Velocity Measurements from the Helen Laser

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Measuring Velocity is easy -

Displacement as a function of time

Differential of position with respect to time

Rate of change of position \((x)\)

Integral of acceleration with respect to time

Displacement divided by time
No substitute for seeing what is happening – Side on Radiography

An experiment doesn’t have to work in order to produce interesting data
- Face on Imaging / Passive Shock Breakout Diagnostic

- Sol Gel AR coated optics.
- Achromatic doublets to minimise chromatic aberration.
- Heavy filtering (OG590) to reject KJ second harmonic drive beams.
- Piezo drives for remote positioning.
Equation of State

Flat

Stepped

Wedged
Early Interferometry – you don’t have to spend a lot of money!!

Targets were fired with gold preheat shields 0,1,2,3,4 and 20µm thick.

Experimental Parameters.

- Probe beam wavelength = 685nm
- Coherence length = 2.5cm
- Streak window = 9ns

Typical streak record showing fringe motion before shock breakout due to thermal surface expansion caused by preheat.

Software has been developed which tracks the fringe position and allows surface velocities to be calculated.
Spallation revisited – classic material property signatures observed

- New laser diode
- Better coherence length
- Robust optical design
- Still short of light

Elastic precursor, acceleration, pull back and spallation break away observed at drives (7J) above material strength
Acceleration, pull back and negative velocity seen at drives (3J) below material strength
A longer window reveals permanent deformation for drives below material strength and -

- New laser diode
- Longer coherence length
- Brighter
- Better quality data
Ringing within the sample for drives above material strength

Elastic precursor, pull back, break away spallation signatures observed.
Spatially & Temporally Resolving Michelson Interferometer

- Ruby Laser
  6ns / 200ns Q-switch pulse

- 6mm OG590 filter glass
- Vacuum window

- 3 mm OG590 filter glass
- Streak Camera S20 photocathode

- 800mm focal length achromatic doublet

- 1/3 25mm dia. Achromatic doublet
- Sol Gel coated glass debris shield
- 500μm dia target
- Second harmonic drive beam

- Illumination system matched to collection system
- Sol Gel AR coated optics.
- Path lengths accurately matched
- Achromatic doublets to minimise aberration.
- Heavy filtering to reject kJ second harmonic drive beams.
- Piezo drives for remote positioning.
- Flat shock breakout
- Evidence of grain boundaries
- Different velocity profiles across different grains
Rarefaction moving in?

- Grain boundary
- Deceleration
- Acceleration
- Shock Breakout
- Stationary
- Time
- Late time pull back

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• Curvature on shock breakout
• Rarefaction moving in
• Grain boundary evidence

Adjacent Grains
different velocity profiles

Curved shock breakout
Rarefaction wave?

Time
Curved Shock Breakout

Rarefaction

Driven strongly on axis
Off Axis almost stationary

Rarefaction

Grain boundary evidence
Flat shock breakout

Acceleration

Deceleration

Acceleration

Pull back
Points to Consider -

• Diagnostics developed for one experiment often have applications for others.

• Achromatic doublets give better resolution for low f number optical systems.

• Don’t ignore spherical aberration.

• Useful material property data can be obtained from low energy laser shots.

• Inexpensive optical diagnostics can still produce useful data.

• Don’t ignore the engineering aspects - Stability is the aspiration goal.

• Each optic in your system has the potential to degrade contrast.

• Don’t focus on more signal, focus on better contrast.

• Should target surfaces be polished shiny or left natural?
Question -

Michelson / VISAR / HetV?