Orion Launch Abort Vehicle Separation Analysis using OVERFLOW

DRAFT

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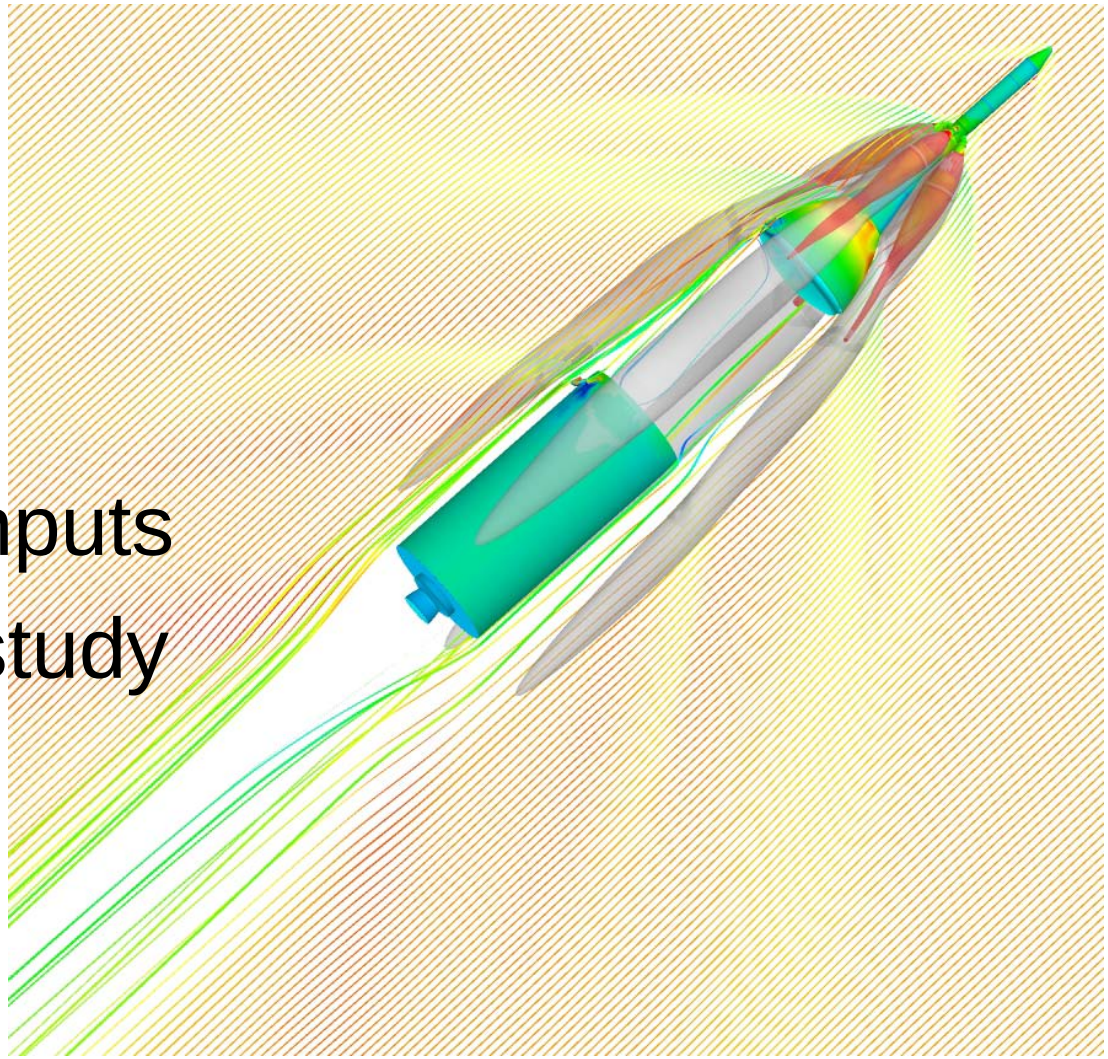
Overview

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



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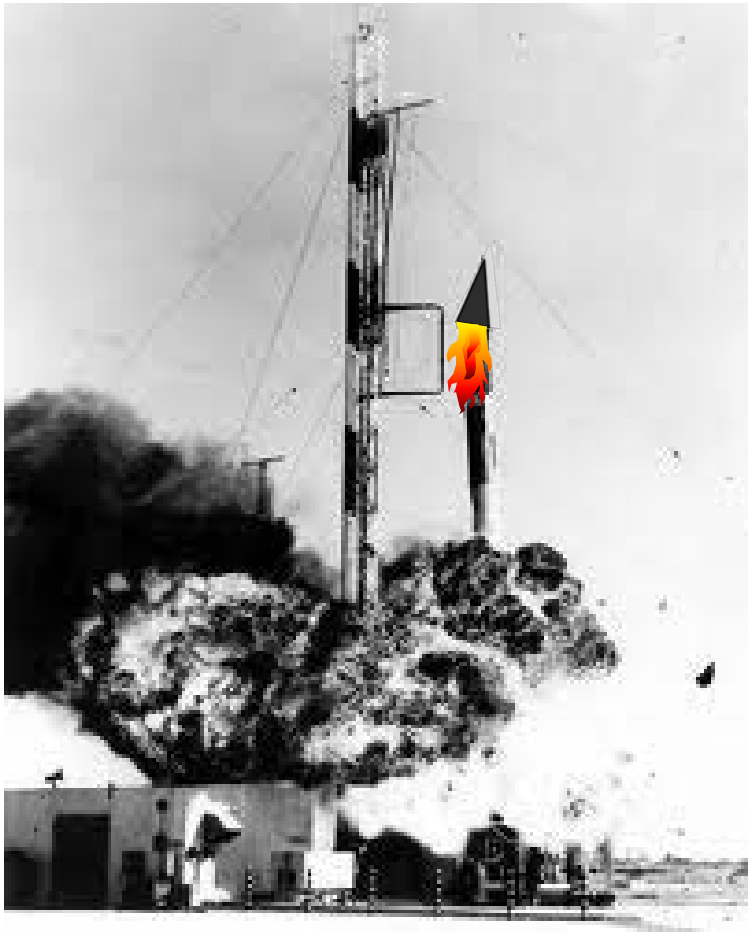
Background

- We want to ride on rockets
- Sometime rockets blow up
- Therefore, we need a launch abort system



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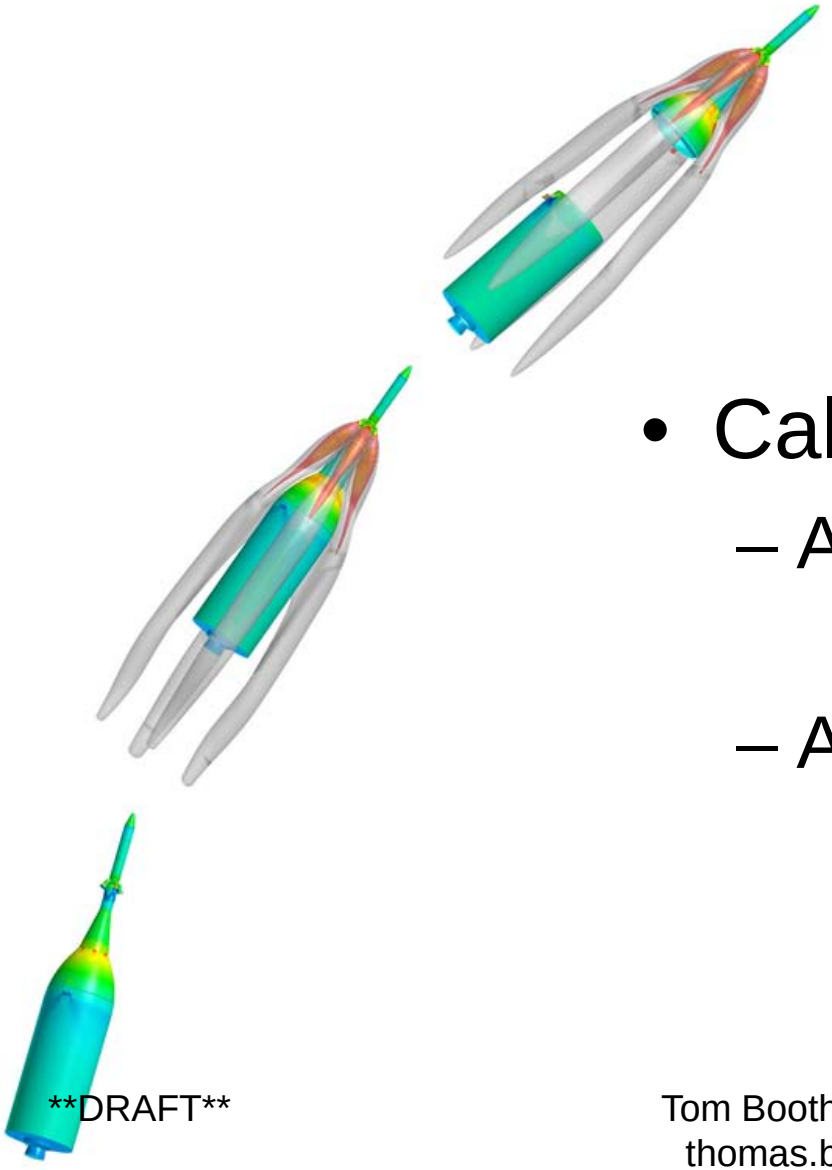
Purpose



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

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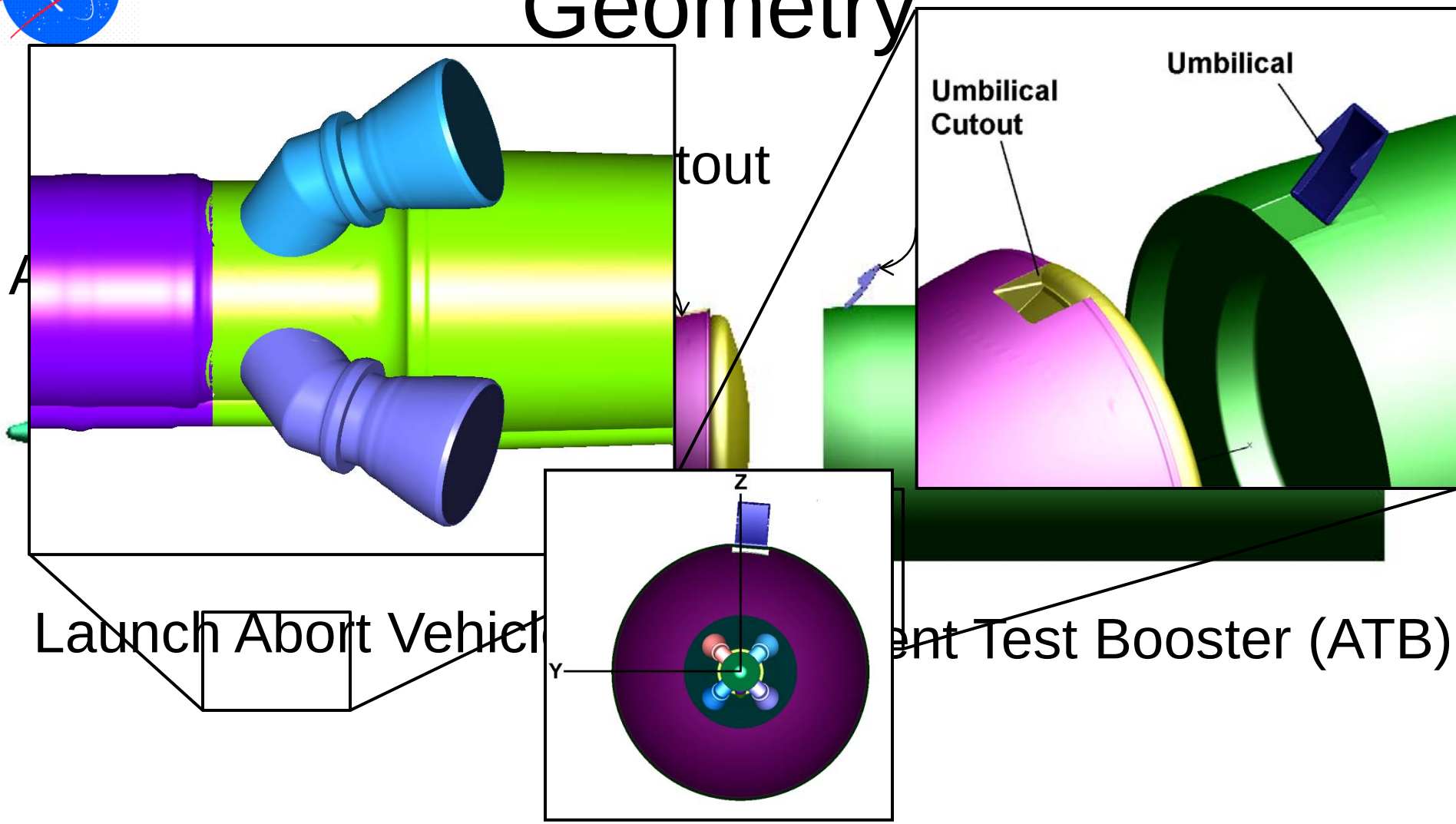
Geometry



tout

Launch Abort Vehicl ent Test Booster (ATB)

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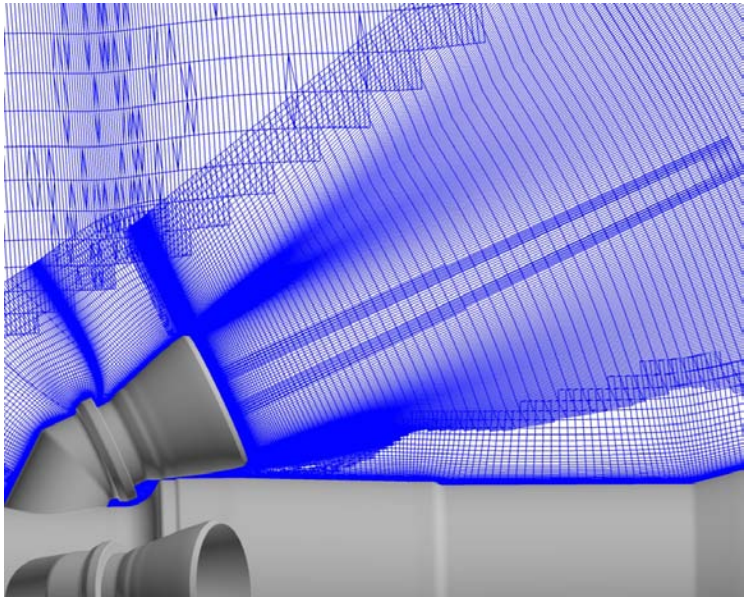
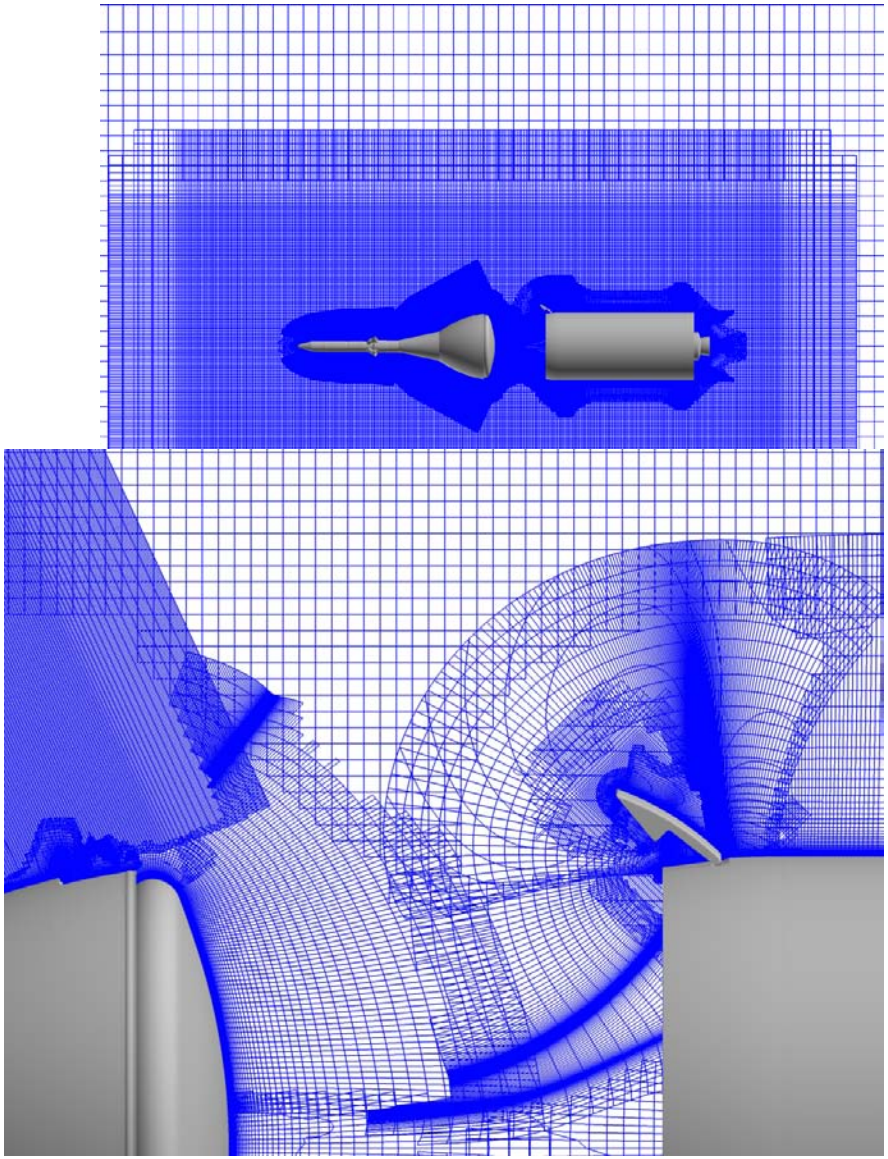
Overset Grids

- Chimera Grid Scripts
- Pegasus5
- 50 grids
  - 93.5 million grid points





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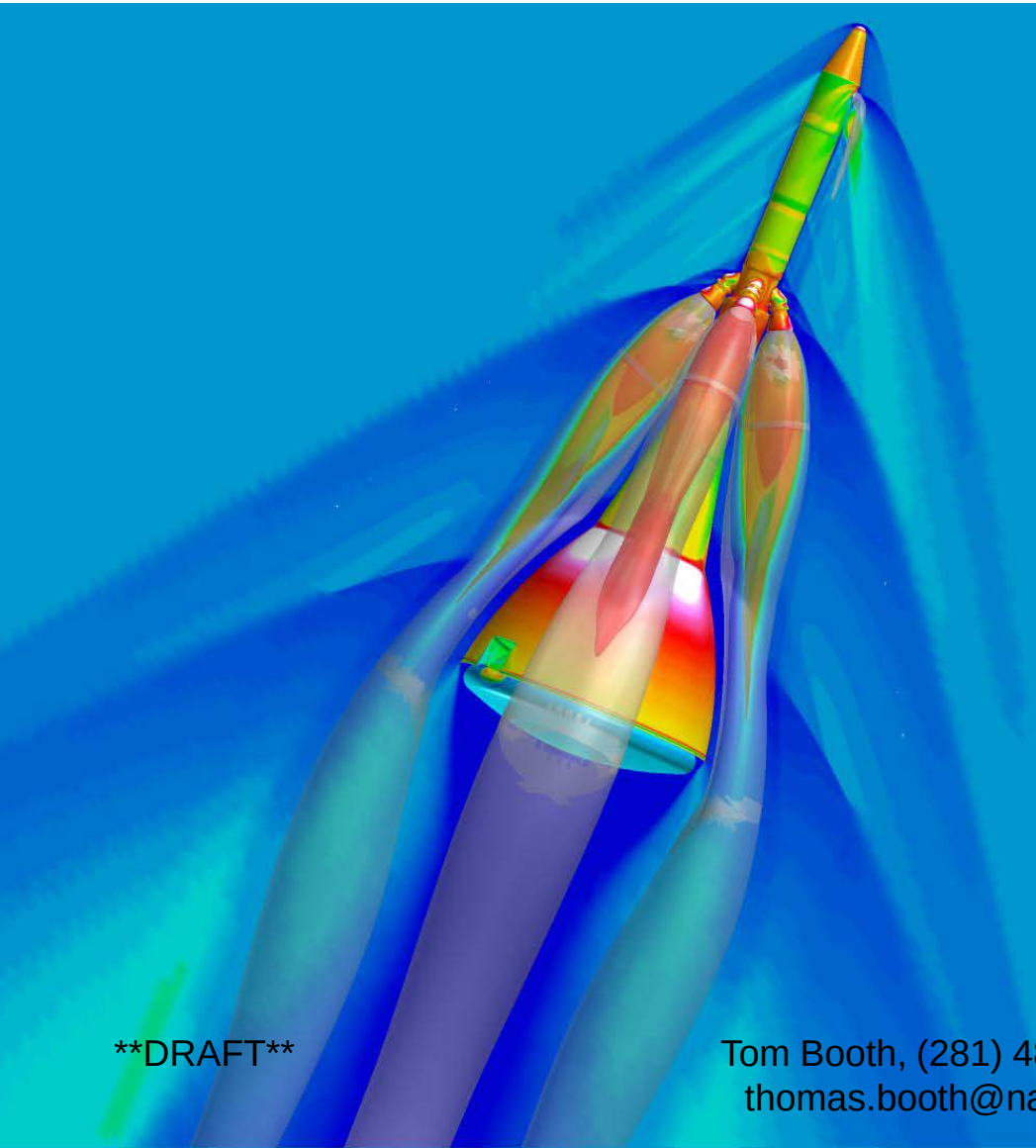
Assumptions



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

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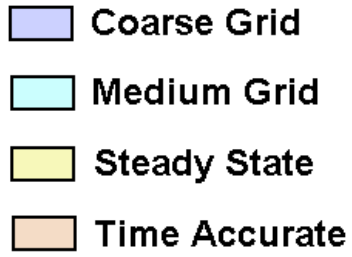
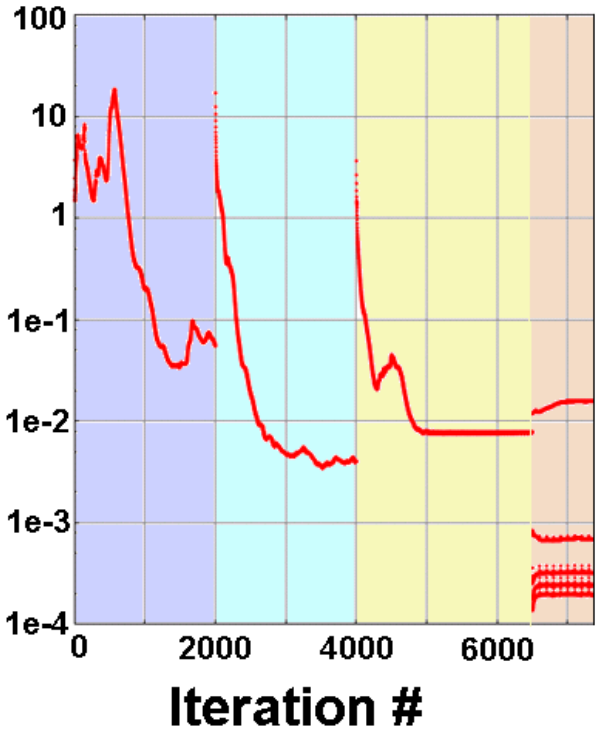
General Run Strategy

- 3 levels of grid sequencing
  - 2000 iterations/level
- Steady state until converged
- Time accurate
  - If needed





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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)

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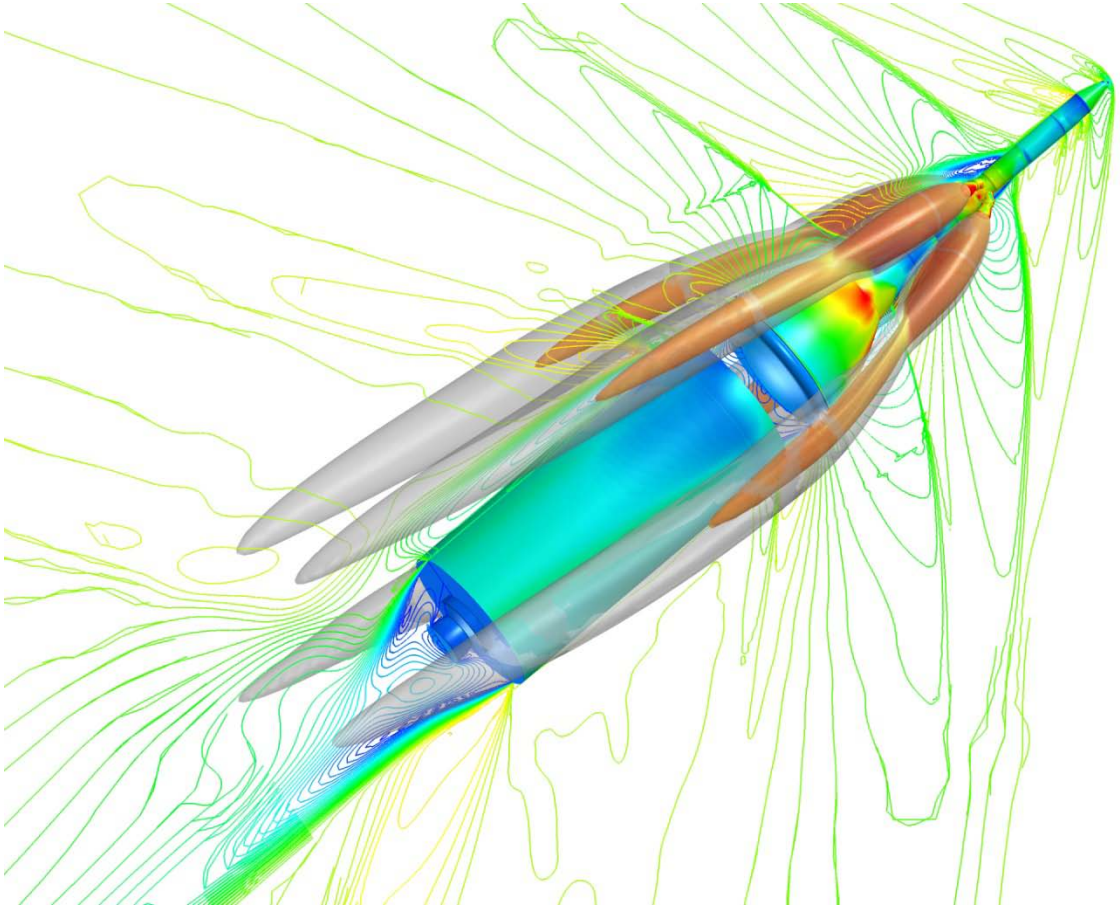
Computational Resources

- 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

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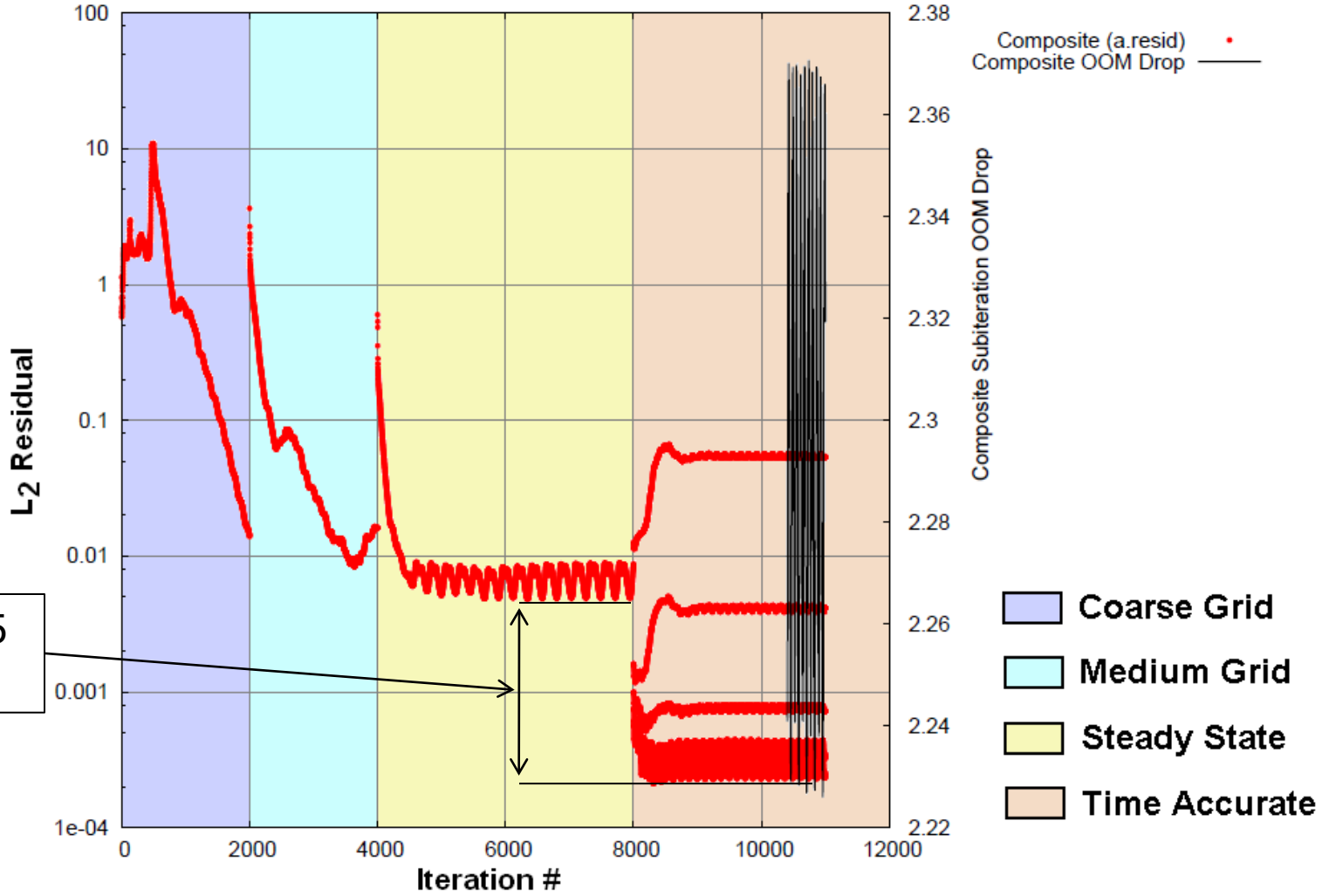
Residual



Additional 1.5 OOM drop

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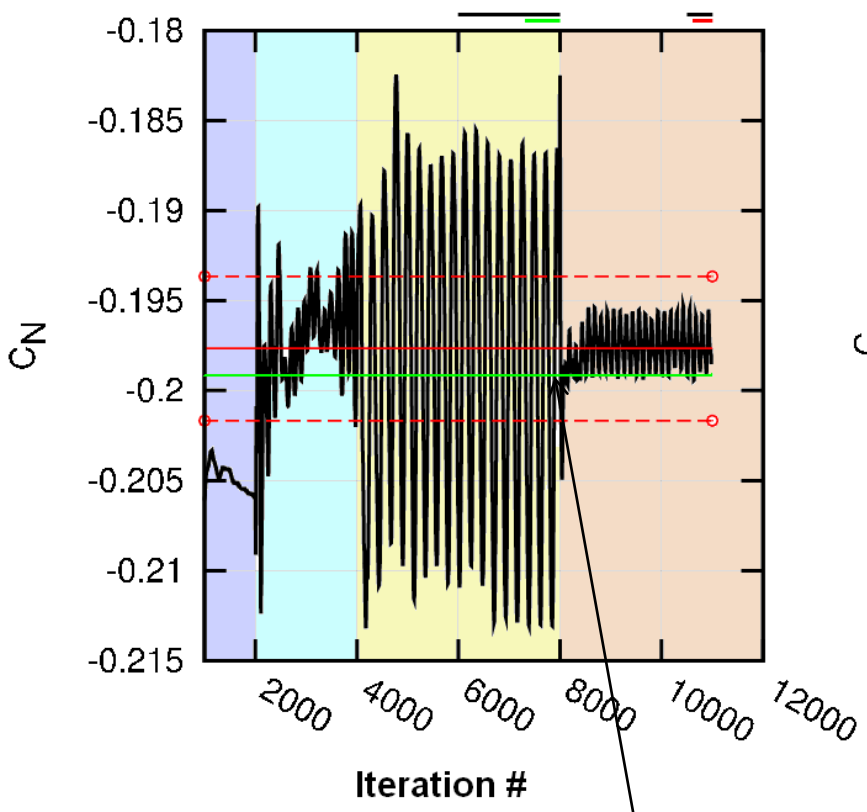
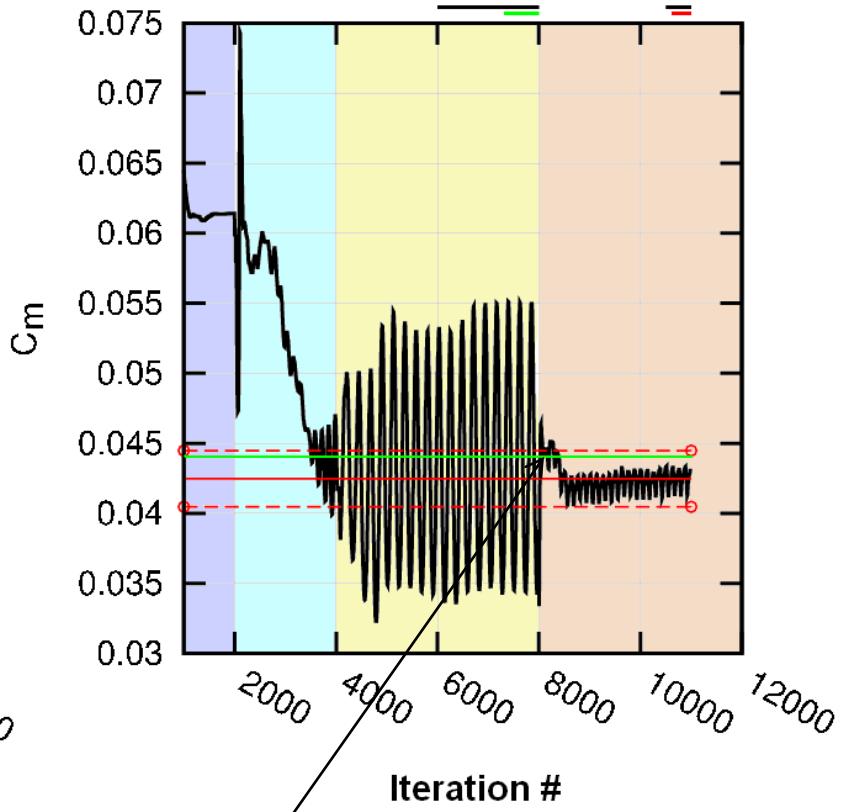
Force/Moment





Within tolerances

Coarse Grid
Medium Grid
Steady State
Time Accurate

Steady State Avg.
Time Accurate Avg.
Convergence Tol.

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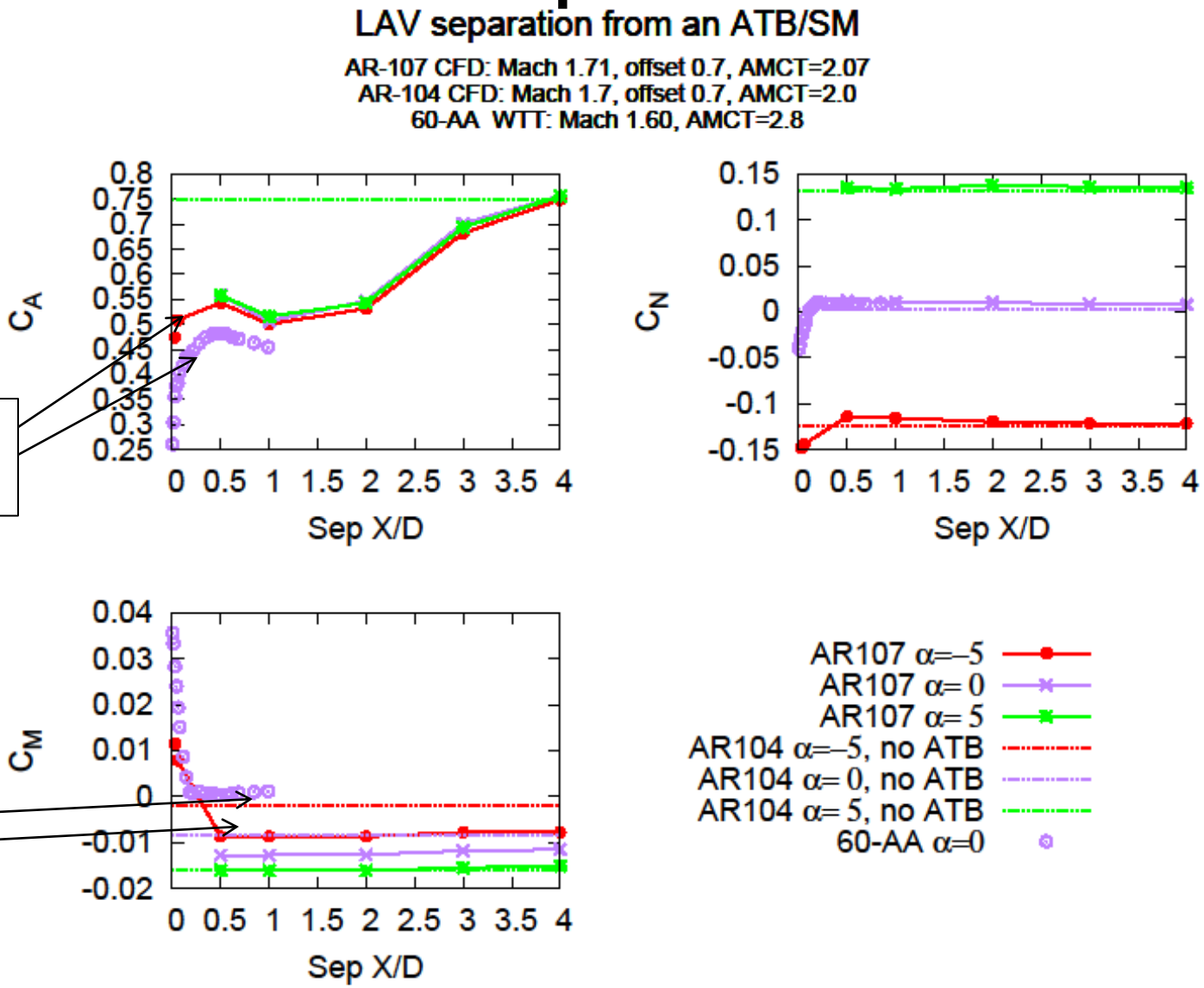
WTT Comparison



CFD matched trend with WTT

CFD had small AMCT delta

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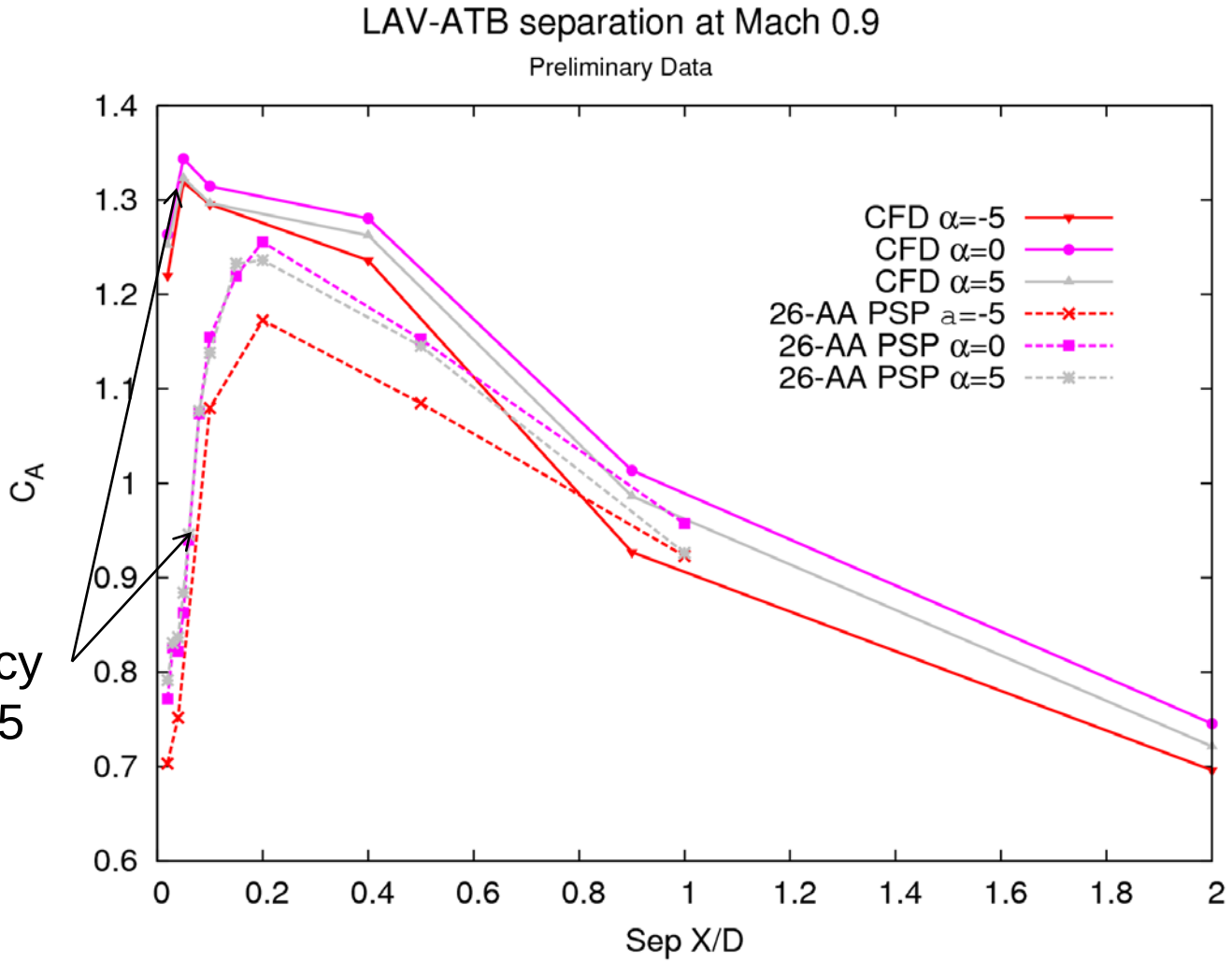
Results



Largest discrepancy at X/D 0.05

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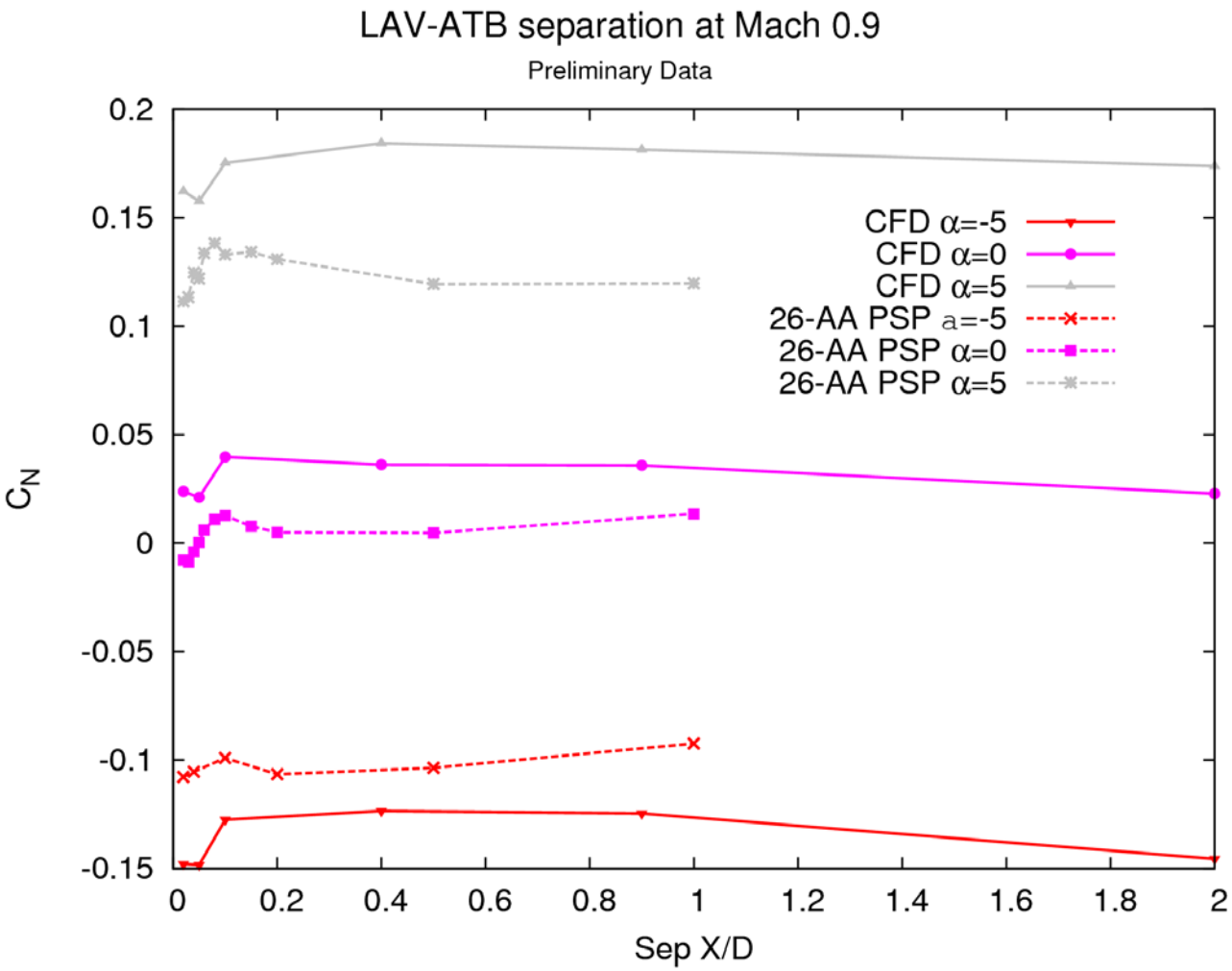
Results



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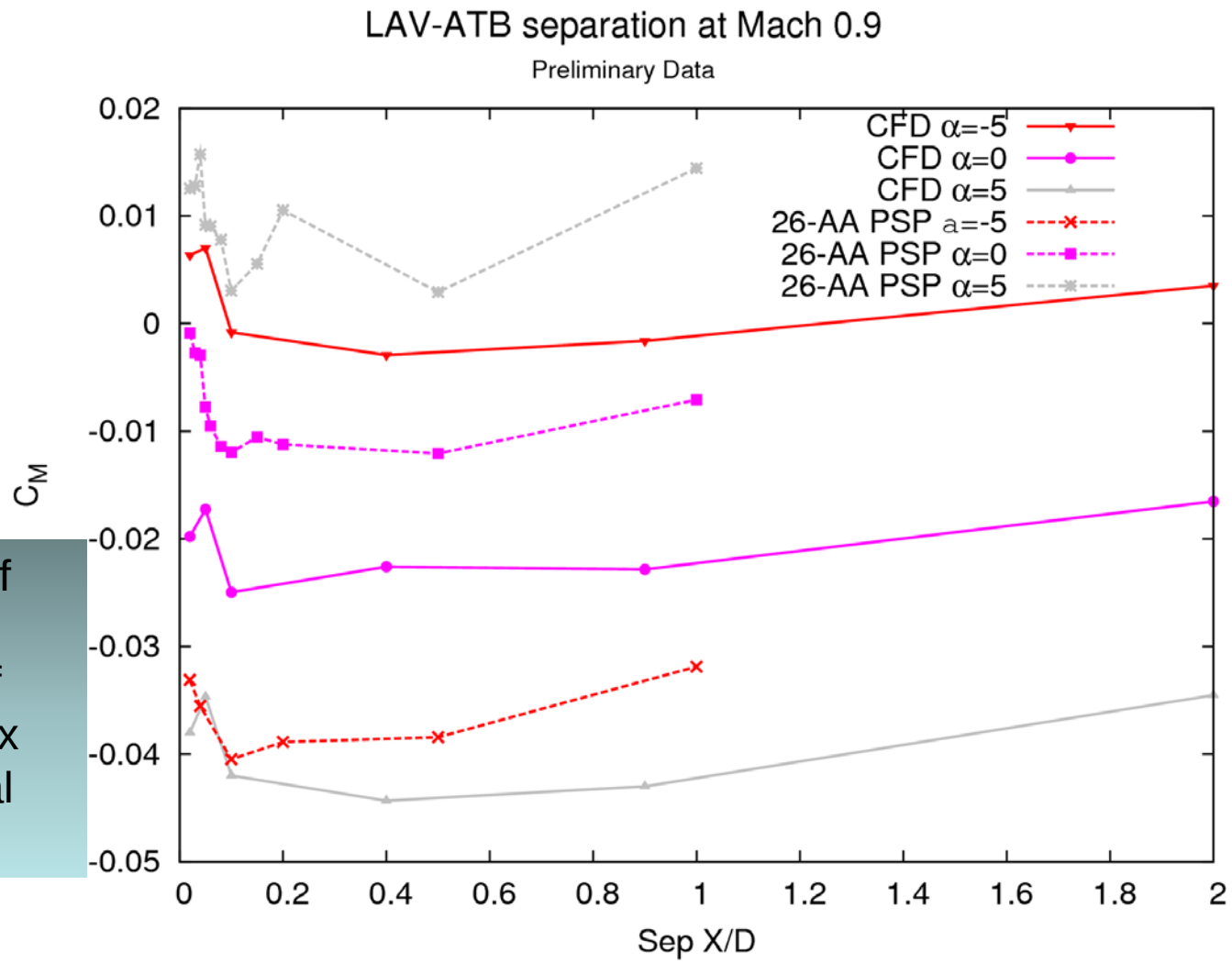
Results



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

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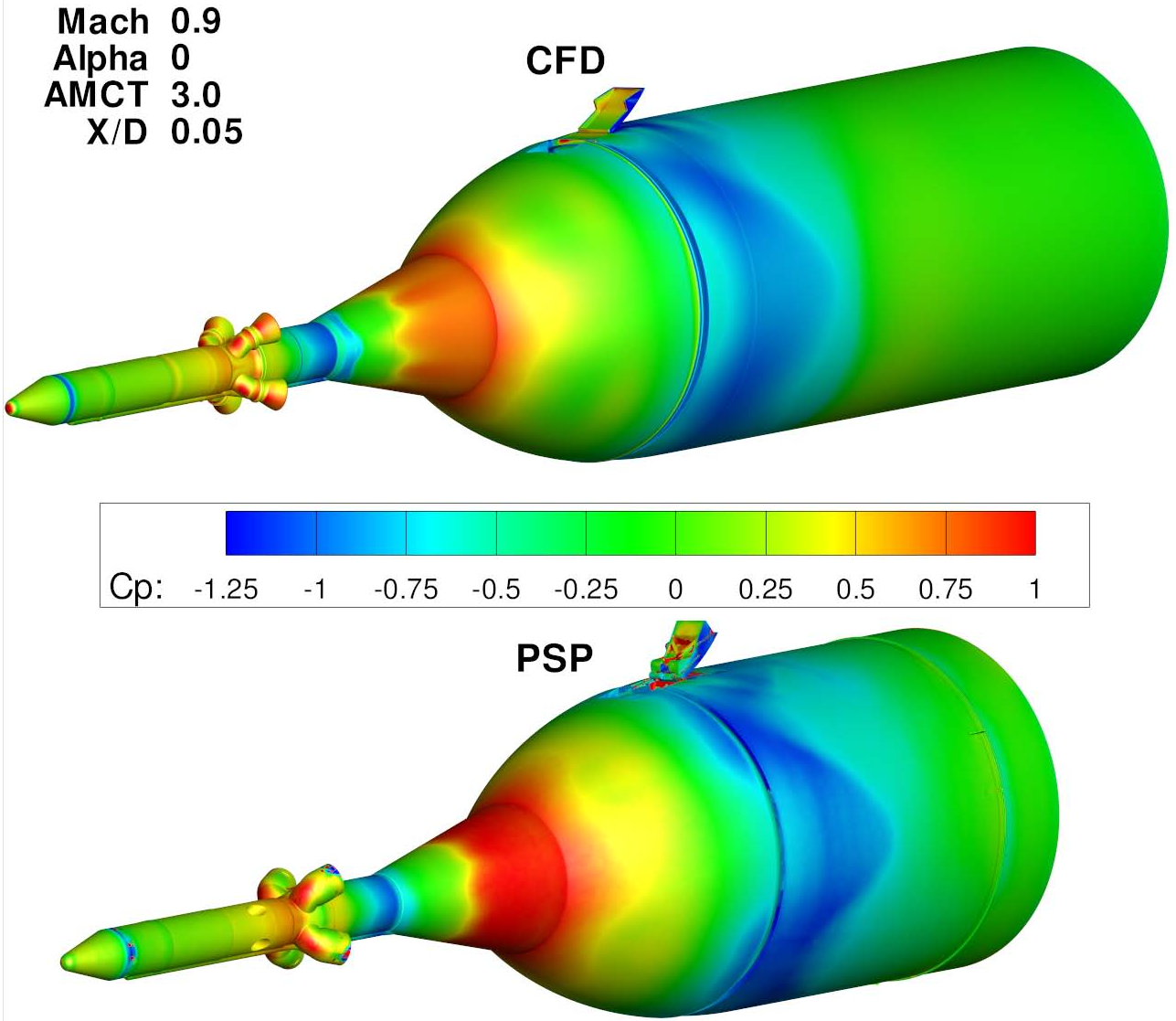
Results



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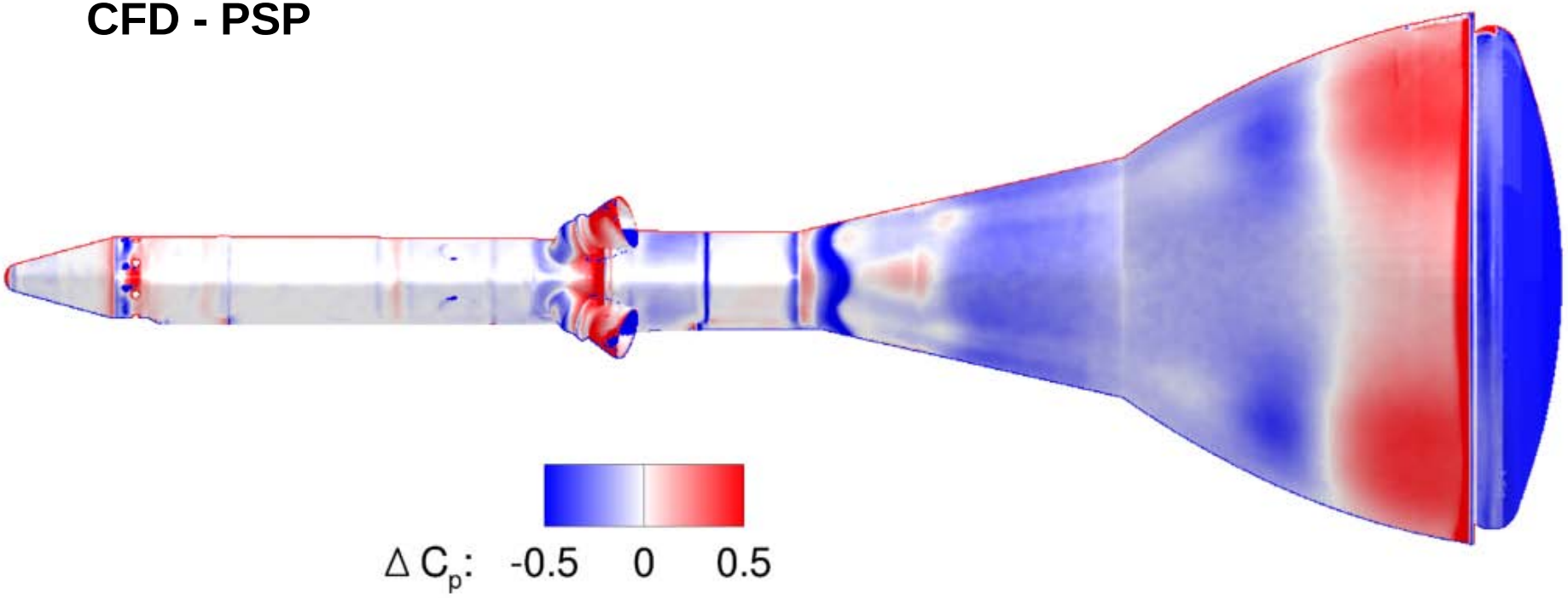
Results

CFD - PSP



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Conclusions

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

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