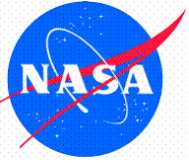# Orion Launch Abort Vehicle Separation Analysis using OVERFLOW
DRAFT

Prepared by:

Tom Booth

Jacobs Technology

NASA JSC/EG3
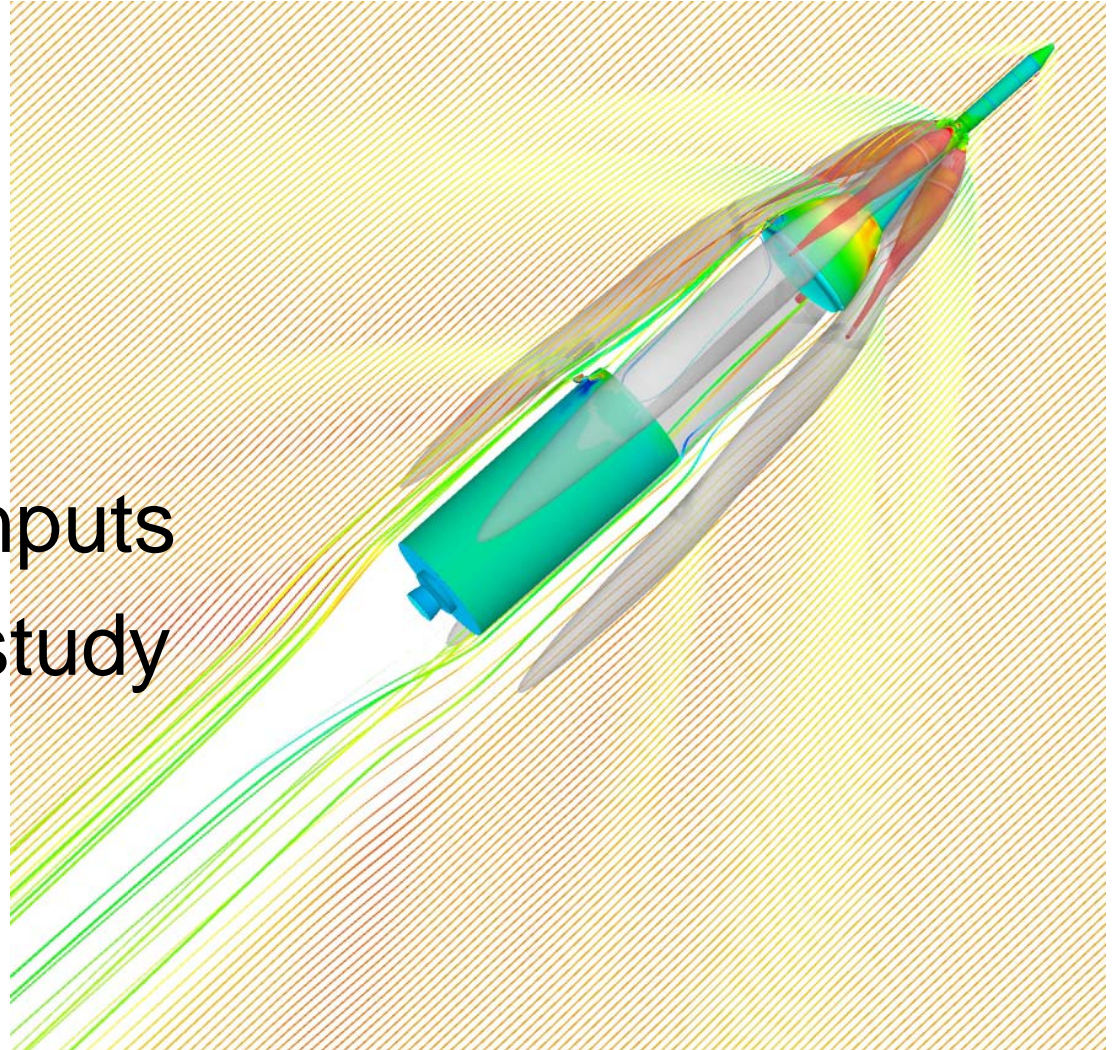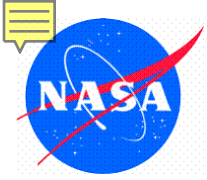
Tom Booth, (281) 483-3234, thomas.booth@nasa.gov

Overview

- Background
- Purpose
- Geometry
- Grids
- OVERFLOW inputs
- Convergence study
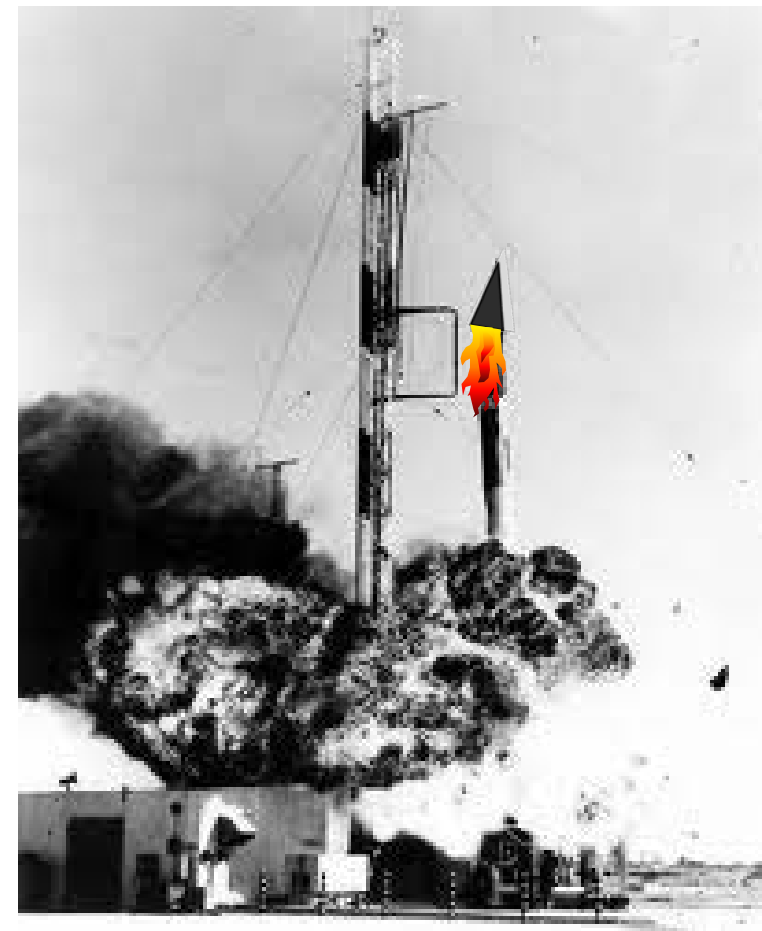- Results
- Conclusions

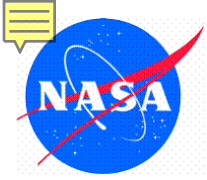**DRAFT**

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thomas.booth@nasa.gov

Background

- We want to ride on rockets

- Sometime rockets blow up

- Therefore, we need a launch abort system

Tom Booth, (281) 483-3234,
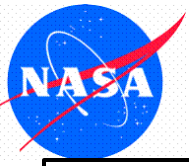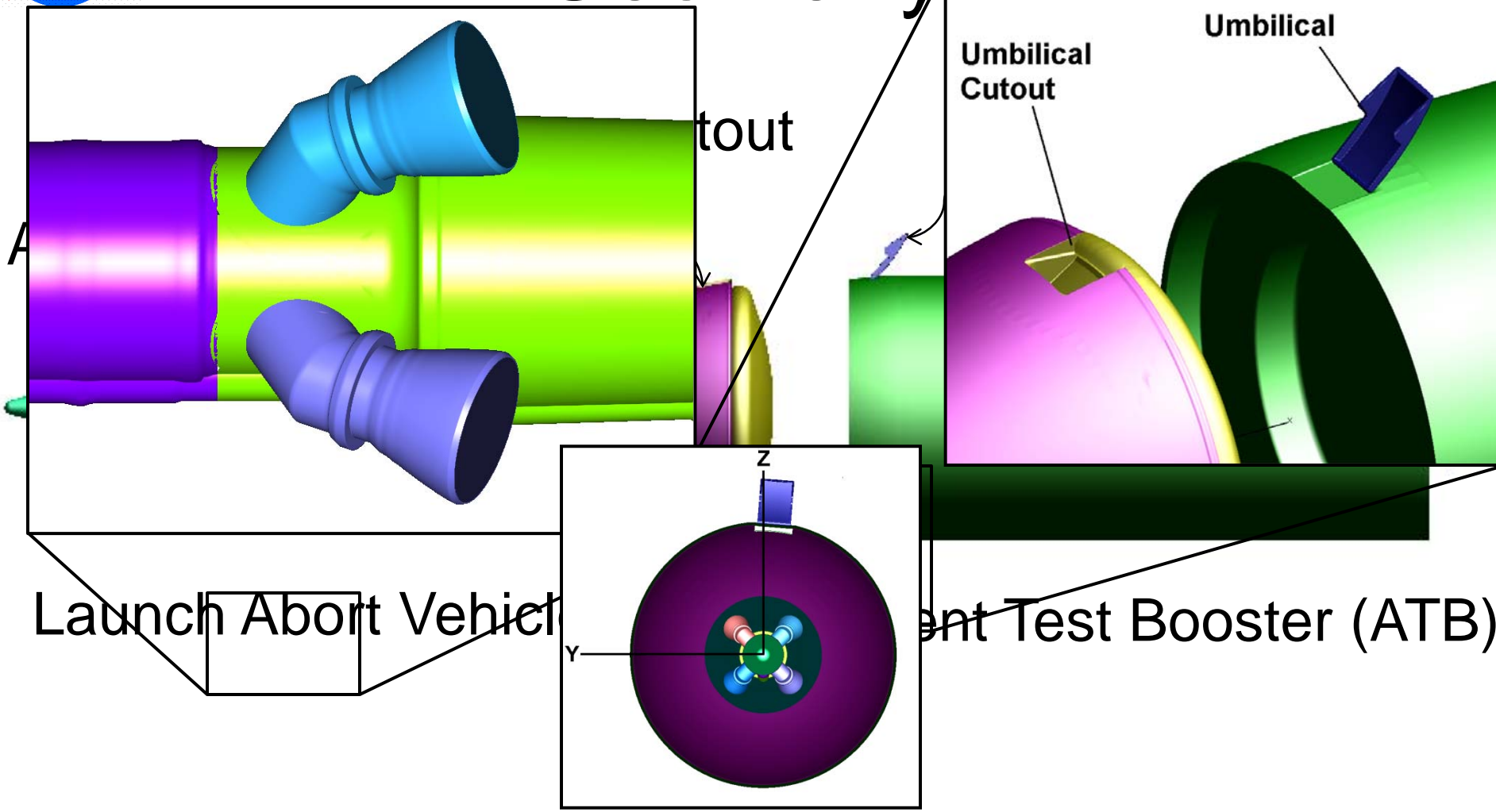thomas.booth@nasa.gov

Purpose

- Calculate separation effects
  - Aerodynamic database
    - Integrated forces/moments
  - Aerodynamic loads database
    - Pressure distributions
    - Line loads

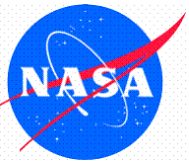Tom Booth, (281) 483-3234,
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Geometry

Umbilical Cutout

Umbilical

Umbilical Cutout

Umbilical

Launch Abort Vehicle ... ent Test Booster (ATB)

Overset Grids

- Chimera Grid Scripts

- Pegasus5

- 50 grids
  - 93.5 million grid points
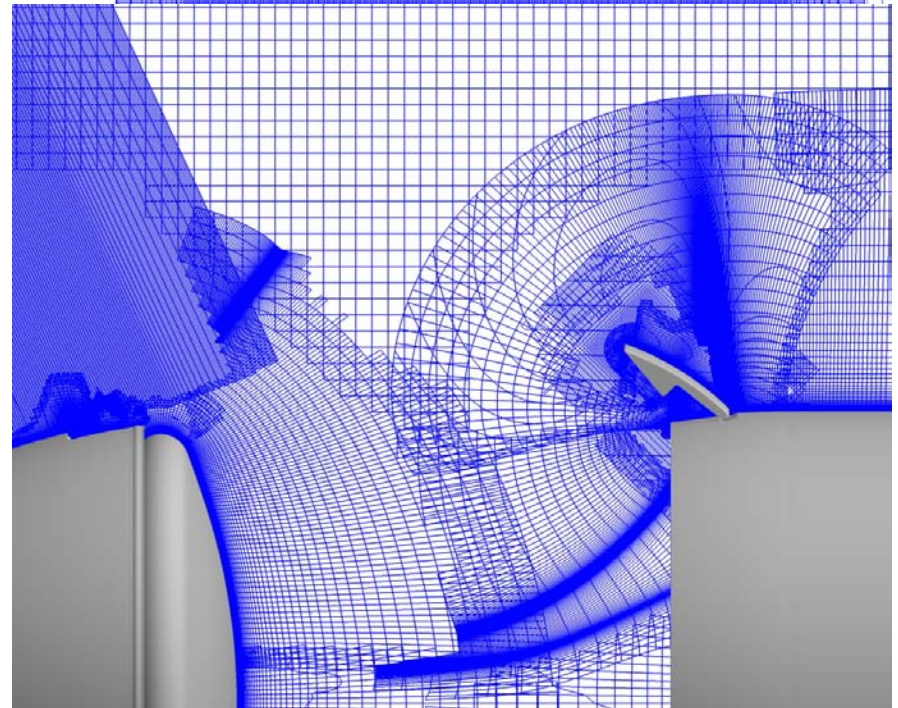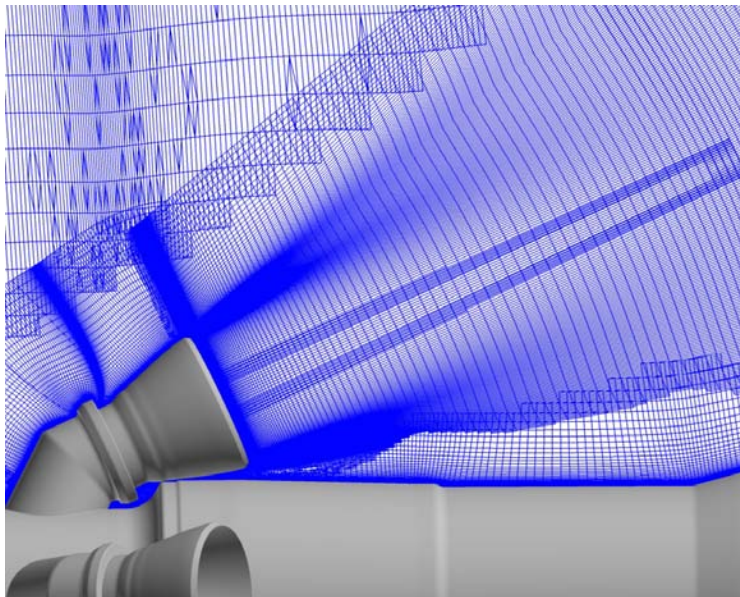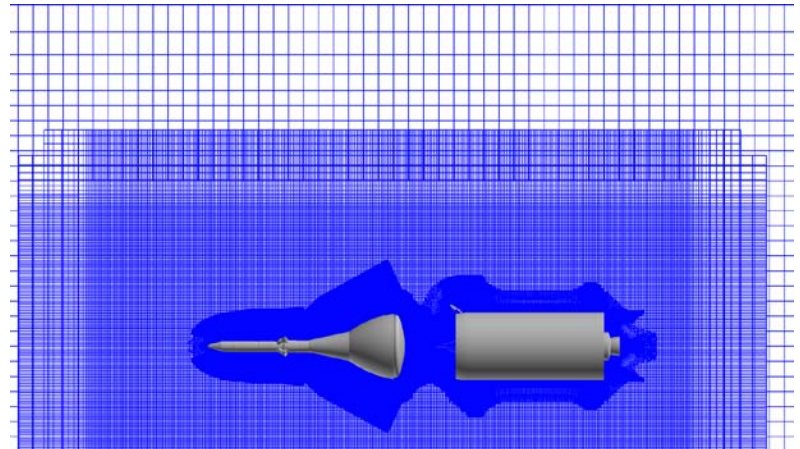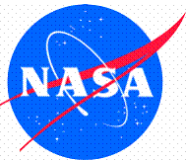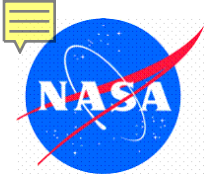
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Assumptions

- Steady state
- Multiple species
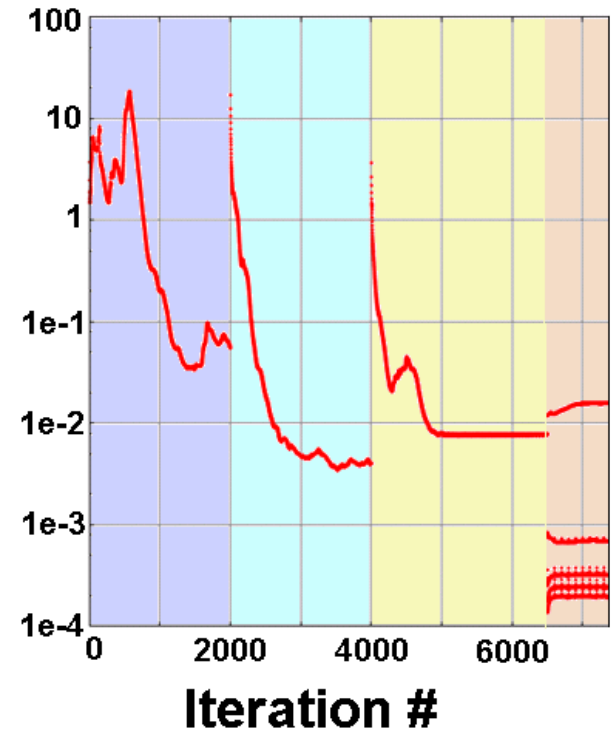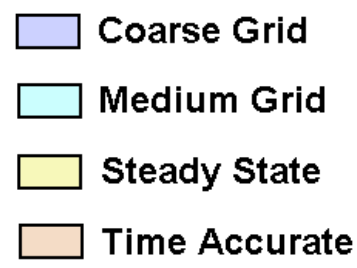- Calorically perfect gas exhaust
- Single phase flow

General Run Strategy

- ## 3 levels of grid sequencing

  - ### 2000 iterations/level

- ## Steady state until converged

- ## Time accurate

  - ### If needed

Coarse Grid
Medium Grid
Steady State
Time Accurate

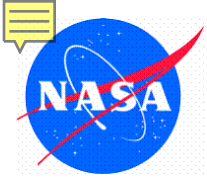Tom Booth, (281) 483-3234, thomas.booth@nasa.gov

Overflow Inputs

- Constant CFL (ITIME=4)

- SST turbulence model (NQT=205)

- Numerical methods
  - HLLC (IRHS=5)
  - 32-bit SSOR (ILHS=16)
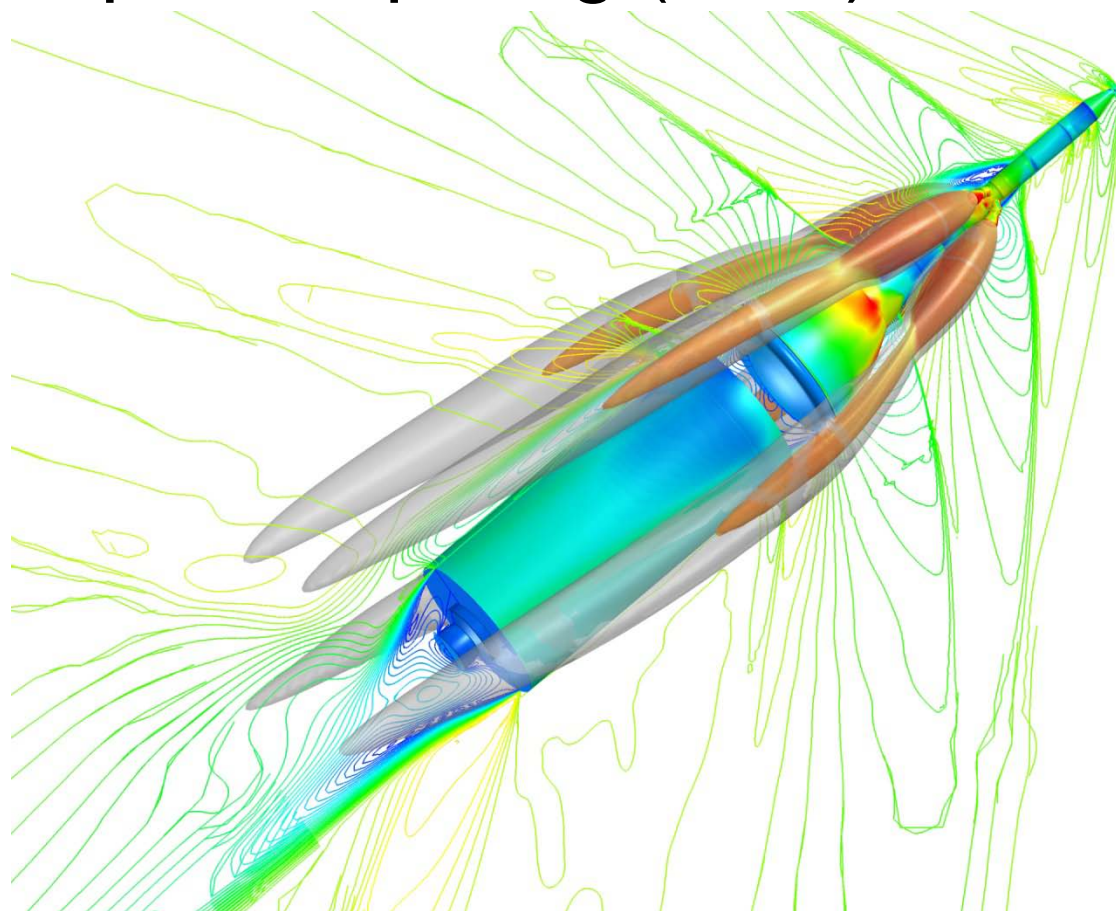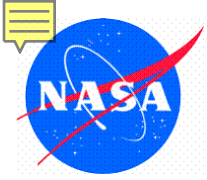
- No Compressibility Correction (ICC=0)

Computational Resources

- NASA Advanced Supercomputing (NAS) division
  - Pleiades
  - Columbia
  - CPU hours used:
    - 907,000 hours

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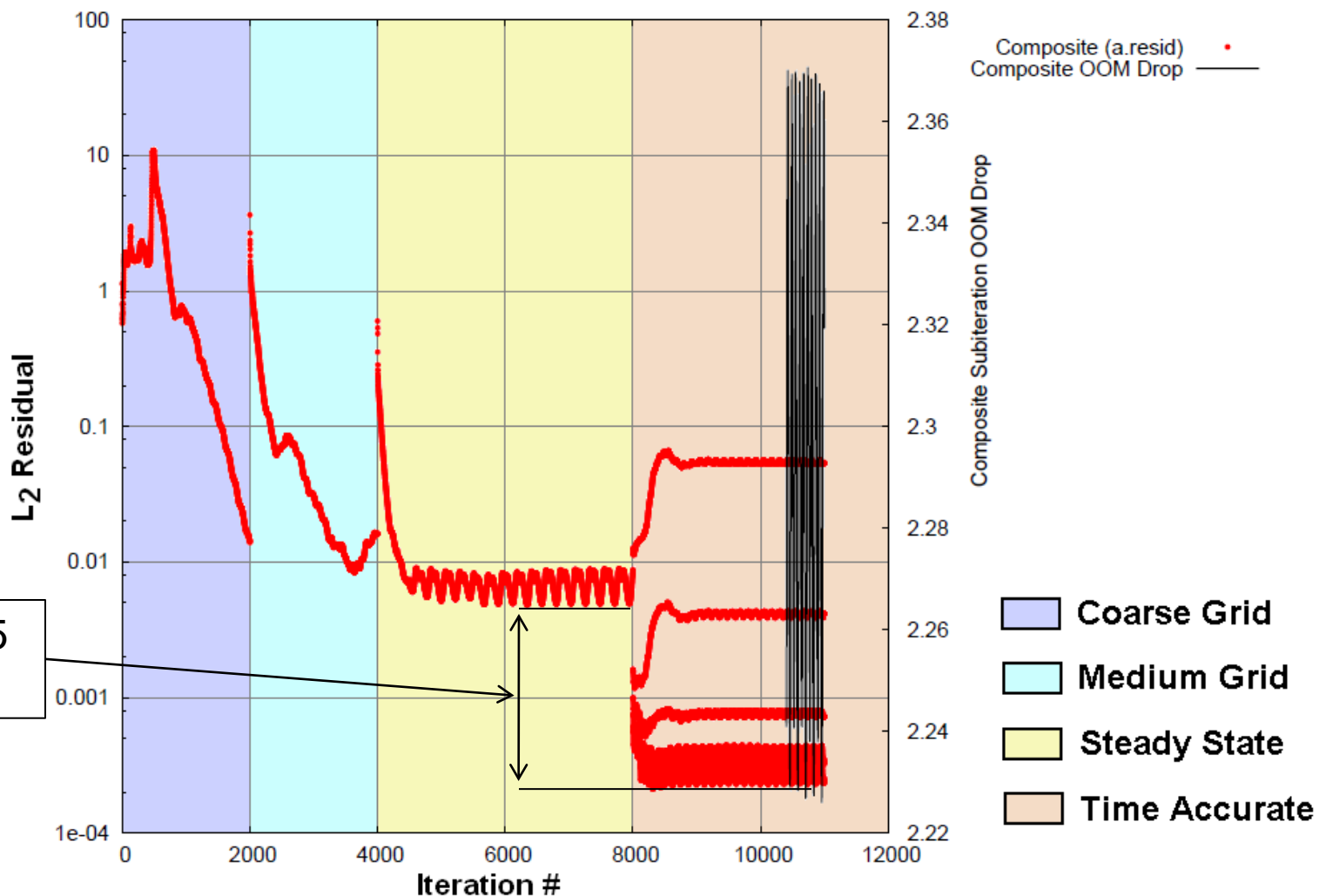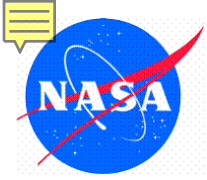# Convergence Study

- Investigate force/moment sensitivity
  - Steady State
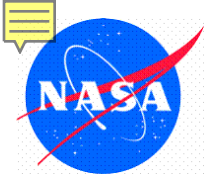 - Time Accurate

- Convergence tolerance
  - ½° AOA for C_m-α at trim

Residual

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Force/Moment
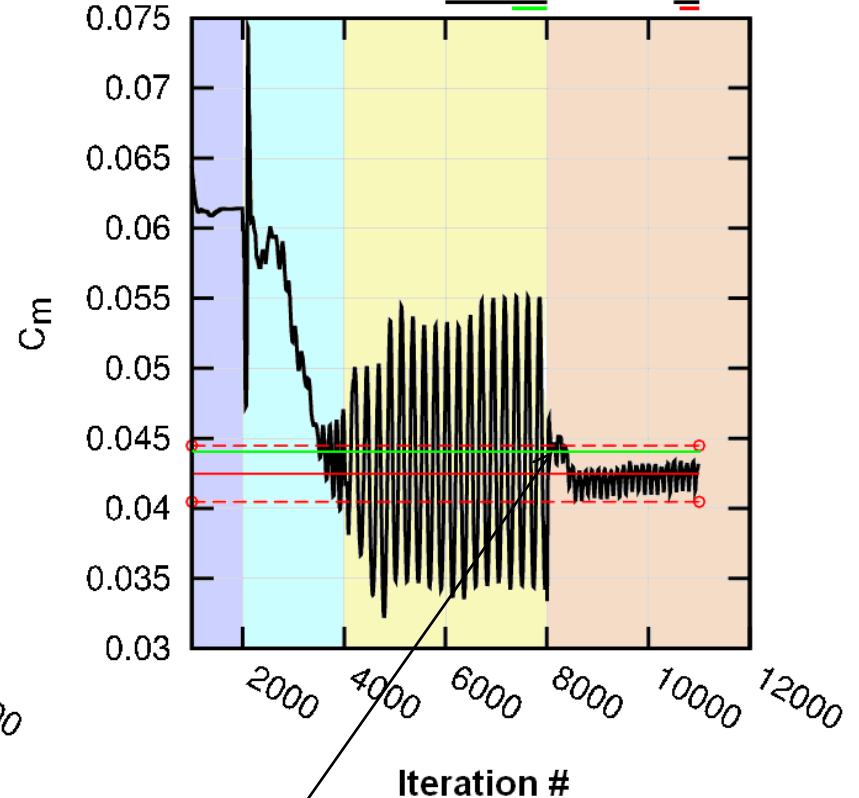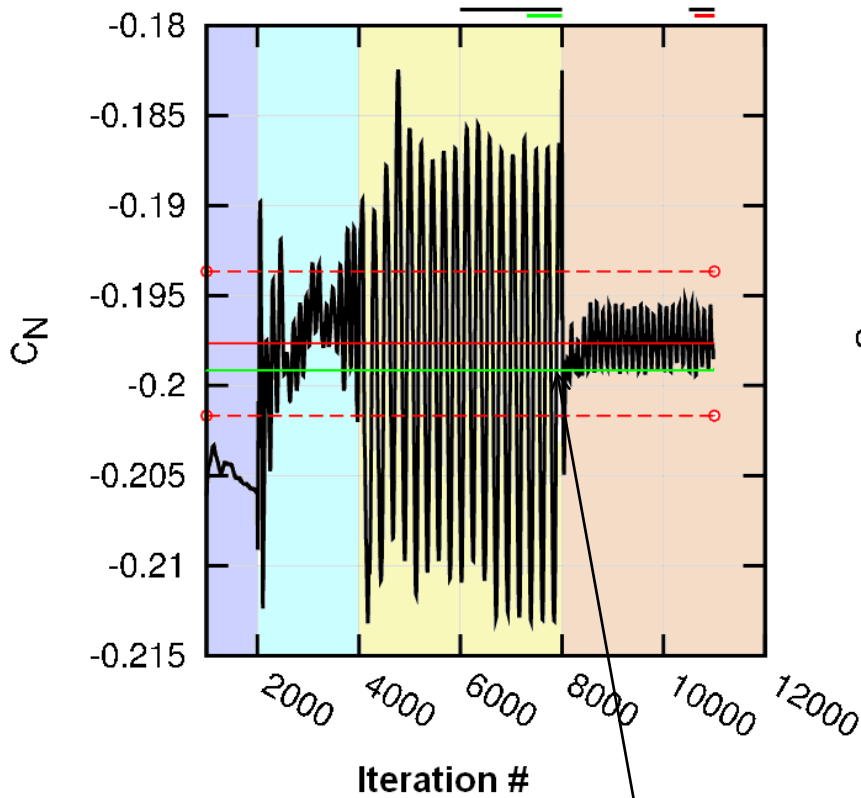
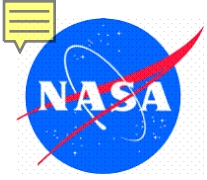Within tolerances

Legend (left plot):
- Coarse Grid
- Medium Grid
- Steady State
- Time Accurate

Legend (right plot):
- Steady State Avg.
- Time Accurate Avg.
- Convergence Tol.

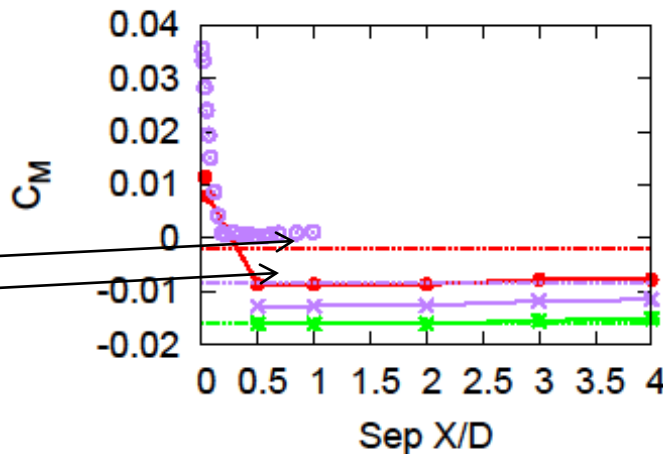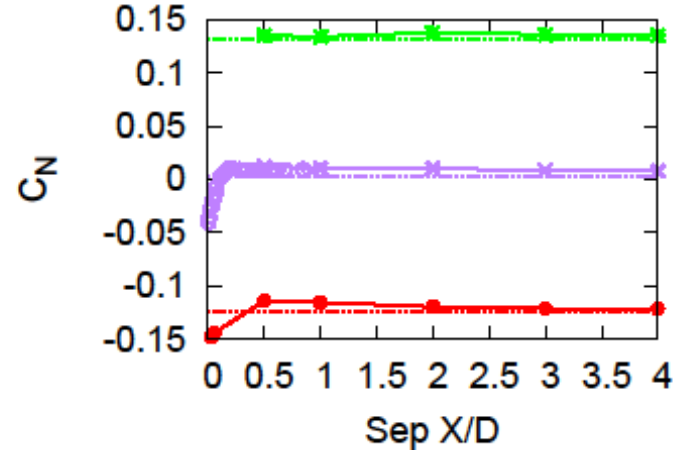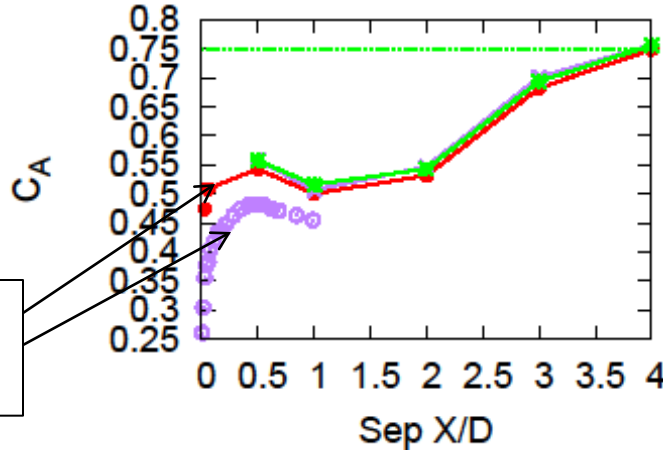**DRAFT**

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WTT Comparison

LAV separation from an ATB/SM

AR-107 CFD: Mach 1.71, offset 0.7, AMCT=2.07
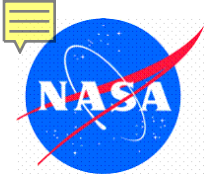AR-104 CFD: Mach 1.7, offset 0.7, AMCT=2.0
60-AA WTT: Mach 1.60, AMCT=2.8

CFD matched trend with WTT

CFD had small AMCT delta

Legend:
AR107 α=−5
AR107 α= 0
AR107 α= 5
AR104 α=−5, no ATB
AR104 α= 0, no ATB
AR104 α= 5, no ATB
60-AA α=0

Results
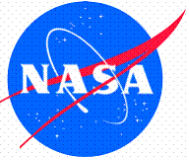

LAV-ATB separation at Mach 0.9
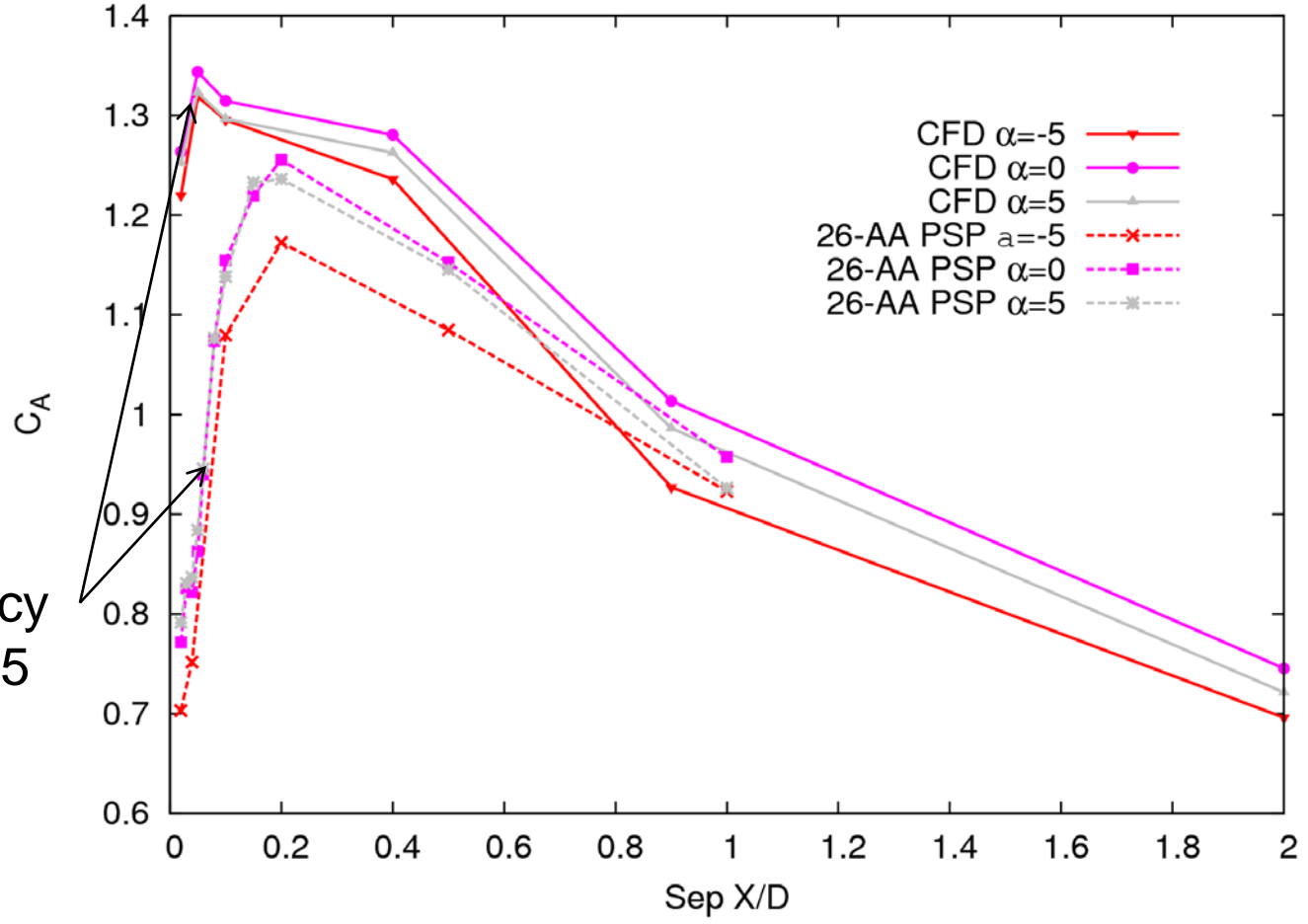
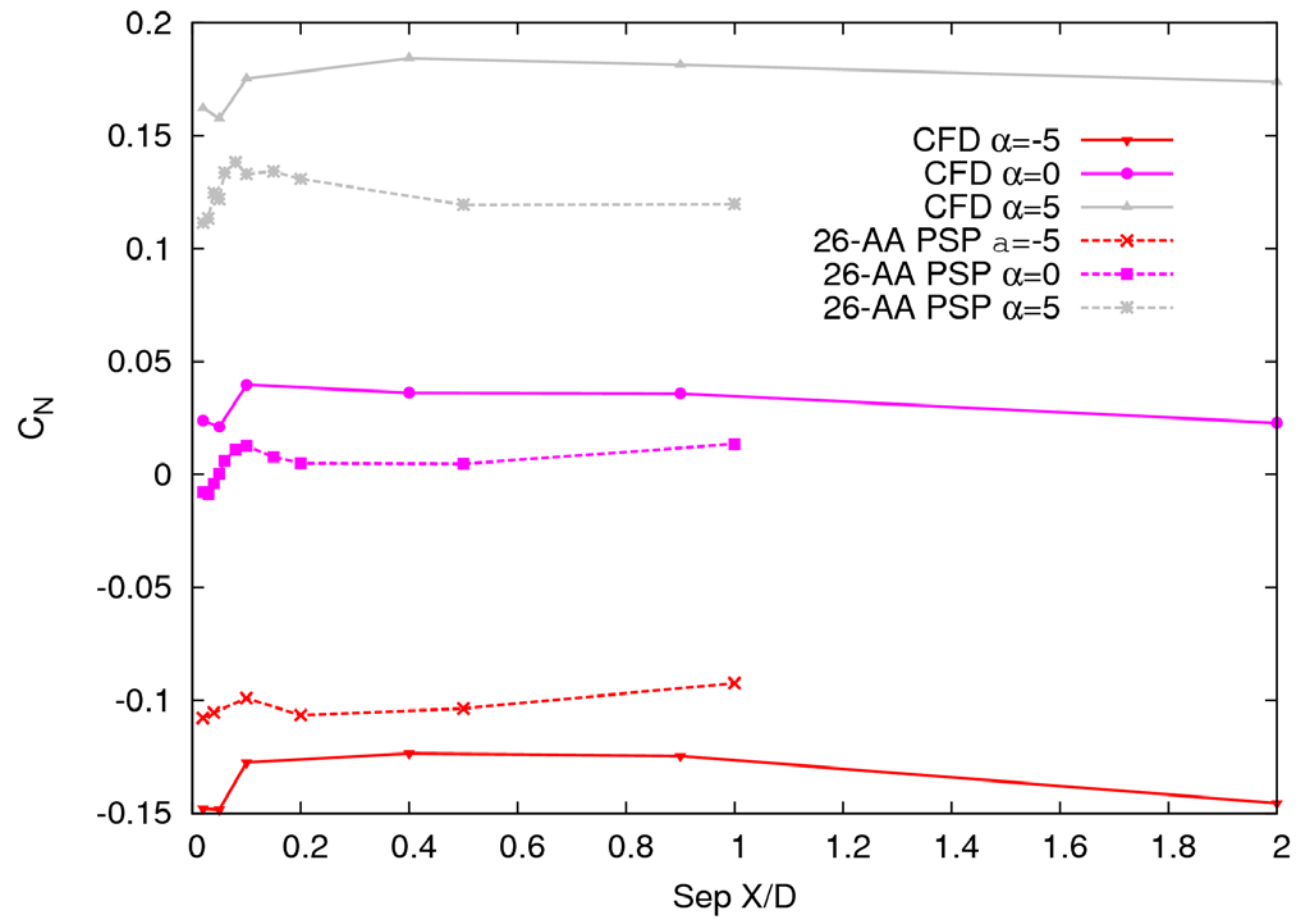Preliminary Data

Largest discrepancy at X/D 0.05

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Results

LAV-ATB separation at Mach 0.9
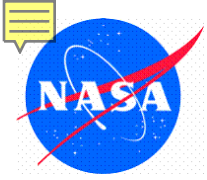Preliminary Data

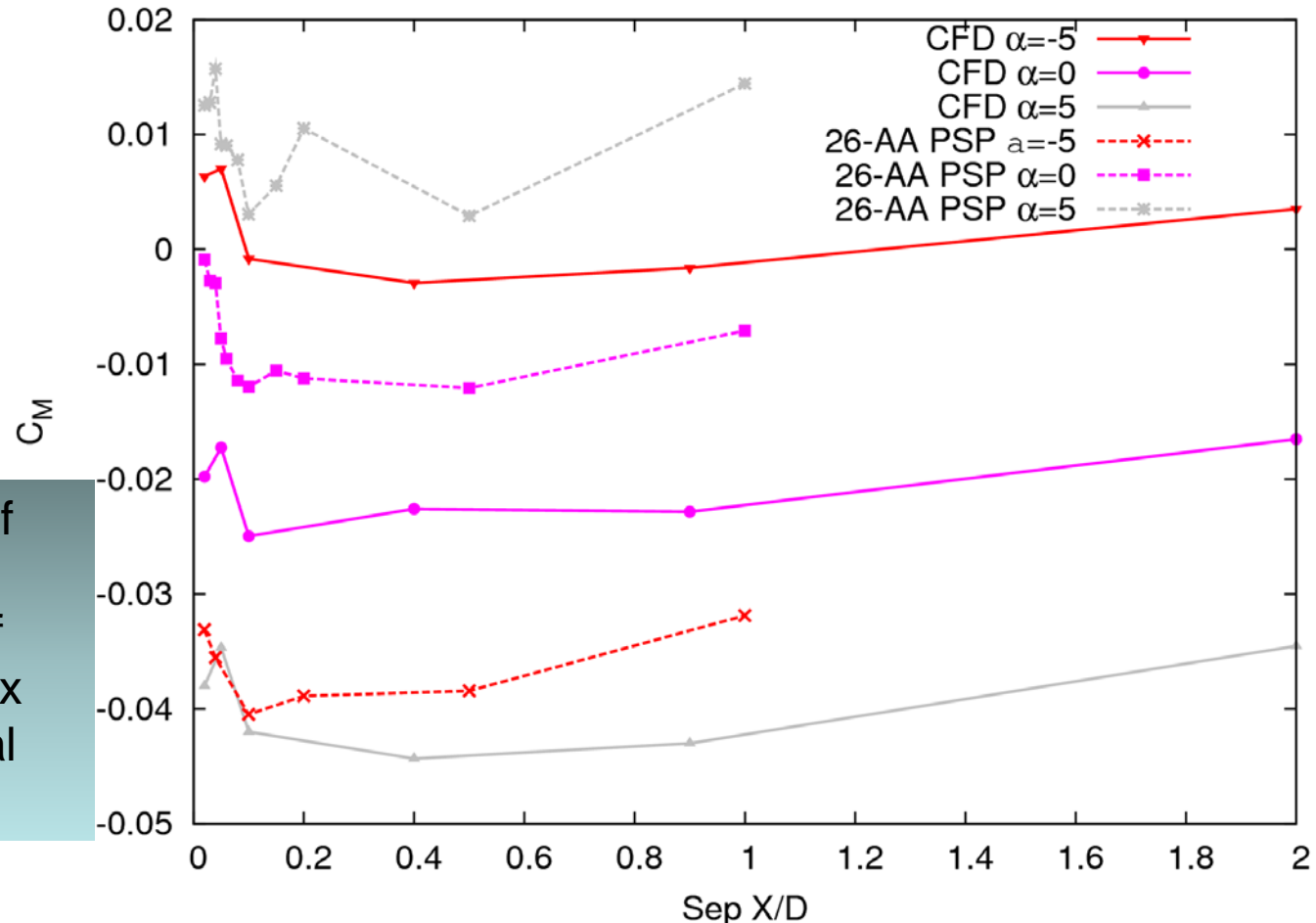**DRAFT**   Tom Booth, (281) 483-3234,
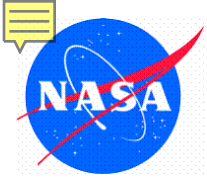   thomas.booth@nasa.gov

Results

LAV-ATB separation at Mach 0.9
Preliminary Data

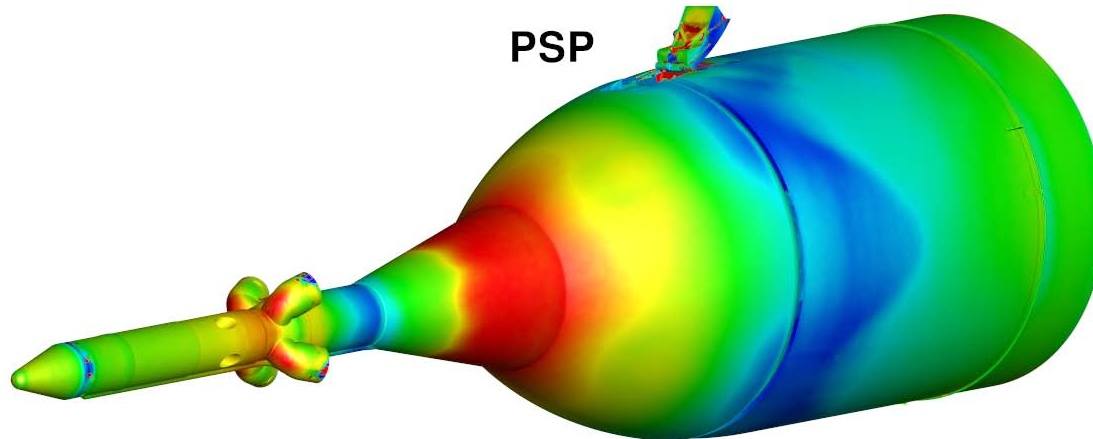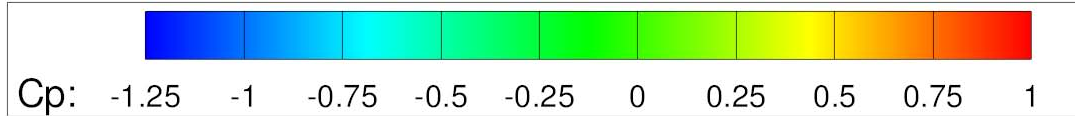Not sure of reason for reversal of trends….fix before final pp

Tom Booth, (281) 483-3234,
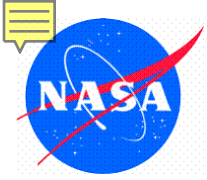thomas.booth@nasa.gov

Results

Mach 0.9
Alpha 0
AMCT 3.0
X/D 0.05

CFD

Cp: -1.25 -1 -0.75 -0.5 -0.25 0 0.25 0.5 0.75 1

PSP
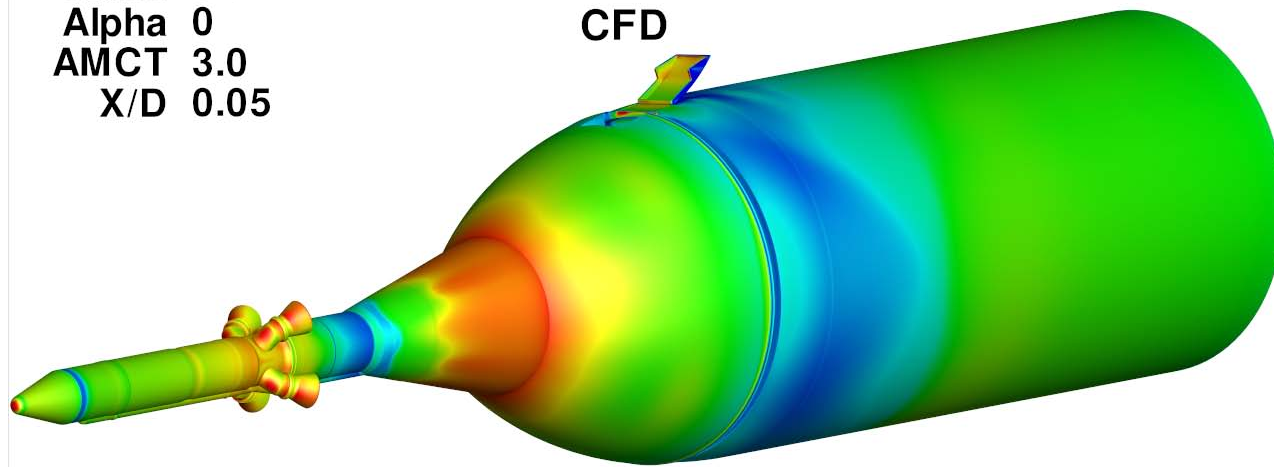
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Results

CFD - PSP
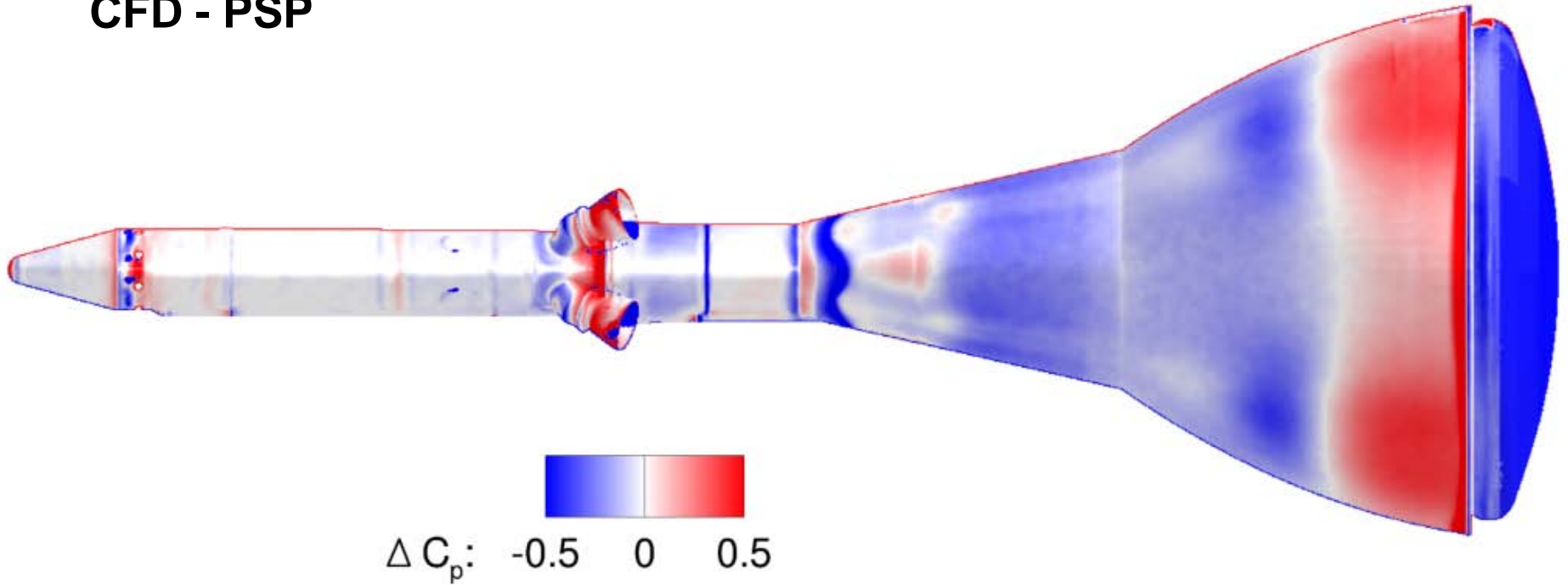
Conclusions

- Steady state assumption valid
  - Avg. integrated loads
  - Investigate effect on instantaneous pressure distribution
- Drag is affected until roughly 7 X/D

Tom Booth, (281) 483-3234, thomas.booth@nasa.gov