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HYDRA (HYpersonic Dynamics Rocket Assembly)

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Introduction

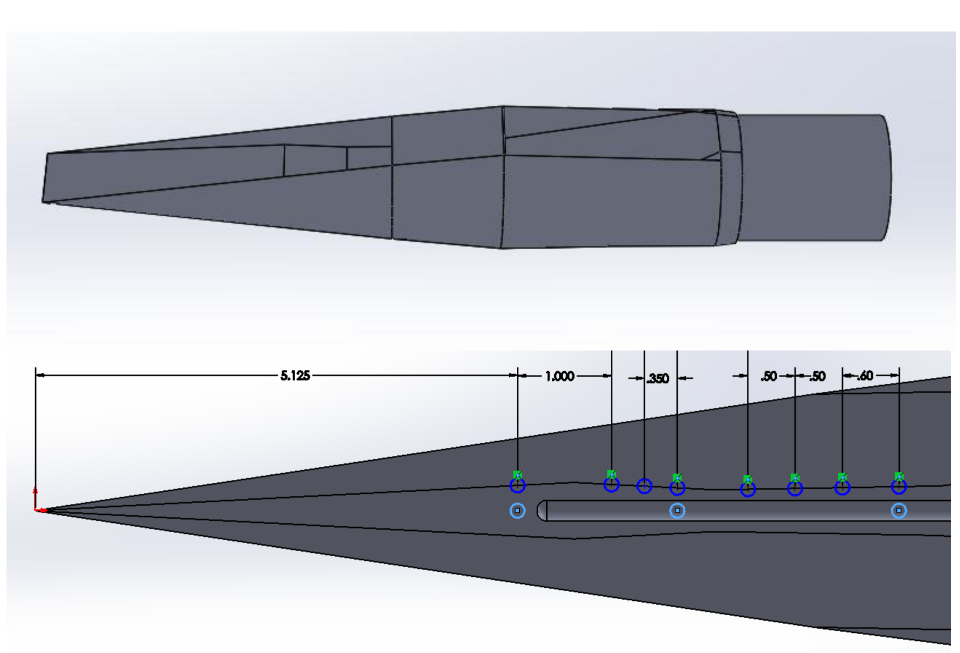
HYDRA is a proof-of-concept vehicle designed to demonstrate the capabilities of a hypersonics testbed. The goal of HYDRA is to validate and verify the use of dynamic pressure analysis as a viable method of cost efficient hypersonic flight testing.

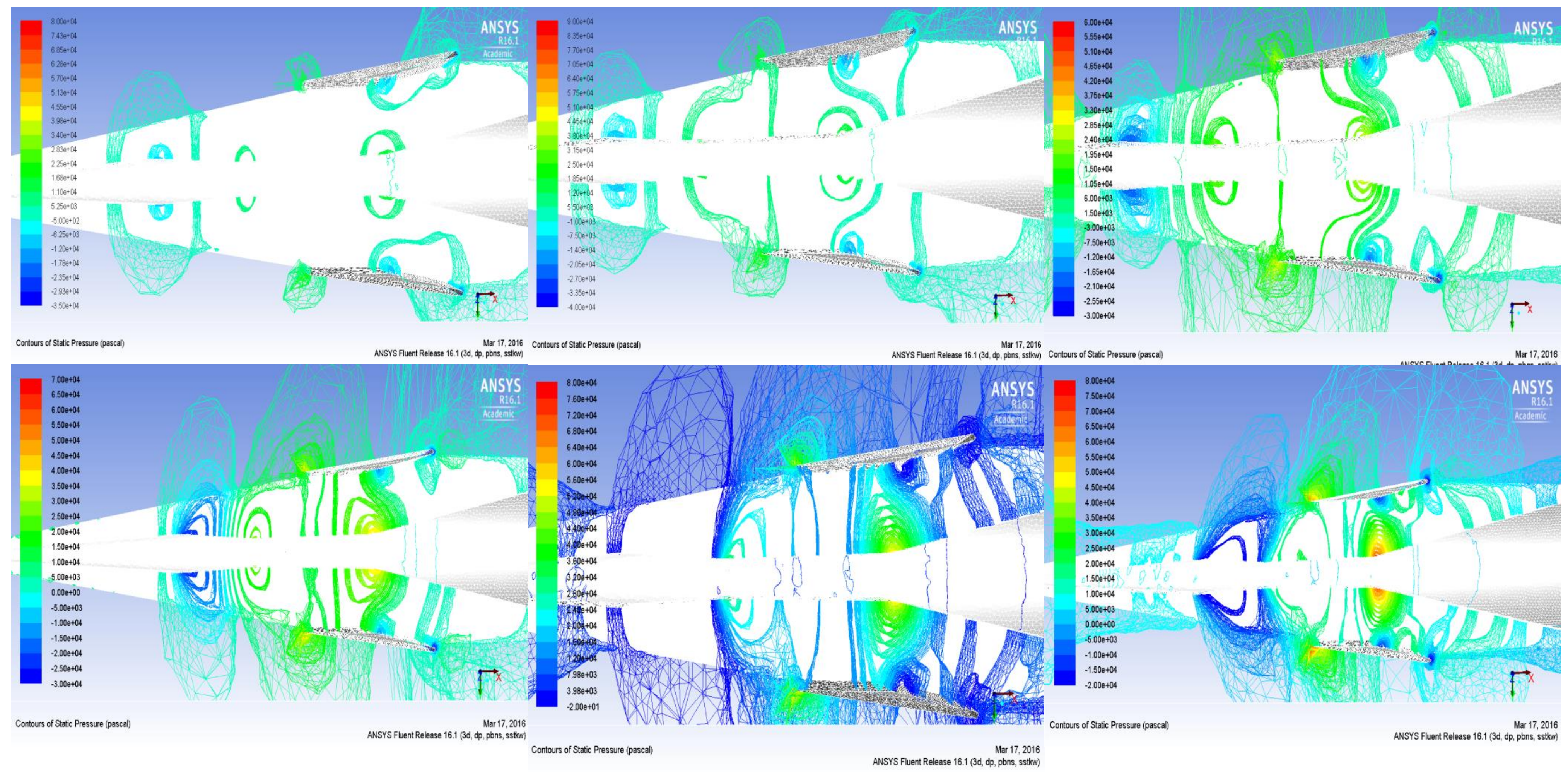
Problem Statement

A testing method is required for hypersonic technologies that can simulate hypersonic conditions at lower velocities and altitudes through dynamic pressure analysis and is reusable, reliable, and cost efficient.

Objective

The objective is to compare the pressures recorded during transonic flight testing to ANSYS CFD simulations to determine the accuracy of the simulation. The resulting analysis will determine if the ANSYS models at Mach 1.6 will match the actual data that would be collected, thus determining the functionality and data collection accuracy of HYDRA.





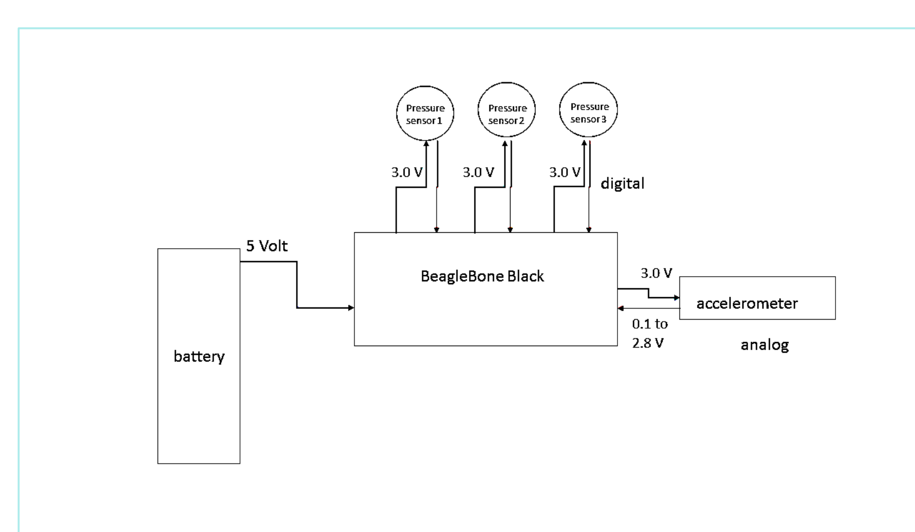
Design

Model & Instrumentation

• 11 static pressure sensors used to measure flow conditions around the nosecone

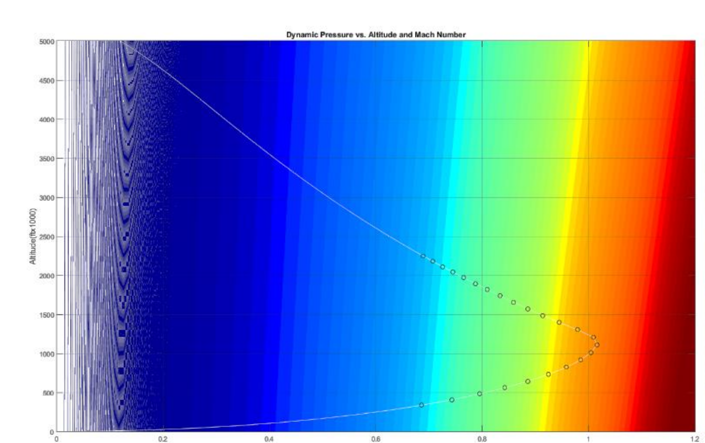
• Data Acquisition Unit: BeagleBone Black

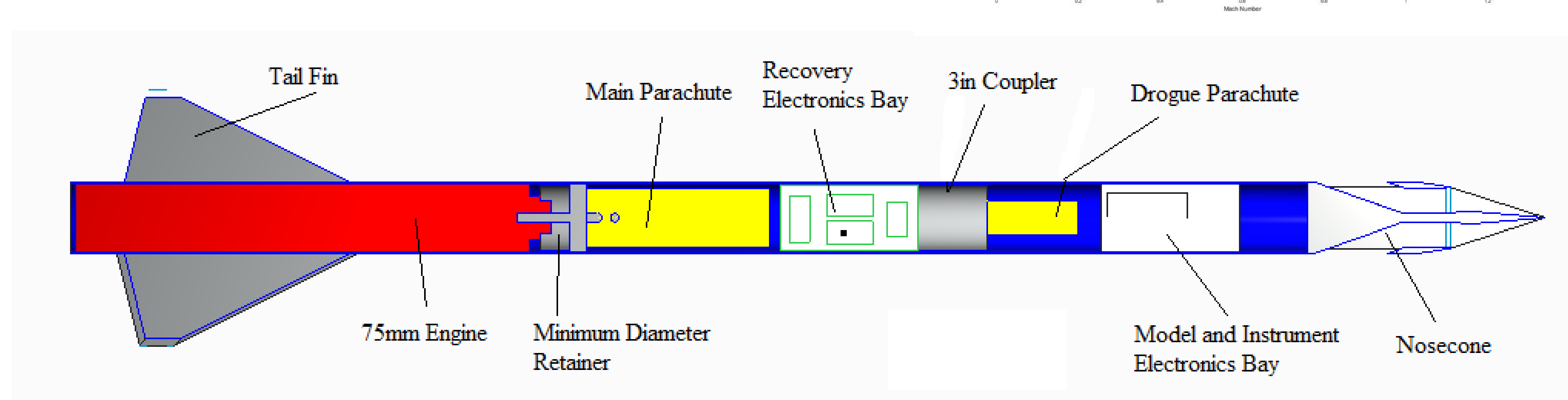
• 2 1-to-8 multiplexers used to expand the BeagleBone Black's I2C Ports to accept 11 sensors



Rocket

- Rocket structure will be constructed of G12 fiberglass tubing
- Total Height: 70 in.
- Total Weight: 10.33 lb.
- J-350W subsonic test will reach altitude of 2450 ft. and maximum velocity of Mach 0.5
- K-1275R transonic test will reach maximum speed of Mach 1.01 and apogee of 5214 ft.





Expected Results

The pressure sensors will read the static pressure in the inlet of the nosecone. The data will be compared to the ANSYS simulations for flows between Mach 0.7 and Mach 1.2.

Success Criteria: Experimental data within 10% of expected pressure gradient from ANSYS simulation.

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Conclusion

Hypersonic flight testing has often been restricted to governments and private companies due to prohibitive costs related to simulating the conditions of a hypersonic environment. Through dynamic pressure analysis, the HYDRA vehicle simulates a hypersonic environment at lower velocities and altitudes, dramatically reducing the cost of testing. This reduction in cost will create greater accessibility to high speed flight testing, allowing further experimentation of new hypersonic designs.

Future Work

HYDRA will be fully tested and its functionality and accuracy for transonic flight determined this semester, but in future semesters it will be launched using an L-sized rocket motor to achieve supersonic velocities, especially Mach 1.6, to validate the ANSYS model. From there, further testing and analysis can be completed, and HYDRA will be ready for use in research and development of hypersonic technologies, specifically scramjets.