Velocity Measurements from the Helen Laser

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Measuring Velocity is easy -

Integral of acceleration
with respect to time

Displacement as a
function of time

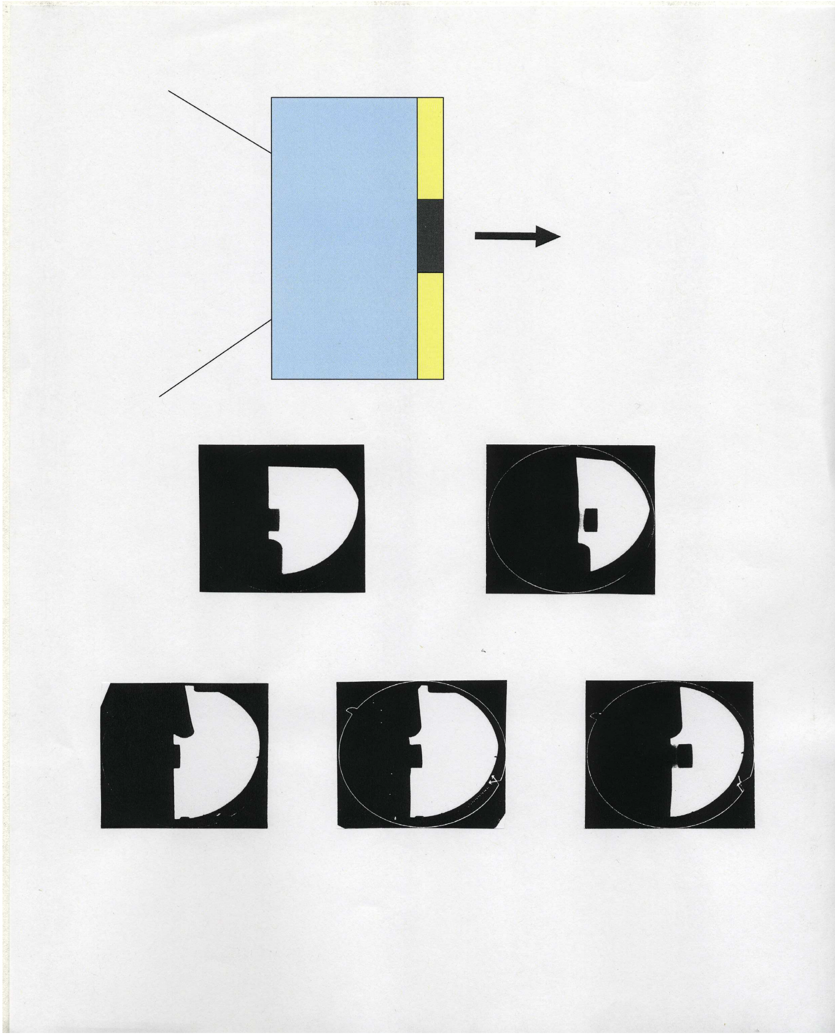
Differential of position
with respect to time

$$\frac{dx}{dt}$$

Rate of change of position (x)

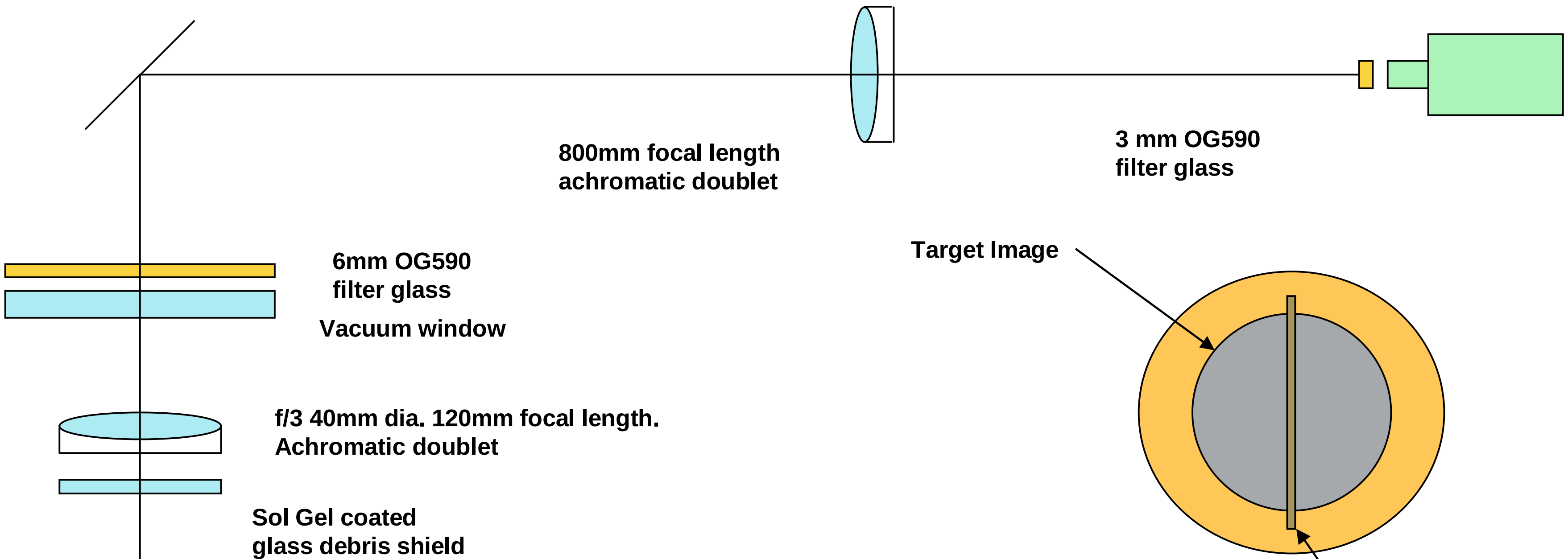
Displacement divided by time

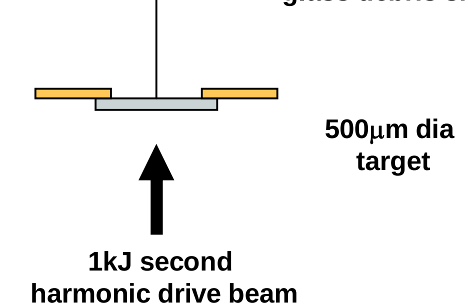
No substitute for seeing what is happening – Side on Radiography



An experiment doesn’t have to work in order to produce interesting data

- Face on Imaging / Passive Shock Breakout Diagnostic

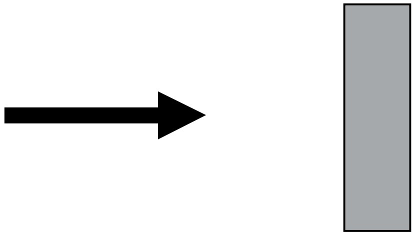


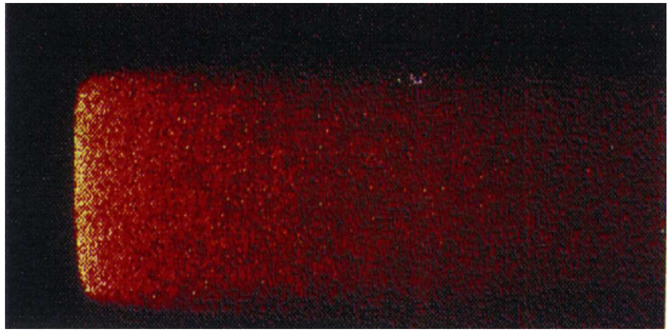


- Sol Gel AR coated optics.
- Achromatic doublets to minimise chromatic aberration.
- Heavy filtering (OG590) to reject KJ second harmonic drive beams.
- Piezo drives for remote positioning.

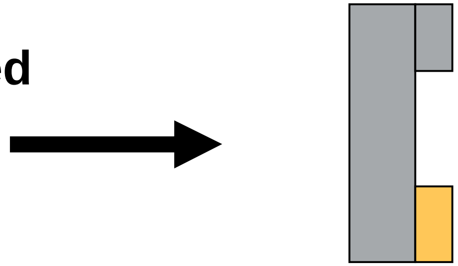
Equation of State

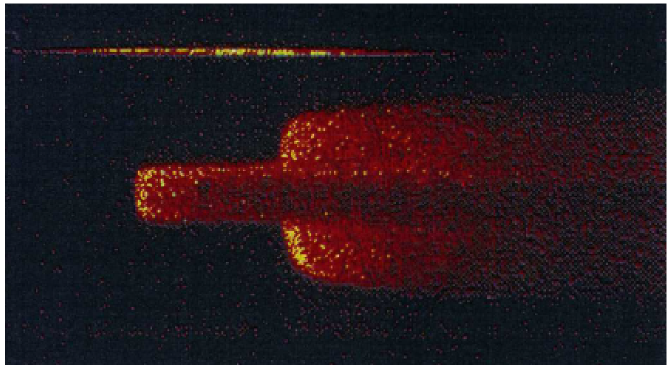
Flat



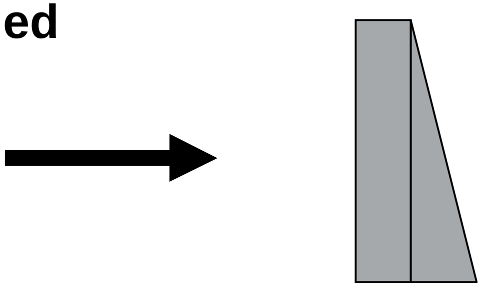


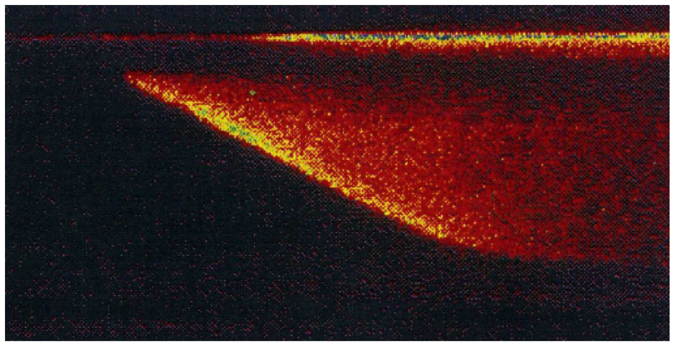
Stepped



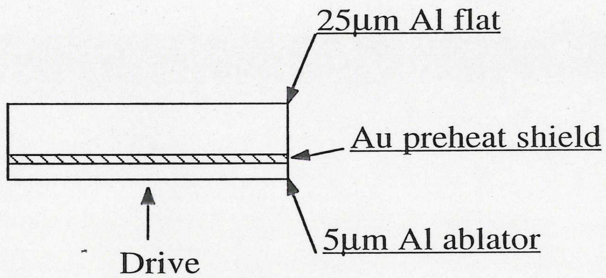


Wedged





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



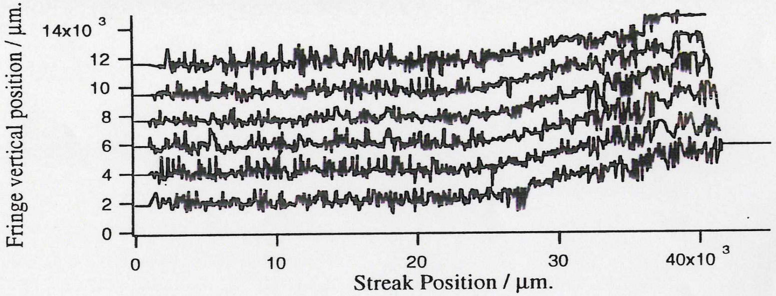
Targets were fired with gold preheat shields 0,1,2,3,4 and 20µm thick.

Time →

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

Experimental Parameters.

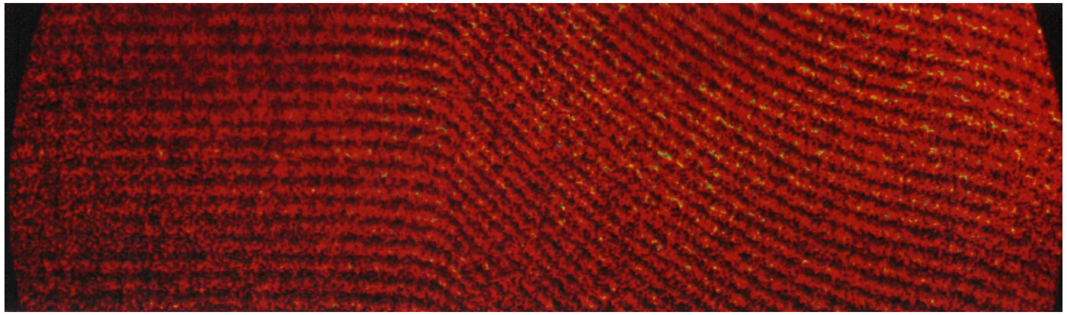
Probe beam wavelength = 685nm
Coherence length = 2.5cm
Streak window = 9ns

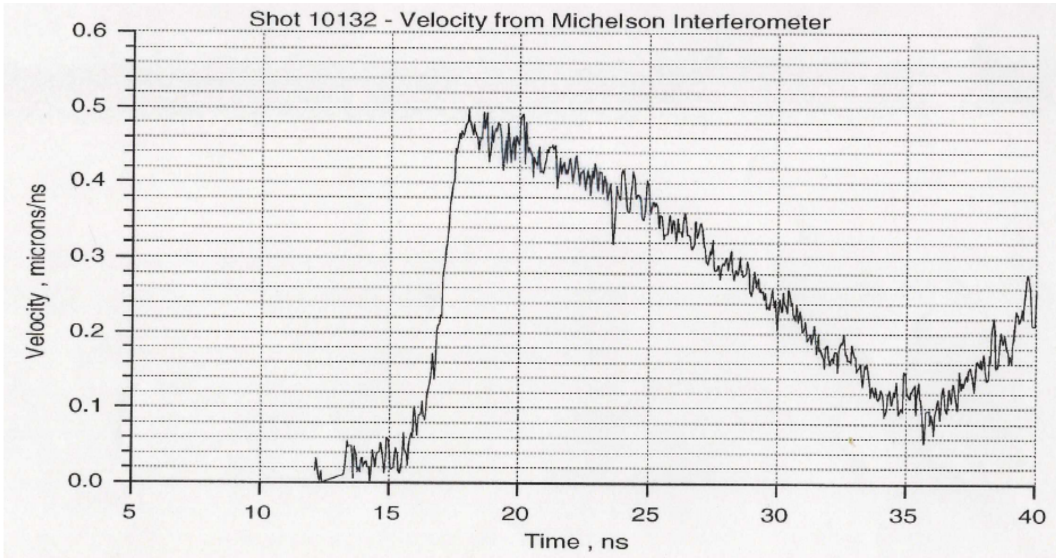


Software has been developed which tracks the fringe position and allows surface velocities to be calculated.

Spallation revisited – classic material property signatures observed

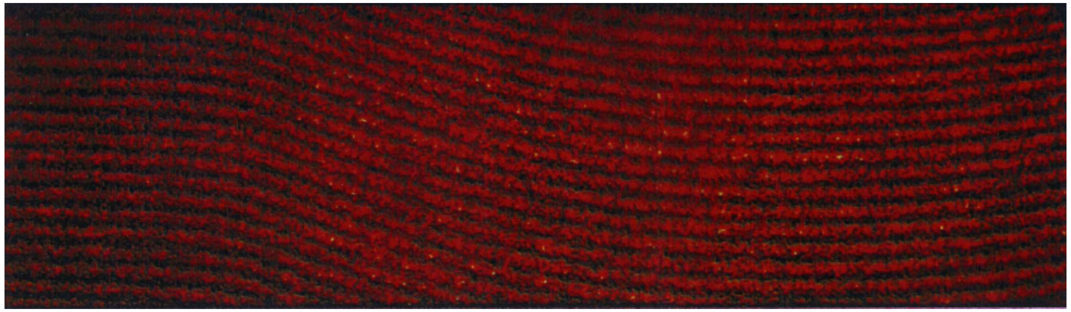
- New laser diode
- Better coherence length
- Robust optical design
- Still short of light

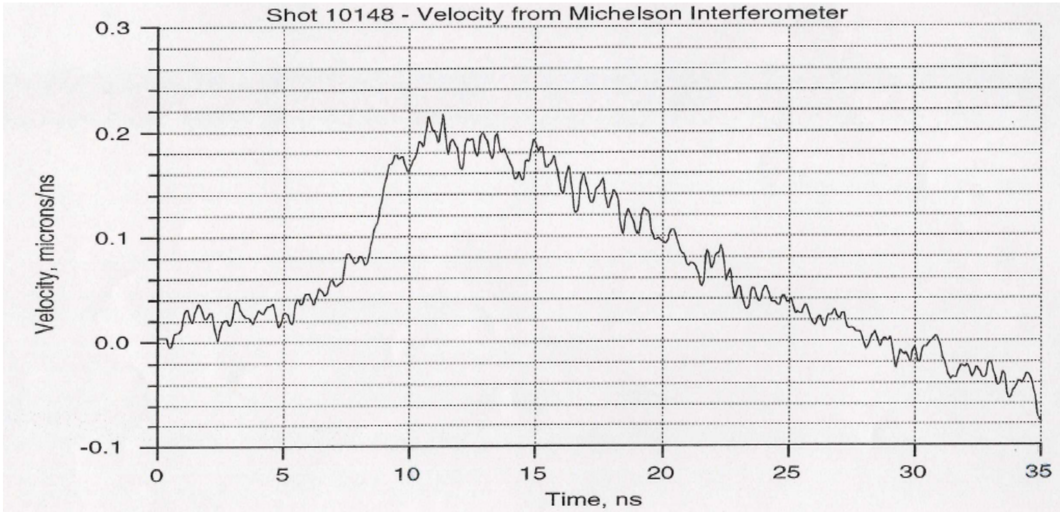




Elastic precursor, acceleration, pull back and spallation break away observed at drives (7J) above material strength

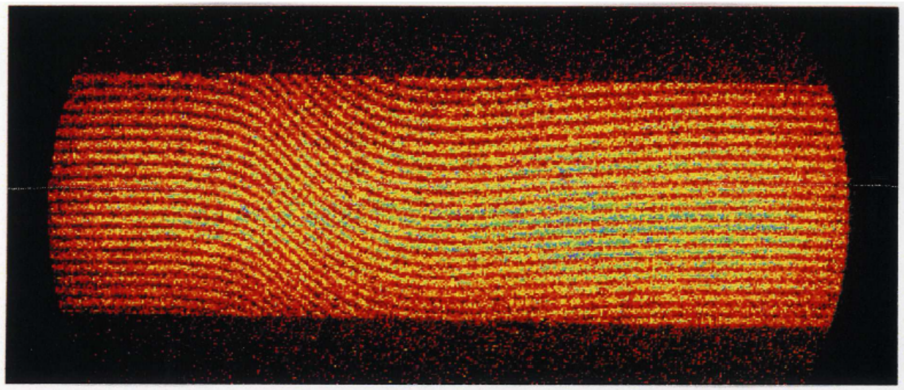
Acceleration, pull back and negative velocity seen at drives (3J) below material strength



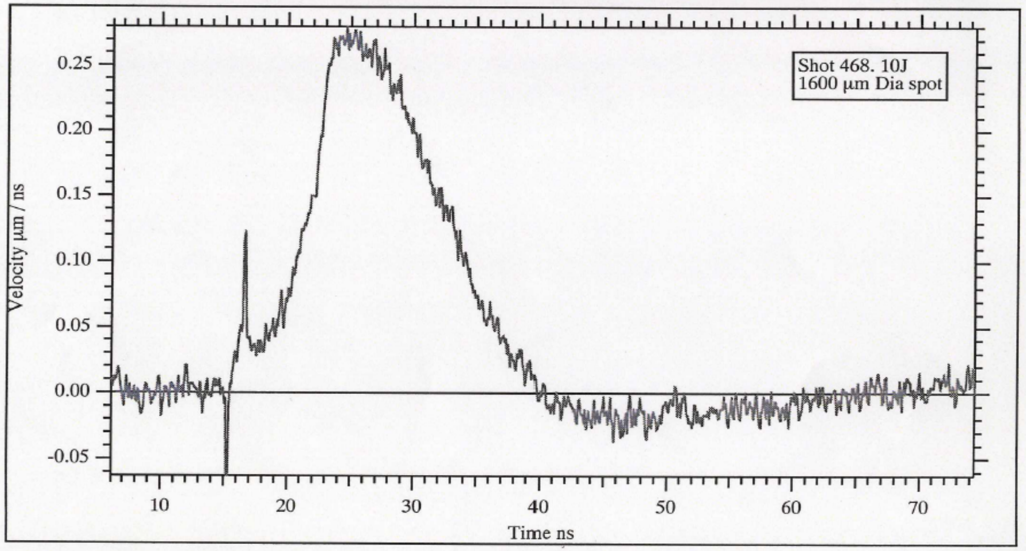


A longer window reveals permanent deformation for drives below material strength and -

Shot no. 468
Laser Energy = 10J
1600 micron Dia. Spot

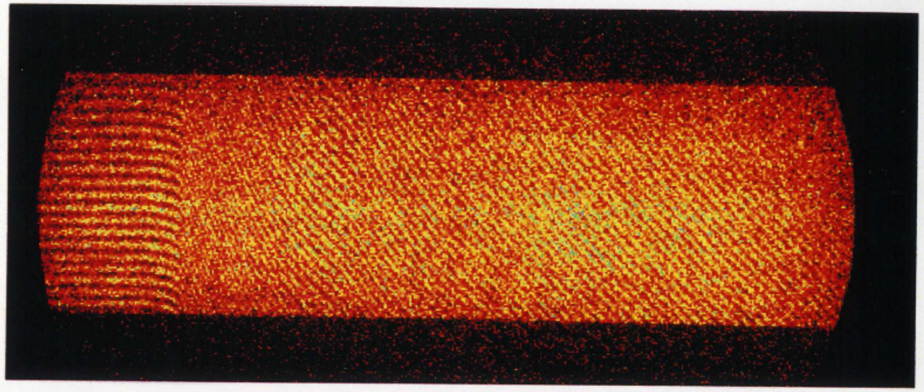


- New laser diode
- Longer coherence length
- Brighter
- Better quality data

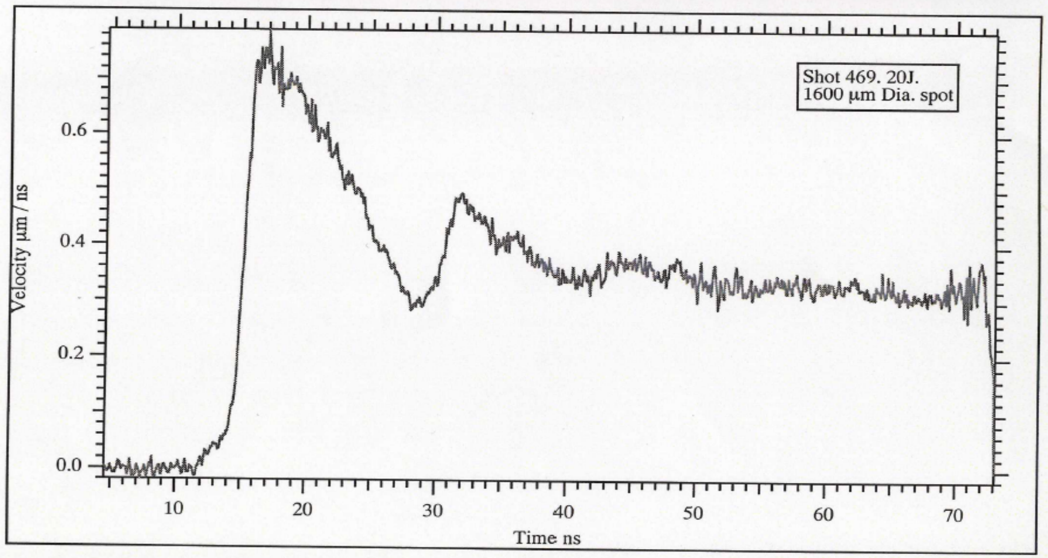


Ringing within the sample for drives above material strength

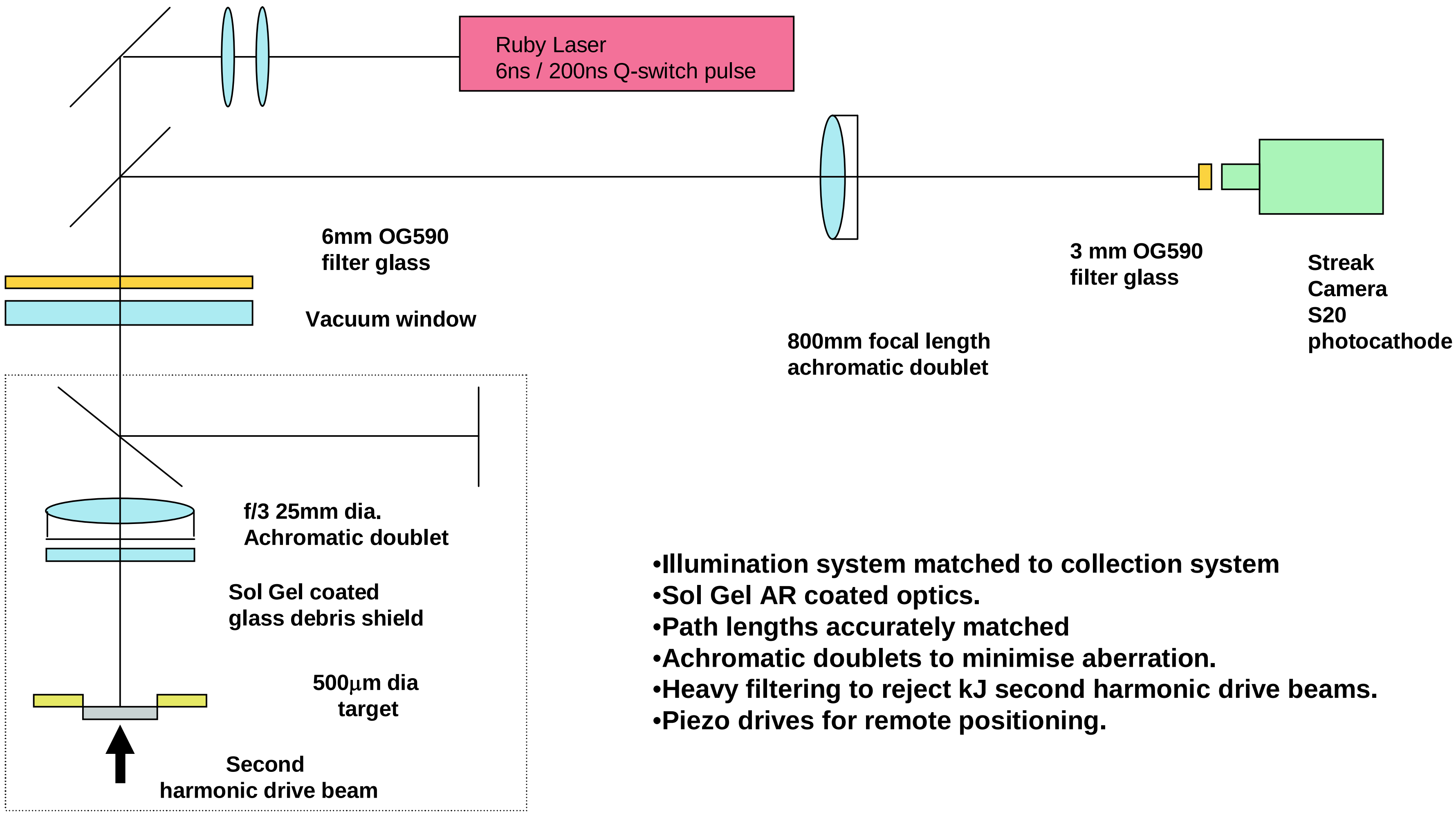
Shot no.469
Laser Energy = 20J
1600 micron Dia. Spot



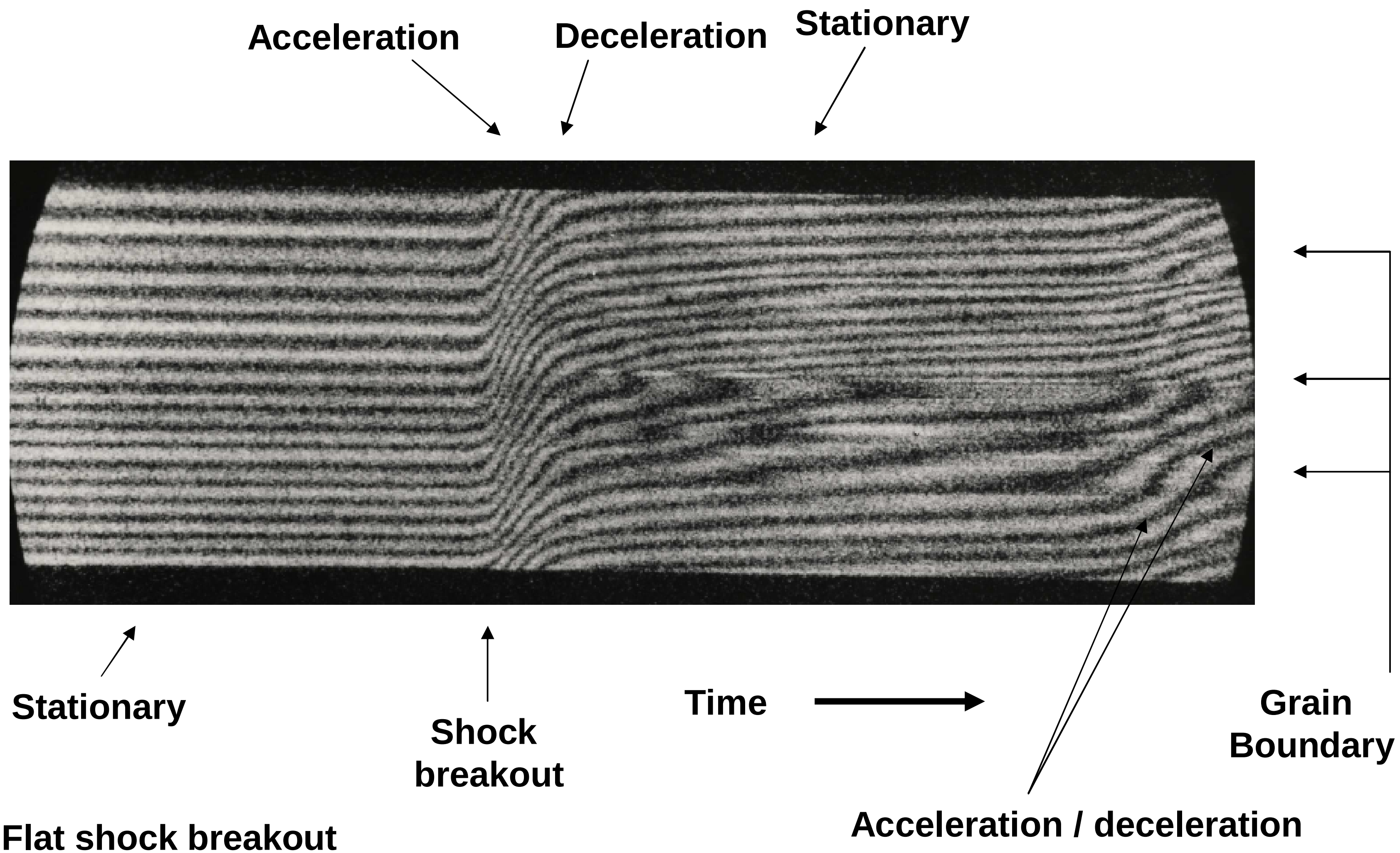
Elastic precursor, pull back, break away spallation signatures observed.



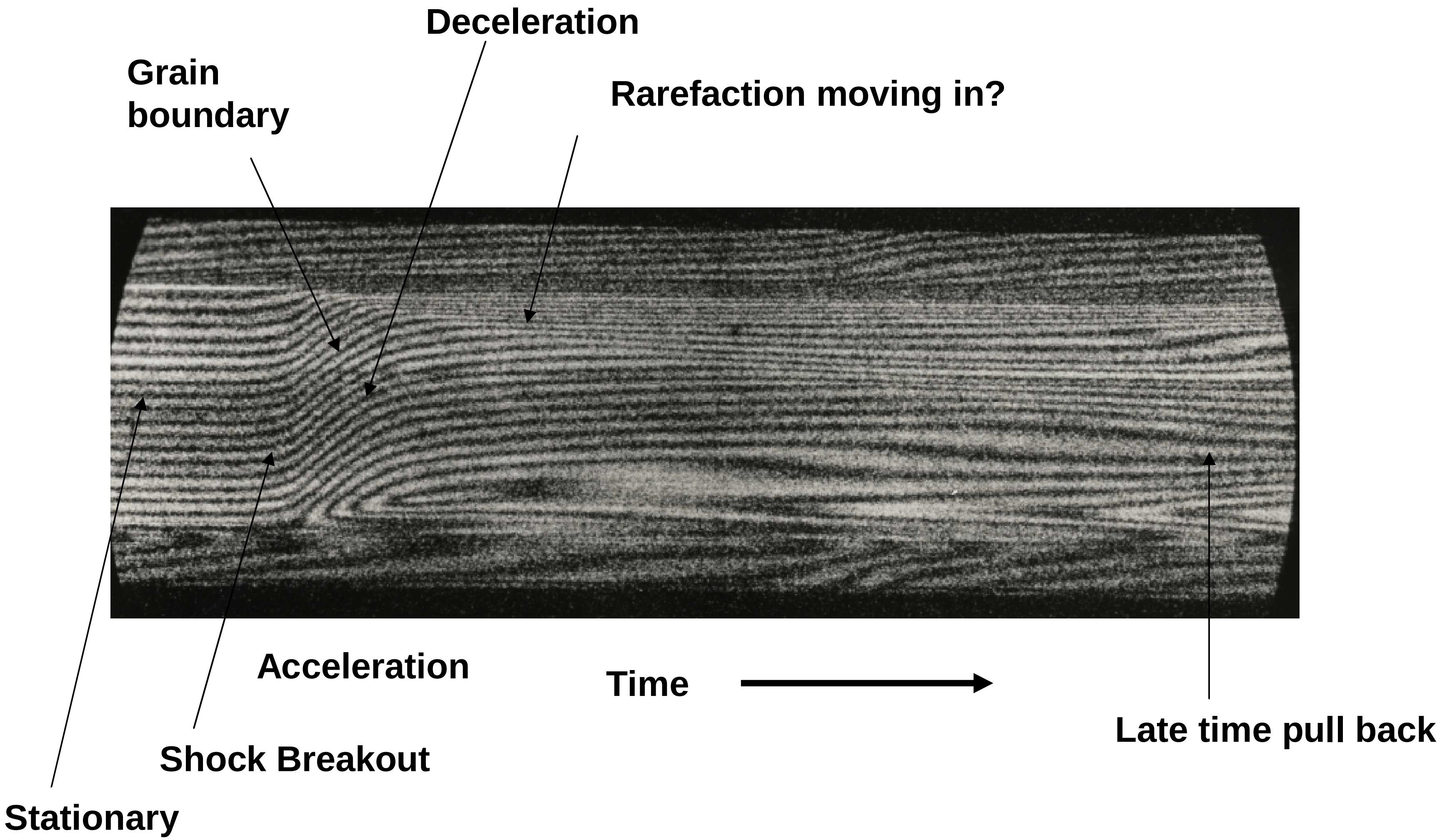
Spatially & Temporally Resolving Michelson Interferometer



- •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.

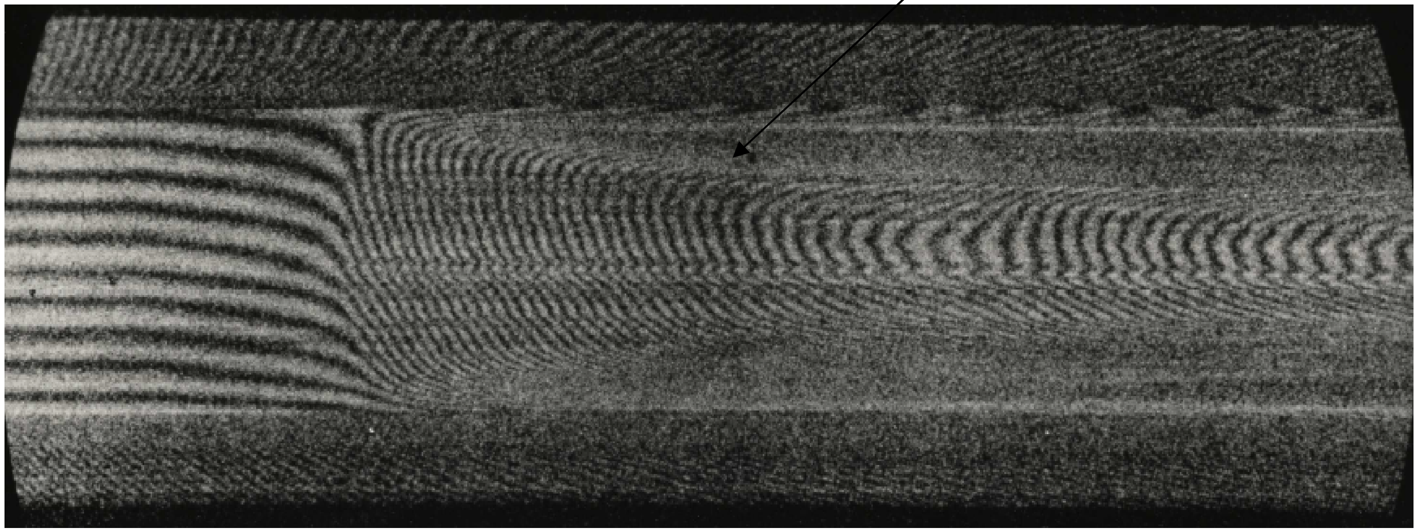


- Flat shock breakout
- Evidence of grain boundaries
- Different velocity profiles across different grains


Deceleration
Grain boundary
Rarefaction moving in?
Acceleration
Time
Shock Breakout
Late time pull back
Stationary

Curved shock breakout

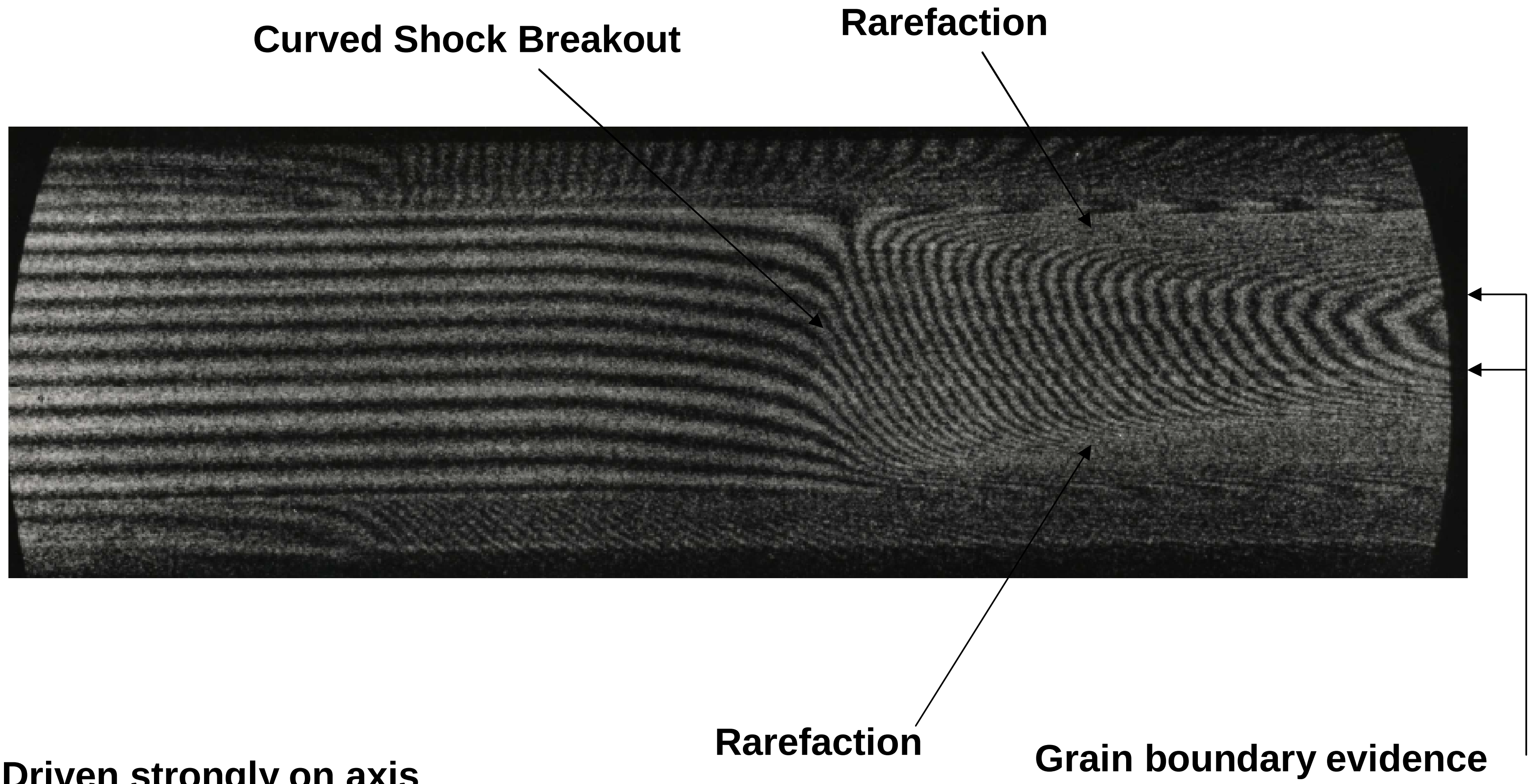
Rarefaction wave?



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

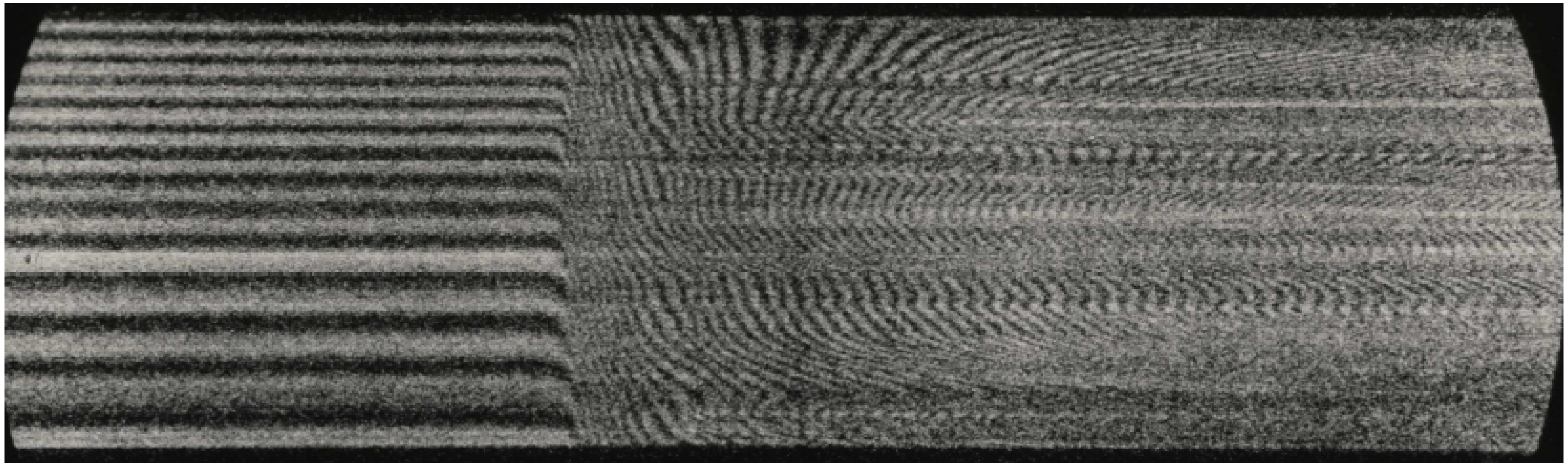
Adjacent Grains
different velocity profiles

Time



Driven strongly on axis
Off Axis almost stationary

Pull back



Flat shock breakout

Acceleration

Acceleration

Deceleration

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 ?