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Title: Proton Radiography Experiments on Shocked High Explosive Products

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Los Alamos
NATIONAL LABORATORY

Proton Radiography Experiments on Shocked High Explosive Products

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2003 APS topical Conference on Shock Compression of Condensed Matter,

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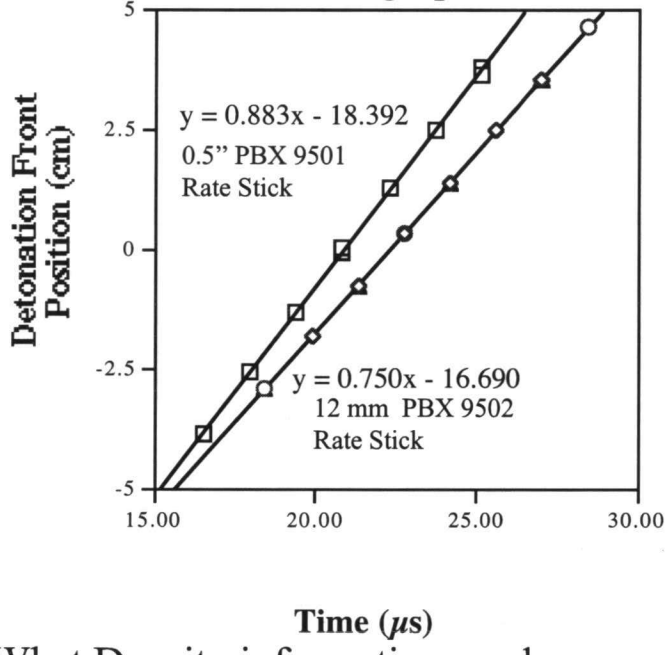
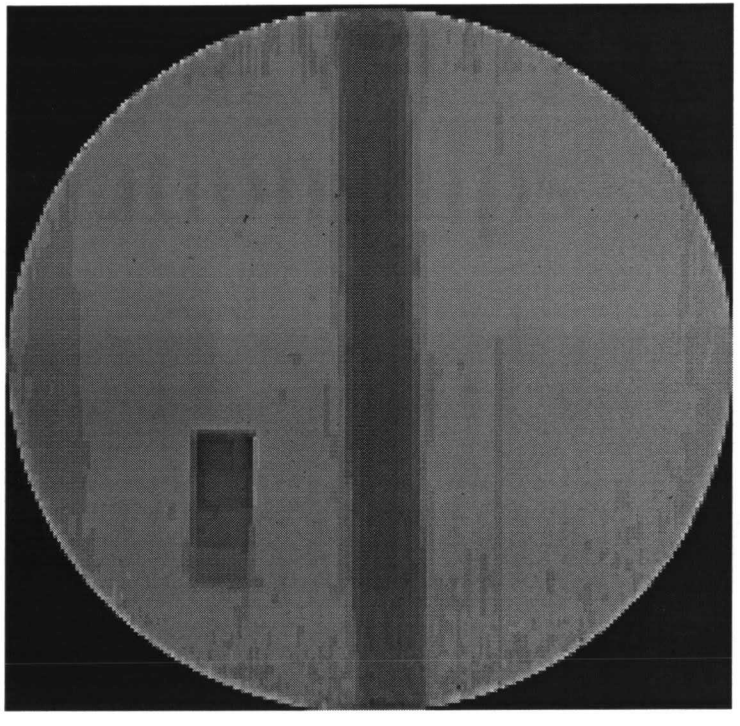
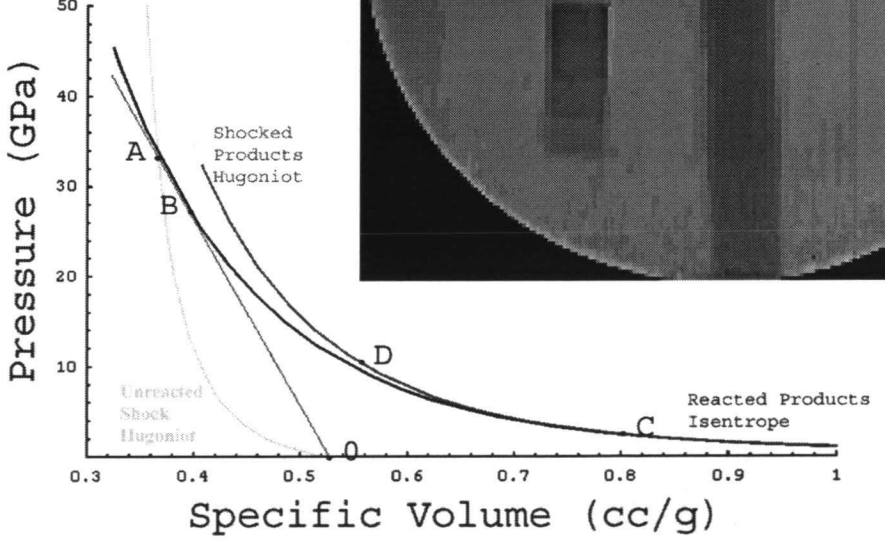
Explosive Experiments to Verify Equations of State Relationships

Steady Rate Stick Velocities determined from Proton Radiographs

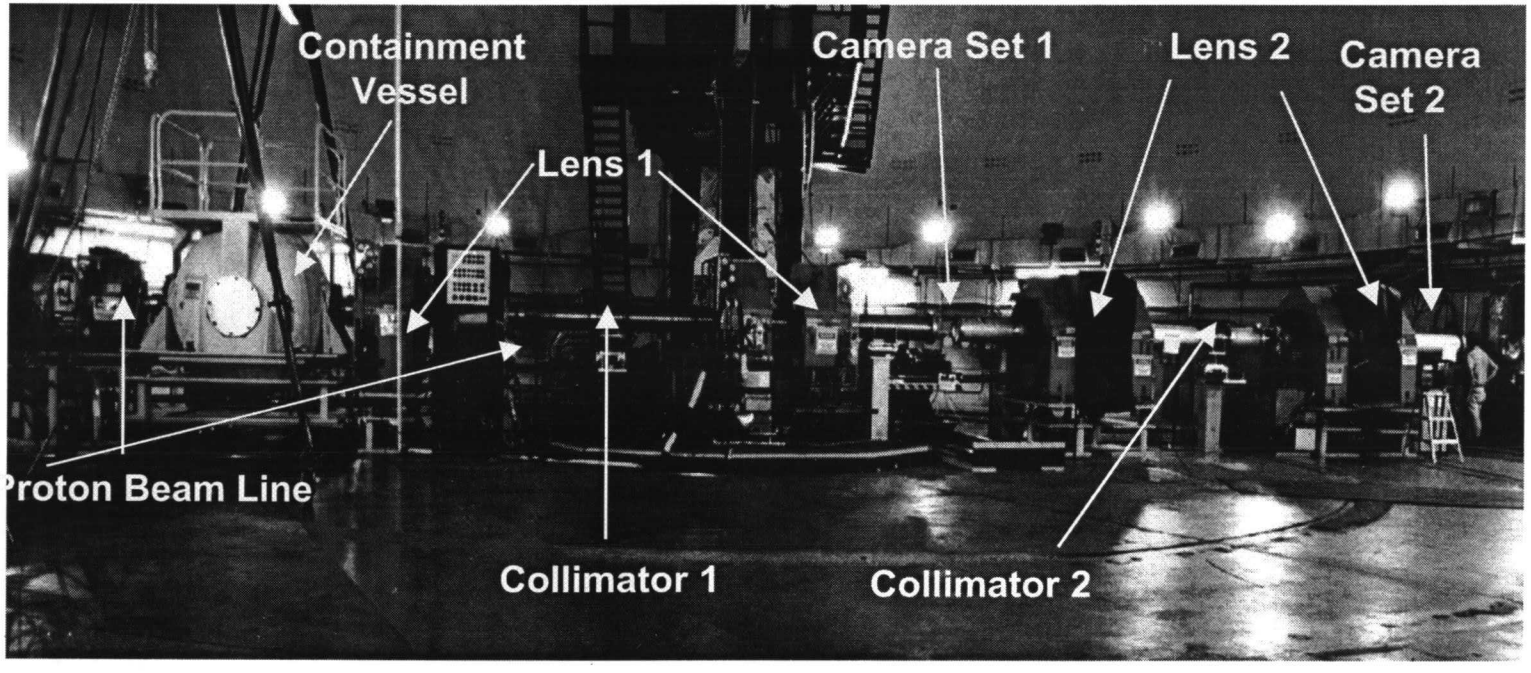






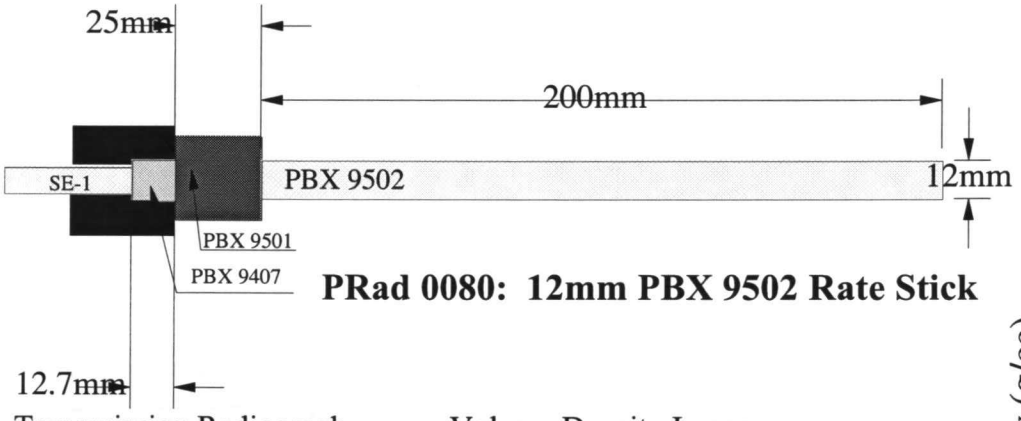
What Density information can be derived from this experiment and other simple HE experiments to test the validity of the explosive Equation of state?.

800 MeV LANSCE pRad Facility



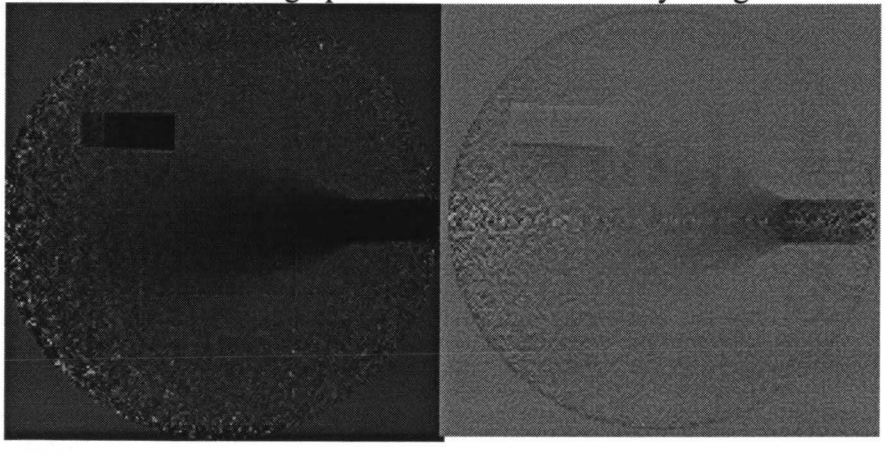
- Accelerator able to give any number of pulses over up to nearly 1 ms.
- Up to 21 pictures, using 3 lenses, 125 mm field of view system(Beam profile, object, and 2 image planes locations)
- Magnifier System 3.1x and new 7.1 x
- Collimators in each lens system
- VISAR and gauge signal recording available
- Effective transmission through up to 20 + g/cm^2
- Scintillators used at image planes to obtain optical image on CCD cameras
- 156 dynamic experiments since 1997
- 10 lbs TNT Equivalent HE authorization
- Capable of classified and unclassified test.

Rate Stick Experiments



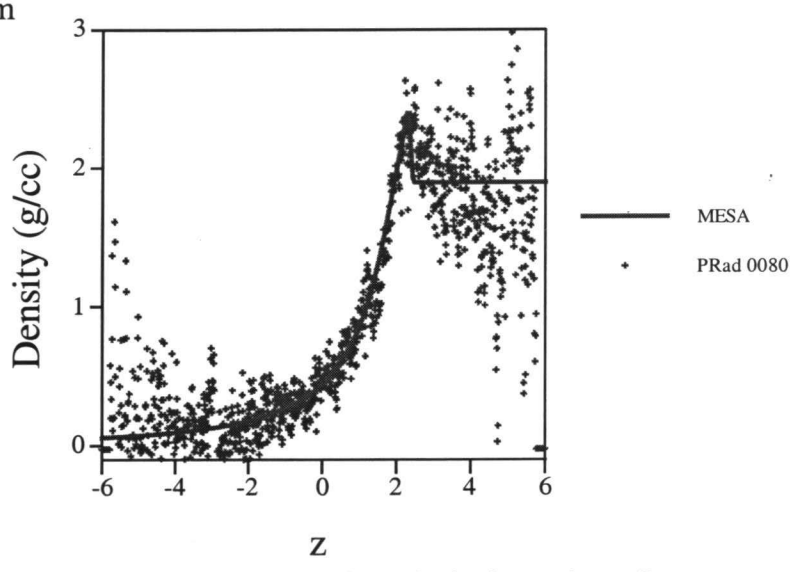
PRad 0080: 12mm PBX 9502 Rate Stick

Transmission Radiograph



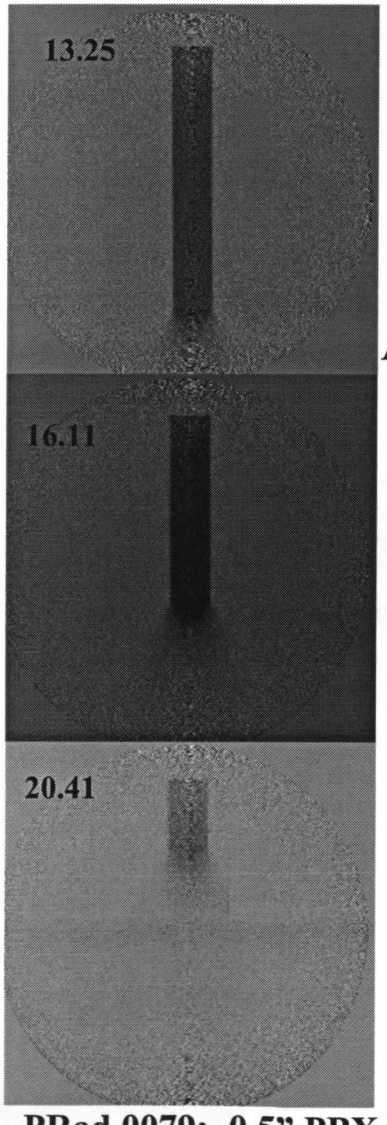
Volume Density Image

Volume density derive from the radiograph assuming axial symmetry and the proton attenuation parameters



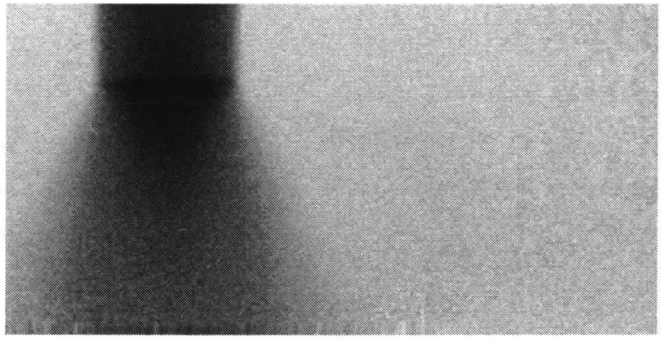
Comparison of axial density from MESA Calculation using the JWL EOS and Density found on axis in image above.

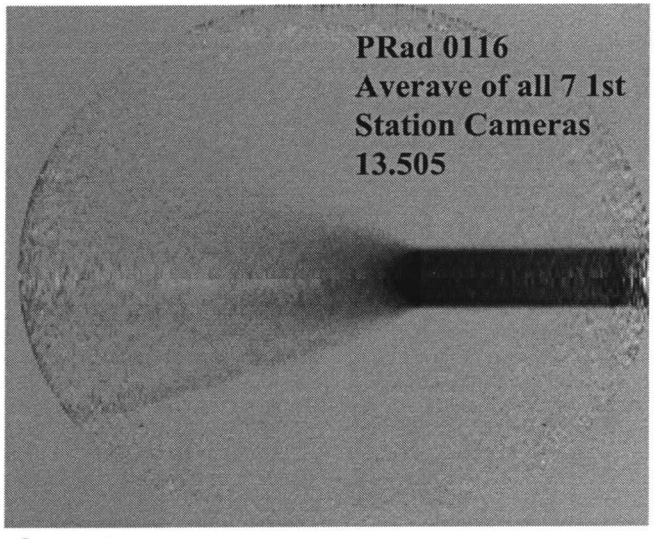
Averaging Techniques to Beat Noise

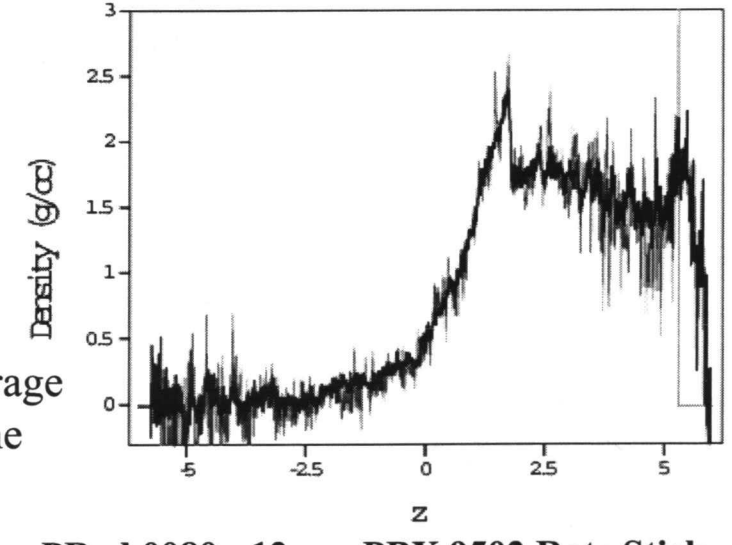


By using different cameras at the same time or steady state behavior of these experiments we can significantly improve our statistics.

Average of the translated Steady Wave





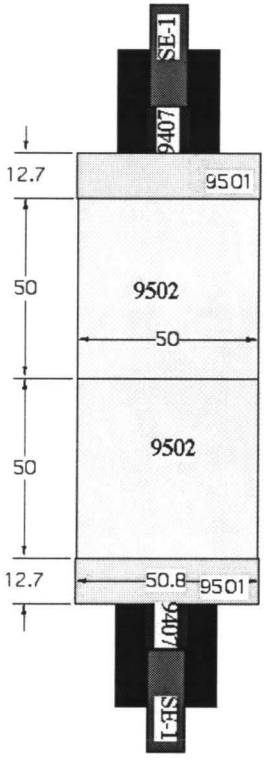


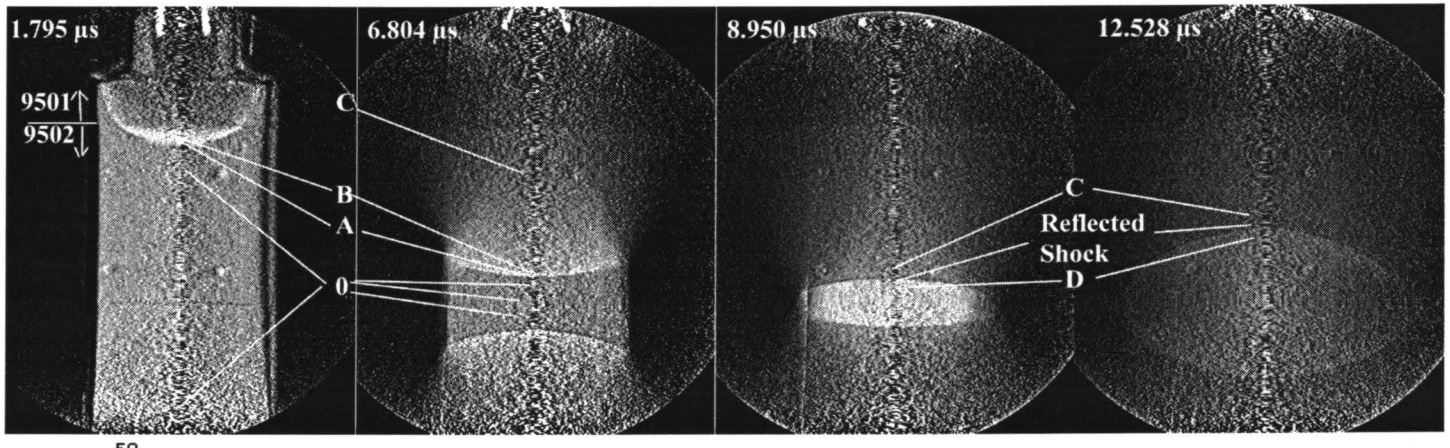
Comparison of 7 camera average density measure (black) to one camera estimates (red)

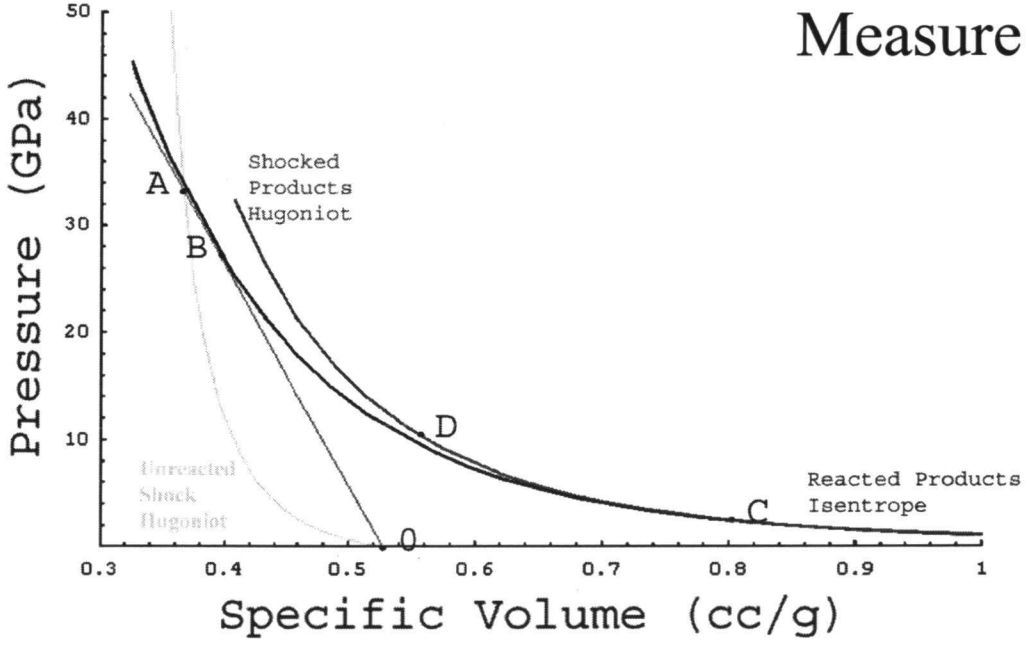
PRad 0080: 12mm PBX 9502 Rate Stick

PRad 0079: 0.5" PBX 9501 Rate Stick

Getting Off of the Principal Release Isentrope



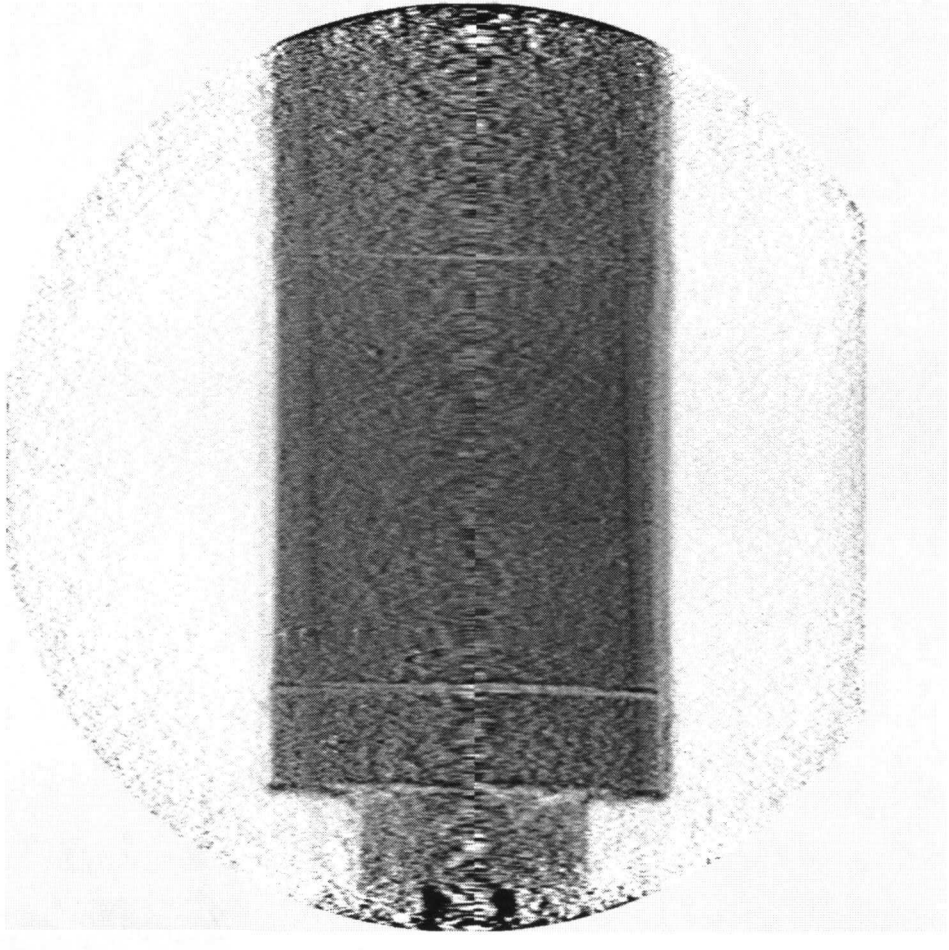


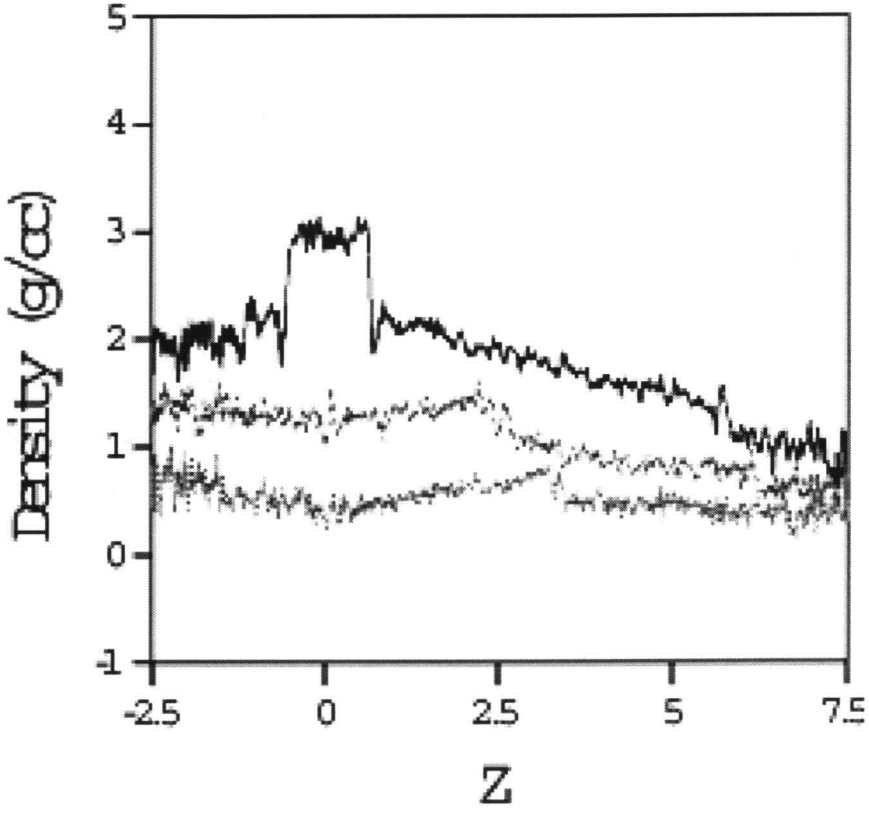


Measure - Reflected Shock Propagation Velocities

Densities on both sides of the Reflected Shock

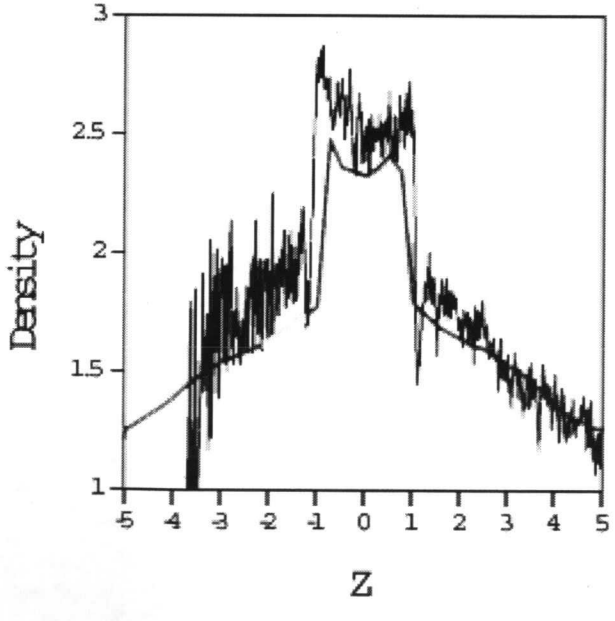
Prad 115 – Wave Reflection in PBX 9502



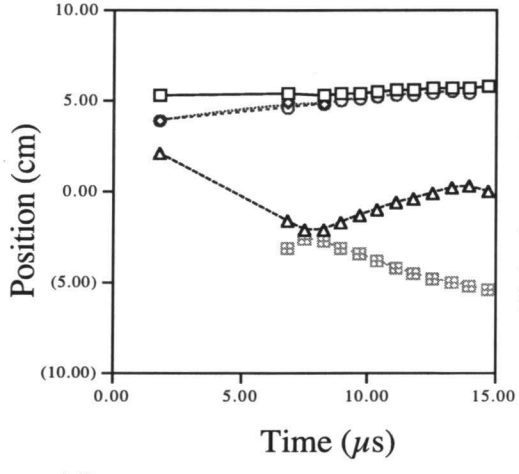


Results for PBX 9502 Wave Collision Experiment PRad 0110

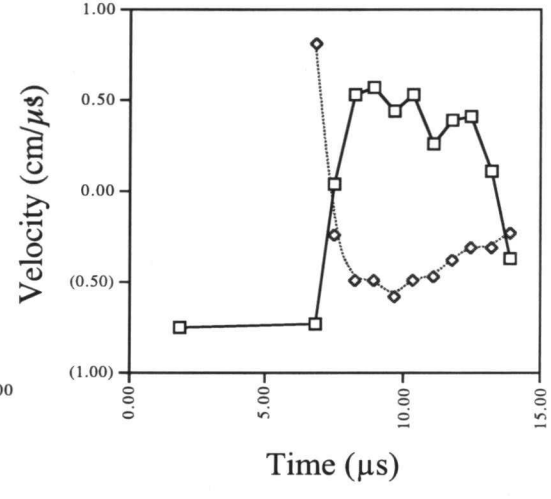
Comparison of axial density from MESA Calculation using the JWL EOS and radiographic determined density found on axis in PRad0110. Lower densities and slower shock velocities than the experiment would indicate.

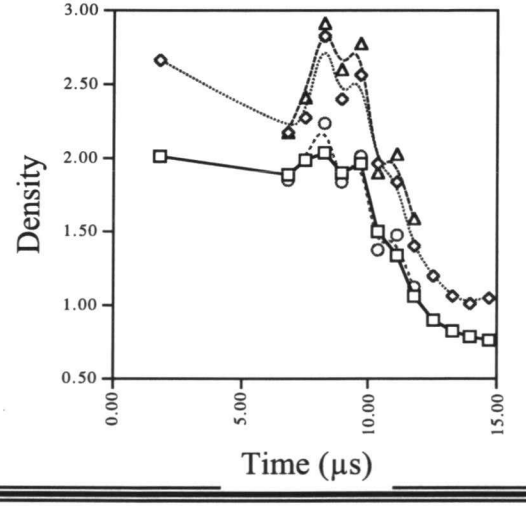


Wave and Particle Positions



Reflected Wave Velocities





•The radiographic data set is being used by Mathews, Brand, Buescher etal. to see if it is possible to estimate EOS parameters from the radiographic images.

Conclusions

- PRad investigations of explosive experiments reveal shock kinematics nicely.
- Good quality density measurements can be estimated in central sections of axis-symmetric experiments - to make the best possible estimates requires significant sacrifice in temporal or spatial extents. -More beam could help improve these statistics without these compromises.
- The data set is being examined by others to see if its possible to estimate EOS parameters using a linked calculational - radiographic image analysis approach.

Acknowledgements

Tariq Aslam, Holmann Brand, John Bdzil, Racci Deluca, Larry Hill, Charles Mader, Allen Mathews, Howard Stacy, John Zumbro

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We have studied the propagation of detonation waves and reflections of normal incident detonation waves in explosive products using the 800 MeV proton radiography facility at LANSCE. Using this system, we obtain seven to twenty-one radiographic images of each experiment. We have examined the experimental wave velocity and density of the materials ahead and behind of the shocks as inferred from radiographs and compare them to standard explosive equations of state. Finally we compare the experiments with calculations of the experiments using the MESA hydrodynamics code.

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