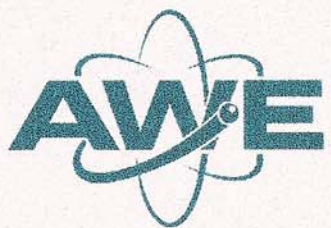




Mix Experiments using a Two-Dimensional Convergent Shock Tube

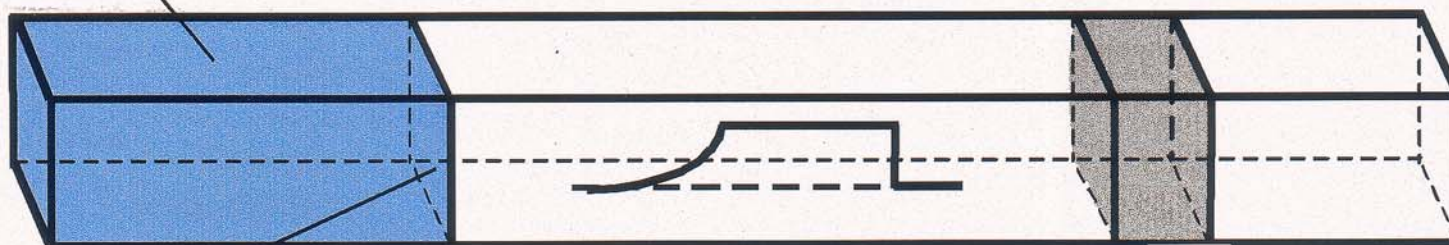
D A Holder, C J Barton, A V Smith, D L Youngs

AWE Aldermaston UK



Principle of Design

Compressed Gas

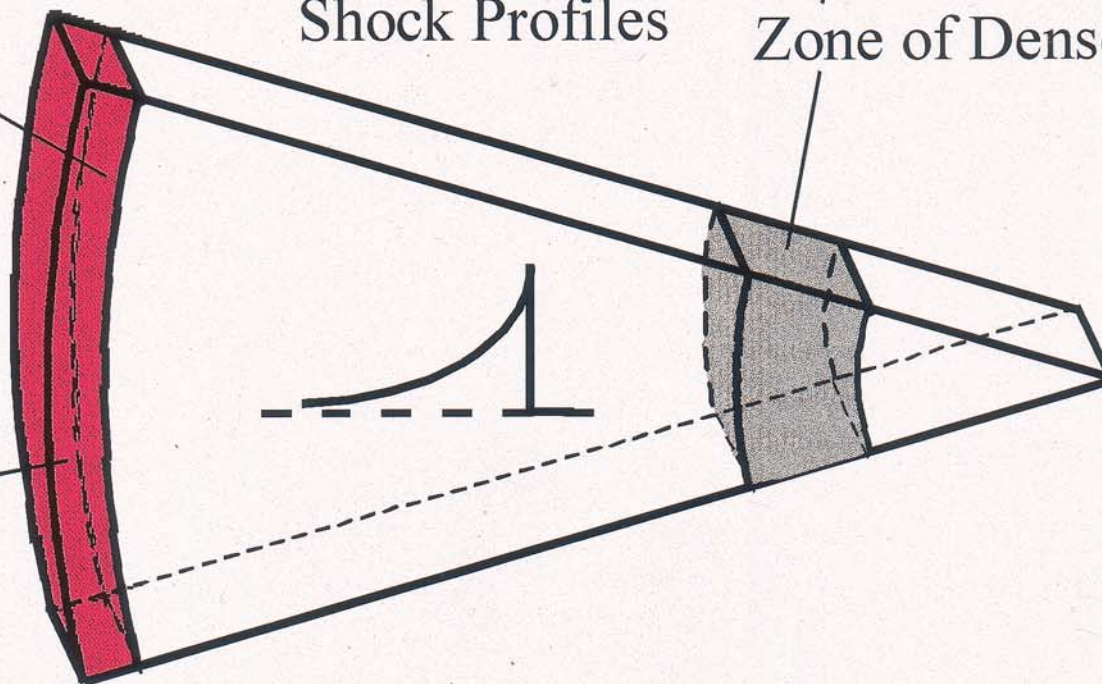


Diaphragm

Shock Profiles

Zone of Dense Gas

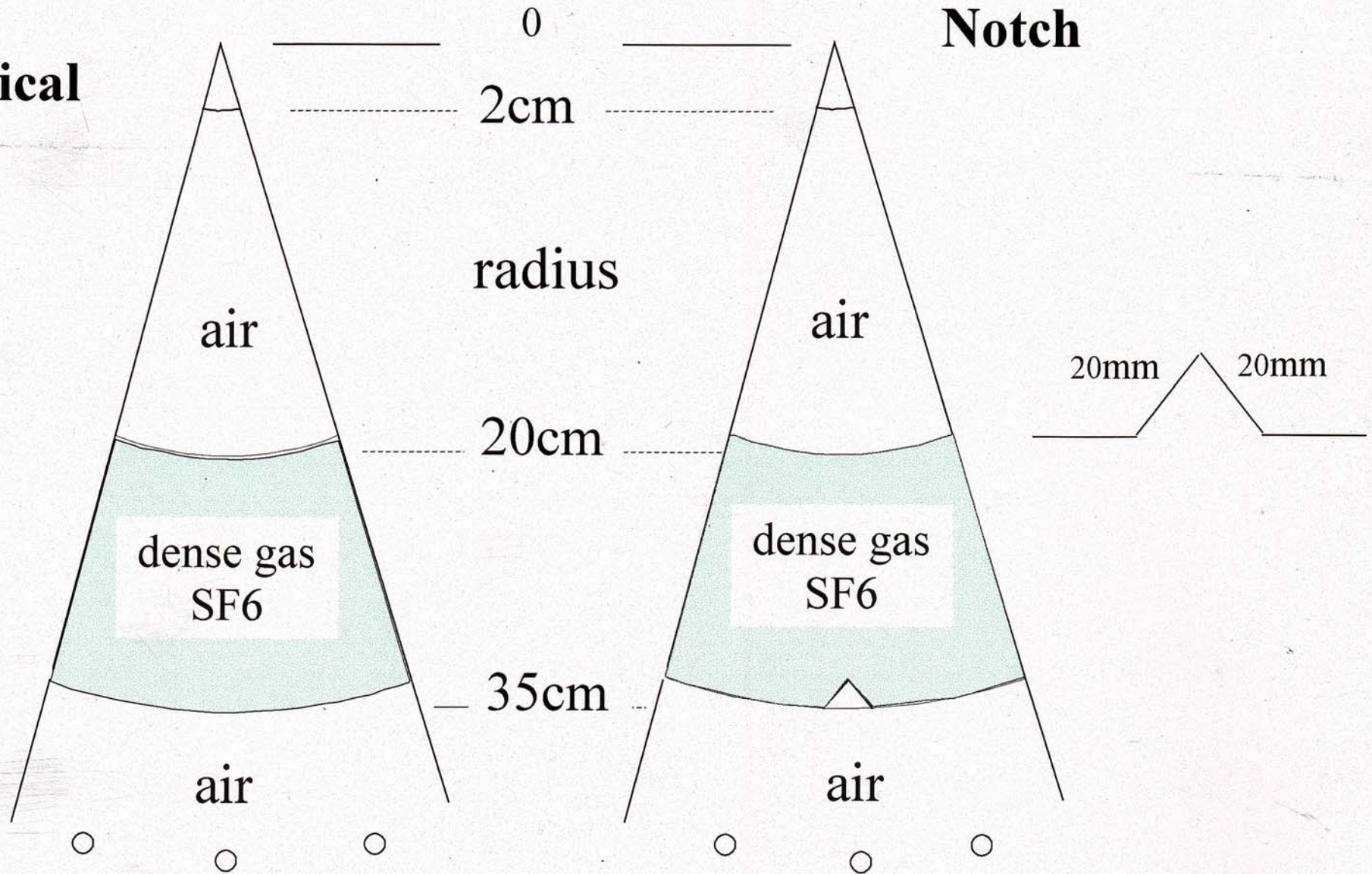
Detonable Gas



Experiments performed

**Basic
cylindrical**

Notch

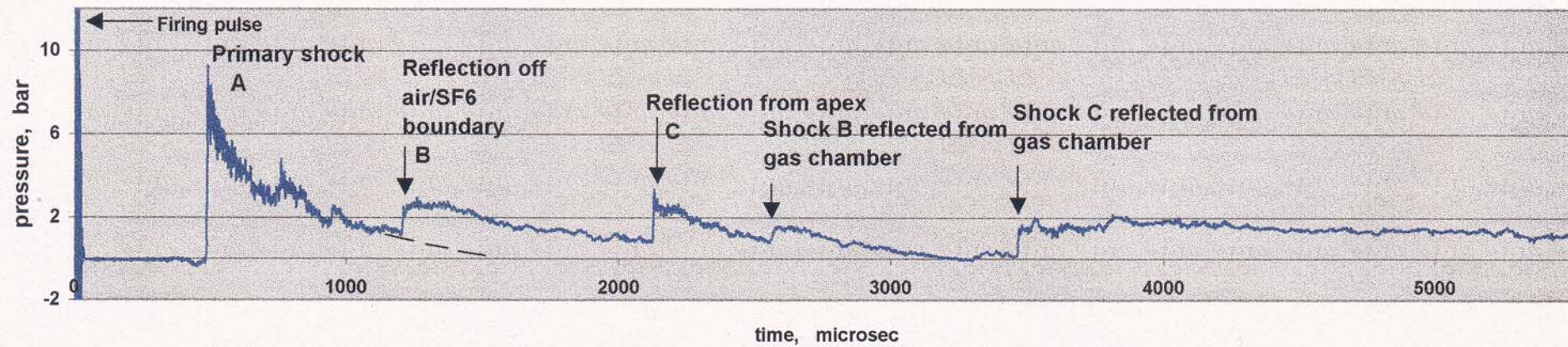




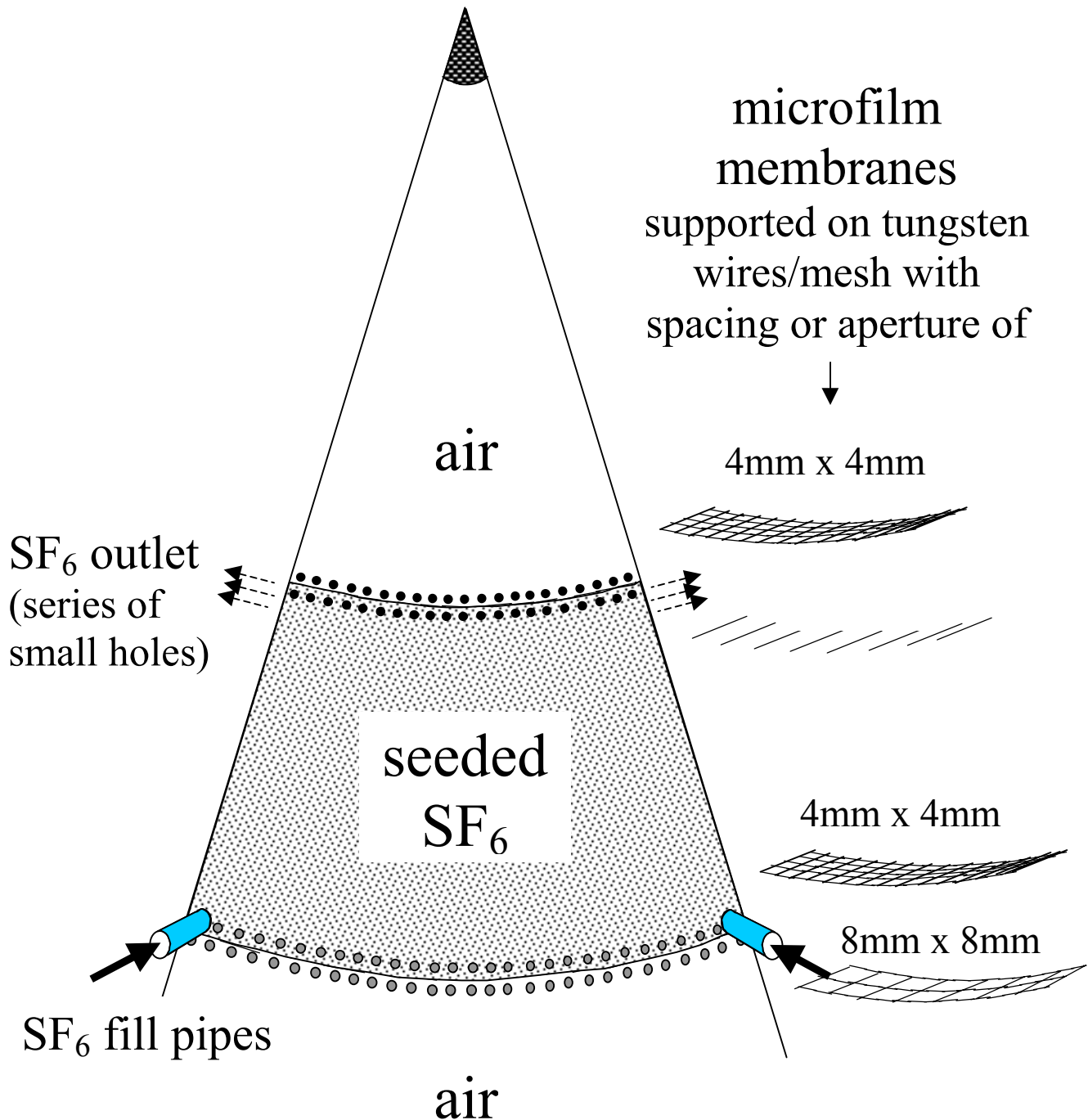
Shock Pressure Waveform

Radius 50cm

radius 50cm



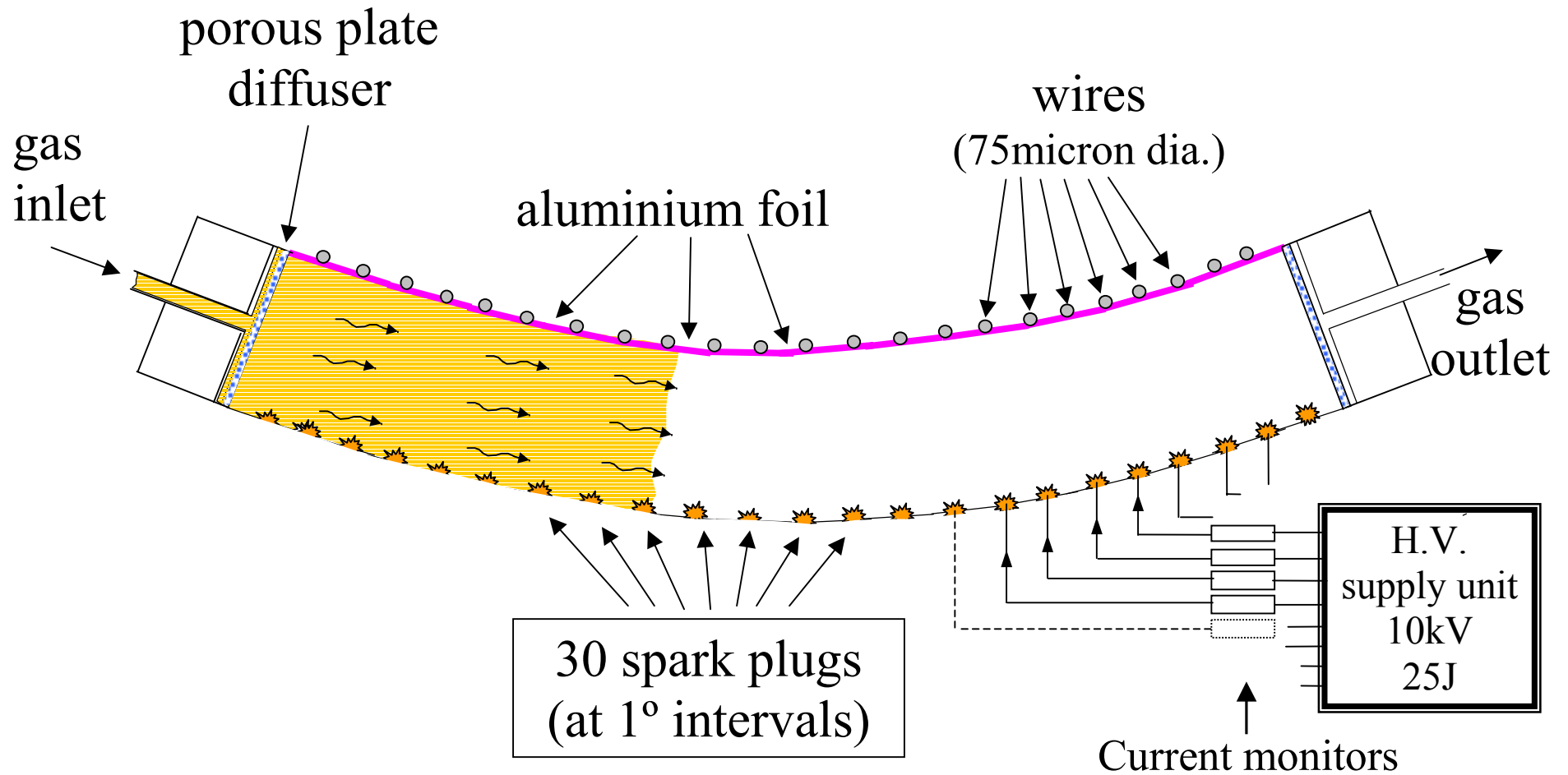
Details of the Dense Gas Containment



Detonable Gas Chamber

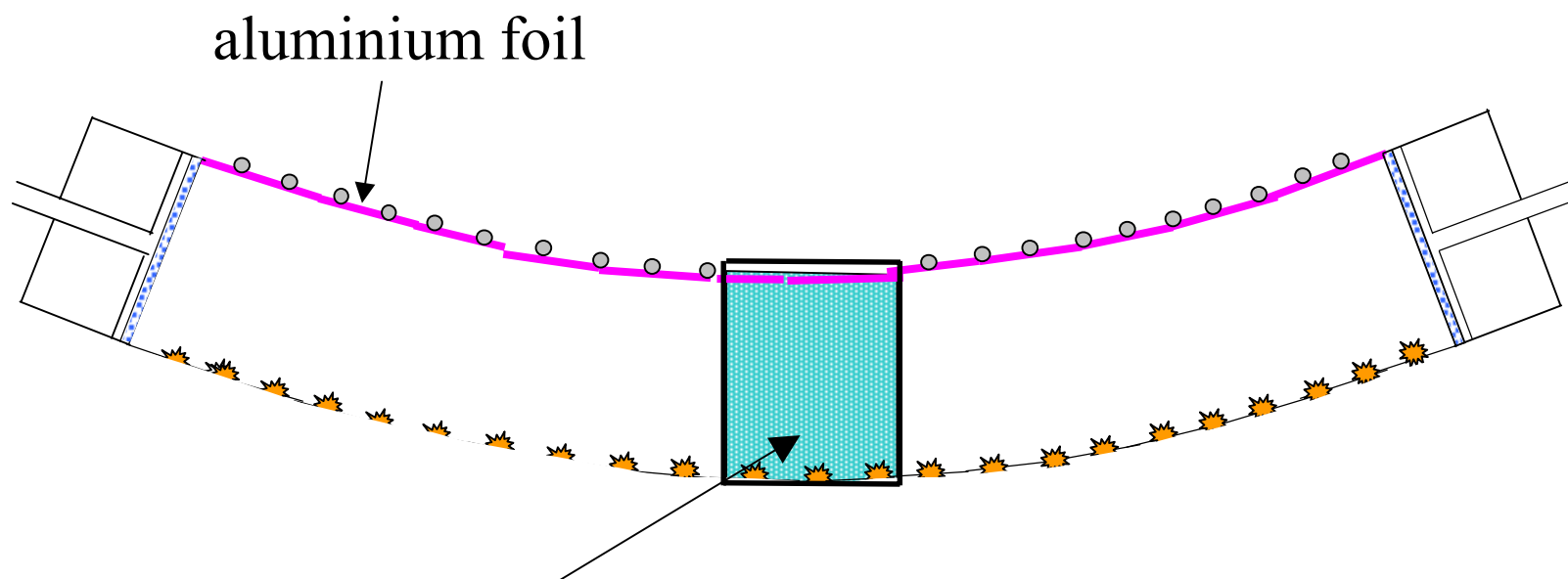


Oxy-acetylene gas chamber



Small Detonation Test-cell

to check for simultaneity of multi-point detonation

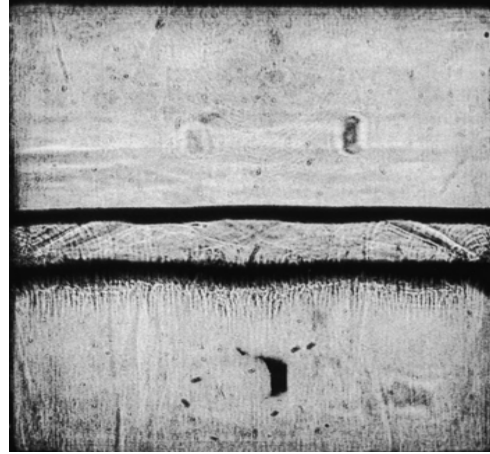


Optical test cell representing a 1/10 volume of the gas chamber - features 3 spark plugs. It allows photographic study of the detonation process

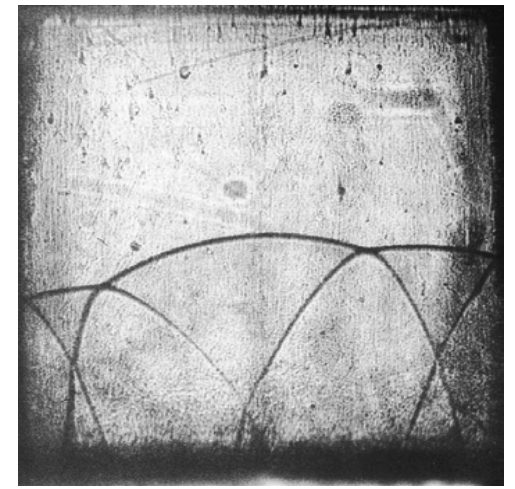
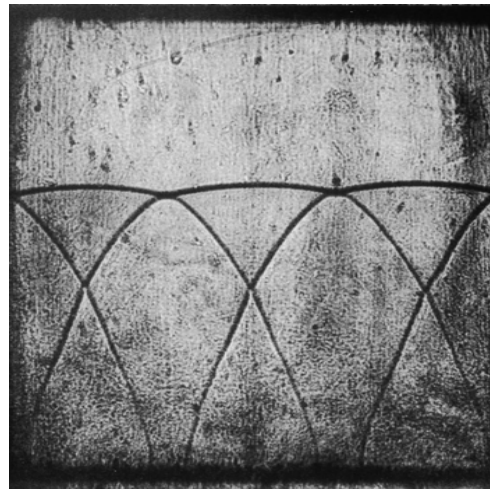
Small Detonation Test Cell - Sample Images



Detonation test cell



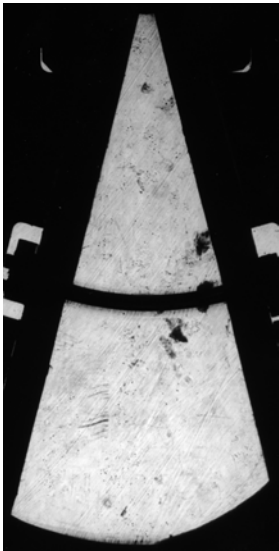
Example of non-simultaneous spark ignition



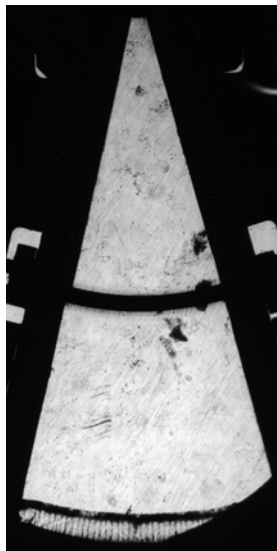
Shadowgraph Images



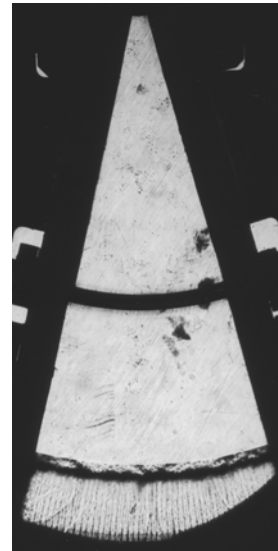
(air / SF₆ / air cylindrical experiment)



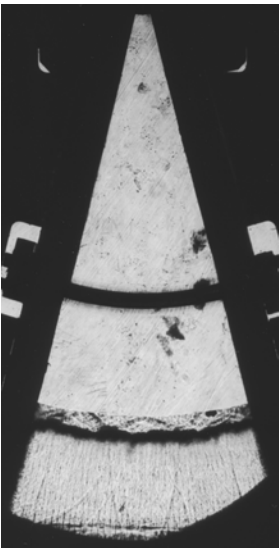
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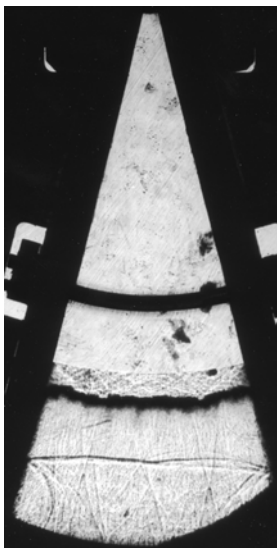
0.73ms



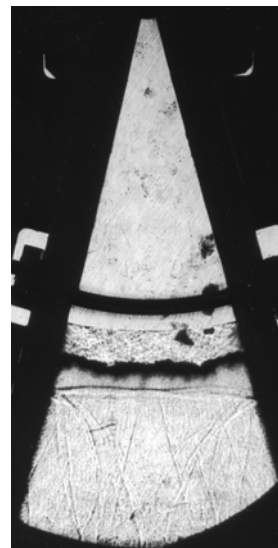
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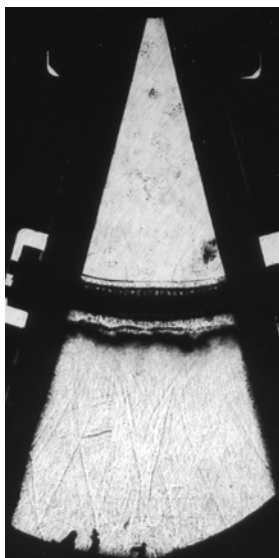
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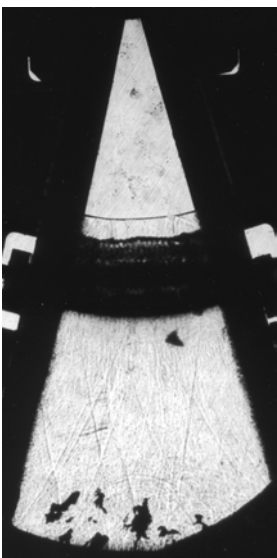
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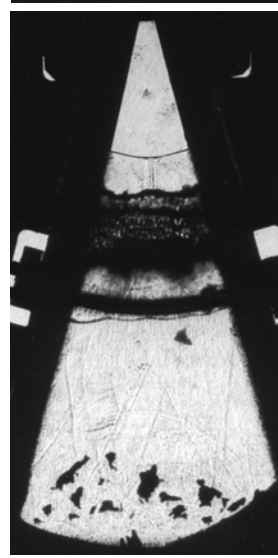
1.00ms



1.07ms



1.13ms

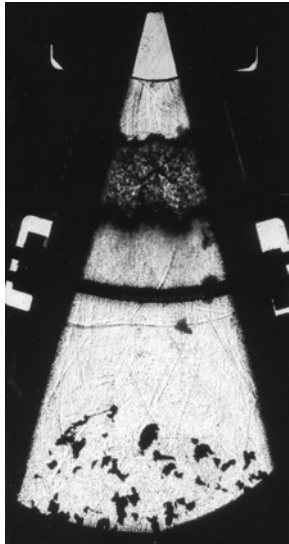


1.20ms

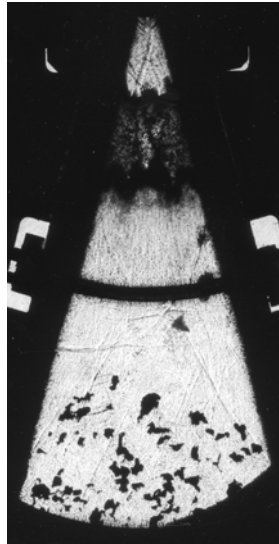
Shadowgraph Images



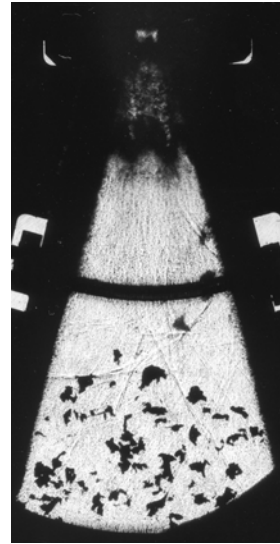
(air / SF₆ / air cylindrical experiment)



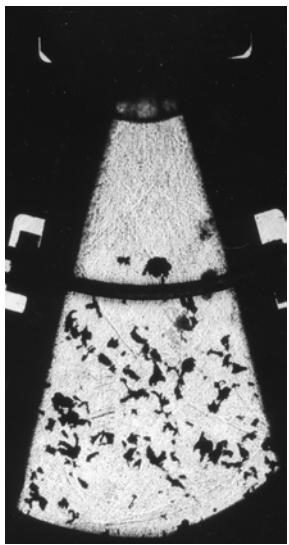
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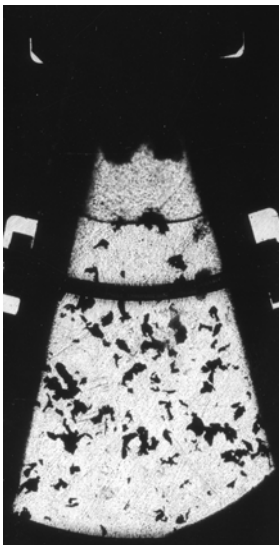
1.33ms



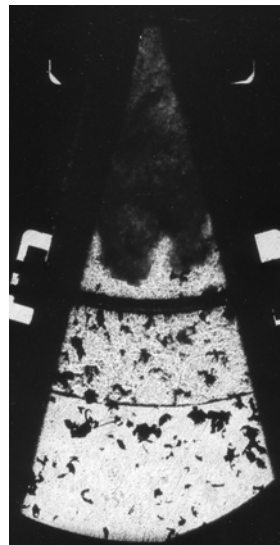
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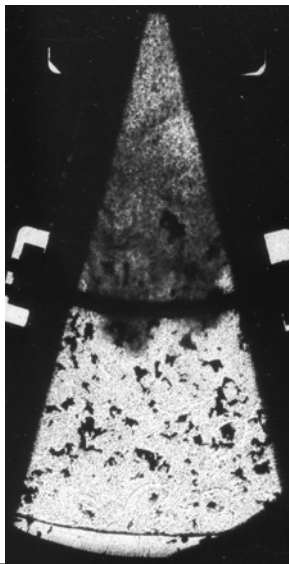
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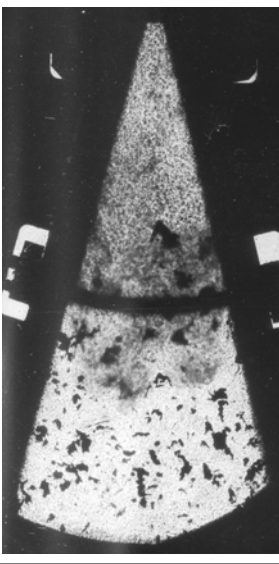
1.80ms



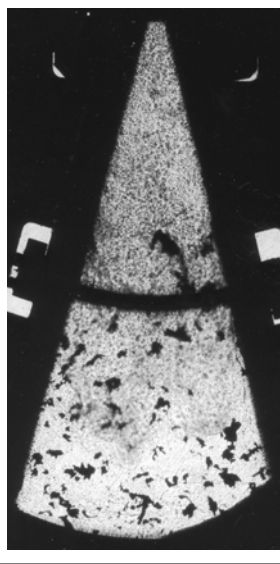
2.00ms



2.13ms



2.27ms

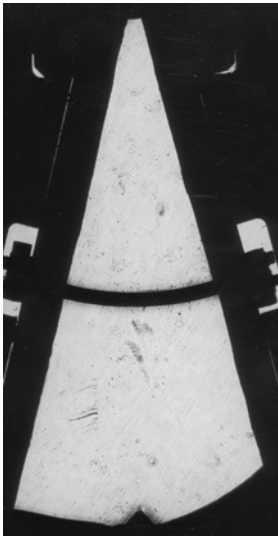


2.40ms

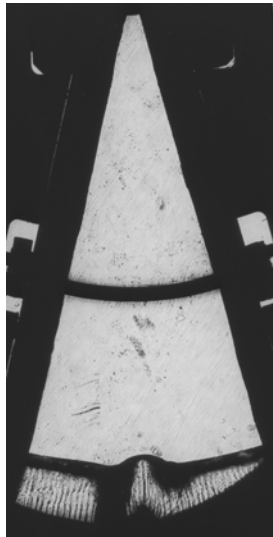
Shadowgraph Images



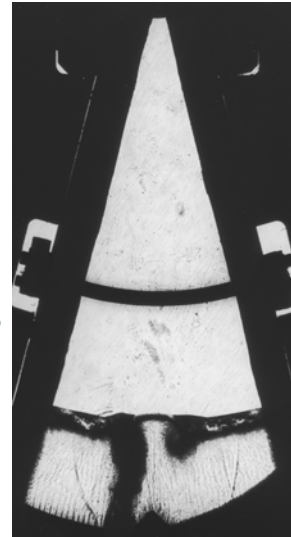
(air / SF₆ / air cylindrical experiment)



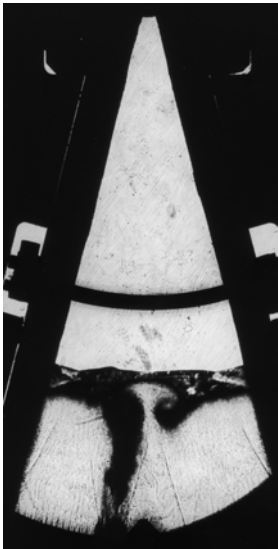
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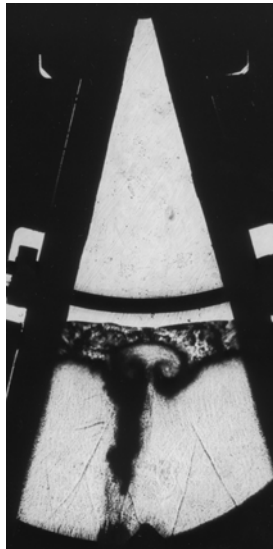
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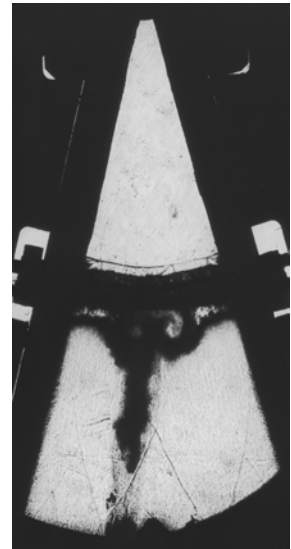
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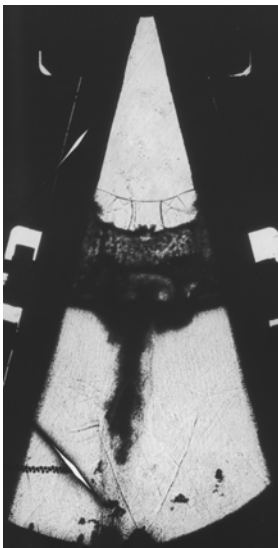
0.87ms



0.93ms



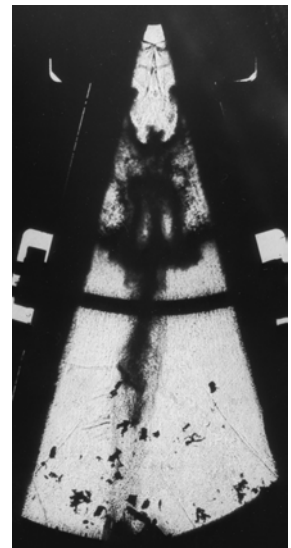
1.00ms



1.07ms



1.13ms

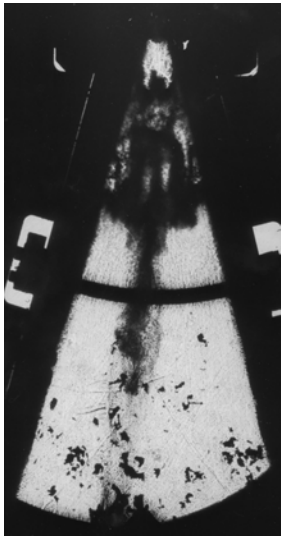


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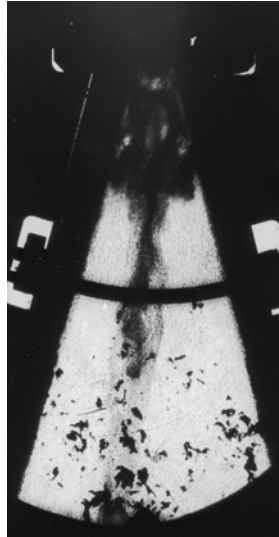
Shadowgraph Images



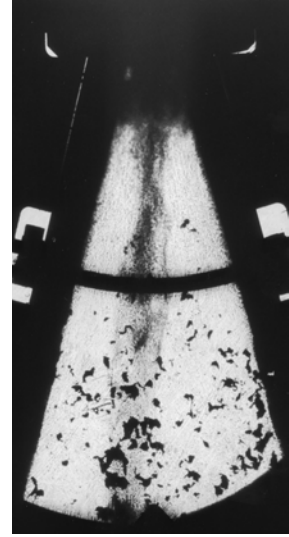
(air / SF₆ / air cylindrical experiment)



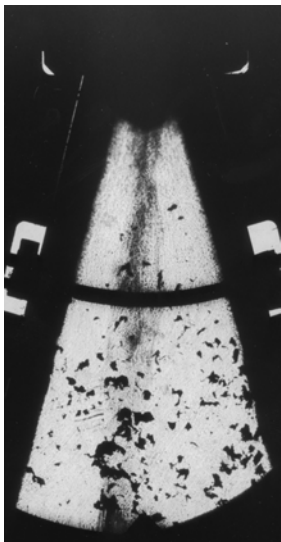
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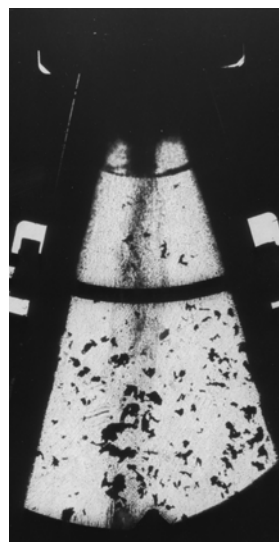
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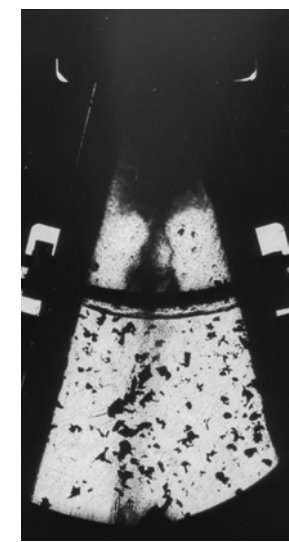
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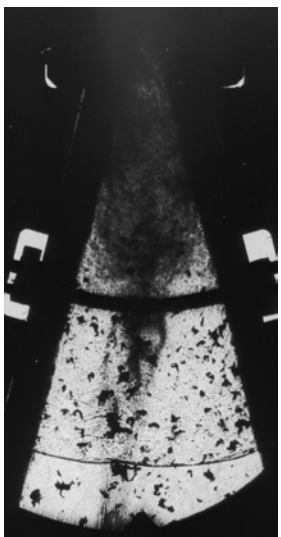
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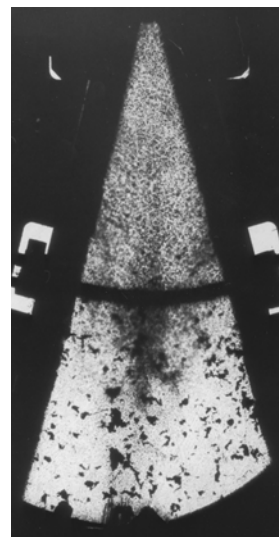
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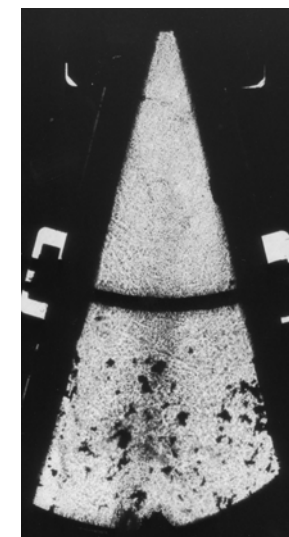
1.73ms



1.87ms

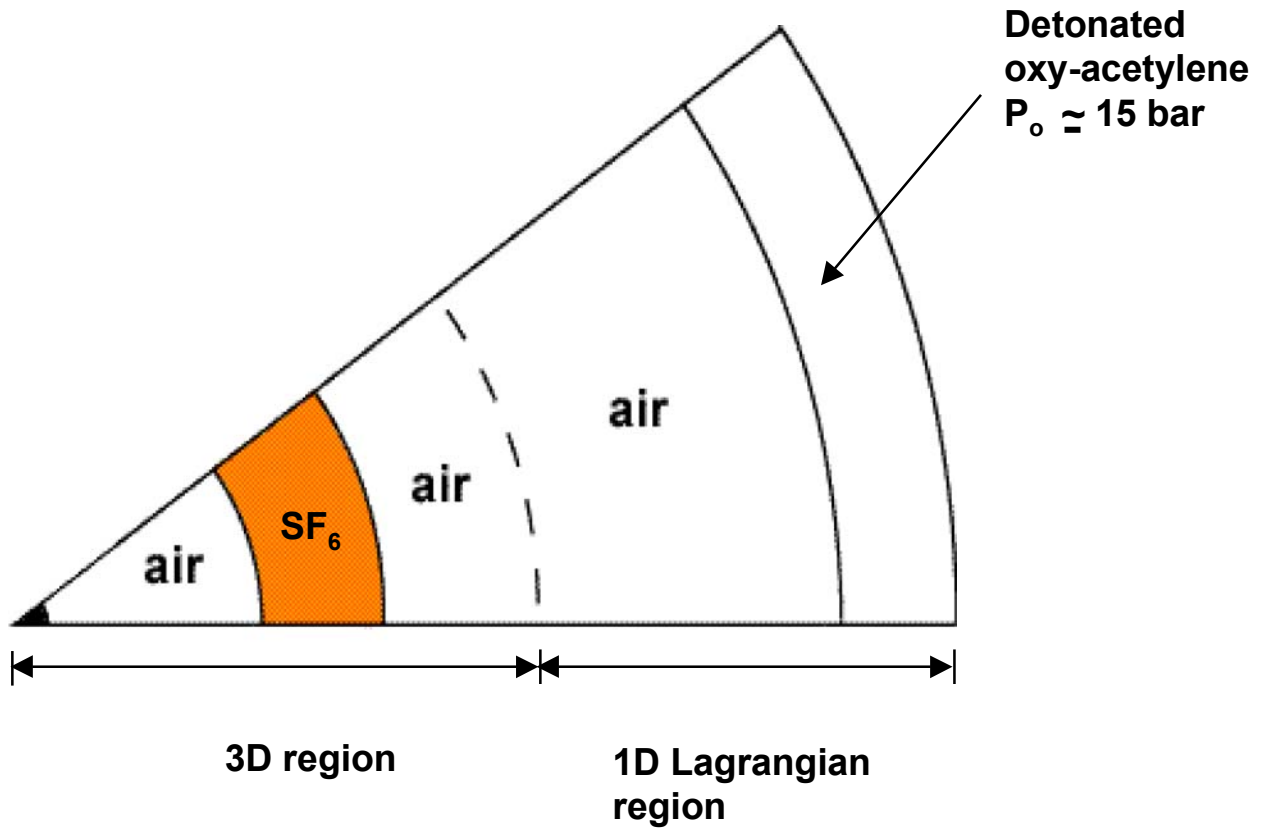


2.07ms



2.33ms

TURMOIL 3D Simulation



Cylindrical polar mesh.

Semi-Lagrangian calculation - r - direction mesh moves with the mean fluid velocity.

Mesh used in the 3D region (r, θ, z): 344 x 200 x 140.

Random perturbations imposed at each interface:

Wavelengths: 0.5 to 5.0cm
s.d: 0.01cm

Notch Experiment

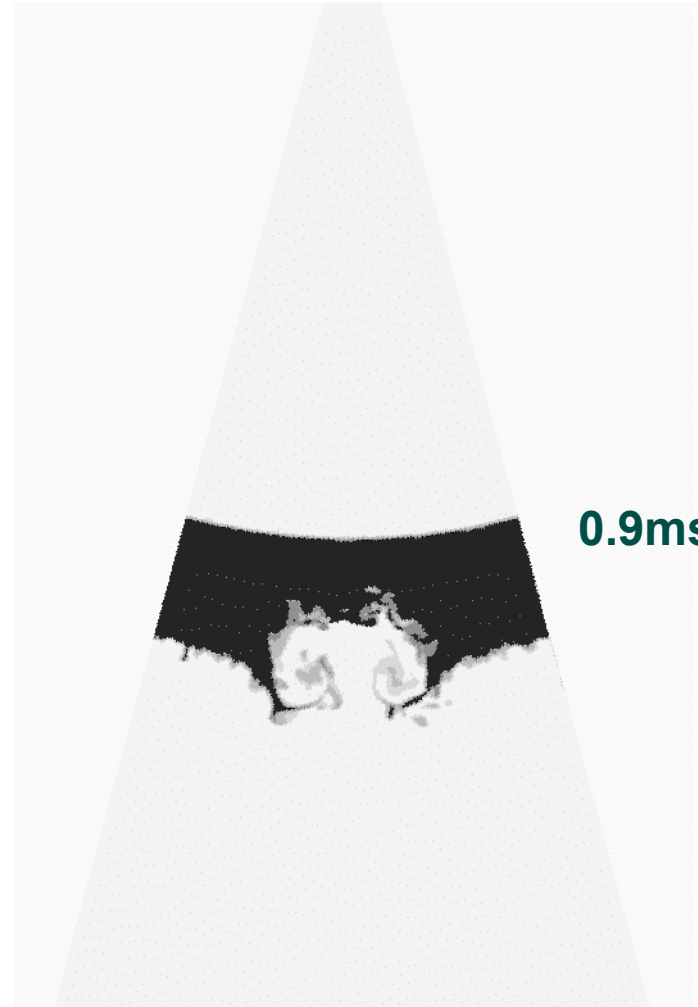


Experiment



0.93ms

Turmoil 3D code

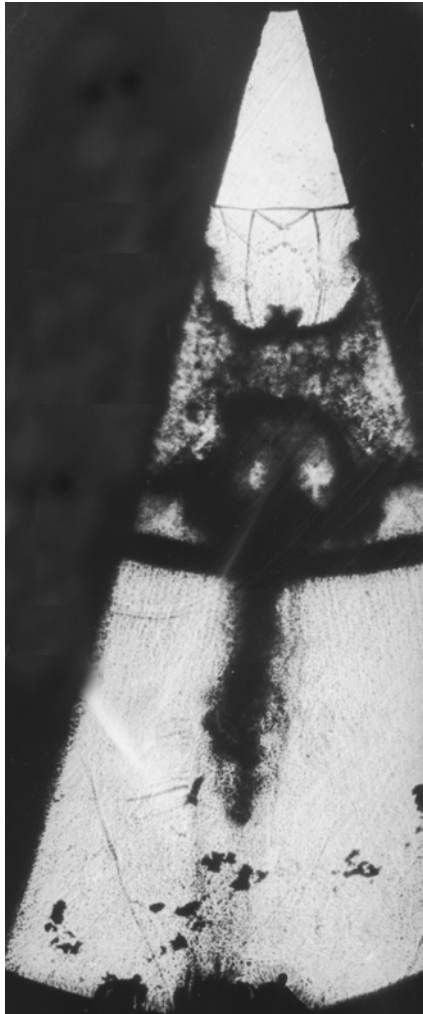


0.9ms

Notch Experiment



Experiment



1.13ms

Turmoil 3D code

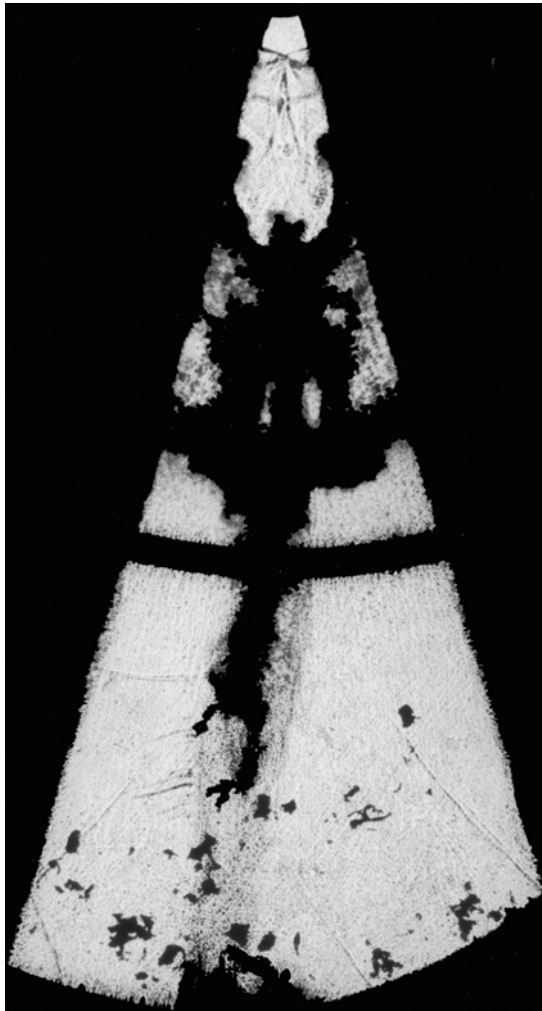


1.05ms

Notch Experiment



Experiment



1.20ms

Turmoil 3D code

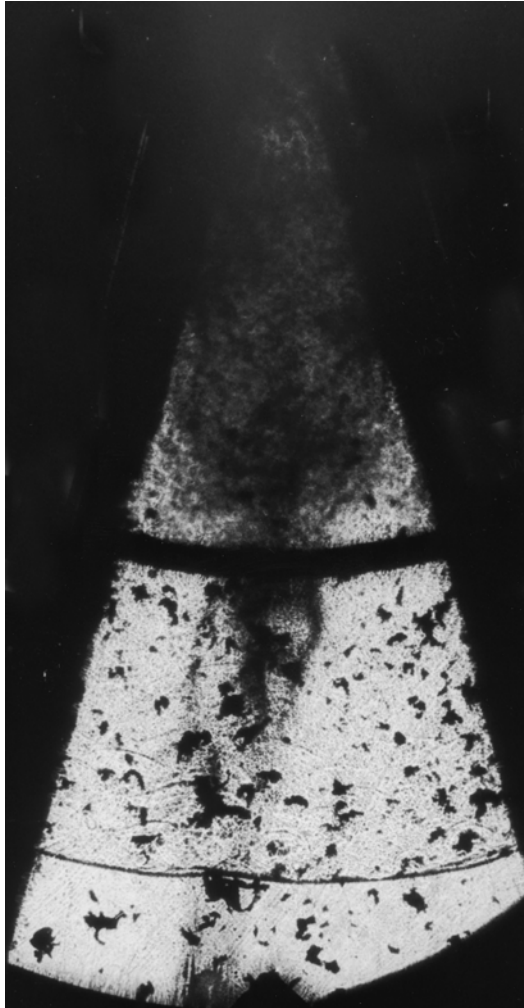


1.15ms

Notch Experiment

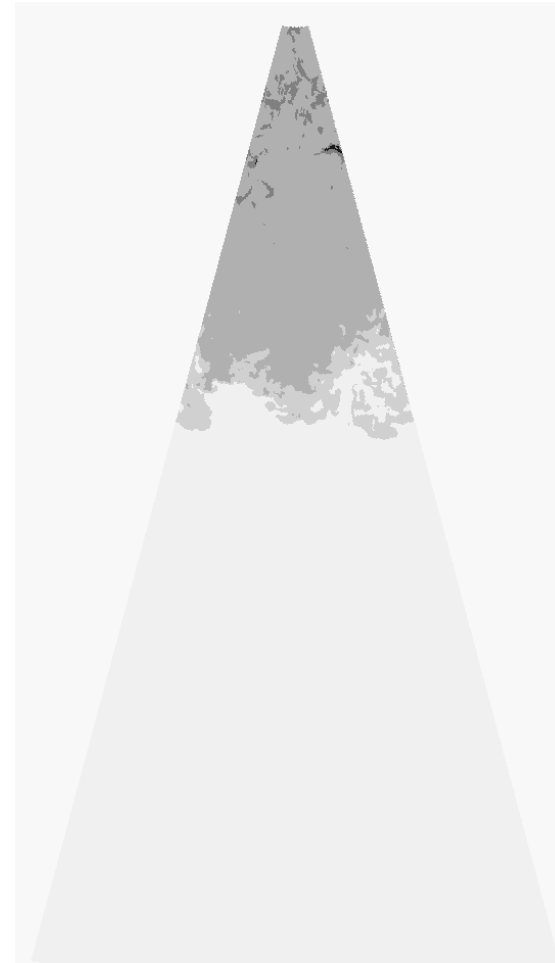


Experiment



1.87ms

Turmoil 3D code



1.75ms

Conclusions



1. Successfully demonstrated suitability of a Convergent Shock Tube for performing R-M experiments with gases in 2D geometry
2. Achieved compressions of dense gas of typically 25 : 1 using shock Mach No. ~ 3
3. Achieved good understanding of design requirements for constructing a new improved Convergent Shock Tube



Future Work

- Construct new Convergent Shock Tube which operates with the laser sheet diagnostic (and variants)
- Establish seeding with fluorescent gas suitable for:-
 - use of notch filter to ‘remove’ laser light scattered from membrane fragments
 - seeding at high gas compression
- Continue experiments with different perturbation profiles
 - Substitute Xe gas for SF₆
 - Establish calibration technique for gas data analysis of laser sheet images
 - [Consider ‘inverse’ experiment to check the influence of the side walls]