We provide motivation and guidance for further development of the experiment, diagnostics and comparisons between two- and three-dimensional models. The FLASH code proved efficient and accurate in modeling the shock-cylinder interaction problem. We find good overall agreement between the experiment and numerical model in structure of the velocity field while model velocities were over 50% larger than in experiment. This discrepancy does not necessarily imply serious problem since our early 3-D calculation did not benefit from the detailed analysis of the initial conditions.

**Los Alamos Experiment**

- Shock tube with square cross section, initially filled with air. Mar=1.2 planar shock.
- Dense gas column: sulfur hexafluoride (SF\textsubscript{6}) enters from a nozzle in the top wall and falls through the test section. Because air and SF\textsubscript{6} interdiffuse, the SF\textsubscript{6} distribution is a function of height.
- Data taken in a single horizontal plane, 2 cm below the top wall. CCD cameras used for imaging initial conditions and evolution; PIV data for analysis of velocity field.

**Study Targets**

- We study the shock-cylinder interaction to validate the FLASH code for vortex-dominated flows and discover three-dimensional effects in a nominally two-dimensional experiment.
- Our objective is to understand behavior of the complete system, including the initial conditions.
- We find the flowfield’s development to be highly sensitive to the distribution of heavy gas, SF\textsubscript{6}, prior to the arrival of the shock, i.e. the initial conditions are extremely important.
- We provide motivation and guidance for further development of the experiment, diagnostics of the initial conditions and the resulting three-dimensional flowfield as indicated by our predictive hydrodynamic model.

**Matching Initial Conditions**

- Simulate the SF\textsubscript{6} falling through the test section, prior to shock interaction, i.e. generate initial conditions for FLASH simulations.
- Main goal is to determine maximum initial mole fraction, X\textsubscript{SF6}, in image plane which cannot be measured directly.
- We model the initial evolution of the gas column by solving a species advection equation, the momentum equation, and an elliptic equation for the pressure, with constant gravity, viscosity, and species diffusion, in axisymmetric geometry.
- Choose inlet velocity and the initial SF\textsubscript{6} mass fraction, then run until steady state is achieved.
- Construct goodness-of-fit map of the initial conditions extracting SF\textsubscript{6} radial profile in image plane and compare to experimental data.

**Revealing the True Nature of the Experiment**

- Comparison between 2- and 3-dimensional models reveals certain differences in morphology indicating additional redistribution of material due to vertical motions and coupling between horizontal and vertical flows. In light of this newly discovered element, 2-D studies appear of very limited use. Comparison of realistic 3-D model to experiment, shows good overall agreement of morphology of large and medium scale structures.

**Conclusions**

- The FLASH code proved efficient and accurate in modeling the shock-cylinder interaction problem. We find good overall agreement between the experiment and numerical model (both morphology and dynamics). The shock-cylinder interaction problem is genuinely 3-dimensional. The magnitude of vertical motions is similar to that of horizontal motions in the cylinder’s frame of reference.
- Modeling of the initial conditions clearly indicates strong vertical stratification. We identified a one-parameter family of initial conditions which is consistent with the experimental data.
- Triangular mixing occurs due to shock-induced horizontal shear as well as due to stratification-induced vertical shear. We use tracer particles to study the interaction between the two processes.
- Development of additional diagnostics (initial conditions, vertical plane) is highly desirable and will enable critical evaluation of our predictive results.

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