# HPCMP CREATE™-AV Kestrel Simulations for the DPW-8/AePW-4 Buffet Working Group: Part 1

APA-31: DPW-8/AePW-4: Buffet Working Group – ONERA OAT15A Test Case

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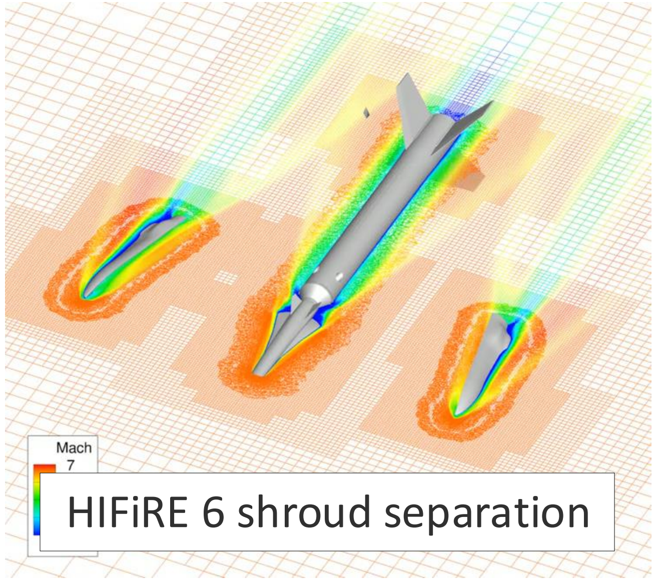
# HPCMP CREATE™-AV Kestrel

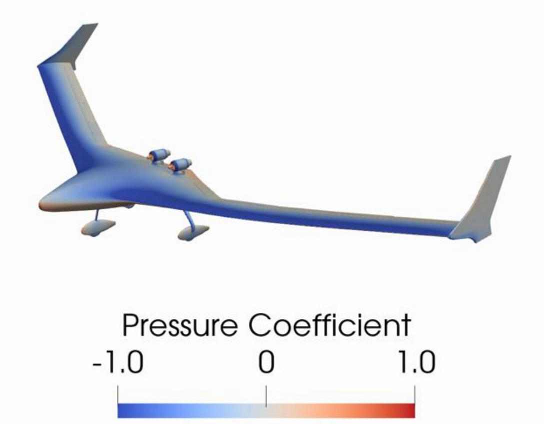
KESTREL

CREATE

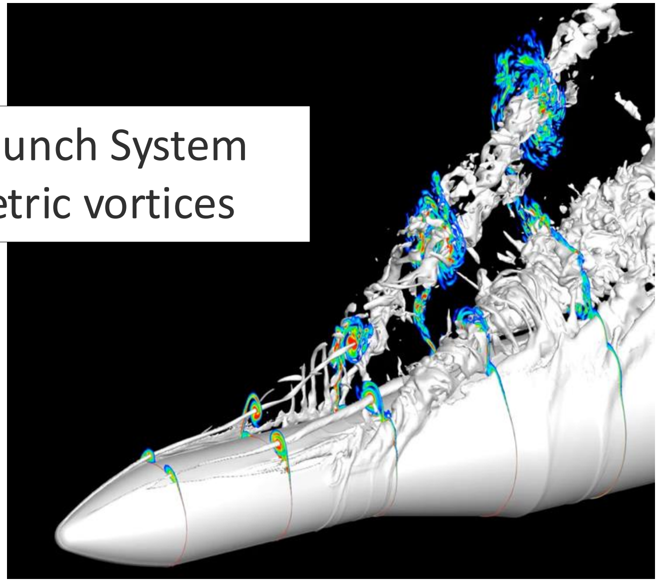
- **Multiphysics simulation code supporting US DoD fixed-wing programs of record**
  - Full spectrum of flight conditions and missions
  - Full spectrum of aircraft/weapons types
  - Coupled physics: **aerodynamics**, thermochemistry, aero-heating, **structural dynamics**, propulsion, flight controls, 6-DoF motion w/ generalized constraints, separation/contact/collision
  - Easy for users to learn, use, customize, and extend




HIFiRE 6 shroud separation



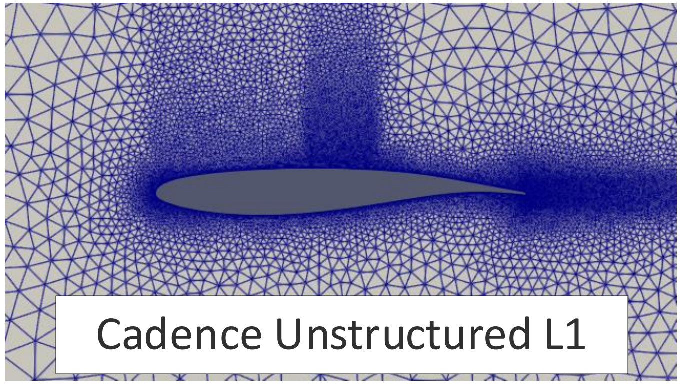

X-56A Body-Freedom Flutter

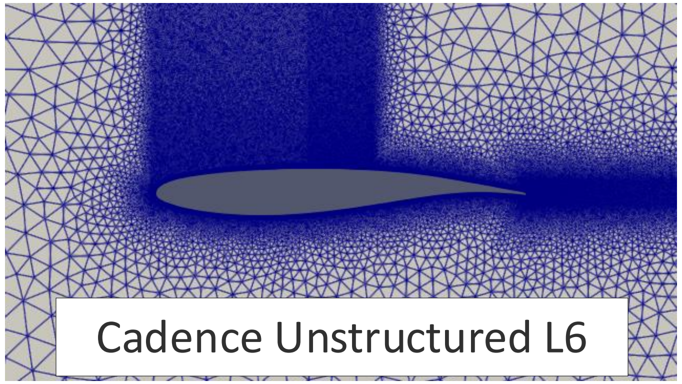


Space Launch System asymmetric vortices

# Problem Description

- **ONERA OAT15A transonic airfoil**
  - Mach 0.73, $Re_c = 3\times10^6$, $T_\infty = 271$ K
  - Experimental $C_P$ and RMS($C_P$) available at several α
- **Workshop Problems**
  - Case 1a – use a steady solver to solve at α = {1.36°, 1.50°, 2.50°, 3.00°, 3.10°, 3.25°, 3.40°, 3.50°, 3.60°, 3.90°}
  - Case 1b – use unsteady solver to solve at same α
    - Focus on grid level 3
- **Kestrel Setup**
  - Use workshop-provided unstructured grids from Cadence
  - Look at both Spalart-Allmaras (SA) and Menter Shear Stress Transport (SST) turbulence models
    - Both rotational/curvature correction and QCR 2020 turned on for both models
  - Using Kestrel's "FN1+NN" expanded gradient stencil

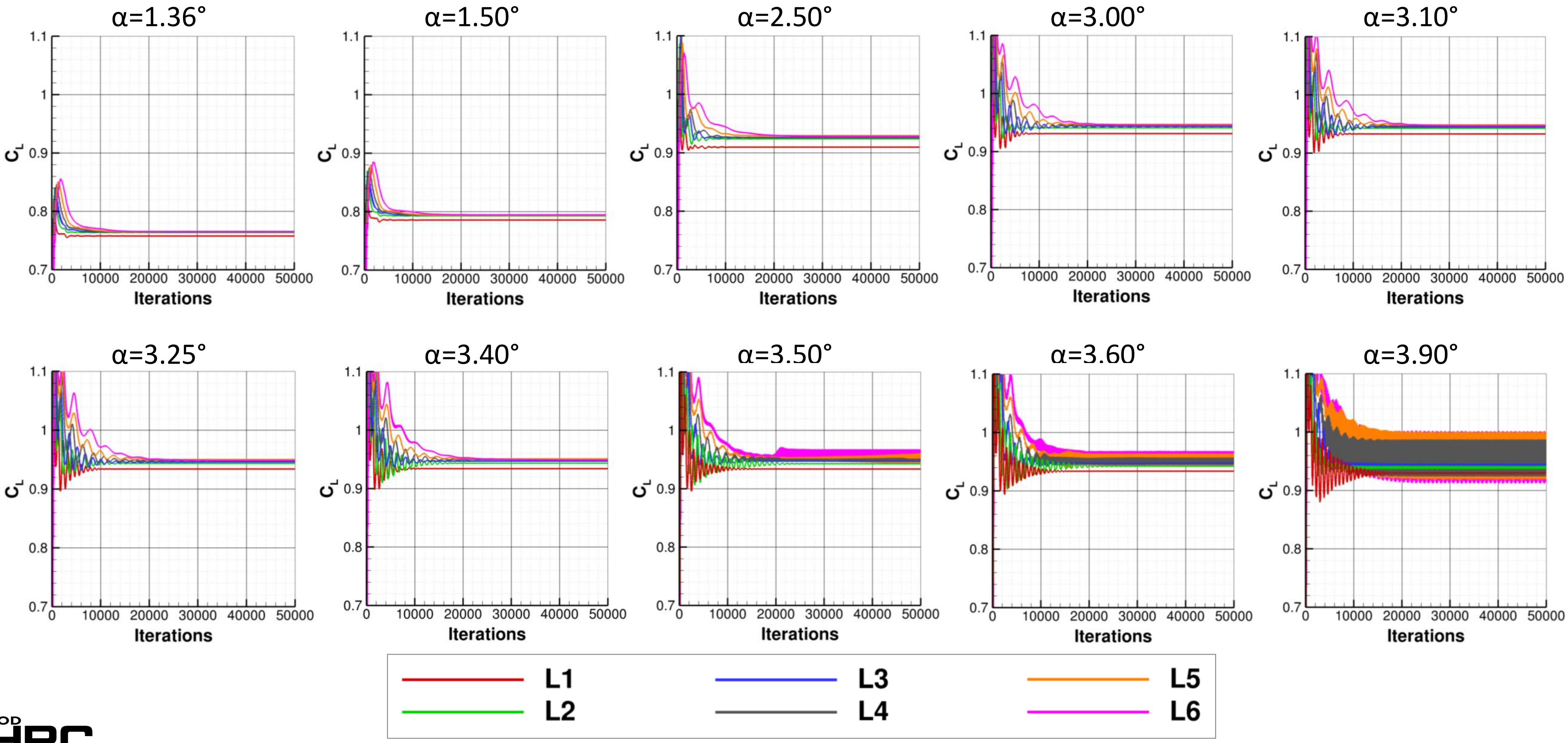


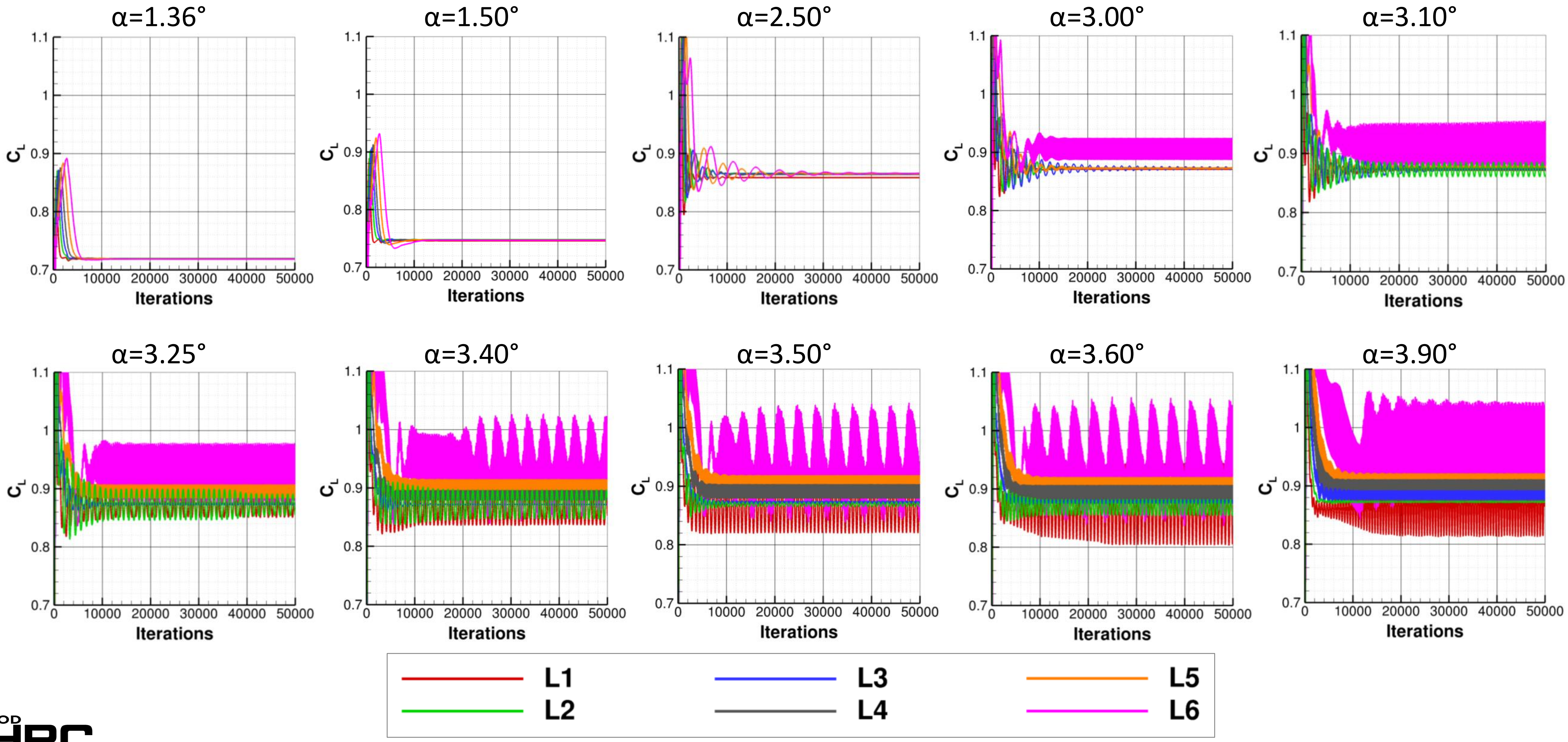
# CASE 1A

CREATE

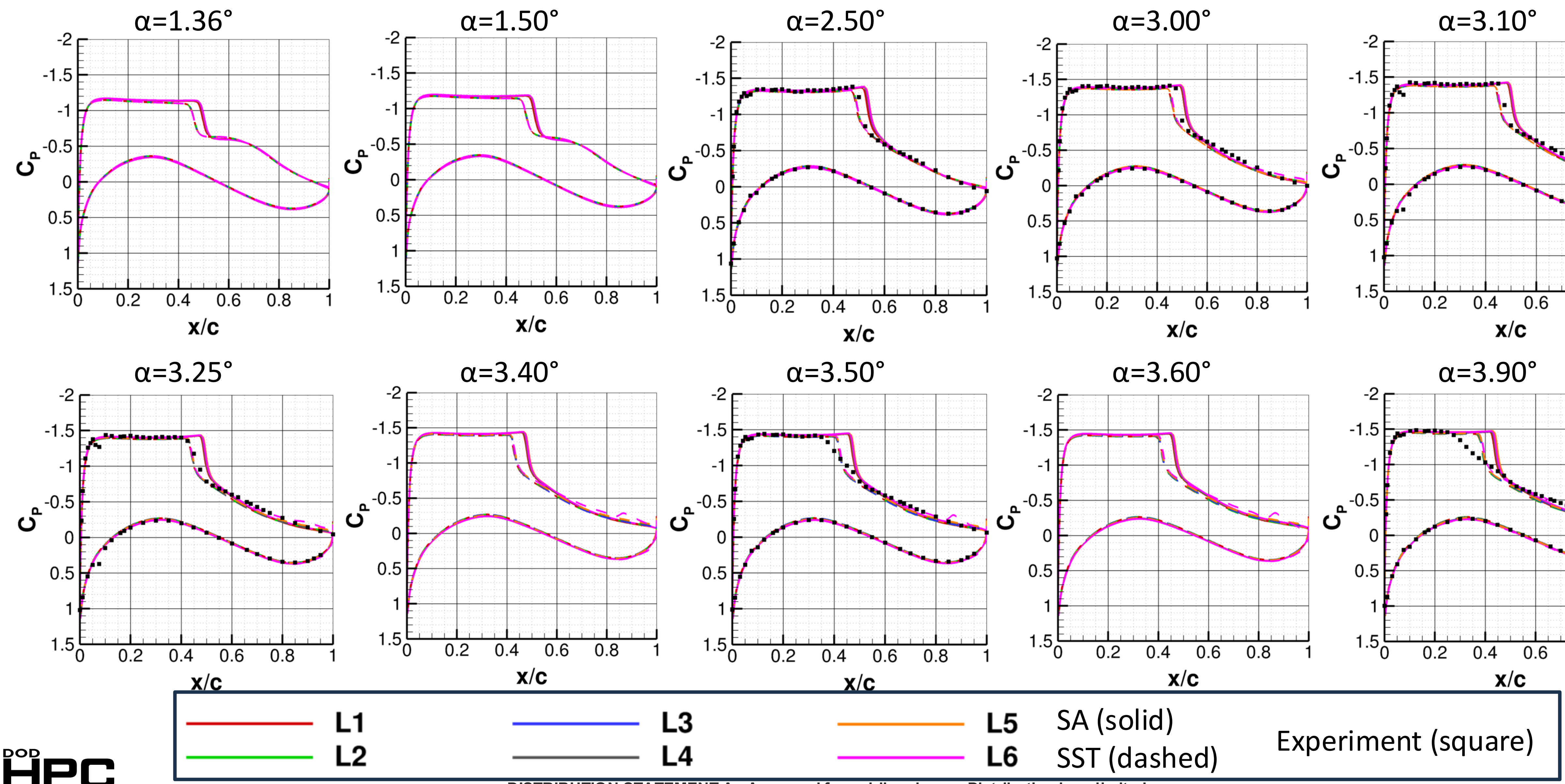
# Steady Solver Results: SA



# Steady Solver Results: SST

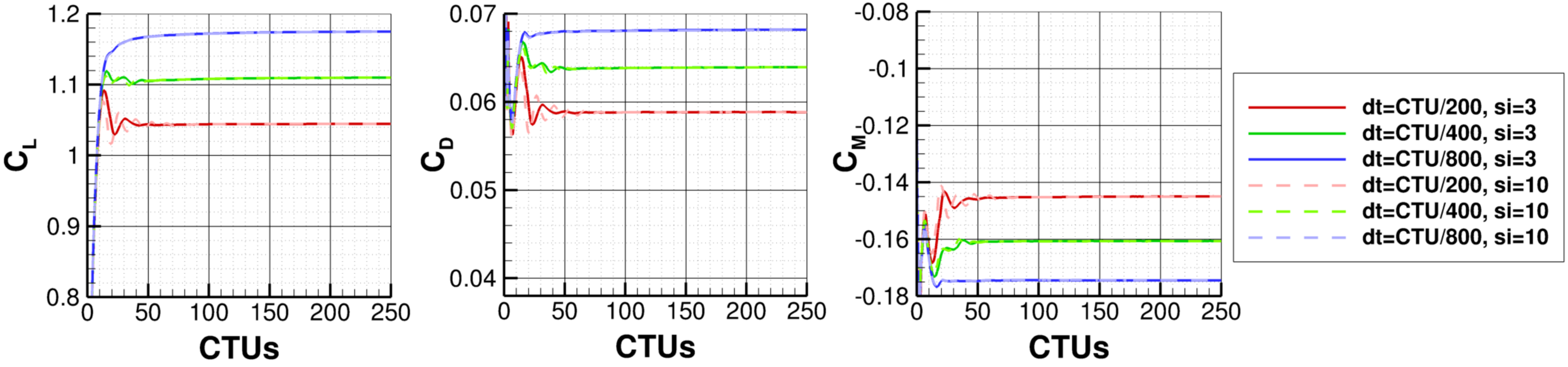


# Steady Solver Results: $C_P$ Distributions



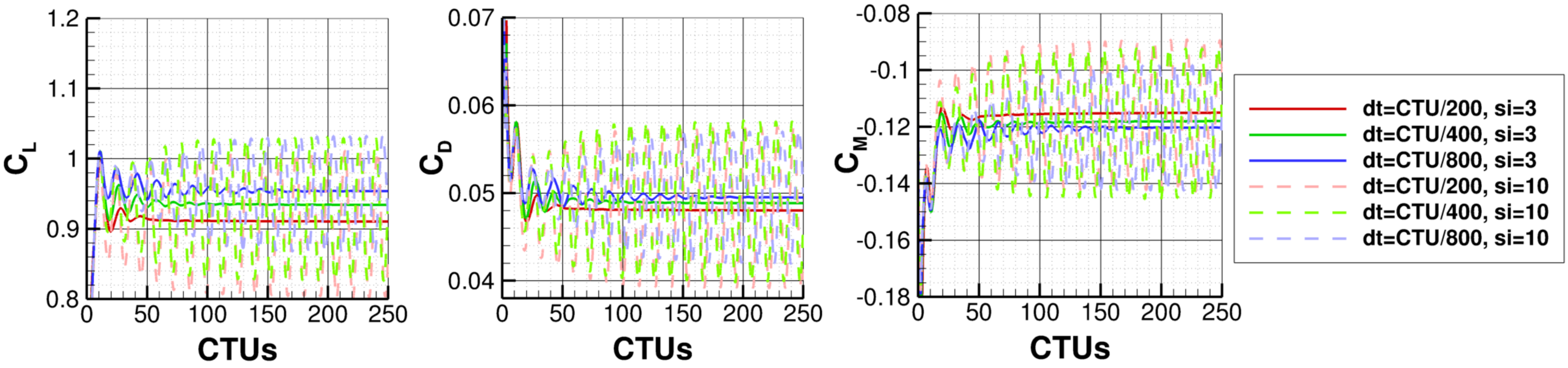
# CASE 1B

# Unsteady Solver Time Step Study: α=3.90°, SA



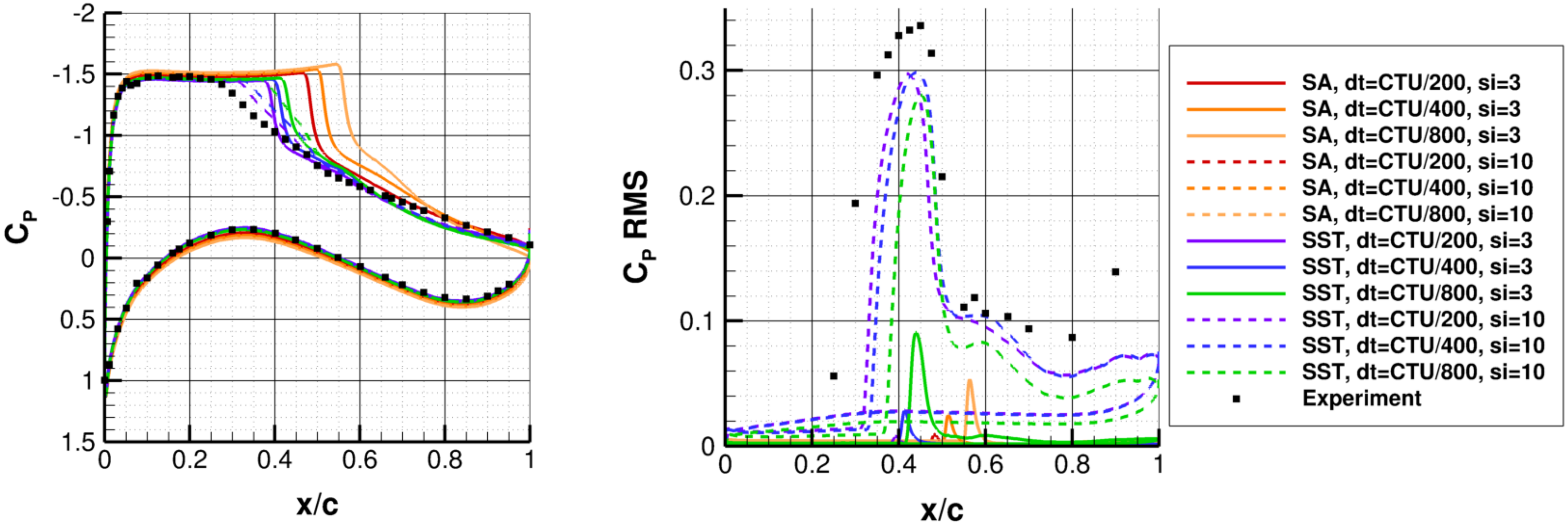

- $C_L$, $C_D$, $C_M$ all move noticeably as time step changes
- Increasing number of subiterations does not have significant impact on behavior

# Unsteady Solver Time Step Study: α=3.90°, SST




- $C_L$, $C_D$, $C_M$ all move noticeably as time-step changes, but less so than for SA
- Subiterations matter
  - 3 subiterations produce steady-ish behavior, 10 subiterations produce unsteady behavior

# Unsteady Solver Time Step Study: α=3.90°, $C_P$




- For SA, no discernable difference between 3 and 10 subiterations
- For SST, 3 subiterations shows similar behavior to steady response, and 10 subiterations shows significantly improved comparison to experimental data

# Conclusions

- **Case 1a – Steady Simulations (RANS)**
  - Conducted steady runs at all grid levels using both SA and SST.
  - Both SA and SST simulations achieved reasonable comparisons to experimental data when comparing mean $C_P$ distribution.
  - The SA shock location tended to be further downstream than the SST shock location. The experimental shock location was between the two for lower $\alpha$ and upstream of both at higher $\alpha$.
  - SST showed signs that the flow was unsteady at most grid levels for $\alpha \geq 3.10°$, but SA only demonstrated signs of potential unsteadiness for the L6 grid.
- **Case 1b – Unsteady Simulations (URANS)**
  - Conducted initial time step study at $\alpha = 3.90°$ on the L3 grid using both SA and SST.
  - For SA, a suitable time step and subiteration count combination has not been found.
  - For SST, multiple time steps using 10 subiterations showed reasonable unsteady results when compared to the experimental data.

# Acknowledgements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# QUESTIONS?