

Absorber Flow Tests

J. Norem
Argonne

Absorber Review
Fermilab
5/17/04

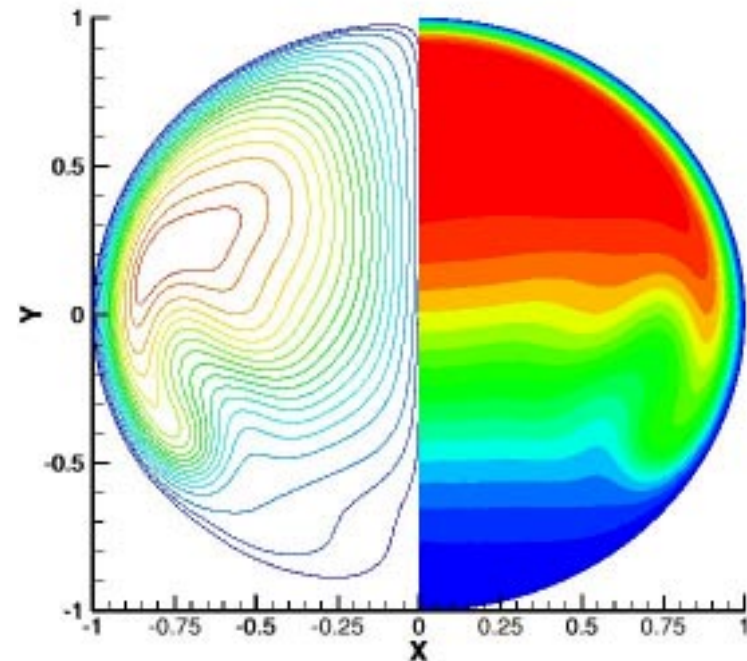


This experiment used water to estimate the response of LH2.

- The goal of this work was threefold
 - Determine if the method worked
 - Measure the turbulence caused by beam heating of liquids
 - Compare with estimates made for LH2

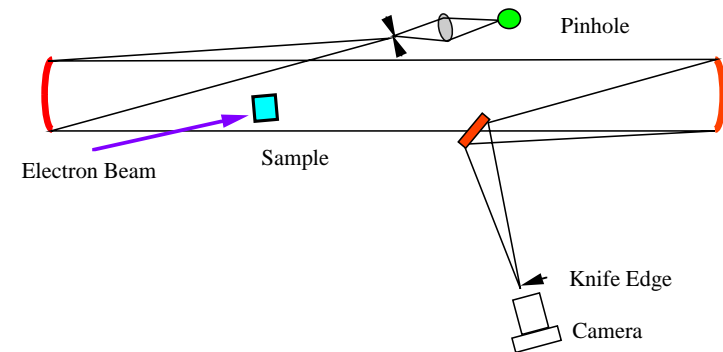
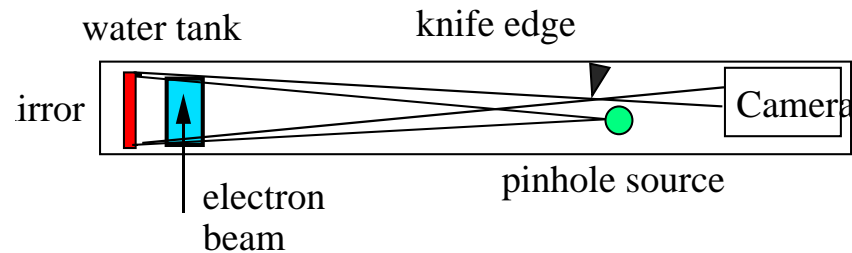
IS FORCED FLOW NECESSARY?

- People
 - Laura Bandura NIU Grad student
 - Mary Anne Cummings, NIU
 - Ed Black, IIT
 - J. Norem, ANL
 - Chuck Jonah ANL/CHM
 - Sergey Chemerisov ANL/CHM
 - D. Errede
- Comparing with
 - Wing Lau Oxford
 - K. Cassel, IIT



Procedure

- Two optical setups were used
Perpendicular
Longitudinal

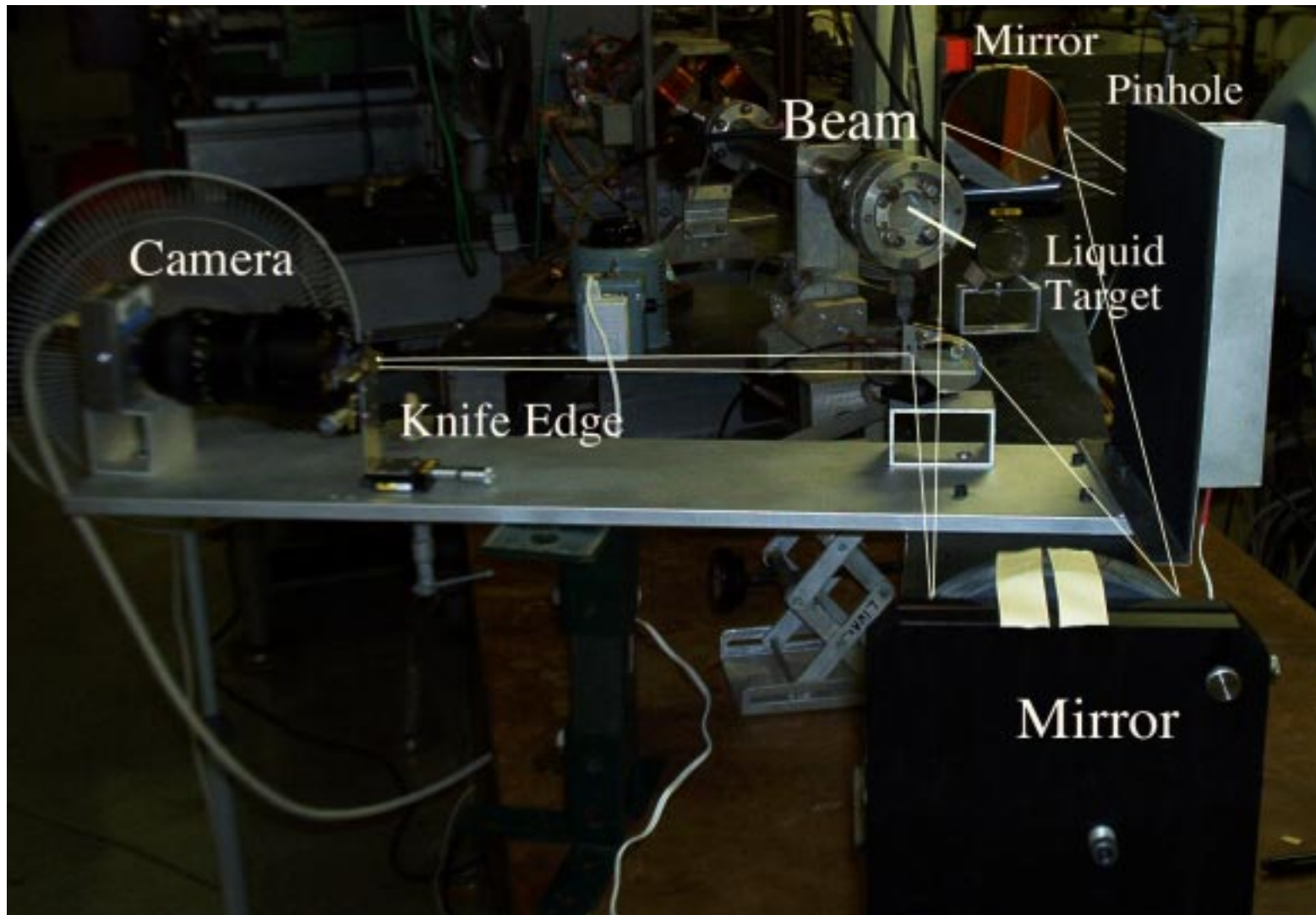


- Both Schlieren and Ronchi optics were used, with vertical and horizontal slits.
- Two Fluids were used
Water, $\eta = 1.0$ cp
almost all data,
Water is an abnormally viscous fluid because it has hydrogen bonds which transfer forces between molecules.
Hexane, $\eta = 0.3$ cp
This was done as a final test for the day.
Hexane is a hydrocarbon which has no hydrogen bonds.

For Comparison . . .

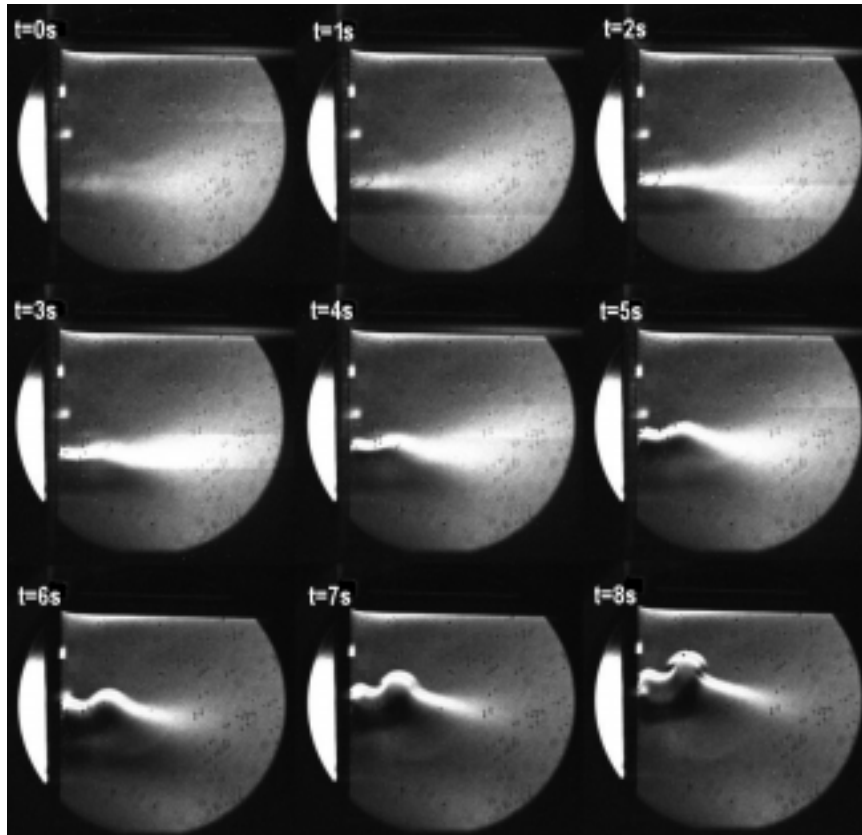
	H₂O	LH₂	C₆H₁₄	
ρ	1.00	0.070	~1	g/cm ³
n	1.33	1.109		
c_p	1.00	3.44		Cal/g ^o K
η	1.005	0.011	0.32	cpoise
$N_R \sim \frac{\rho}{\eta}$	1	6.3	~3	

The (second) setup

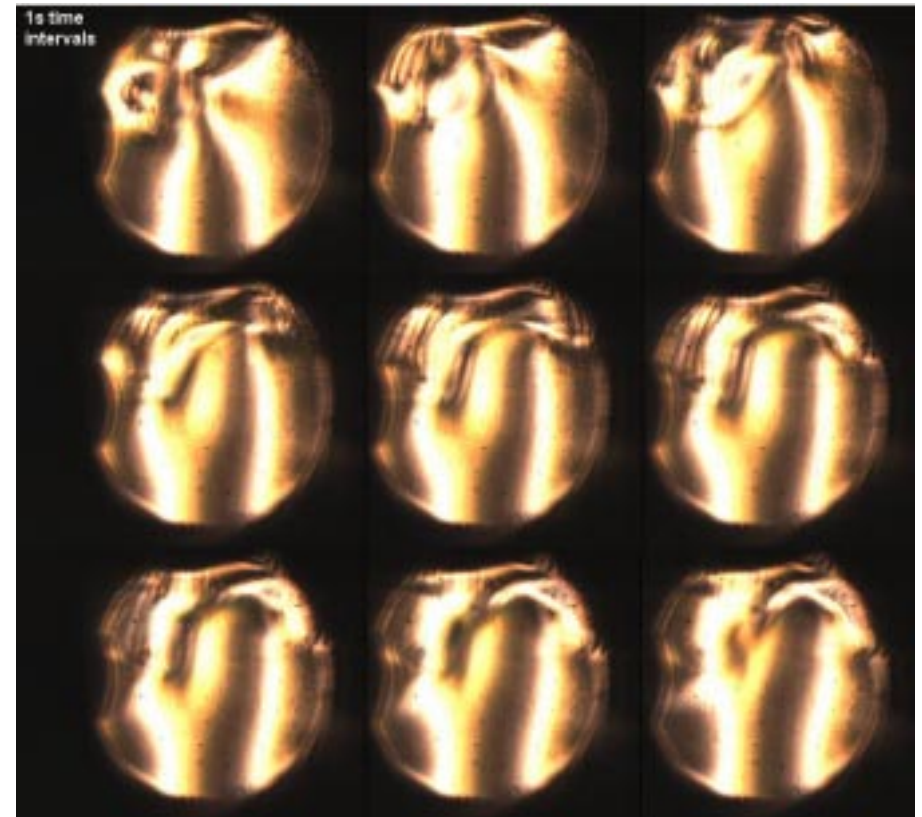


Data

Schlieren



Ronchi



Timeline

Jan. - Mar. '03, data for Laura's Masters Thesis

Mar.- May '03, Paper for Accelerator conference

May - July '03, New data for NIM paper

shock magnetohydrodynamics exp at FSU

Following this Laura went back to school, and I to the about rf and FNAL Booster.

Results

The method worked.

1 Joule seems to be enough power to see a schlieren image

clear eddies formed,

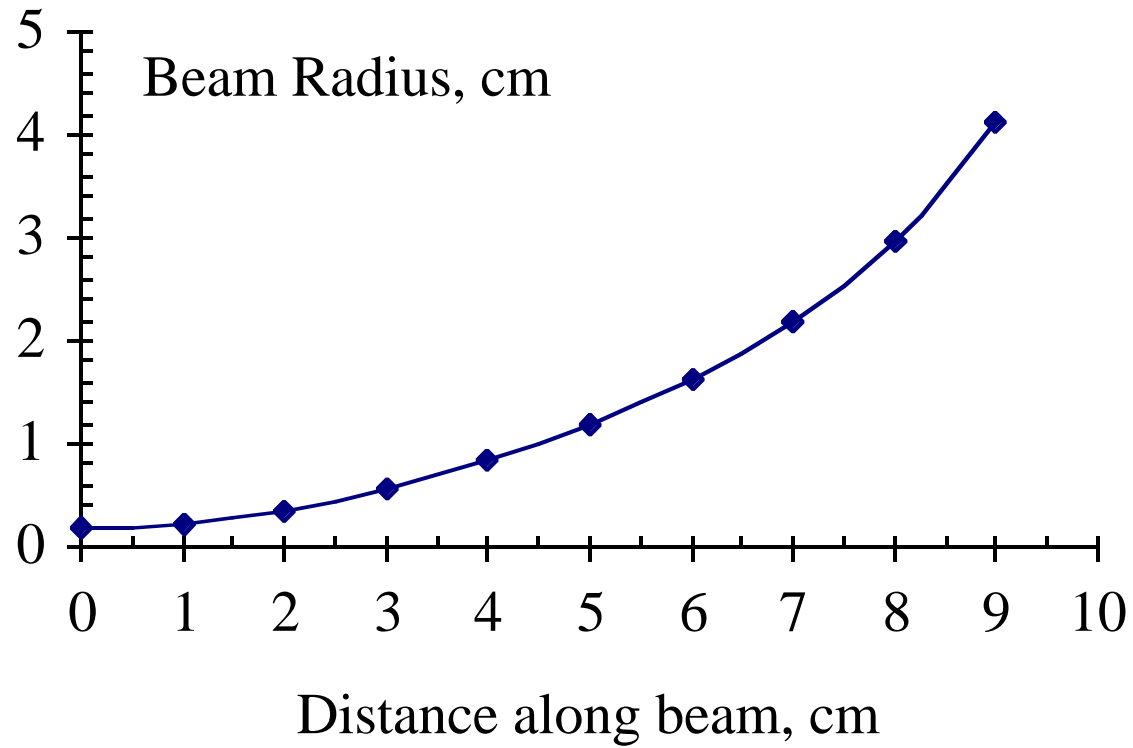
proportional to beam heating

estimates of beam heating checked with measurements

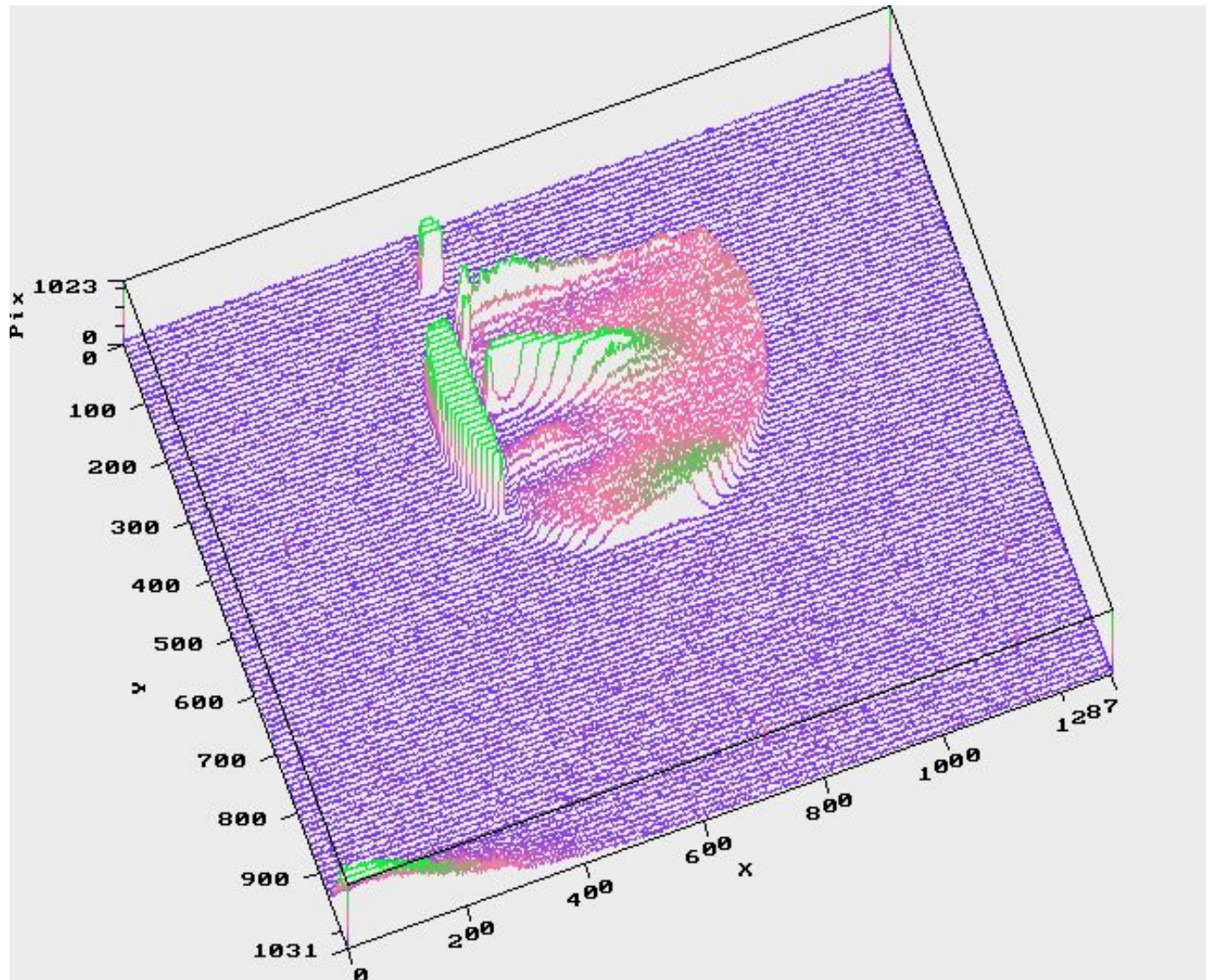
lots of structure

look at windows. Thin plates in water

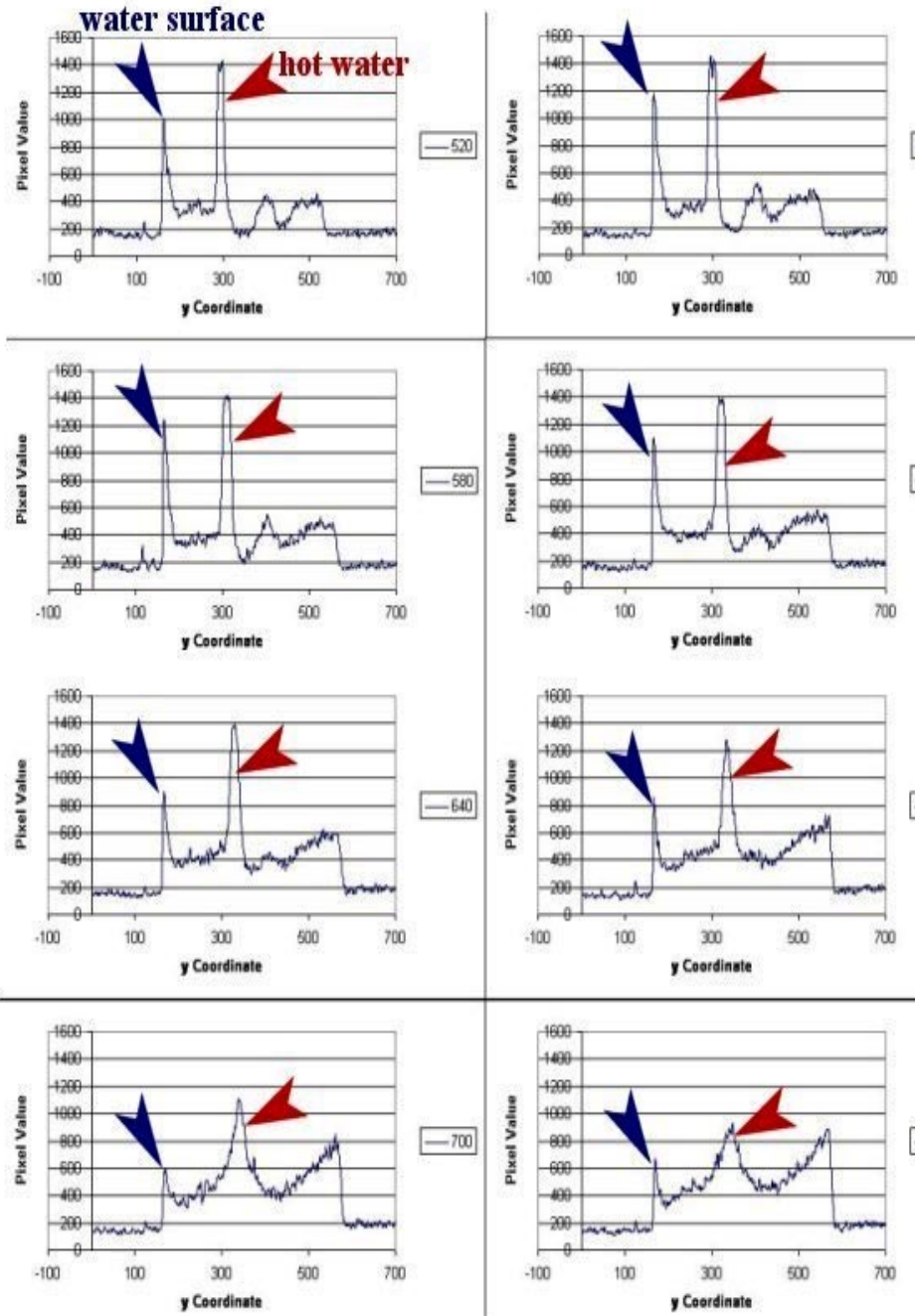
Beam Radius



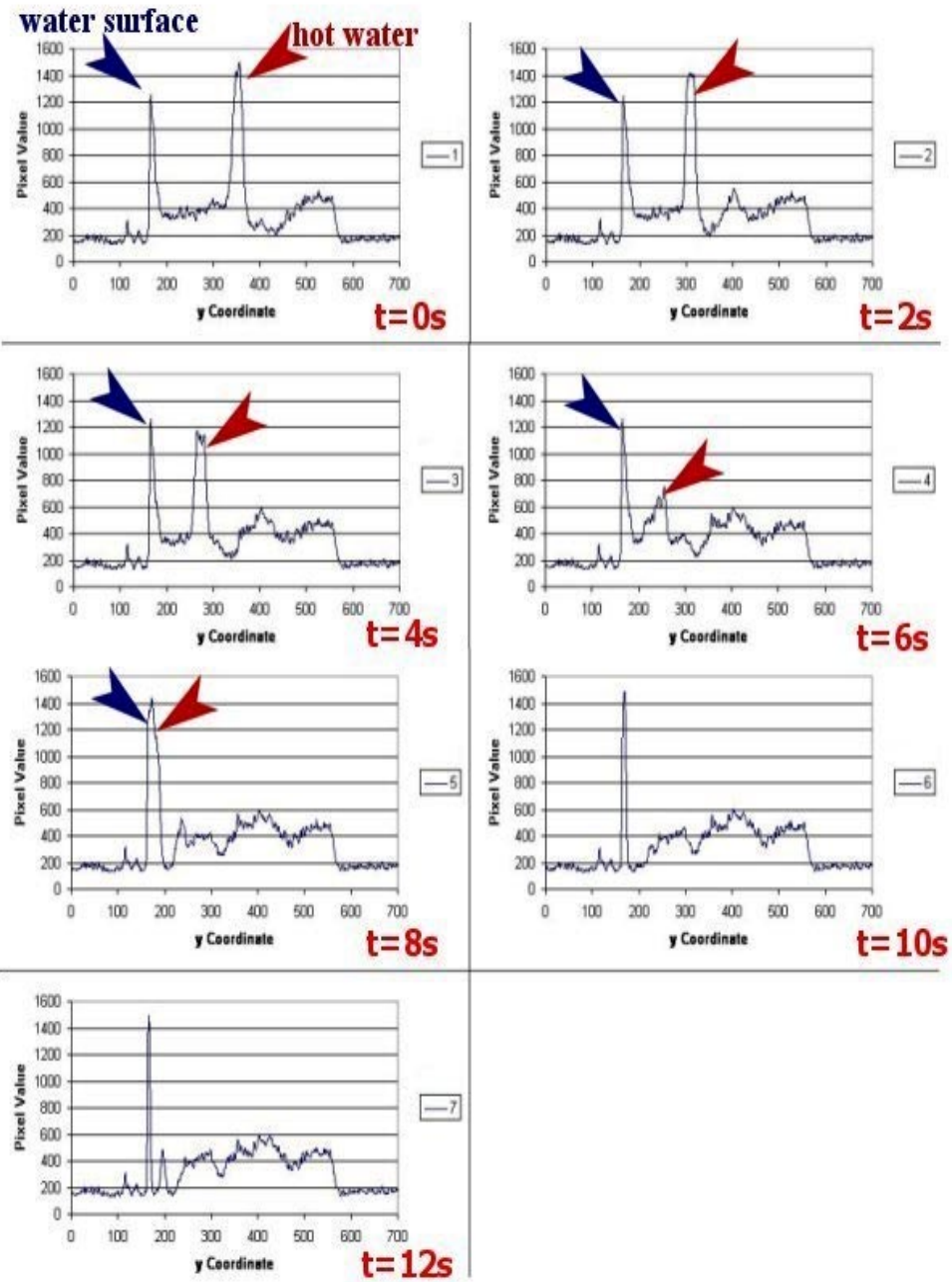
Data Analysis



Space slices



Time Slices



Window Heating

- One problem is what happens to heat in windows.
- We have experimentally studied this by putting an Al vane in the water and looking at the circulation around it.
- A vacuum windows has no heat coming out one side, the other is cooled by LH2.
- Vanes approximate this geometry.

The vane is twice as thick as a window would be.

No heat crosses the midplane of the vane.

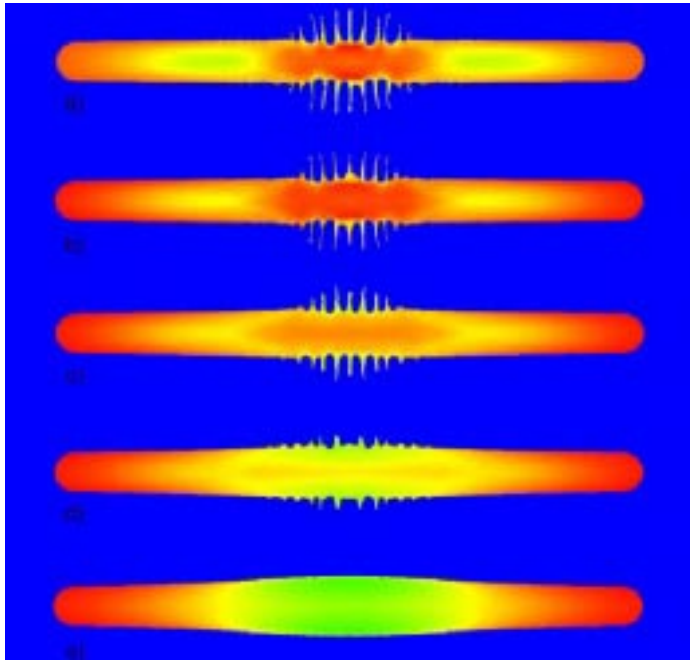
Two windows are effectively equal to one vane.

Follow on experiments

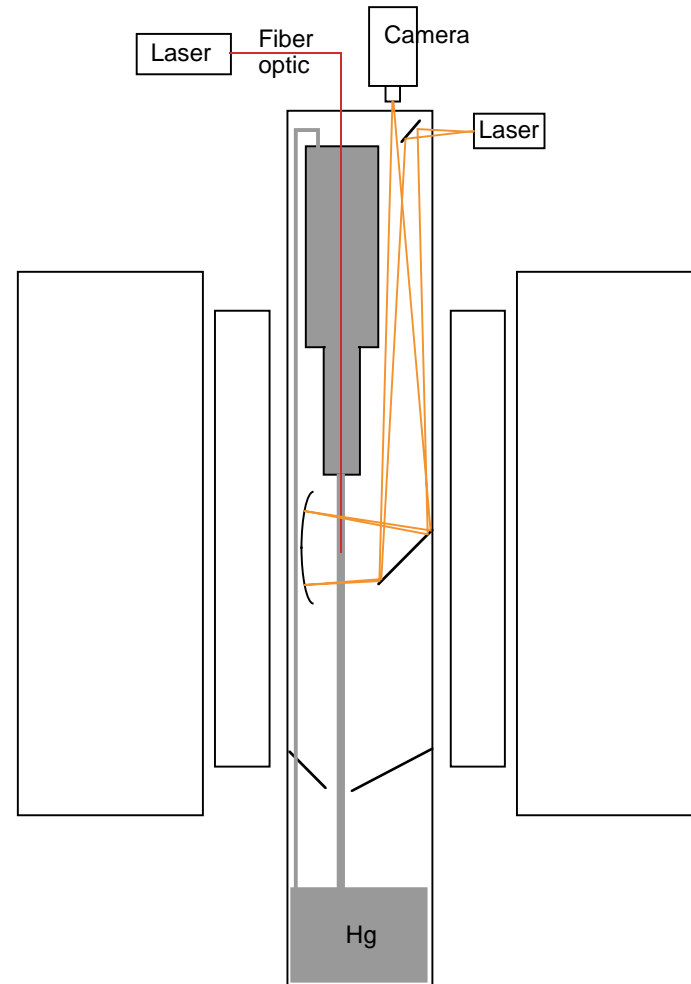
High power shock magnetohydrodynamics with explosives in mercury.

- The magnet should stop the mercury from transverse motion.

simulation 0 - 10 T



- Does the mercury shoot out along the field lines????



Present Status

- There is a lot of data which has not yet been looked at.
- Laura is teaching and taking courses, I have other projects.
- There is a lot of quantitative analysis which could be done to look at hydrodynamics.

Conclusions

- Our method works.
- We have more data than we have been able to analyse.
- This is an inexpensive method at looking at beam induced hydrodynamic turbulence.