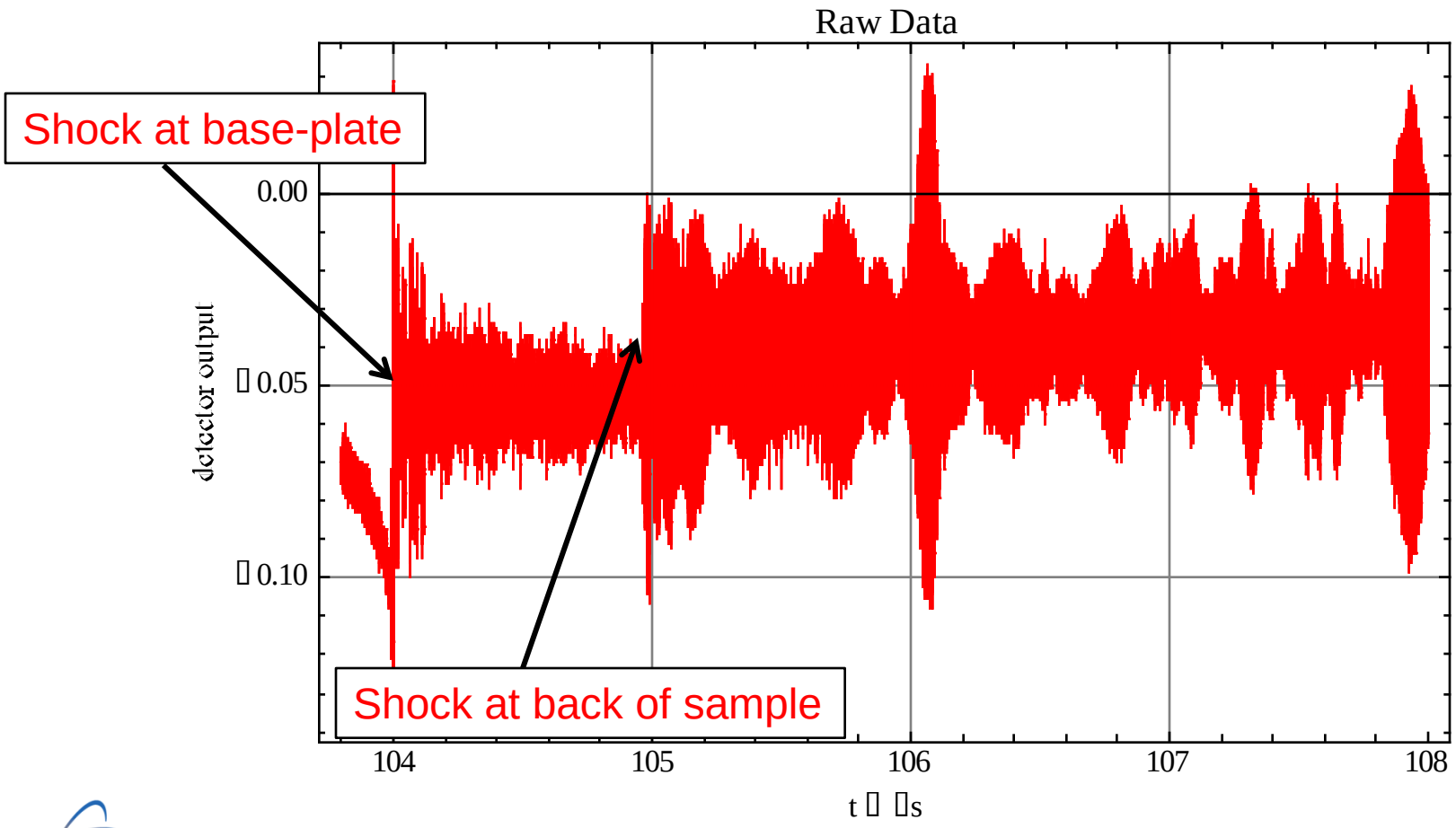




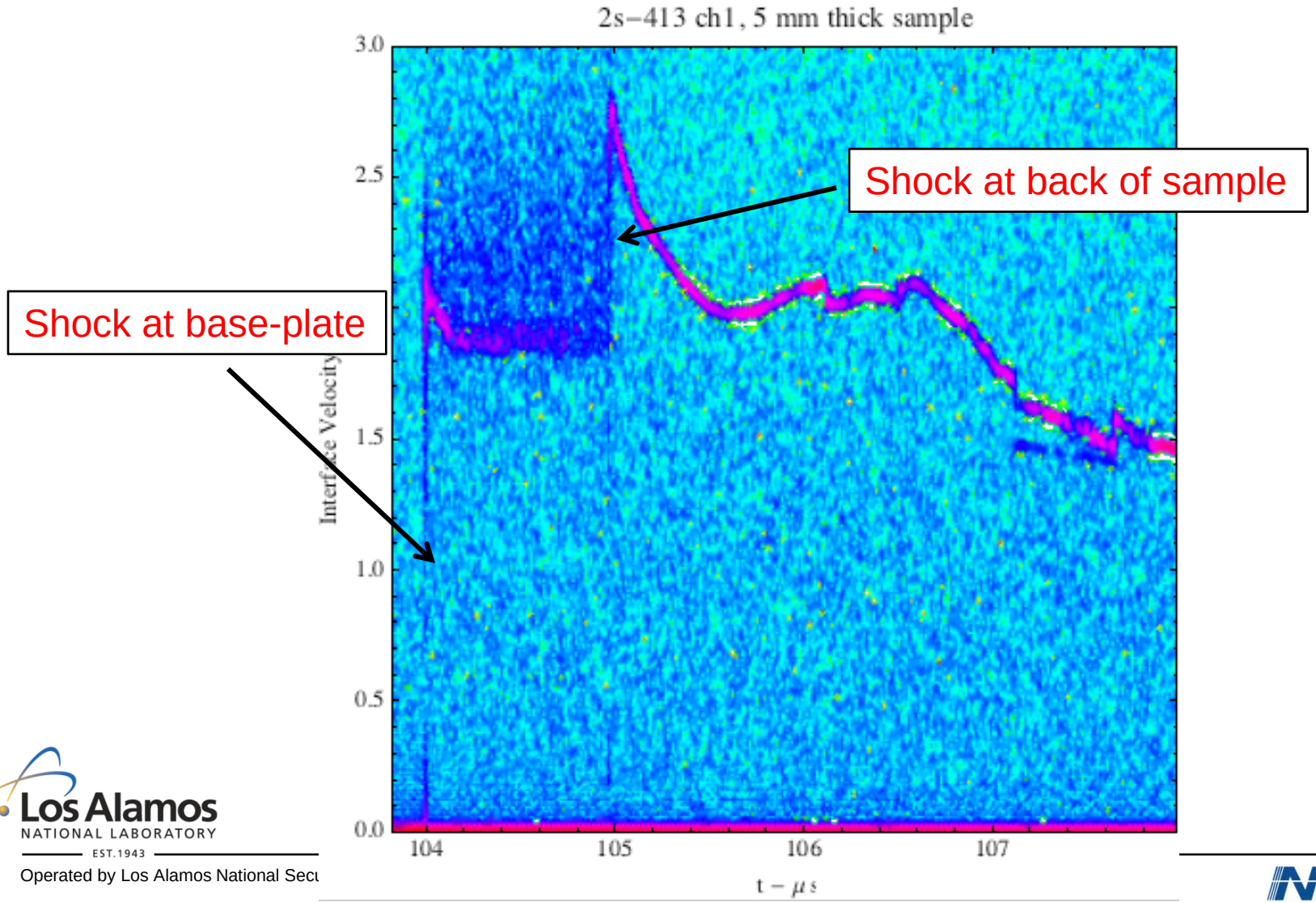
Optical layout and Interferometer setup



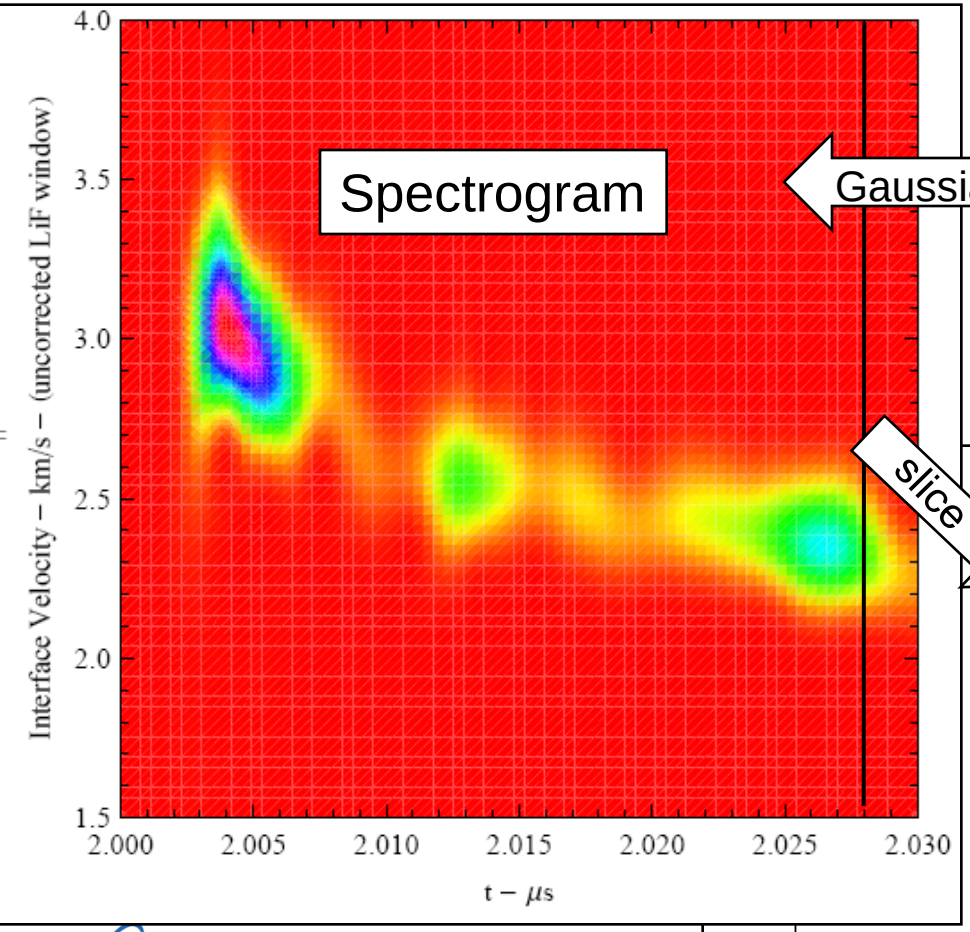
Raw Data (example)



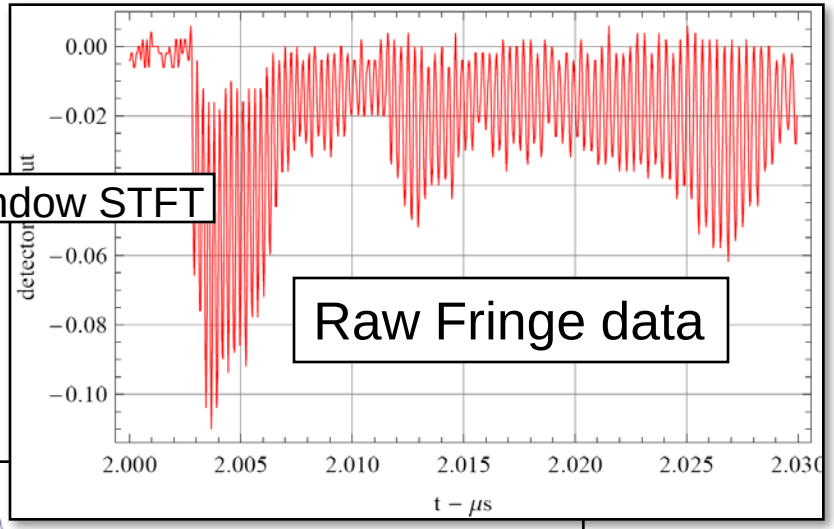
Spectrogram (example)



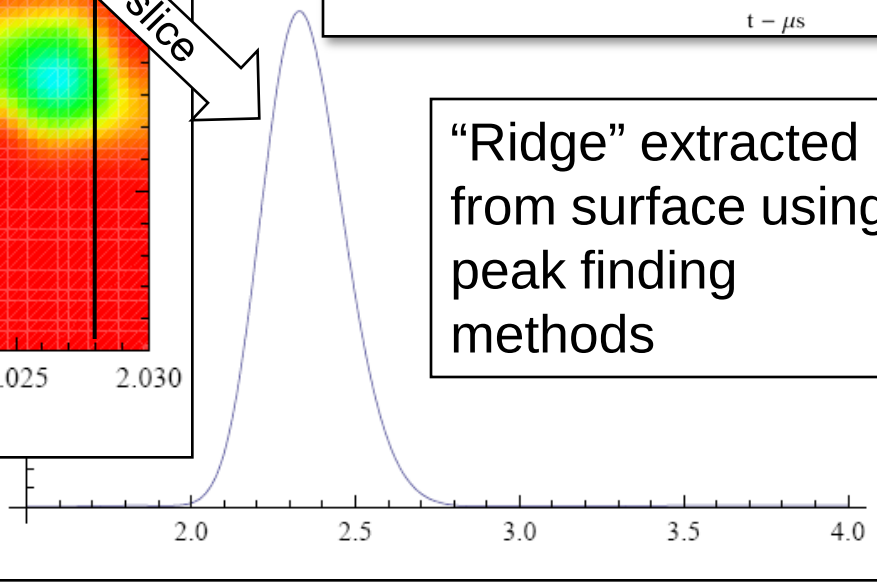
Time - Frequency Analysis: "Time resolution" defined by FFT window size.



Gaussian window STFT

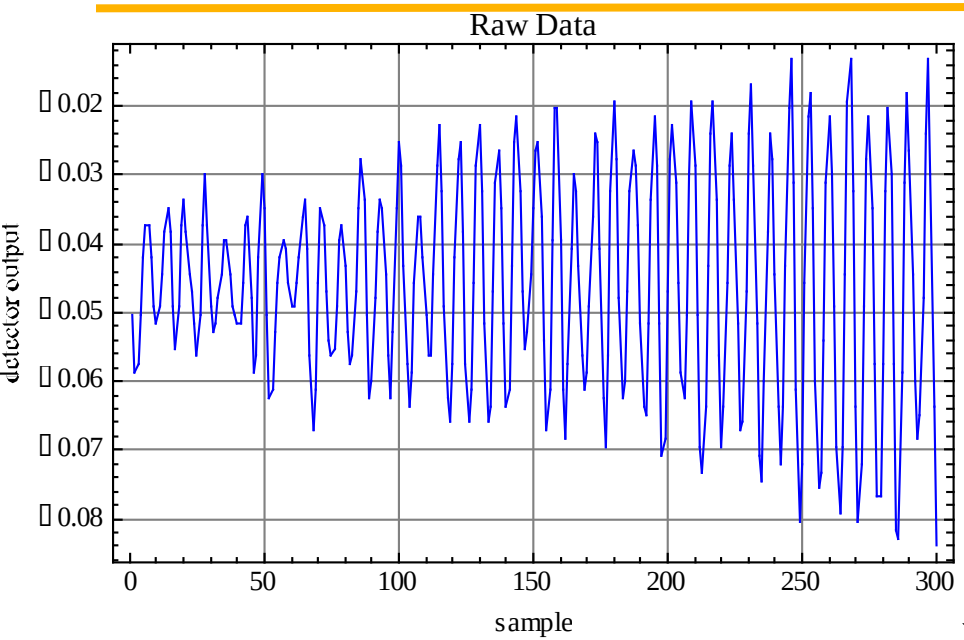


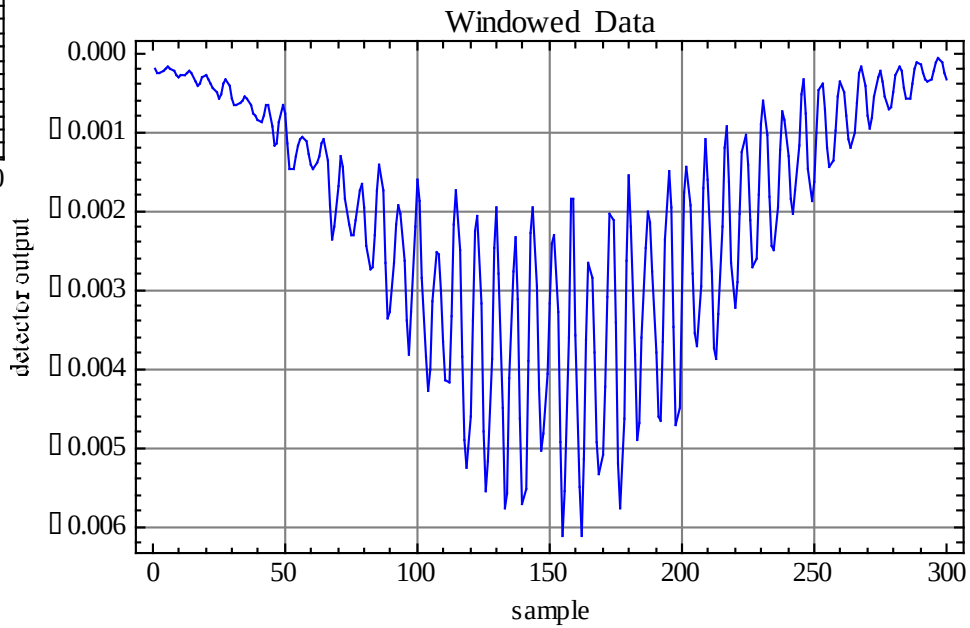
slice



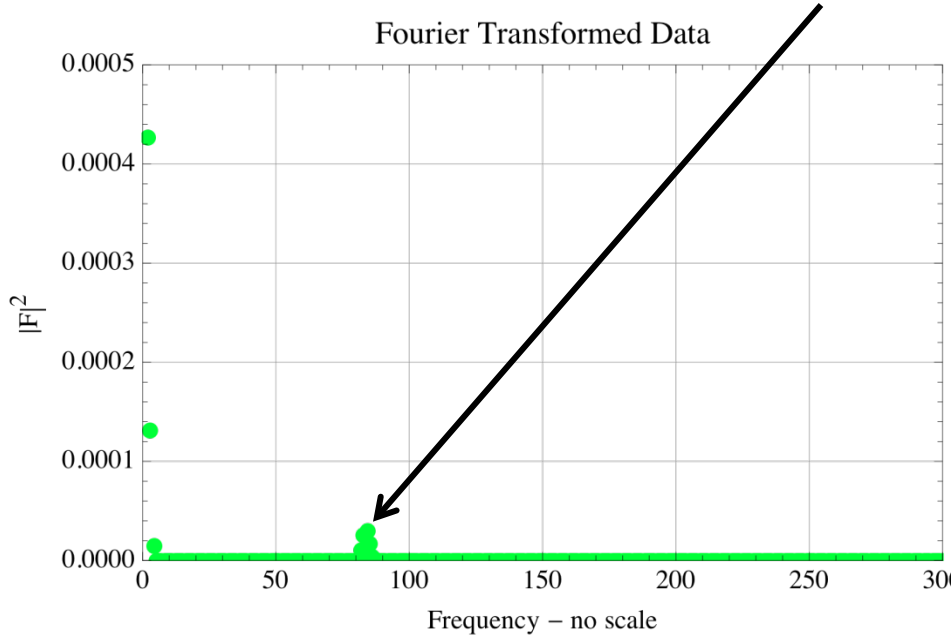
"Ridge" extracted from surface using peak finding methods

Raw data and Windowed data

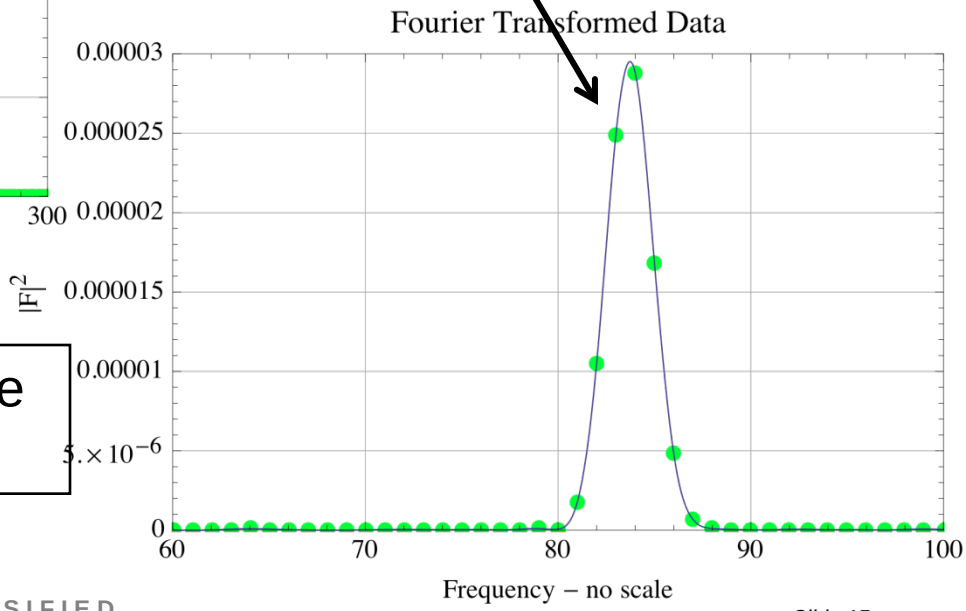




Fourier transformed data



After interpolation with 3rd order spline.



Interpolation is actually in both time and frequency directions.

Another method for finding the peak

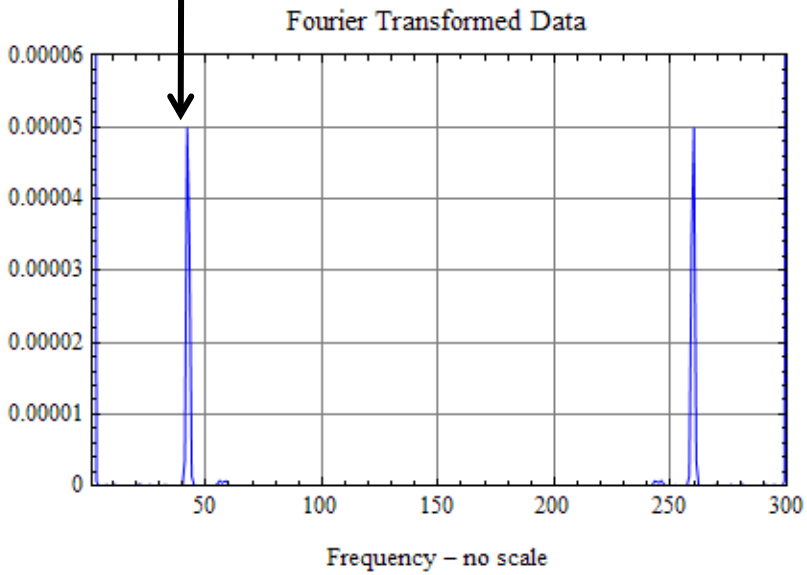
Frequency Shift

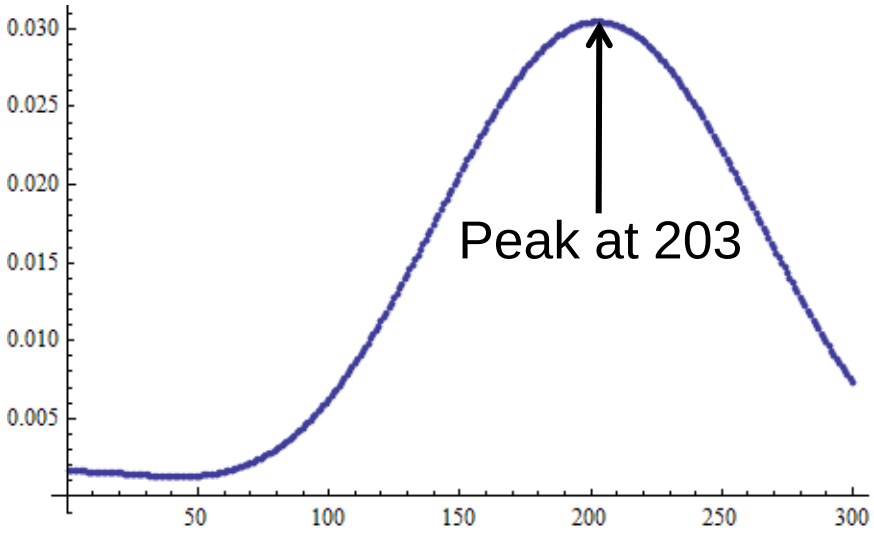
$$\exp(i2\pi\omega t)\, f(t) \rightarrow F(s-\omega)$$

Fractional Fourier Transform

$$F_n = \sum_{k=0}^{N-1} f_k \exp(ib2\pi nk / N)$$

Peak at 42



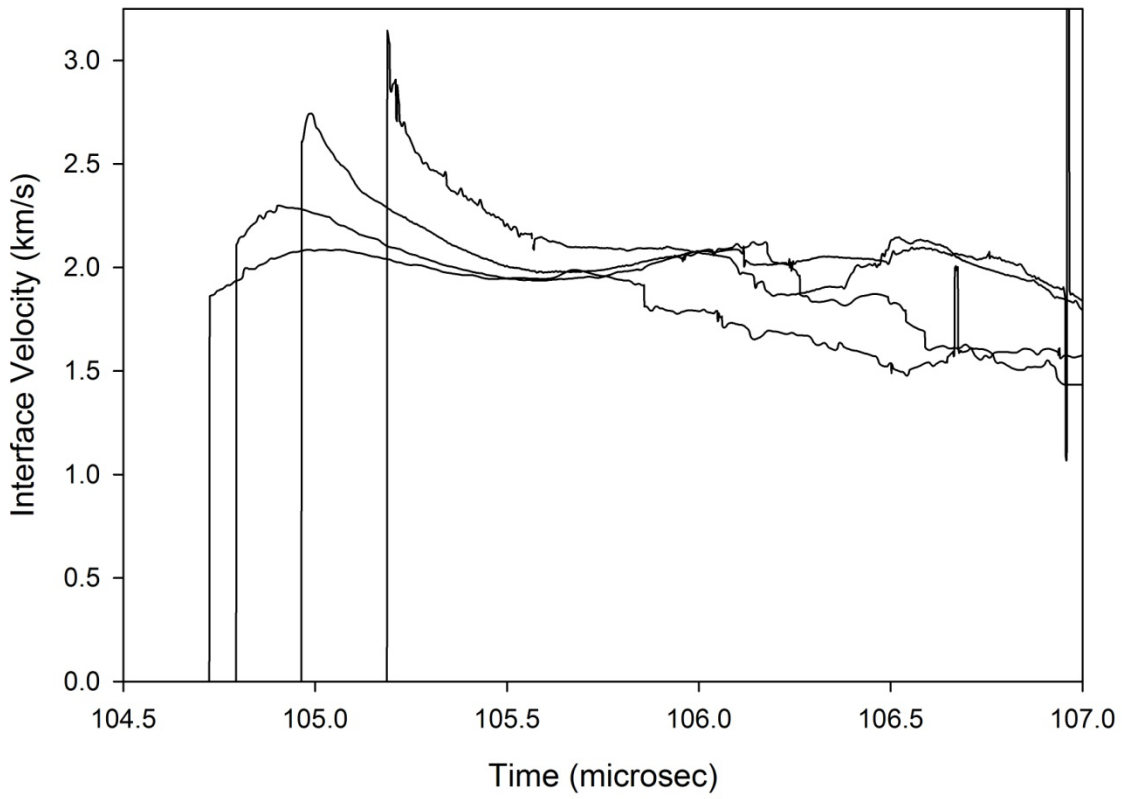


$$freq. = [42-2] - (203-1)\left(\frac{2}{300}\right) = 41.347$$

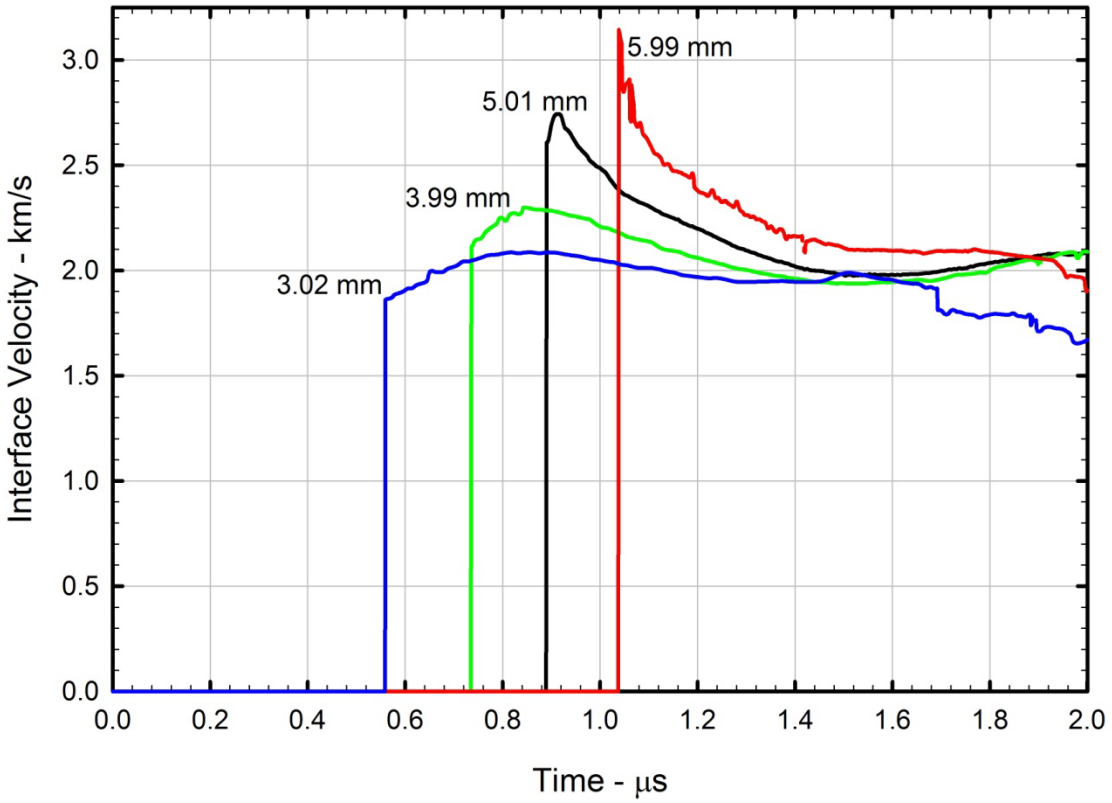
Shift

Fraction, b

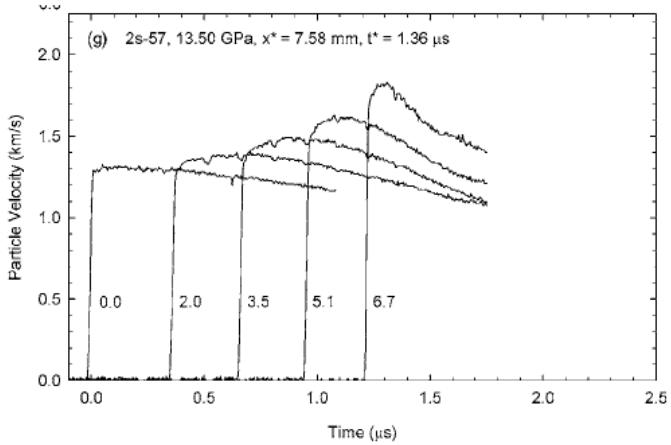
Shot 2s-413 data prior to correcting for tilt – raw time



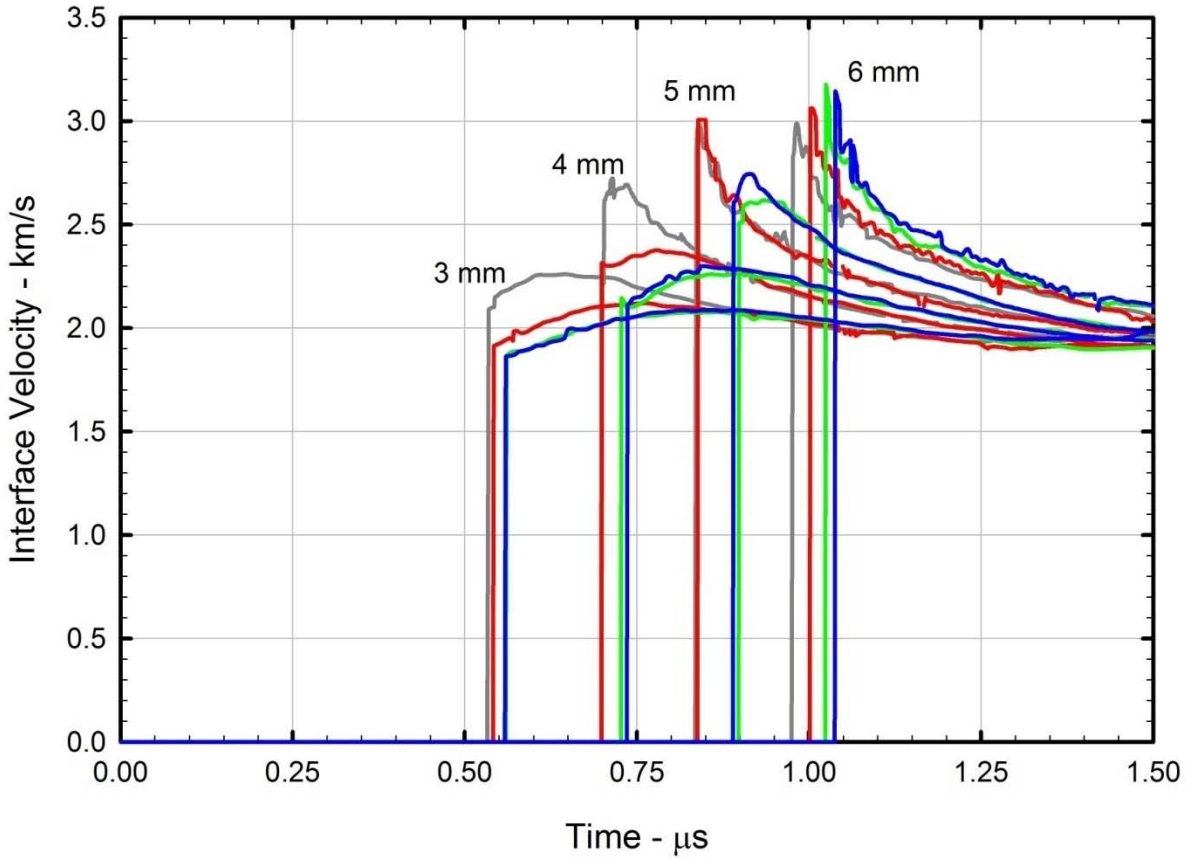
Shot 2s-413 corrected for tilt and time origin



- Impact velocity 2.138 km/s
- Impact Pressure ~ 13.62 Gpa
- Tilt ~ 11 mrad. Top first.
- Nominal distance to detonation 6.2 mm



Four experiments, different materials, same input, different sensitivity



Conclusions

- Methods for measuring wave-profiles from multiple samples presented.
- Wave evolution displayed, similar to that seen in embedded gauge measurements.
- Base-plate and sample signals multiplexed onto same detector. Signals must be separated in time and/or space.
- Tilt corrections are important in this type of experiment.