



5...4...3...2...1...

SPACE LAUNCH SYSTEM

Date: 1/5/2016

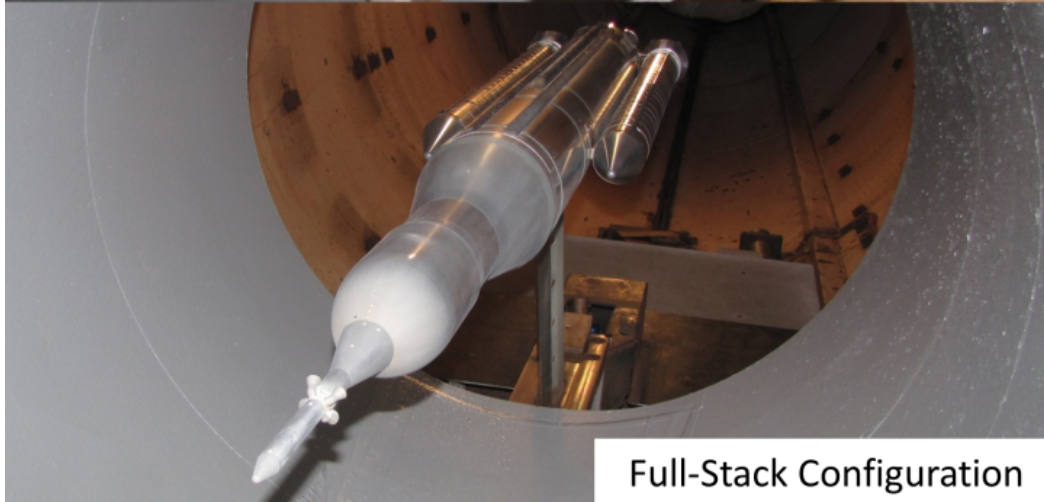
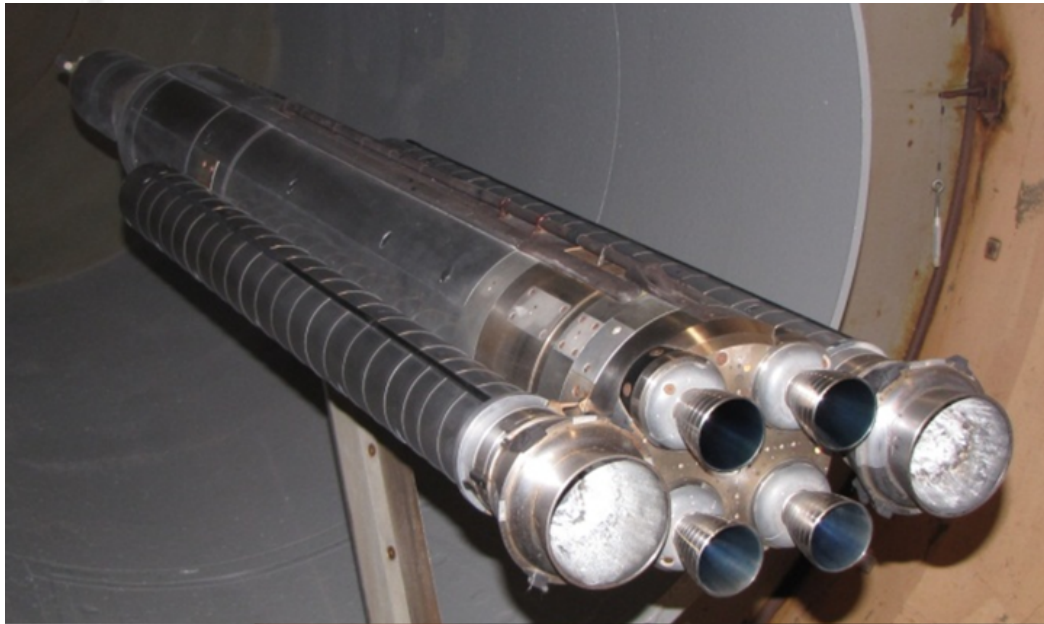
Base Heating Test: Experimental Operations and Results

Aaron Dufrene, Matthew MacLean and Michael Holden
CUBRC Inc. Aerosciences

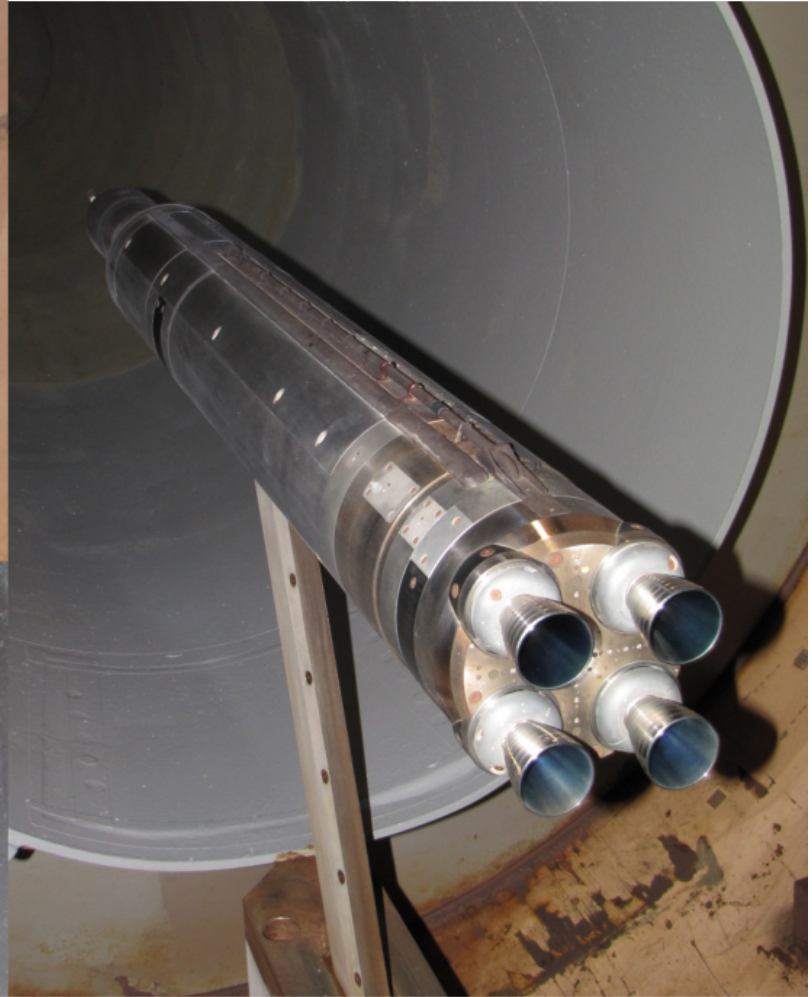
Manish Mehta and Mark Seaford
NASA Marshall Space Flight Center Aerosciences Branch



2% SLS Base Heating Model

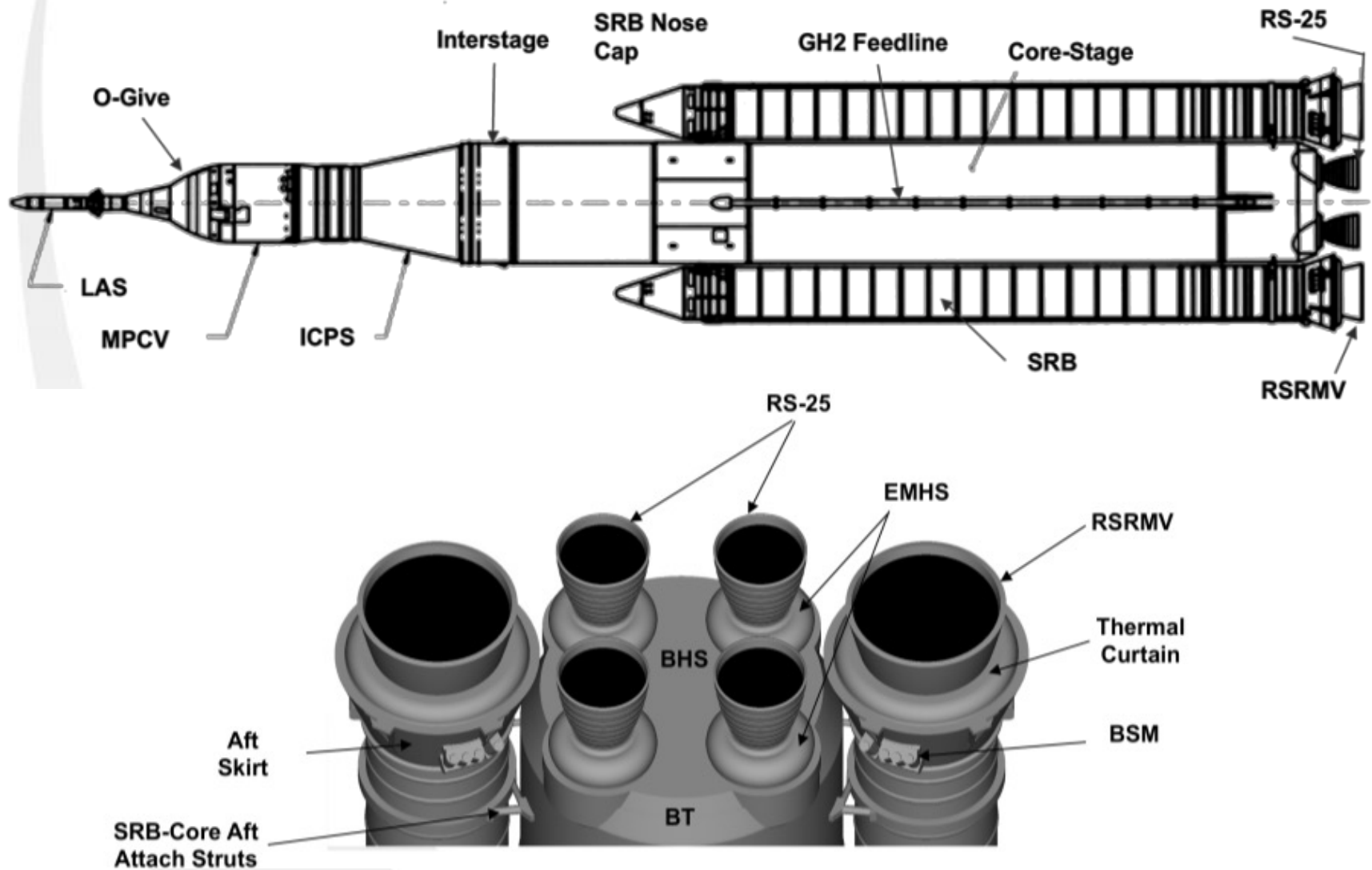


Full-Stack Configuration

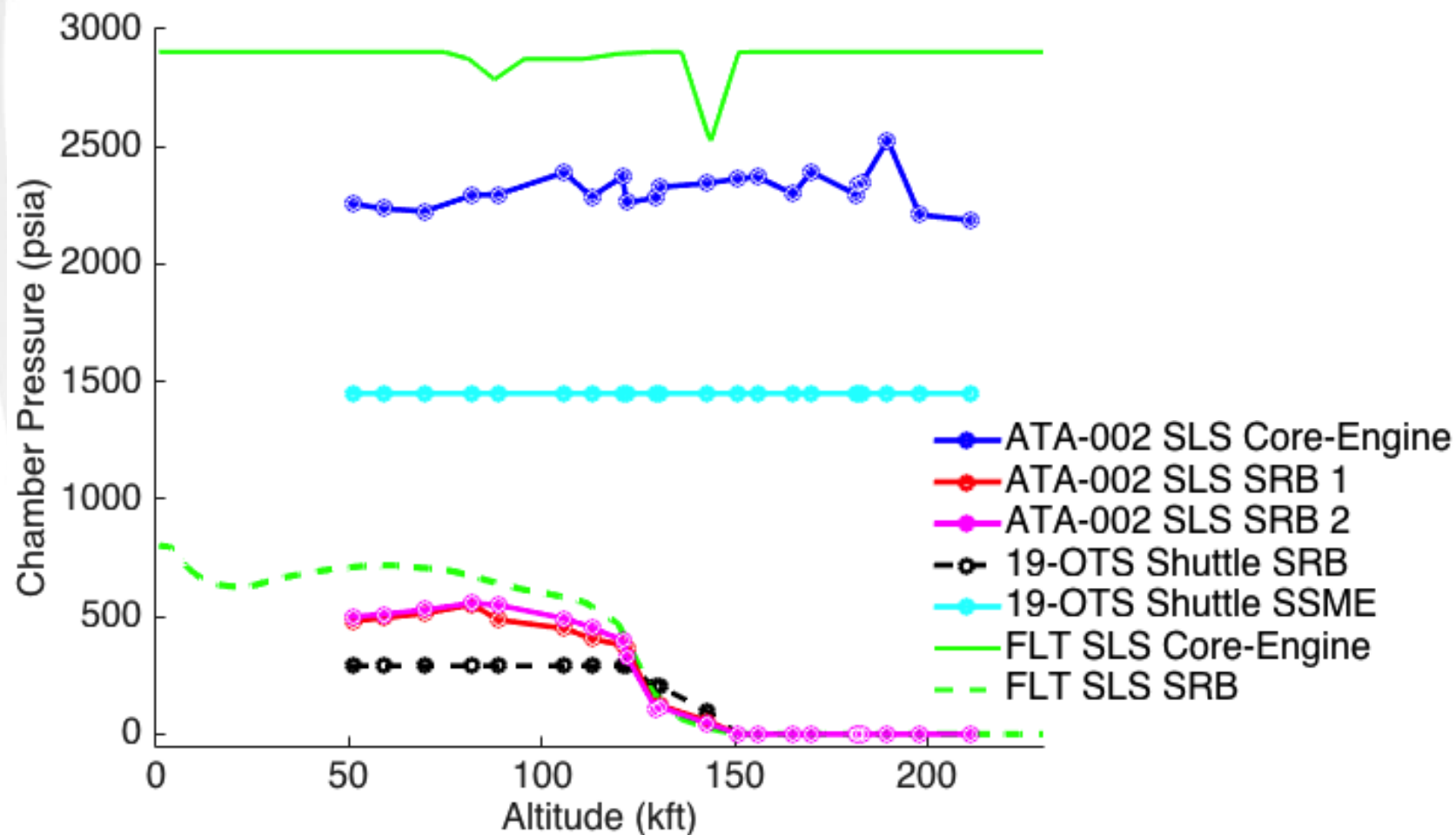


Core-Stage Configuration

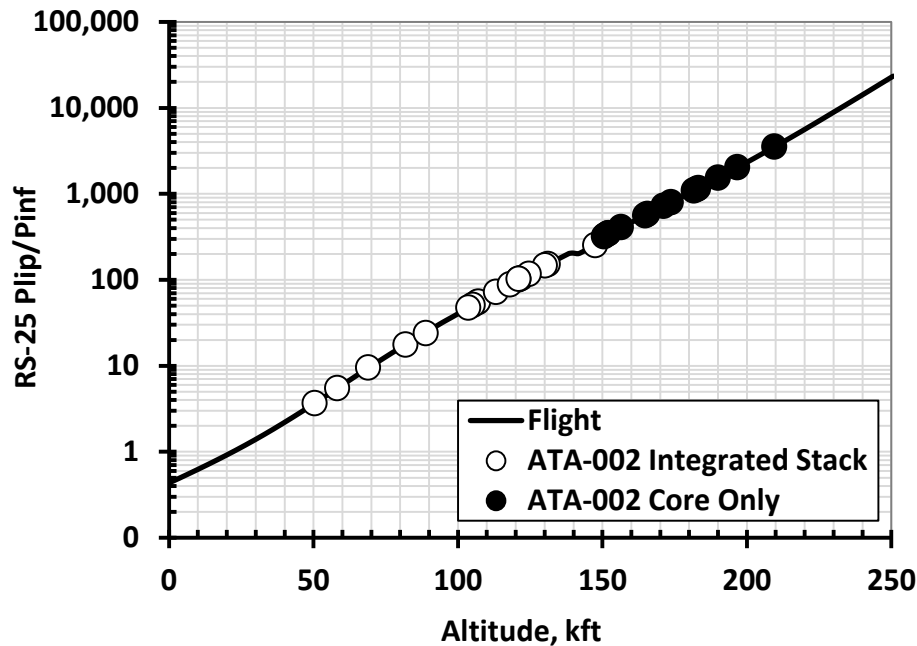
SLS Vehicle



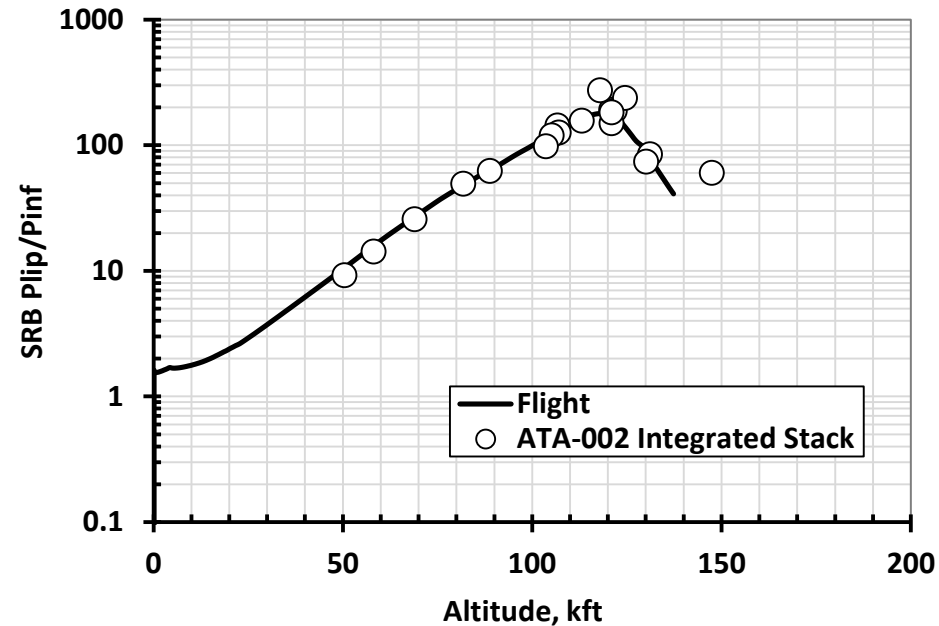
ATA-002 SLS Model Propulsion Performance



ATA-002 Similarity Parameter: P_{lip}/P_{inf}

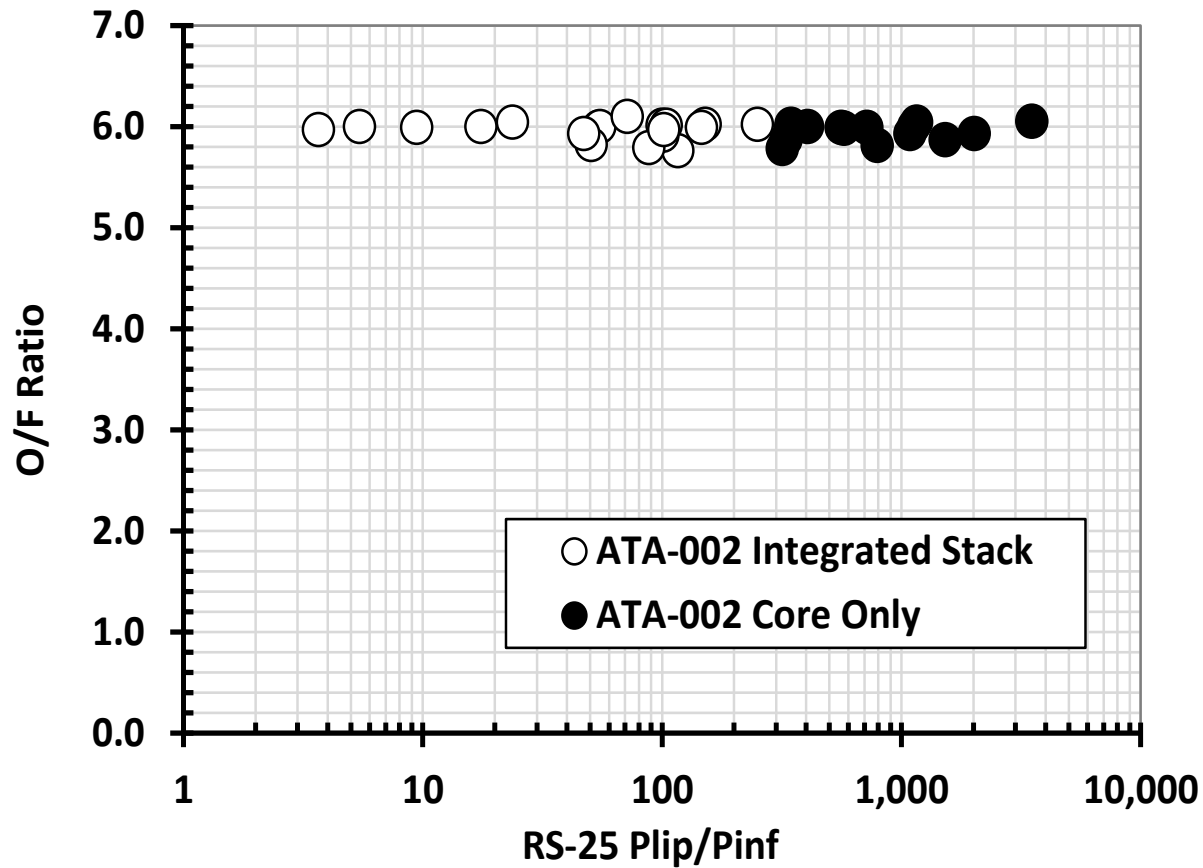


Core engine P_{lip}/P_{inf} vs. altitude

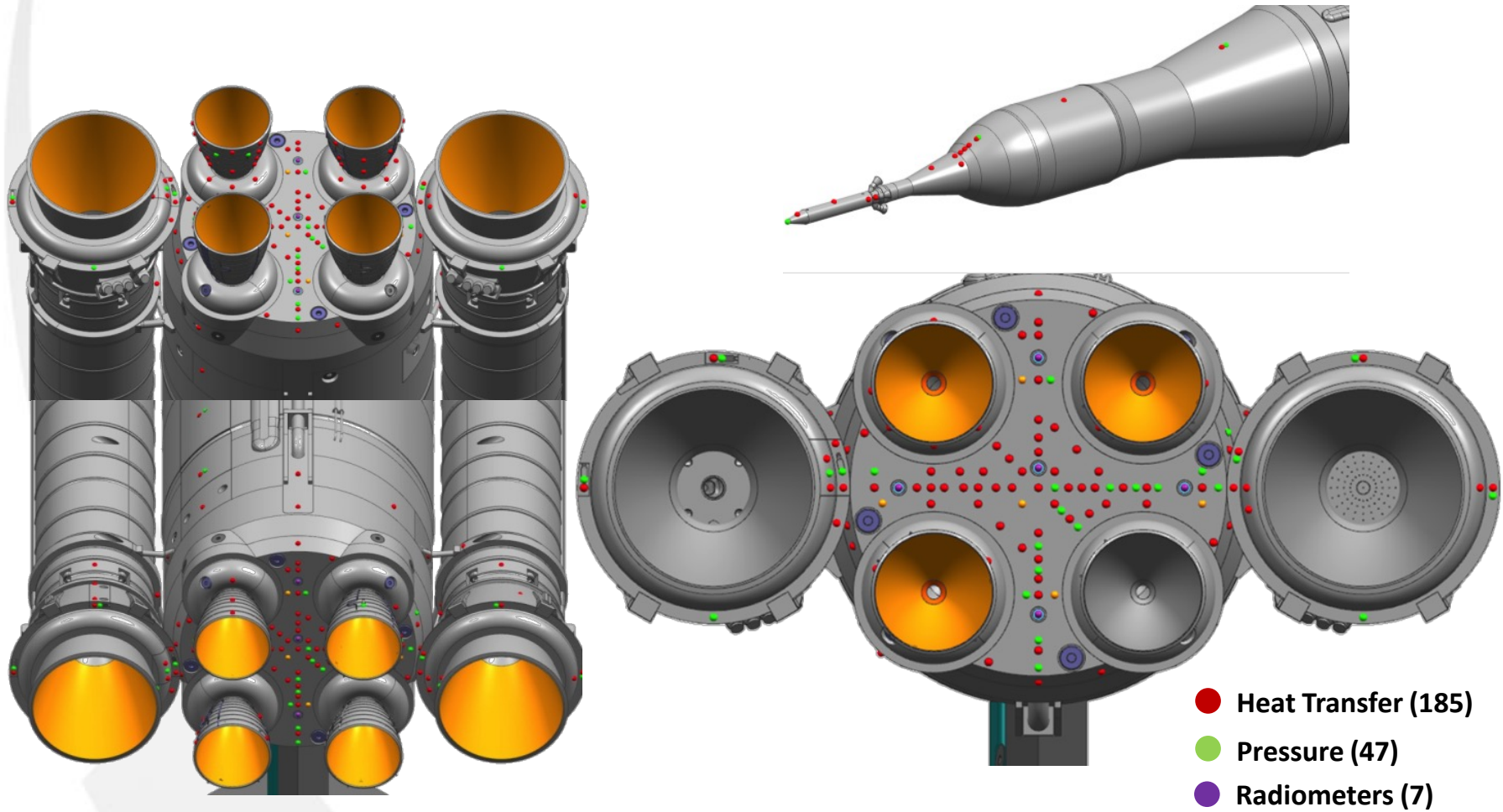


Solid rocket motor P_{lip}/P_{inf} vs. altitude

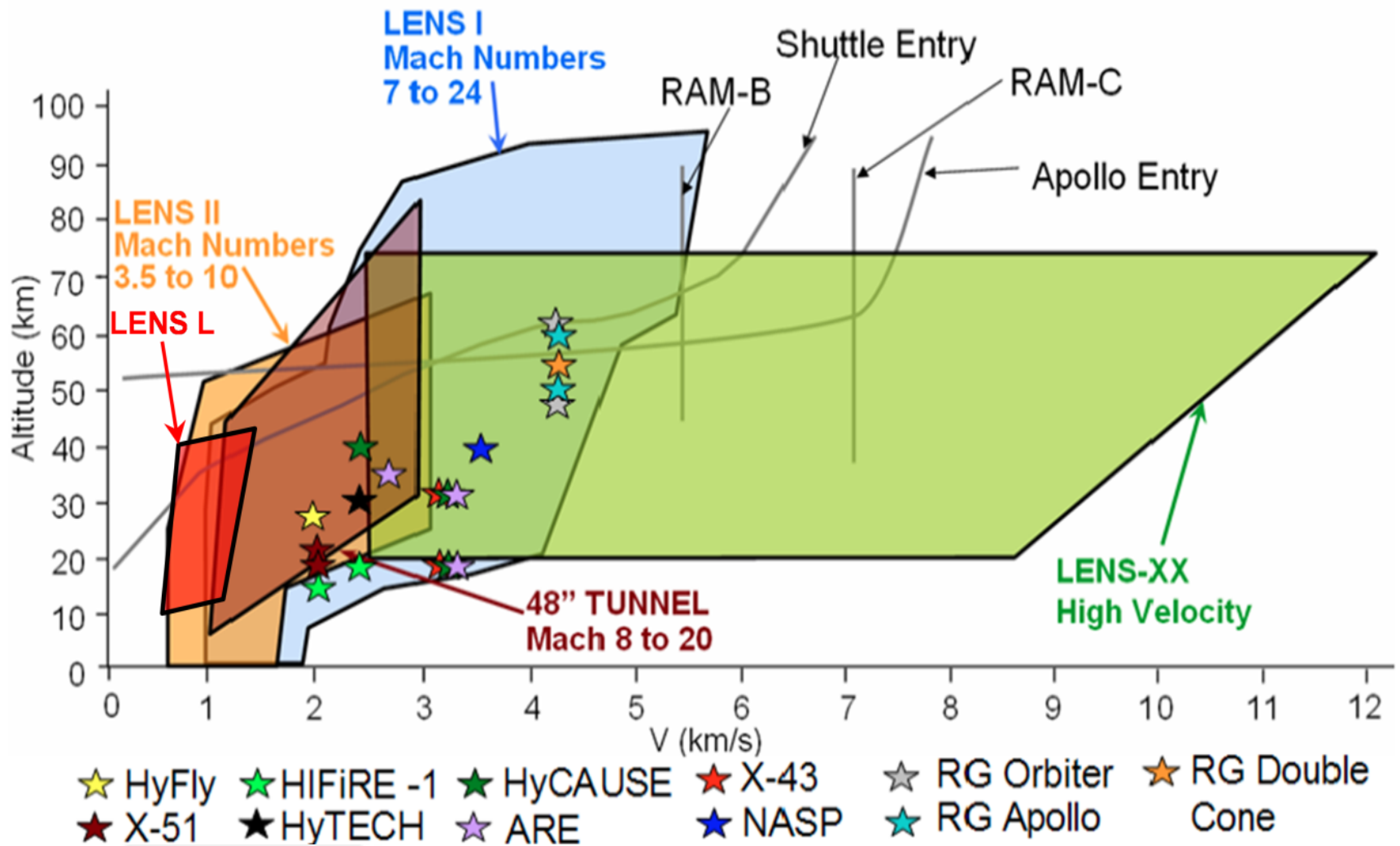
ATA-002 Similarity Parameter: O/F Ratio



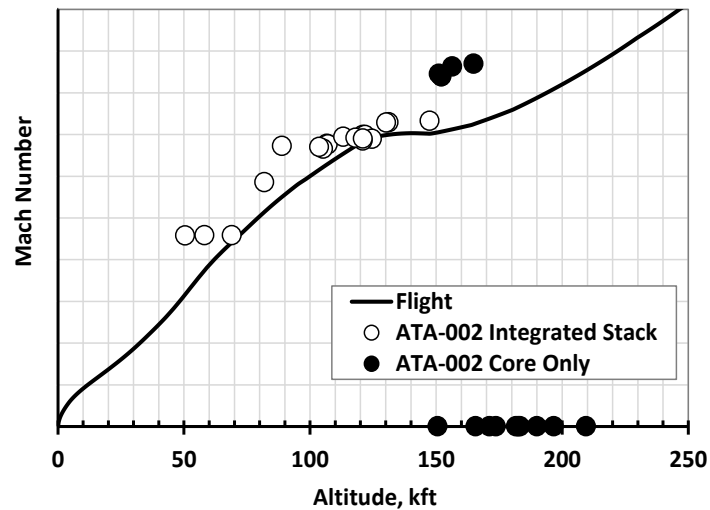
SLS Base Heating Model Instrumentation Layout



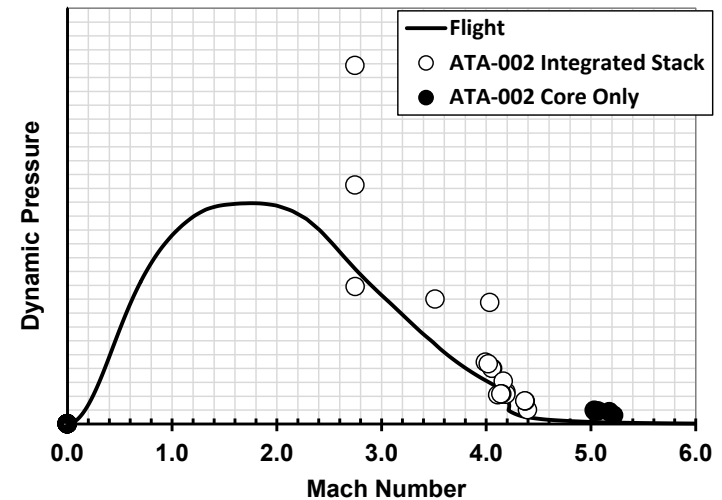
LENS Velocity/Altitude Capabilities



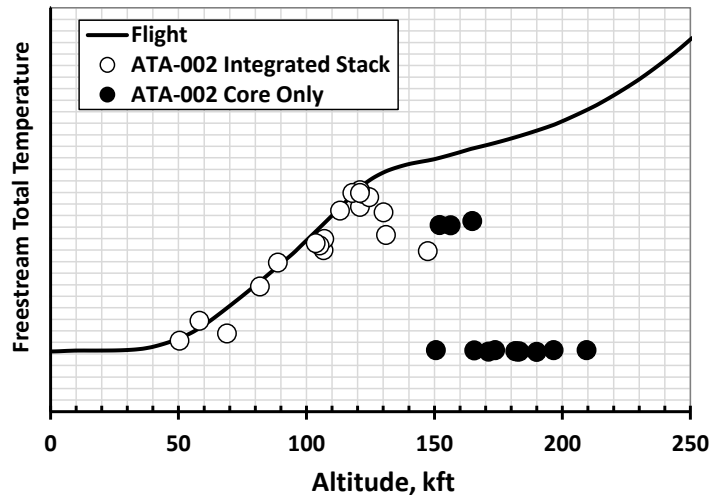
ATA-002 Test to Flight Condition Comparisons



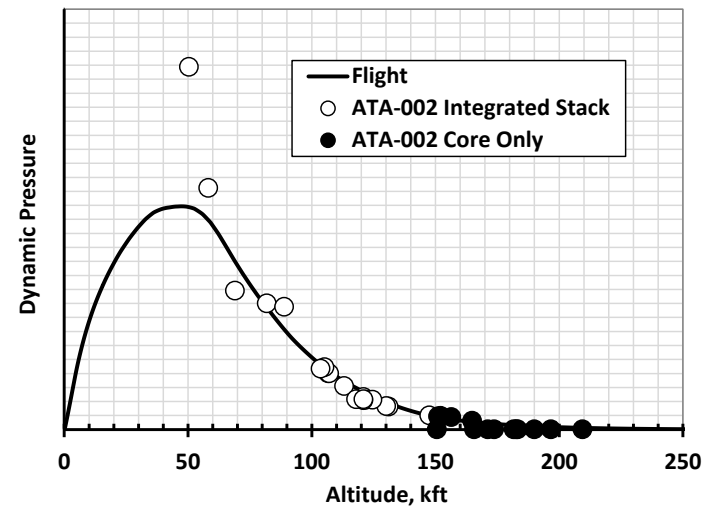
Mach number vs. altitude



Dynamic pressure vs. Mach number

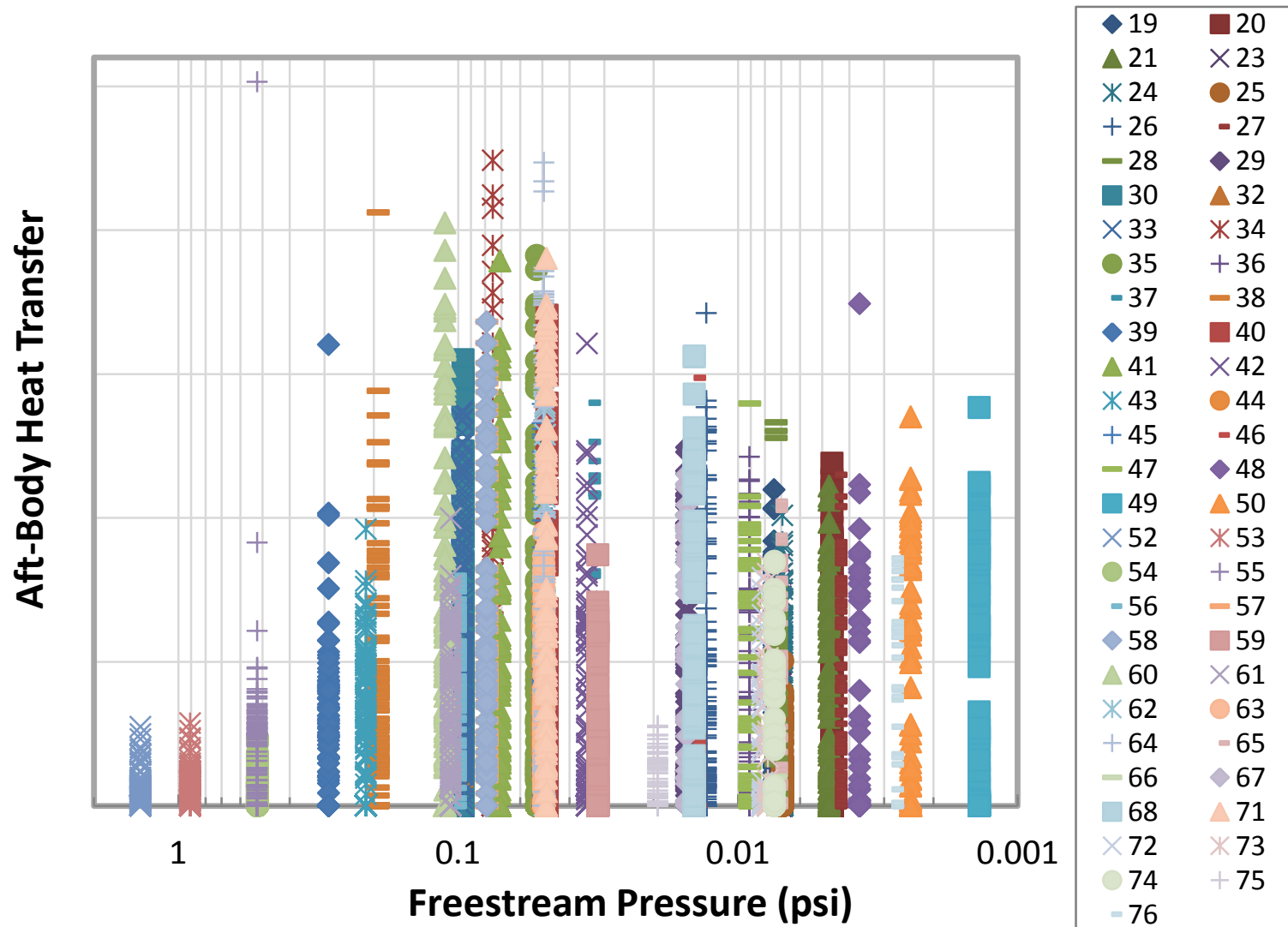


Total temperature vs. altitude

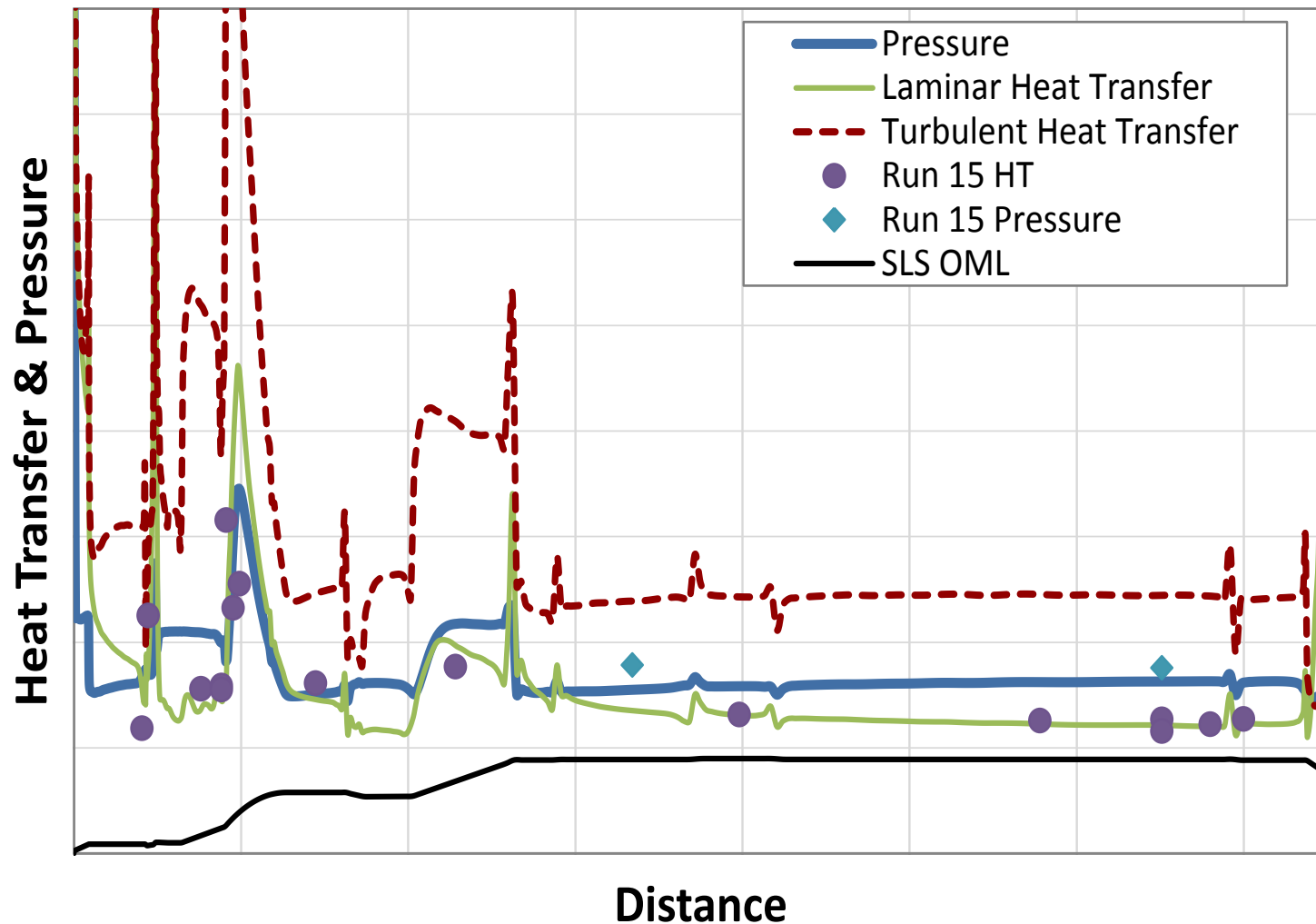


Dynamic pressure vs. altitude

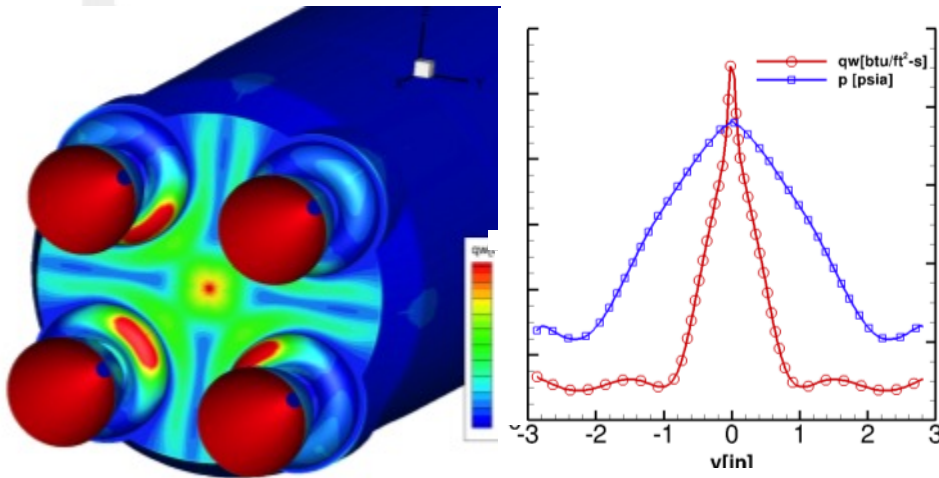
Aft-Body Heat Transfer vs. Freestream Pressure Data



Surface Aerothermal Predictions & Data for 70kft Condition



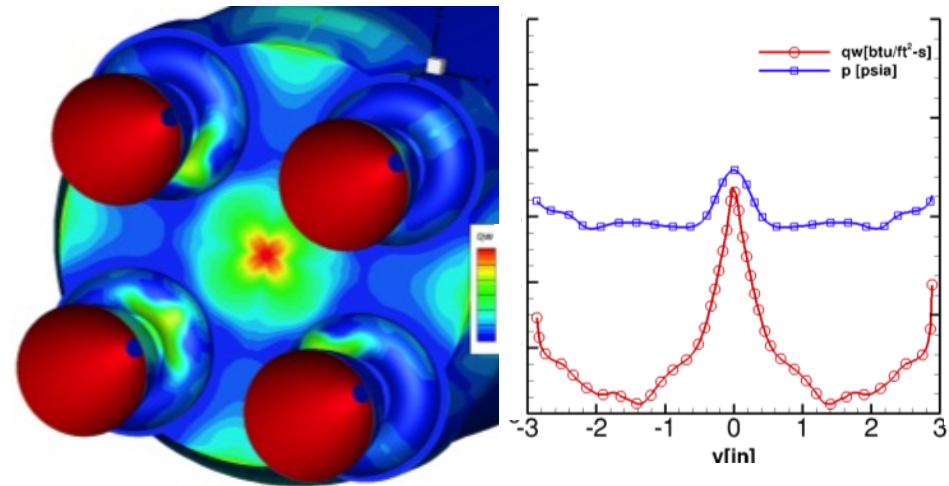
CFD Calculation of Core-Only Configuration



Heat Flux Contours

Line cuts across symmetry plane

150 kft conditions (Run 26)

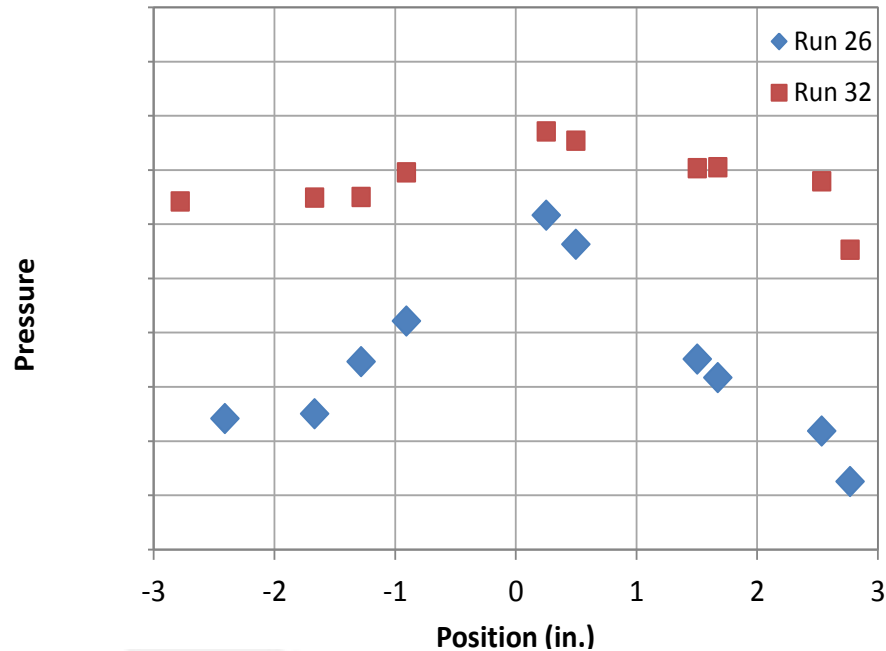


Heat Flux Contours

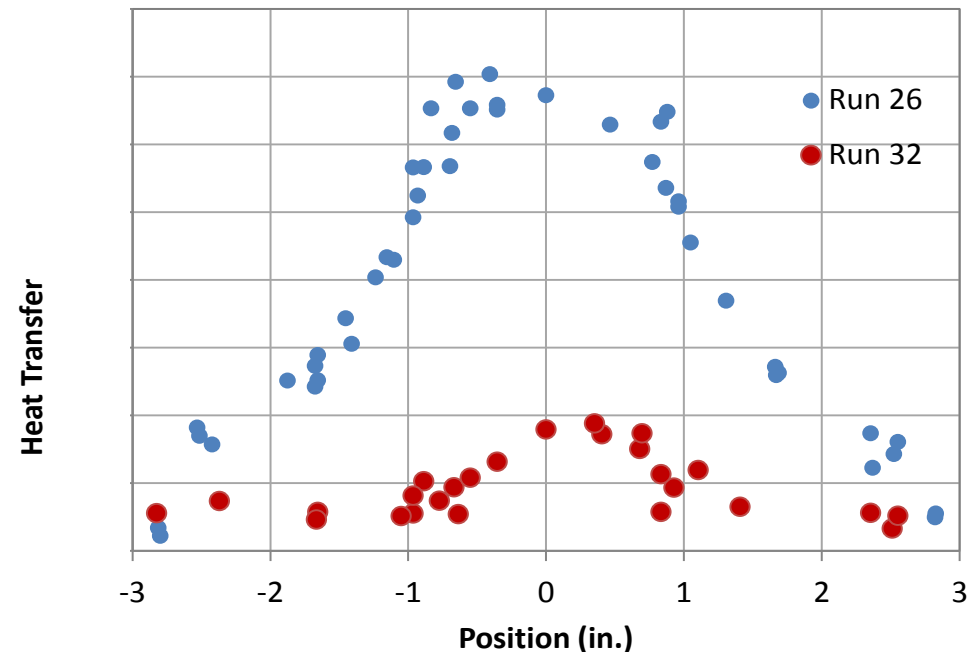
Line cuts across symmetry plane

100 kft conditions (Run 32)

Core-only Aerothermal Test Data for 150kft and 100kft



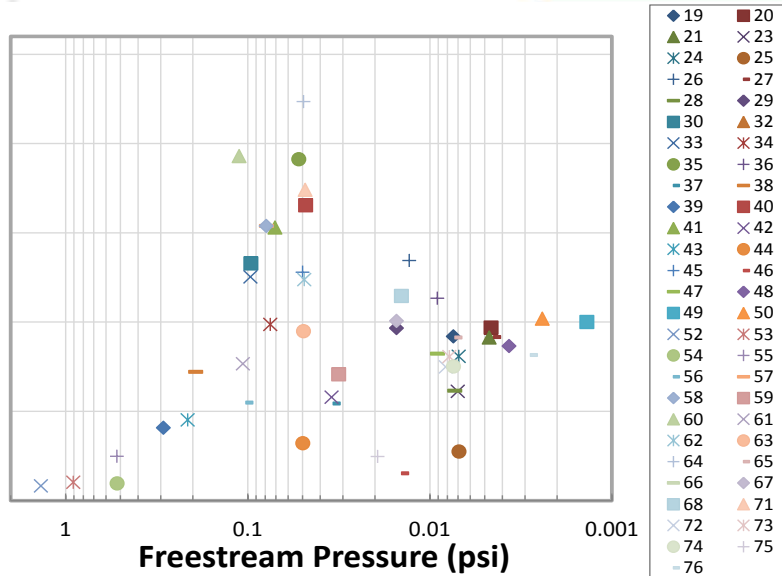
Pressure vs. Radial Distance



Heat Transfer vs. Radial Distance

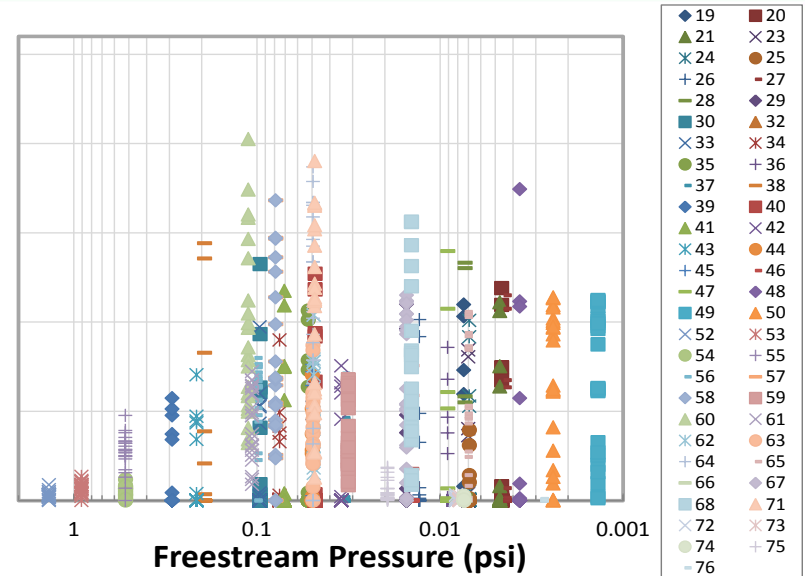
Region Specific Heat Transfer Measurements

Base Center Heat Transfer



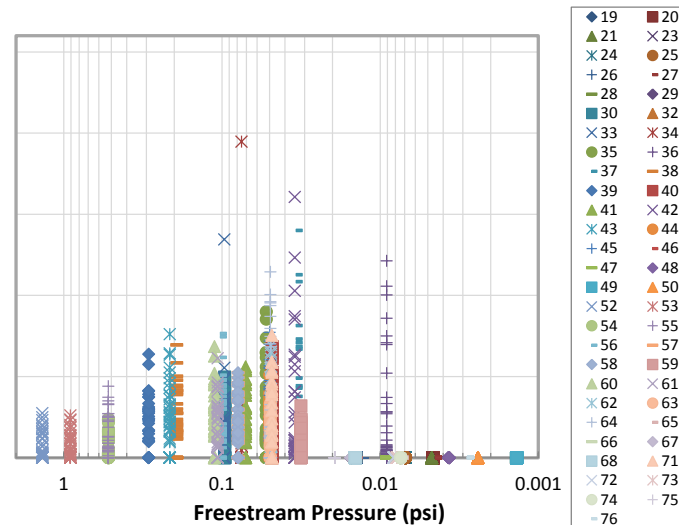
Base center heat flux

EMHS Heat Transfer



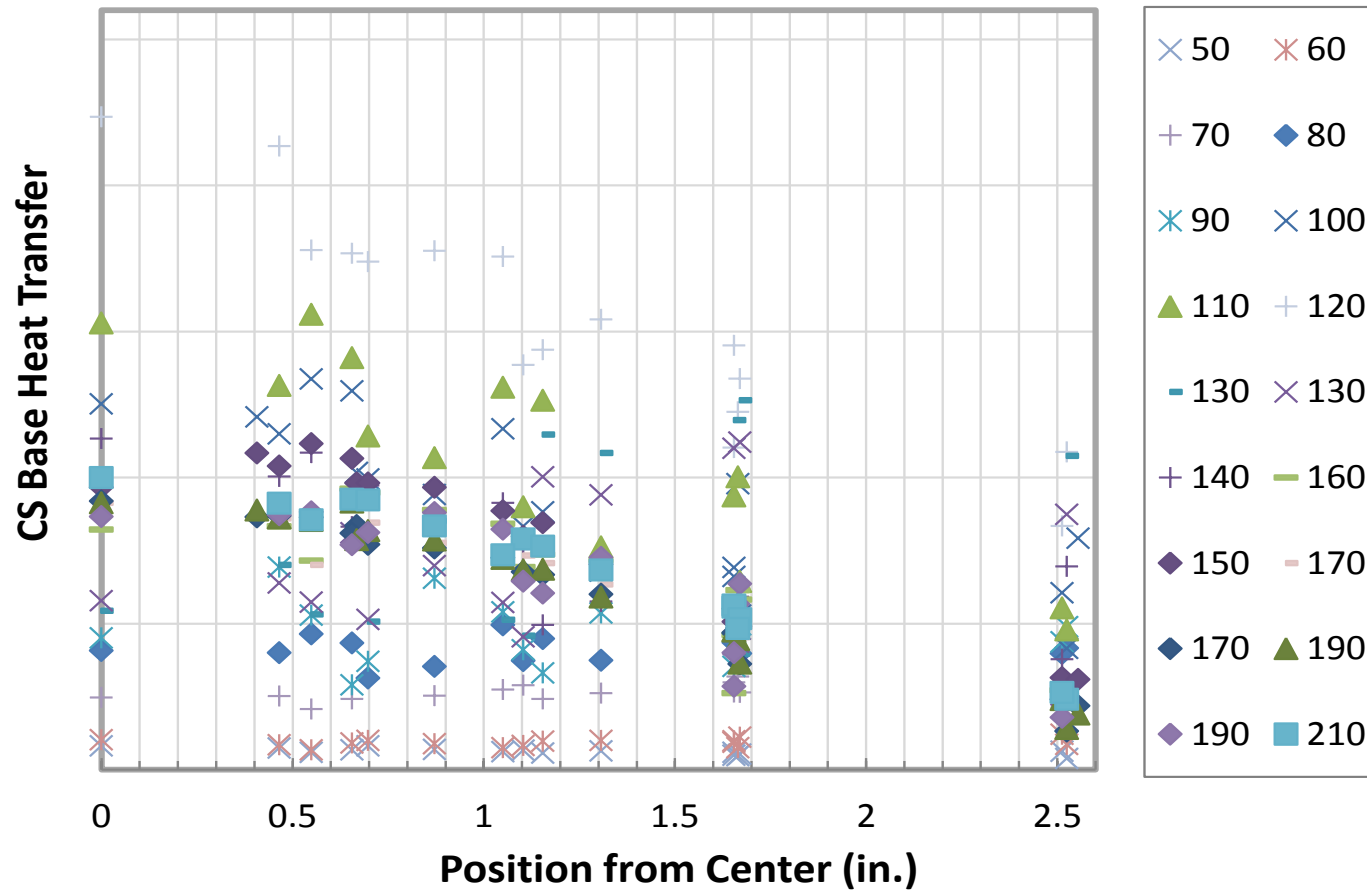
EMHS heat flux

SRB Base Heat Transfer

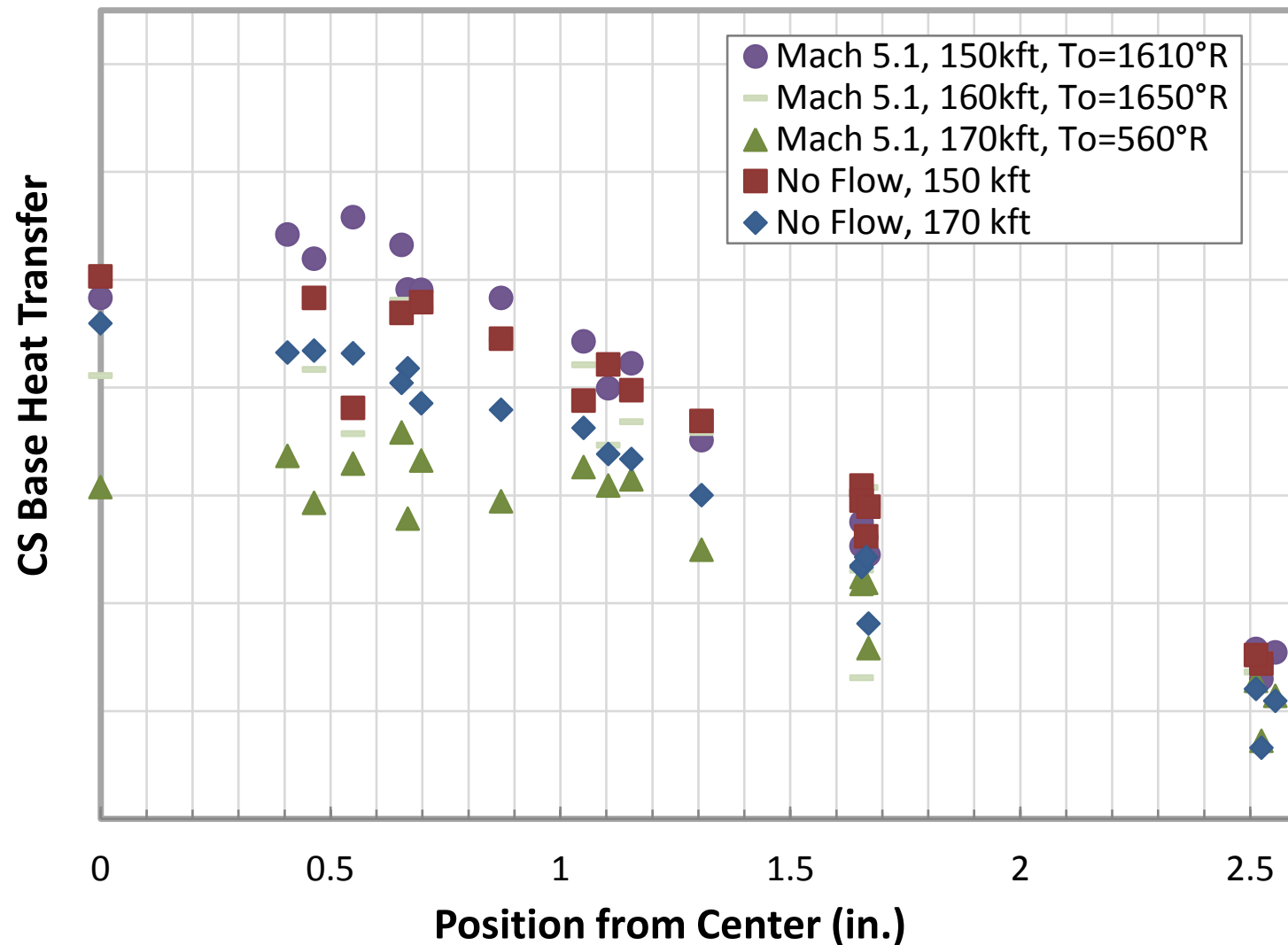


SRM base heat flux

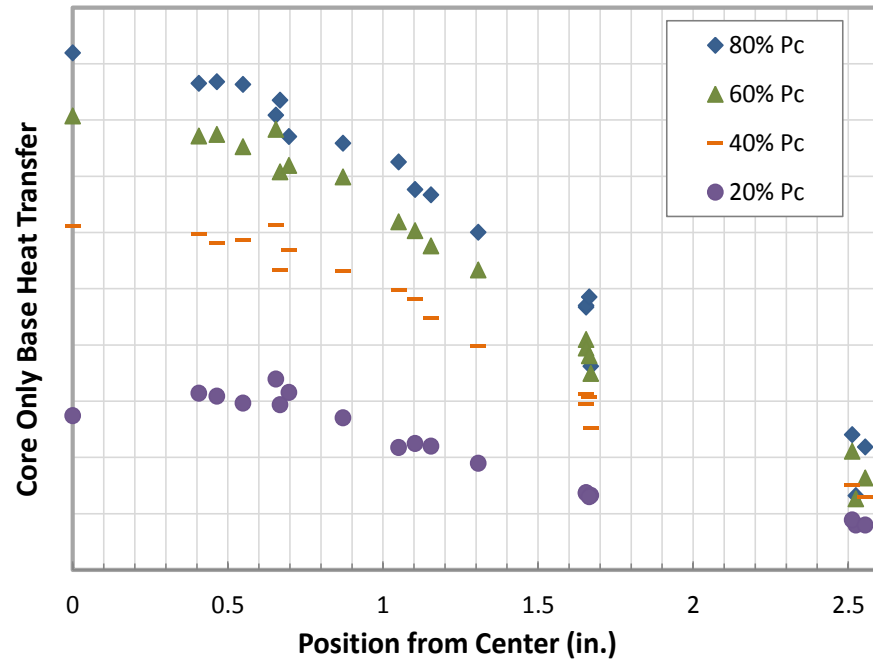
Nominal BHS Heating Spatial Distribution from 50 kft-210 kft



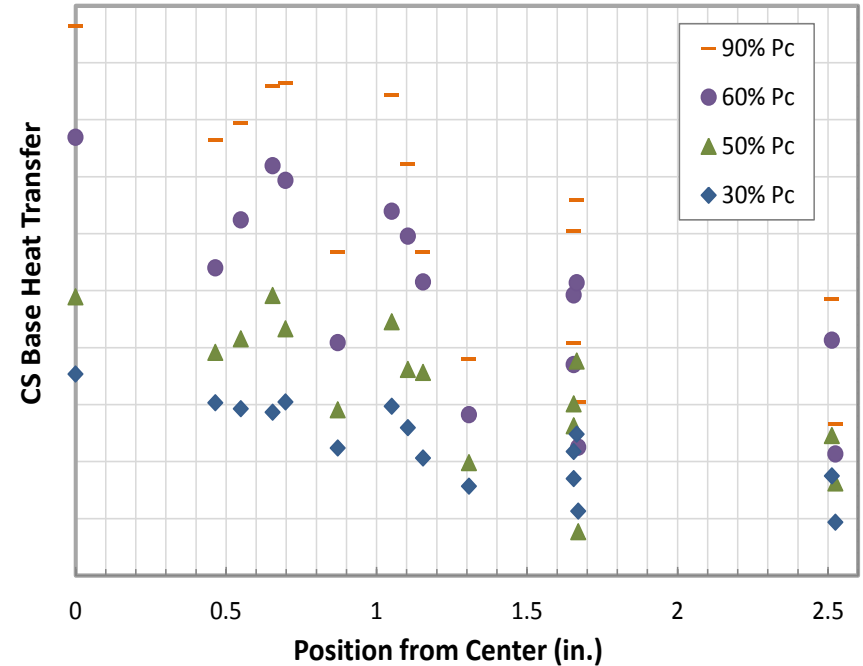
Freestream Flow Effects on BHS Heating Spatial Distribution



Chamber Pressure Effects on BHS Heating Spatial Distribution

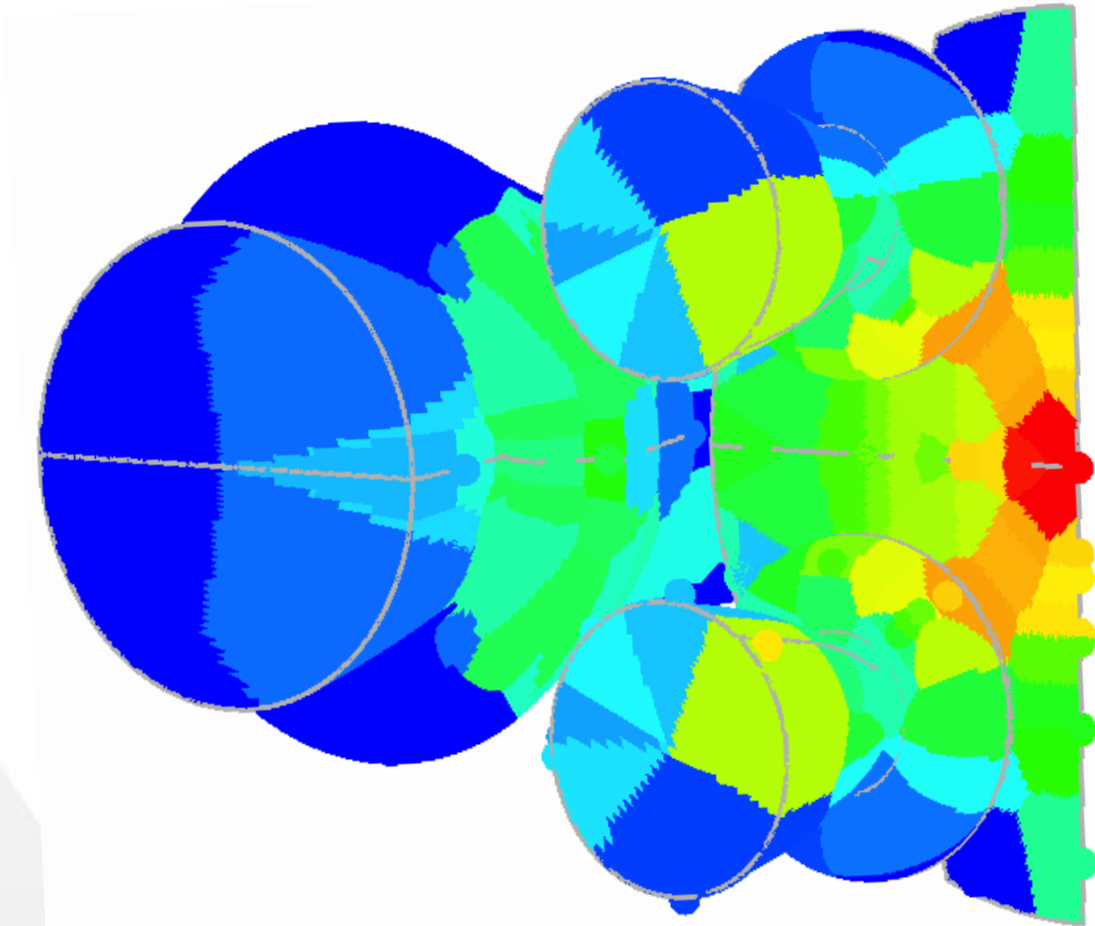


Core only heating distribution

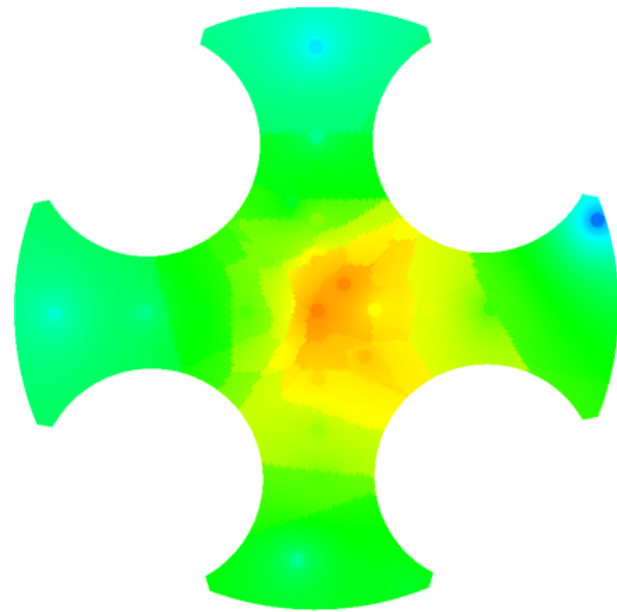


Full-Stack heating distribution

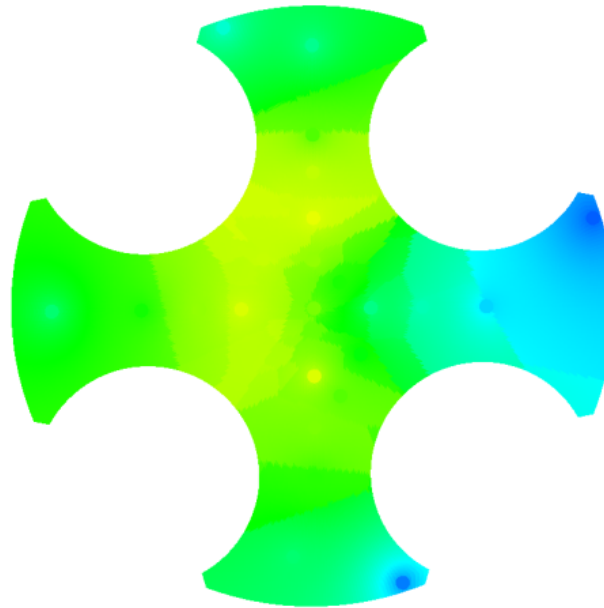
Base Heat Flux Data Interpolation at 120 kft



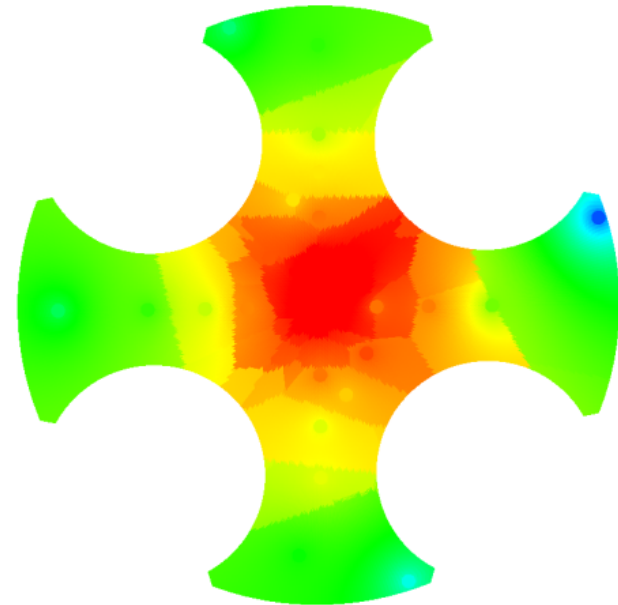
Base Heat Flux Contour Plots



120 kft Condition with 2-deg Gimbaled Nozzles (Run 71)

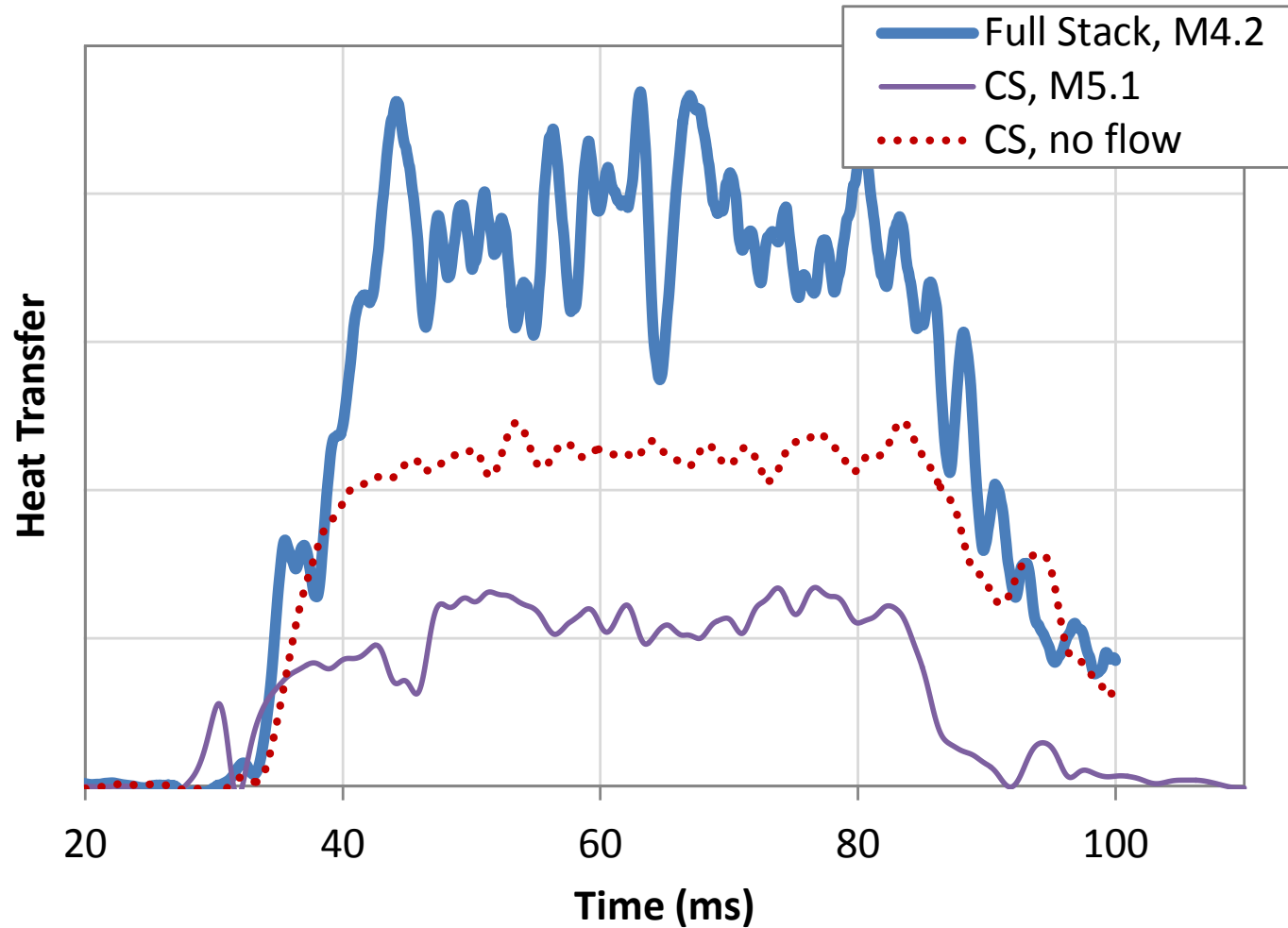


120 kft Condition at 4 deg AoA (Run 62)

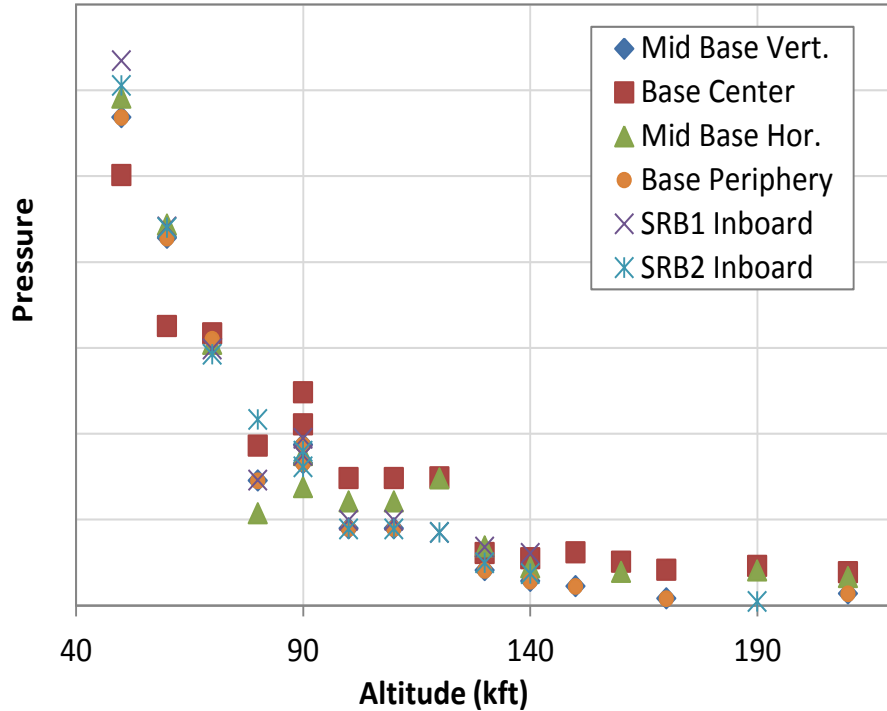


120 kft Nominal Condition (Run 64)

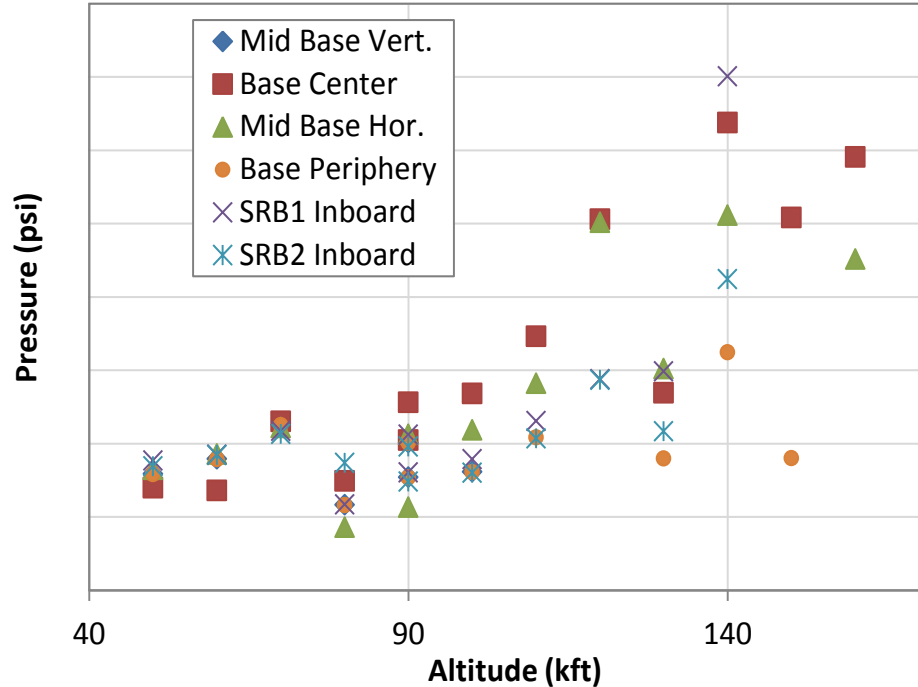
Unsteady Base Heat Transfer Measurements



Base Pressure Measurements

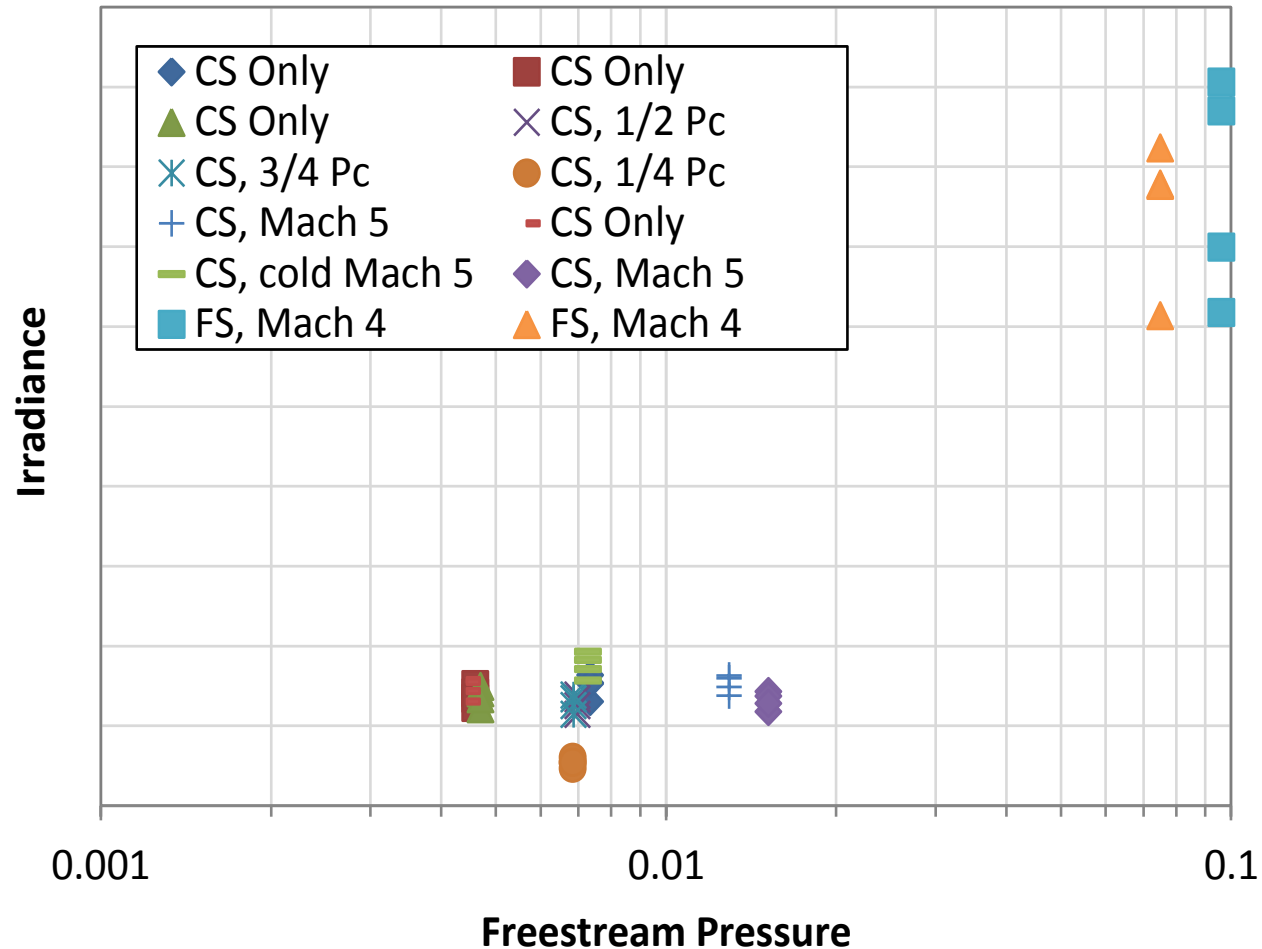


Base Pressure

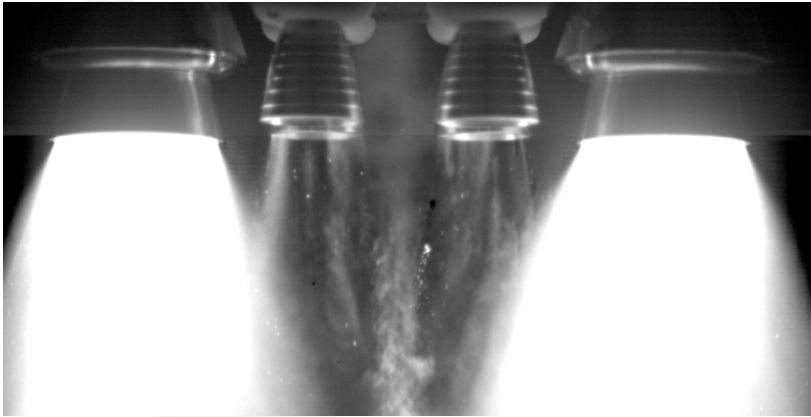


Normalized base
pressure by dynamic
pressure

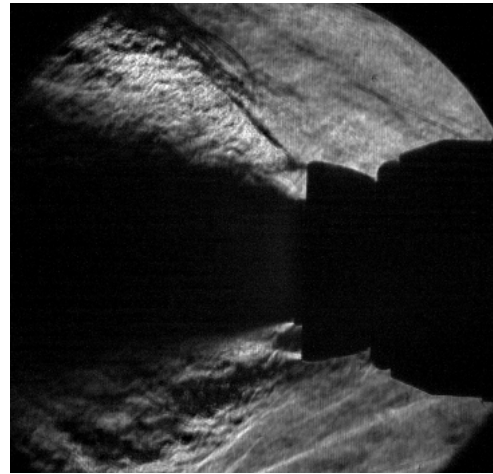
IR Radiometer Measurements



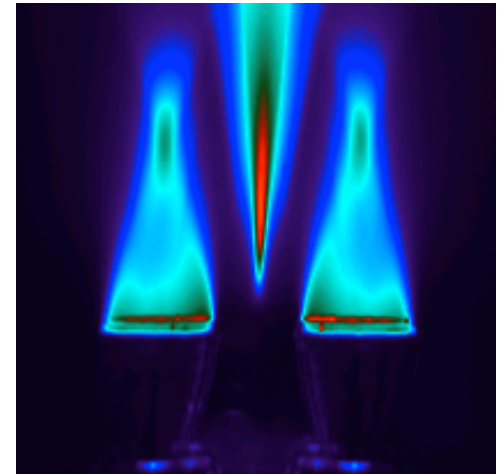
Imaging



Visible camera, top view,
70kft, full-stack



Schlieren side view,
100 kft, full-stack



Long-wave IR, Top
view, 170 kft, Core
only

Conclusions

- ◆ **ATA-002 test operations, instrumentation layout and test matrix and conditions were described.**
- ◆ **Nominal and off-nominal test results are described.**