AePW-4 High-Angle Working Group Meeting

February 13, 2024

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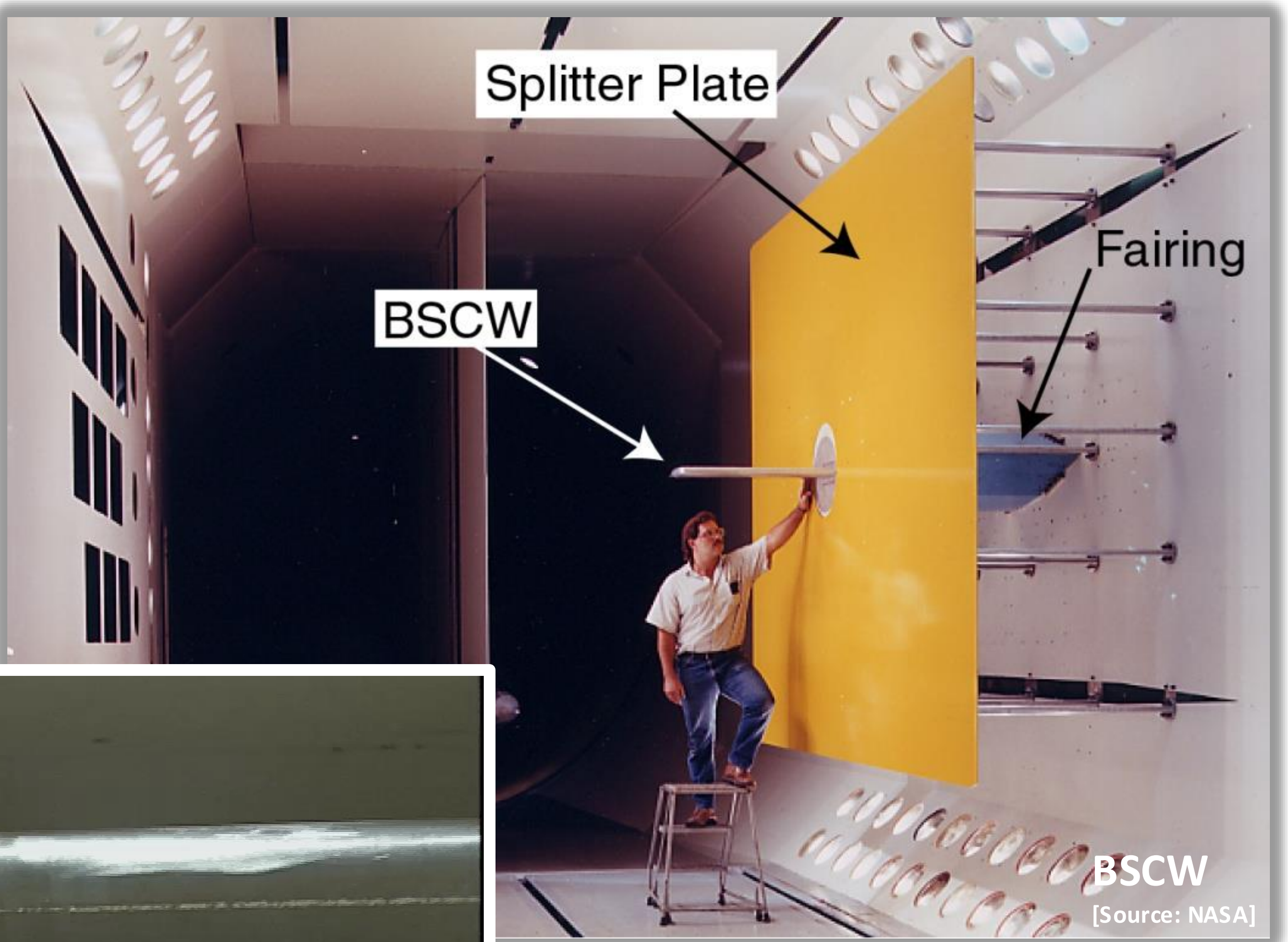
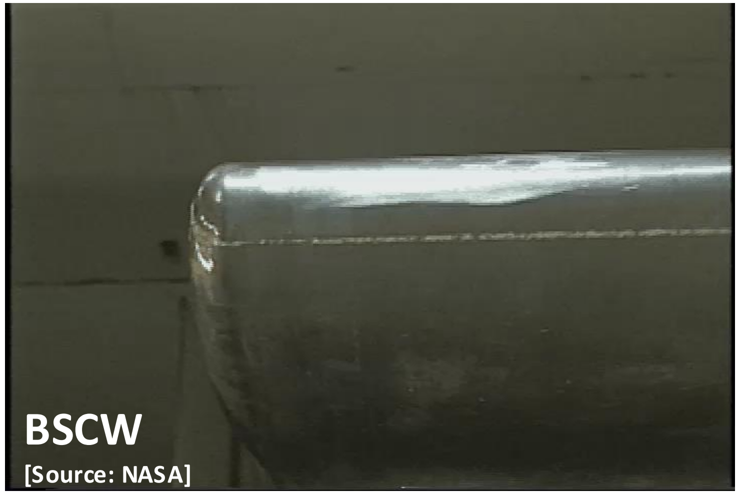
Agenda, February 13

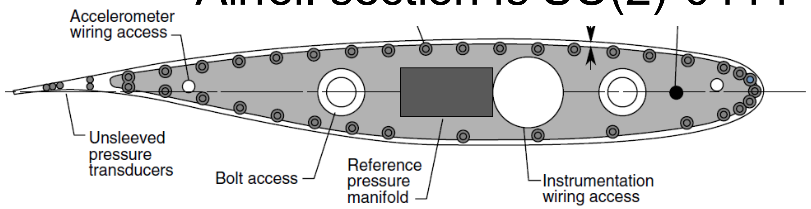
- AIAA SciTech 2025: Orlando, FL, Mini Workshop 1, Thursday, January 9
- AIAA Aviation 2025: three sessions dedicated to DPW-8/AePW-4
- Summer 2025: New BSCW Experiment
- AePW-4 website: https://nescacademy.nasa.gov/workshops/AePW4/public
- AePW-4 HAWG objectives
- Presentation today:
  - 2D BSCW flutter analysis status, Pawel, Kevin
  - 2D Flutter-Onset BSCW, Jeff Thomas, Duke
- Next meeting, March 13
- AIAA Aviation 2026: DPW-8 and AePW-4 Workshop

High-Angle WG: BSCW Wing Configuration

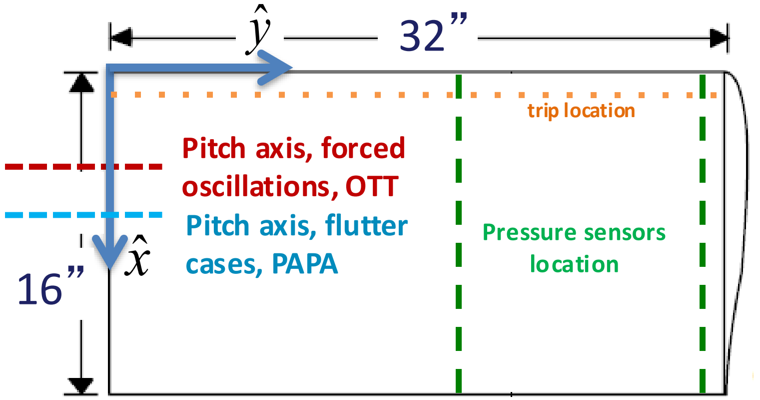




Airfoil section is SC(2)-0414



Cross-section at 60% span, showing the layout of the unsteady pressures.



Model planform. Dimensions are in inches.

Past Experimental Data

EXPERIMENTAL UNSTEADY PRESSURES AT FLUTTER ON THE SUPERCRITICAL WING BENCHMARK MODEL

AIAA-93-1592-CP

Bryan E. Dansberry, Michael H. Durham*, Robert M. Bennett**, José A. Rivera*, Walter A. Silva*, and Carol D. Wieseman*; Structural Dynamics Division, NASA Langley Research Center, Hampton, VA 23681-0001
and David L. Turnock*
Lockheed Engineering and Sciences Corporation

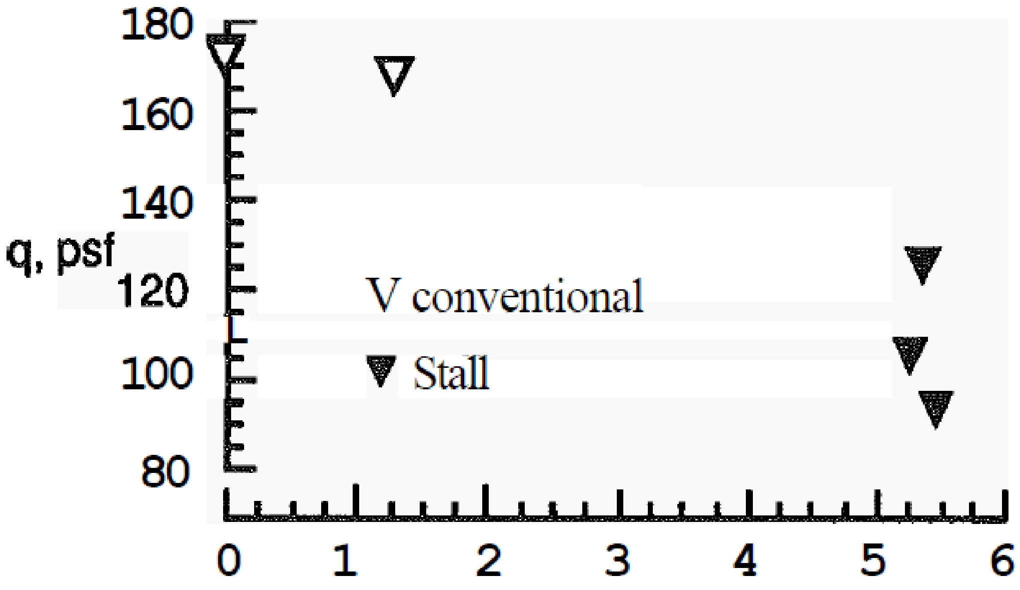


Figure 9. Stall flutter boundary in R-12 at M = 0.80.

BSCW Wing Configuration Past Workshop Conditions

- AePW-1:
  - Steady-rigid and forced-oscillation cases at Mach 0.85, AoA = 5° ✓
- AePW-2:
  - Forced-oscillation case at Mach 0.70, AoA = 3° ✓
  - Flutter prediction at Mach 0.74, AoA = 0° ✓
  - Unsteady-rigid, forced-oscillation, and flutter cases at Mach 0.85, 5° ✓ ✓ ✓
- AePW-3:
  - Flutter prediction at Mach 0.80, AoA = 5° ✓
  - Shock-buffet case at Mach 0.80, AoA = 5° ✓

AePW-4 High-Angle WG Cases

- Mandatory
  - Flutter prediction at Mach 0.80 and angle-of-attack sweep: 0° – 6°

- Optional
  - Flutter prediction at Mach 0.78, 0.76, 0.74 and angle-of-attack 3°

- Mandatory (?)
  - 2D BSCW flutter prediction at Mach 0.80 and angle-of-attack sweep: 0° – 6°

AePW-4 High-Angle WG Cases

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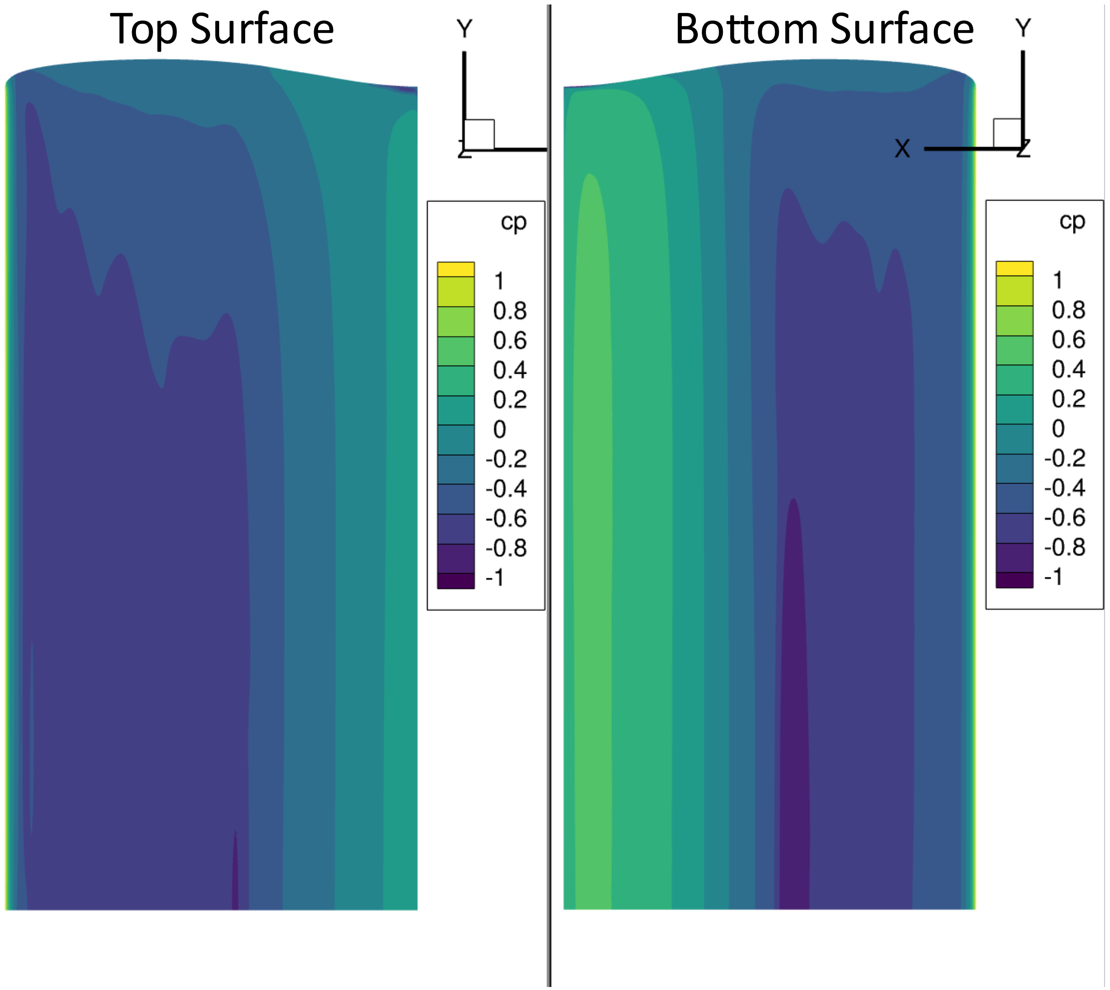
  - 2D BSCW flutter prediction at Mach 0.80 and angle-of-attack sweep: 0° – 6°

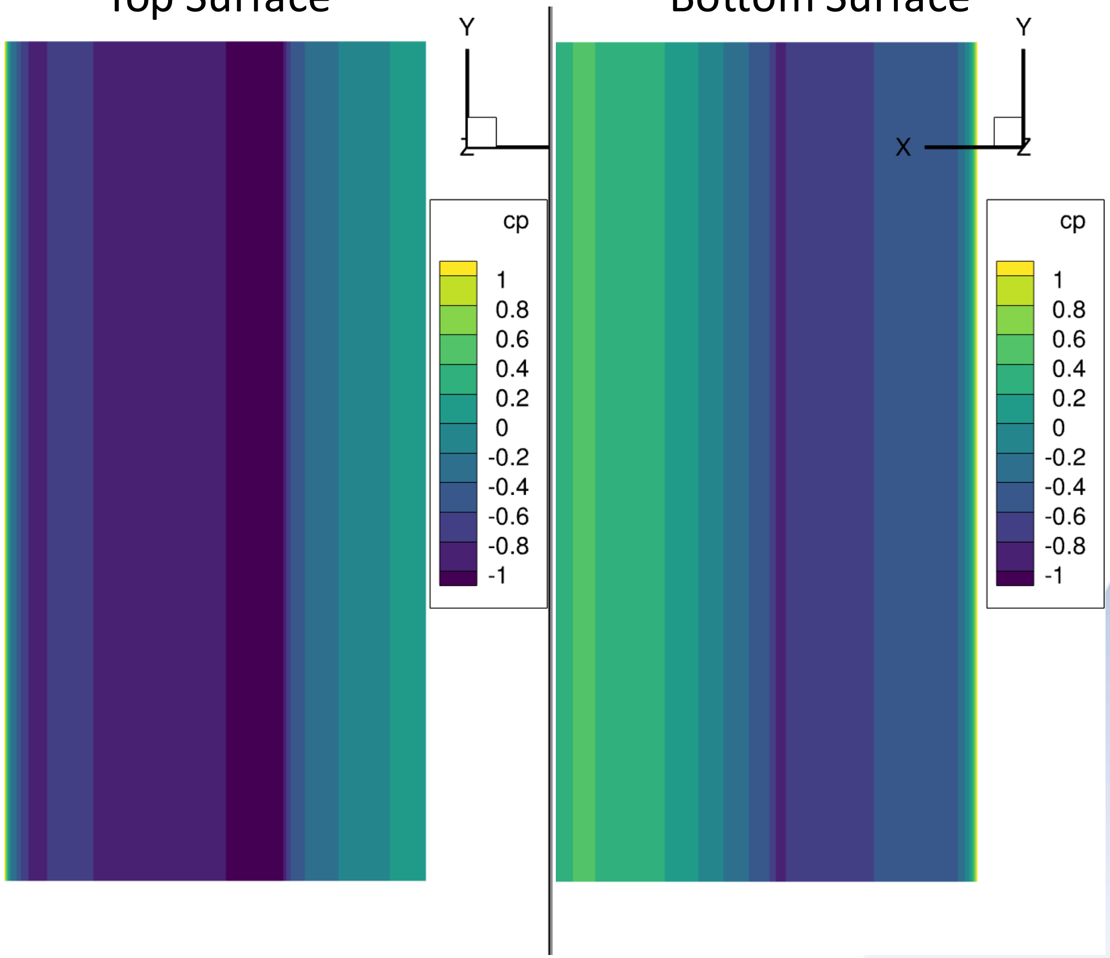
2D, or not 2D, that is the question:

BSCW 2D vs 3D Aeroelastic Analysis, Mach 0.80 AoA = 0deg, q = 169 psf

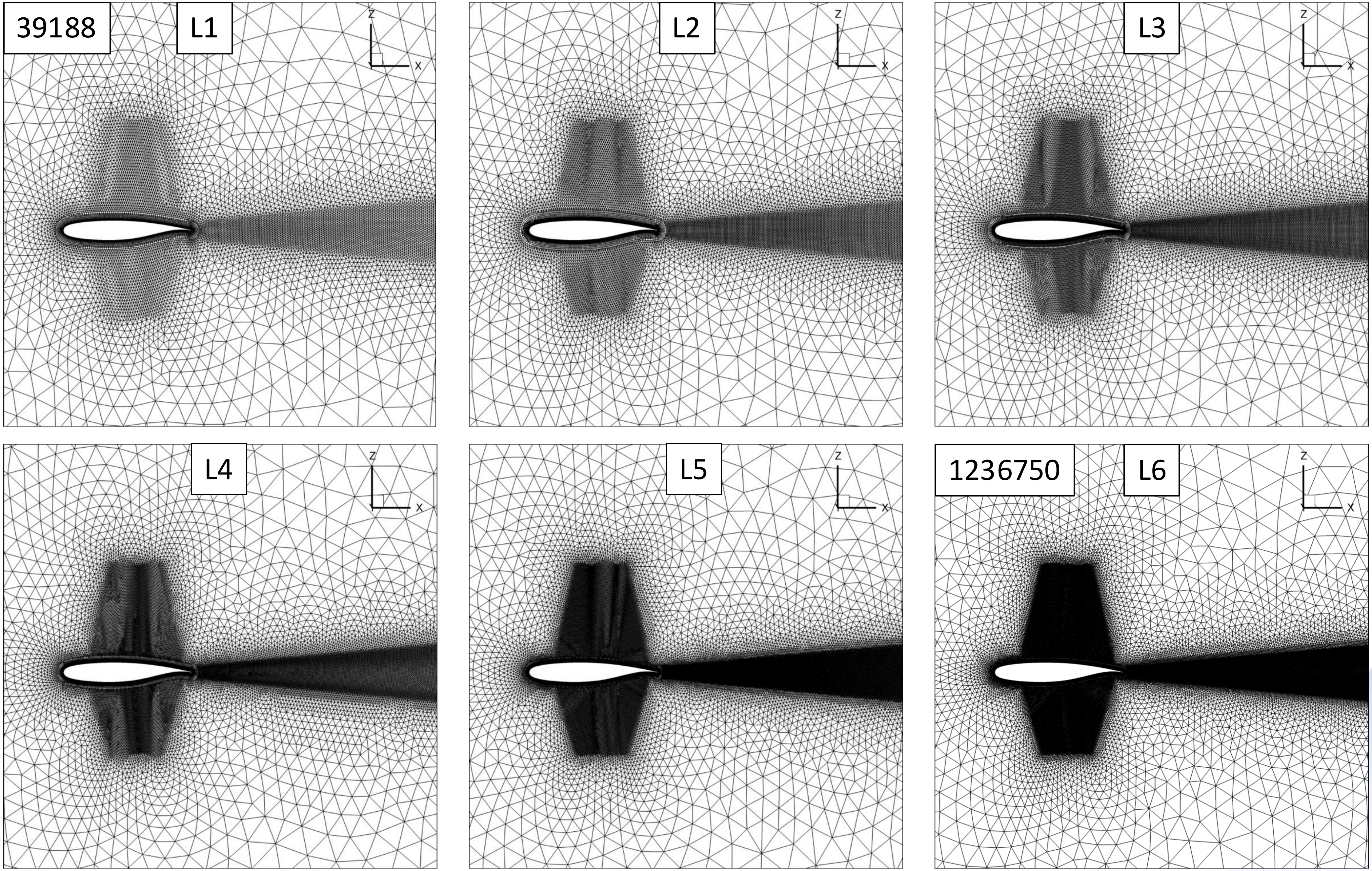
3D Wing

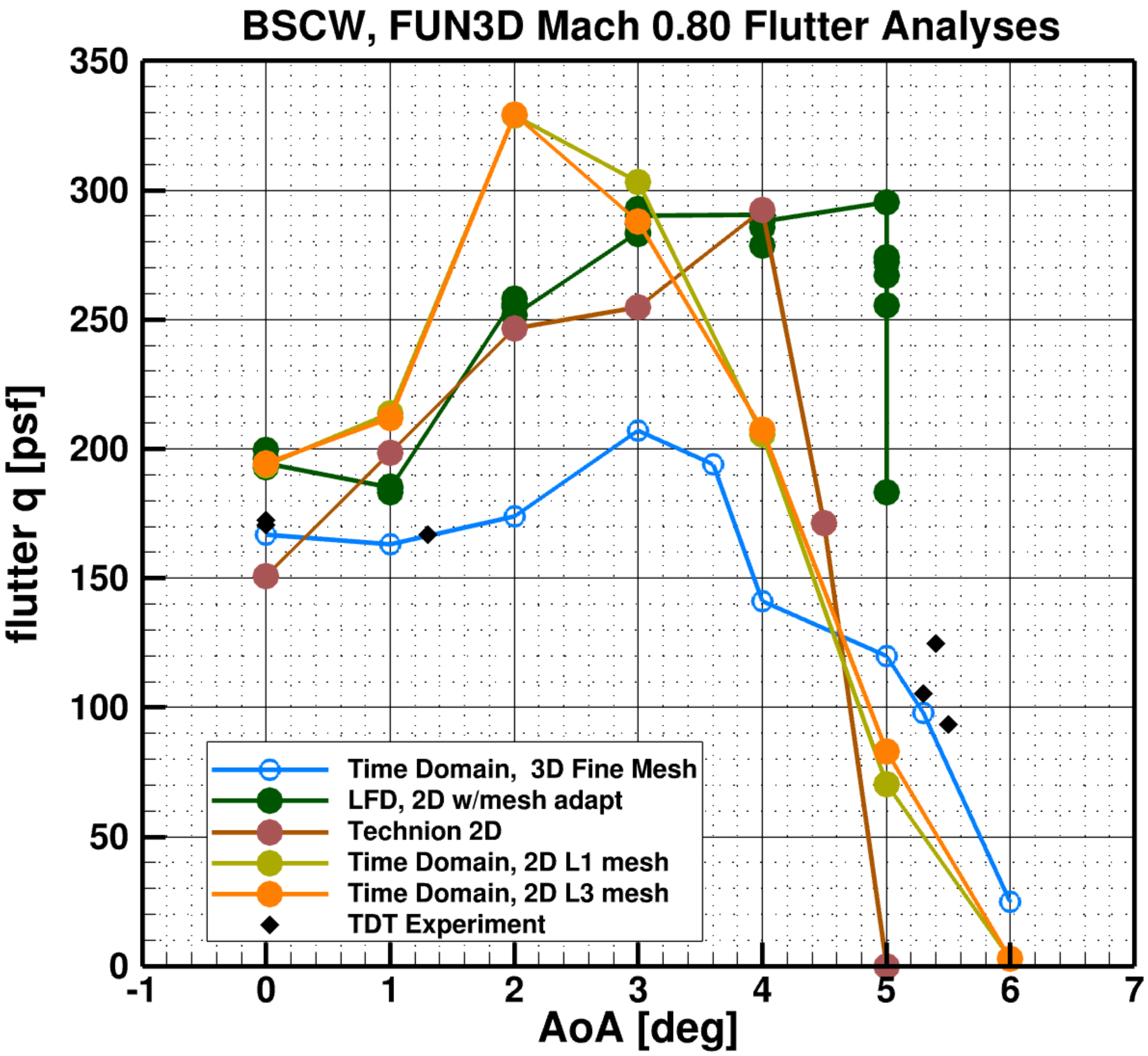


2D Wing

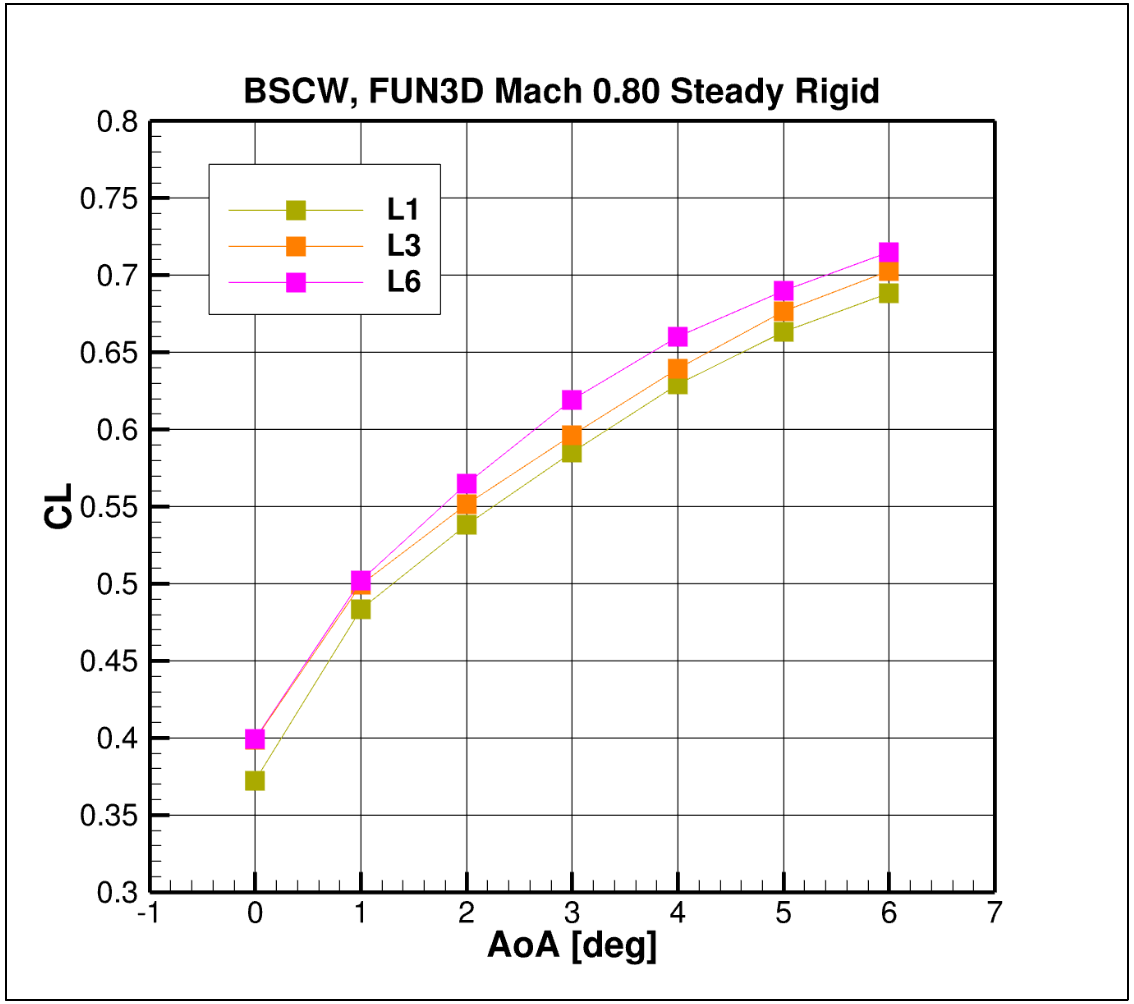


2D Mesh: 32-inch span wing with two symmetry planes



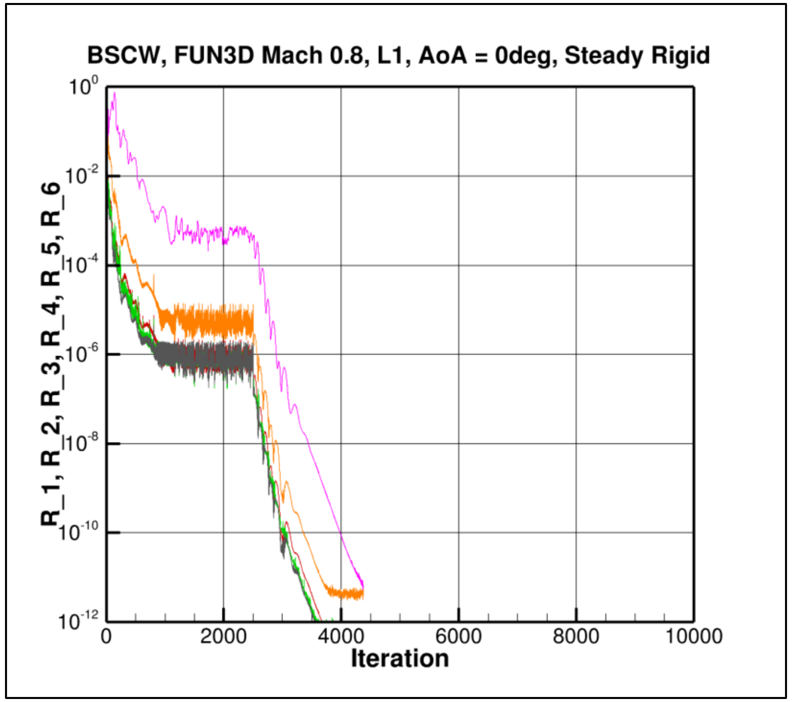

BSCW, FUN3D Mach 0.80 Flutter Analyses
flutter q [psf]
AoA [deg]
350
300
250
200
150
100
50
0
-1
0
1
2
3
4
5
6
7
Time Domain, 3D Fine Mesh
LFD, 2D w/mesh adapt
Technion 2D
Time Domain, 2D L1 mesh
Time Domain, 2D L3 mesh
TDT Experiment

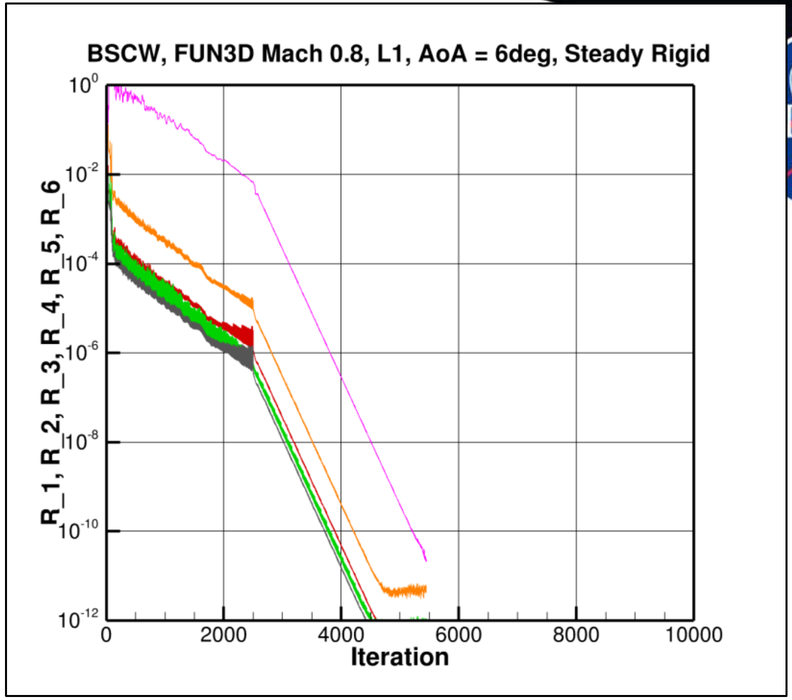
Aerodynamic Coefficients



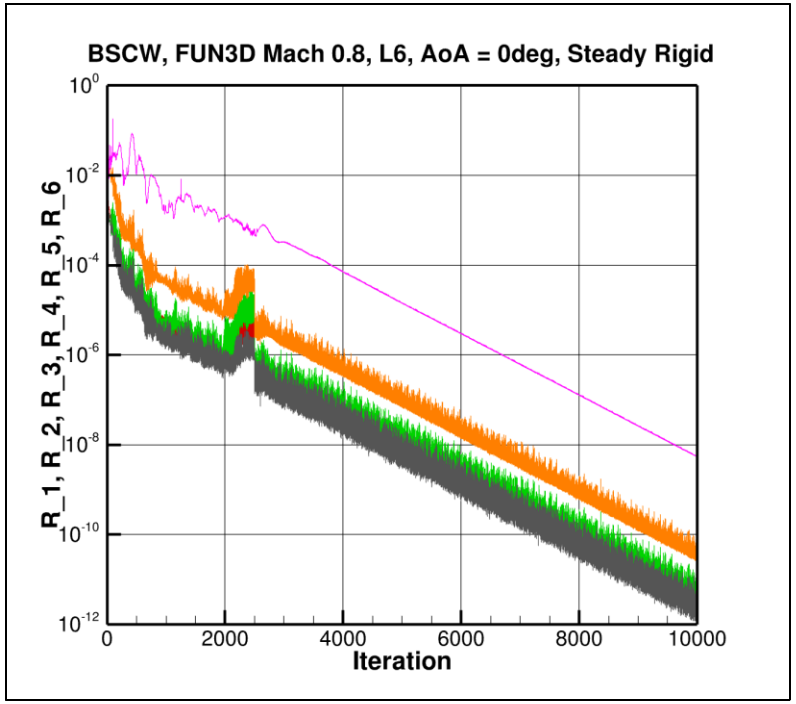
Convergence Plots
Steady rigid

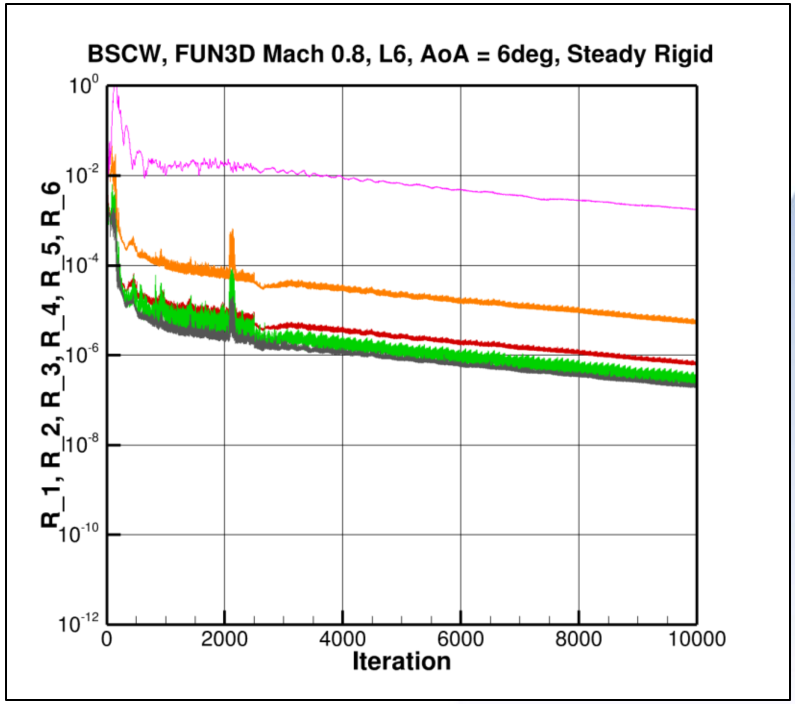
Mesh L1





Mesh L6



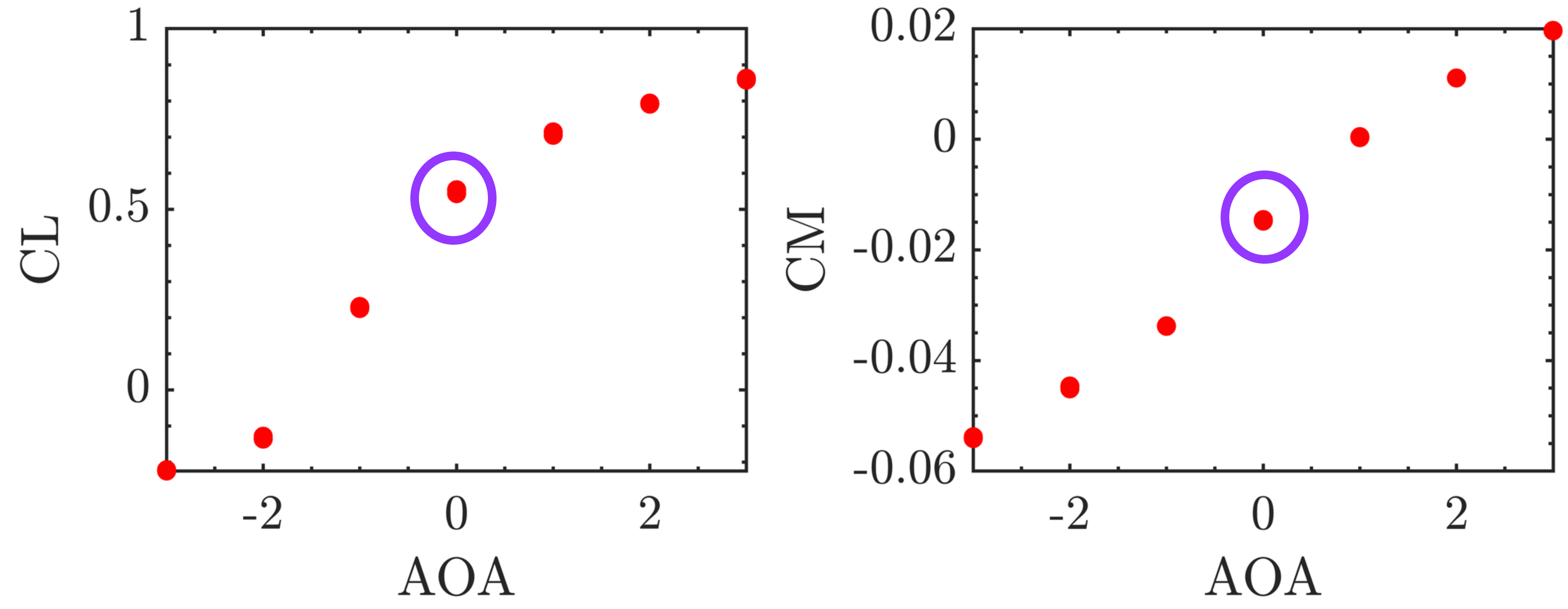


Kevin’s slides

Steady Angle of Attack Sweep

Bret’s adapted solutions

- Finest 3 meshes for each angle of attack

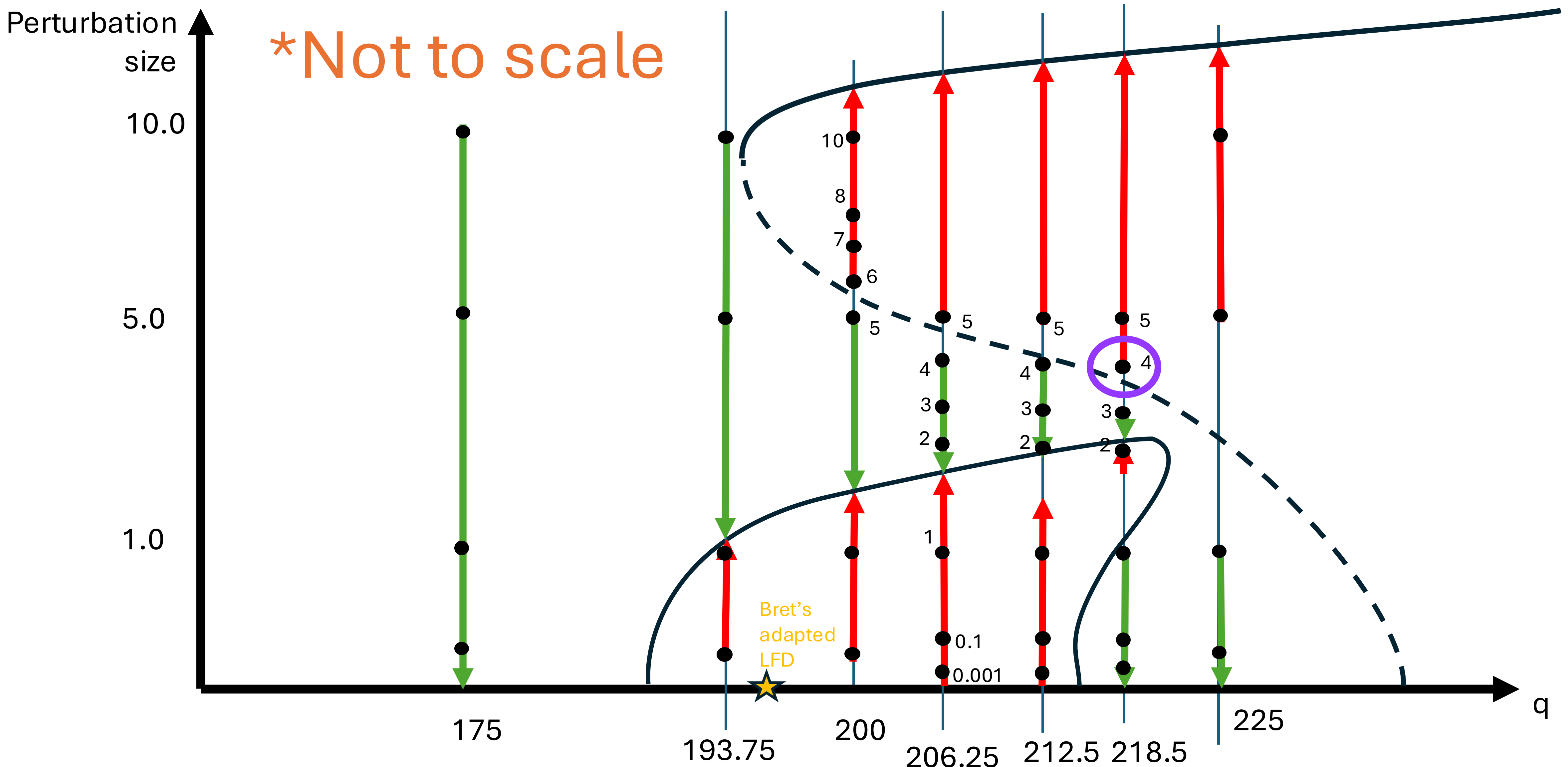


Dynamic Responses

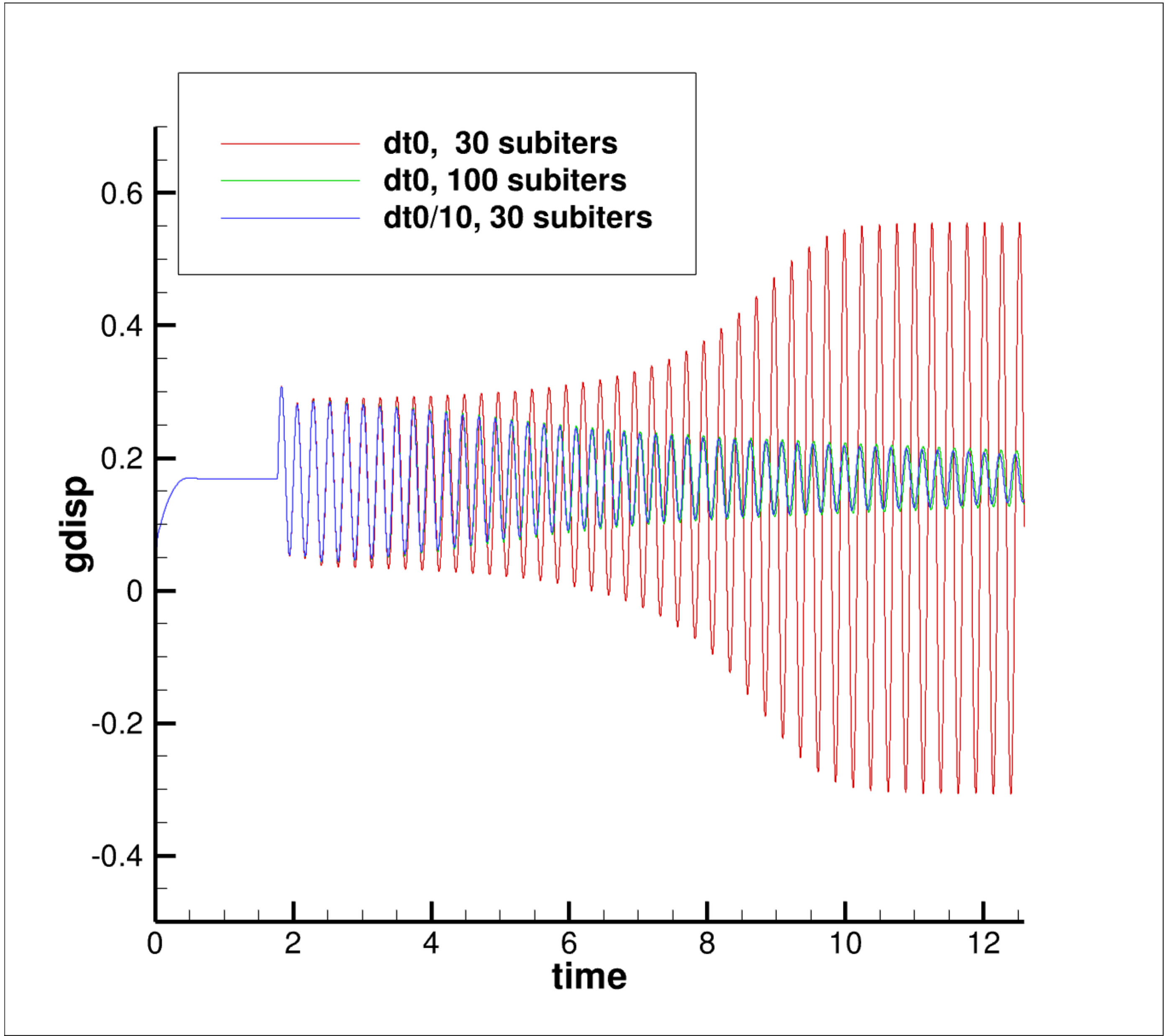
- AOA = 0°
- Pawel’s L3 (161,918 nodes) and L6 meshes (1,236,750 nodes)
- Studying the sensitivity to:
  - Initial perturbation size
  - Time step size
  - Number of subiterations

Initial exploration of dynamic response

- L3 mesh, Pawel's initial dt size, 30 subiterations

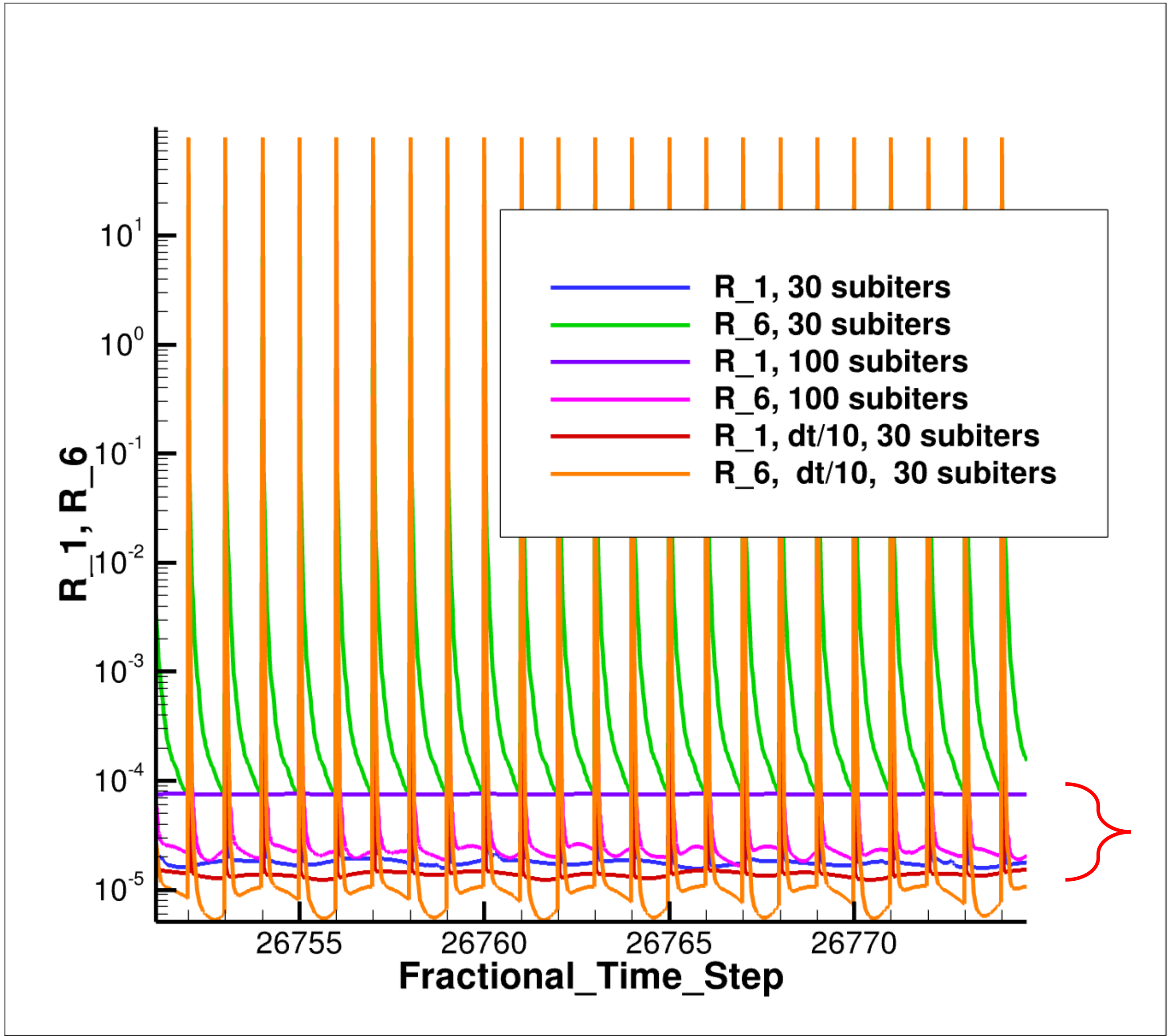


Adjusting the temporal settings at kick size 4.0, q = 218.5



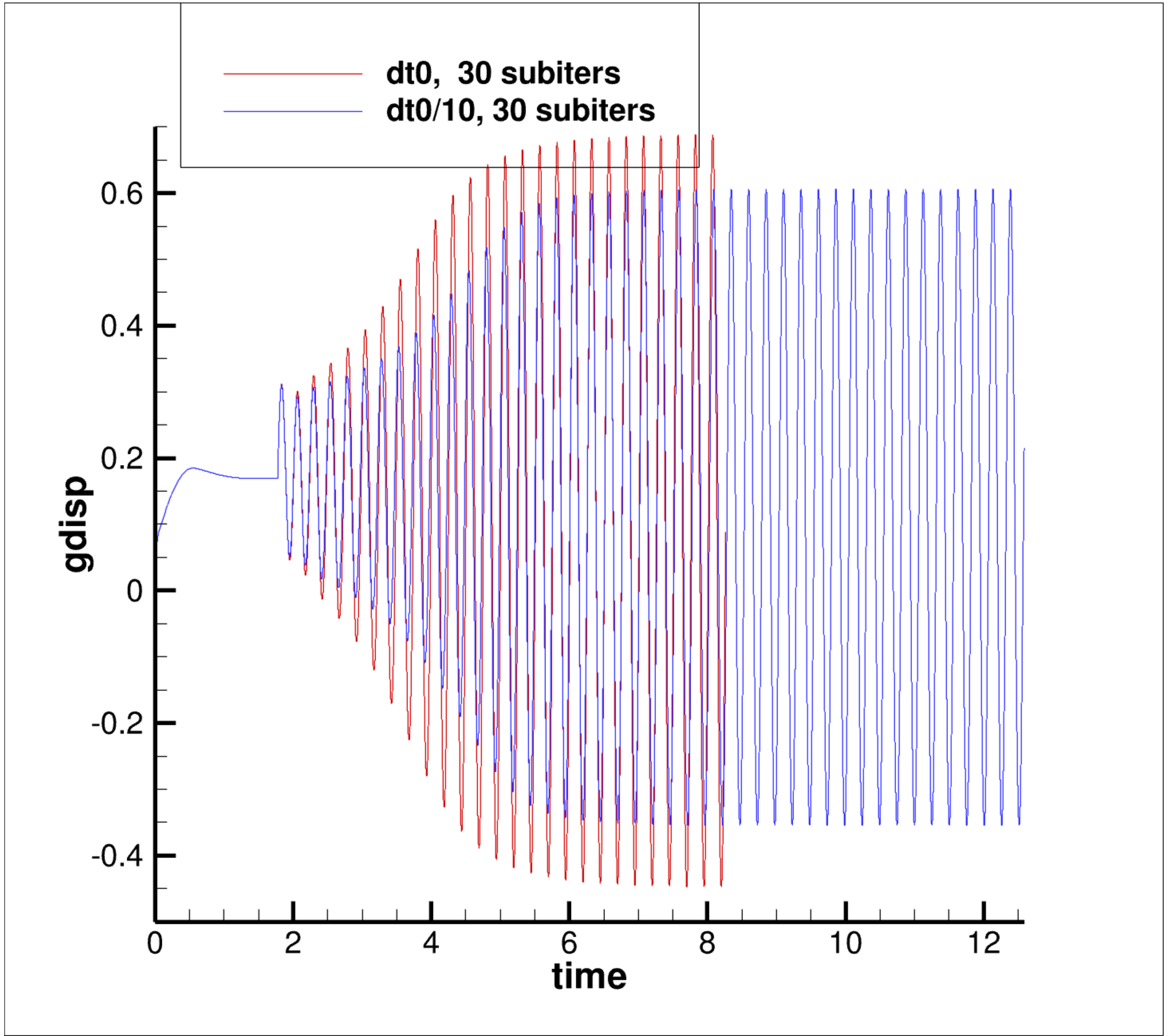
Subiteration convergence

Fractional time step is normalized by number of subiterations per step. 100 subiterations is not converging faster, just compressed on x-axis



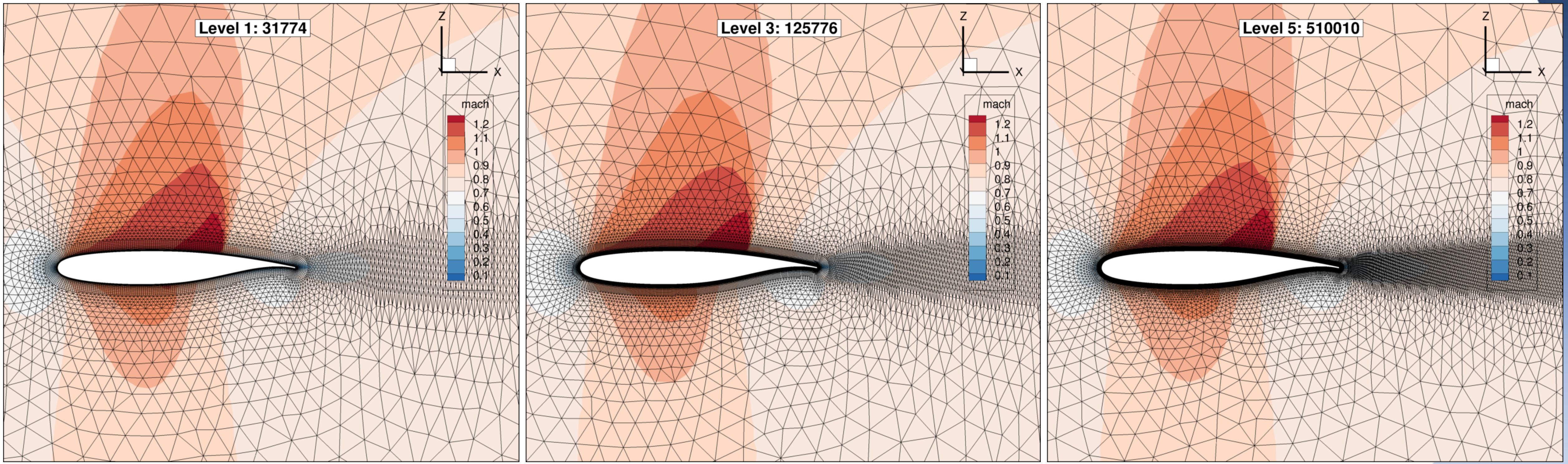
Less than an order of magnitude difference in R6 convergence

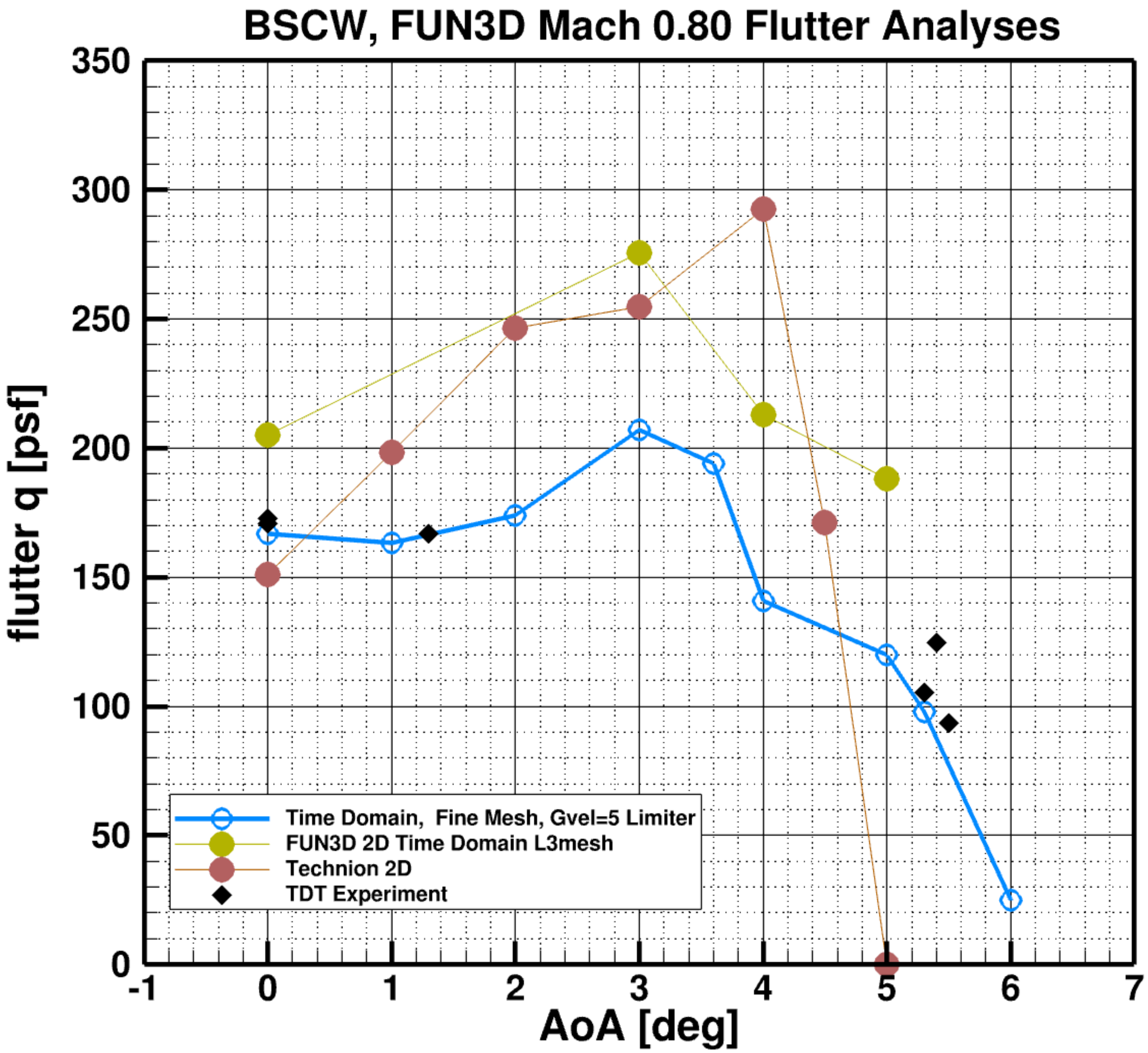
Refining the mesh, L6



BSCW 2D vs 3D Aeroelastic Analysis, Mach 0.80 AoA = 0deg, q = 169 psf

2D Coarse Mesh: 32-inch span wing with two symmetry planes





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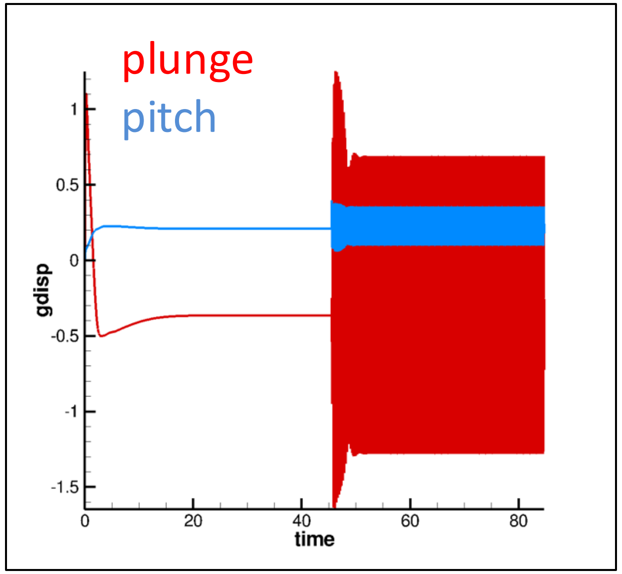
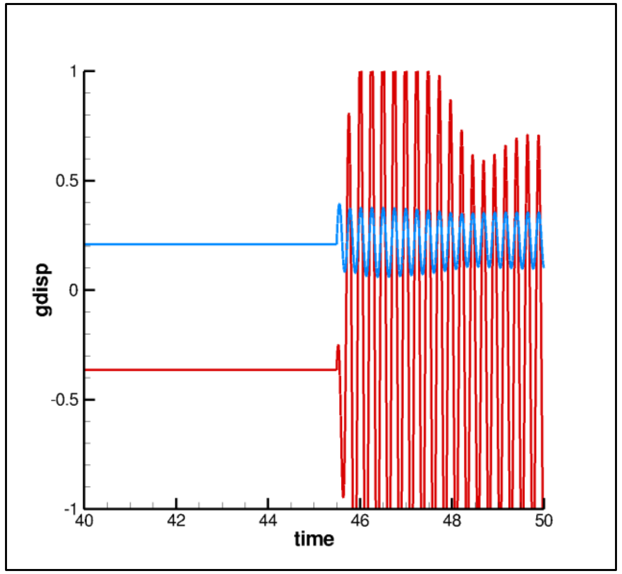
Time Domain, Fine Mesh, Gvel=5 Limiter
FUN3D 2D Time Domain L3mesh
Technion 2D
TDT Experiment

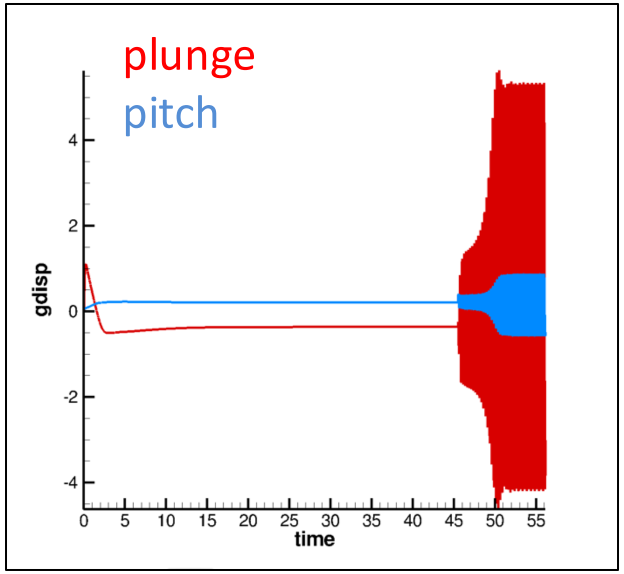
Mach 0.8, Q=250 psf, aoa = 0 deg

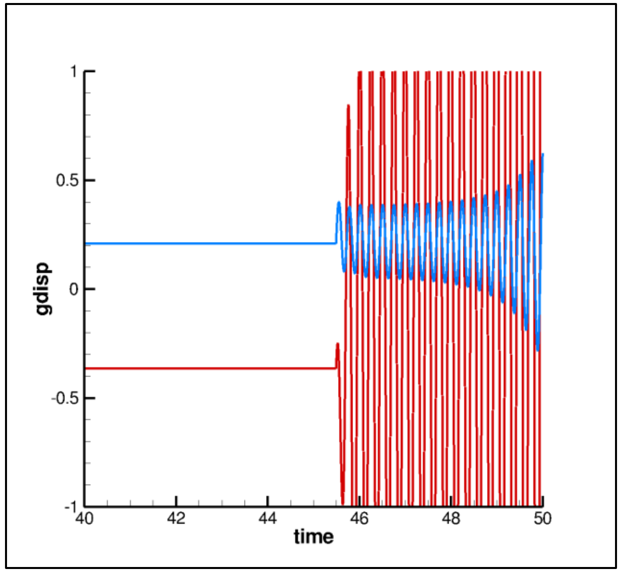
dt = 0.0002 seconds



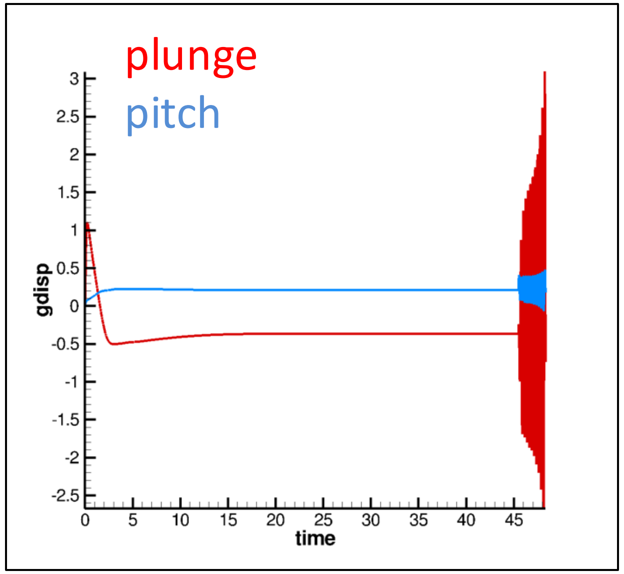


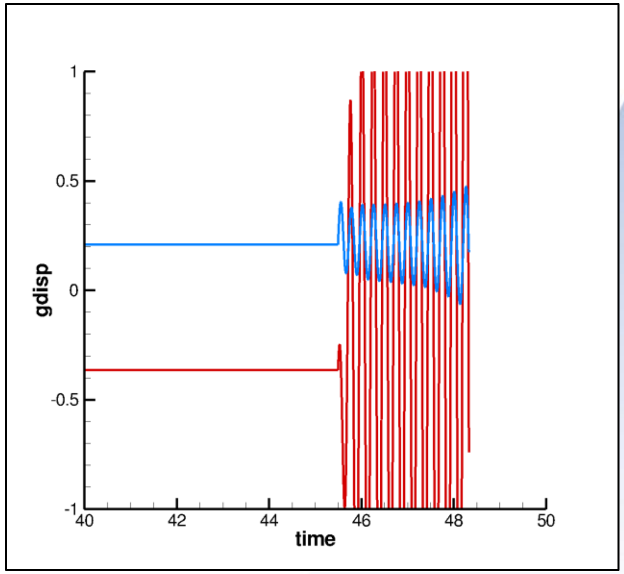
dt = 0.00002 seconds





dt = 0.000002 seconds





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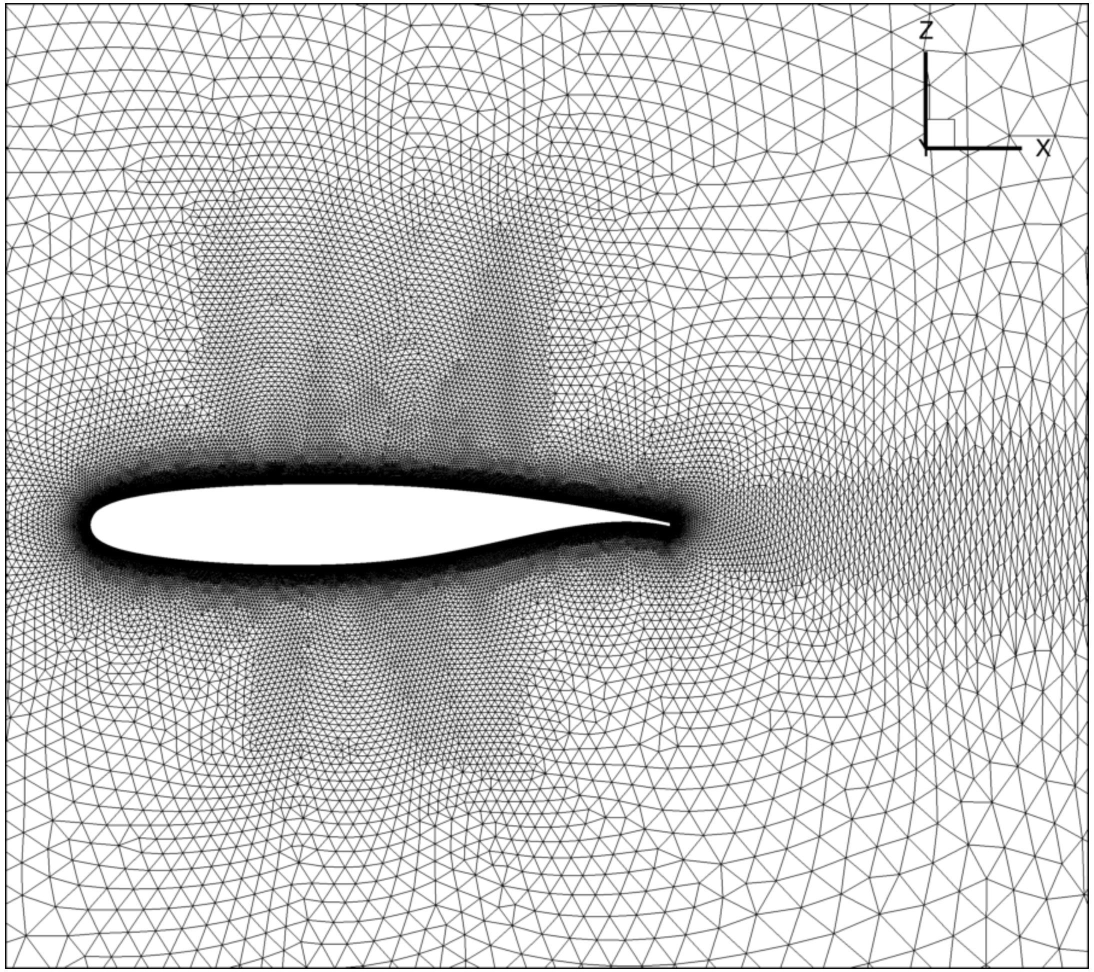
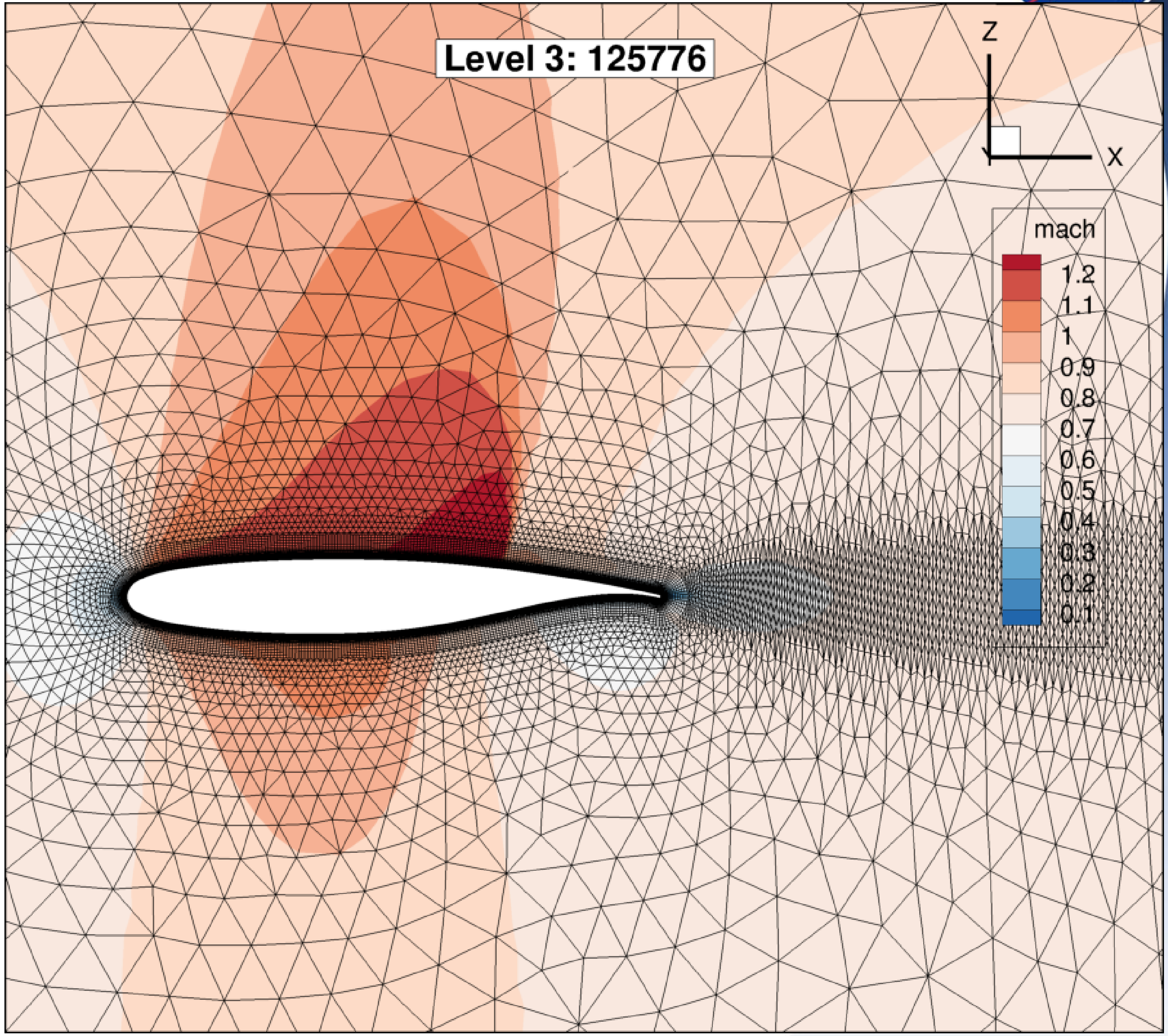
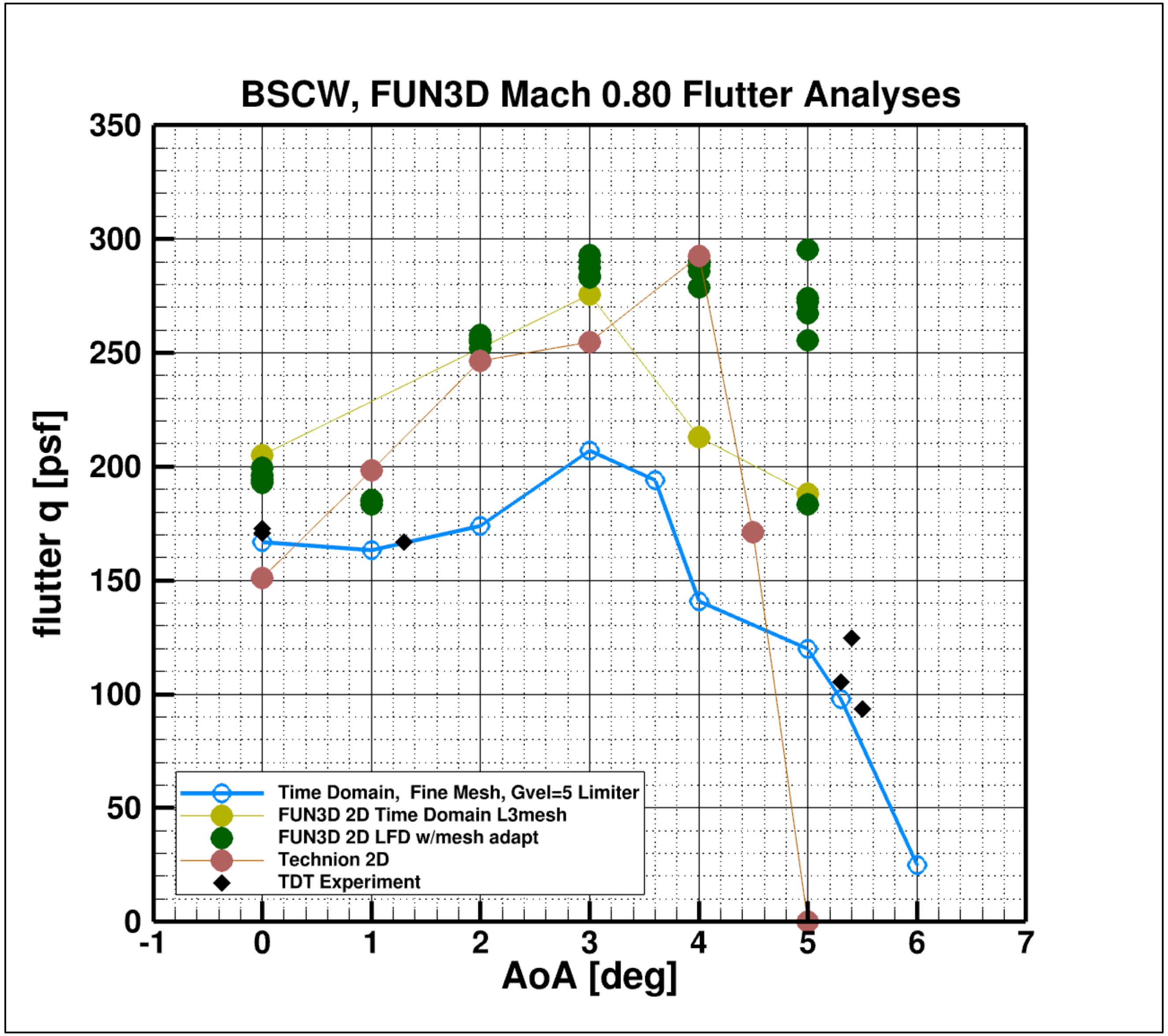




Bret’s FUN3D 2D LFD w/mesh adaptation

2D Results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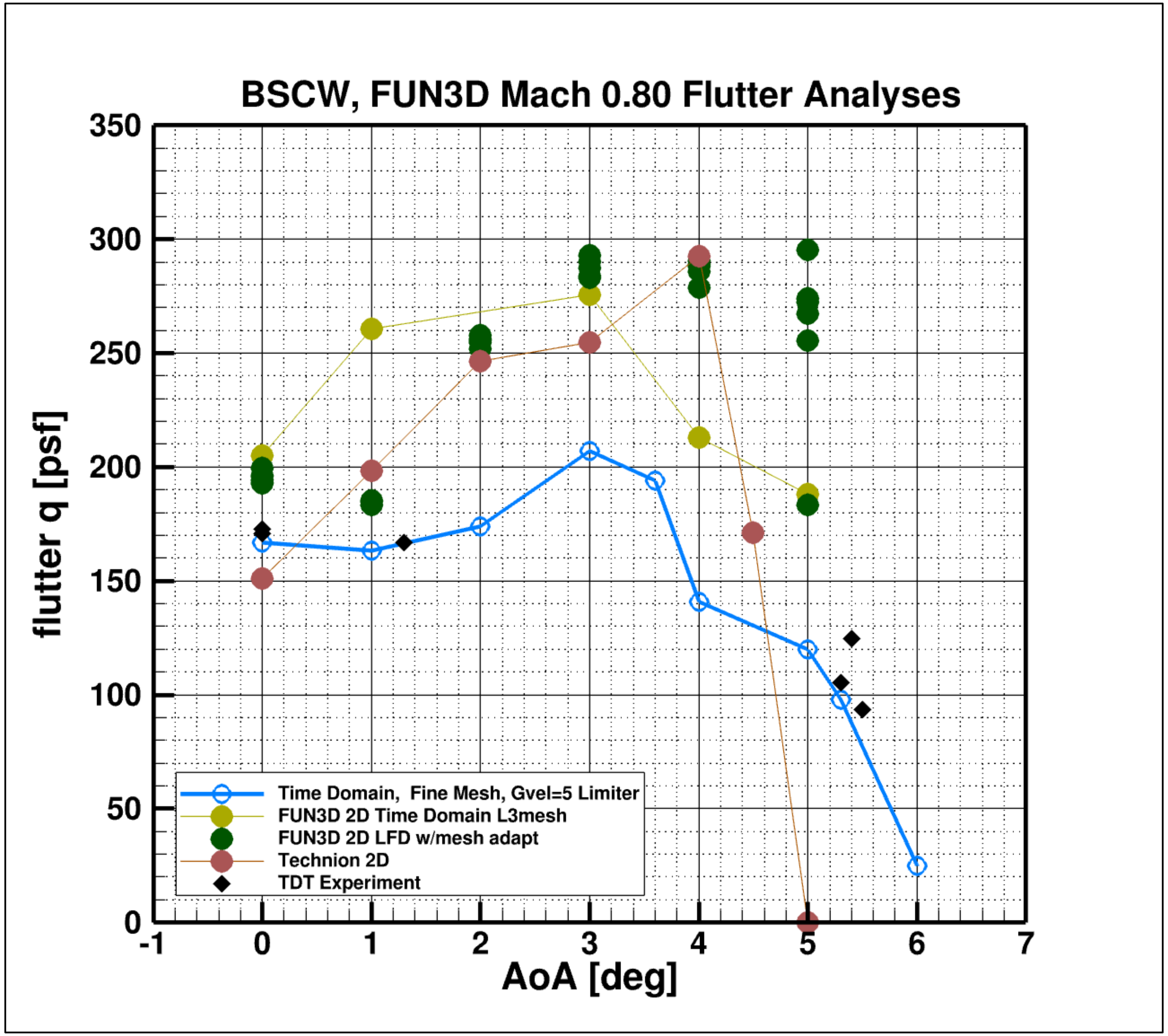
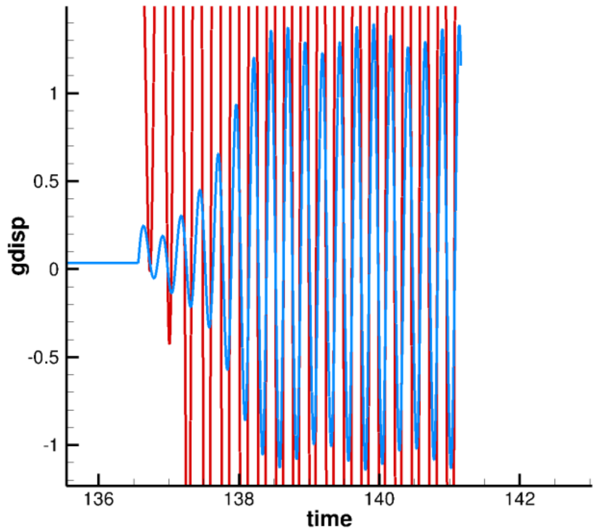


AoA = 1deg, q=300 psf



AoA = 4deg, q=300 psf