Results obtained with the DLR TAU Code

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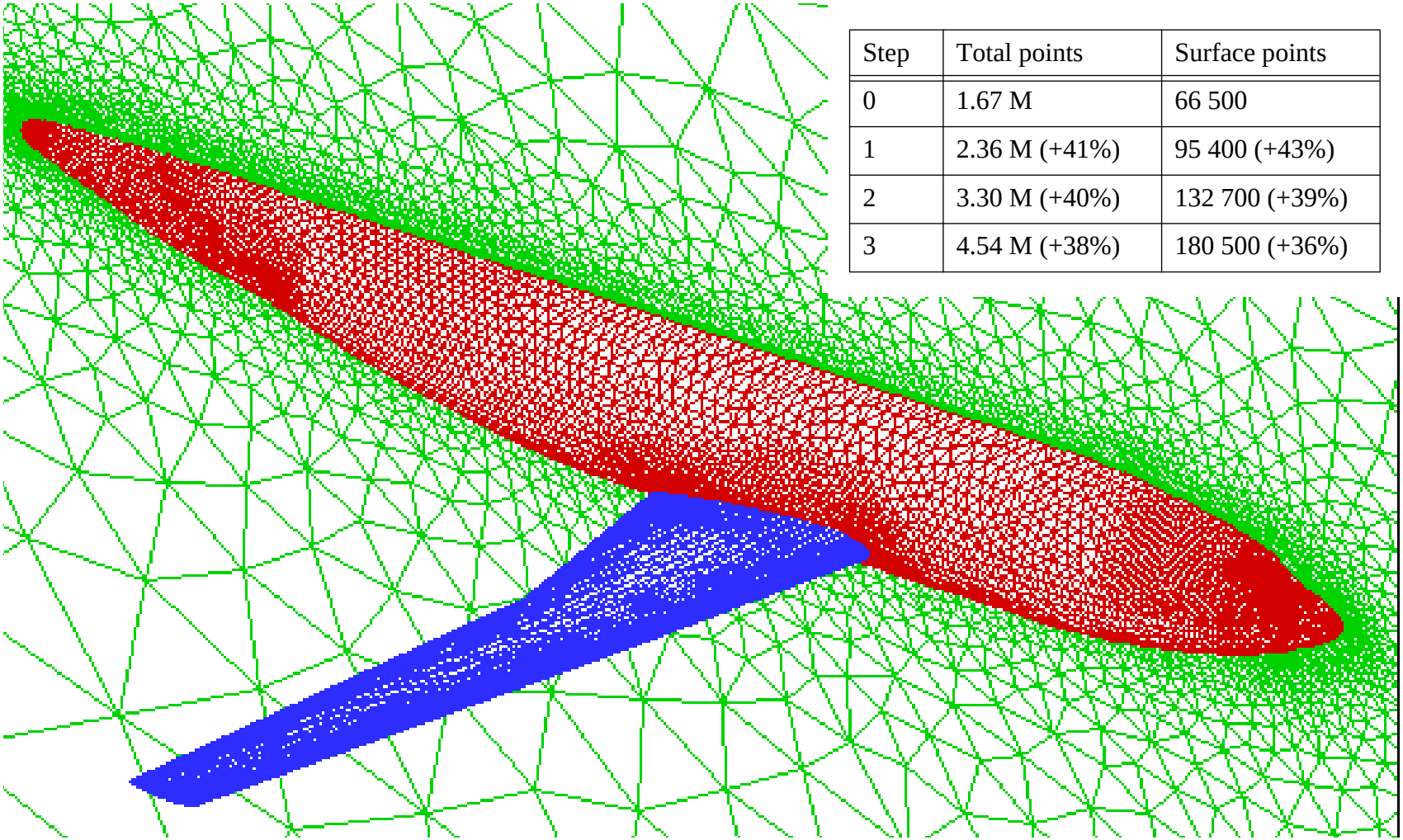
DLR TAU Code

- Finite volume method solving the Euler and Navier-Stokes equations
- employing an edge-based data structure allowing for
- hybrid grids (tetrahedrons, hexahedrons, prisms and pyramids)
- Central or upwind-discretisation of inviscid fluxes
- Runge-Kutta time integration
- accelerated by multi-grid on agglomerated dual-grids
- One- and two-equation turbulence models: Spalart-Allmaras, k-ω
- Parallelized with MPI and optimised for vector- and cache-based computers

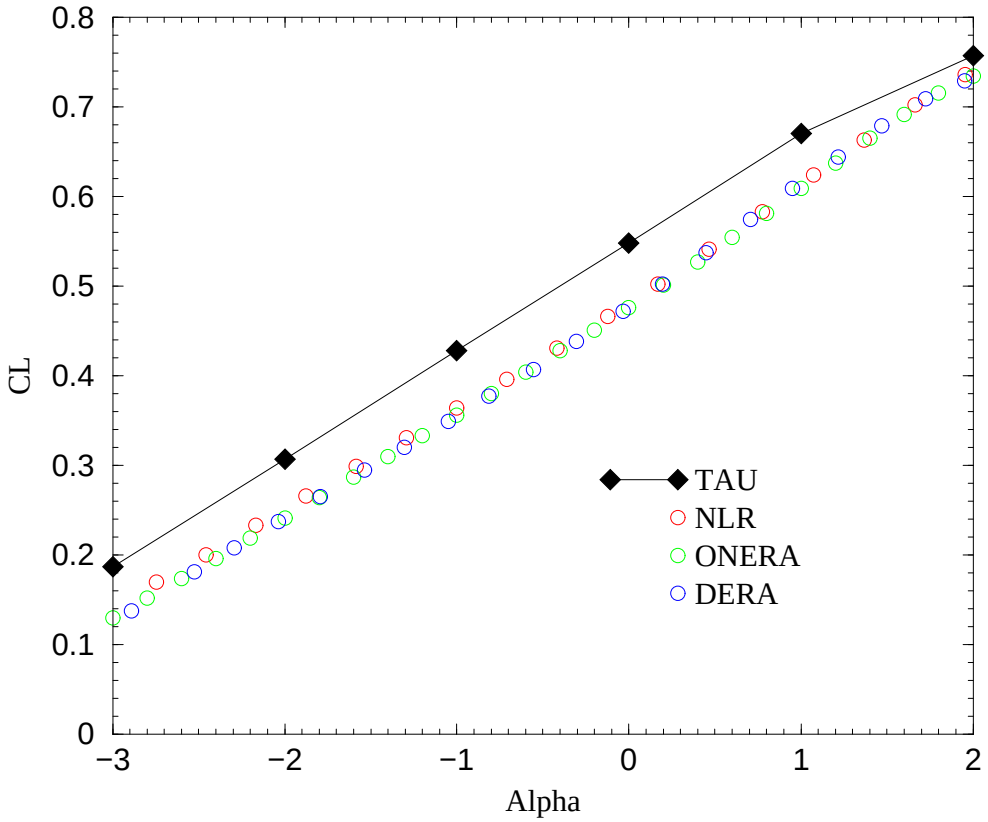
Initial grid (CENTAUR) with adaption (TAU)



Step	Total points	Surface points
0	1.67 M	66 500
1	2.36 M (+41%)	95 400 (+43%)
2	3.30 M (+40%)	132 700 (+39%)
3	4.54 M (+38%)	180 500 (+36%)

DLR−F4 Wing−Body Results

Case 2: M=0.75, Re=3e6



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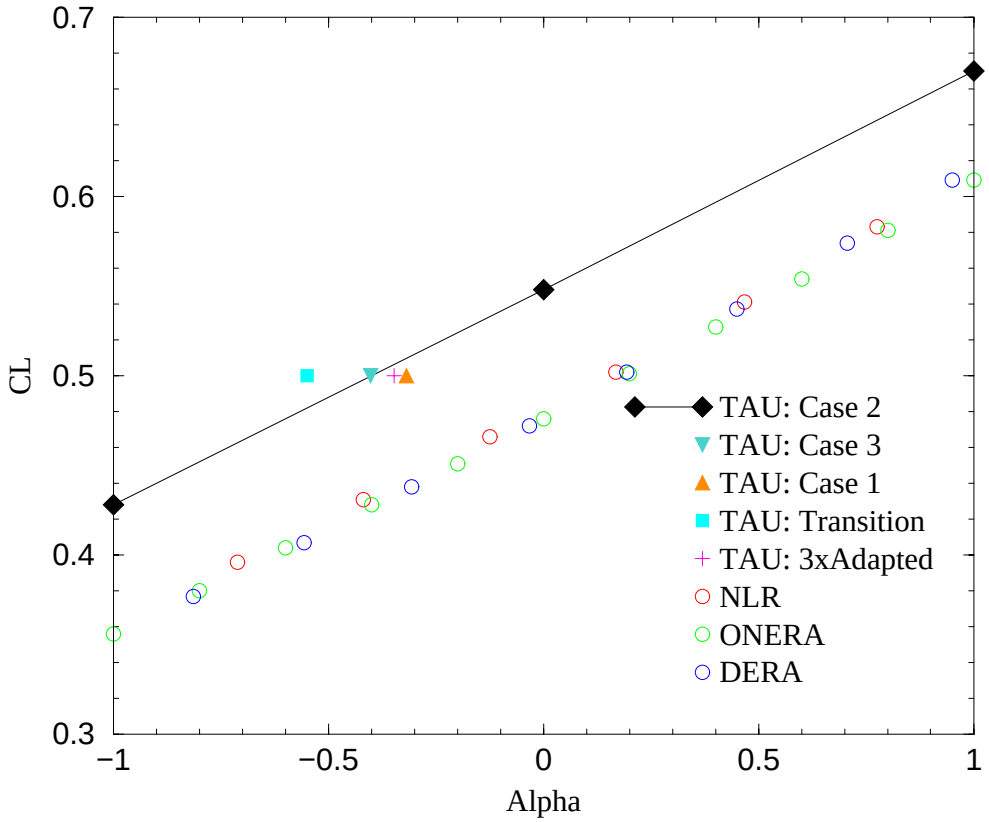

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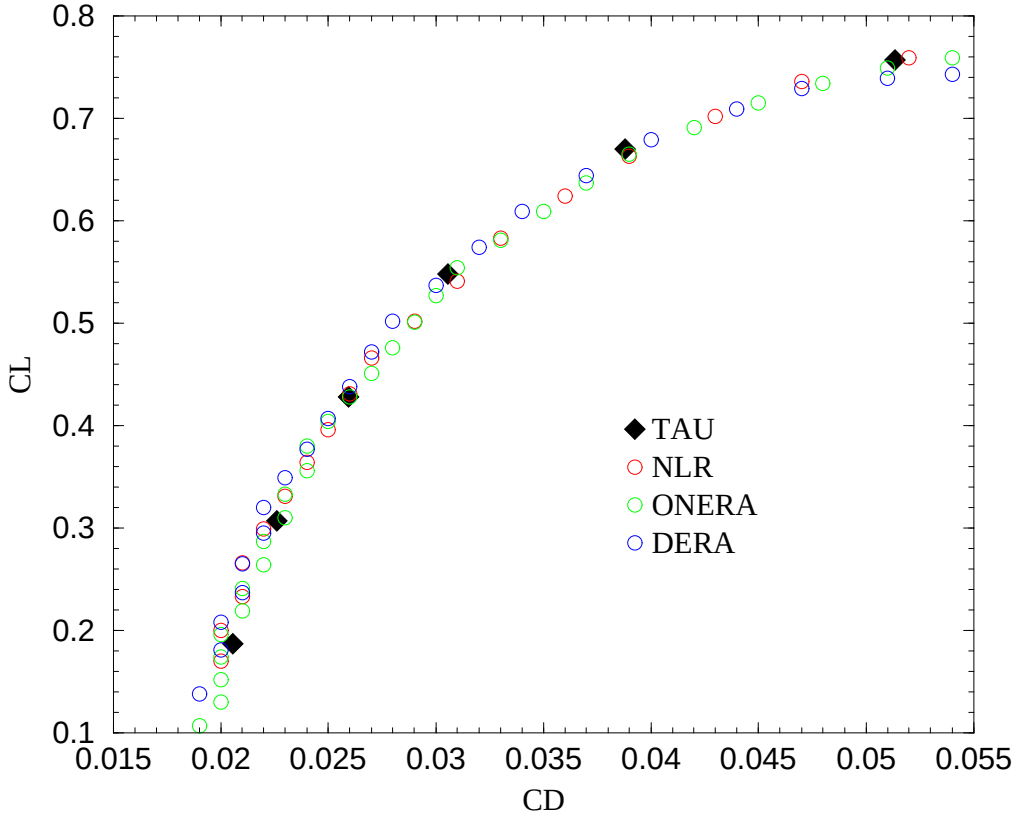

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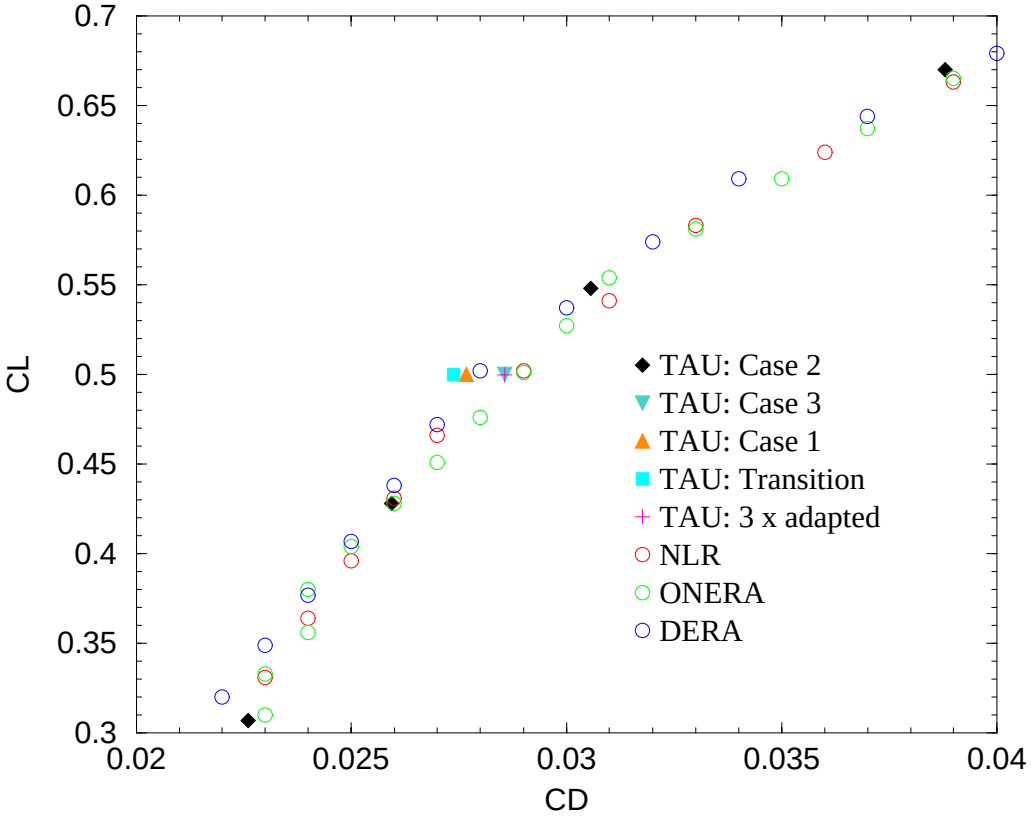

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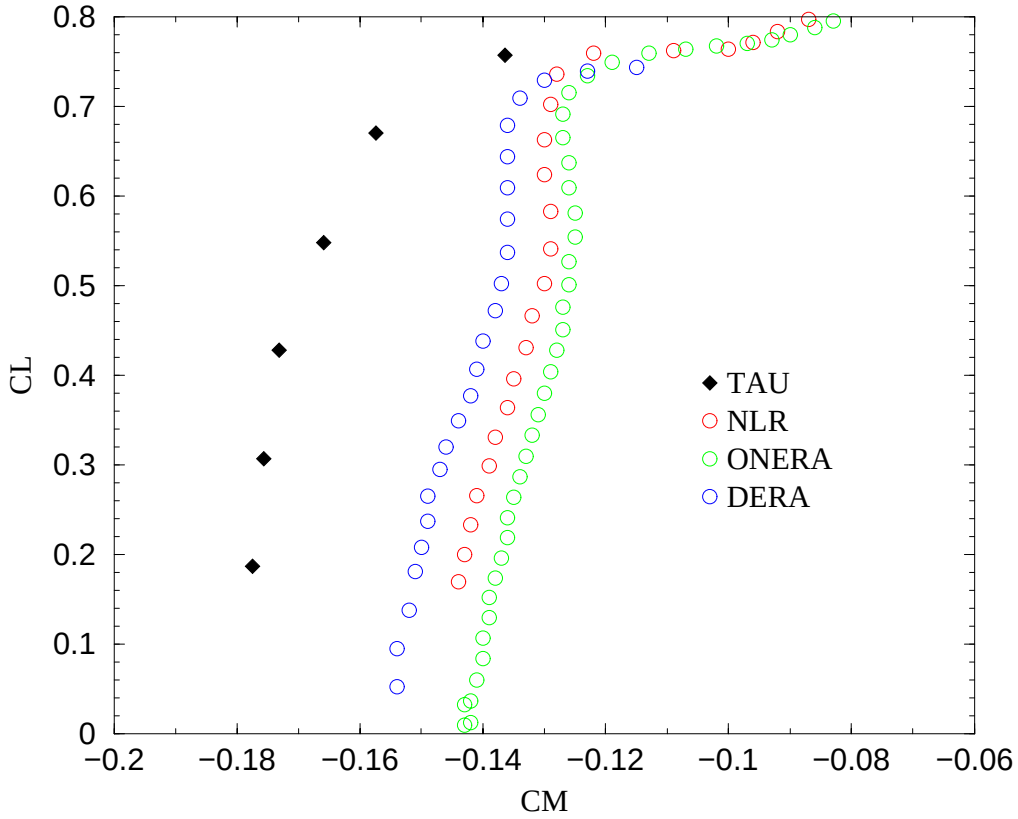
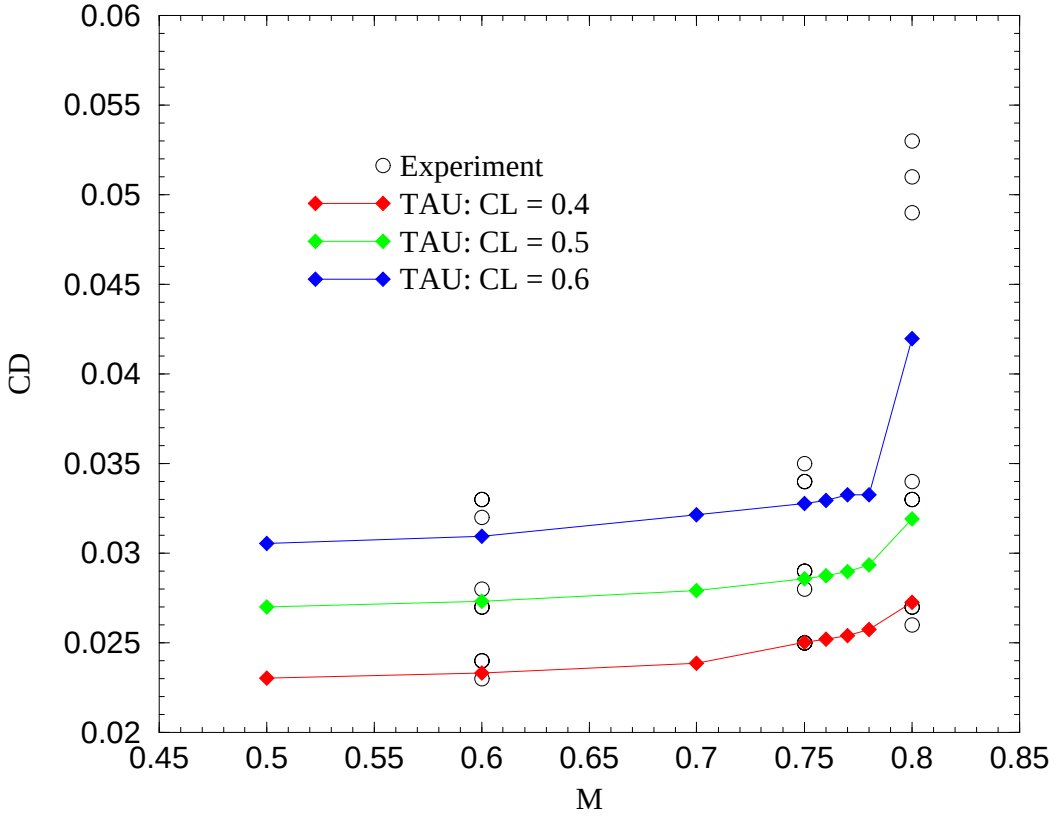


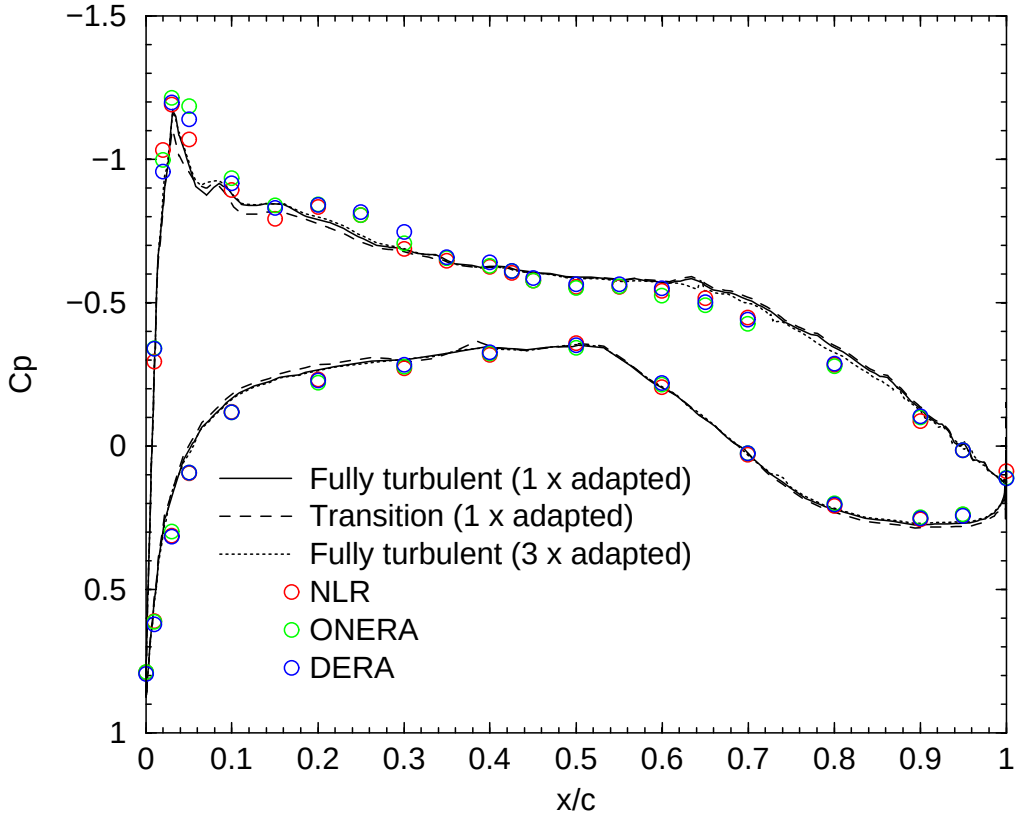
DLR−F4 Wing−Body Results

Drag Rise Curves



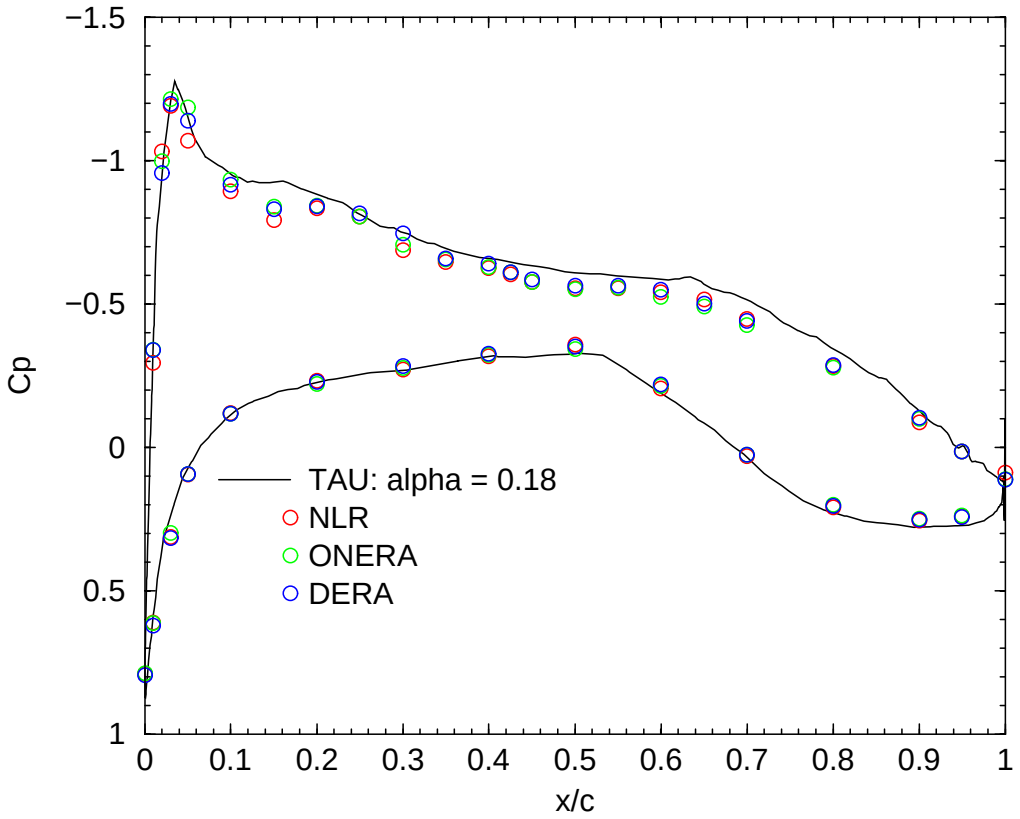
DLR−F4 Wing−Body Results

Case 3: M=0.75, CL = 0.5, neta: 0.185



DLR−F4 Wing−Body Results

Case 3: M=0.75, alpha = 0.18, neta: 0.185



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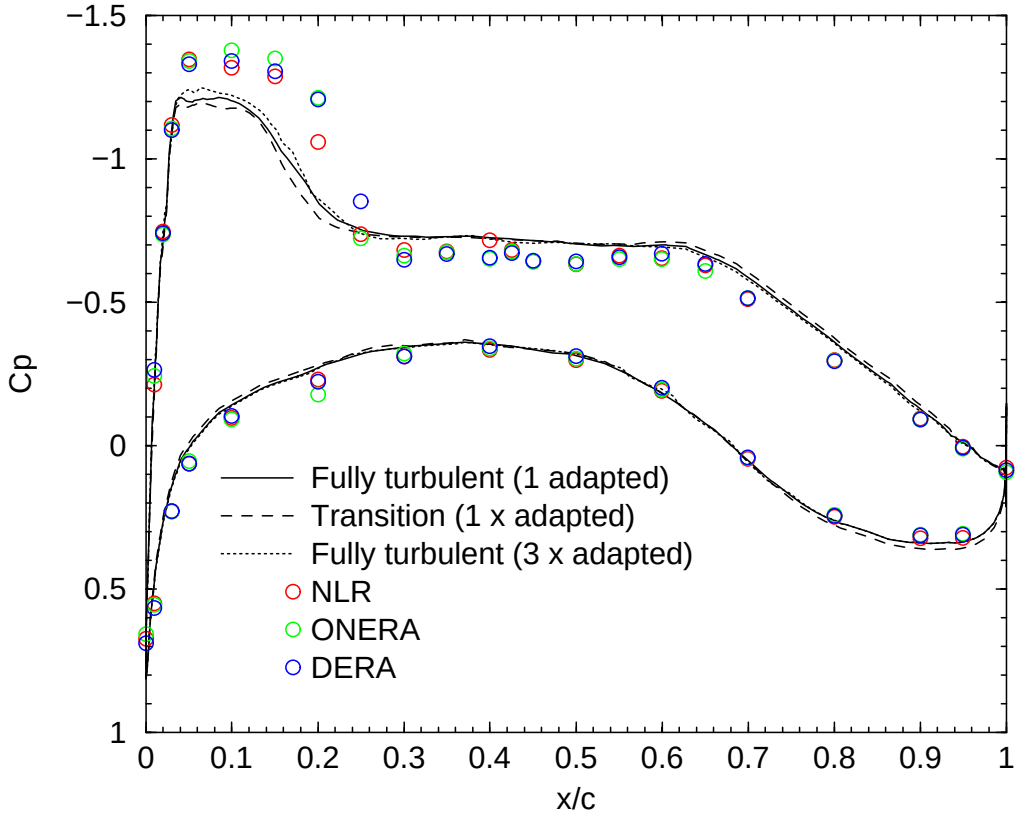
DLR−F4 Wing−Body Results

Case 3: M=0.75, CL = 0.5, neta: 0.331



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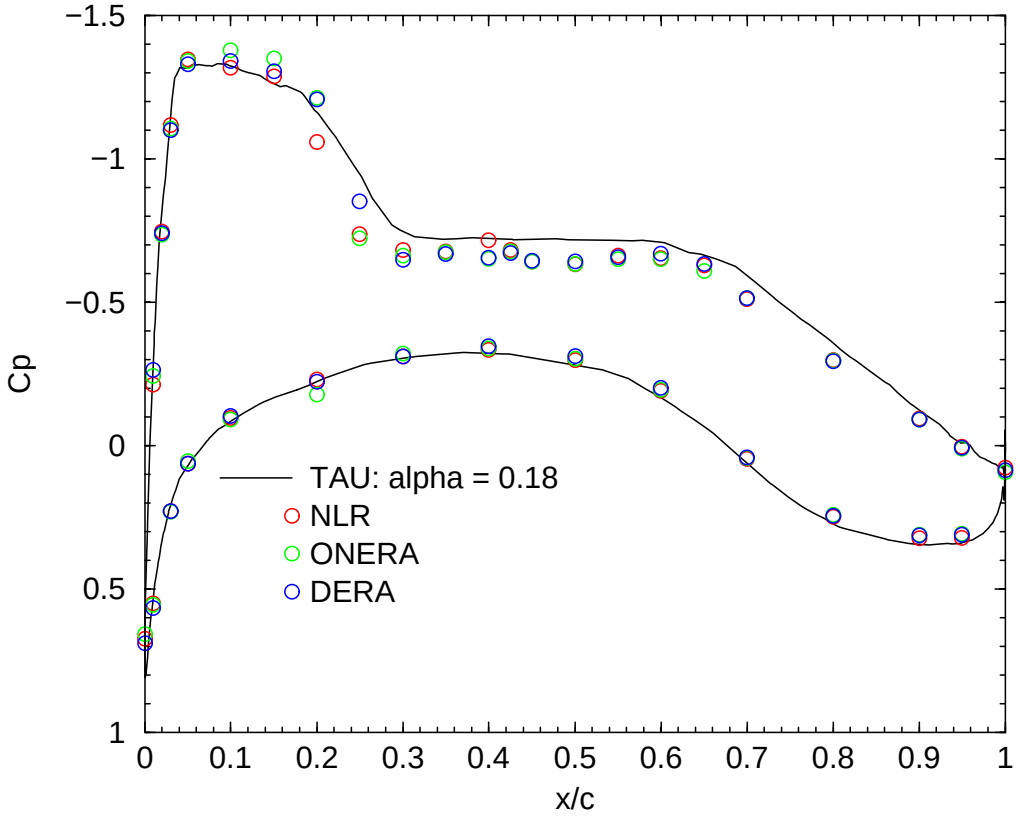
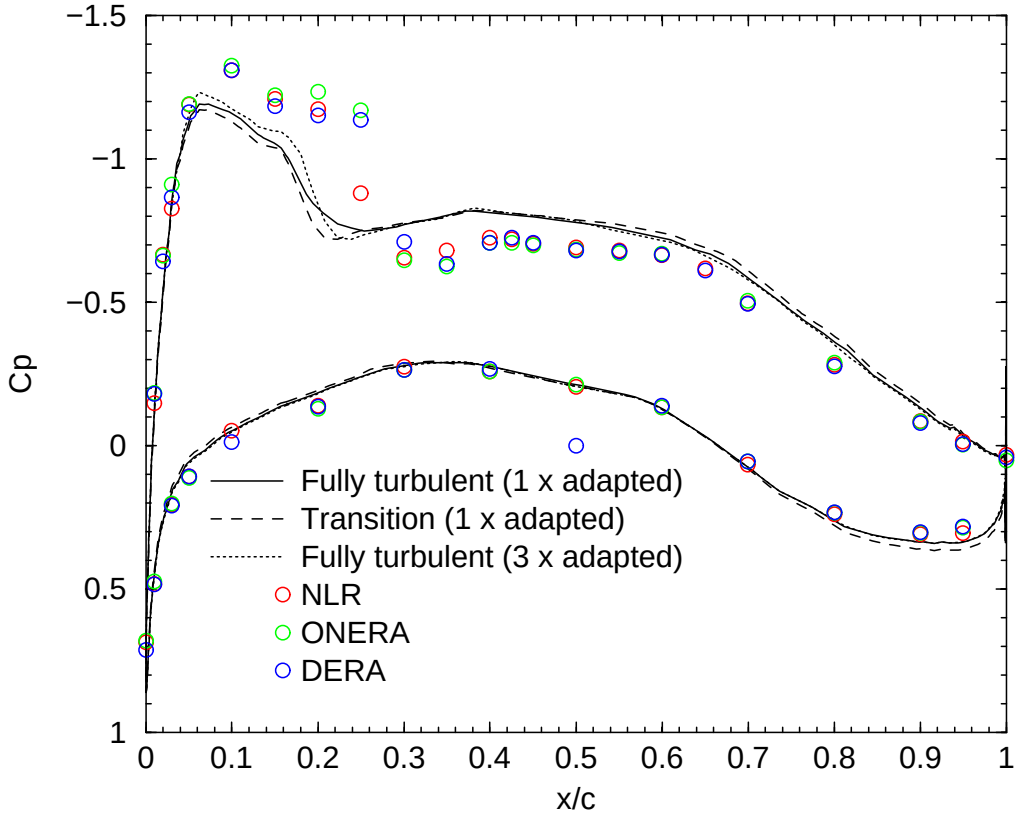


DLR−F4 Wing−Body Results

Case 3: M=0.75, CL = 0.5, neta: 0.512



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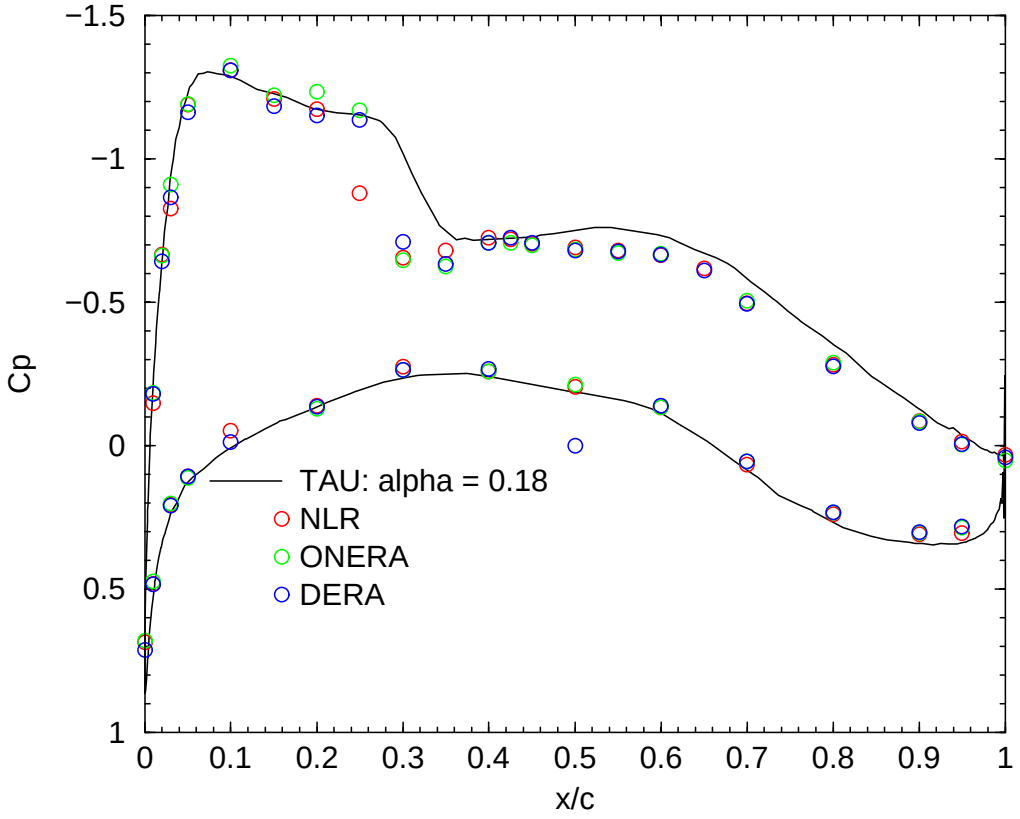
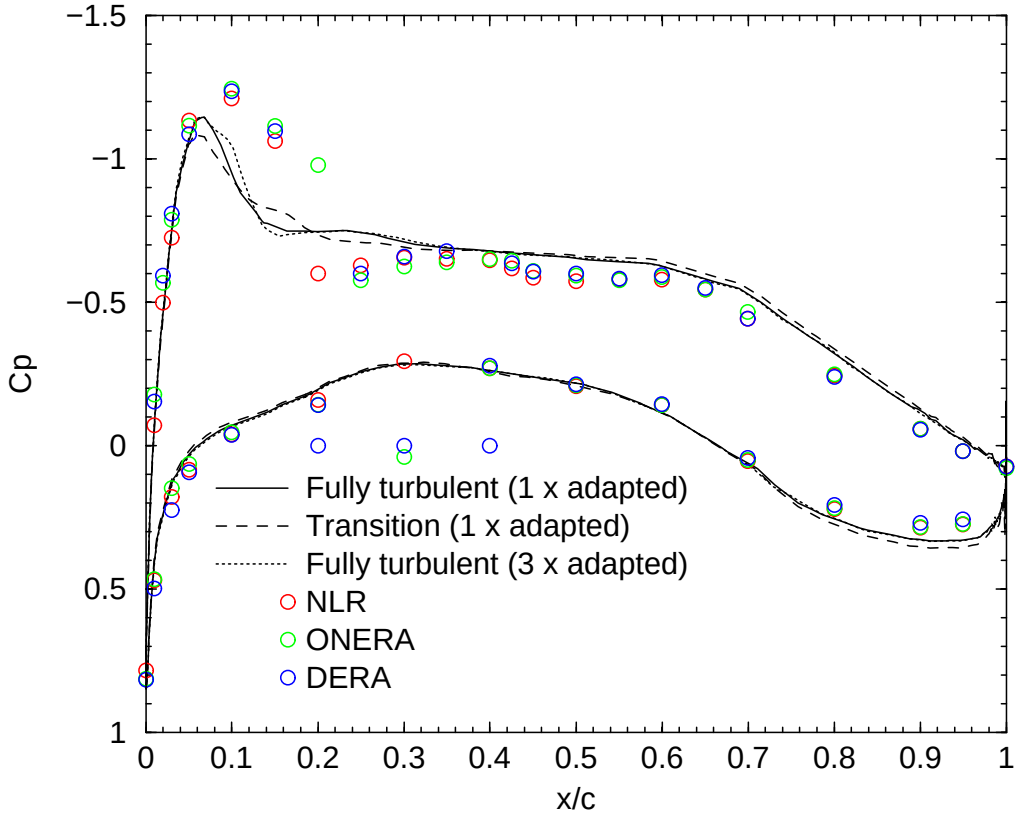


DLR−F4 Wing−Body Results

Case 3: M=0.75, CL = 0.5, neta: 0.844



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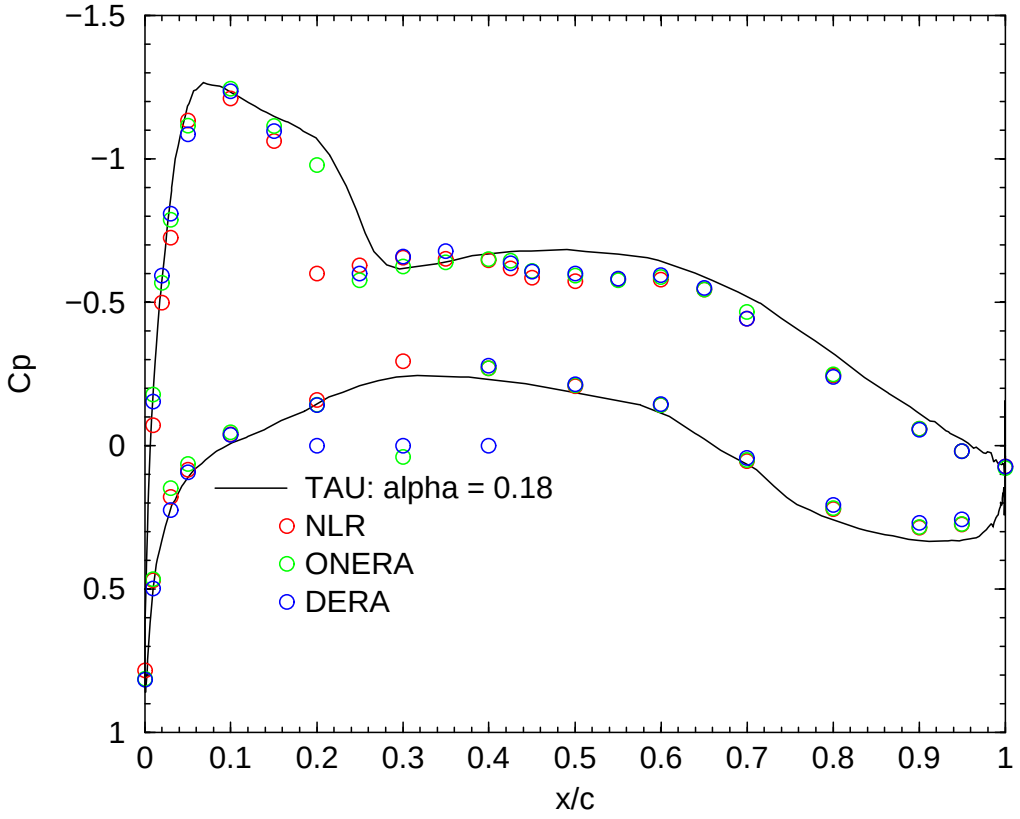


DLR

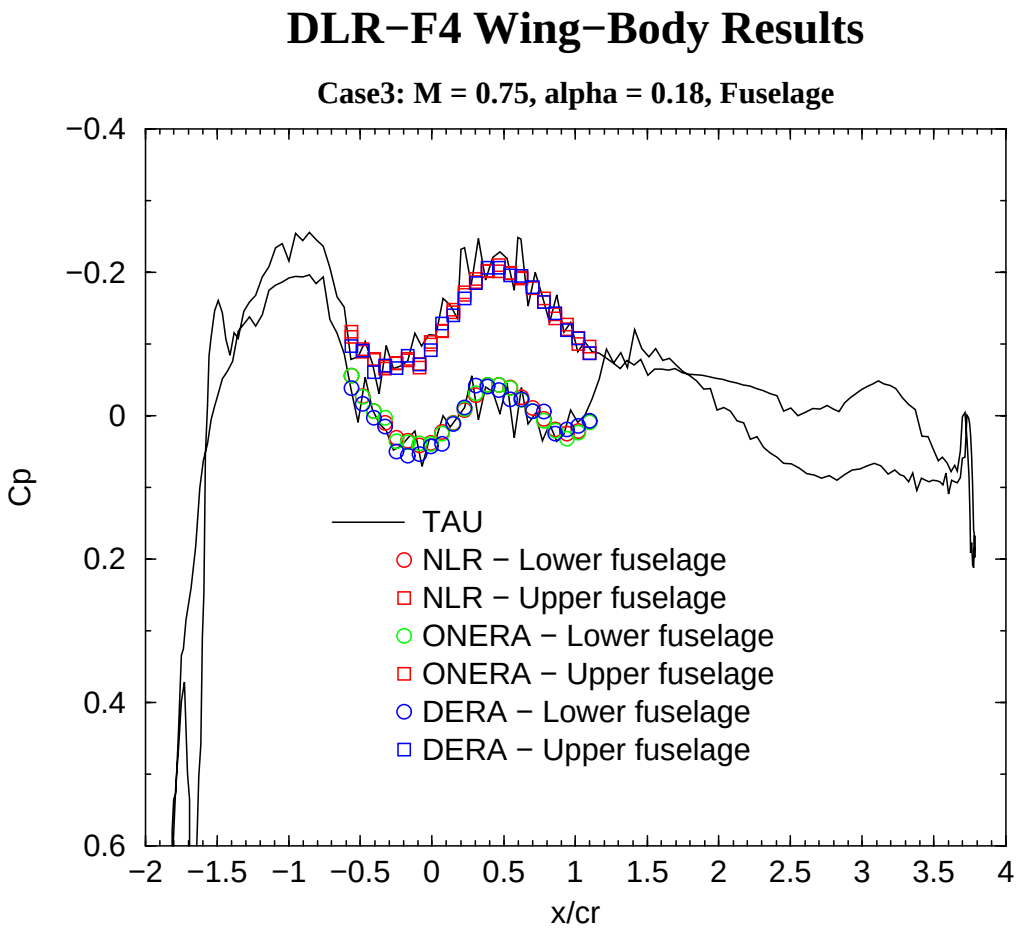
ALPHA = 0.18 (CL = 0.5 in experiment)

CL_{TAU}= 0.5724

LIFT DUE TO PRESSURE

CL_{TAU} (Wing) = 0.4908 (85.7%)

CL_{TAU} (Fuselage) = 0.0818 (14.3%)



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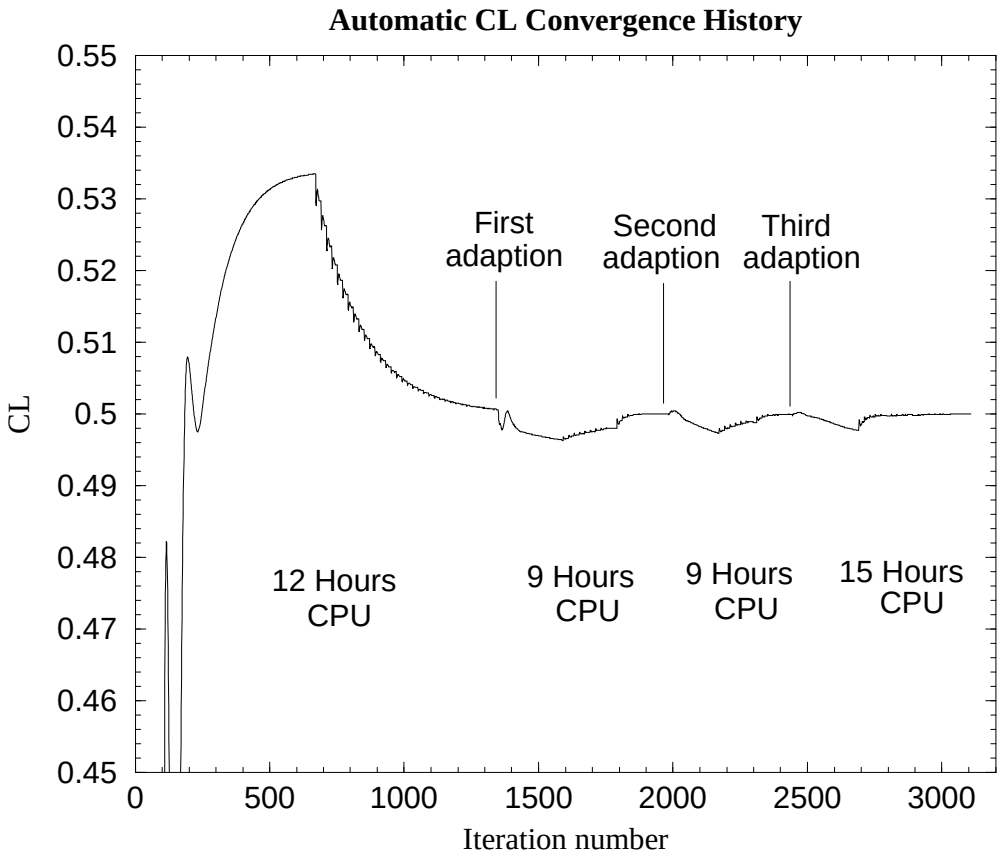

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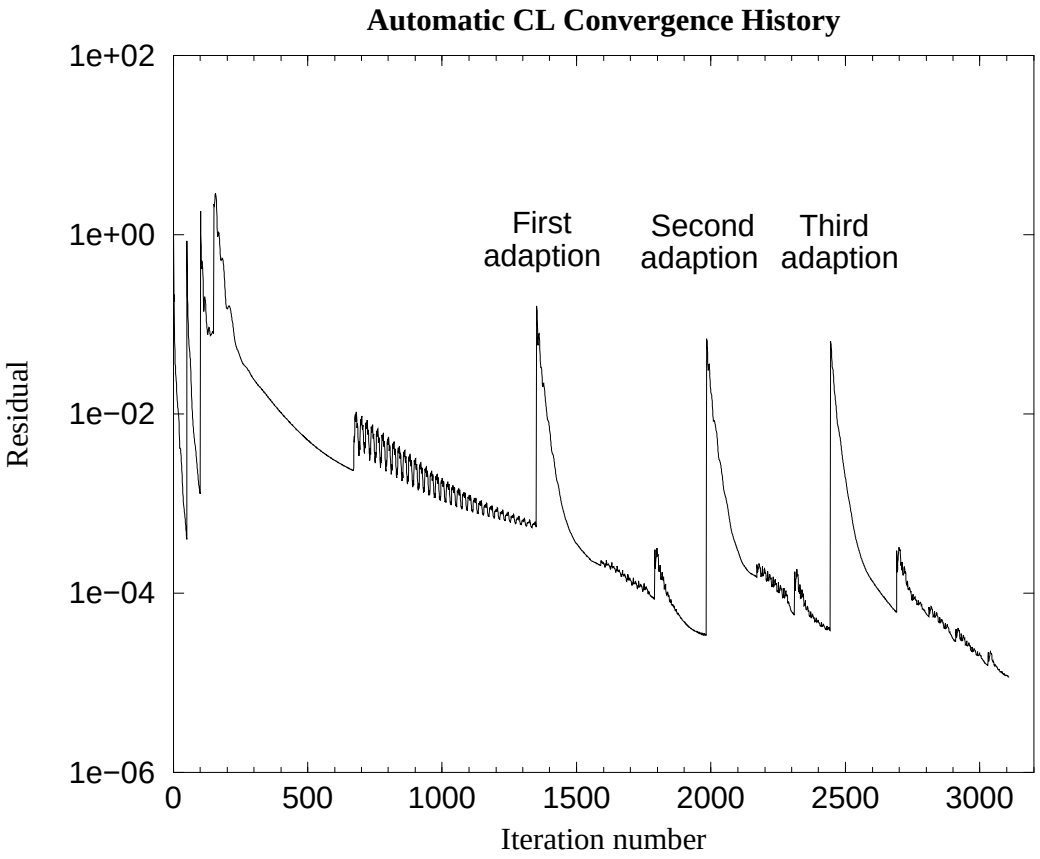

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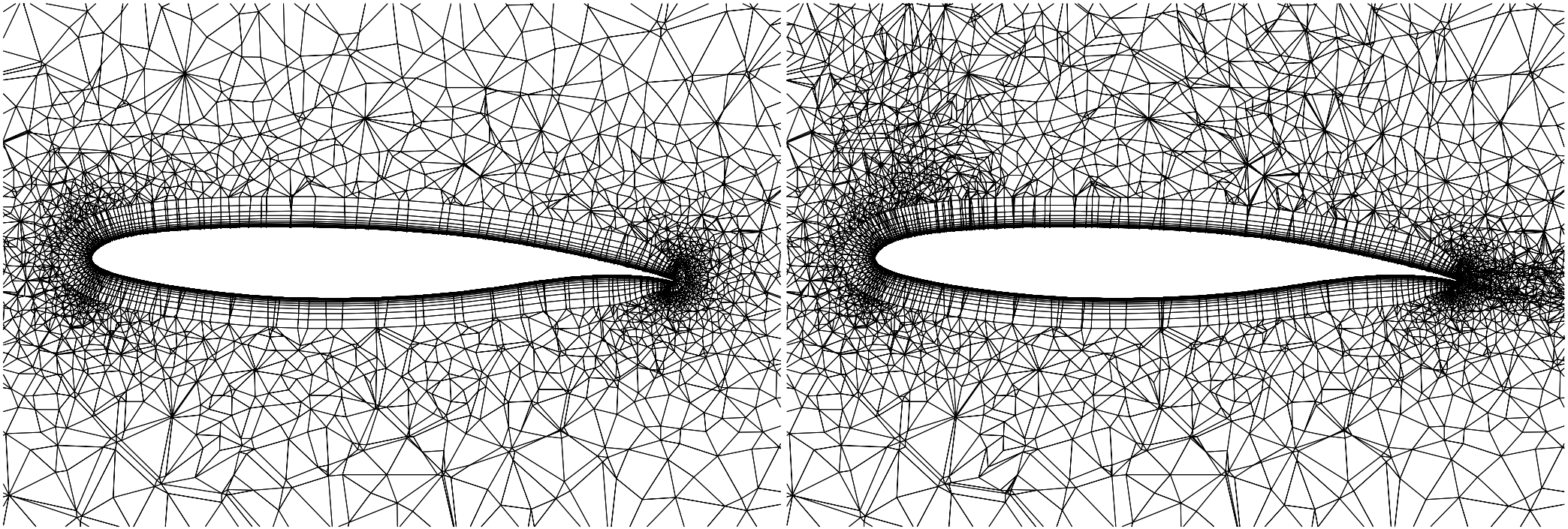
Influence of adaption

Volume grid, neta = 0.512



Initial grid

3 x adapted

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Summary

From the comparison between experiment and “free-air” computations:

- Good match of the drag polar
- Difference in lift at a set angle of attack (~10-15 %)
- Including transition in the calculations sightly increased this lift difference
- Good match between computations and AVAILABLE pressure measurements at same angle of attack (extra lift ?)
- Further adaption had a small influence on the case chosen
- May be different at higher Mach numbers and/or CL
- Influence of turbulence model (e.g. 2-eqn.) ?