



Reacting Flow Environments Branch



Space Technology Division

Aerothermodynamic Testing Of Aerocapture and Planetary Probe Geometries In Hypersonic Ballistic- Range Environments

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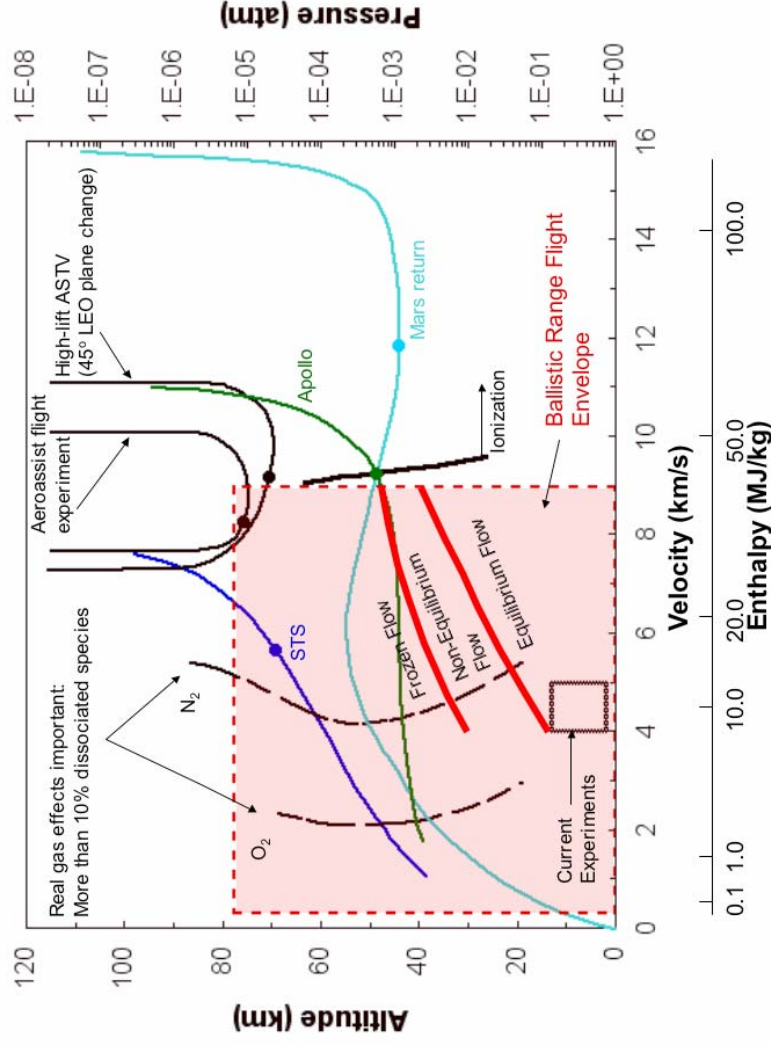
Work Supported by the In-Space Propulsion Program

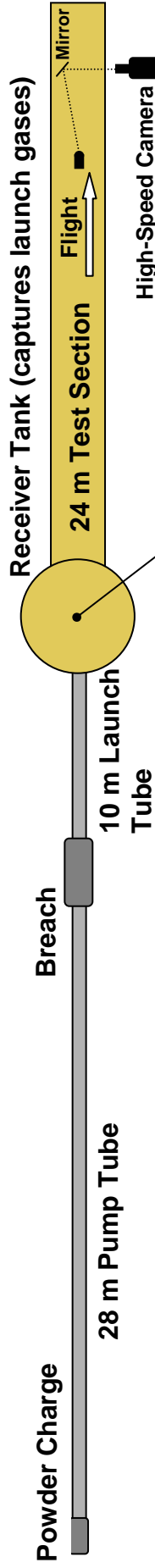
Introduction

- Flight data needed to validate and verify aerothermodynamic design methods
- Not always possible to instrument actual entry vehicles, and dedicated flight experiments are expensive
- Consequently, design methods must be validated against experiments in ground-test facilities
 - Wind tunnels, arcjets, shock tubes/tunnels, ballistic ranges
- No single facility type can reproduce all parameters of full-scale hypersonic atmospheric-entry flight
 - Different facility types complement each other by providing validation data over largest possible parameter space
 - Available flight data helps verify traceability between ground-test and flight conditions

- Ballistic-range uniquely provides opportunity for small-scale flight test
- Hypersonic flight through a quiescent, well characterized atmosphere
- Correct flight enthalpy and Mach number
- Real-gas effects with uncontaminated chemistry
- Broad operational envelope
 - Flight velocity and effective altitude (freestream pressure) are independently variable
 - V_{∞} up to 9 km/s ($h_{\text{stag}} \approx 40 \text{ MJ/kg}$)
 - P_{∞} from 0.005 atm to 1.0 atm
 - Selectable test atmosphere: Air, CO_2 , N_2 , He, Ar, Kr, Xe, etc.

Flight Domain Simulation Capability



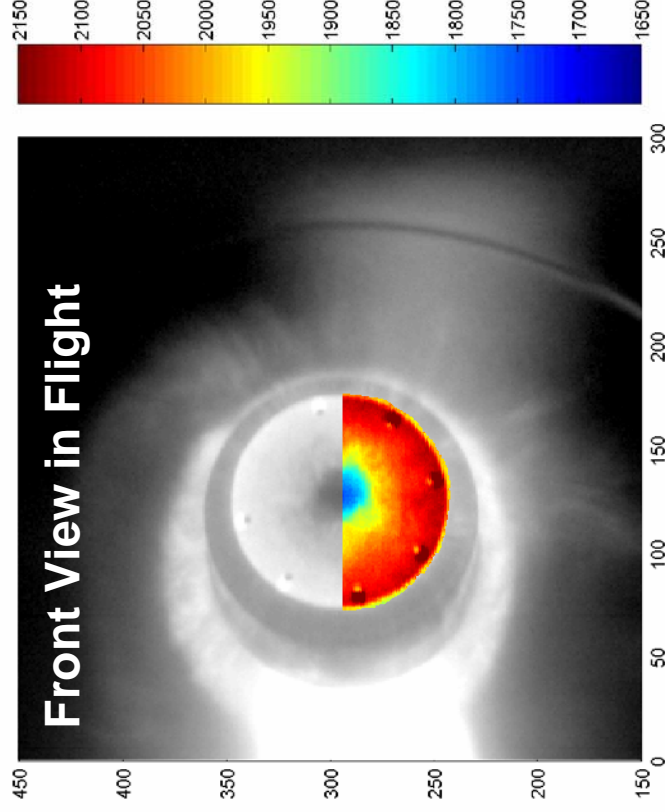


**Model: 70° Sphere-Cone
Cylindrical Afterbody
(for in-barrel launch stability)**

Side View



Front View



Representative Results

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70° Sphere-Cone
 $V = 3.8 \text{ km/s}$ ($V_L = 4.5 \text{ km/s}$)
 Flight Time = 7.74 ms
 $P_\infty = 0.658 \text{ atm}$ (500 mmHg)

70° Sphere-Cone
 $V = 3.7 \text{ km/s}$ ($V_L = 4.5 \text{ km/s}$)
 Flight Time = 7.89 ms
 $P_\infty = 0.75 \text{ atm}$ (570 mmHg)

