

NASA LaRC Contributions to the Static Deformation Working Group

Bret Stanford
Aeroelasticity Branch
NASA LaRC



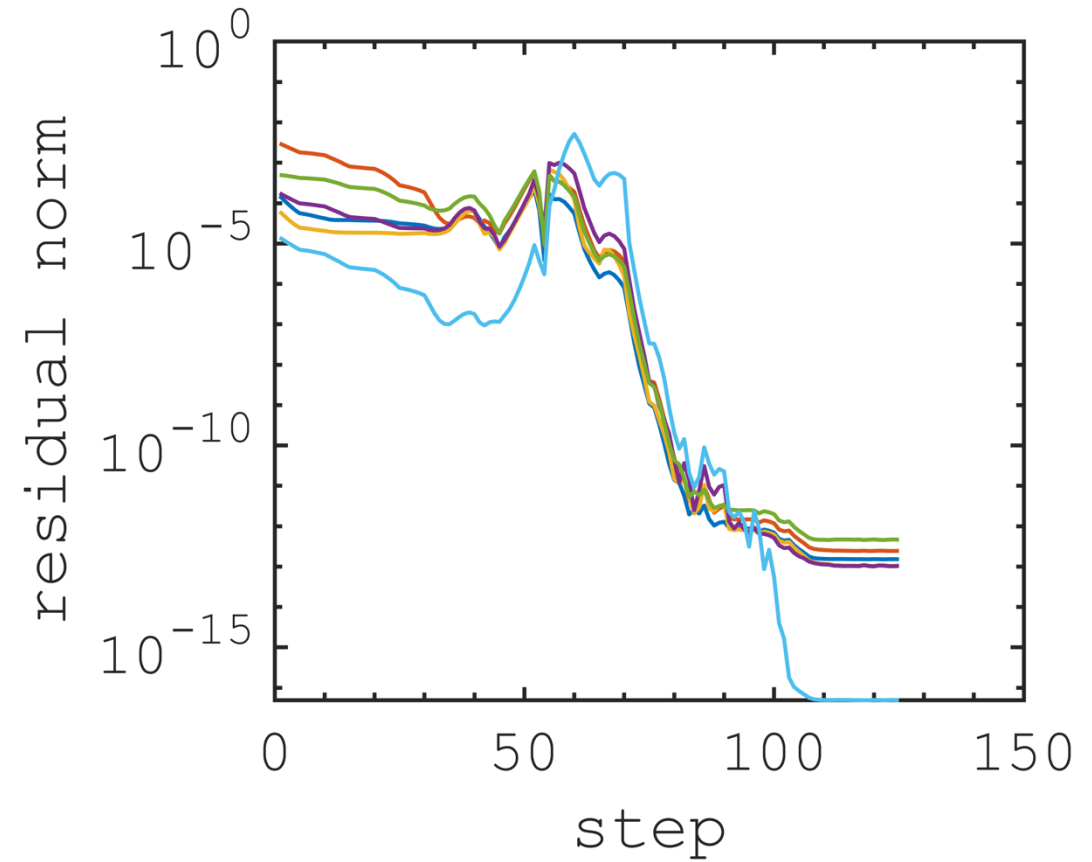
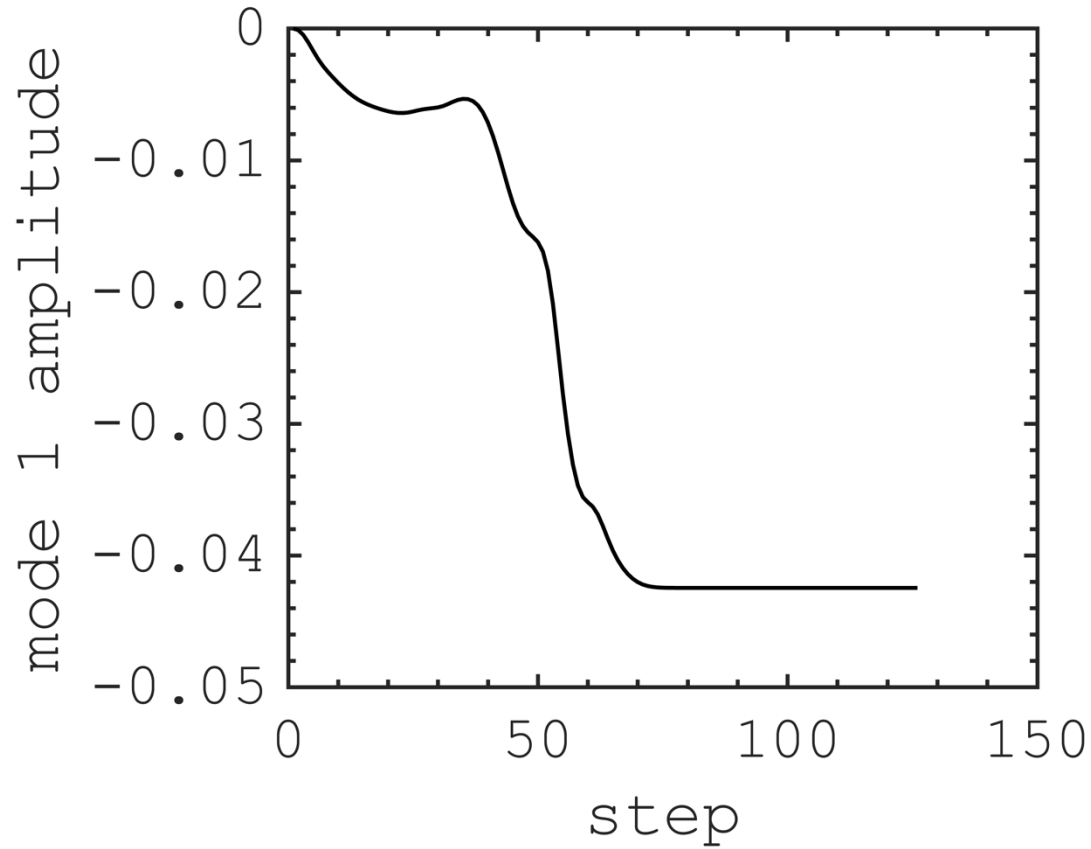
- **This work computes aeroelastic solutions with the modal solver inside FUN3D**
- **At a given time step:**
 - The flow solver converges
 - The flow solver uses surface pressures to compute generalized modal forces
 - Those forces are passed to a modal solver, which computes the modal amplitudes at the next time step
 - The new modal amplitudes, plus the surface mode shapes, are used to construct the new surface mesh
 - The new volume mesh is computed, via an elasticity solver
- **If desired, this process can iterate more than once per time step**



- **For static aeroelastic problems, the solution is accelerated by:**
 - Increasing the damping of each mode to 0.99
 - Turning off the unsteady part of the flow solver
 - FUN3D operates in a steady mode, but still interfaces with the unsteady modal solver at each iteration
 - The mesh is still deforming at each step

- **FUN3D's Stabilized Finite Element Solver (FUN3D/SFE)**
 - Streamline Upwind Petrov-Galerkin (SUPG) Stabilization
 - Negative Spalart-Allmaras model with QCR
 - Workshop-provided grids from Cadence Pointwise
- **NASTRAN structural model of the tet-discretized semi-span vehicle**
 - First 20 mode shapes retained for coupling
- **Radial basis functions used to map mode shapes onto CFD surface mesh**

Typical Convergence

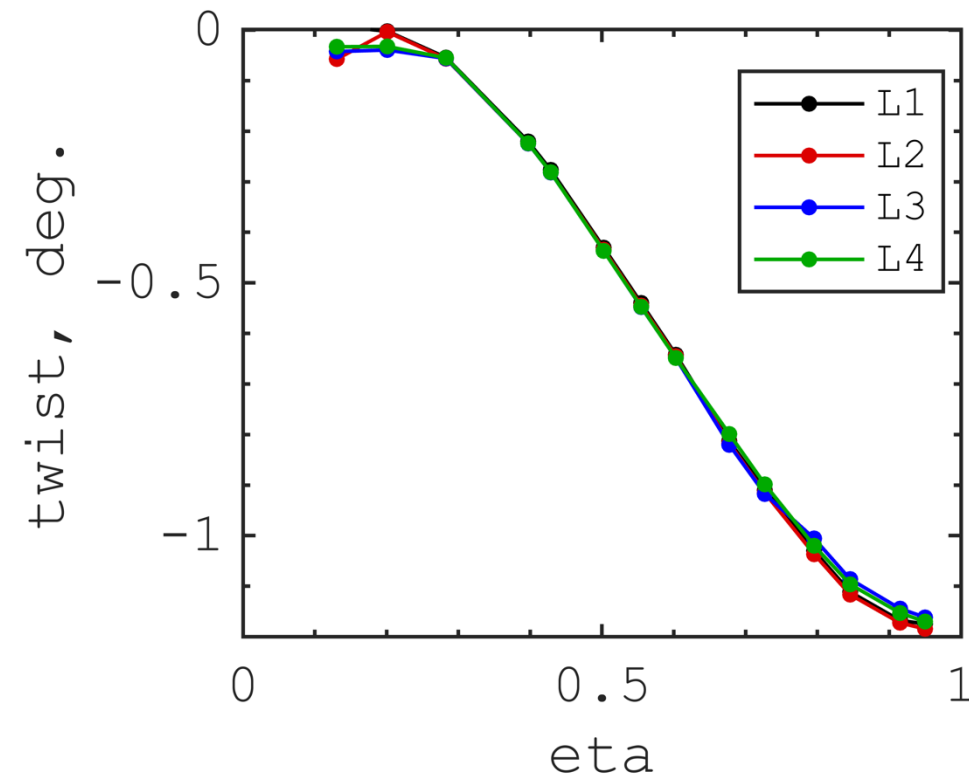
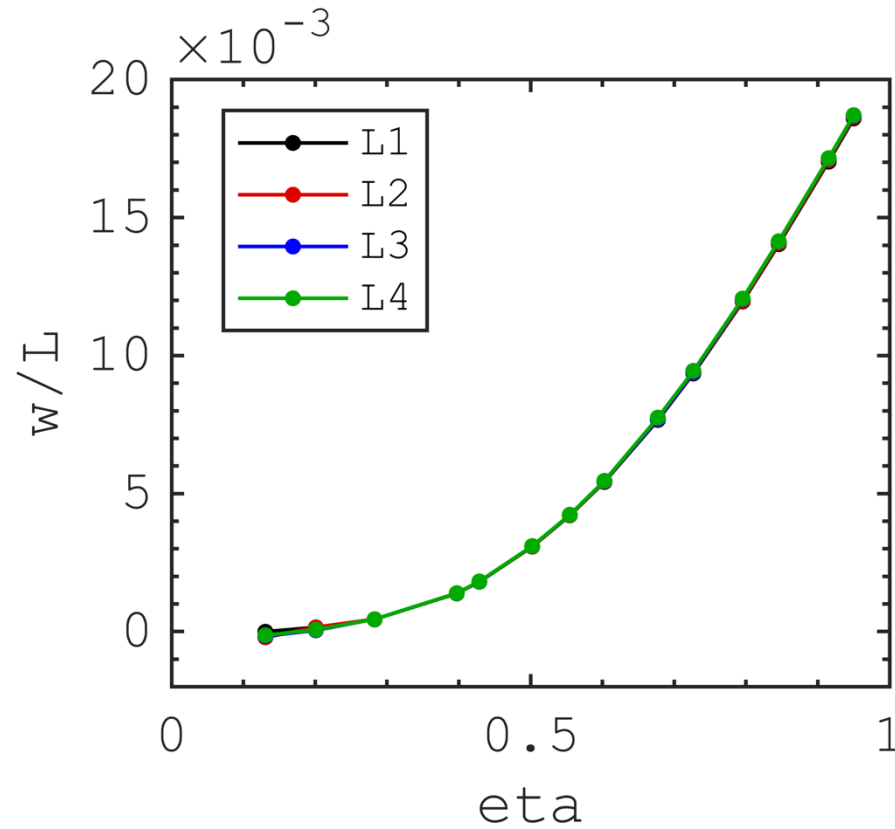


- Mach = 0.85, Re = 5M, CL = 0.5

	L1	L2	L3	L4
AoA	2.54481	2.50852	2.49561	2.48780
CL	0.49997	0.50000	0.49999	0.50000
CD	0.02607	0.02580	0.02570	0.02566
CM	-0.08754	-0.08984	-0.09072	-0.09133

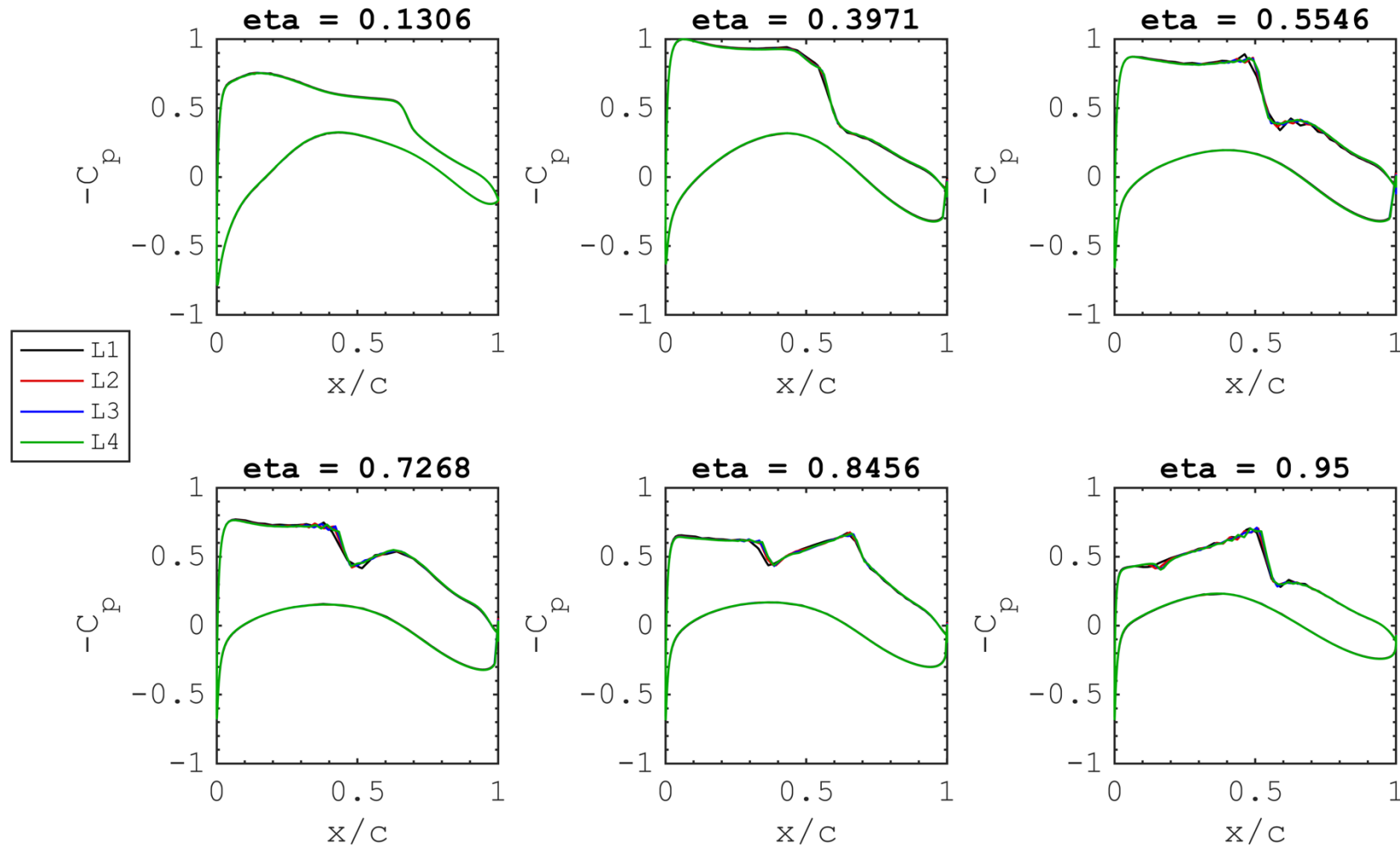
Case 2a(E) Deformations

- **Mach = 0.85, Re = 5M, CL = 0.5**



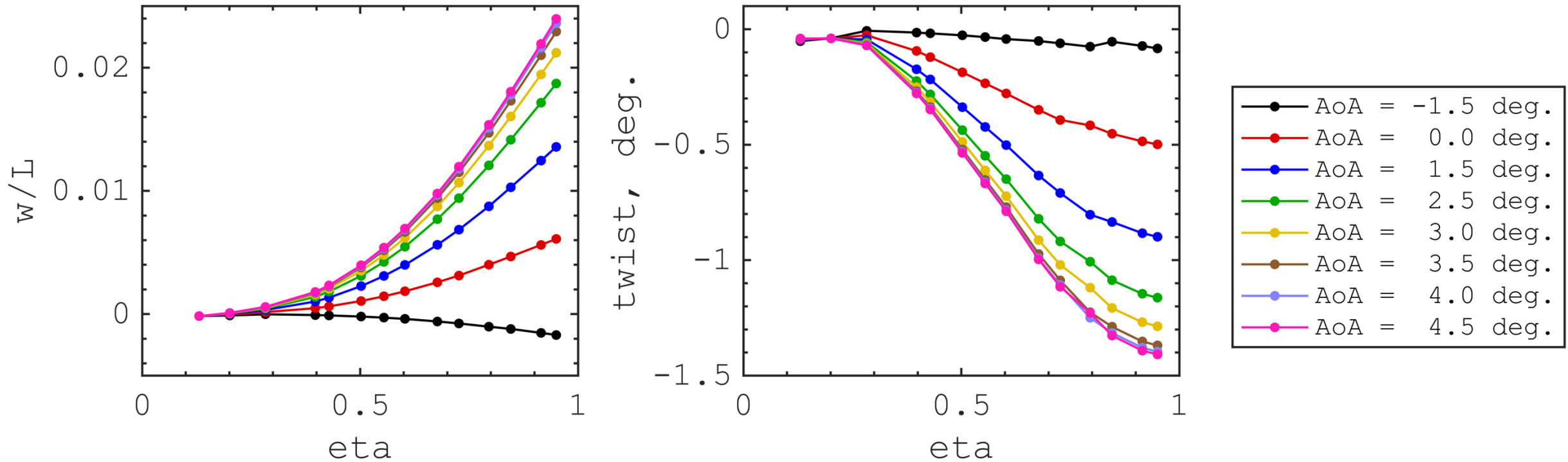
Case 2a(E) Pressures

- **Mach = 0.85, Re = 5M, CL = 0.5**



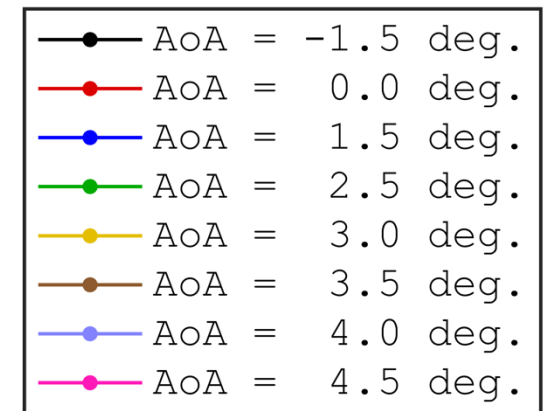
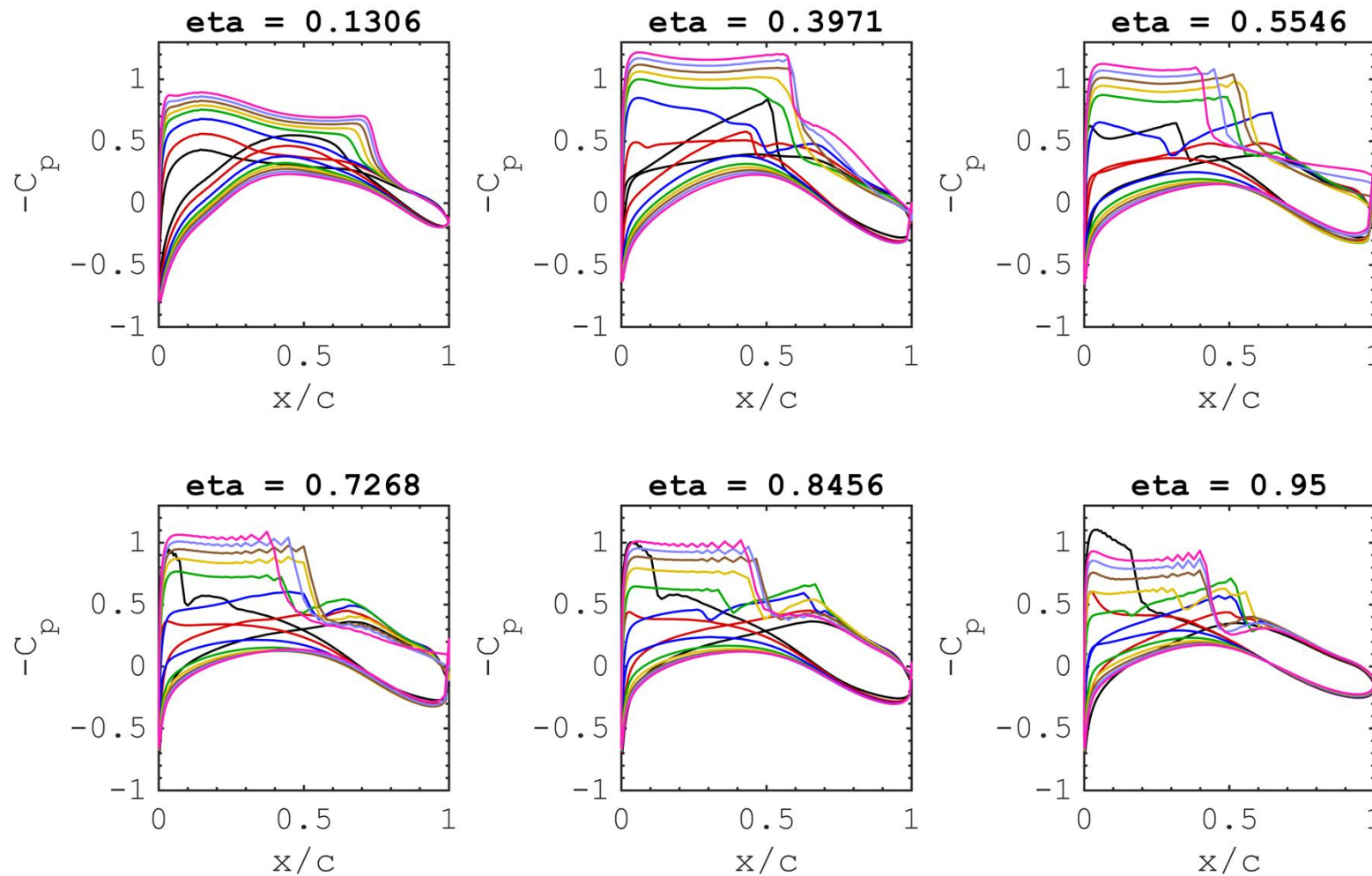
Case 2b(E) Deformations

- Mach = 0.85, Re = 5M, AoA-sweep



Case 2b(E) Pressures

- **Mach = 0.85, Re = 5M, AoA-sweep**



- Run results for the L5 mesh
- The SFE solver is under-dissipative for hex-dominated meshes, leading to wiggles in pressures (?)
- Tweak slicing tool, to get smoother elastic twist curves