



Integrated Analysis of a Ramjet Test Vehicle

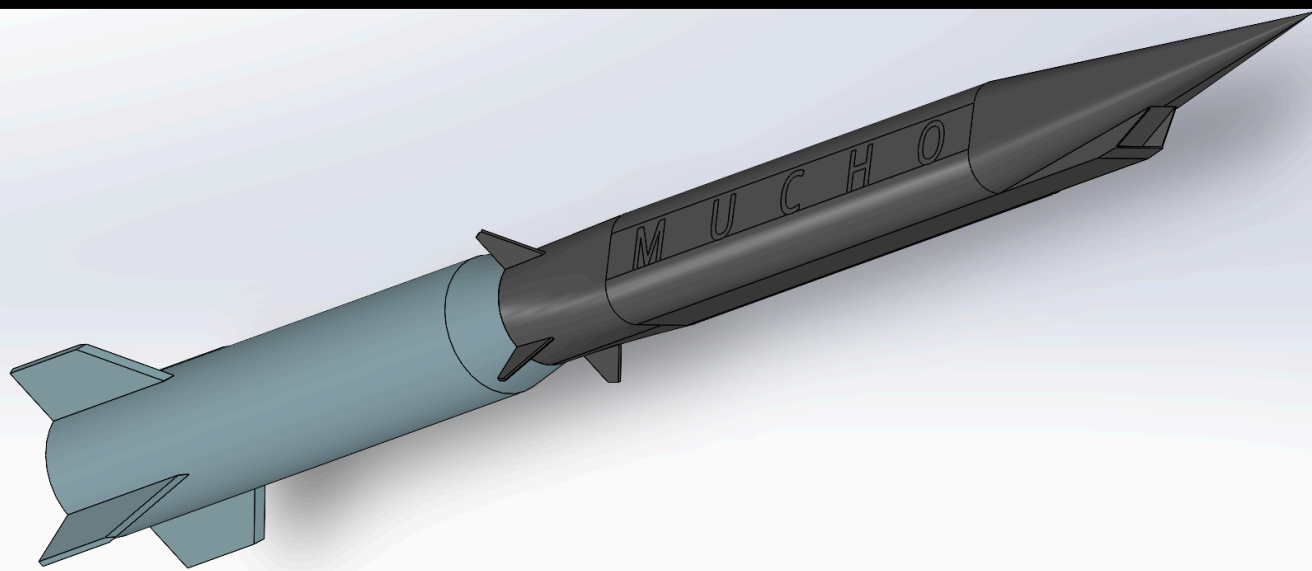
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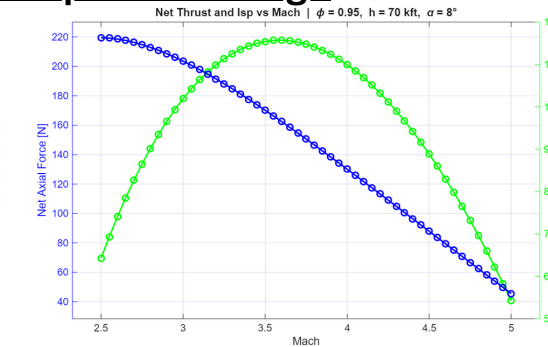
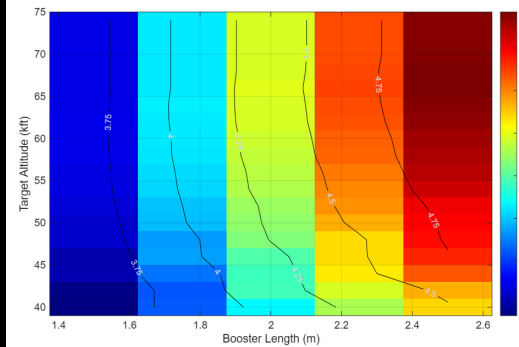
A. JAMES CLARK
SCHOOL OF ENGINEERING

The Mission

Air-launched from a Boeing F/A-18E/F at Mach 0.8 & 36,000 ft
Cruise at Mach 4 & +70,000 ft w/ 220lbs max payload
1st stage solid rocket and 2nd stage Ramjet powerplant



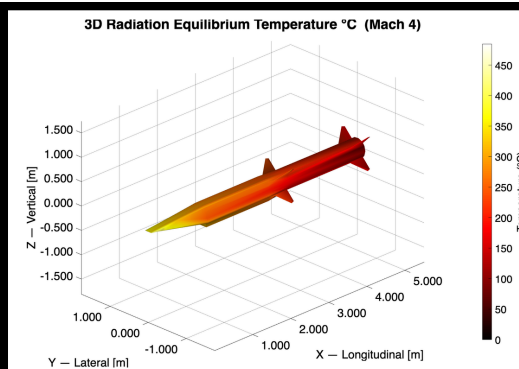
Propulsion Design



- Mixed Compression
- 4-Shock Inlet
- 100 kg of JP-10

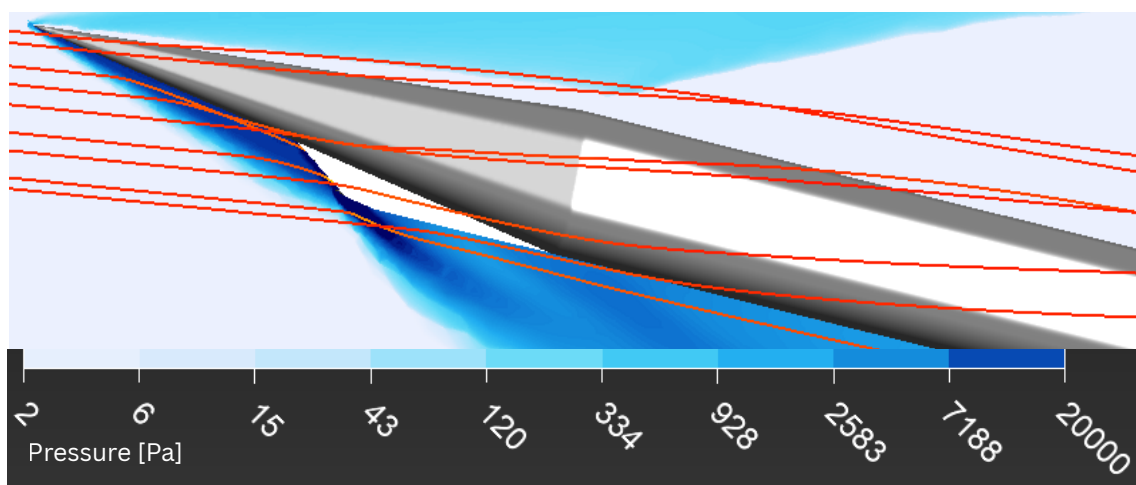
Airbreather ISP: 1100 s / Booster ISP: 240 s

Thermal Simulation



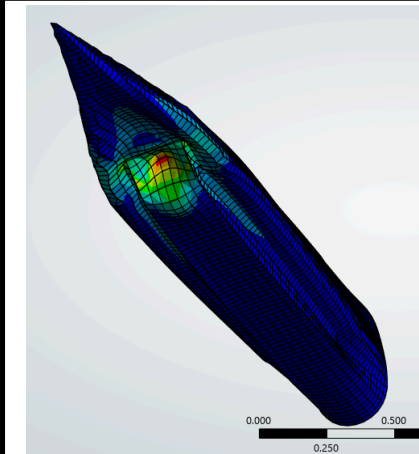
- 1.9mm Ti-6Al-4V Outer Skin
- 32 mm Phenolic Foam Insulation
- 3D Heat Flux Surface Triangulation

Aerodynamic Simulation

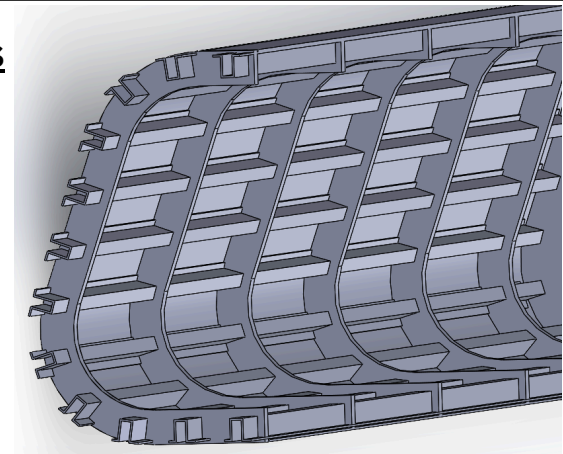


- Consistent performance across a diverse altitude range.
- Rapid aerodynamic iteration using **CHAMPS+**
- Internal flow analysis with **Ansys Fluent**

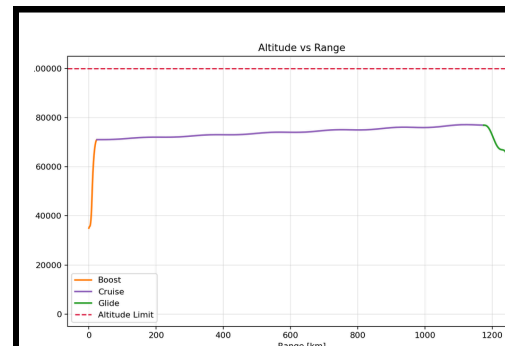
Structural Design & Analysis



- Survives Mach 2, 15G Pull @ Sea Level
- Max Deformation < 1mm
- Ortho-grid Skin Panel, 1.7mm Ribs
- Cost of the structure: **\$6107.44**



Trajectory Modeling



- Rocket Boost + Cruise + Glide Analysis
- 780 mi covered in 20 Minutes

