DPW-3 DLR F6/FX2B Results

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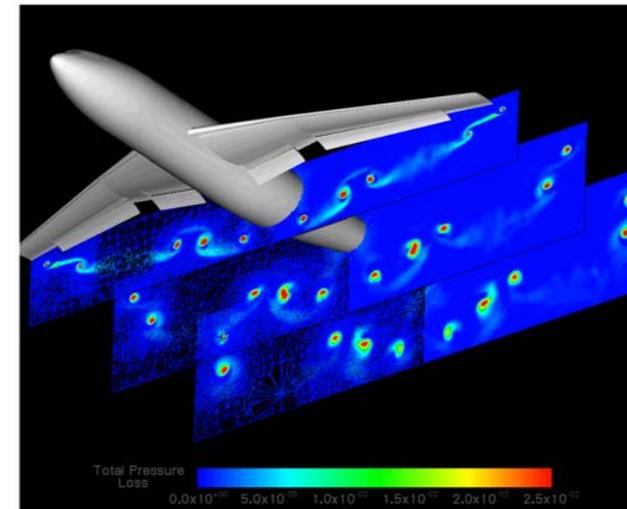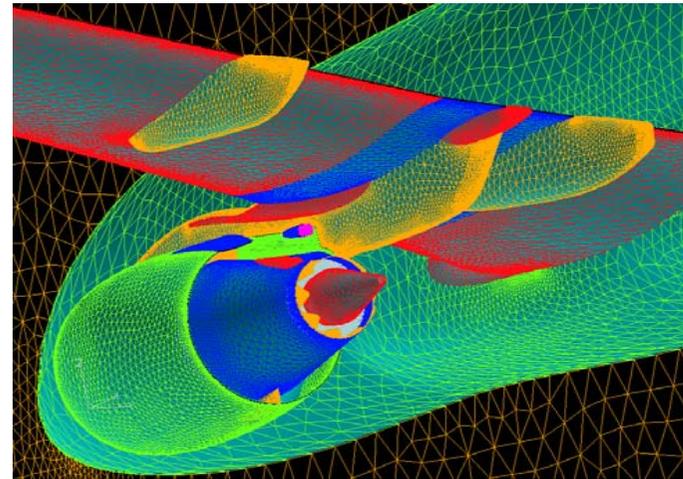
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in der Helmholtz-Gemeinschaft

AIAA
American Institute of
Aeronautics and Astronautics

Method

- RANS solver DLR TAU
- Unstructured database, node based
- State-of-the-Art algorithms
- 1- and 2-eq. turbulence models
- Fluid-Structure coupling
- Overlapping grids
- Grid adaptation
- Hypersonic extensions
- C code and Python scripting
- High performance on parallel machines
- Applied in European aircraft industry
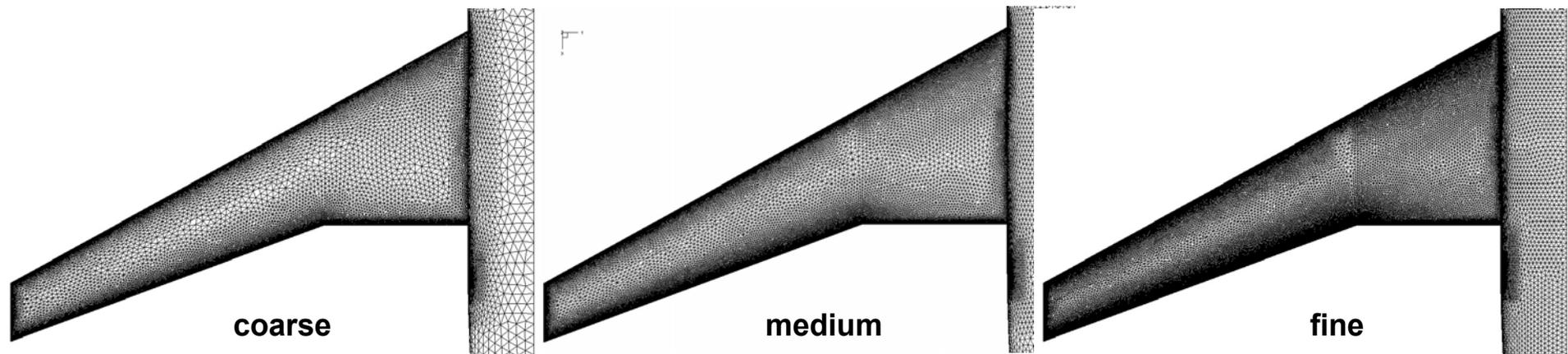 and research

Grids

- Unstructured hybrid grids generated with Centaur from Centaursoft
- Prismatic elements for BL
- 3 grid densities
- Specification of sources for wing surface
- Constant refinement factor

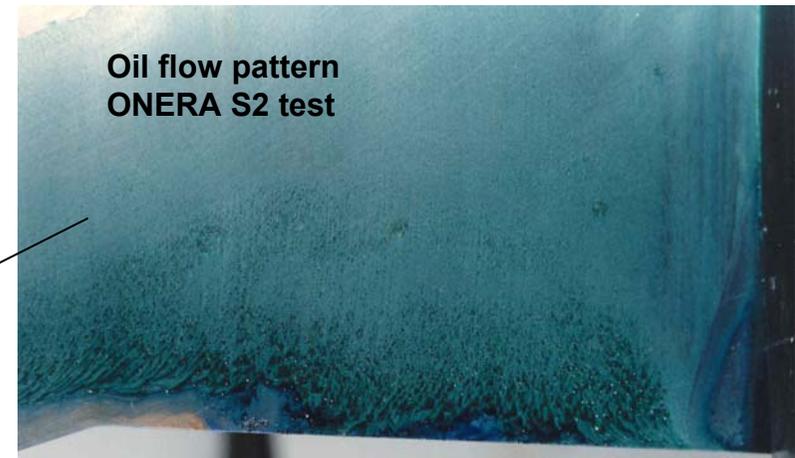|	Coarse	Medium	Fine
Nodes	2.46 (f6wb) 2.87 (fx2b)	5.10 6.11	8.53 10.30
Boundary nodes	45065 60423	85769 112672	121588 167434
Prismatic layers	21	31	40

coarse

medium

fine

Results

- TAU sae, medium prismatic grids, CL=0.5
- DPW-2:
  - separations Wing/fuselage, pylon/wing found
  - no trailing edge flow separation
- Flow separation at fuselage wing junction
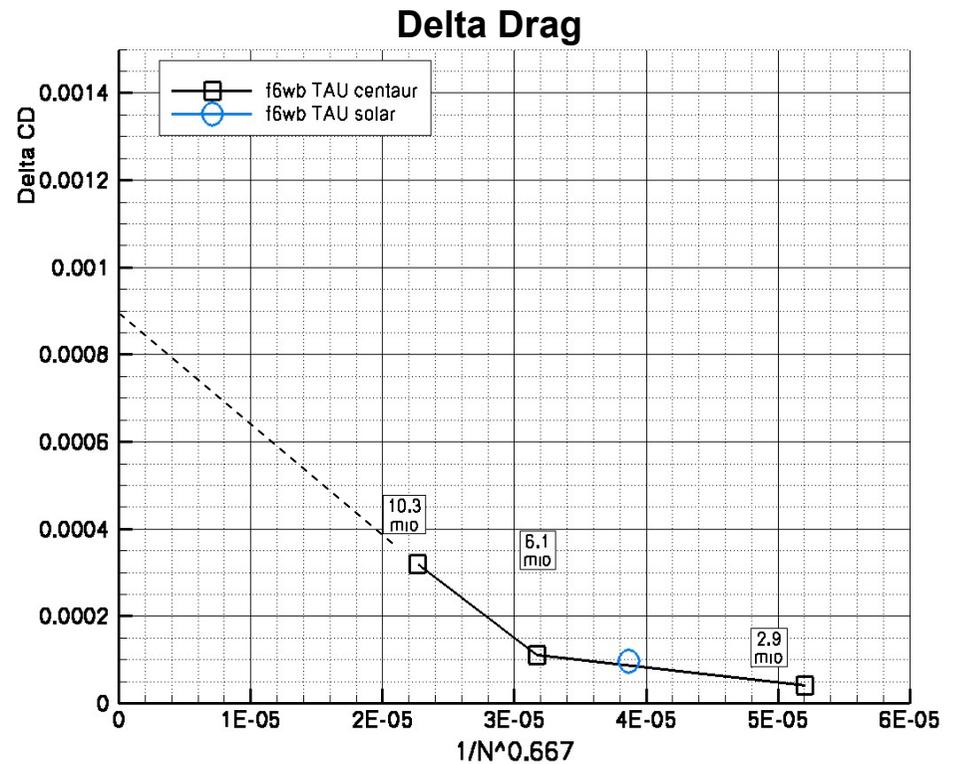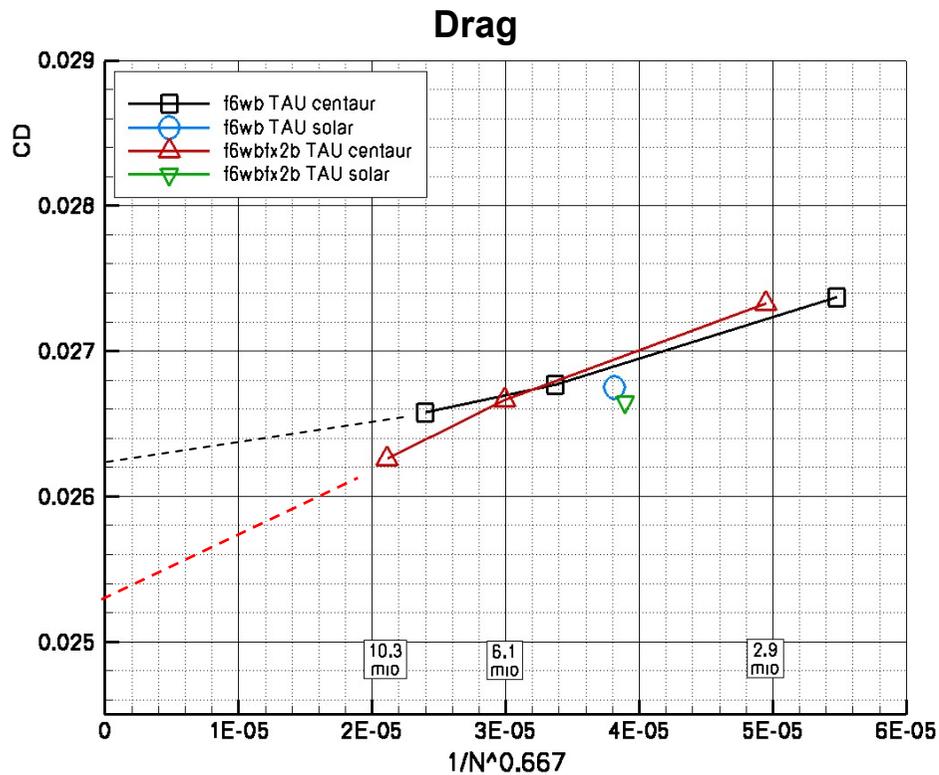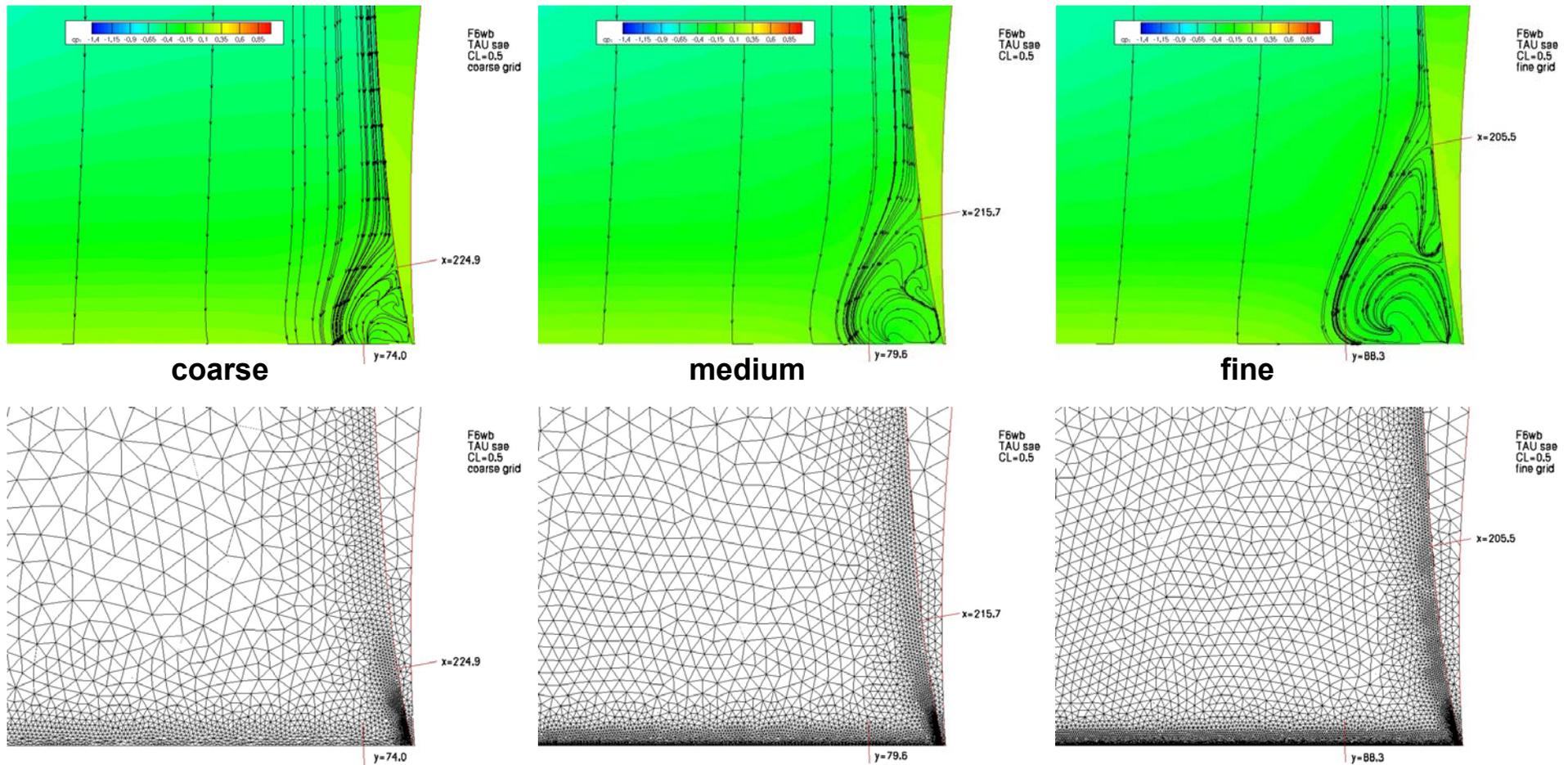- No separation for FX2B (all α)

F6fx2b

F6wb

**Oil flow pattern
ONERA S2 test**

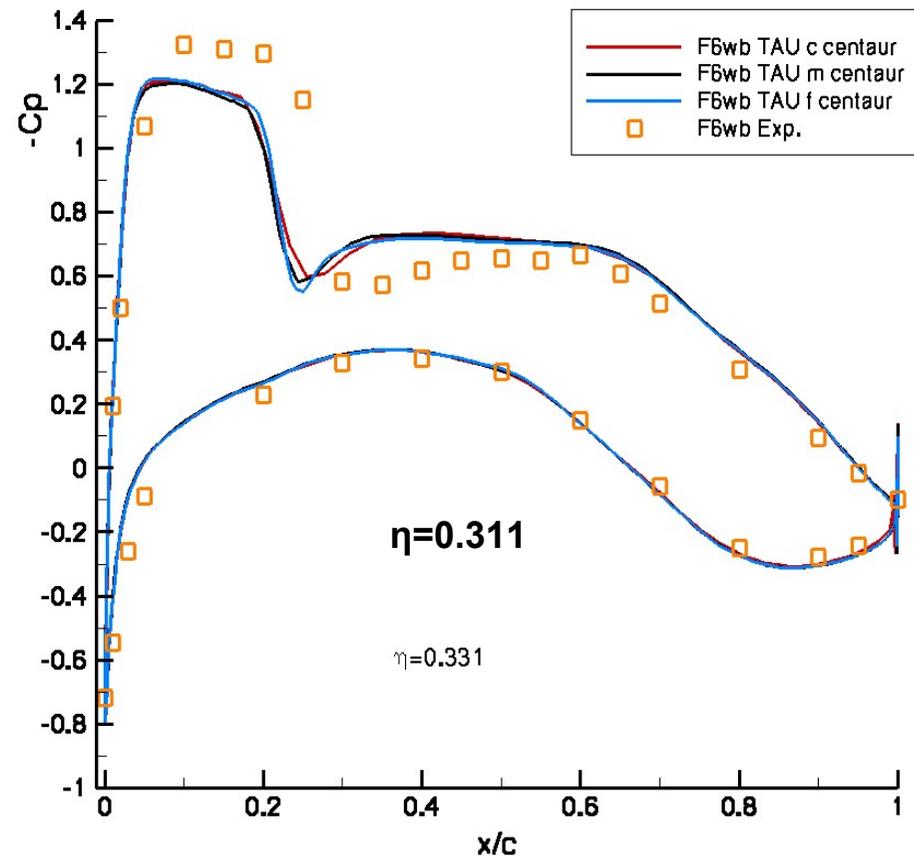# Results: Grid Influence
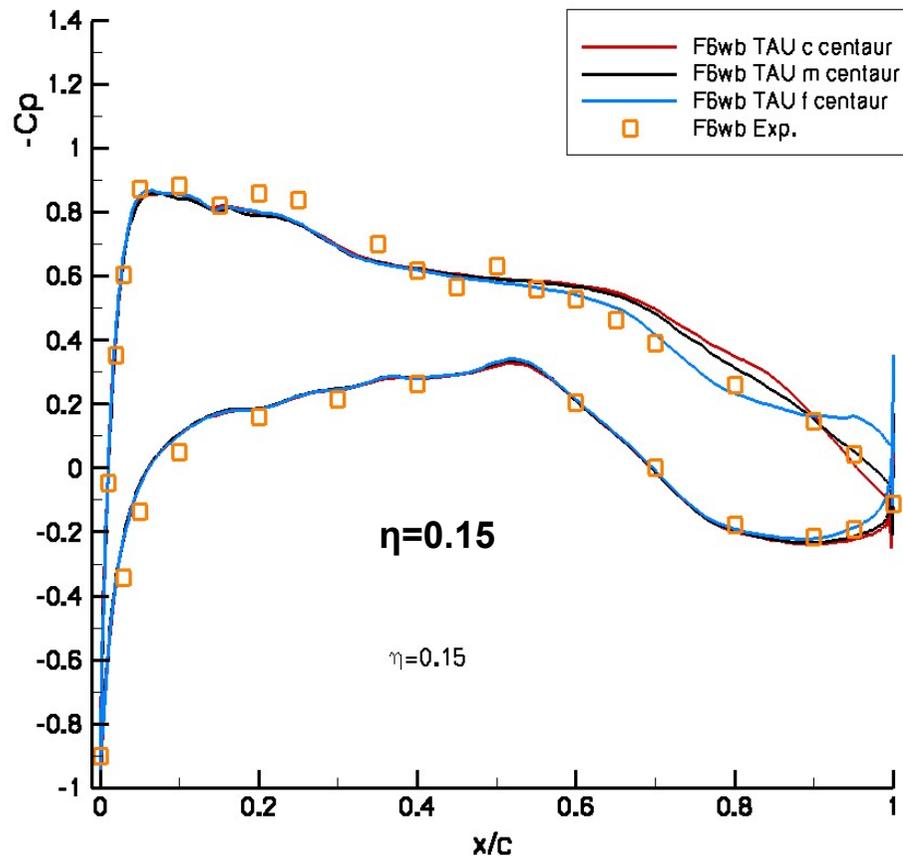
Convergence Study

Results: Grid Influence

Influence on Flow Separation F6wb for CL=0.5

coarse
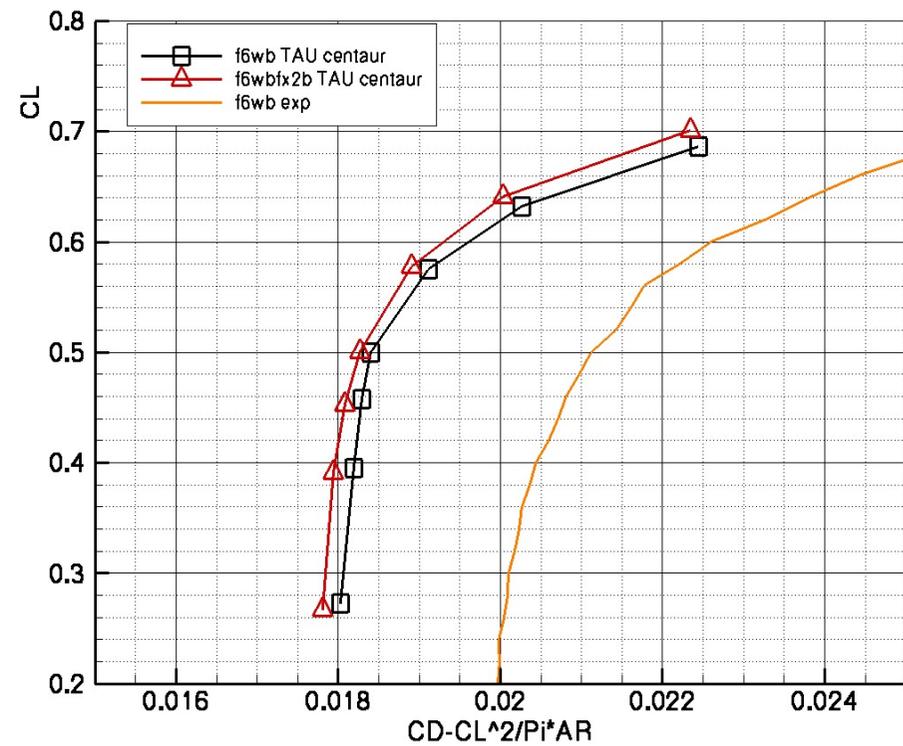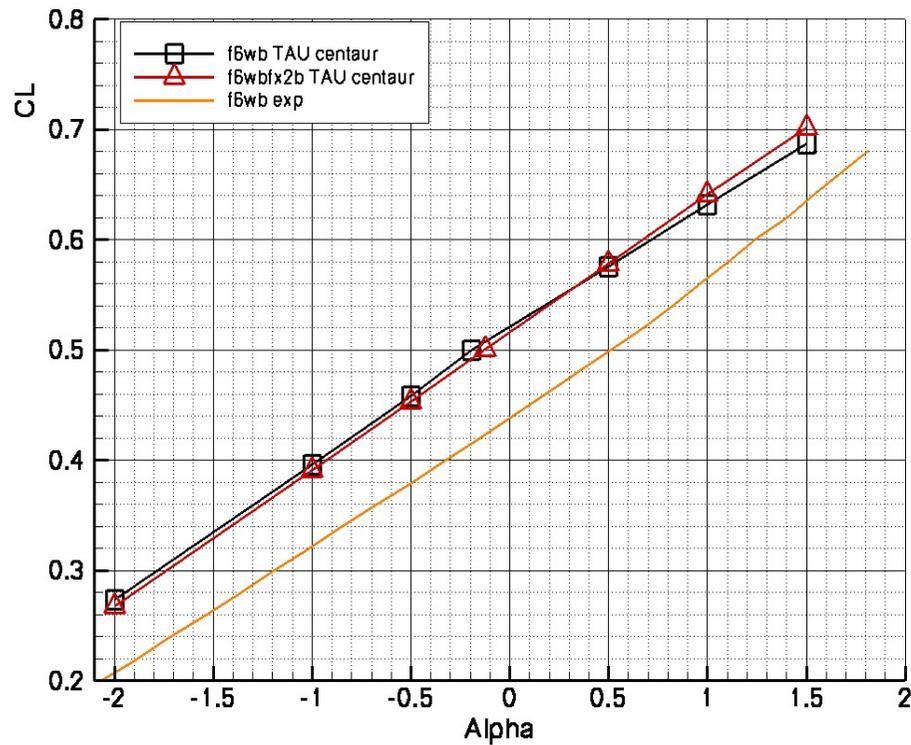
medium

fine

Results: Grid Influence
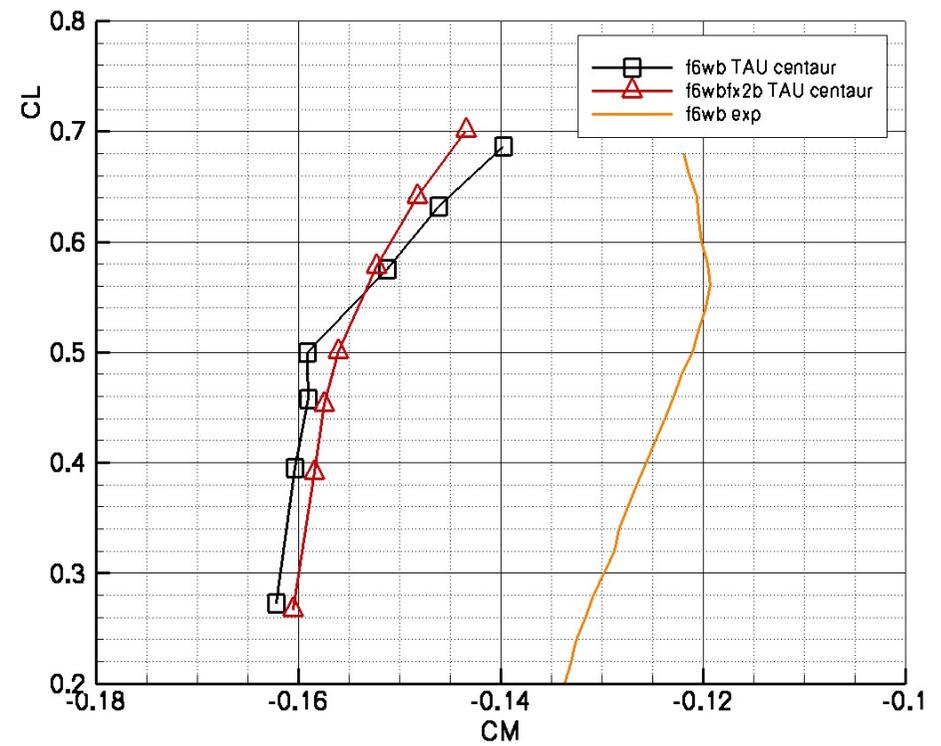
Influence on Cp for CL=0.5
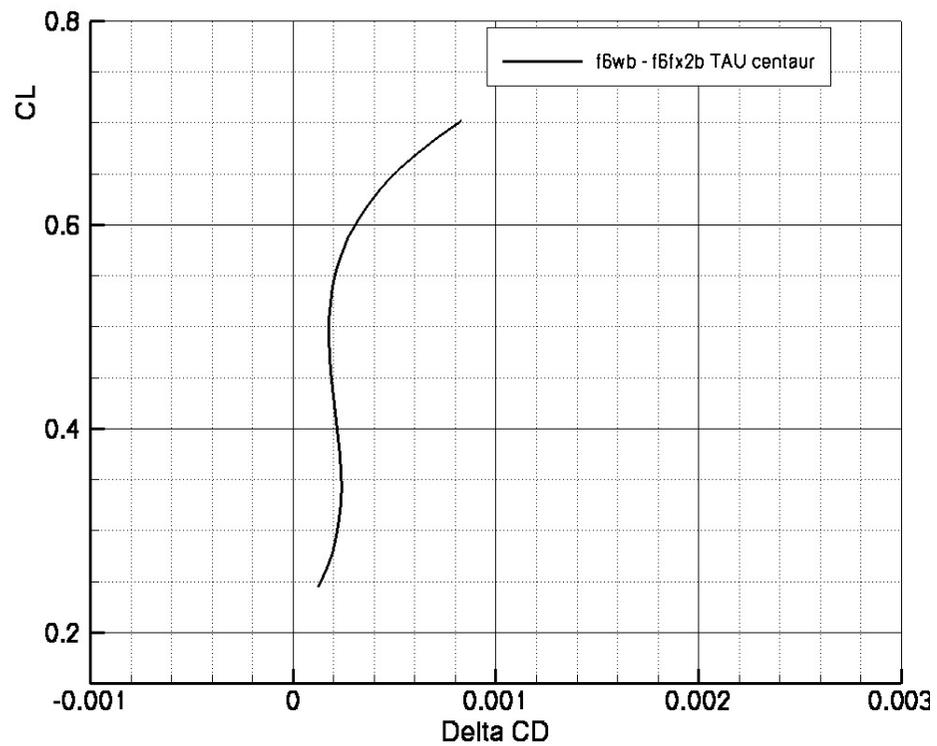
Results: F6 / F6FX2B
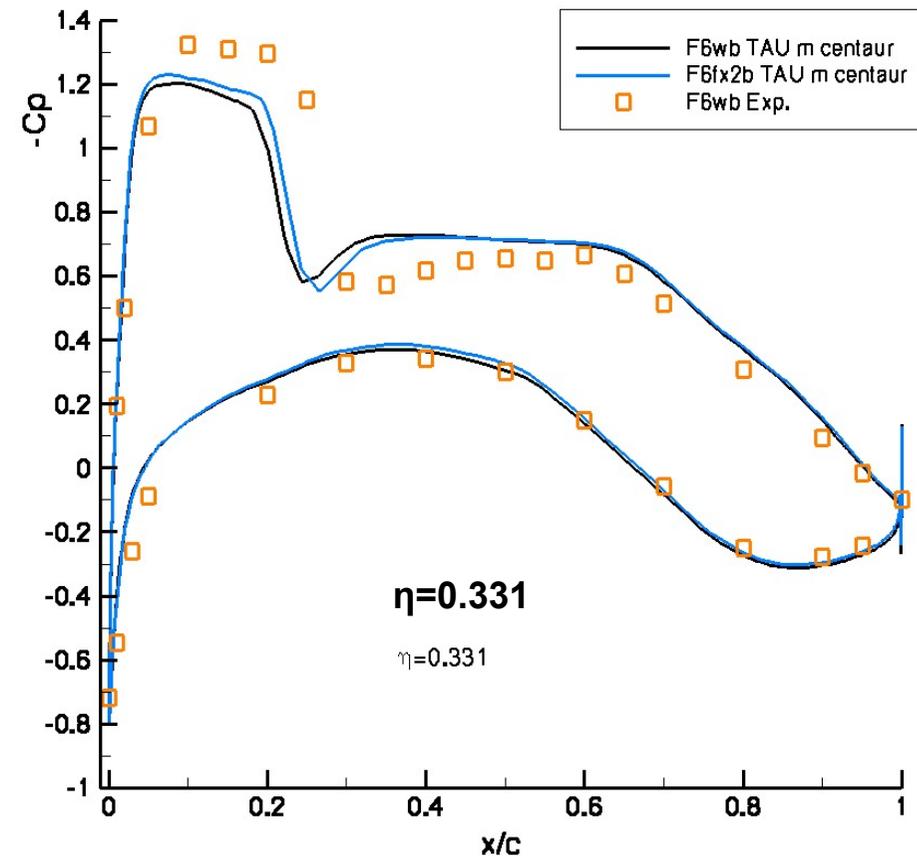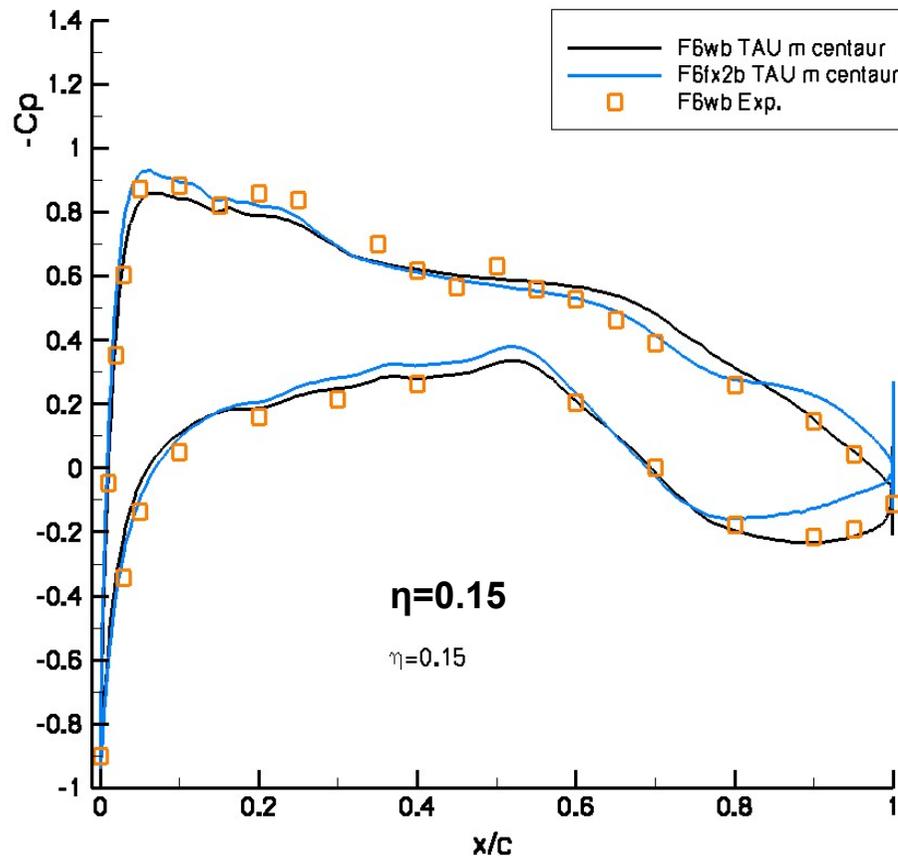
Medium Grid: lift and drag

Results: F6 / F6FX2B

Medium Grid: delta drag , moments

Results: F6 / F6FX2B
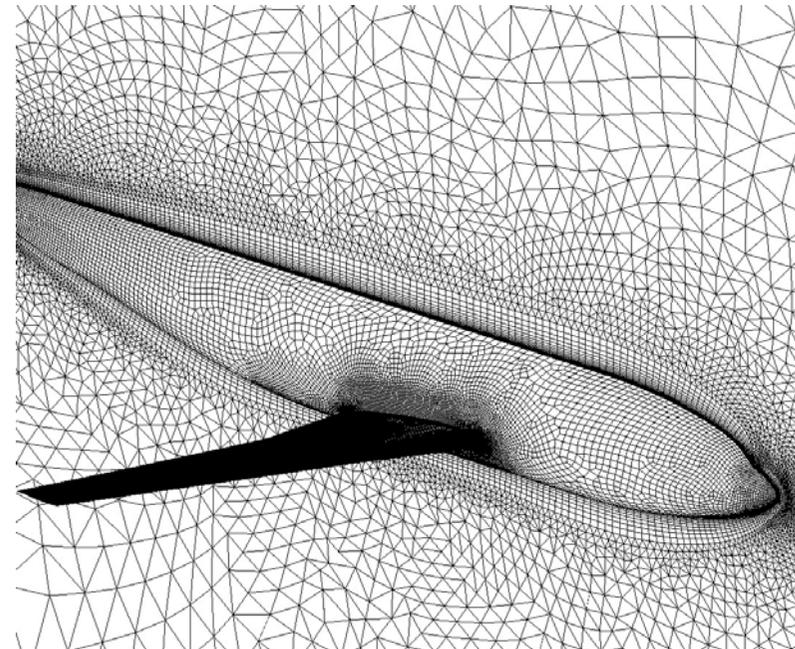
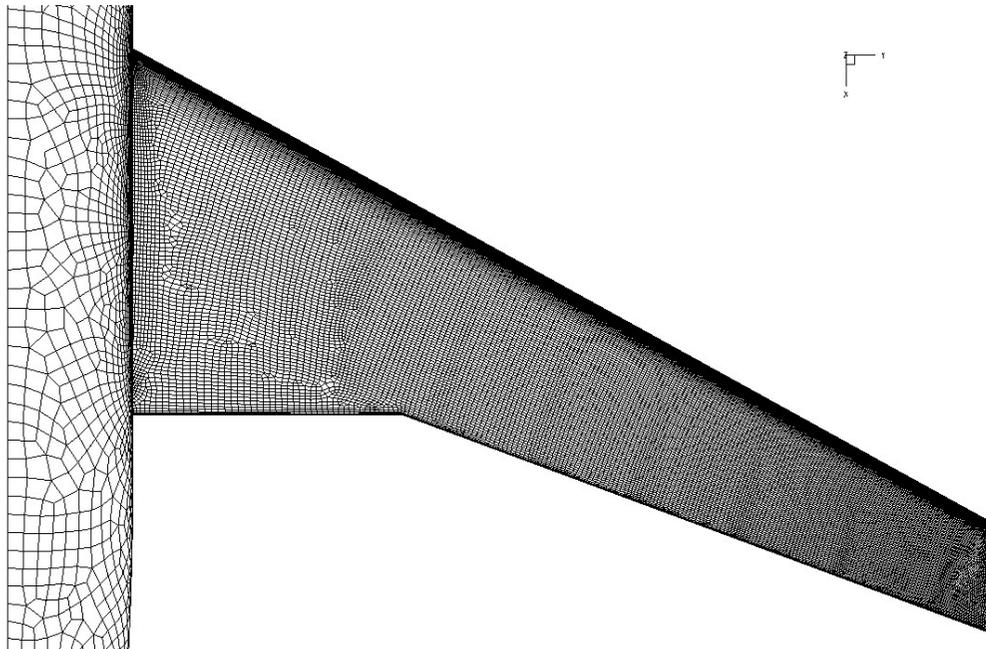Medium Grid: influence on Cp for CL=0.5

Grids

- Well-known: grid quality and density is important
- Different approach: hexahedrals and tetrahedrals
- Hexahedral elements for BL resolution
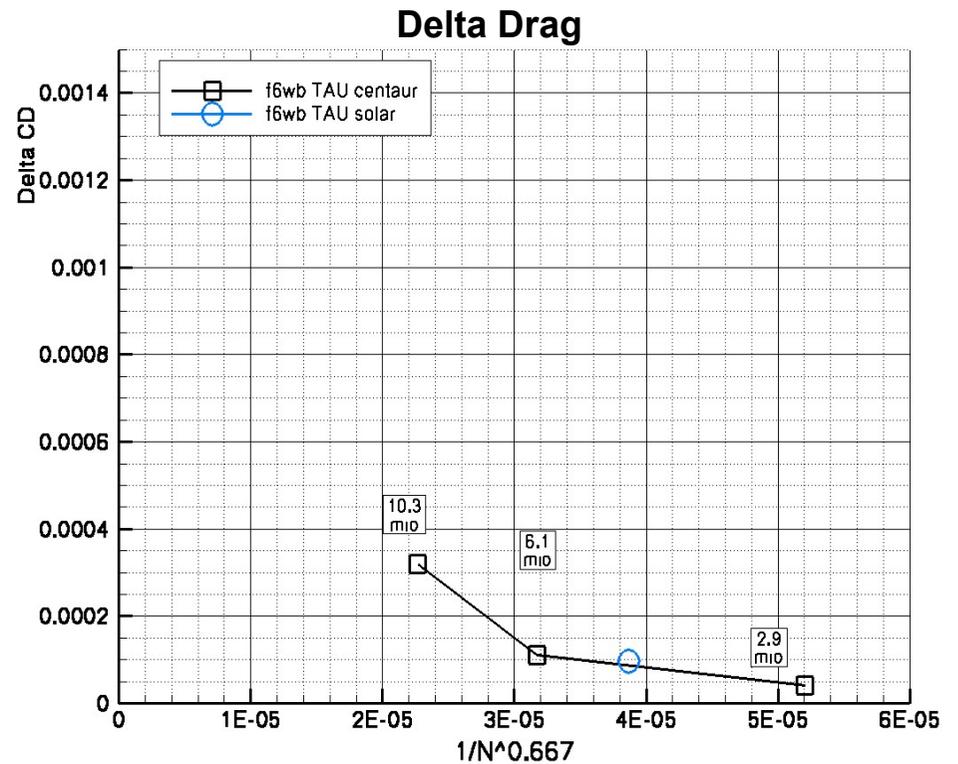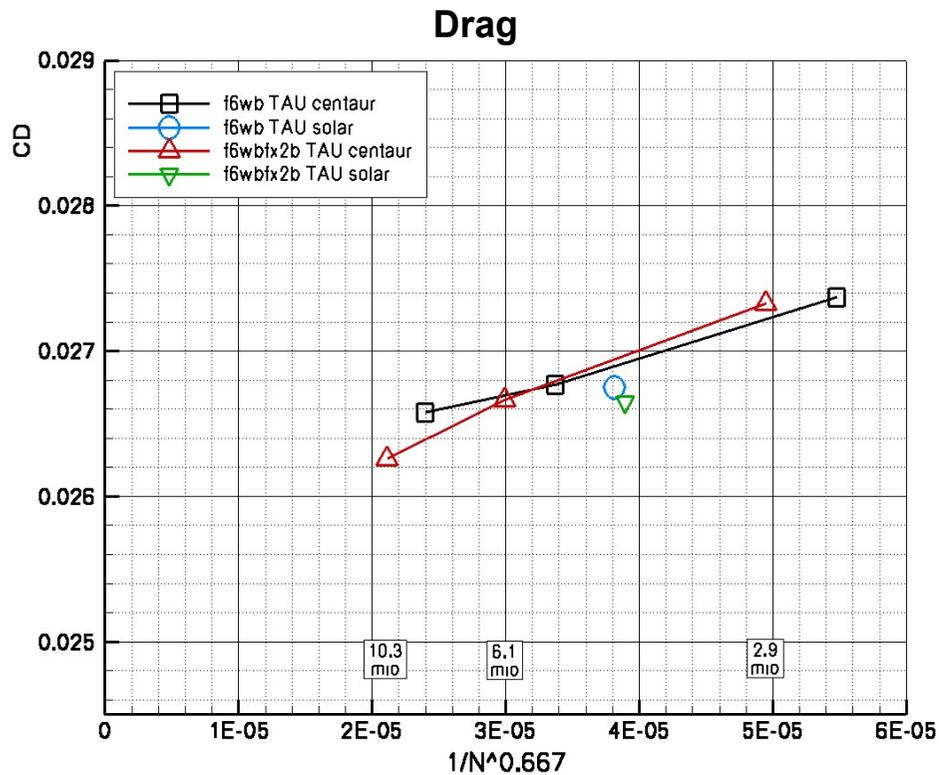- Solar grid generator from Airbus, ARA, BAES
- Grids generated by QinetiQ

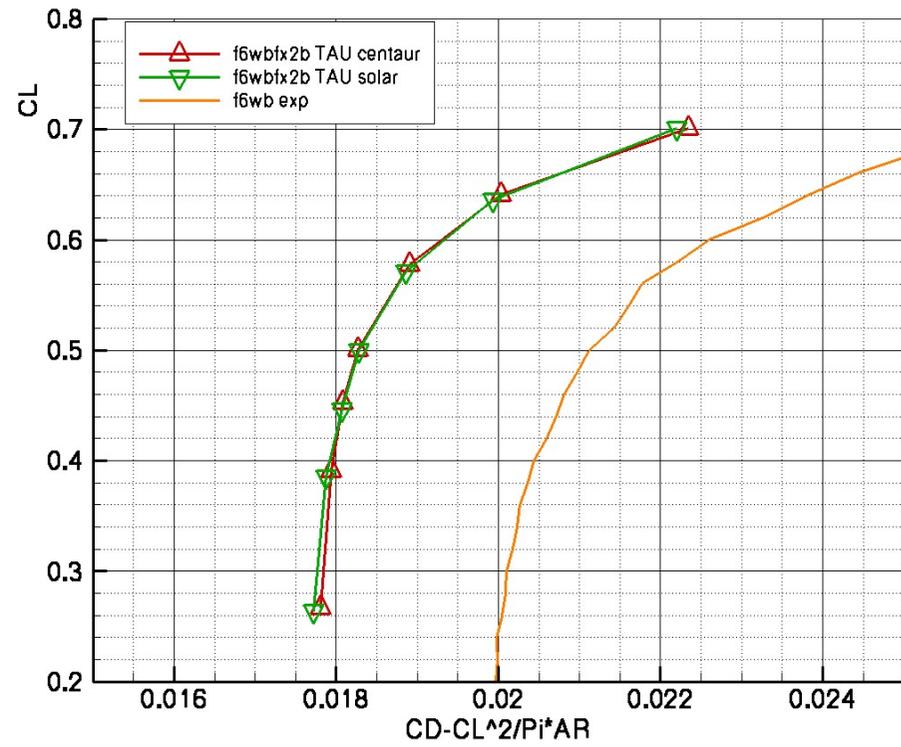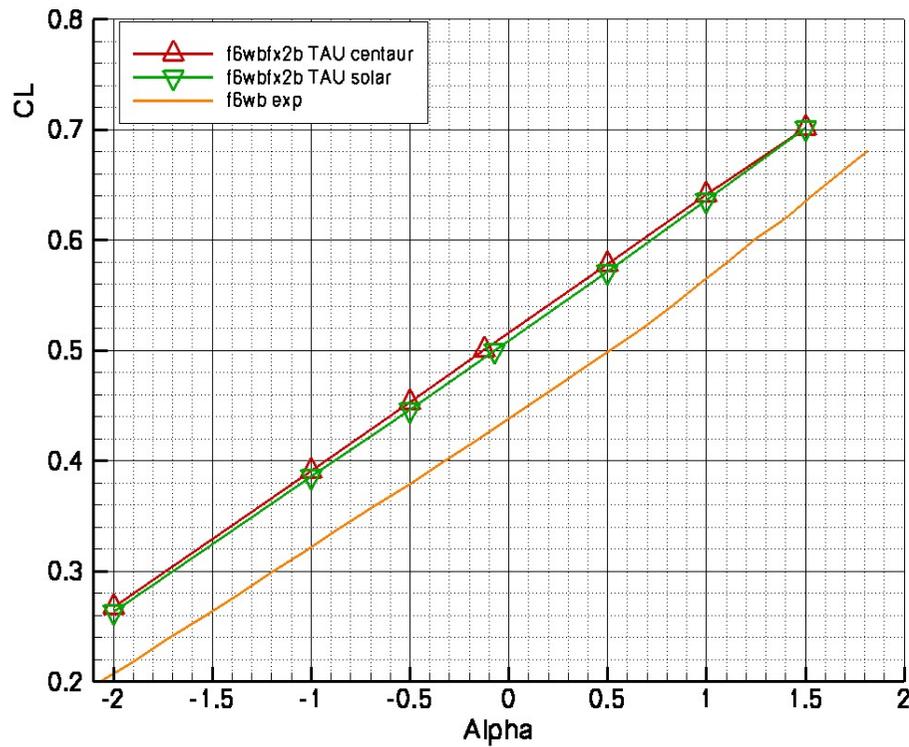|	Medium
Nodes	4.24
	4.11

Results: Grid Influence
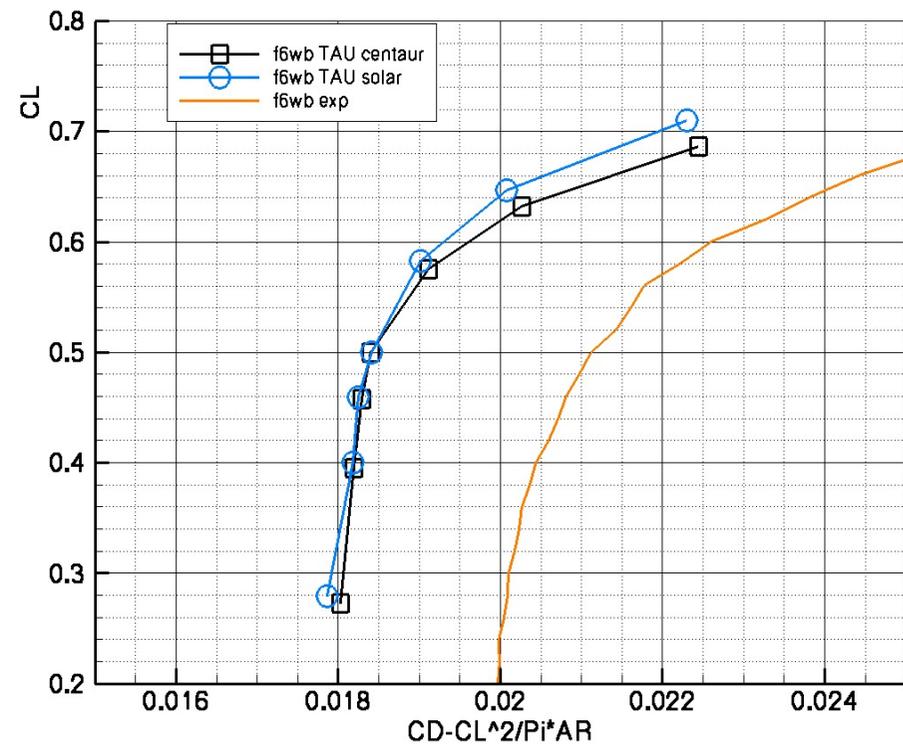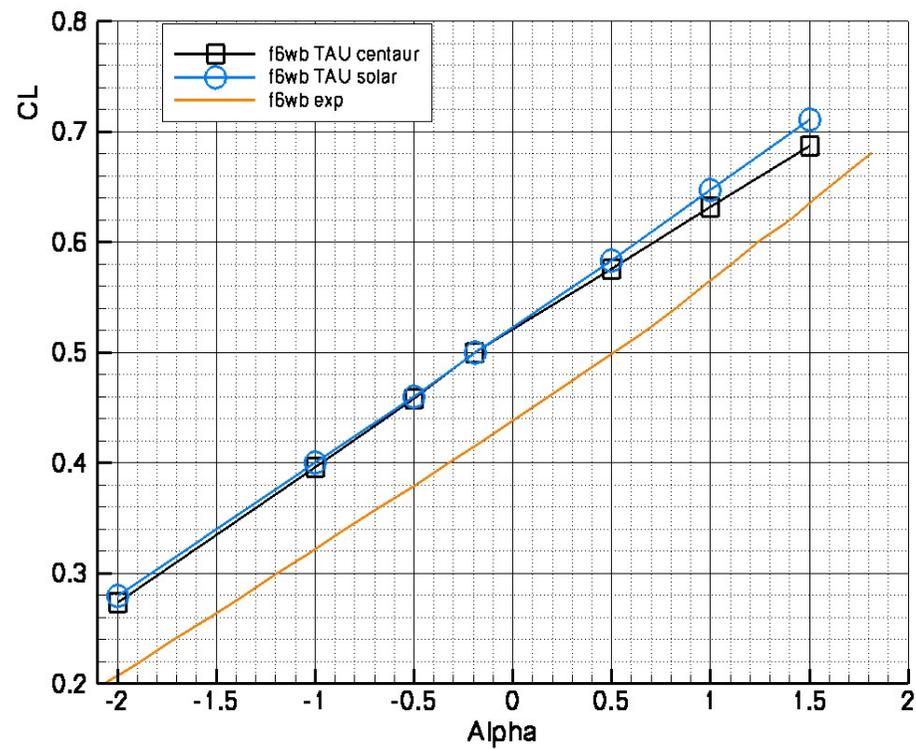
Convergence Study

Results: Grid Type

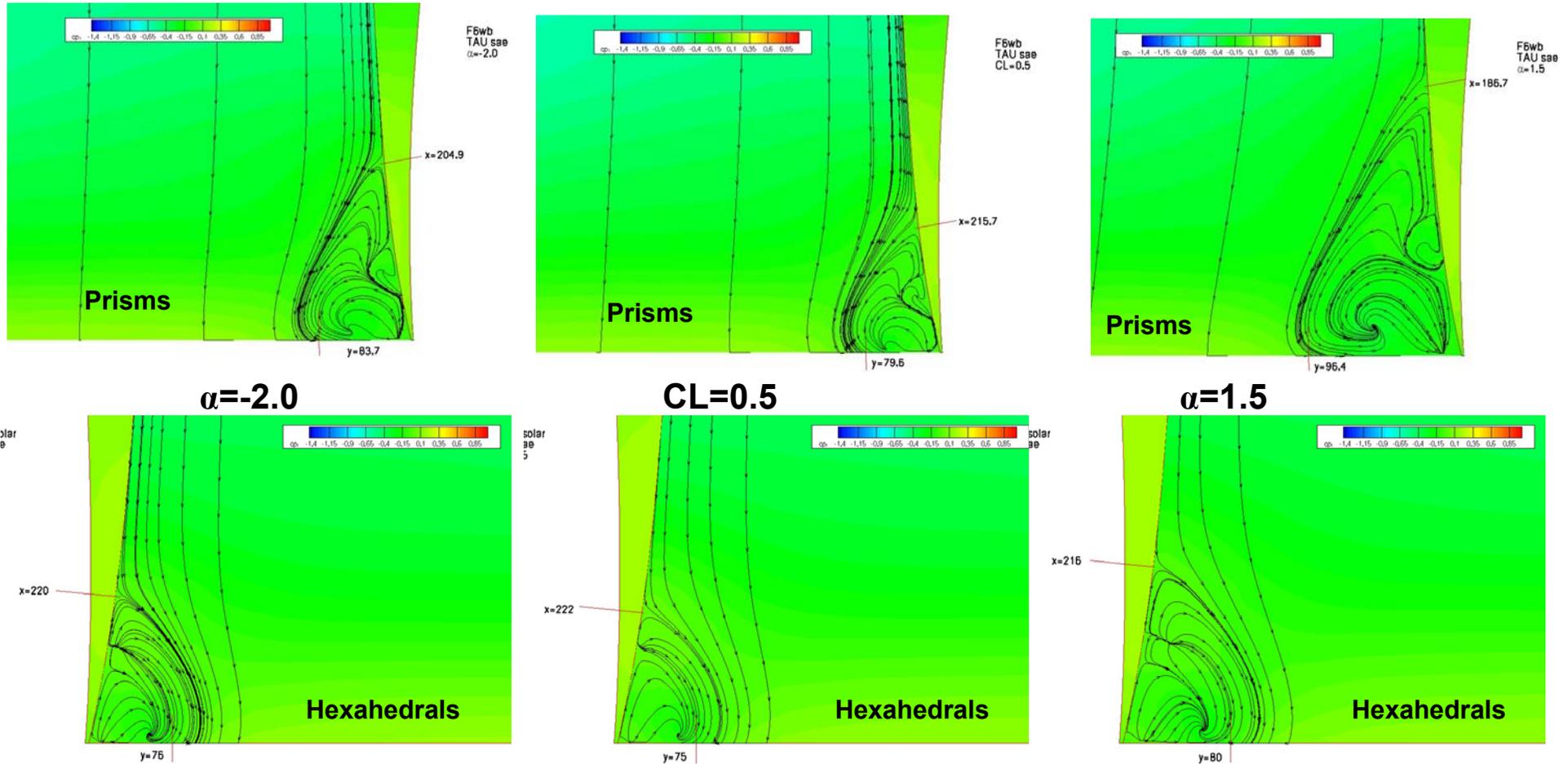F6fx2b: Prismatic / Hexahedral hybrid grids

Results: Grid Type

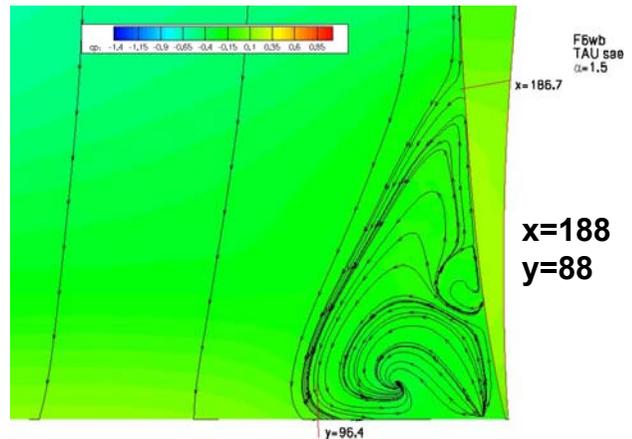F6wb: Prismatic / Hexahedral hybrid grids

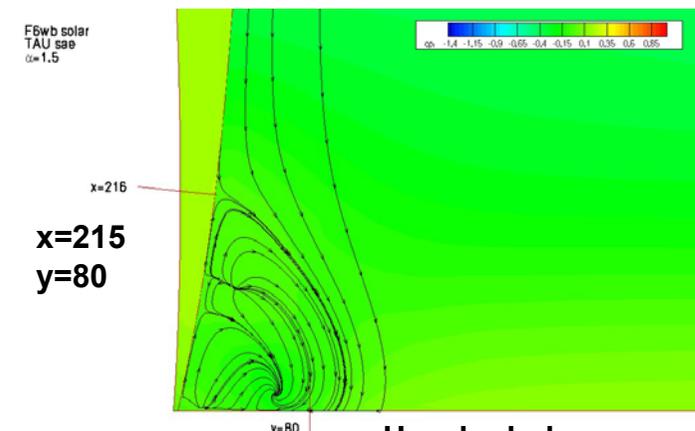# Results: Grid Type

Influence of alpha on flow separation

Results: Grid Type

Influence on flow separation F6wb for α=1.5
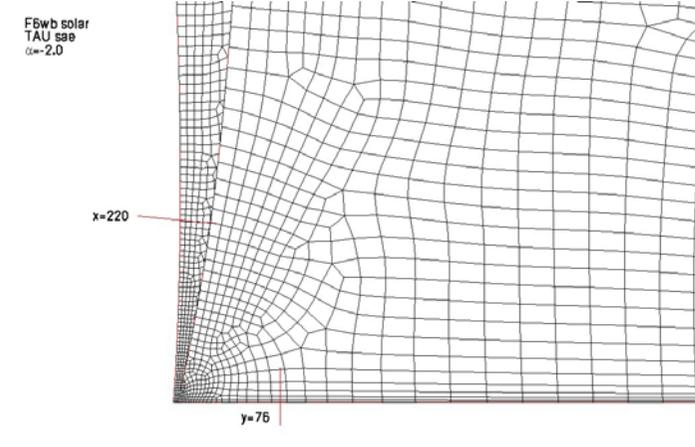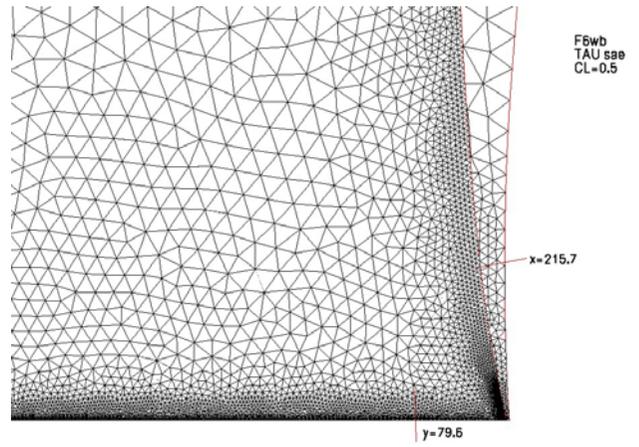

x=188
y=88

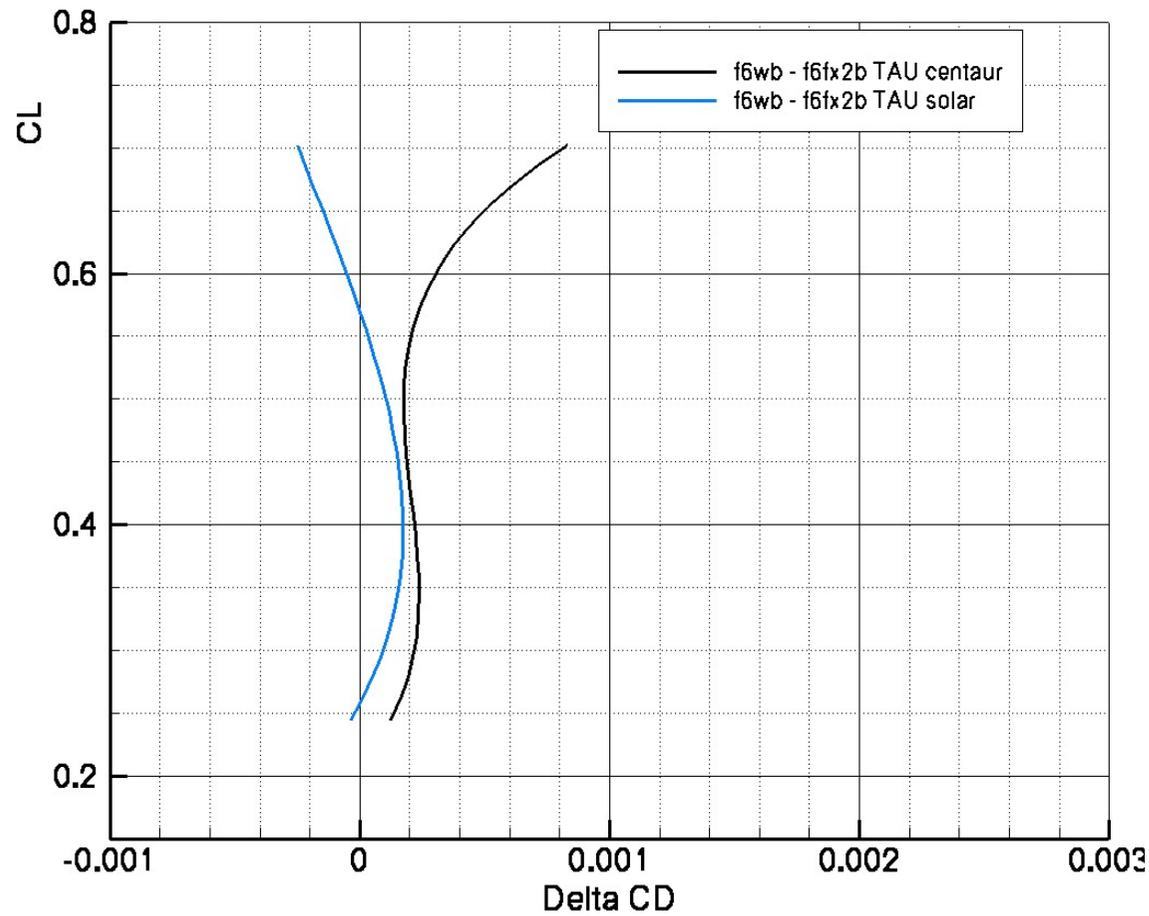**Triangles**

x=215
y=80

Hexahedrals

Results: Grid Type

F6wb / F6fx2b Delta Drag

Summary

- F6fx2b shows improved junction flow

- Delta drag at design point approx.:

  - ≈ 1.5 dc for medium grid

  - ≈ 9 dc for extrapolation

- Grid density in wing fuselage junction has major effect on size
  of separation bubble at high alpha (SAE model)

- Delta drag of F6wb-F6fx2b can switch its sign for high / low alpha

- Wing trailing edge separation can not be found with SAE (see also DPW-2)

- Hybrid hexahedral grids are very promising
  (improved convergence, less nodes)

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