# Experimental Study of Single-Mode Richtmyer-Meshkov Instability for 2D and 3D Perturbations

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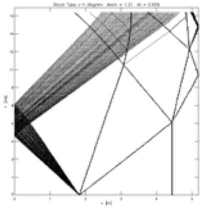
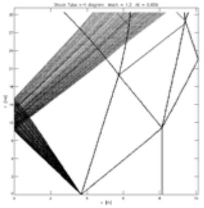
The experiments were carried out in a pair of vertical shock tubes utilizing the membraneless setup of Collins and Jacobs[1]. Thin sheets of polypropylene are used to contain the pressurized gas in the driver section. Air seeded with acetone vapor is fed into the driven section where it flows downward to meet upward flowing $SF_6$. The gases meet and flow out of the tubes through small openings in the side, thereby producing a flat interface. The tubes are then oscillated by a stepper motor-crank combination to create the initial perturbation. A solenoid is used to puncture the polypropylene diaphragm that creates the shock wave. Synchronizing the oscillations with the solenoid allows experiments to be performed with repeatable initial conditions.



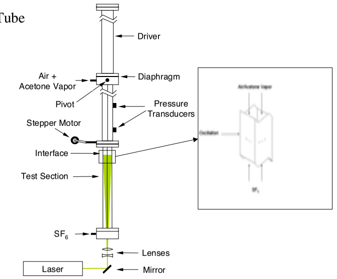
x-t Diagram for 3D Experiments

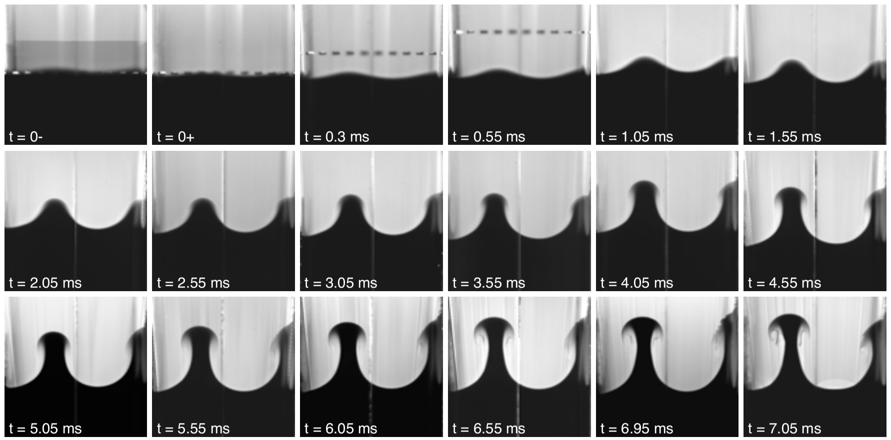
The fourth harmonic of a pulsed Nd:YAG laser is used along with a set of lenses that create a thin laser sheet that is spread across the cross-section of the tube. The UV light causes the acetone vapor to fluoresce and the image is captured using a cooled CCD camera. The low repetition rate of the laser only allows for one picture to be acquires for each experiment thus, the camera must be repositioned and the laser pulse delayed by a small amount for subsequent experiments. To create the 2D perturbation the square tube is oscillated parallel to the walls while rotating the tube 45° and oscillating along the diagonal generates the 3D perturbation.



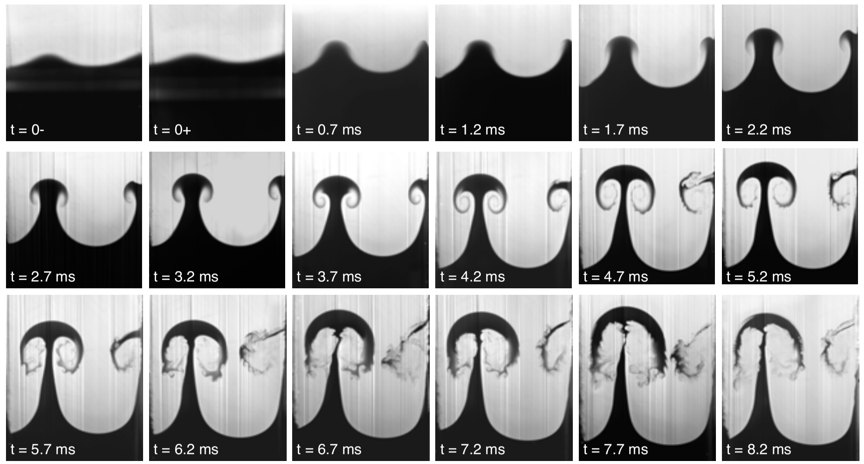
x-t Diagram for 2D Experiments

Shock Tube

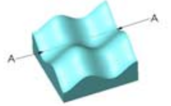


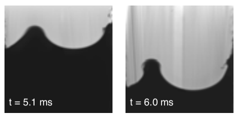




The pictures above are from the 3D experiments. The first picture is just prior to the arrival of the shock wave. Each subsequent picture is taken at the time indicated.

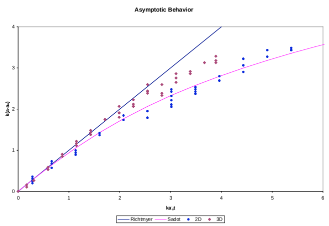



The pictures above are from the 2D experiments. The first picture is just prior to the arrival of the shock wave. Each subsequent picture is taken at the time indicated.

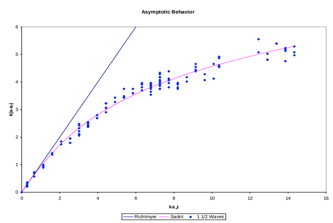



These pictures where taken along the cross-section A-A showing profiles of the saddle points.




The amplitude growth of the 3D perturbation shows better agreement with Richtmyer's[2] Linear Theory at later dimensionless time.




The longer shock tube used in the two-dimensional experiments allows for greater dimensionless time measurements. There is good agreement between the experimental values and the model of Sadot et al[3].

## Conclusions

- New experiments with a 3D membraneless initial perturbation were conducted.
- 3D amplitude measurements agree with linear theory to later time than 2D.
- Vortex structures develop and become turbulent more quickly in 2D.
- 3D perturbation amplitude grows faster than 2D.

[1] BD Collins and JW Jacobs, "PLIF Flow Visualization and Measurements of the Richtmyer-Meshkov Instability of an Air/$SF_6$ Interface," *J. Fluid Mech.* **464**, 113 (2002).
[2] RD Richtmyer, "Taylor Instability in Shock Acceleration of Compressible Fluids," *Commun. Pure Appl. Math.* **13**, 297 (1960).
[3] O Sadot, L Erez, U Alon, D Oron, LA Levin, G Erez, G Ben-Dor, and D Shvarts, "study of Nonlinear Evolution of Single-Mode and Two Bubble Interaction Under Richtmyer-Meshkov Instability," *Phys. Rev. Lett.* **80**, 1654. (1998).