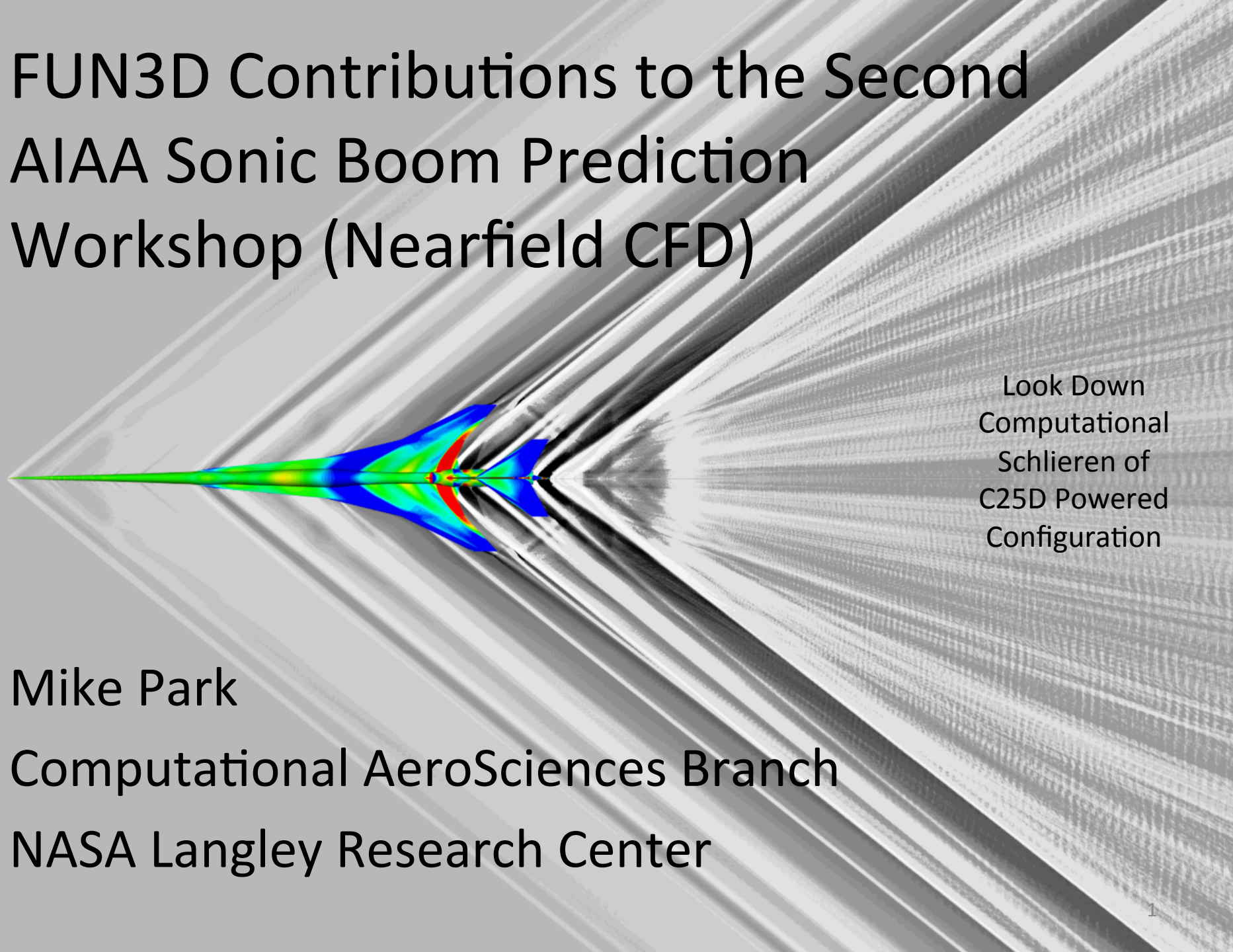
FUN3D Contributions to the Second AIAA Sonic Boom Prediction Workshop (Nearfield CFD)



Look Down Computational Schlieren of C25D Powered Configuration

Mike Park

Computational AeroSciences Branch

NASA Langley Research Center

Cases

- All workshop grids
  - 0.6 to 56 million node Euler AXIE (5)
  - 6, 11, and 18 million node Euler JWB (3)
  - 3-104 million node Euler C25F (6)
  - 5-138 million node viscous C25F (6)
  - 3-52 million node Euler C25P (5)
  - 5-70 million node viscous C25P (5)

Cases

- Participant grids
  - C25F ANSA and Pointwise (S. Cliff)
  - C25P ANSA and 3 Pointwise (S. Cliff)

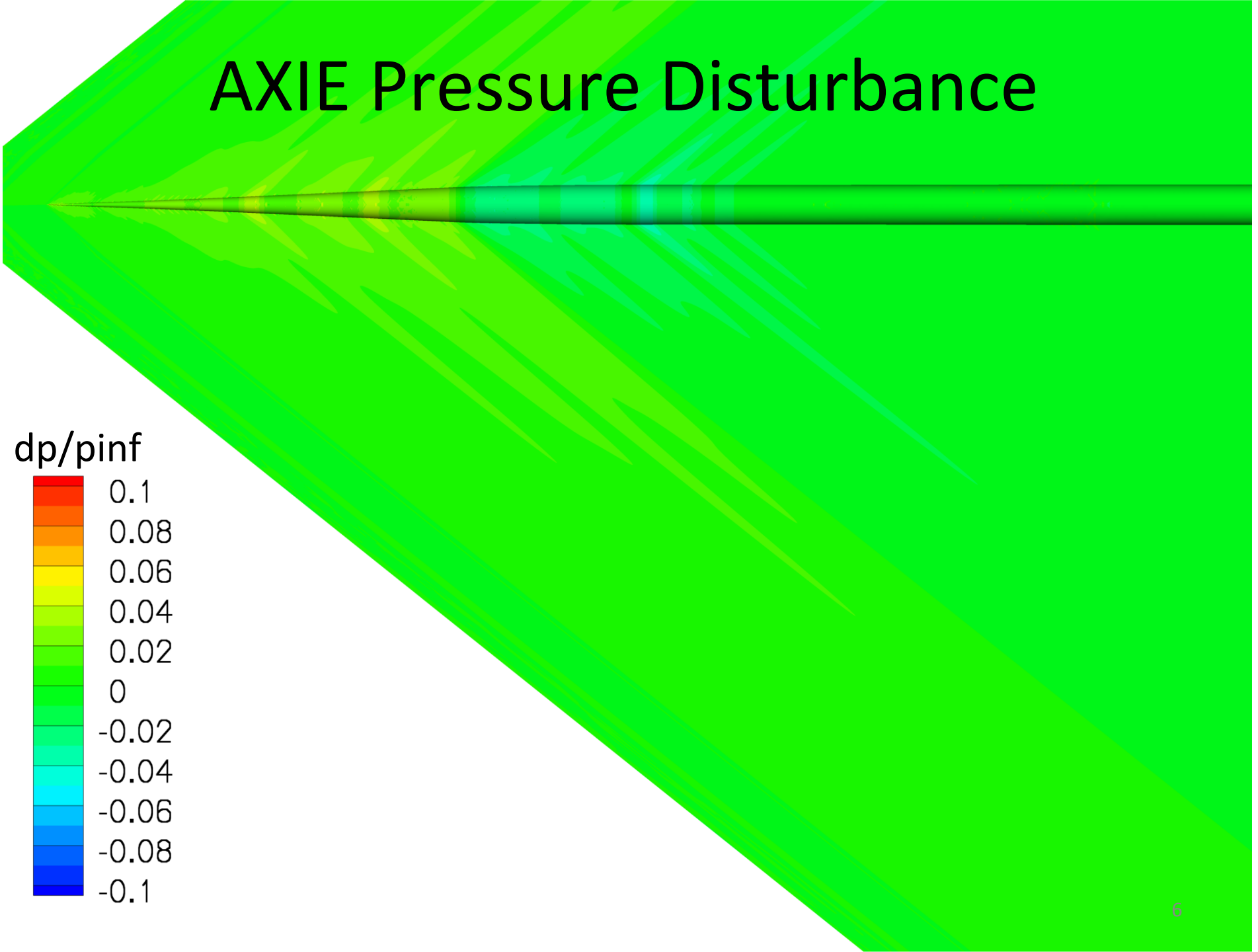
FUN3D

- Node-based solver for mixed-element grids
- Blended upwind and central difference
  - Roe flux function
  - van Albada limiter (frozen)
- Euler and Spalart-Allmaras turbulence model
- Legacy defect correction implicit solution advancement scheme

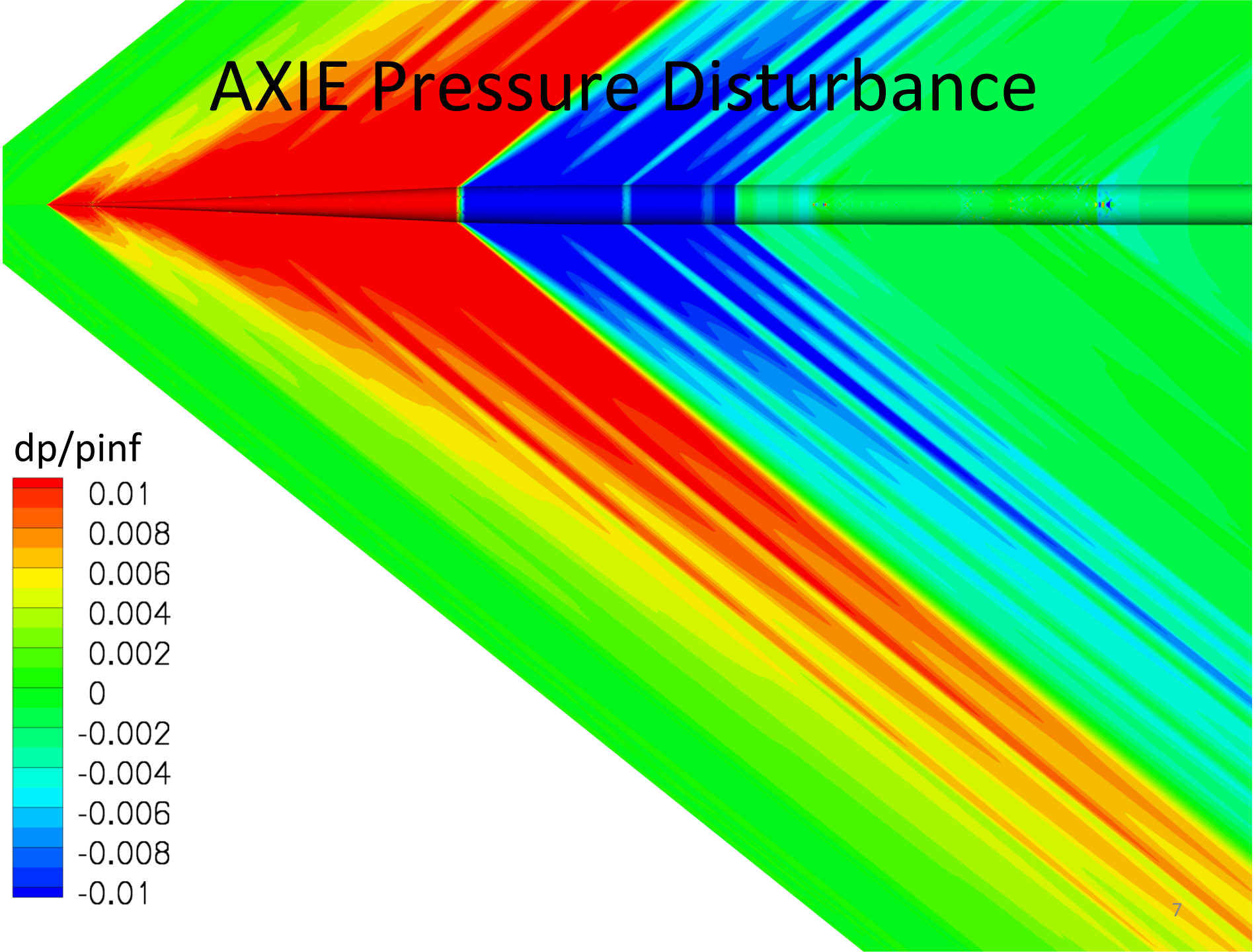
Resources

- NASA Langley mid-range computing facility
  - SGI ICE Altix Cluster
- FUN3D
  - 160-400 core jobs limited by number of free cores and queue sizes
  - Few minutes to a few hours

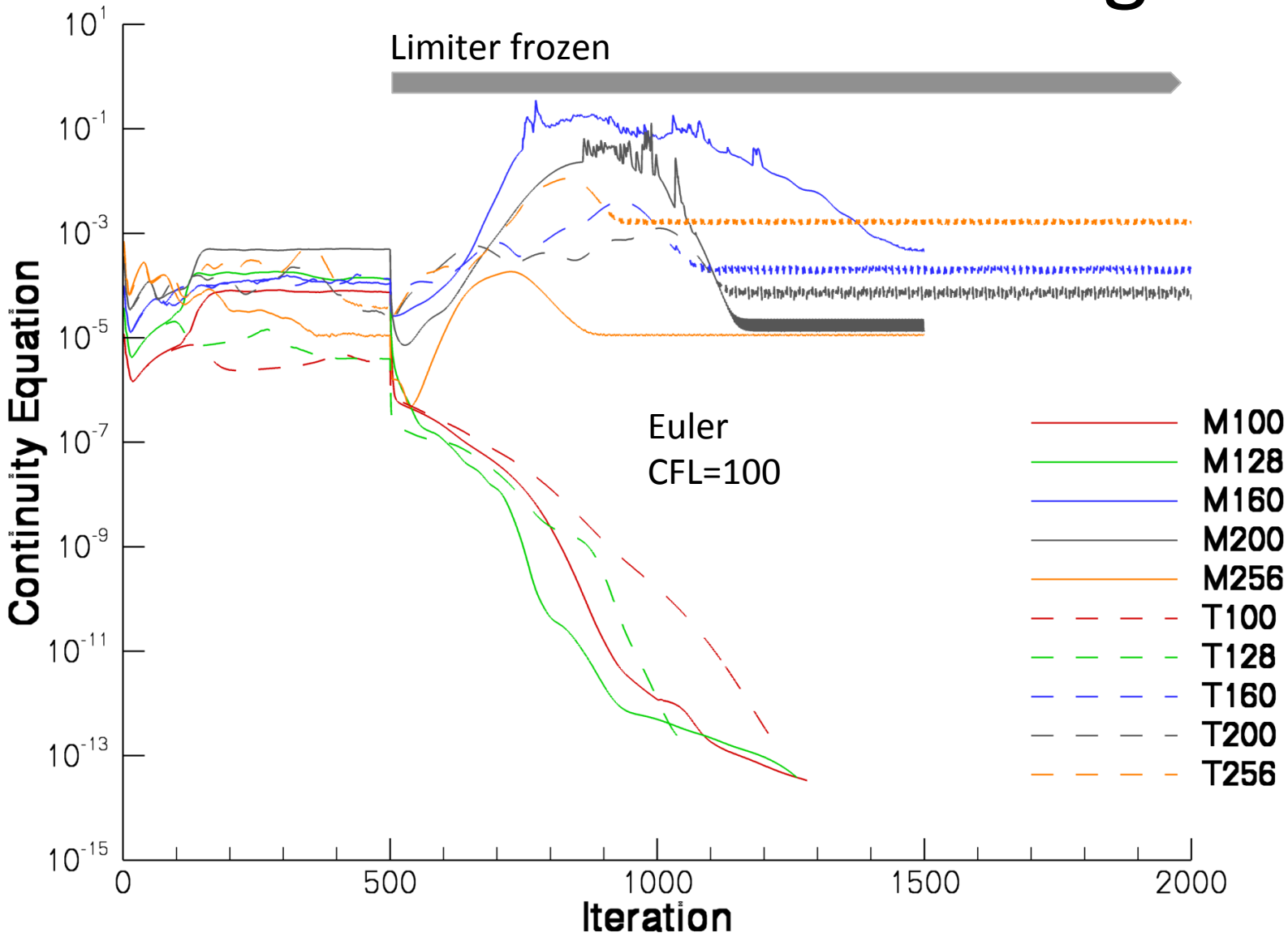
AXIE Pressure Disturbance



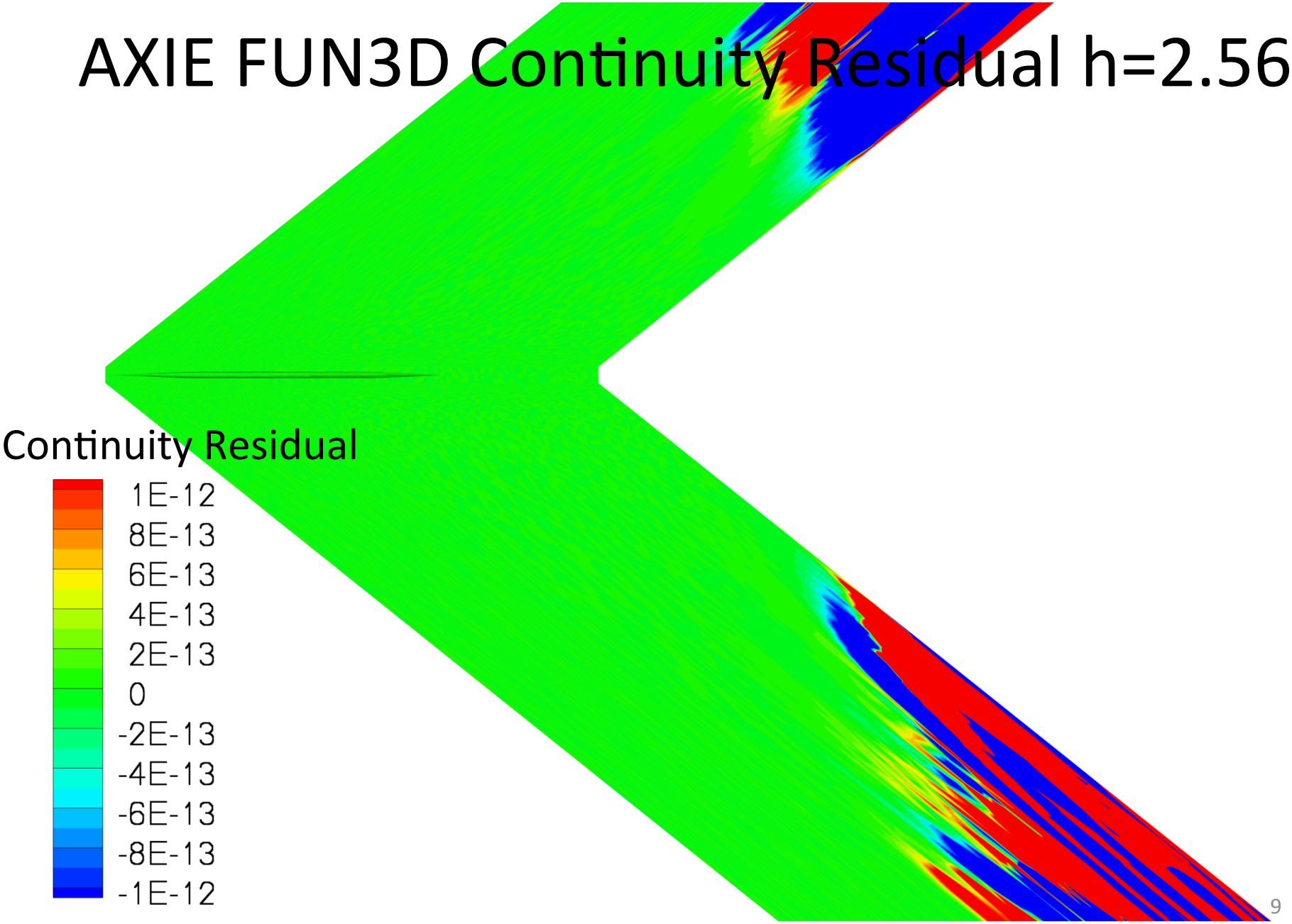
AXIE Pressure Disturbance



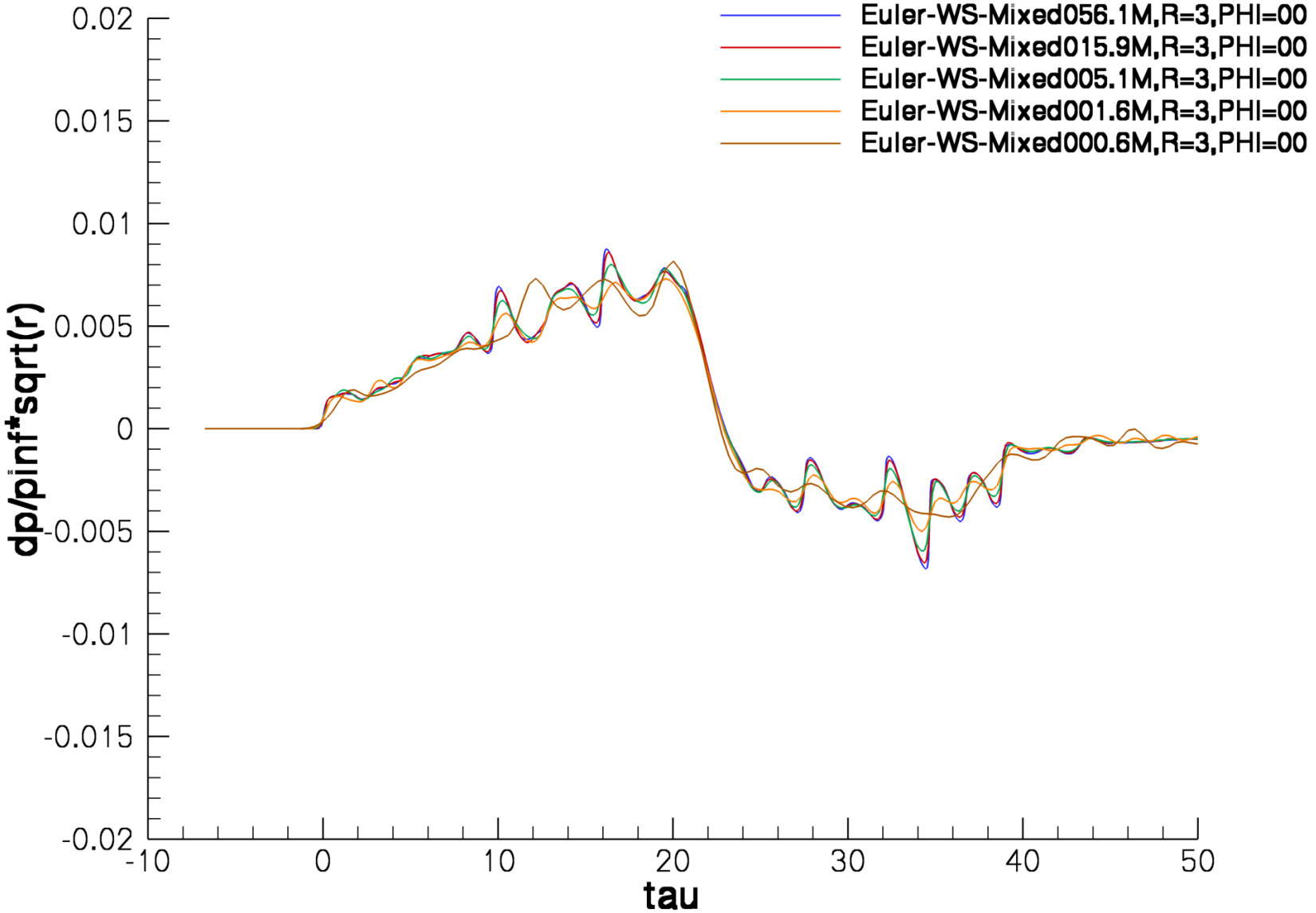
AXIE FUN3D Iterative Convergence



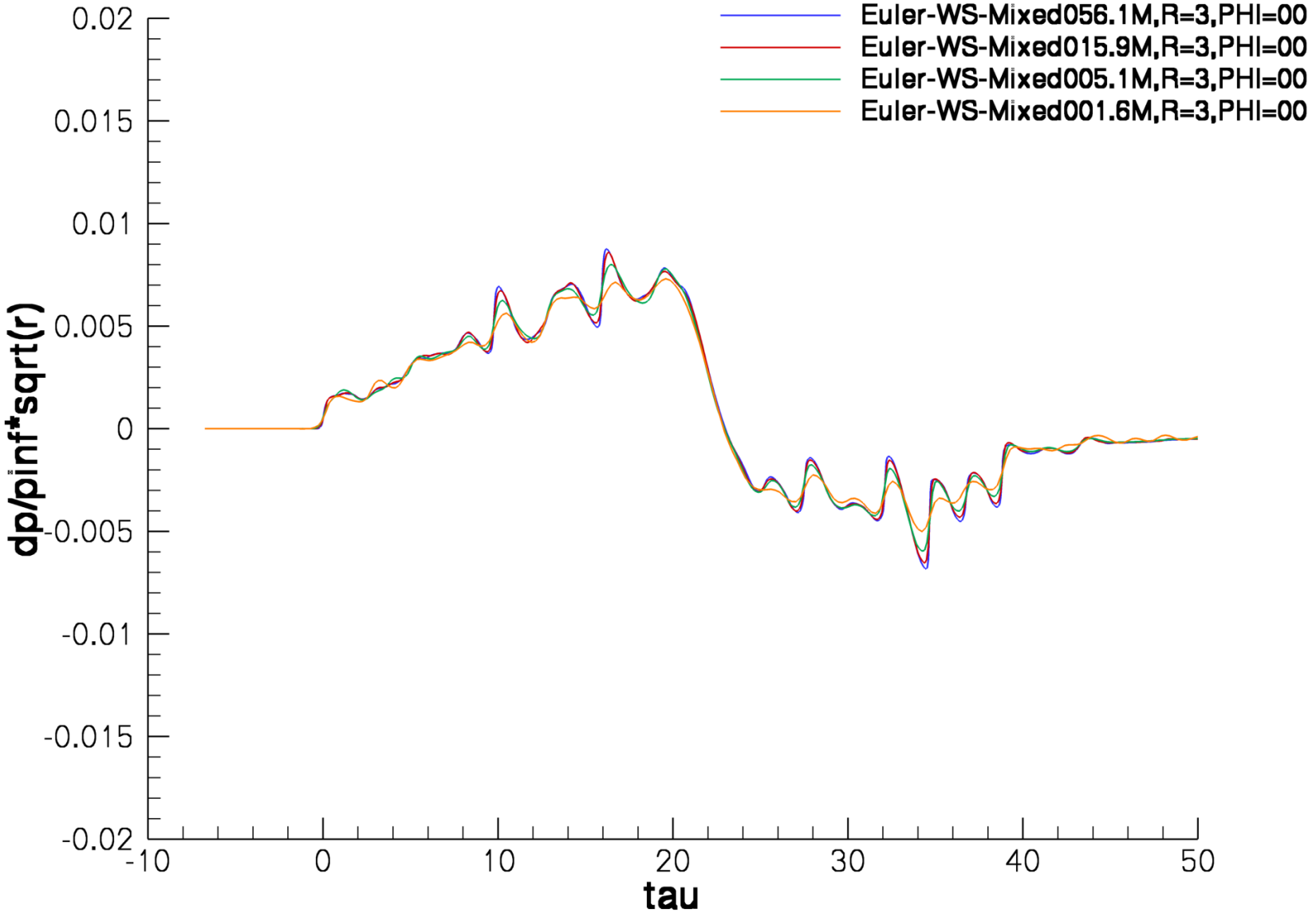
AXIE FUN3D Continuity Residual h=2.56



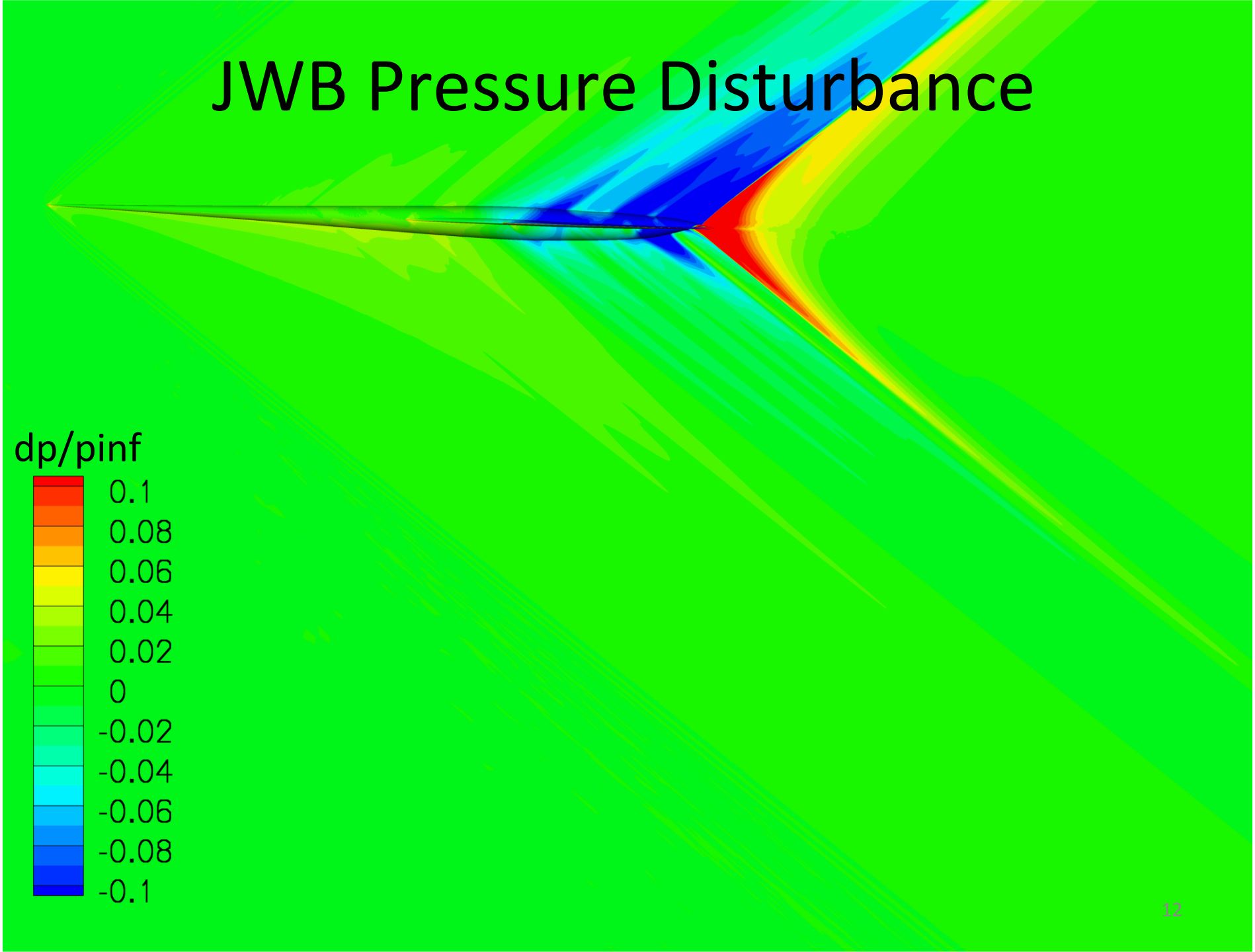
AXIE FUN3D Mixed-Element Euler



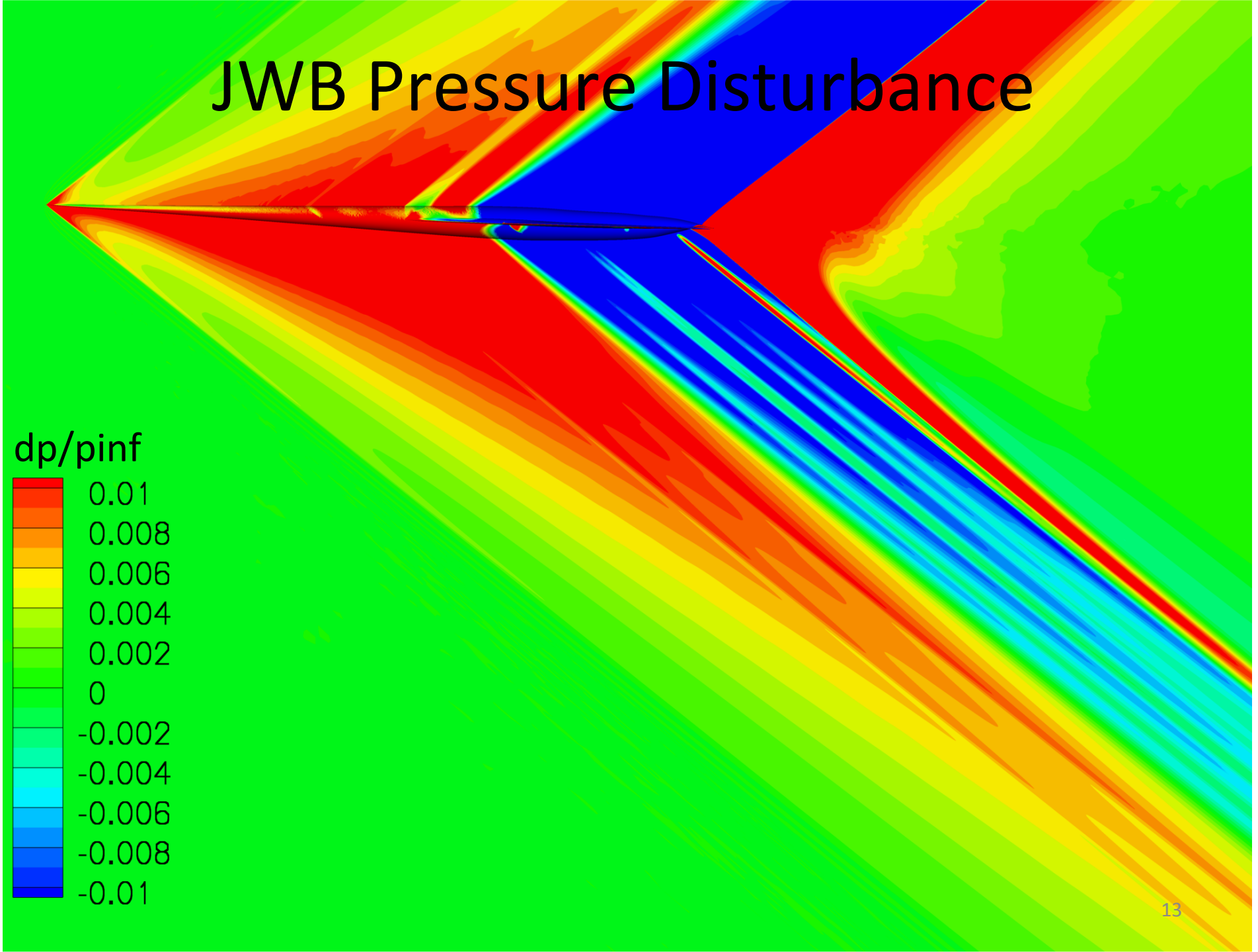
AXIE FUN3D Mixed-Element Euler



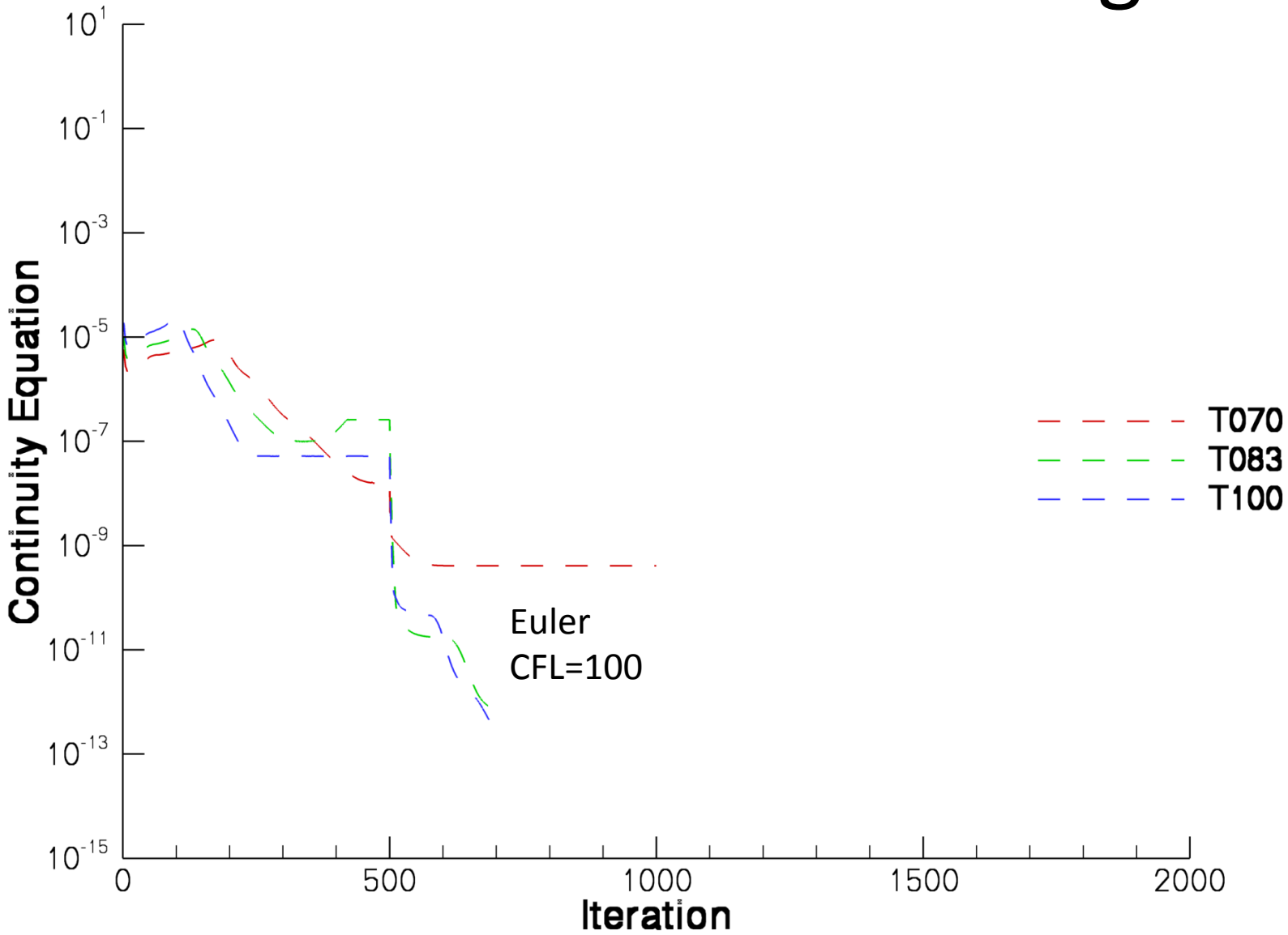
JWB Pressure Disturbance



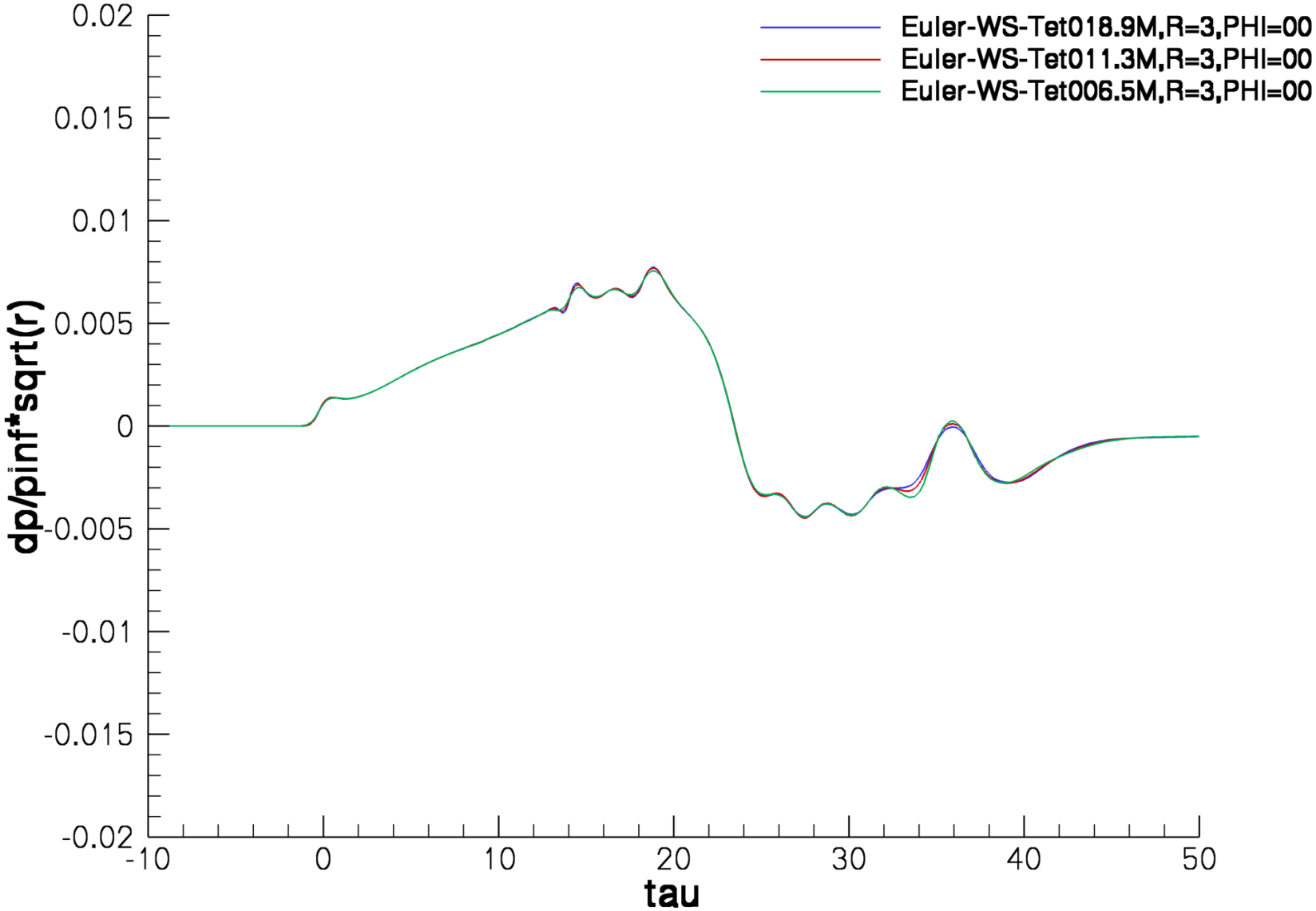
JWB Pressure Disturbance



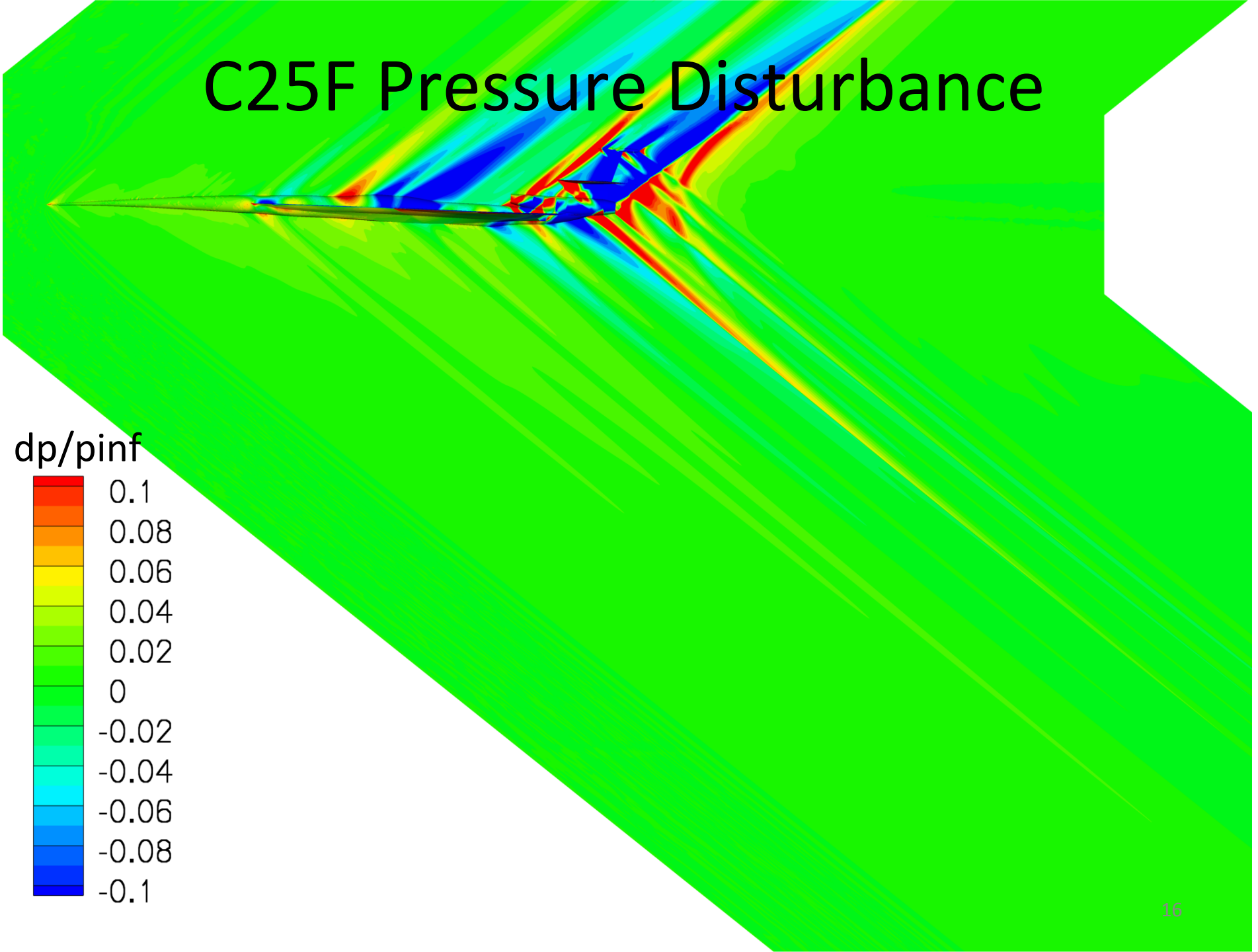
JWB FUN3D Iterative Convergence



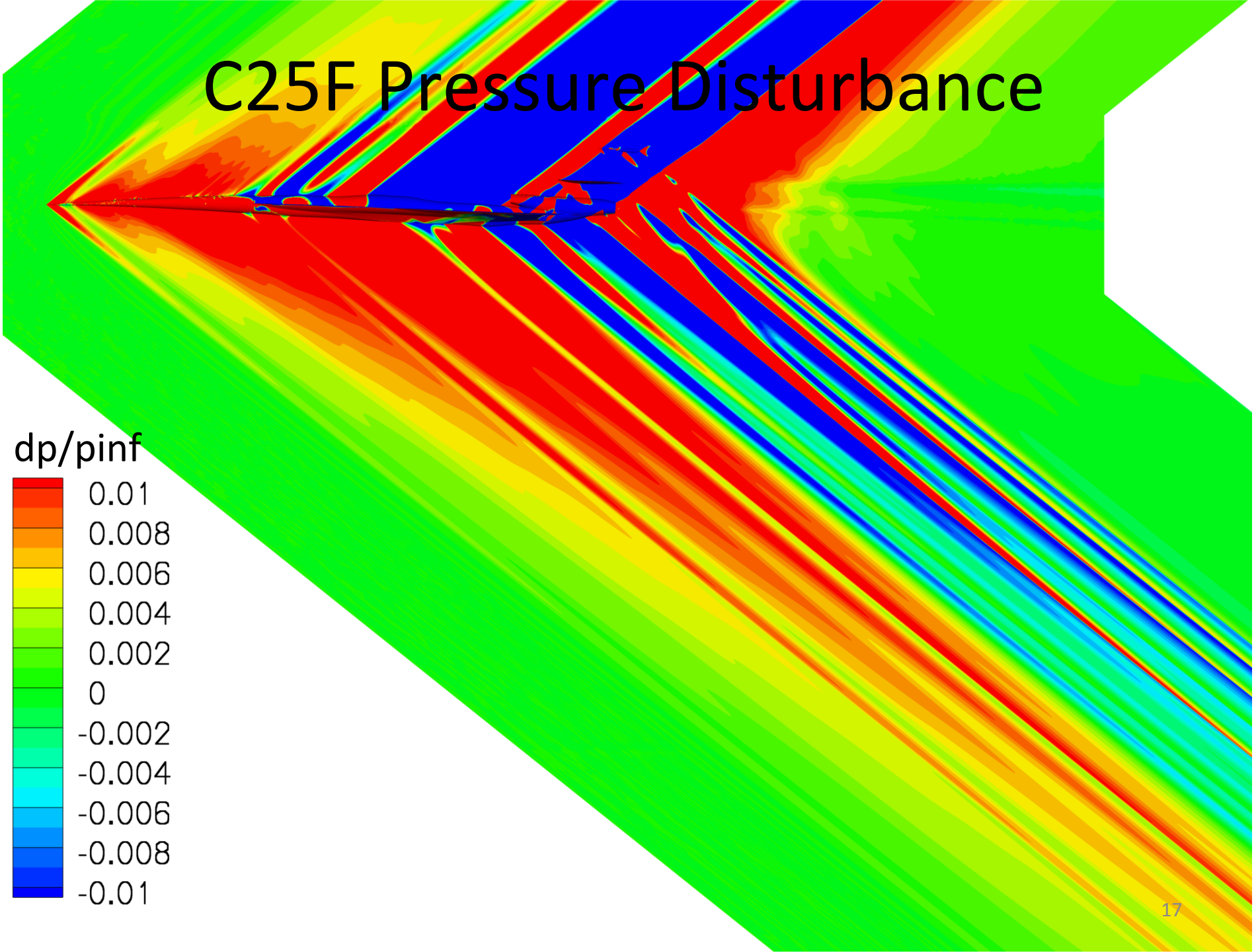
JWB FUN3D Tetrahedral Euler



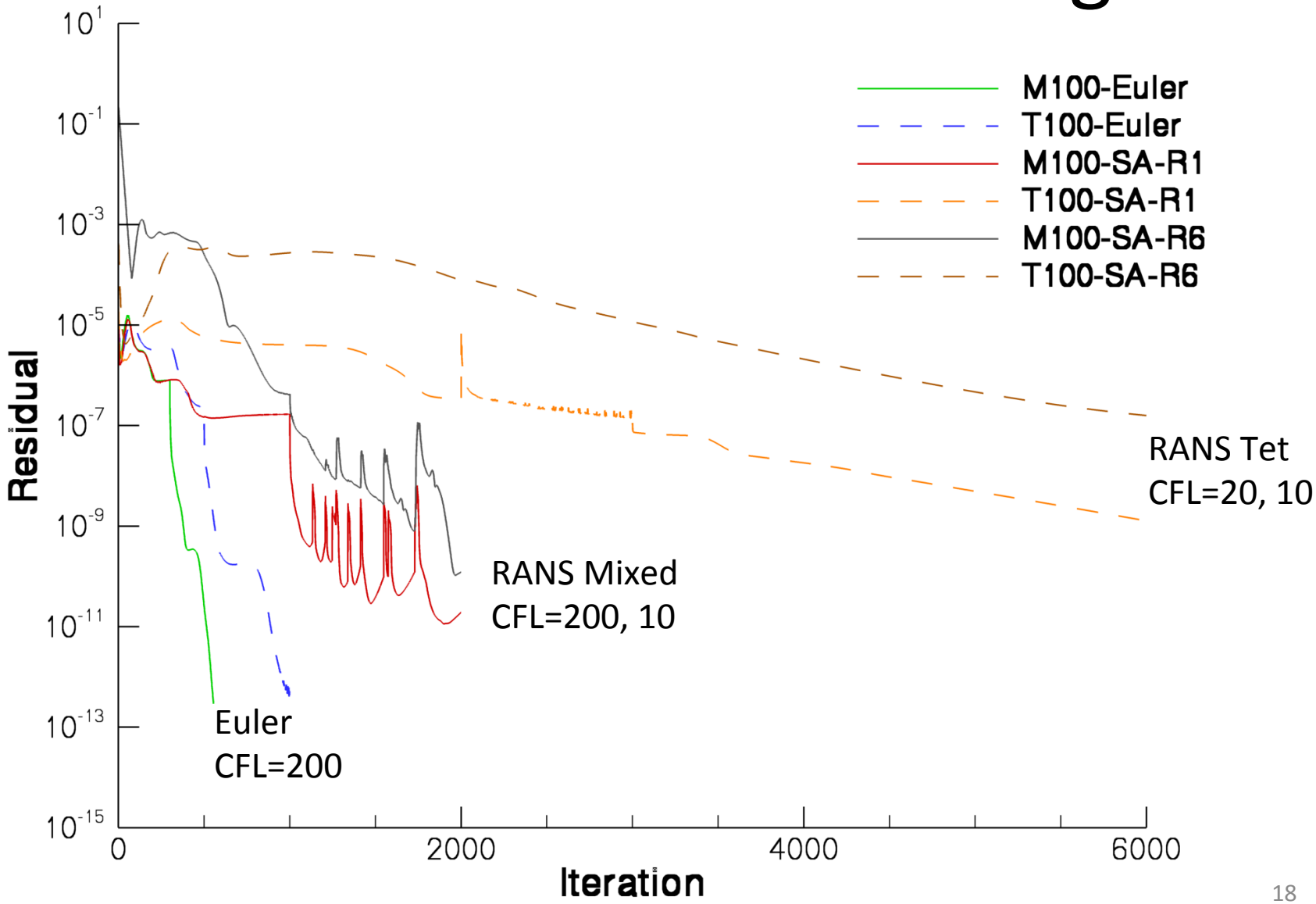
C25F Pressure Disturbance



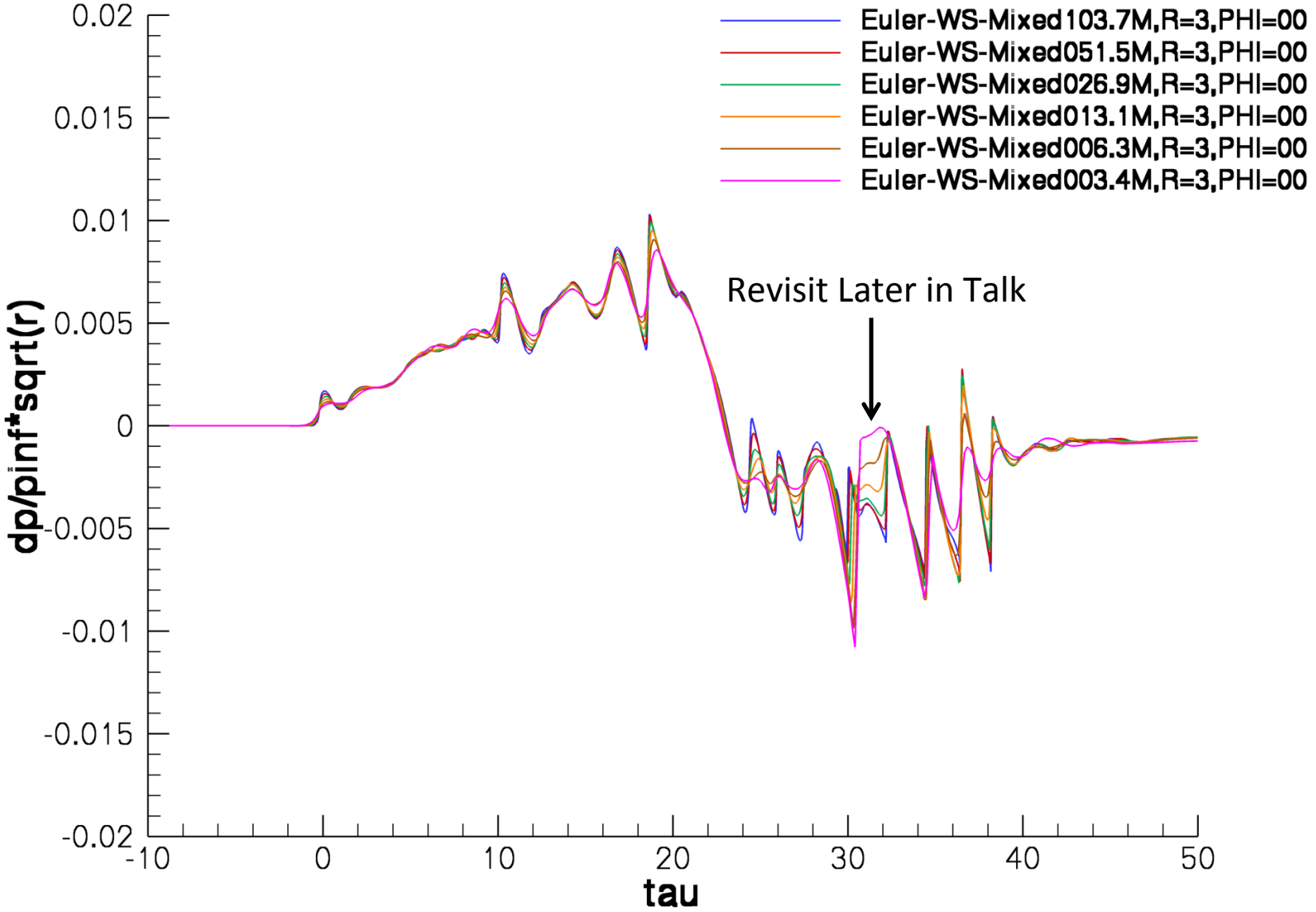
C25F Pressure Disturbance



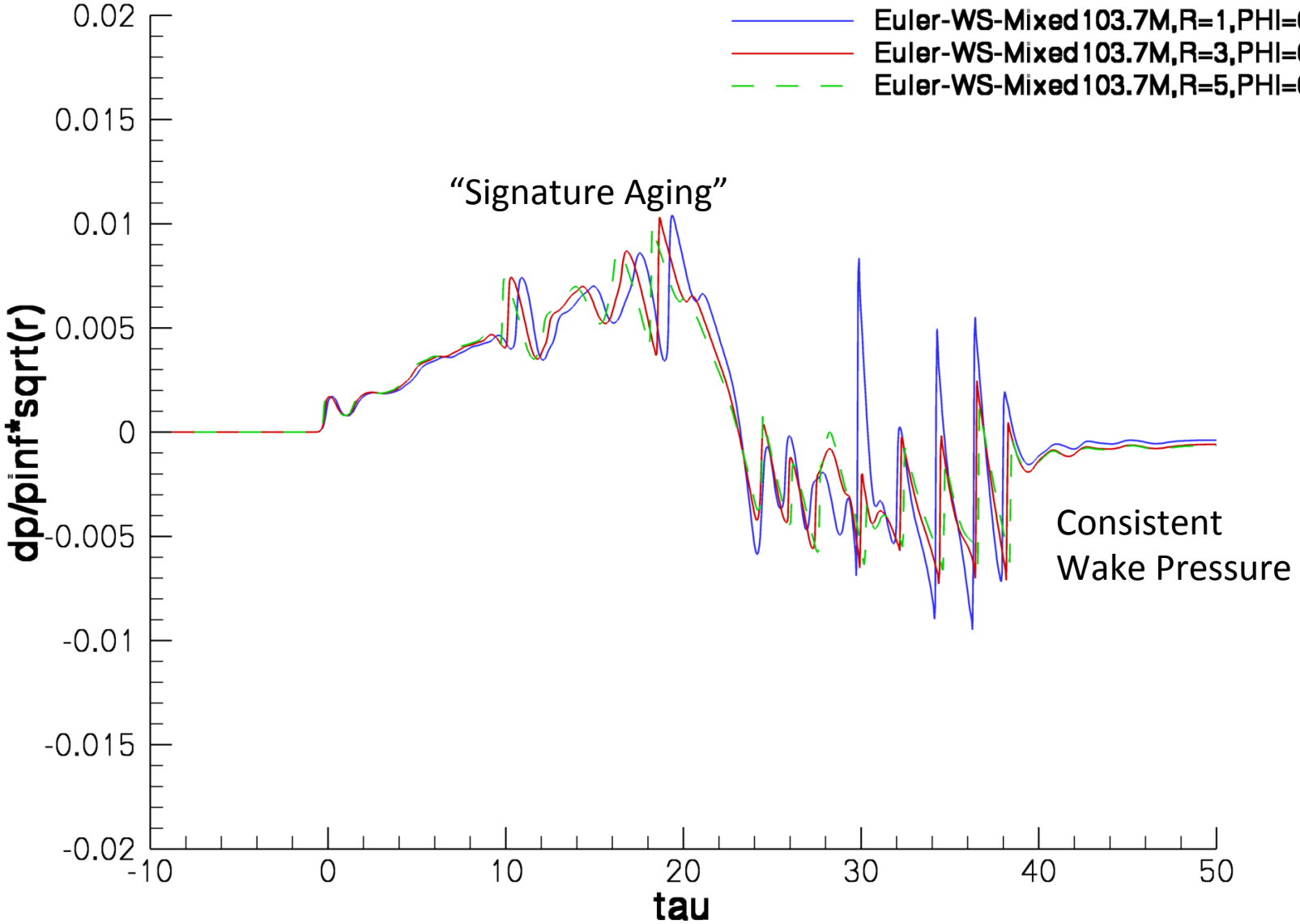
C25F FUN3D Iterative Convergence



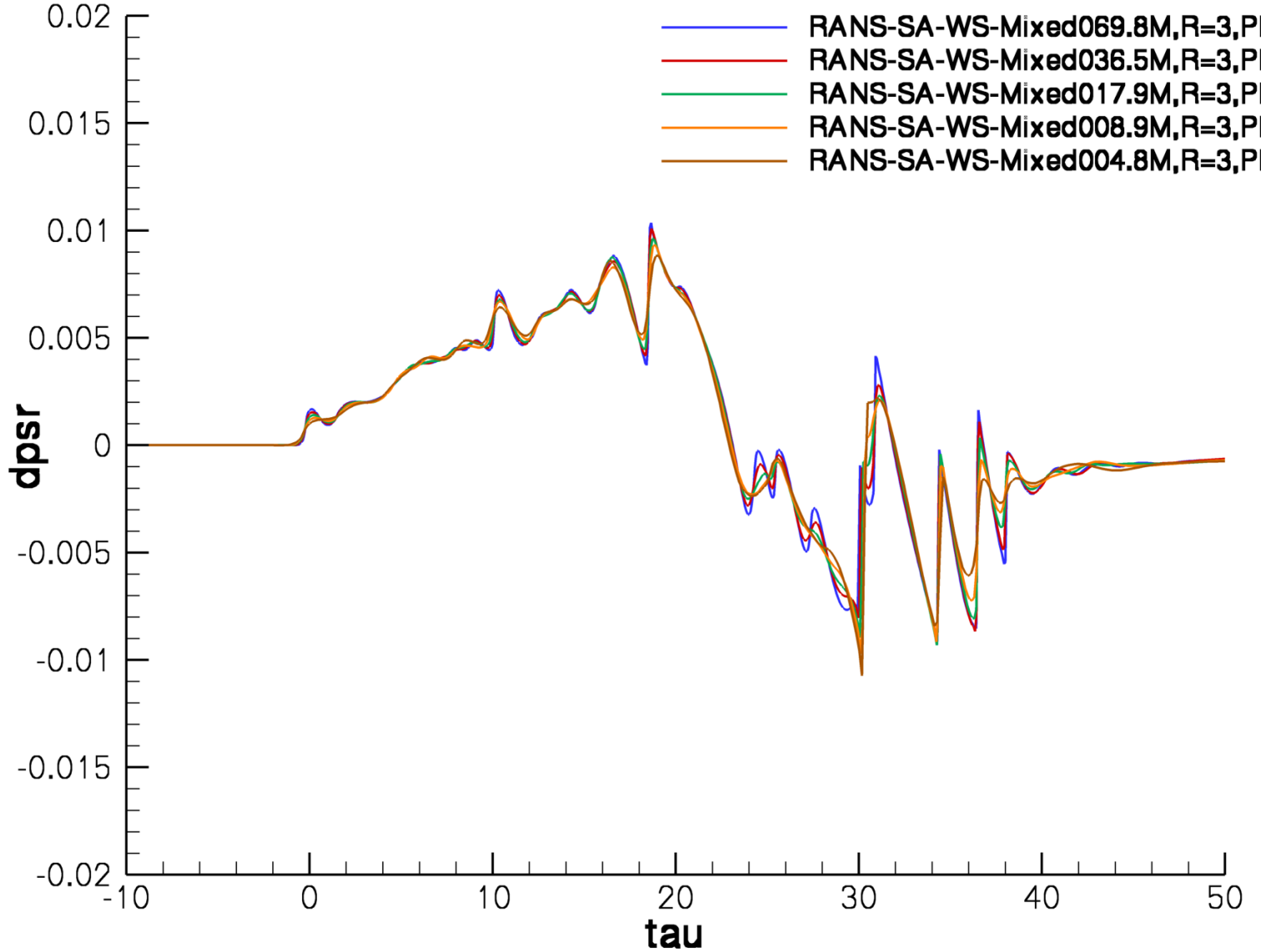
C25F FUN3D Mixed-Element Euler



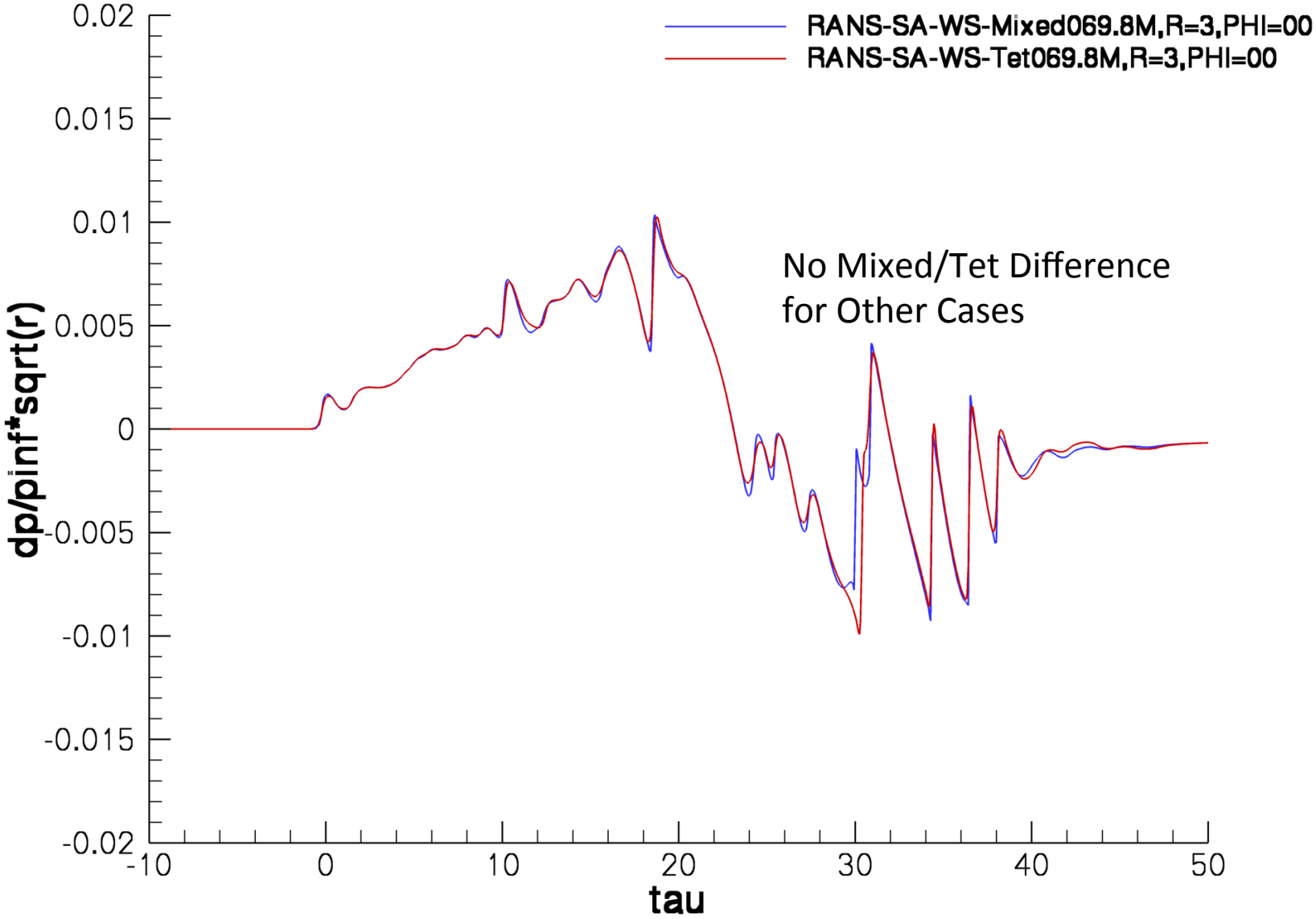
C25F FUN3D Mixed-Element Euler



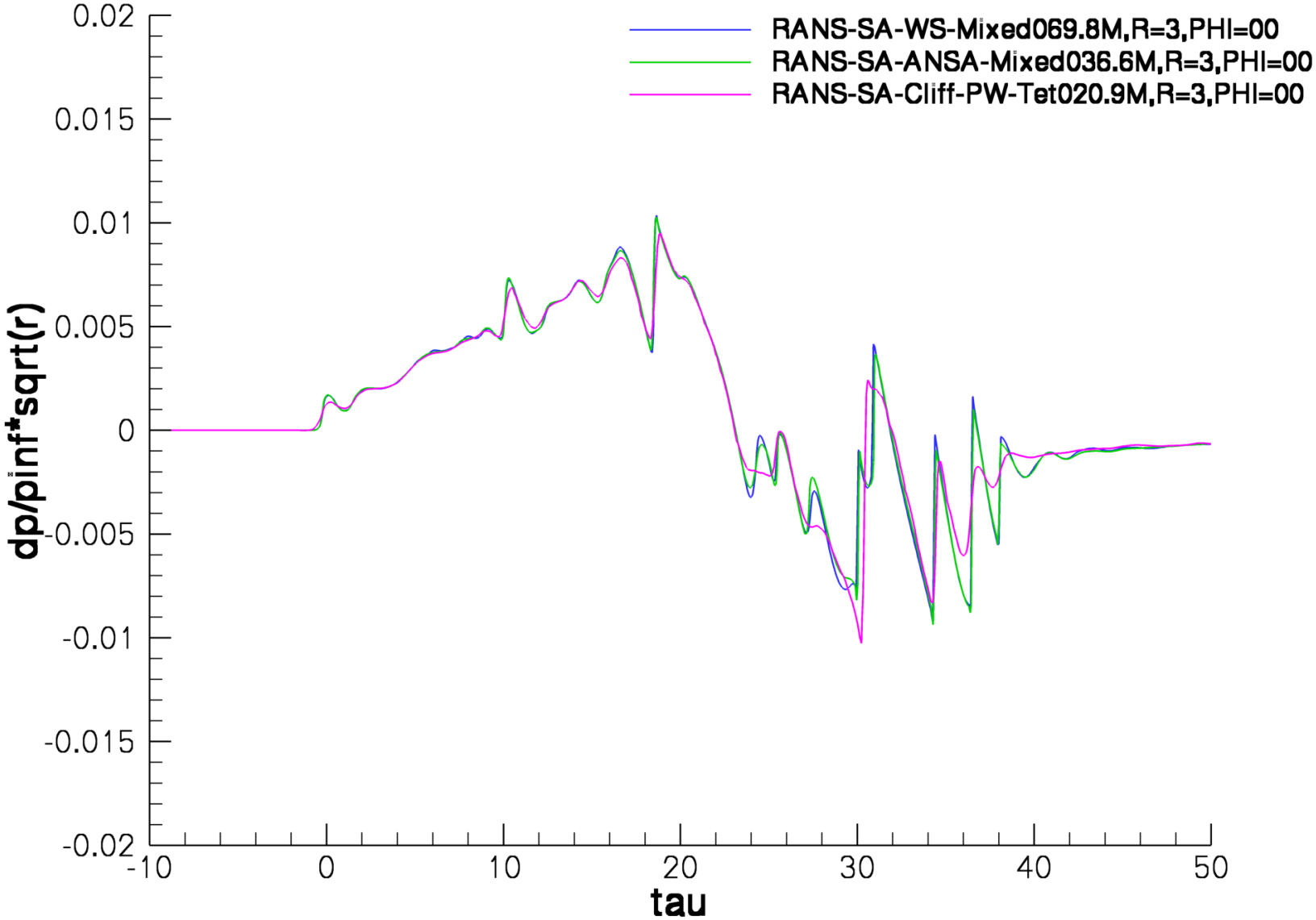
C25F FUN3D Mixed-Element RANS-SA



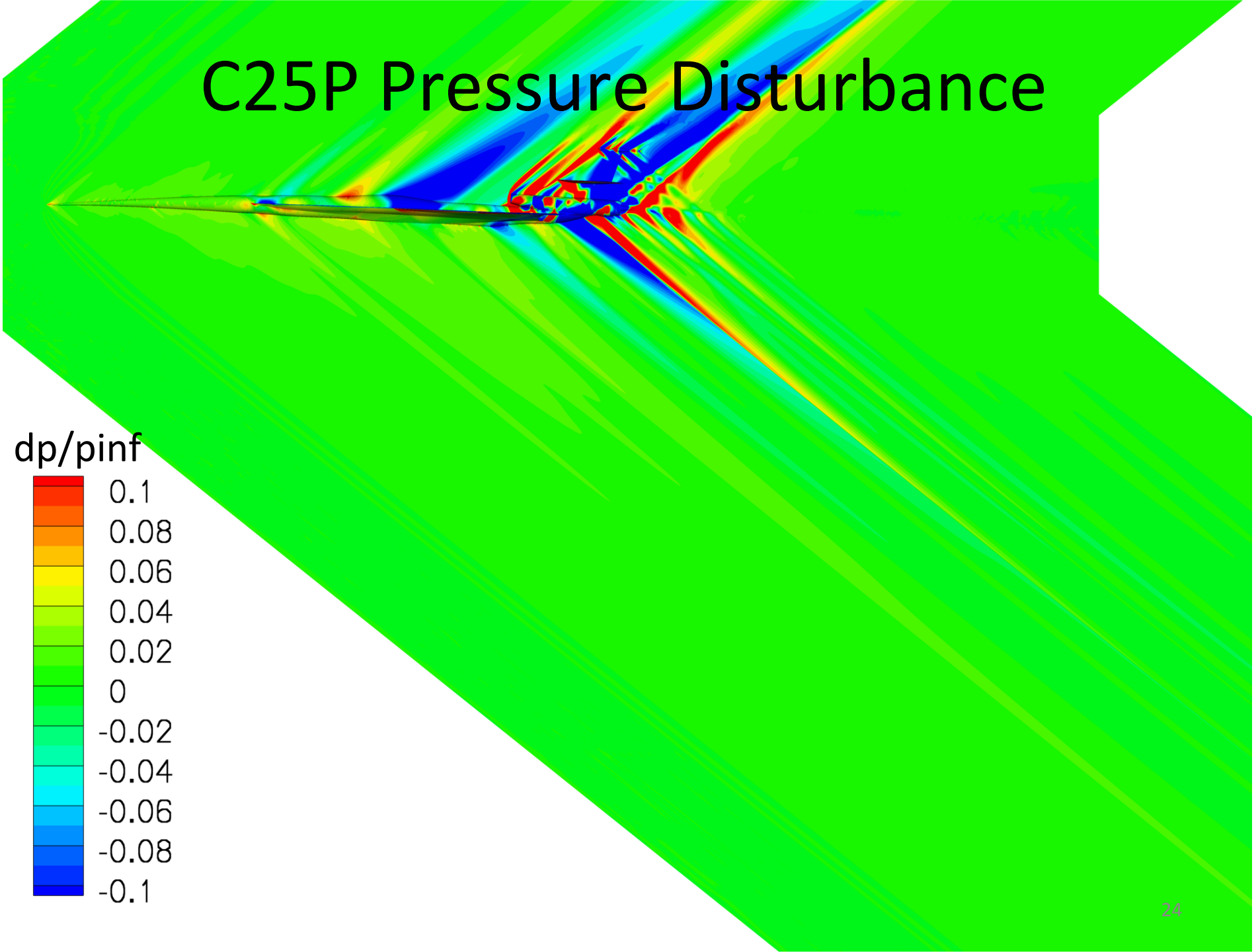
C25F FUN3D RANS-SA Grid Sensitivity



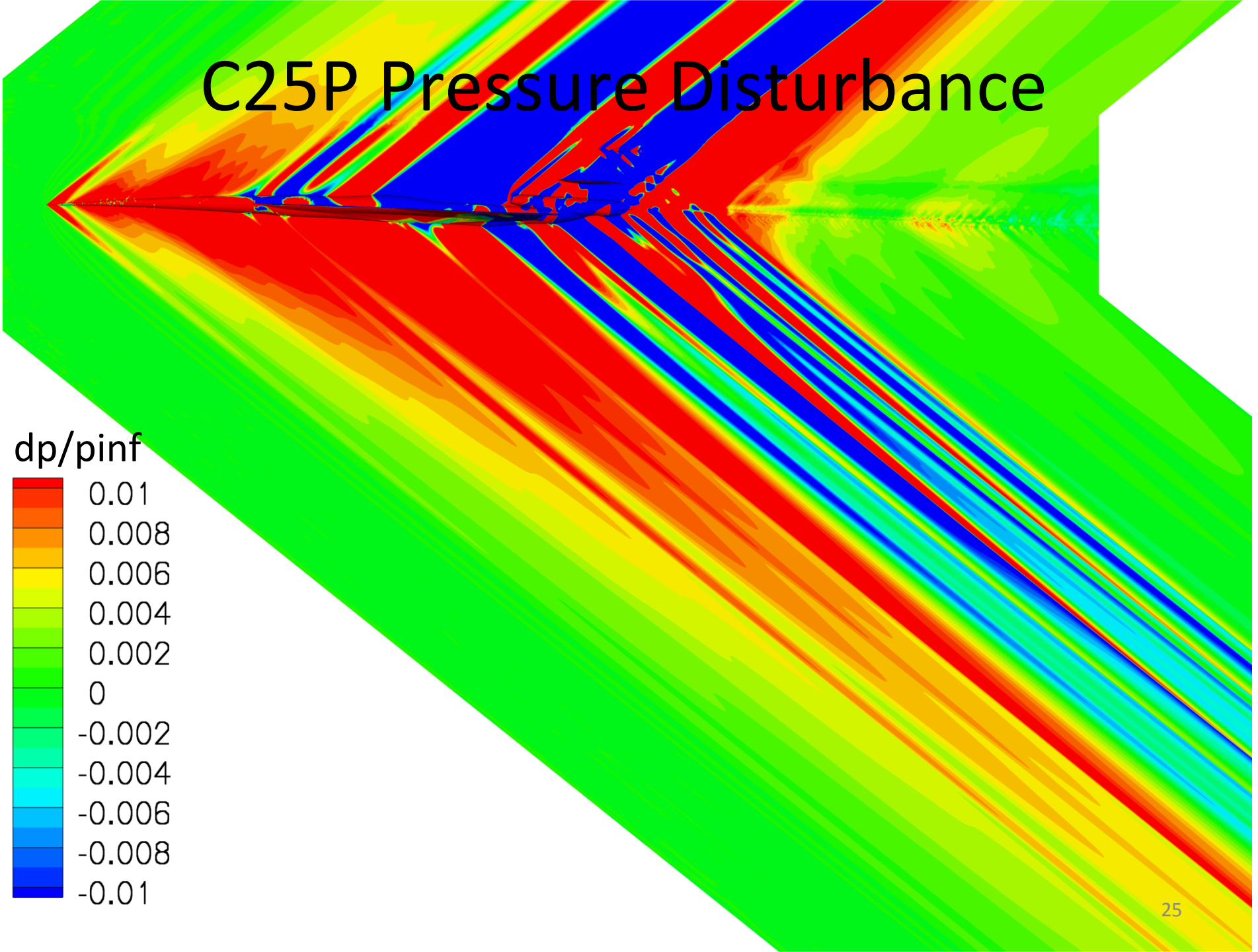
C25F FUN3D RANS-SA Grid Sensitivity



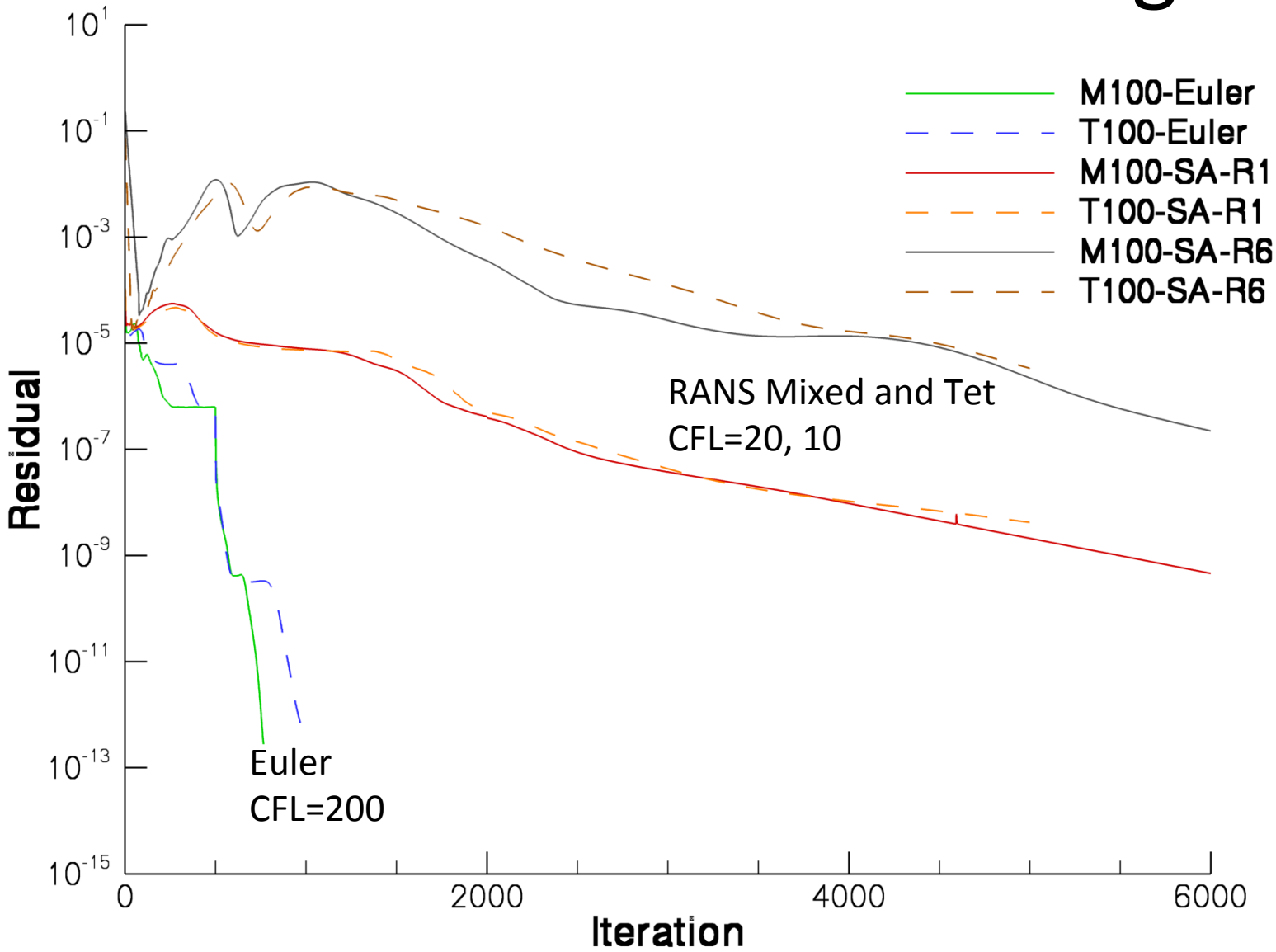
C25P Pressure Disturbance



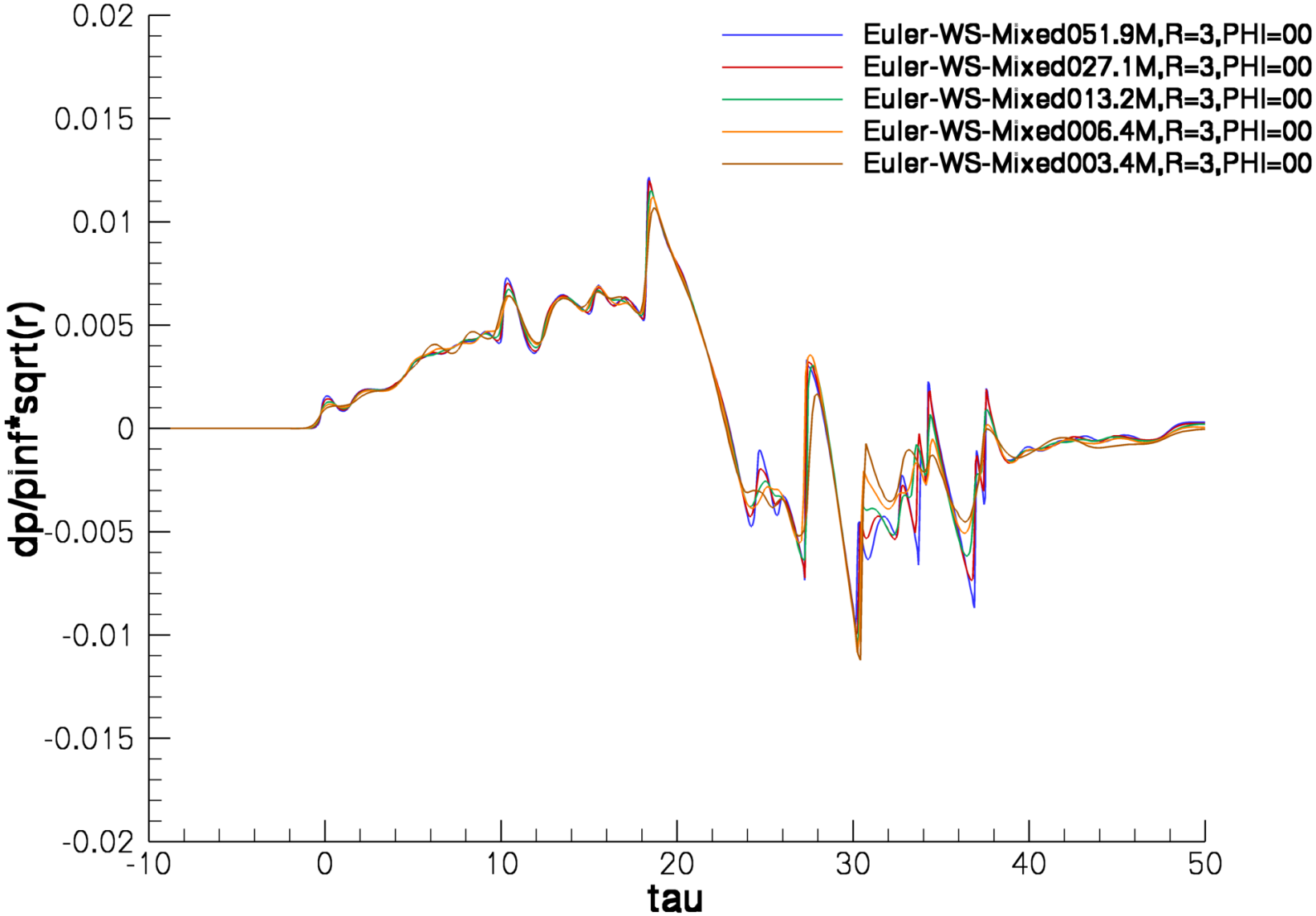
C25P Pressure Disturbance



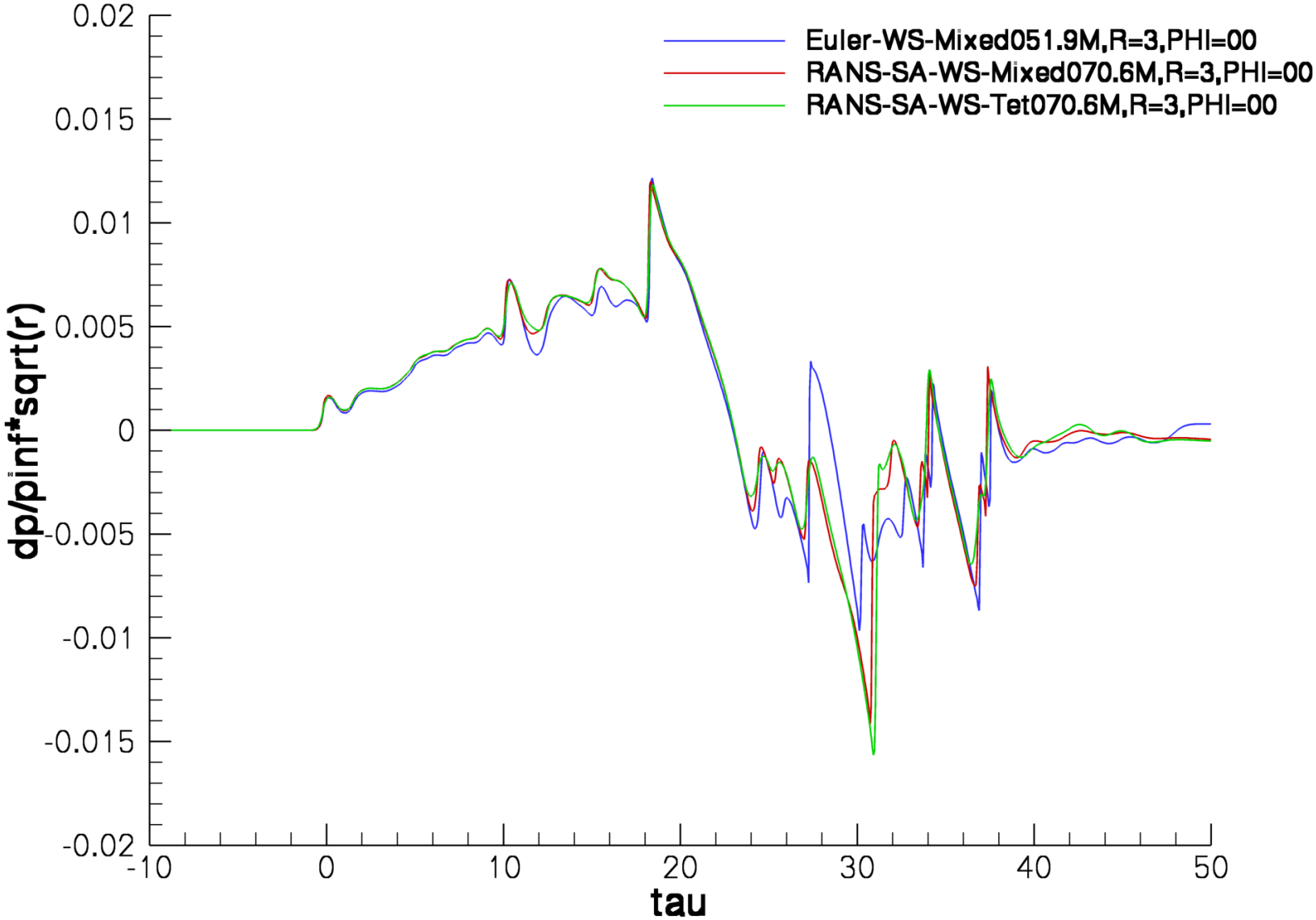
C25P FUN3D Iterative Convergence



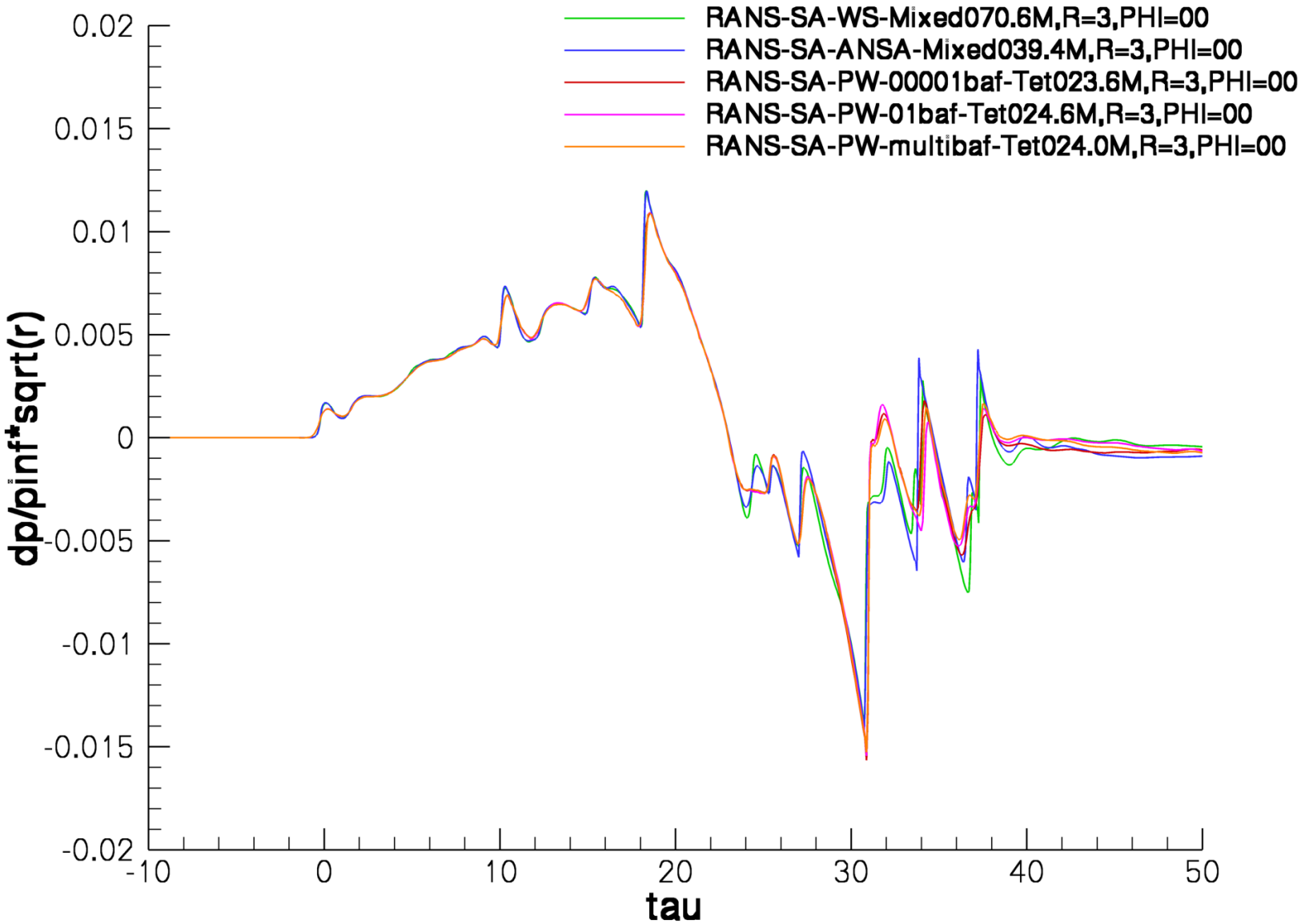
C25P FUN3D Mixed-Element Euler



C25P FUN3D Euler and RANS-SA



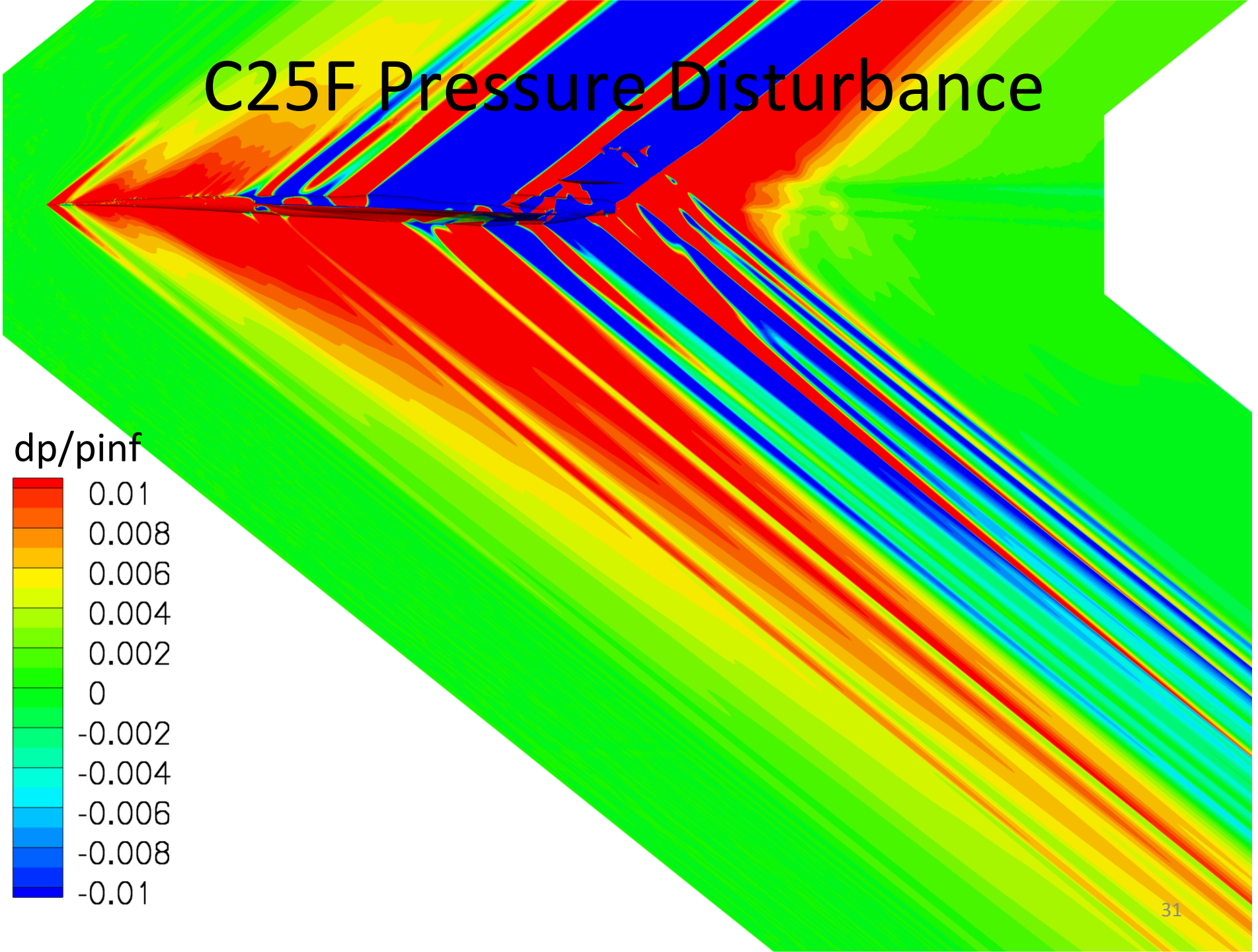
C25P FUN3D RANS-SA Grid Sensitivity



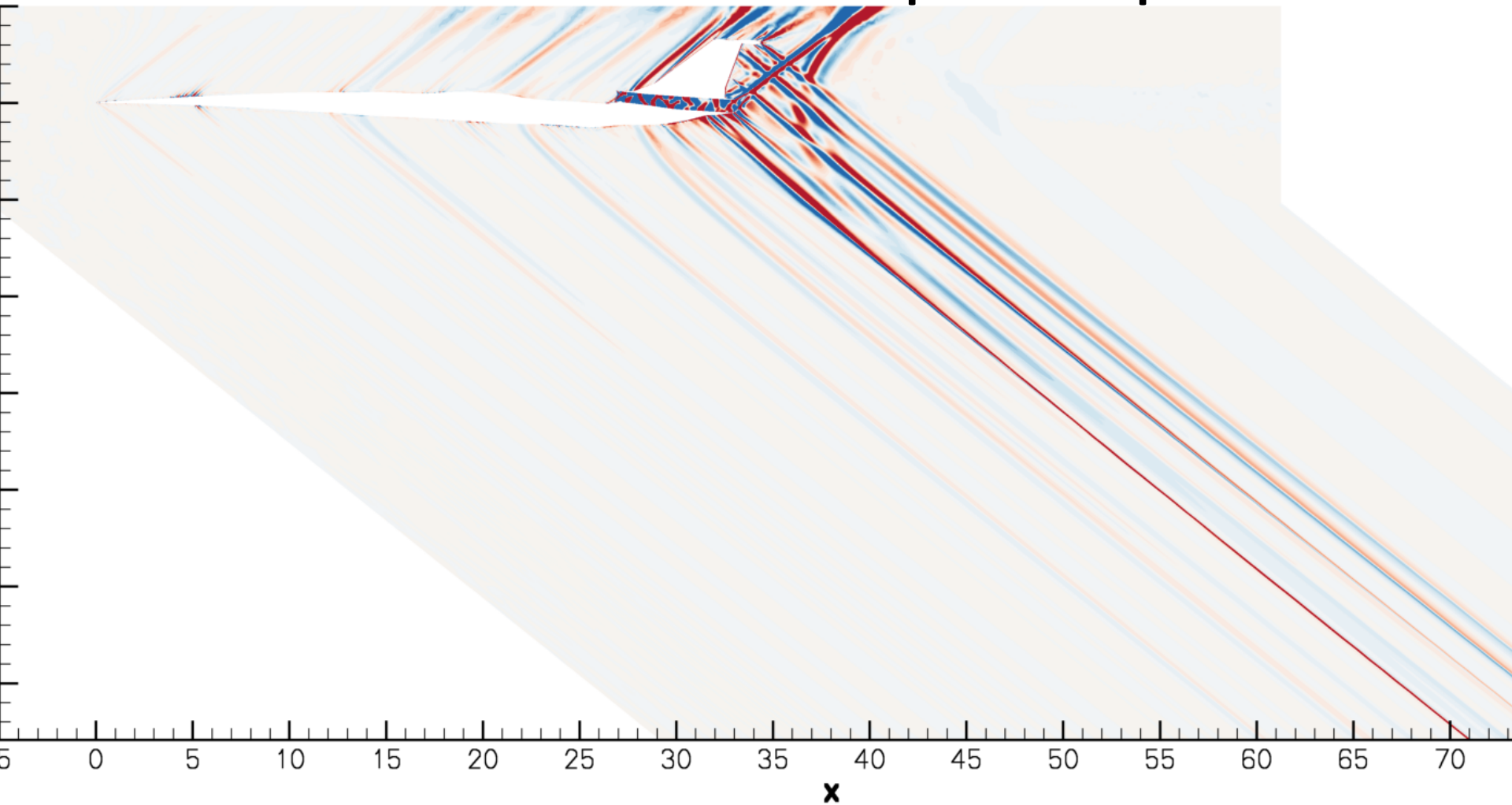
FUN3D Error Transport Equation

- Truncation error estimate from the Venditti adjoint adaptation scheme
- Propagated as a source term to complex-valued FUN3D, sBOOM, and ASEL measure
- Impact of estimated discretization error on entire solution and output functionals
- FD-03, CFD Applications, Monday, 10-10:30 AM, Texas 3, "Application of Exactly Linearized Error Transport Equations to AIAA CFD Prediction Workshop" by Derlaga, Park, and Rallabhandi

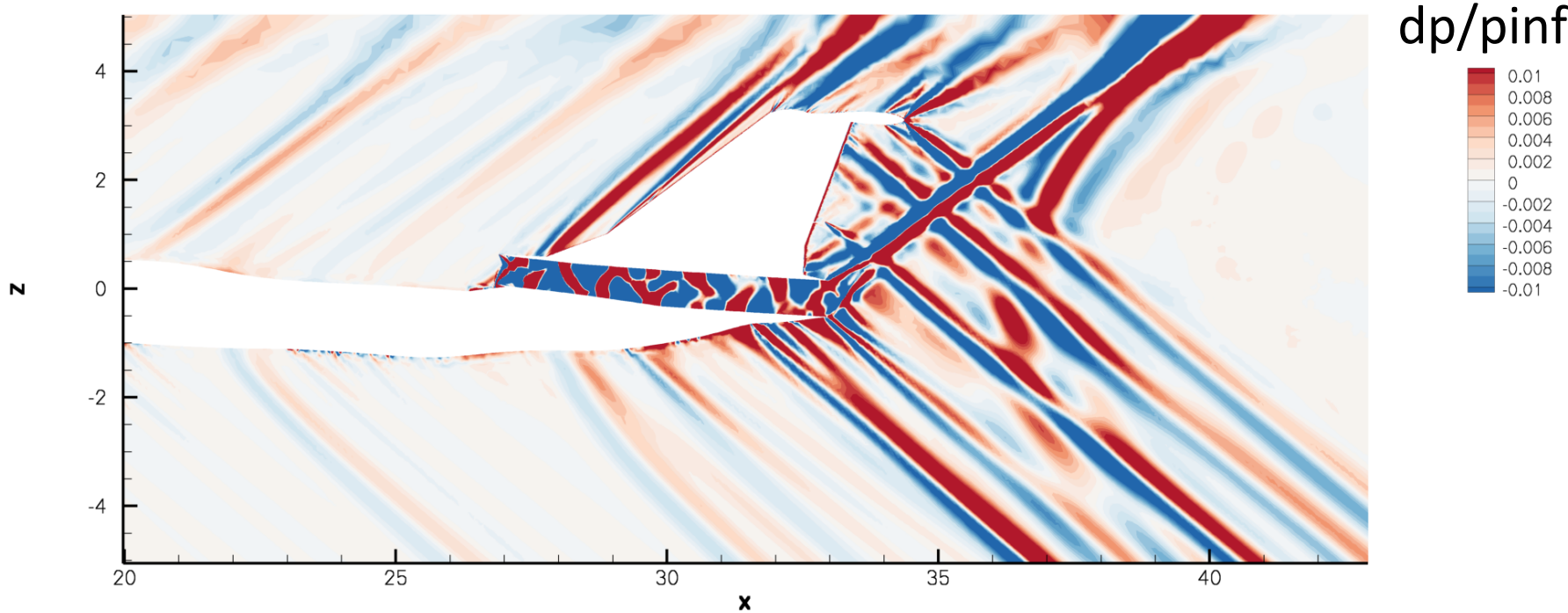
C25F Pressure Disturbance



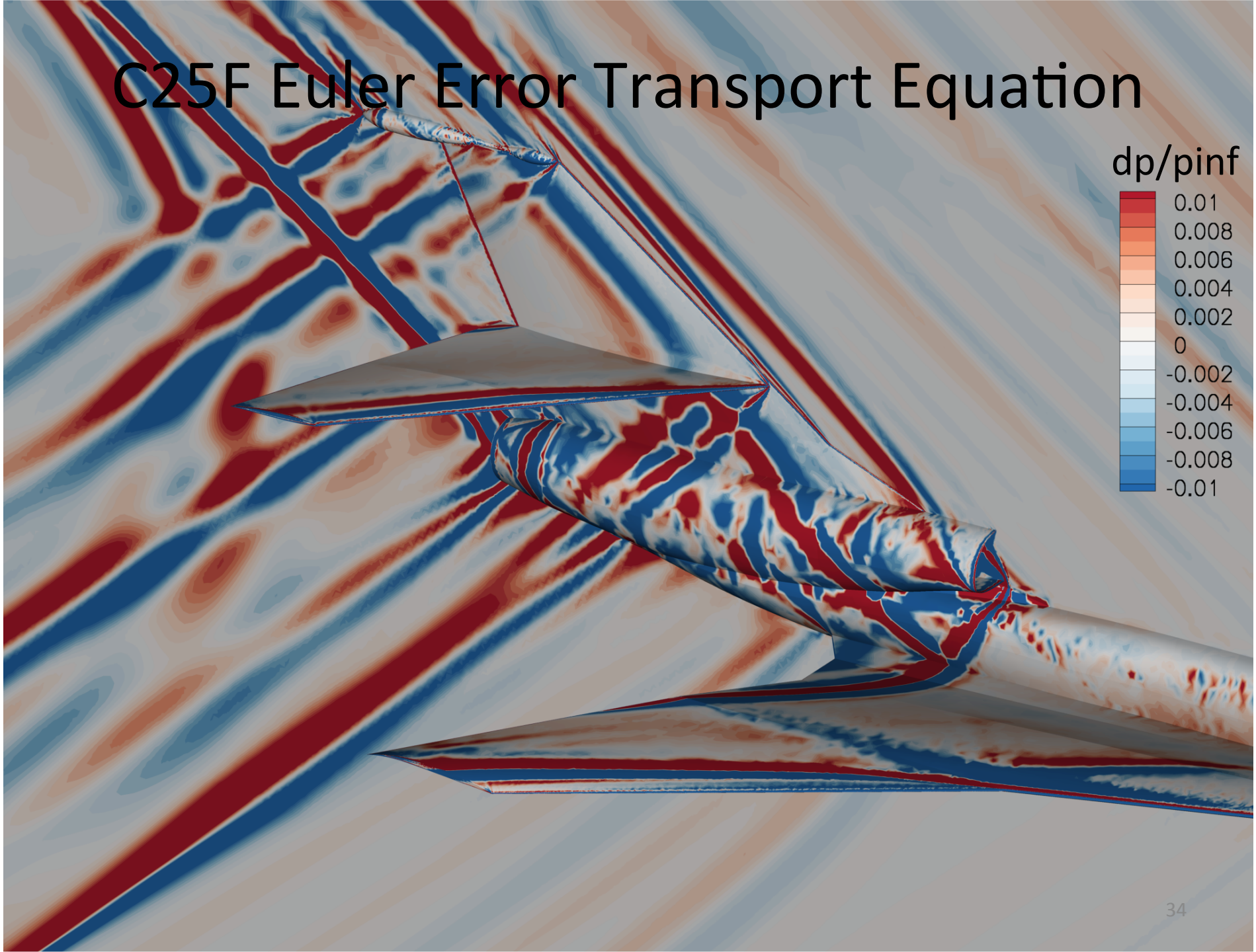
C25F Euler Error Transport Equation



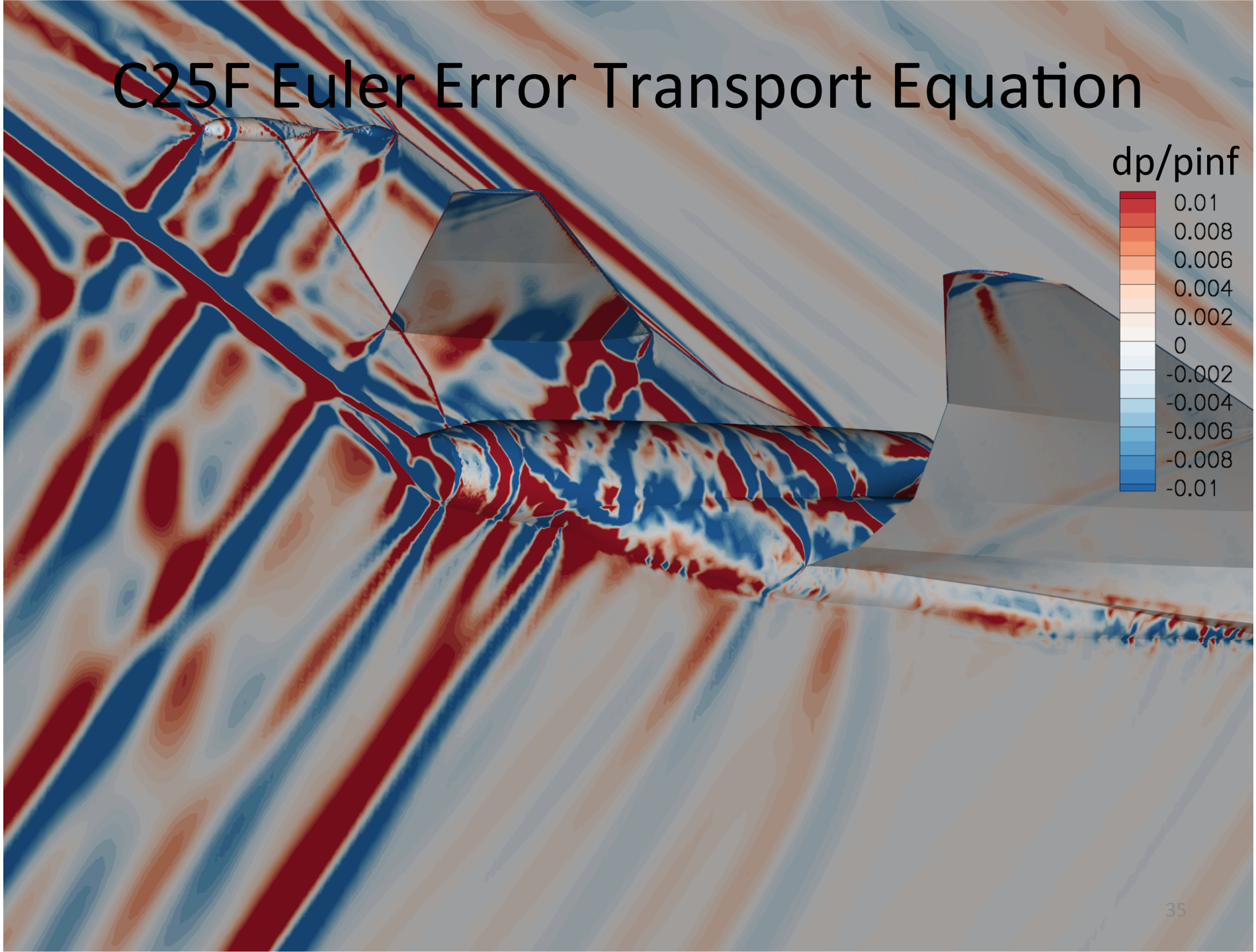
C25F Euler Error Transport Equation



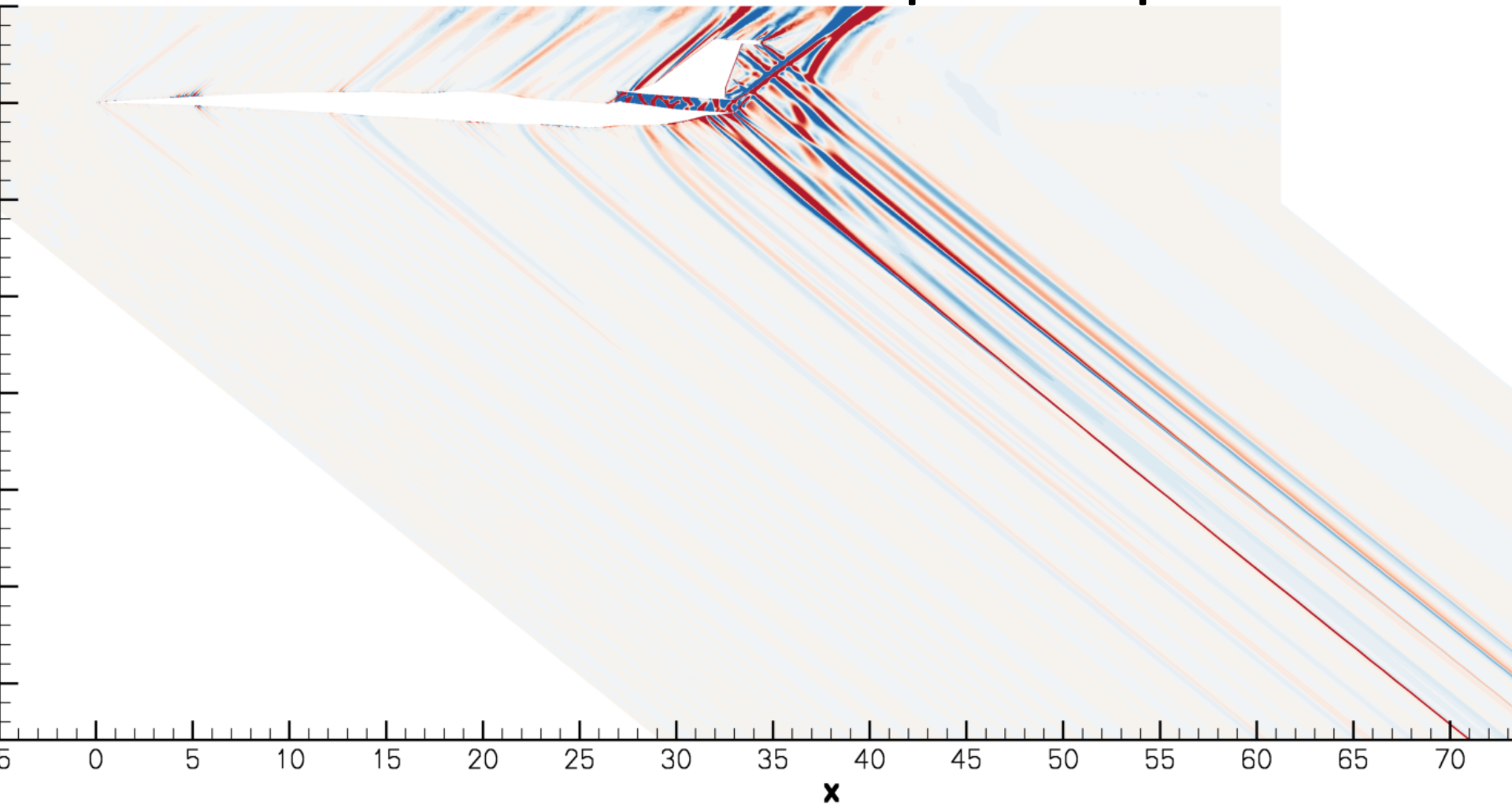
C25F Euler Error Transport Equation



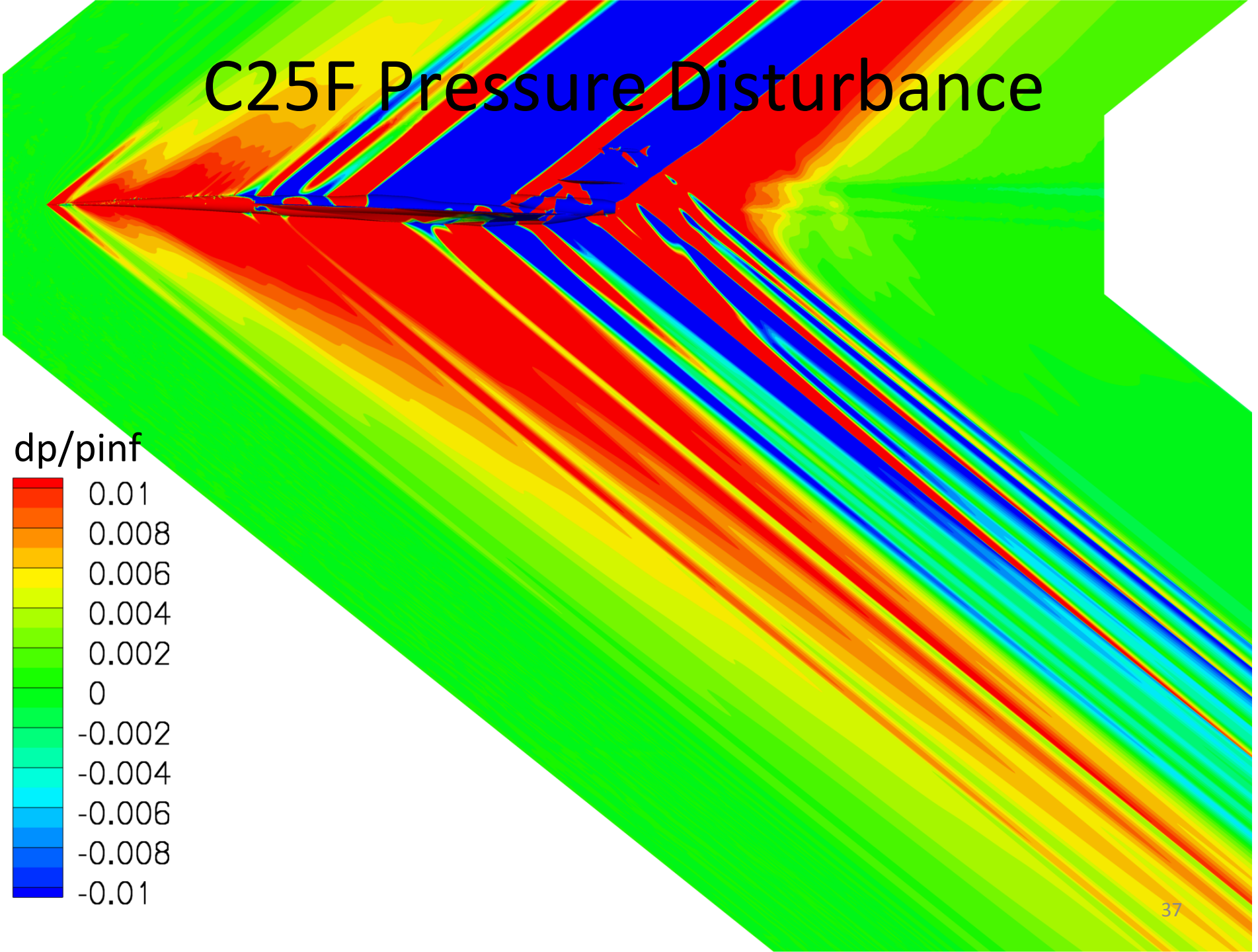
C25F Euler Error Transport Equation

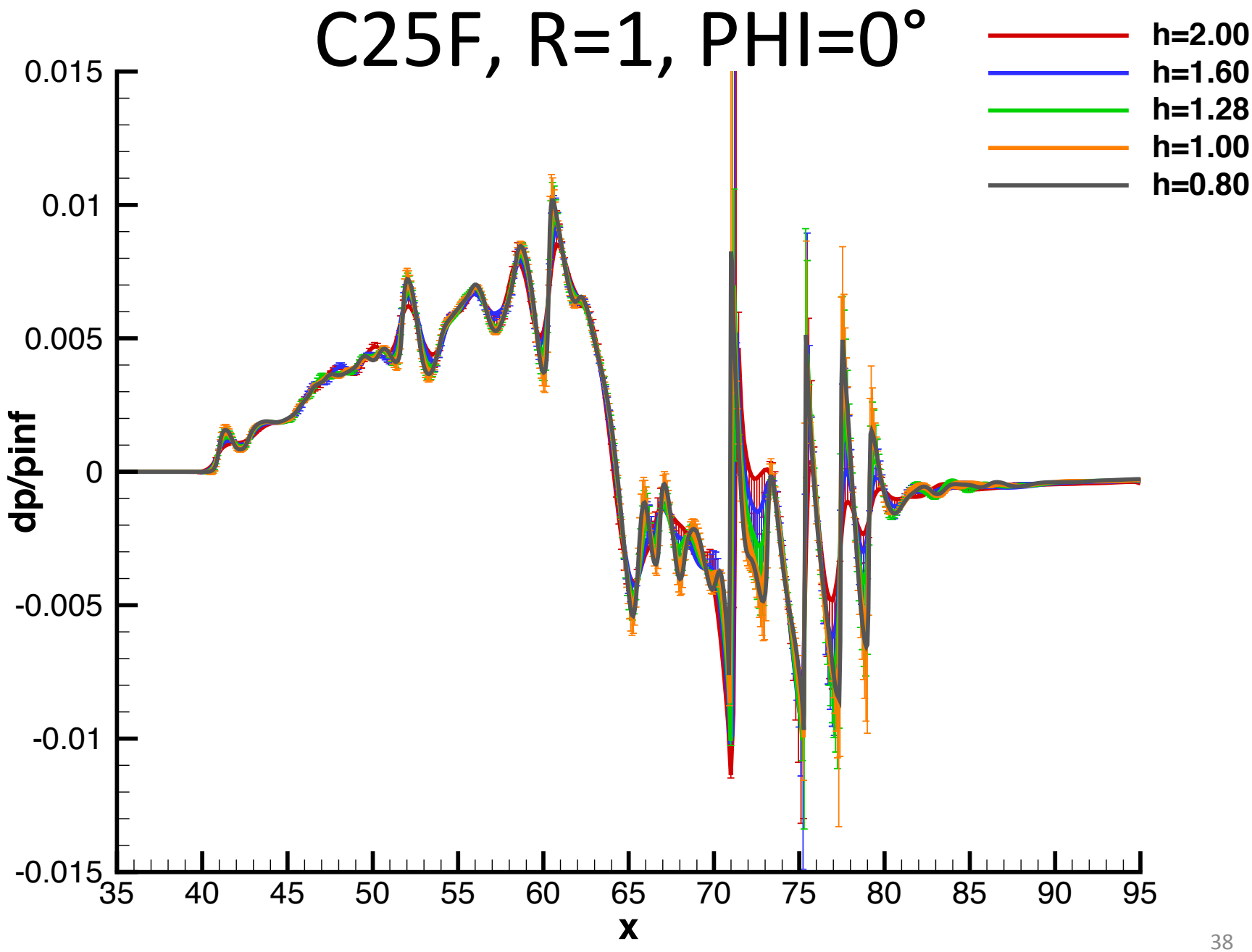


C25F Euler Error Transport Equation



C25F Pressure Disturbance




C25F, R=1, PHI=0°
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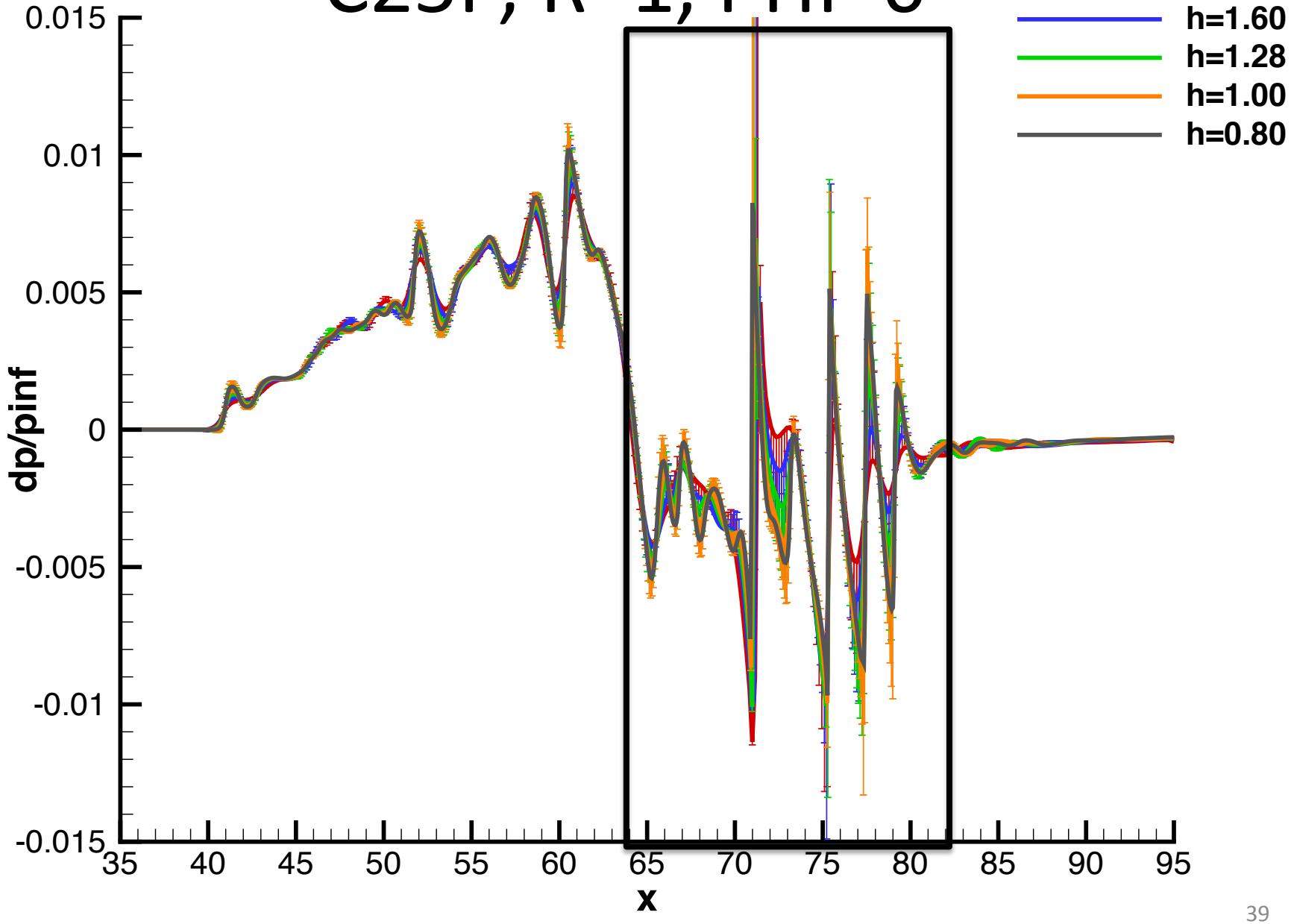
h=1.28
h=1.00
h=0.80
dp/pinf
x
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
35
40
45
50
55
60
65
70
75
80
85
90
95

C25F, R=1, PHI=0°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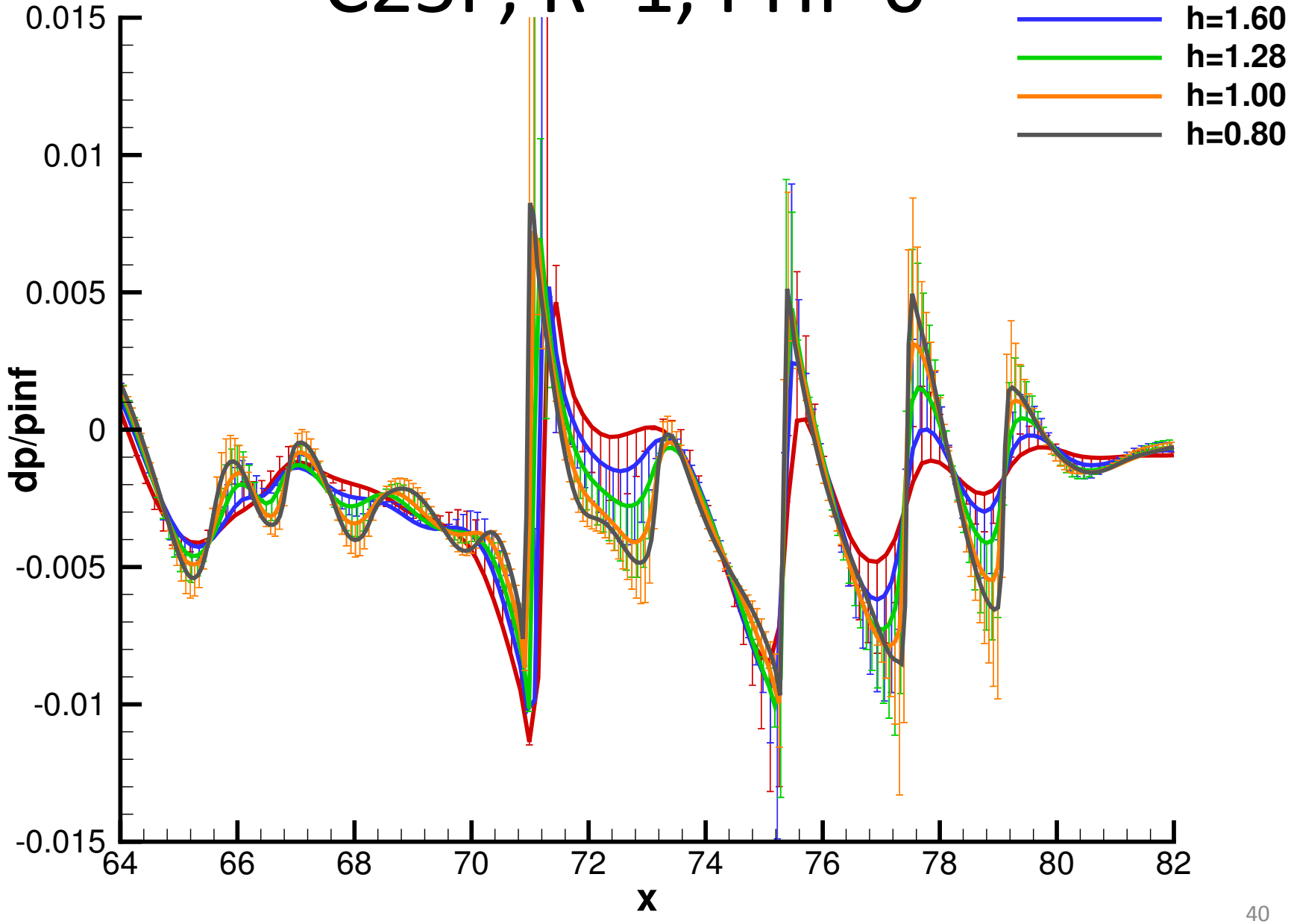
h=1.28
h=1.00
h=0.80
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
dp/pinf
35
40
45
50
55
60
65
70
75
80
85
90
95
x

C25F, R=1, PHI=0°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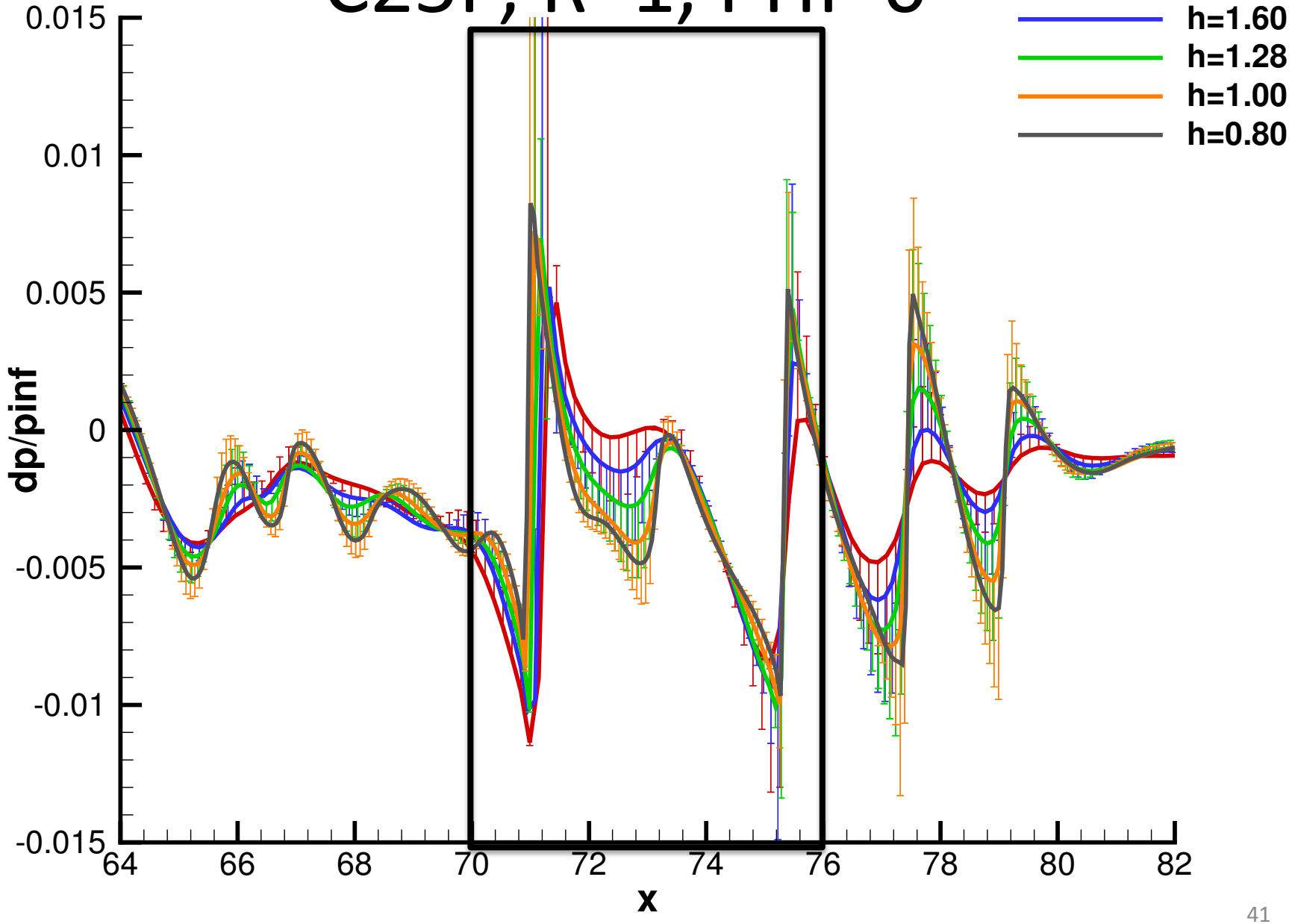
0.01
0.005
0
-0.005
-0.01
-0.015
dp/pinf
64
66
68
70
72
74
76
78
80
82
x

C25F, R=1, PHI=0°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h=0.80
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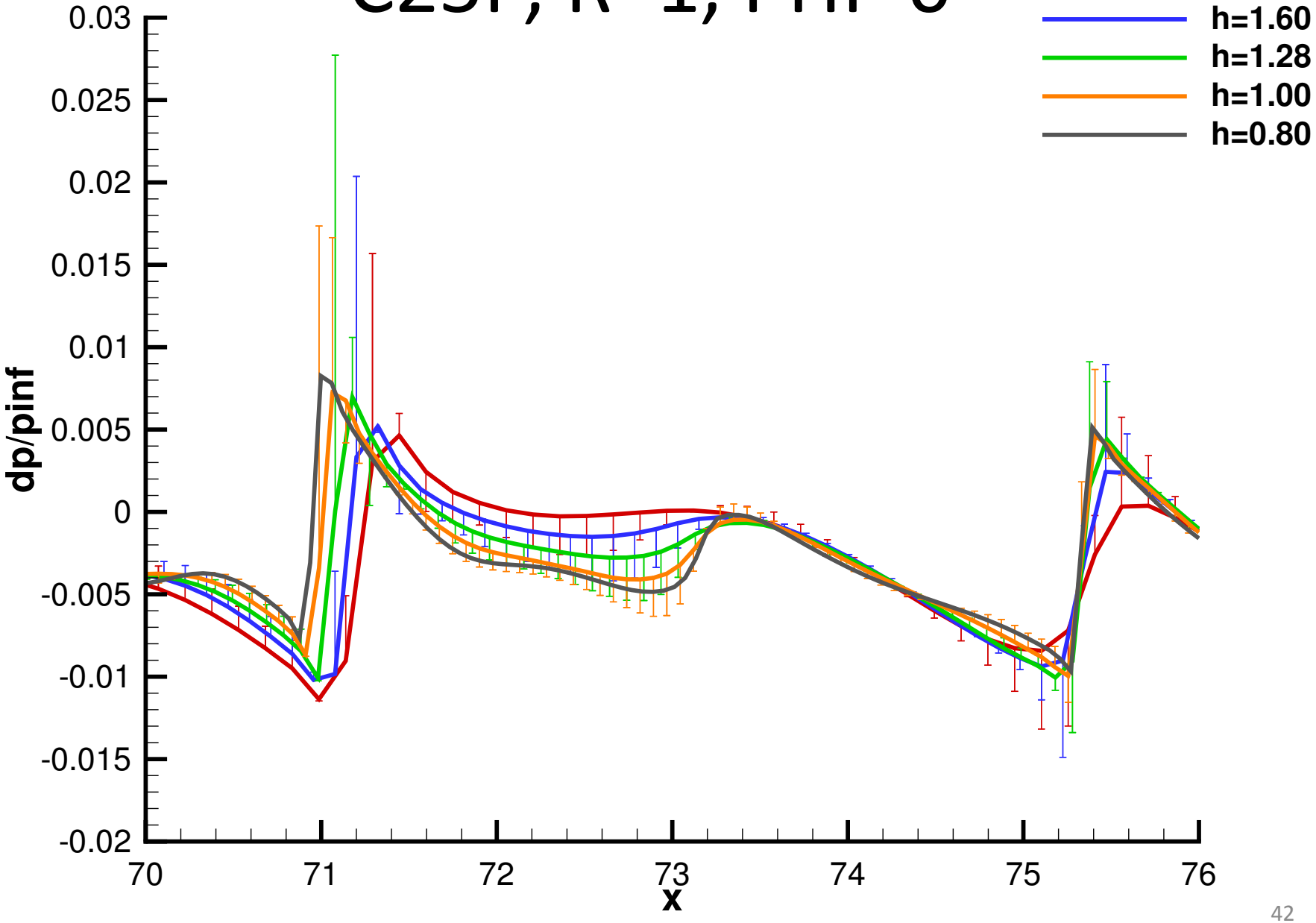
0.01
0.005
0
-0.005
-0.01
-0.015
dp/pinf
64
66
68
70
72
74
76
78
80
82
x

C25F, R=1, PHI=0°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h=0.80
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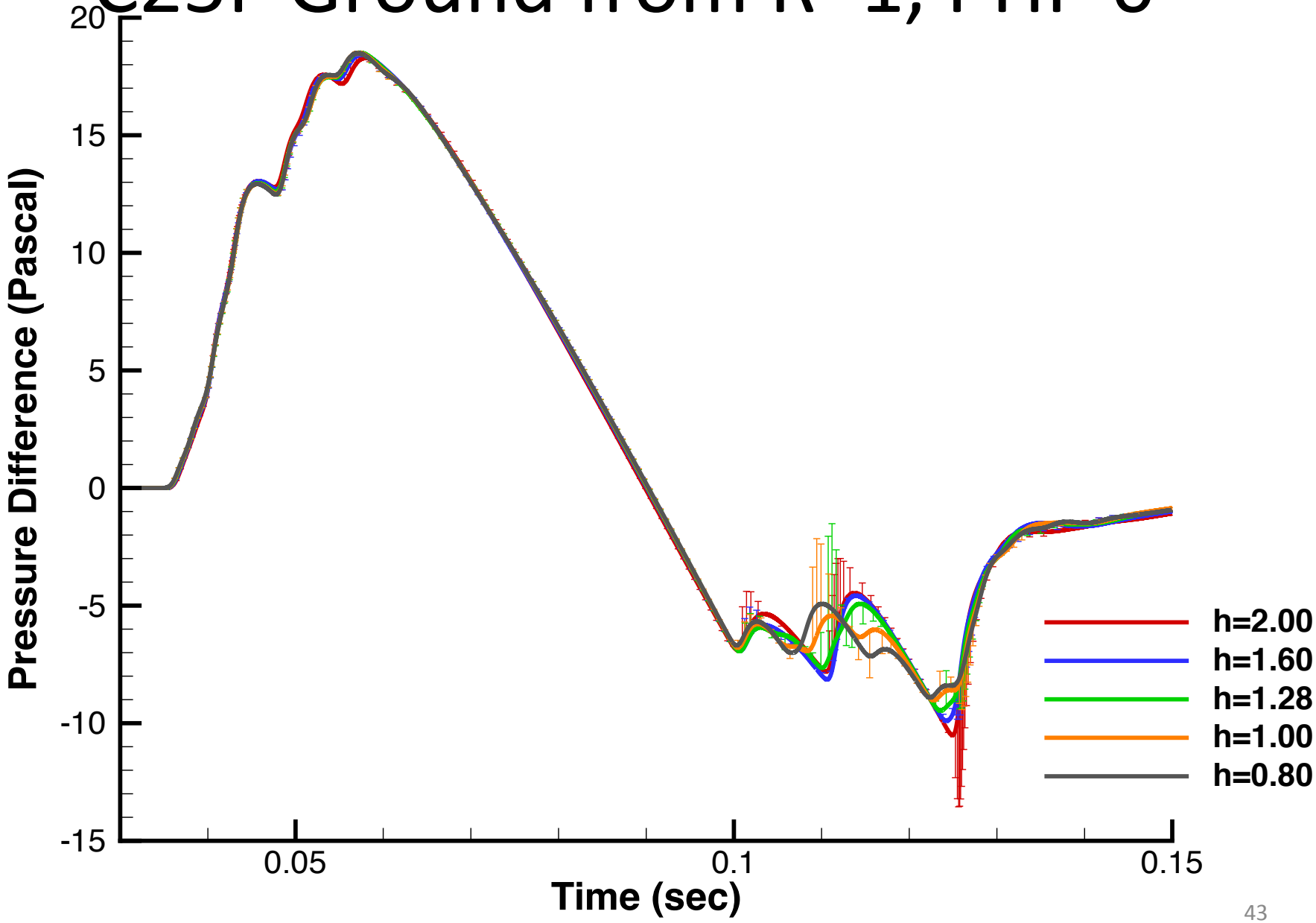
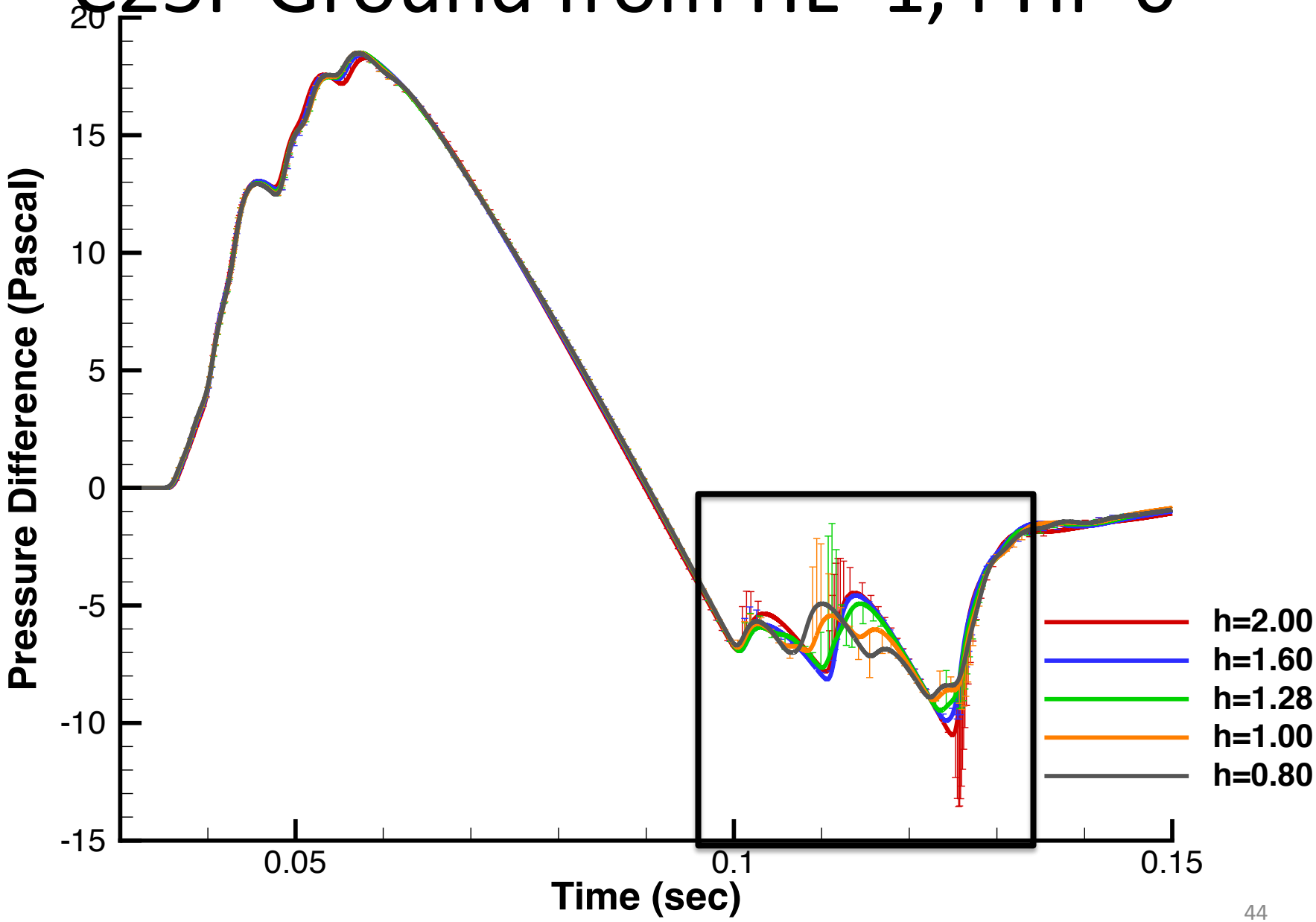
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
70
71
72
73
74
75
76
x

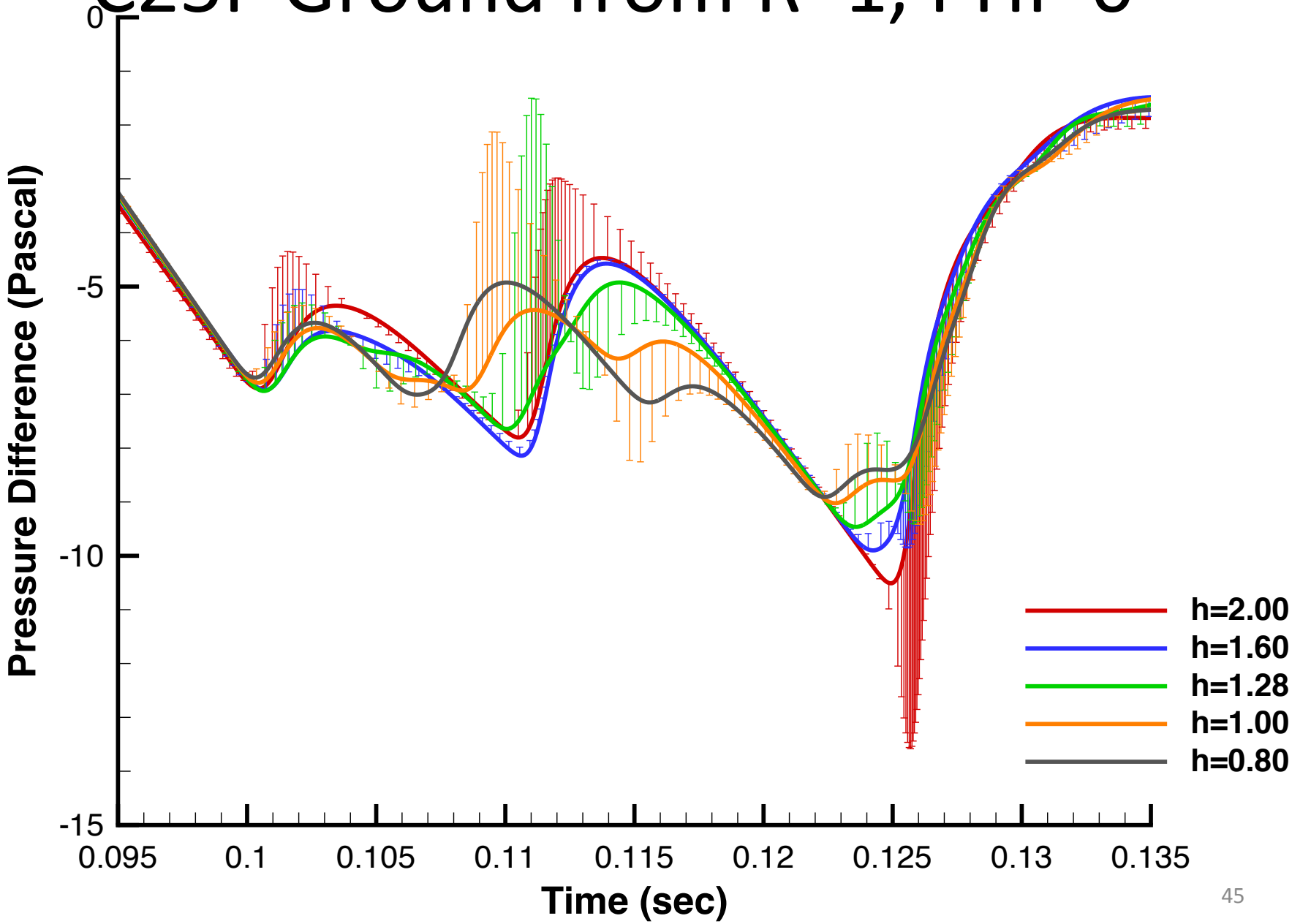
C25F Ground from R=1, PHI=0°



C25F Ground from HL=1, PHI=0°

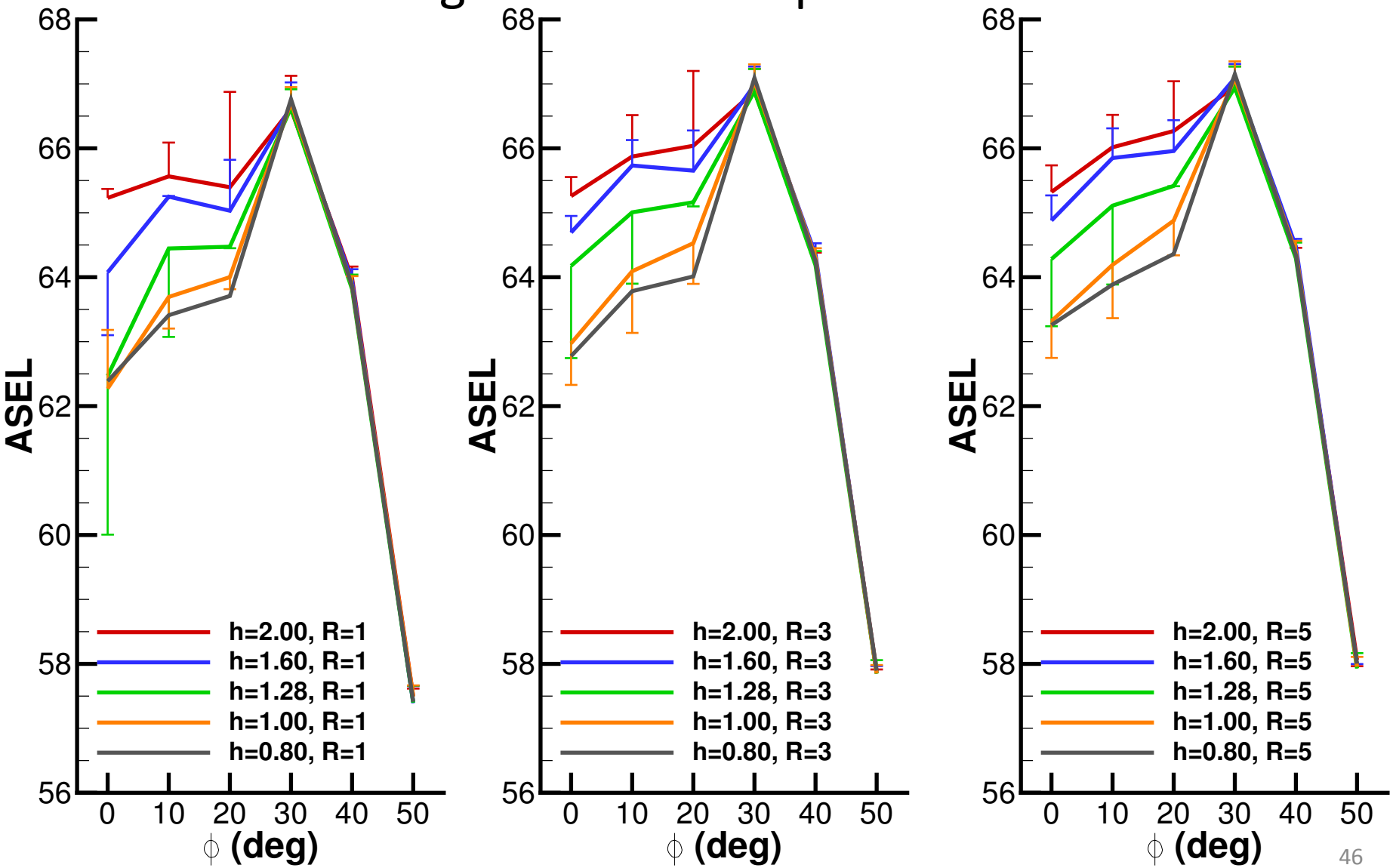


C25F Ground from R=1, PHI=0°



C25F ASEL Carpets

A-weighted Sound Exposure Level



Summary

- Submissions provided for all workshop grids and some participant grids
  - Iterative convergence
  - Nearfield signature variation
- Exactly linearized error transport equations
  - Monday, 10-10:30 AM, Texas 3
  - Truncation error estimate
  - Complex-step FUN3D, sBOOM, ASEL
  - Consistent trends with grid refinement for intermediate sized grids
  - Illustrate the grid sensitivity mechanism of inlet shock reflecting off upper wing and lower horizontal tail