Diagnostics of Flow in Supersonic Nozzle Design

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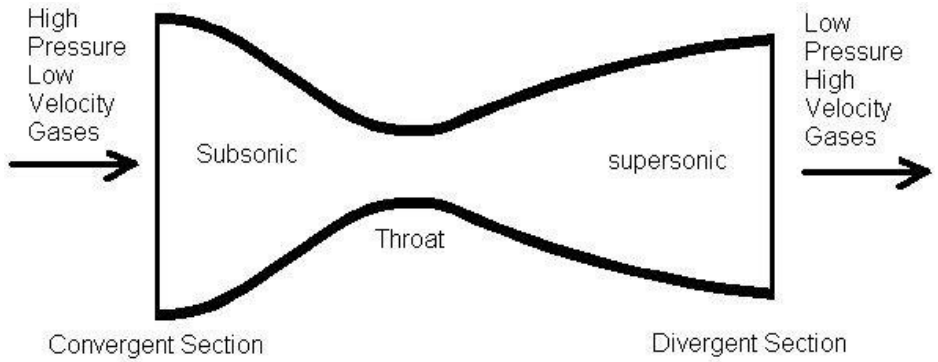
Outline

- Background
- Project Details
- Methodology and Results
- Future Plans
- Acknowledgements
- Questions

Background

- Converging-Diverging nozzles are used to create thrust

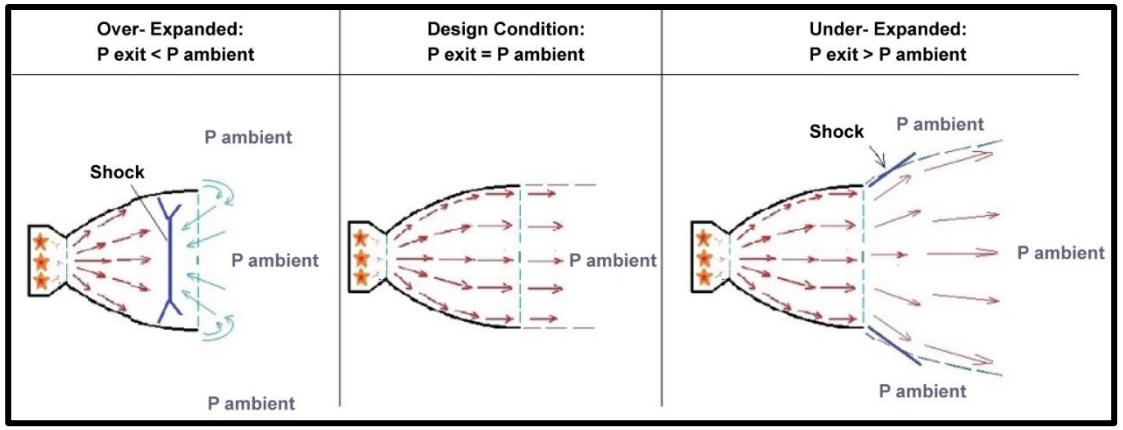


- Flow accelerated to supersonic speeds

- Rocket Propulsion, Jet Engines

Background

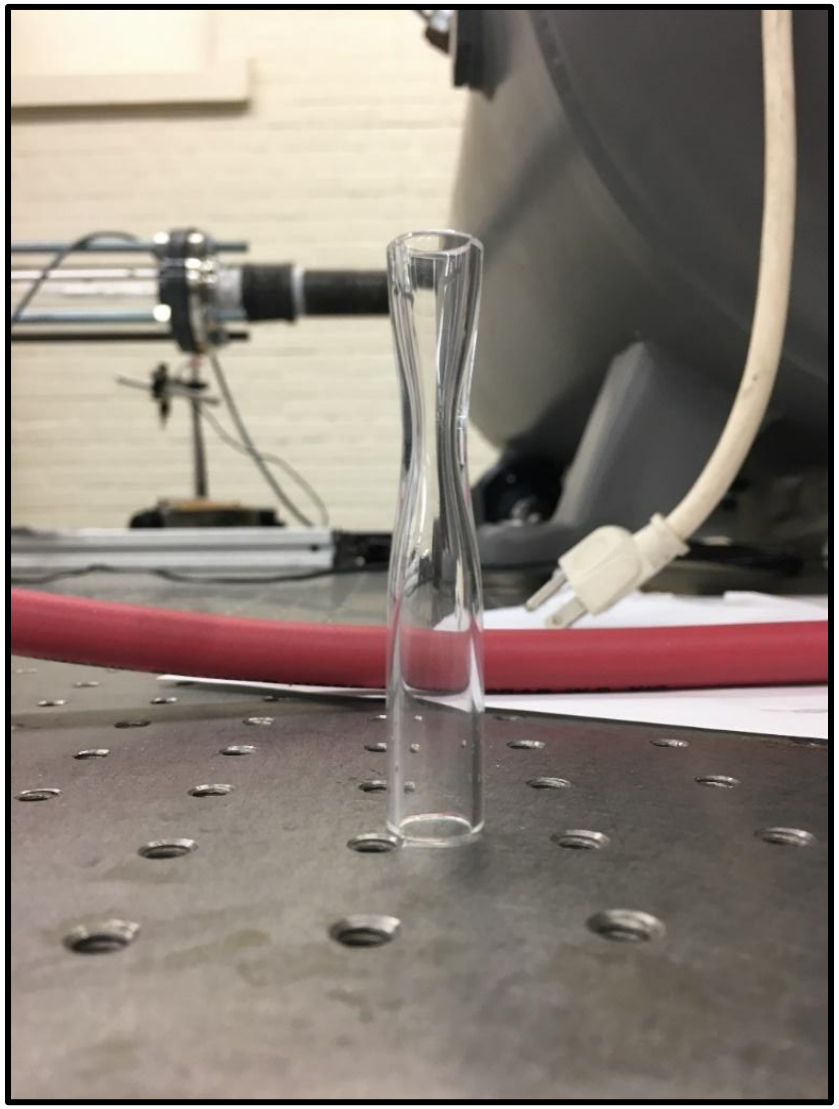
- Outlet Flow is well understood



- Flow inside nozzle has not been as widely experimentally studied

Project Details

- Glass nozzles to see interior flow
- Shadowgraphs and Schlieren imaging for outlet flow
- Particle Image Velocimetry (PIV) for interior flow



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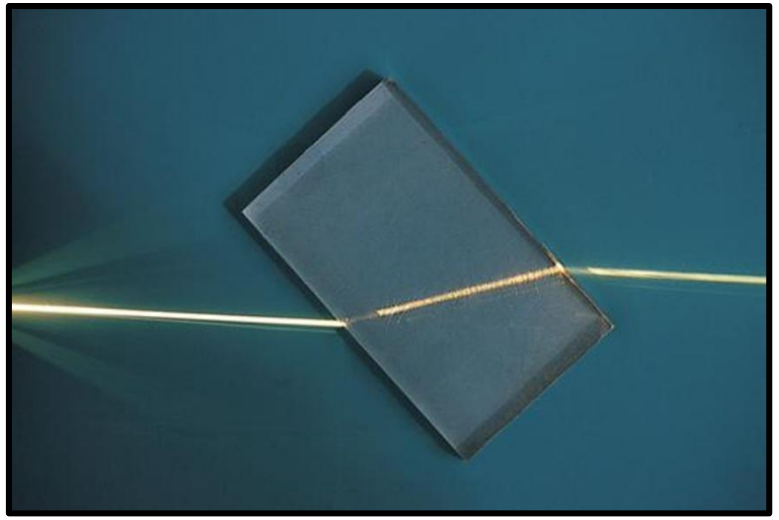
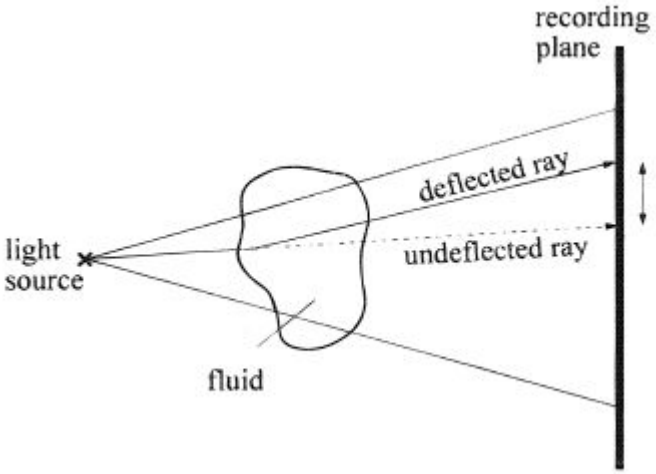
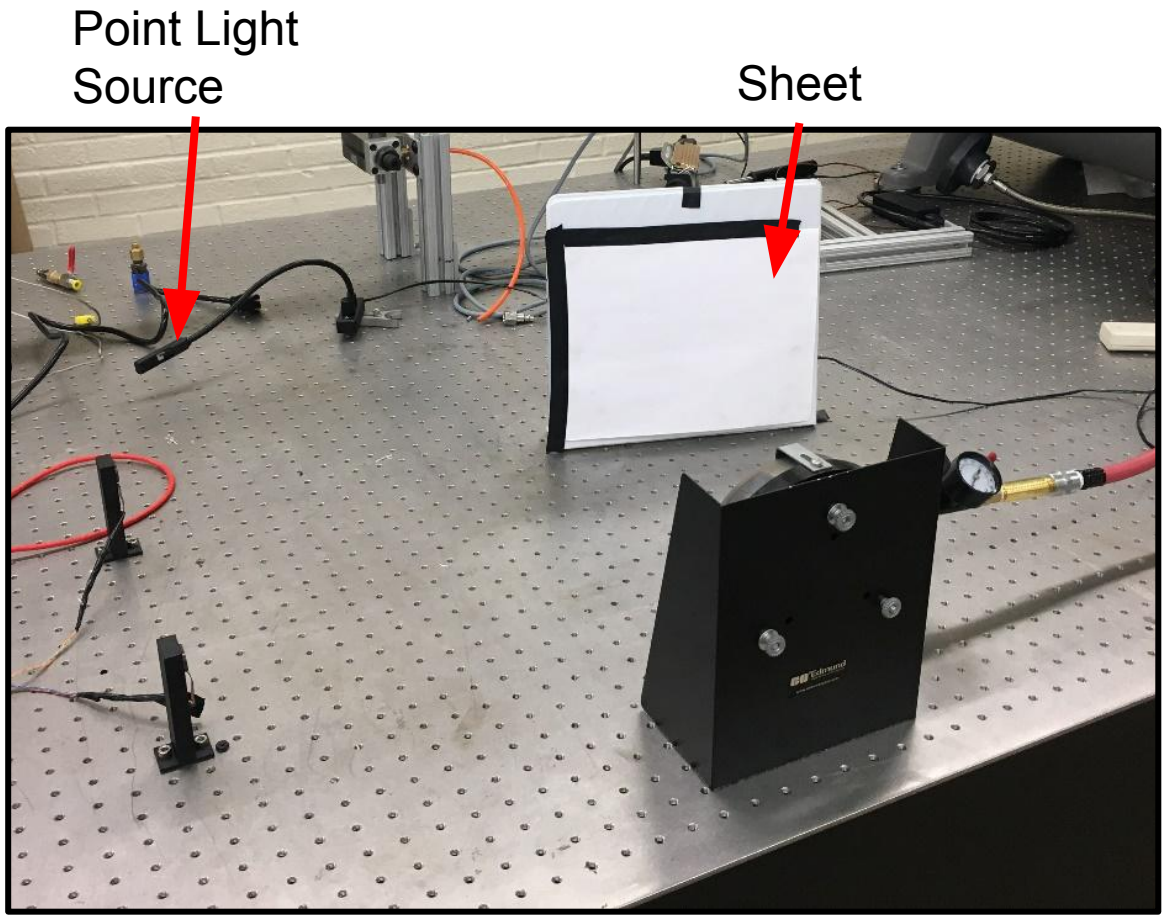
Methodology: Shadowgraphs

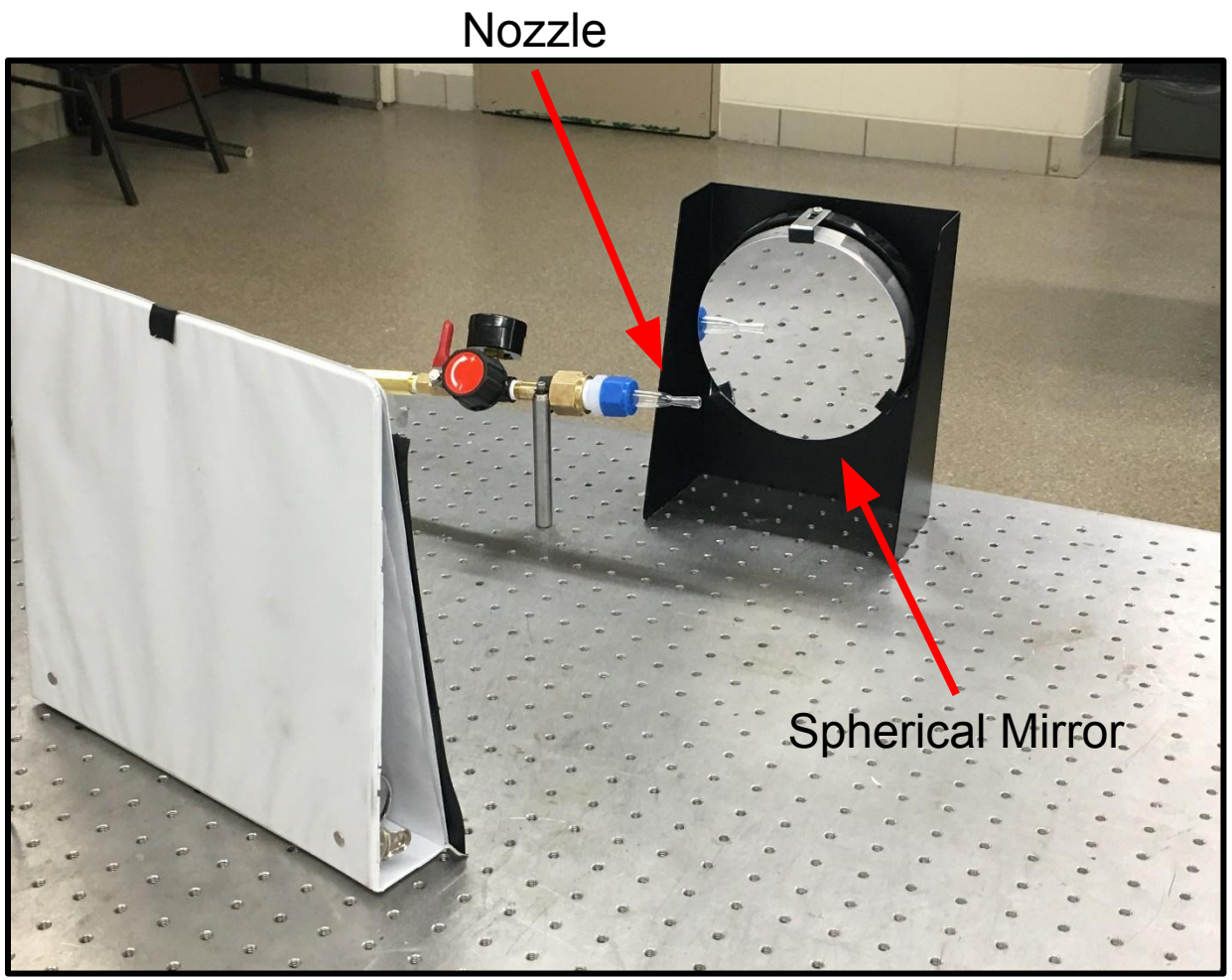
- Shock waves create very high pressures and densities
- Light refracts through different densities at different angles
- Shadowgraphs show portions of flow with high density i.e. shockwaves





Methodology: Shadowgraphs





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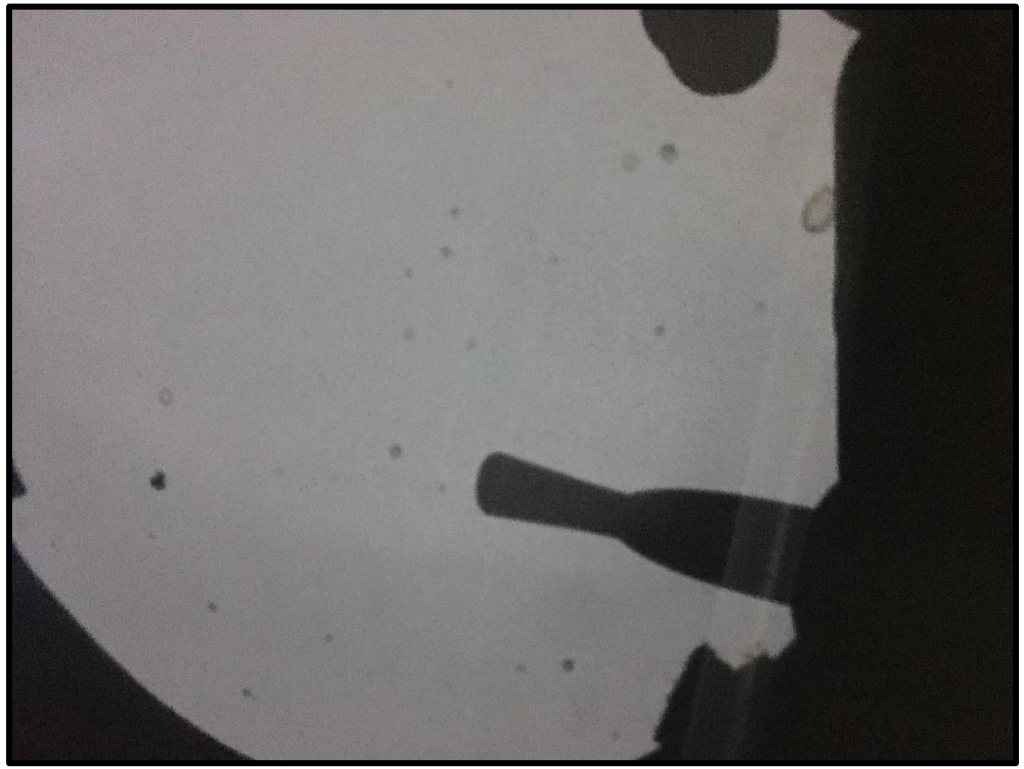
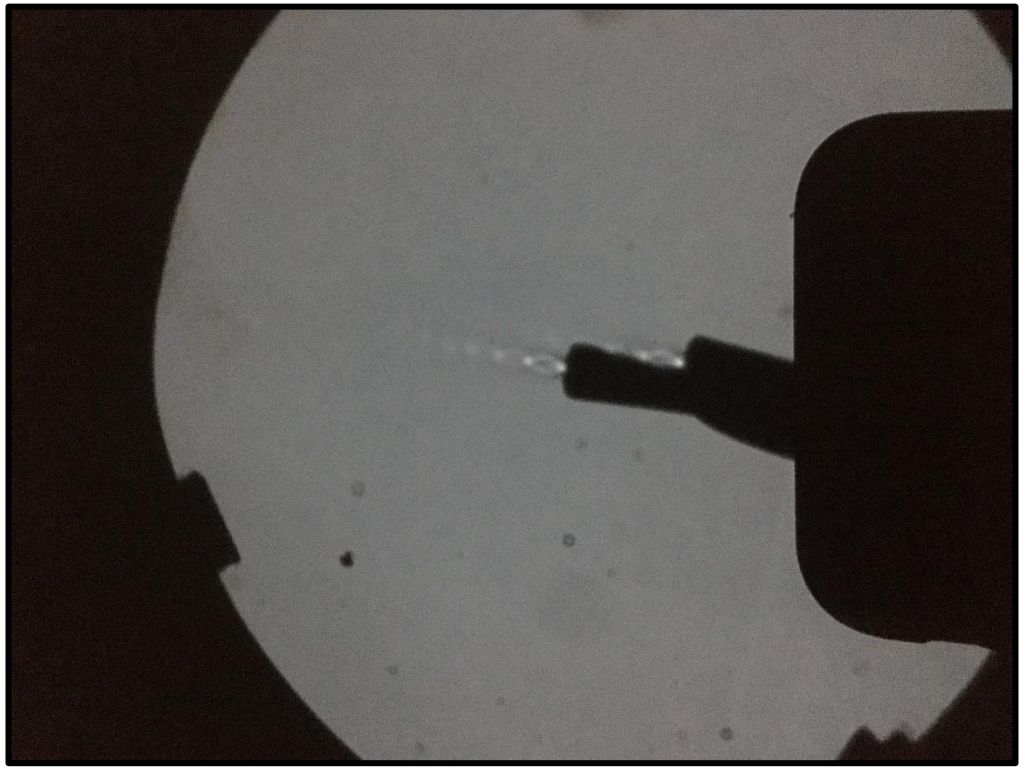
Shadowgraphs: Result



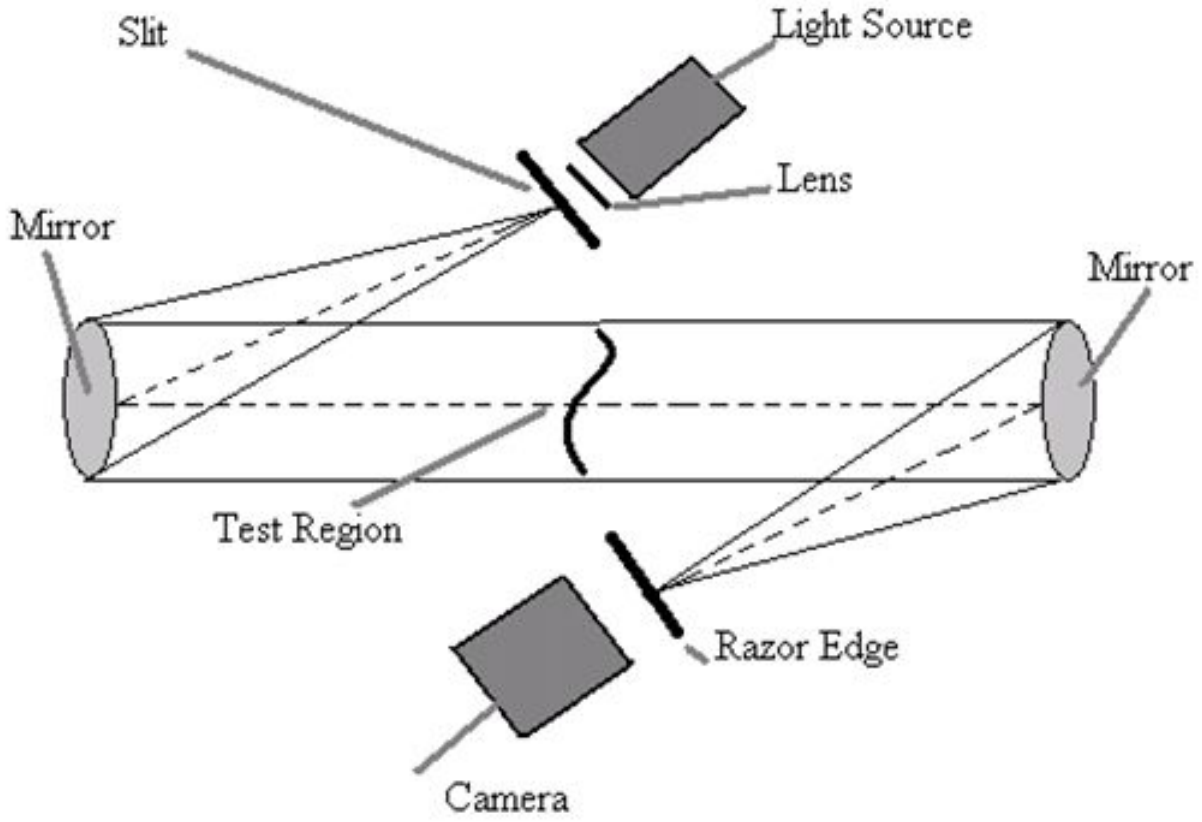
30 PSI Inlet Pressure



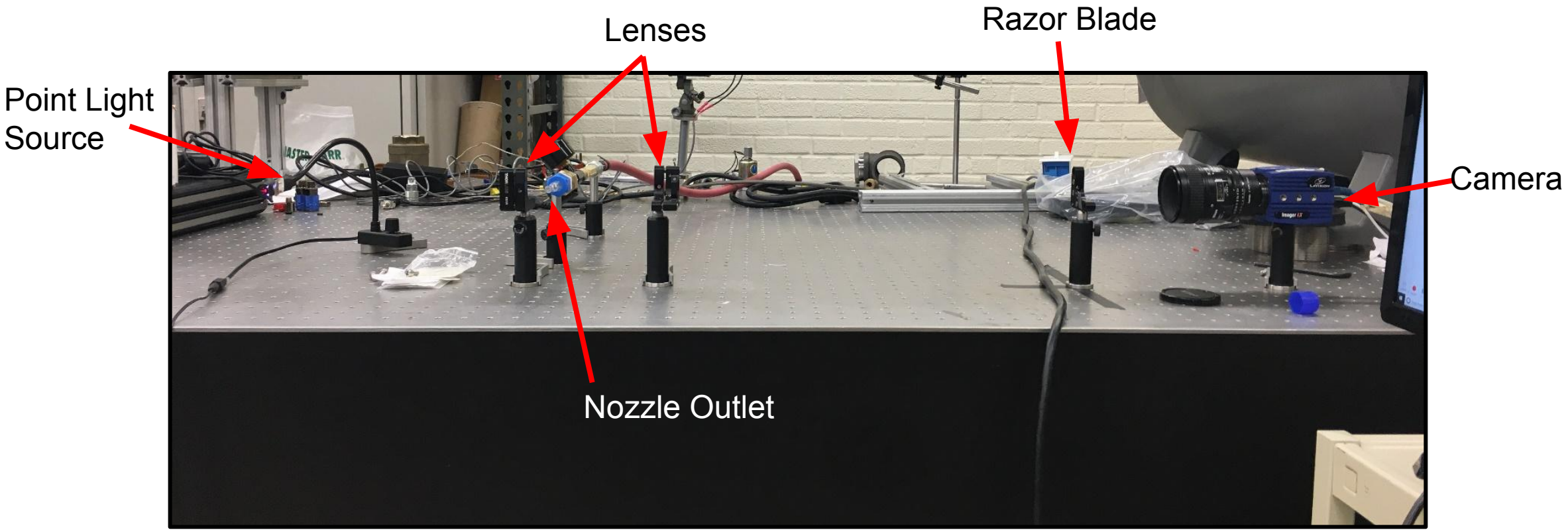
70 PSI Inlet Pressure

Schlieren

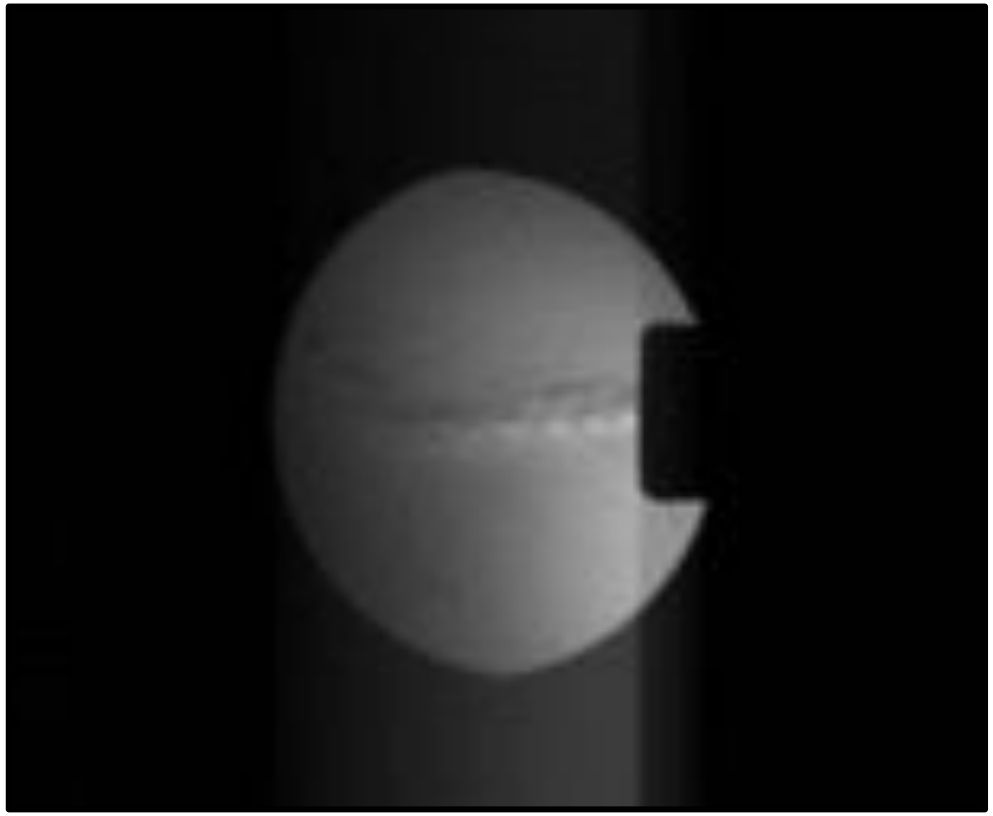
- Very similar to shadowgraphs
- Knife edge blocks some light, sharpening image



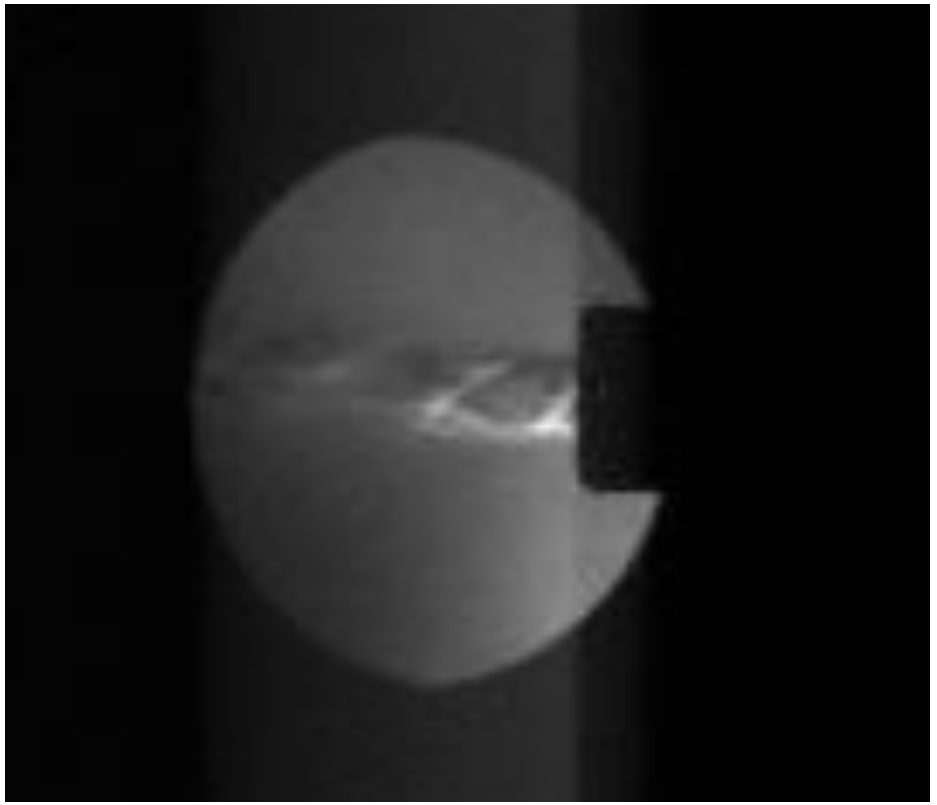
Schlieren Setup



Schlieren Results



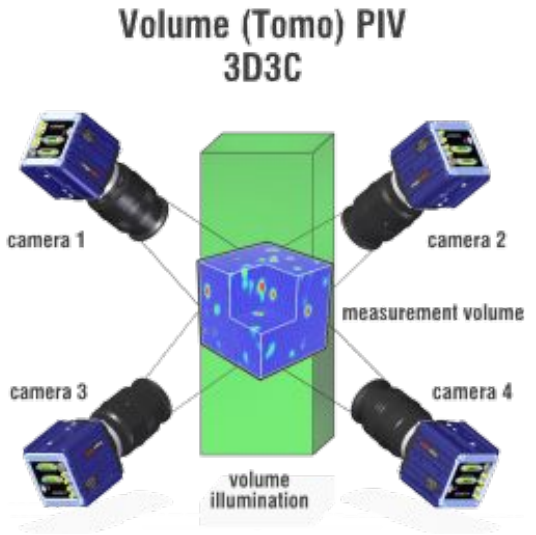
30 PSI Inlet Pressure

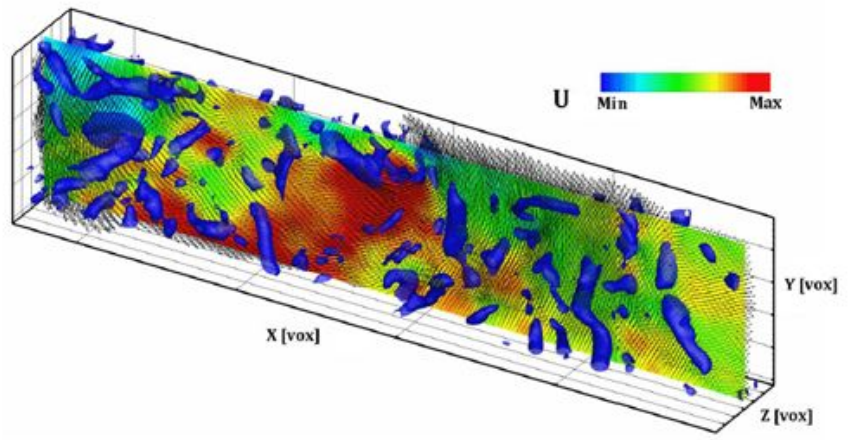


70 PSI Inlet Pressure

Future Plans

- 2/3D PIV
- Different nozzle geometries





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NORTH DAKOTA SPACE GRANT CONSORTIUM

Questions?

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