2nd AIAA Drag Prediction Workshop

TAU Results

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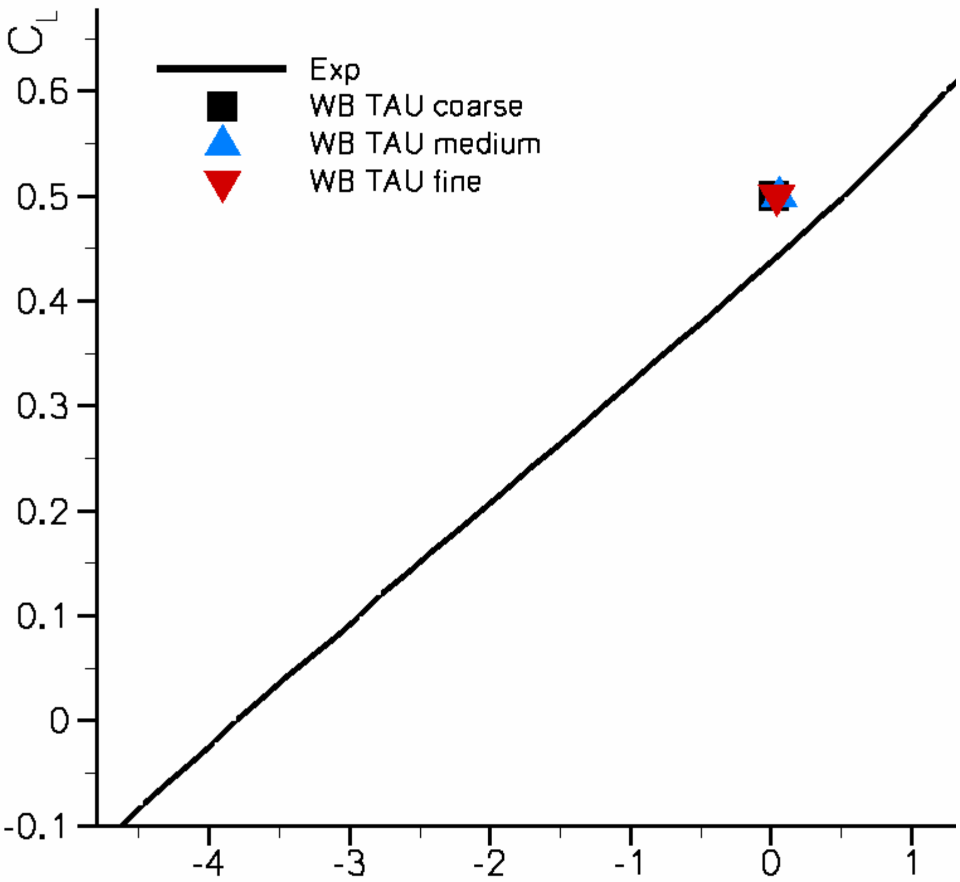
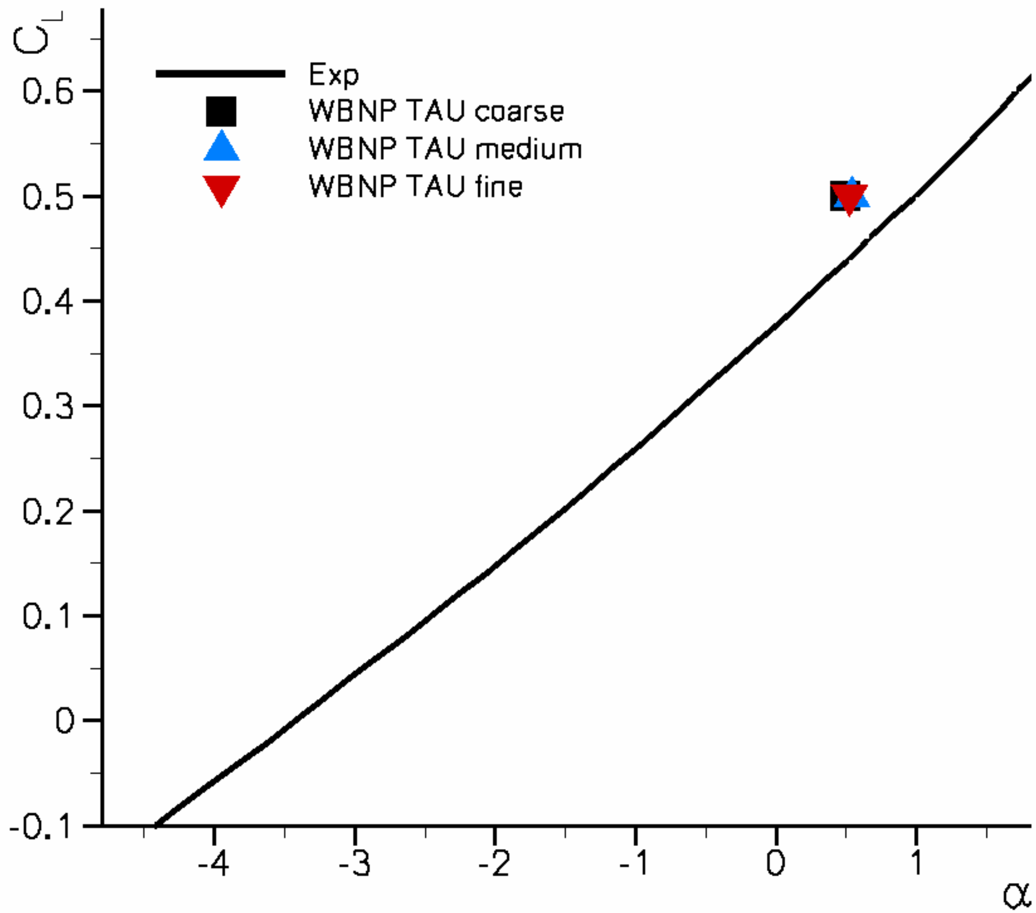
Numerical Method

- DLR-TAU software solves RANS equations
- Node-centered, hybrid grids, dual grids
- Various discretization schemes, turbulence models
- Grid adaptation
- Acceleration techniques, vectorized, parallelized
- Grids generated with Centaur from Centaursoft
- TAU was developed in the German MEGAFLOW project

Case 1: Influence of Grid Density





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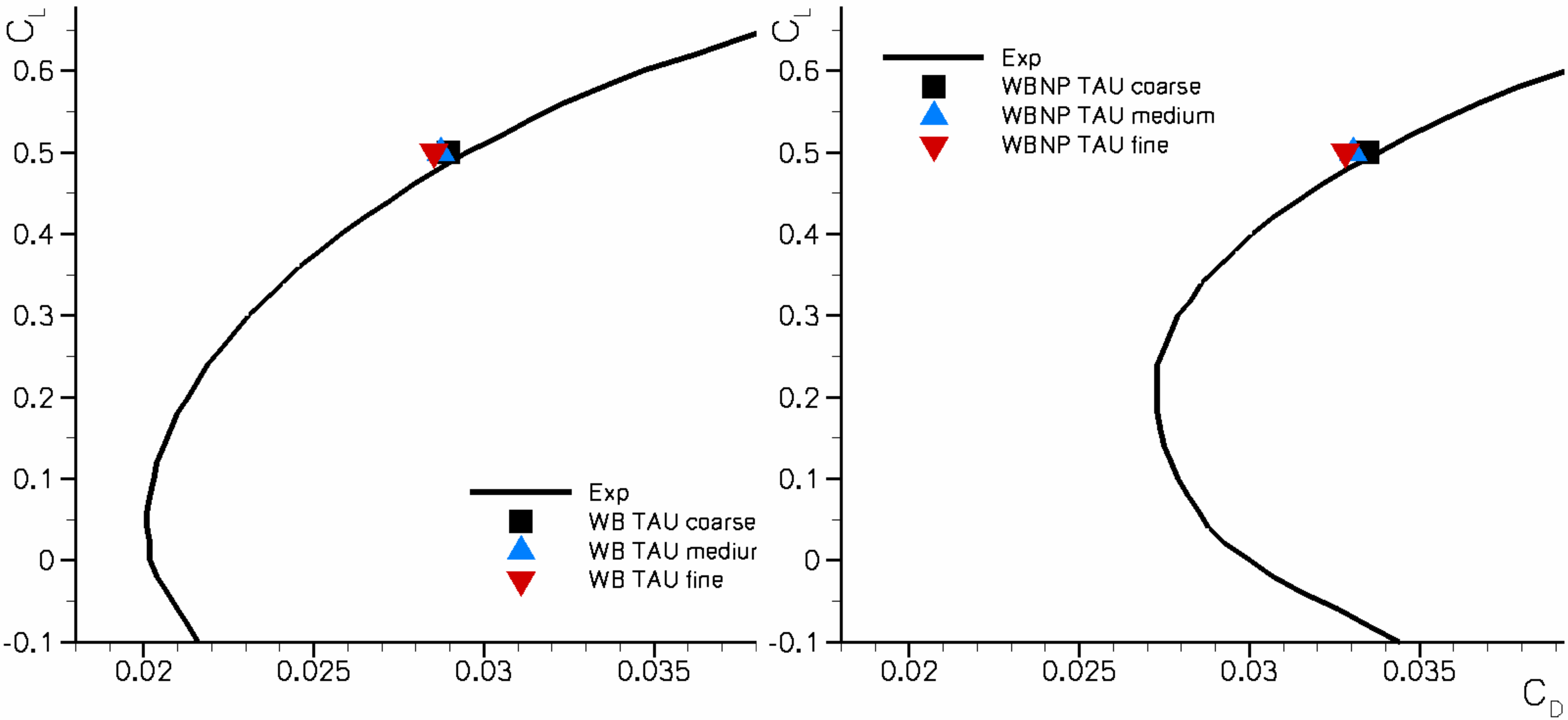

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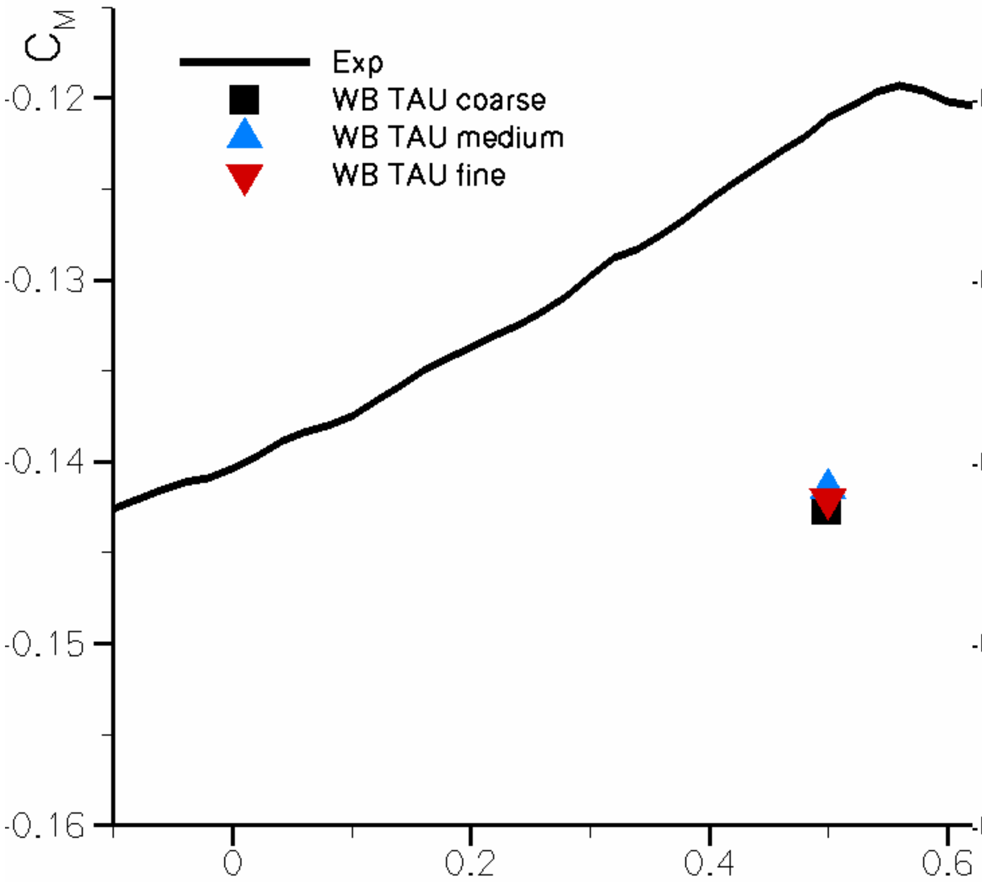

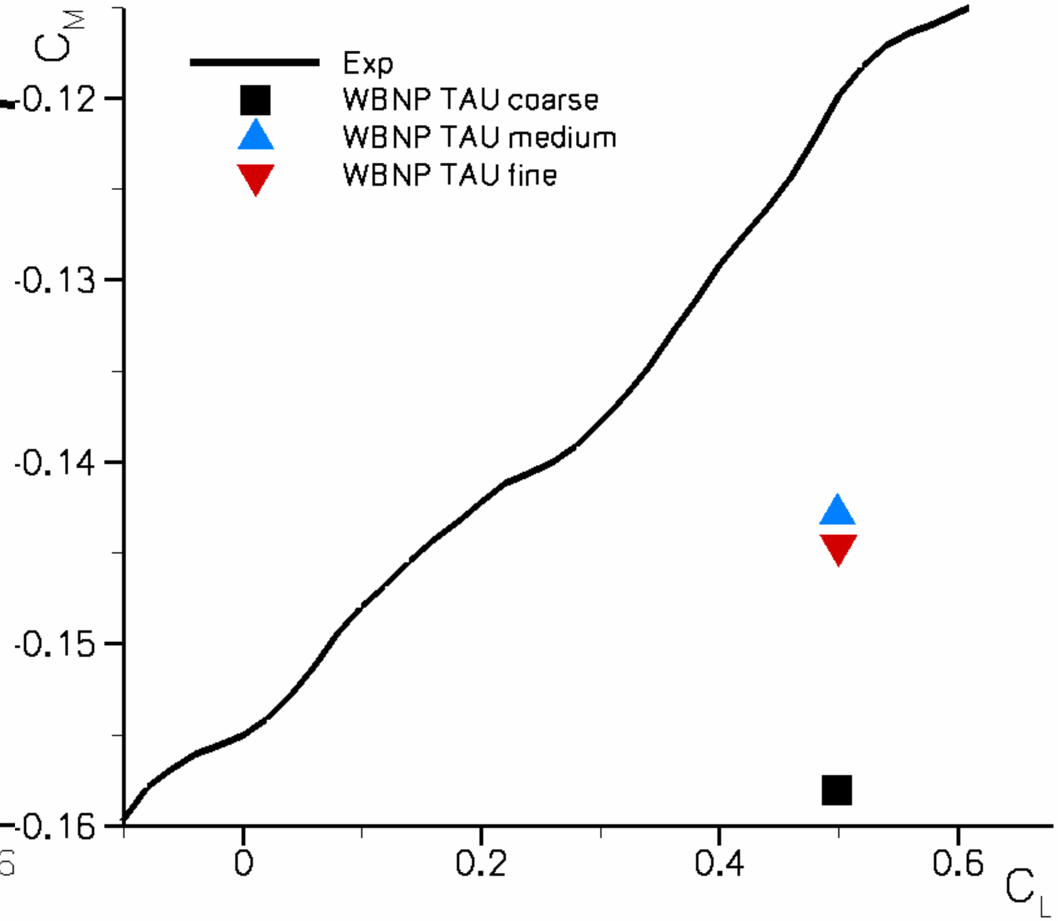

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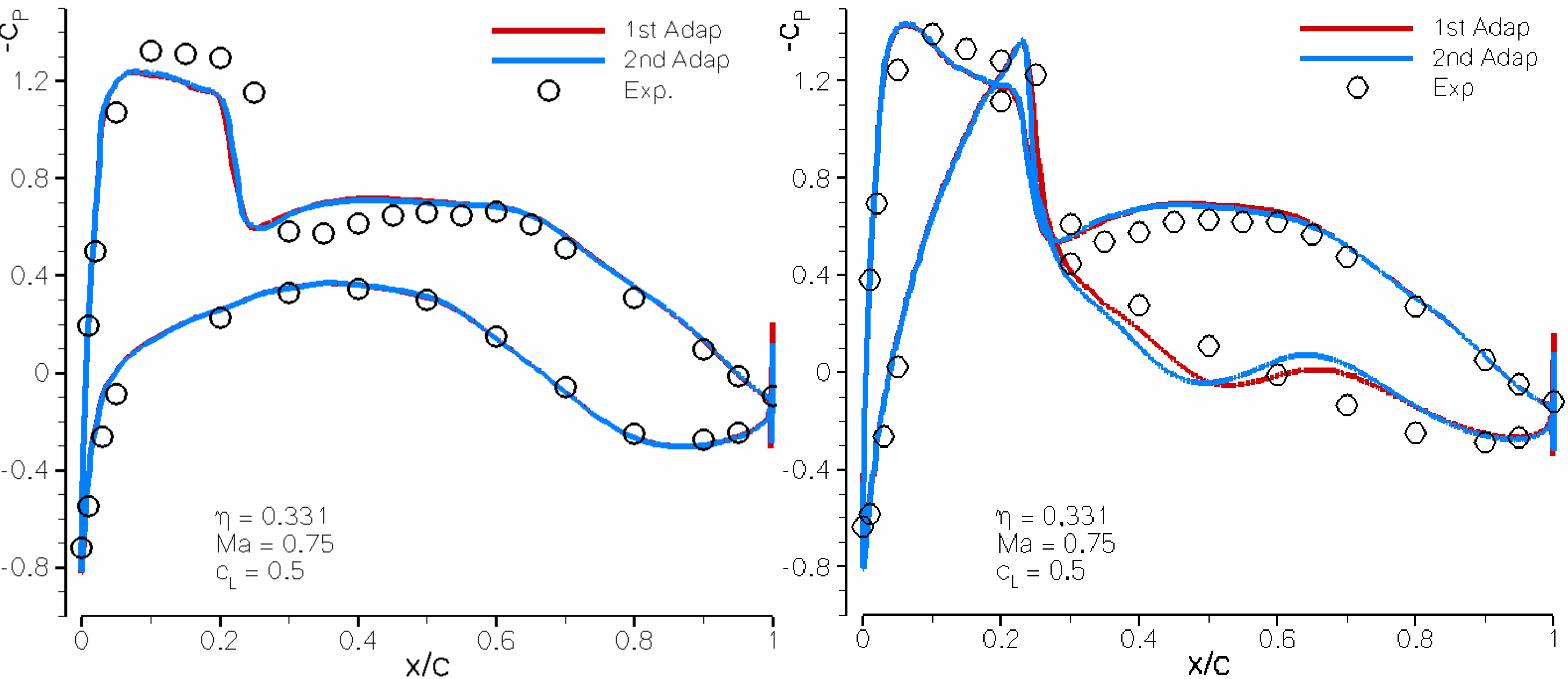

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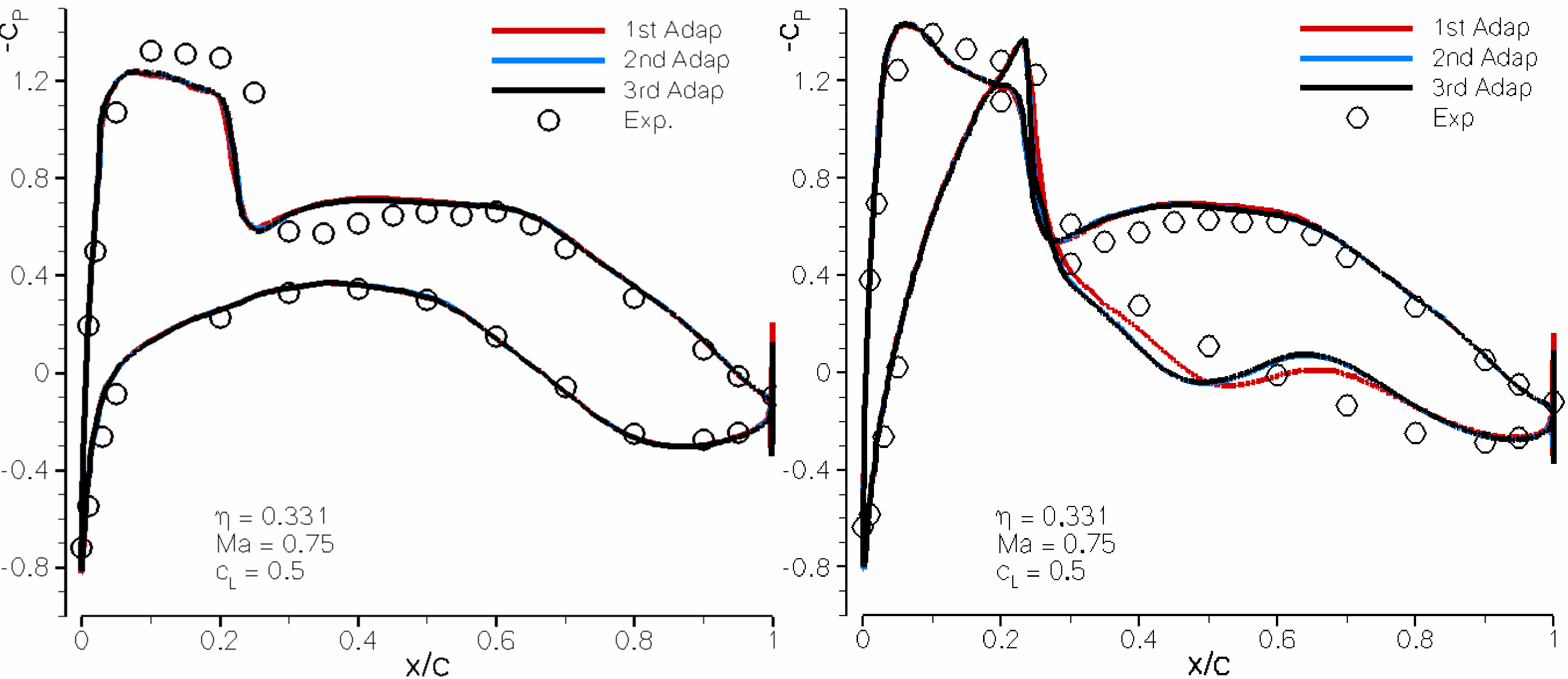
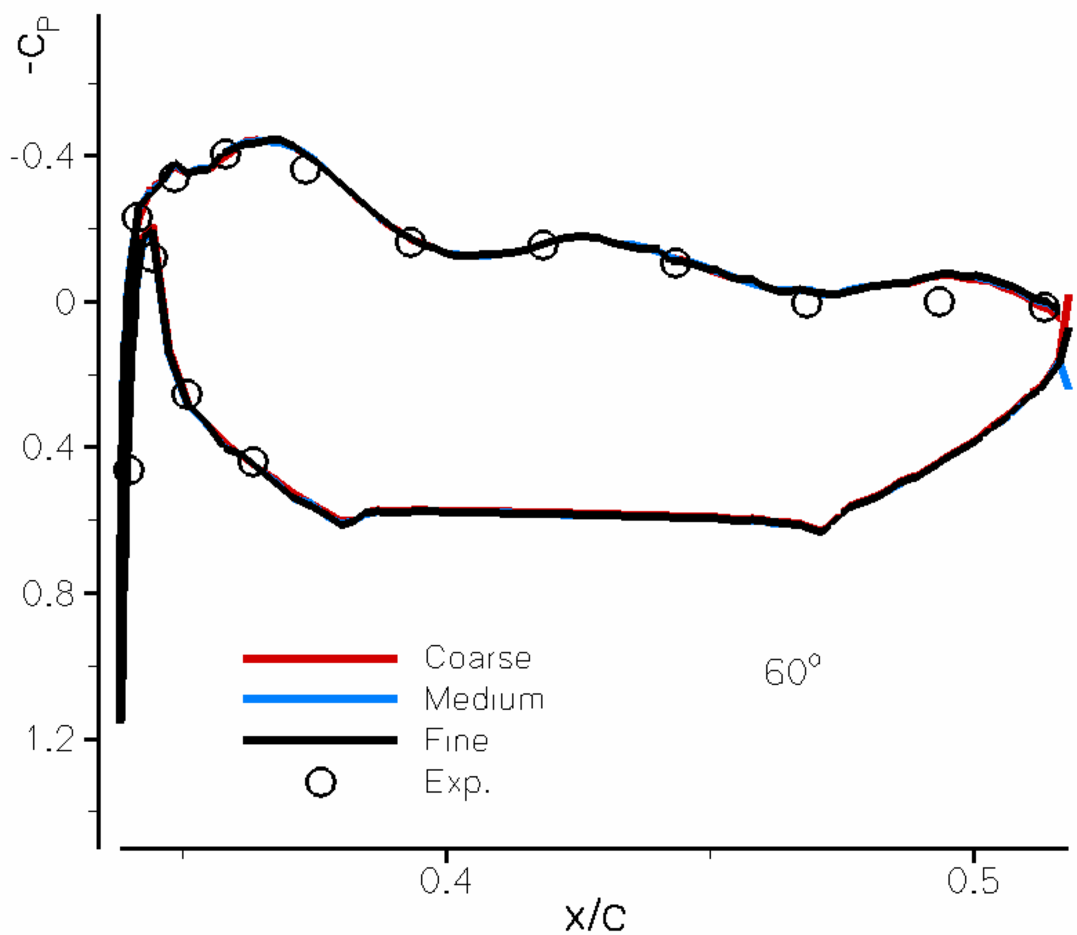


Case 1: Influence of Grid Density

Nacelle pressure distribution

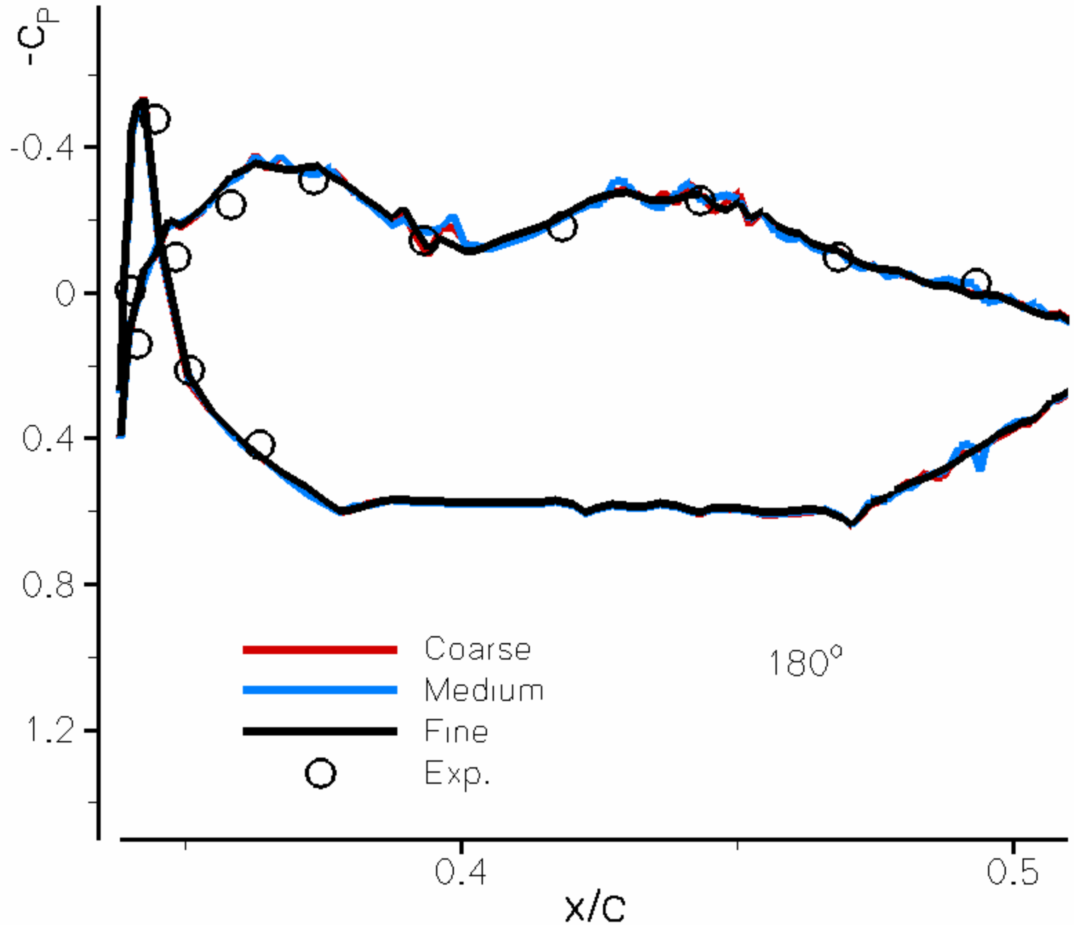
60º



Case 1: Influence of Grid Density

Nacelle pressure distribution

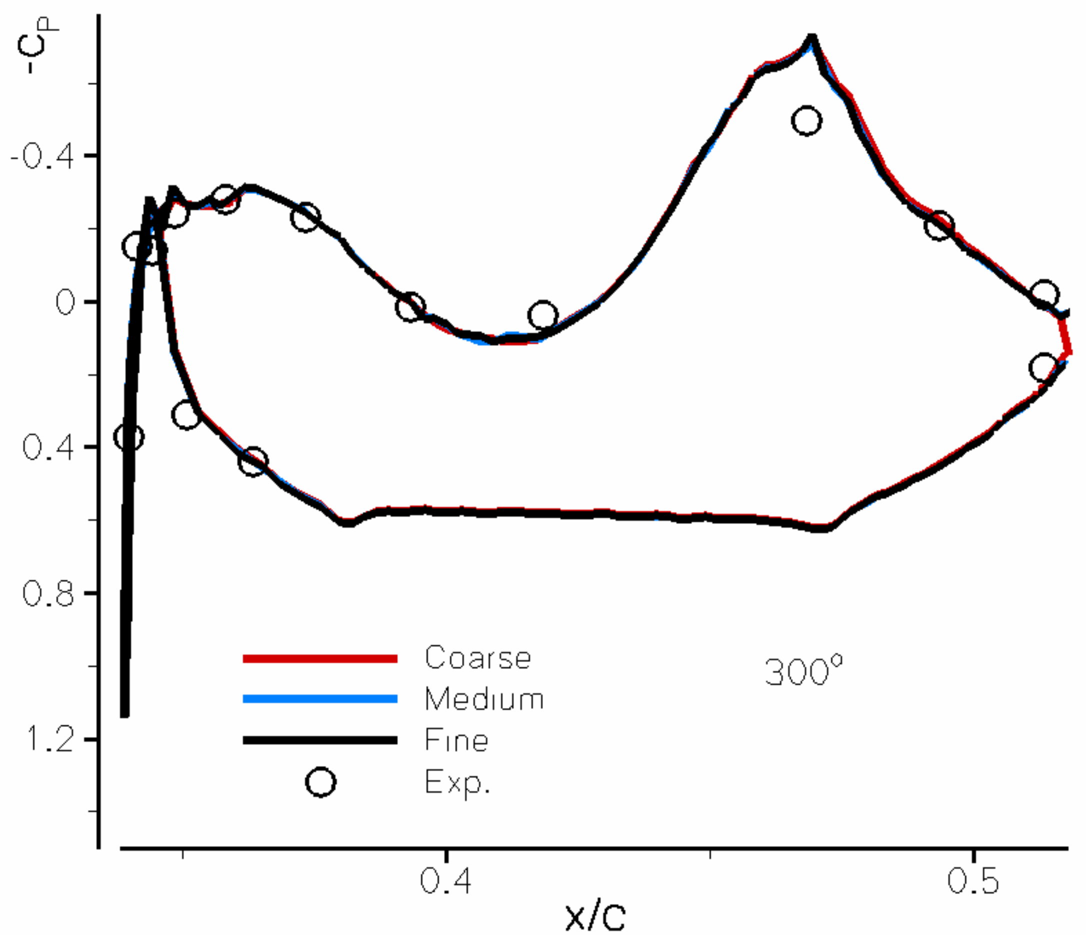
180°



Case 1: Influence of Grid Density

Nacelle pressure distribution

300°



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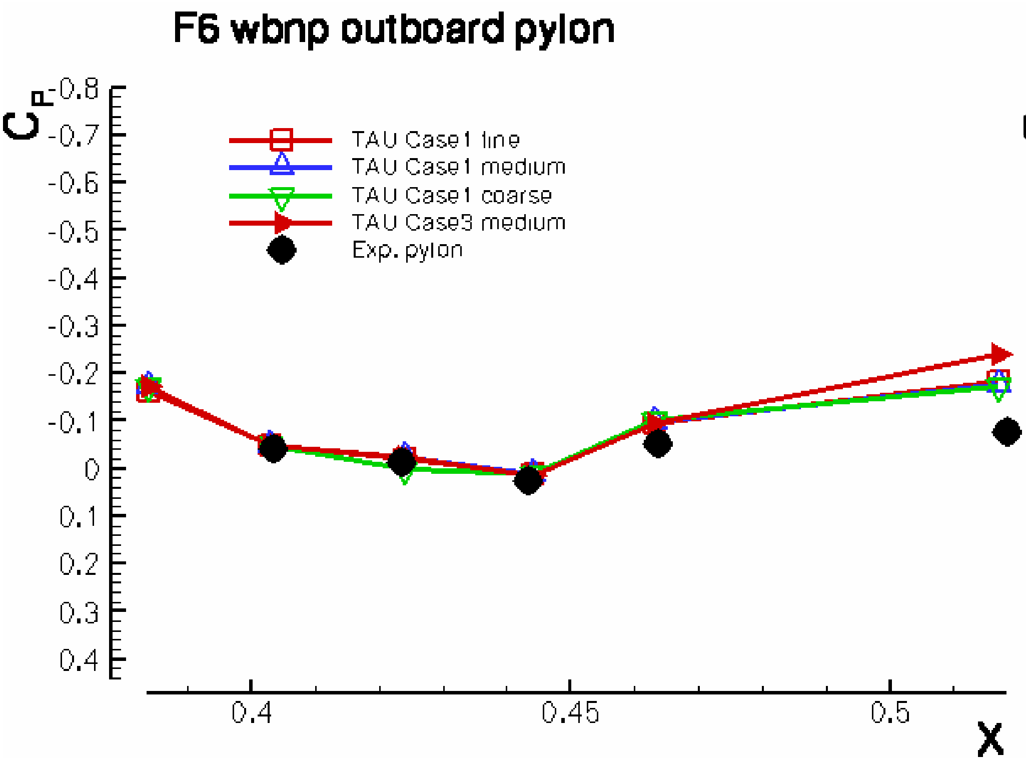
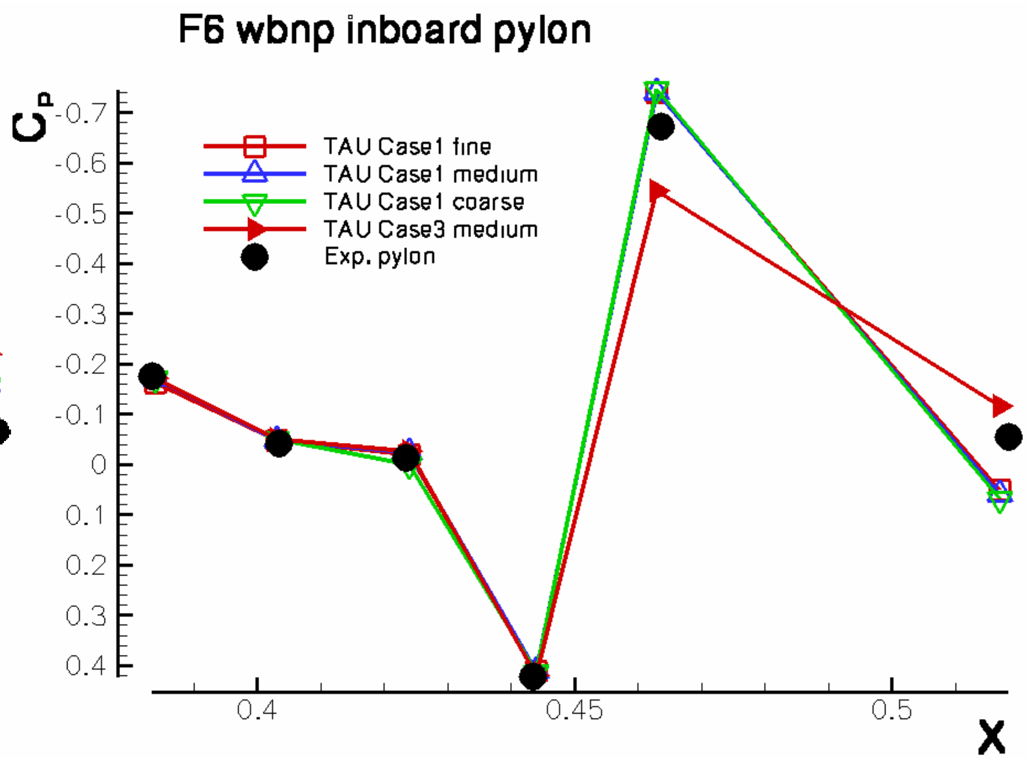


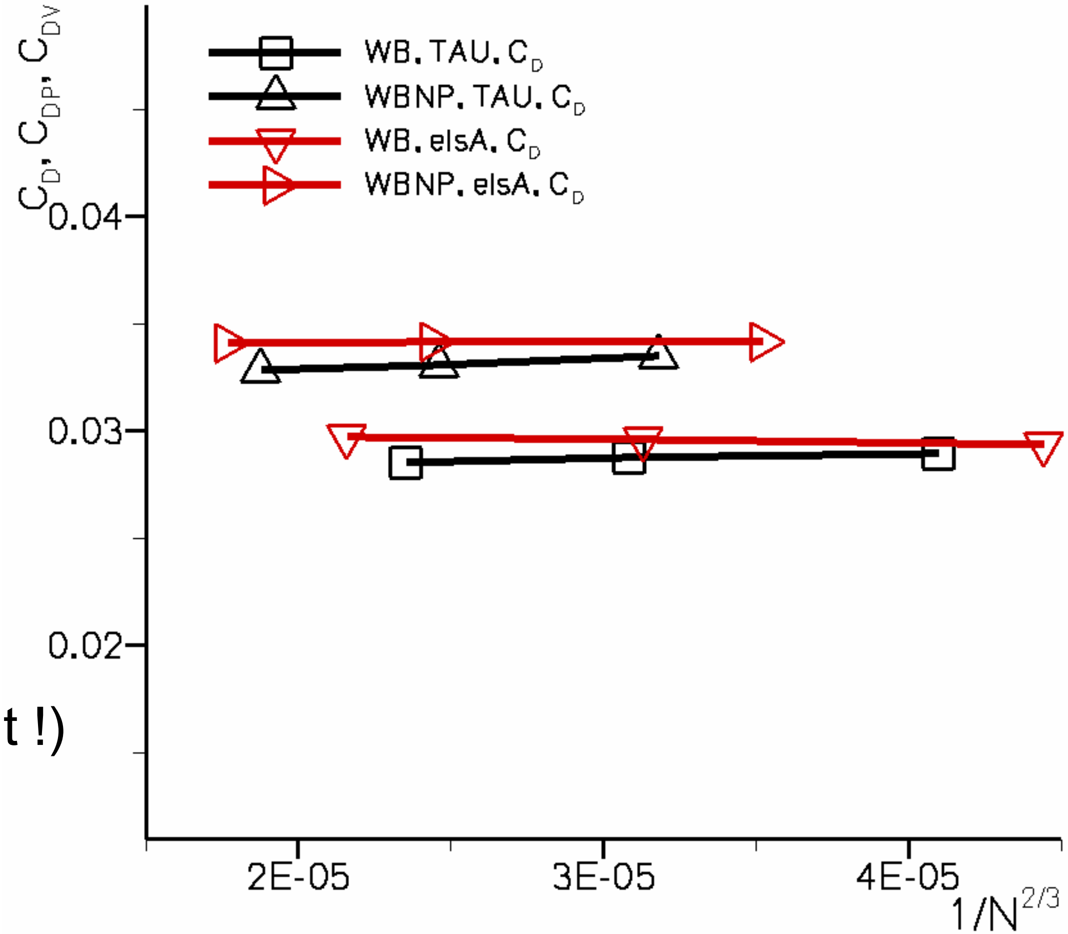


Case 1: Influence of Grid Density

ΔC_D extrapolated

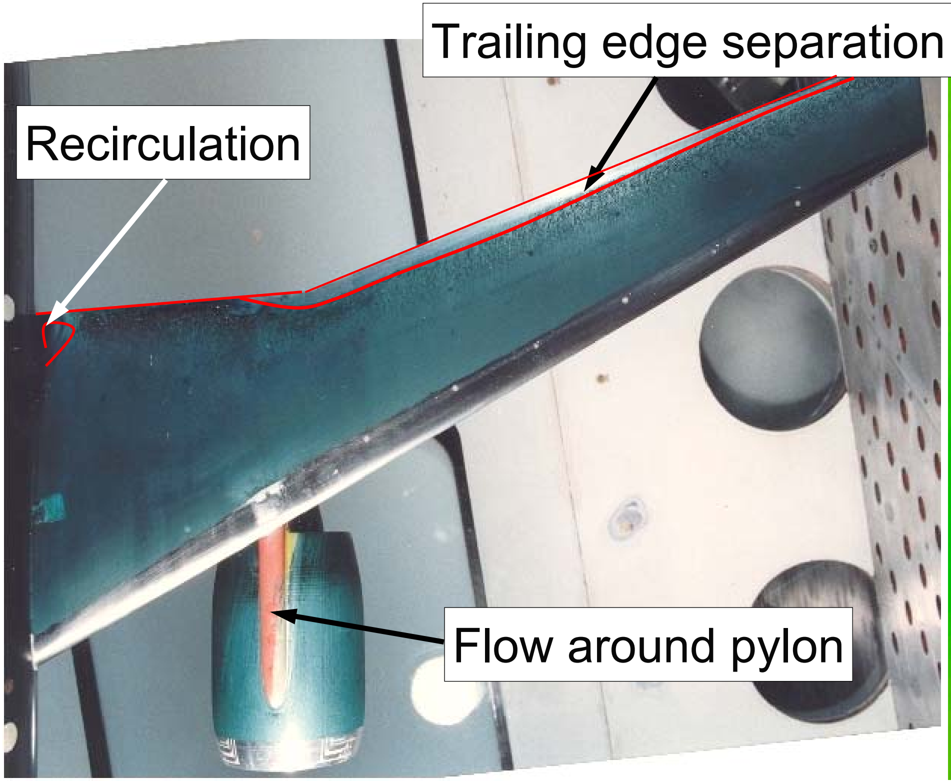
Code	WB	WBNP
TAU	-2.3%	-2.4%
elsA	+1.0%	+0.9%

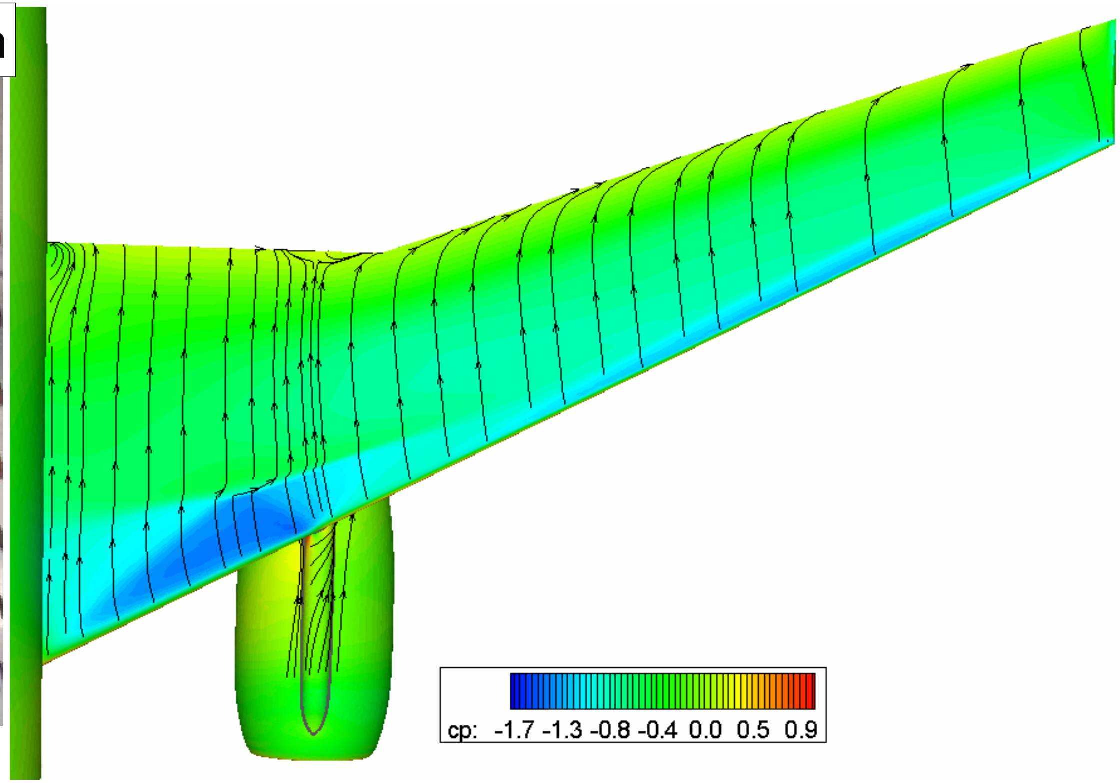
elsA (ICEM grids used;
grids not suitable for grid refinement !)



Case 1: Flow Phenomena

→ Geometry influences trailing edge separation





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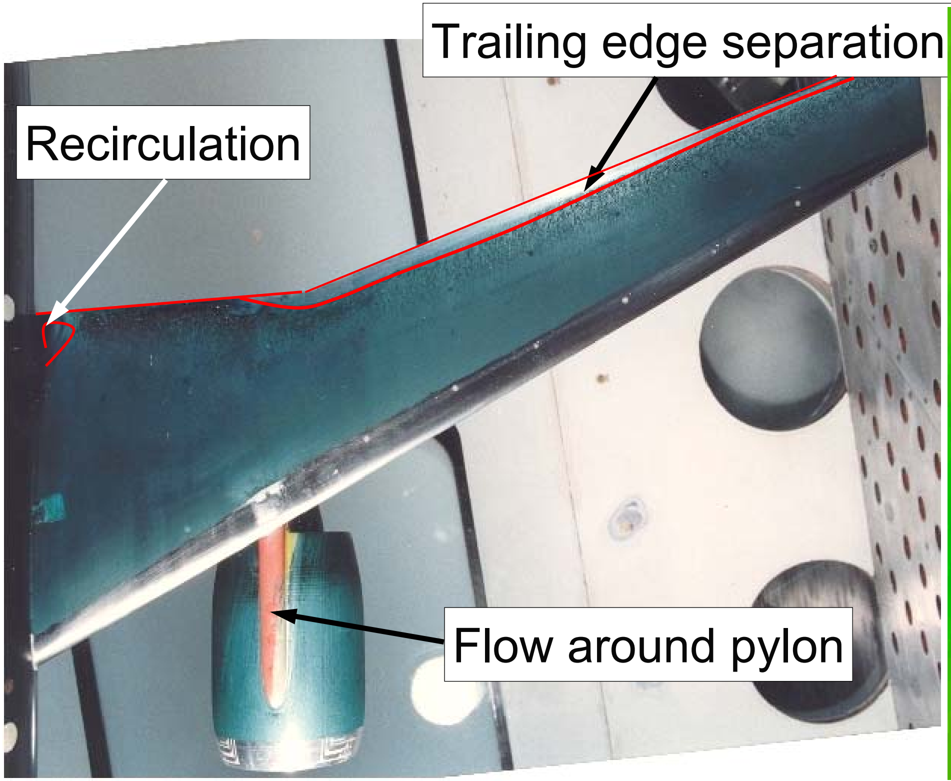

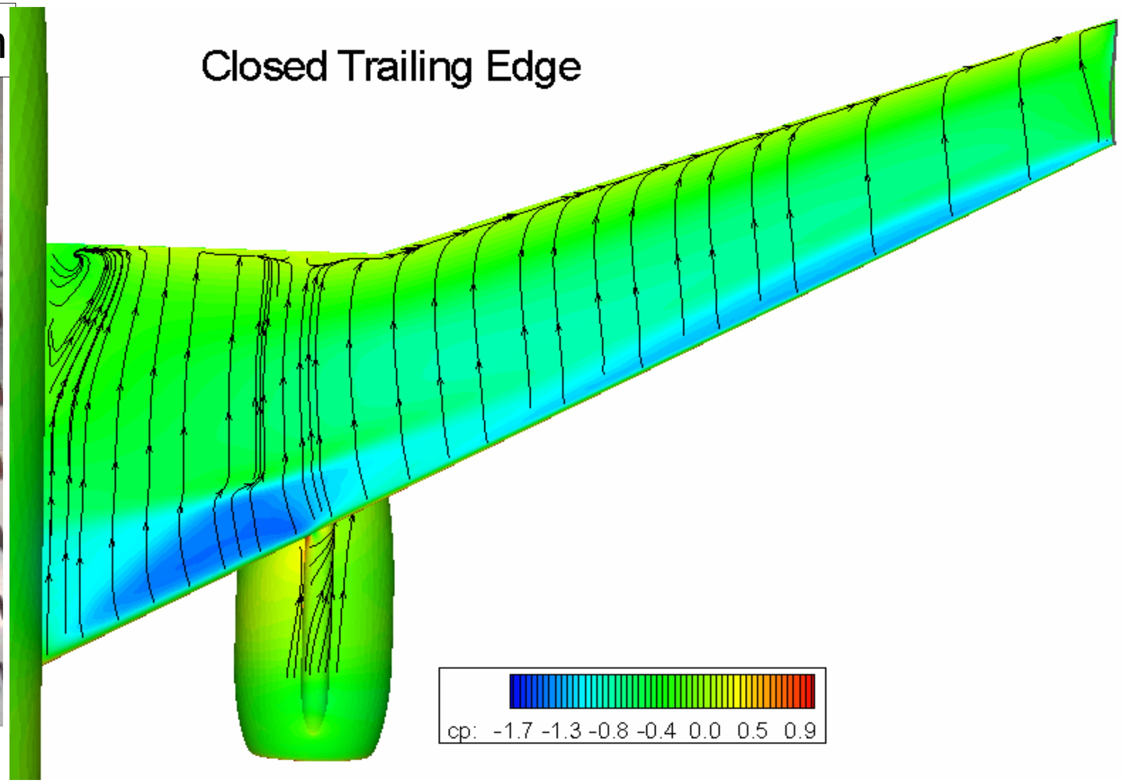

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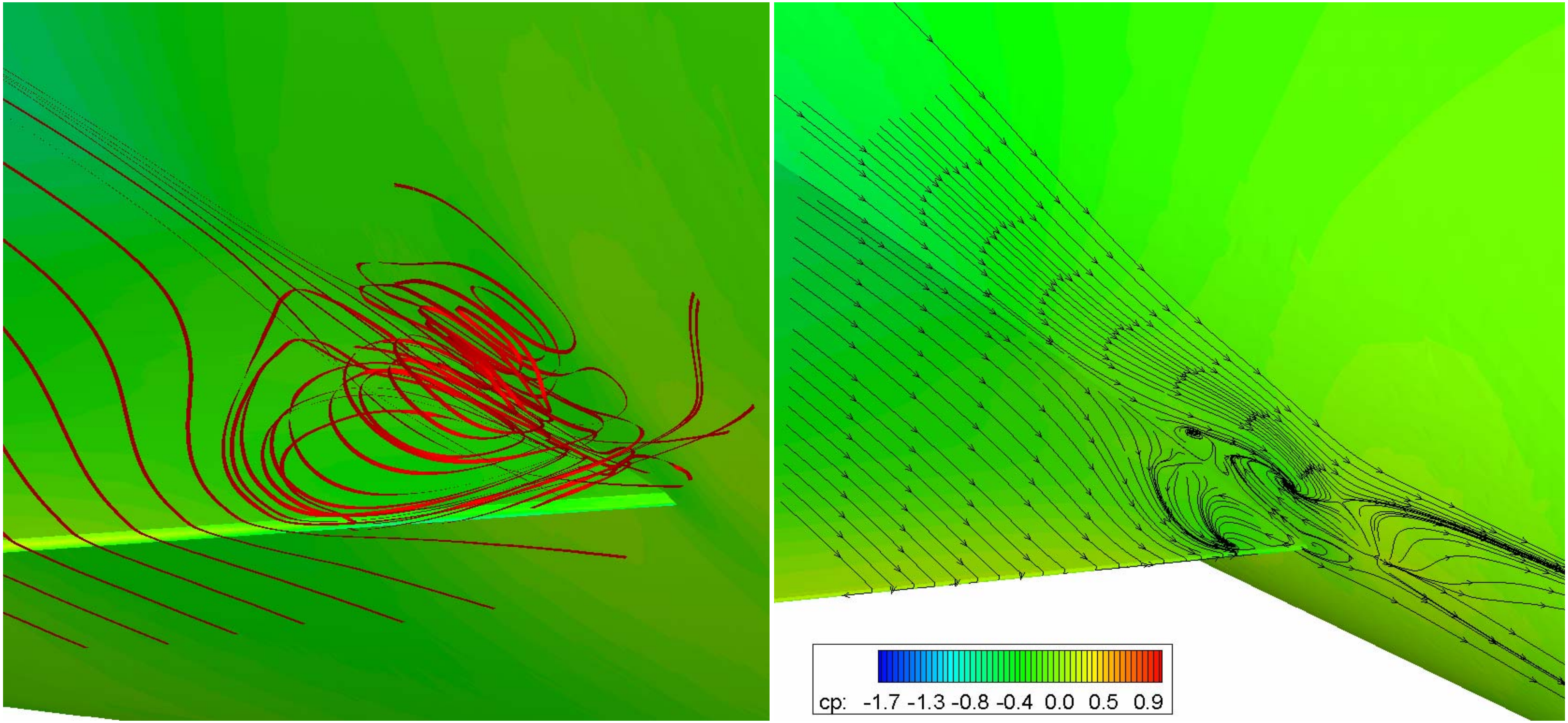

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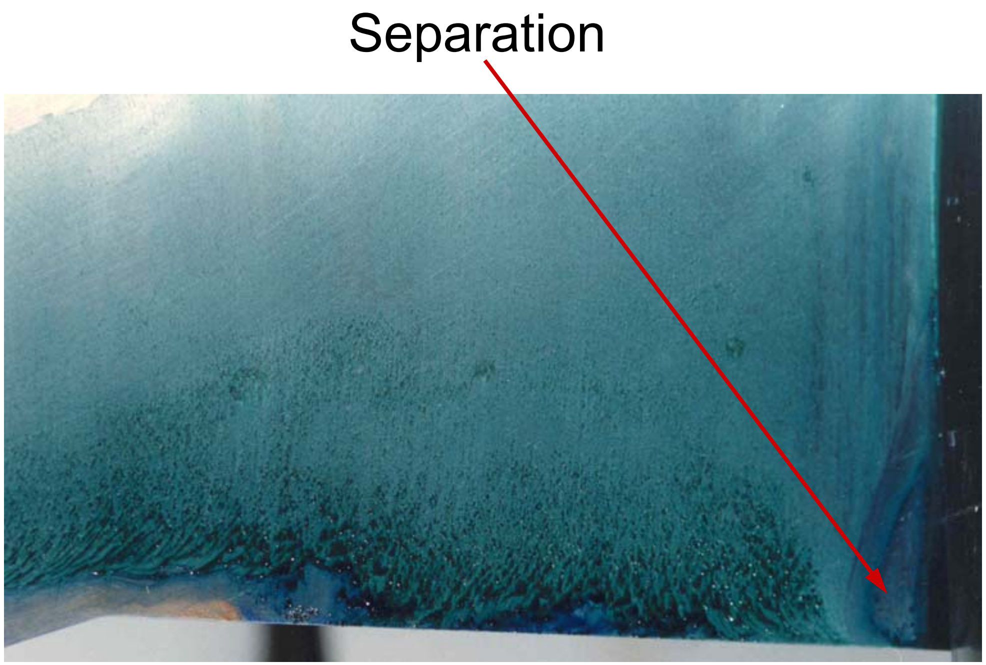

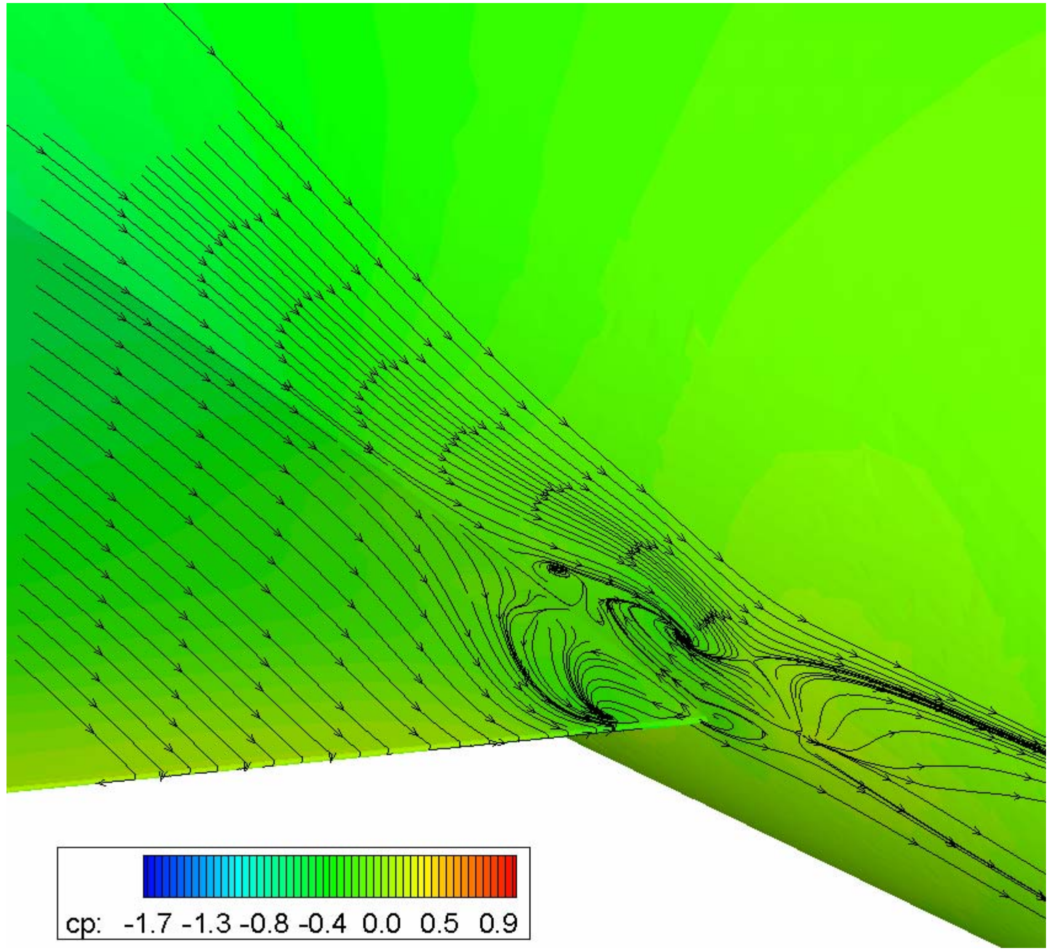

DLR ONERA AIRBUS

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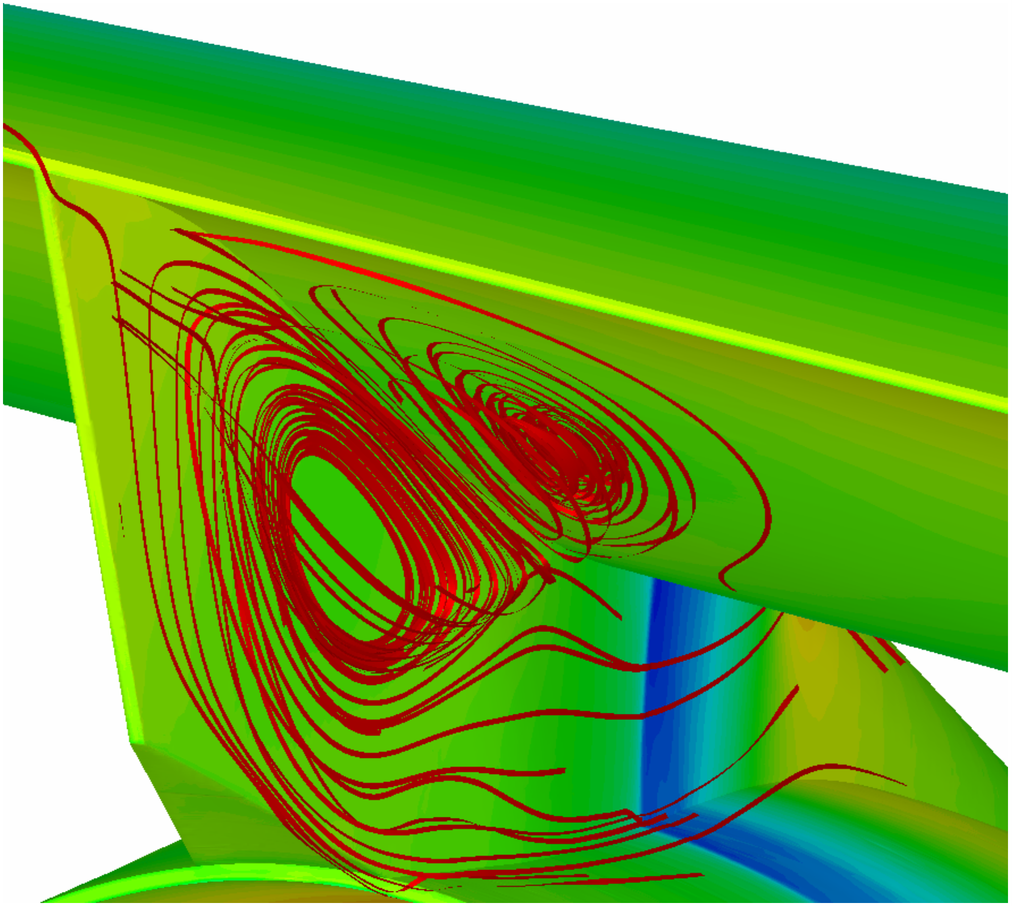

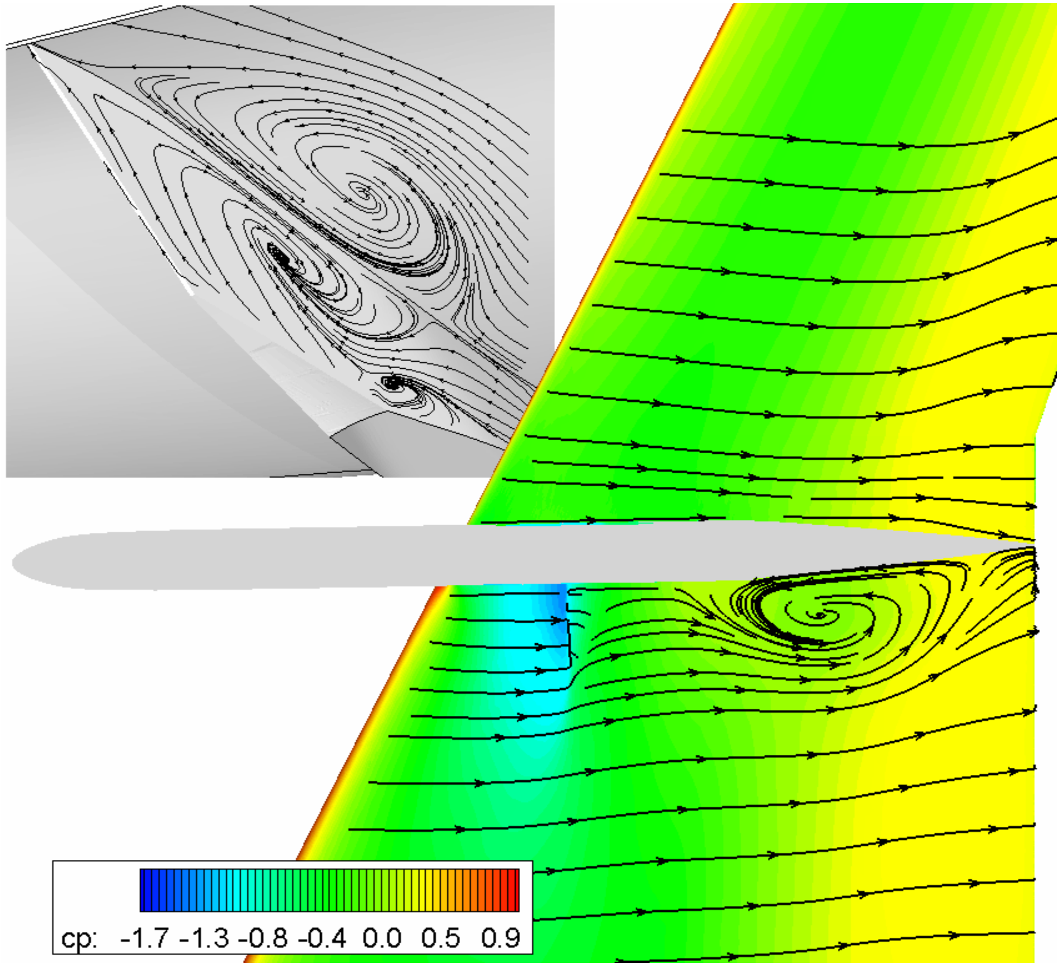

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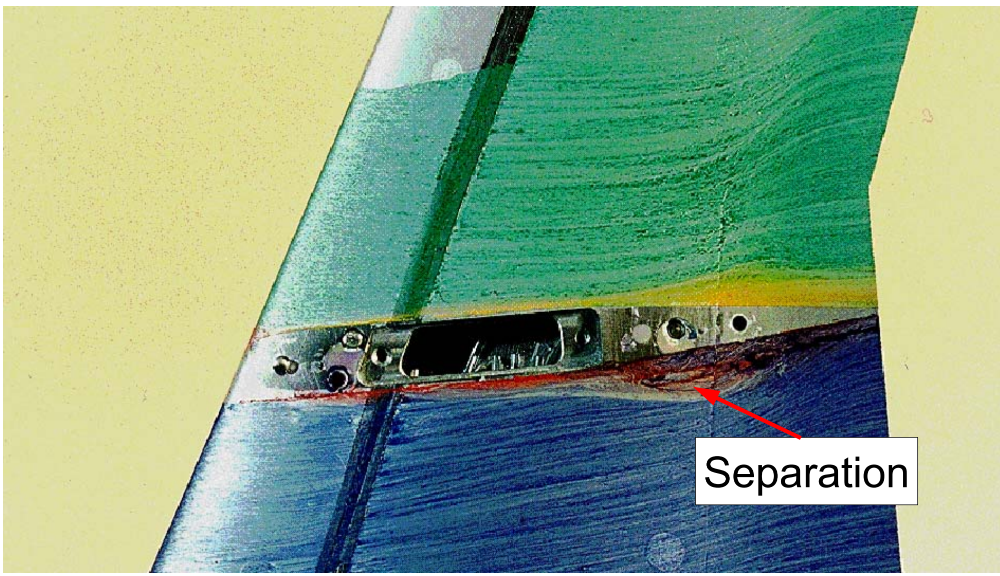
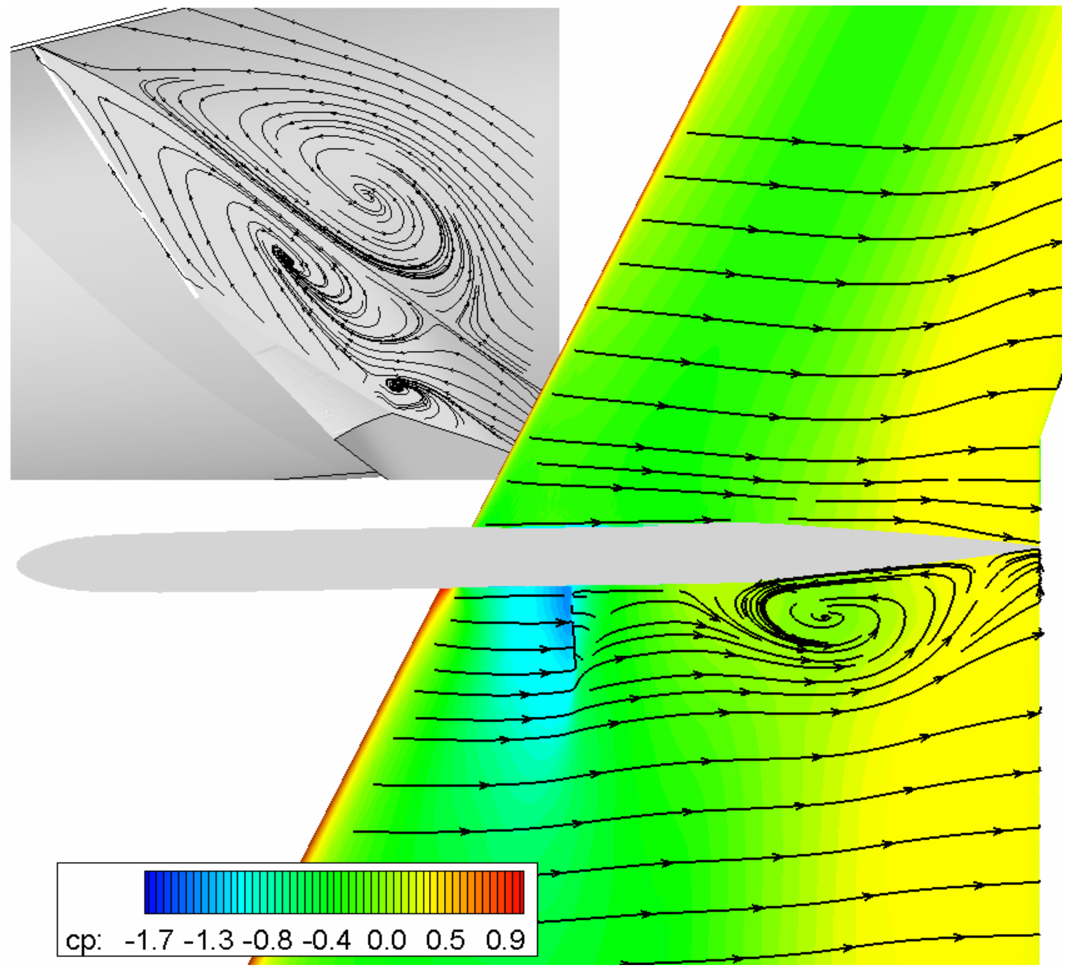
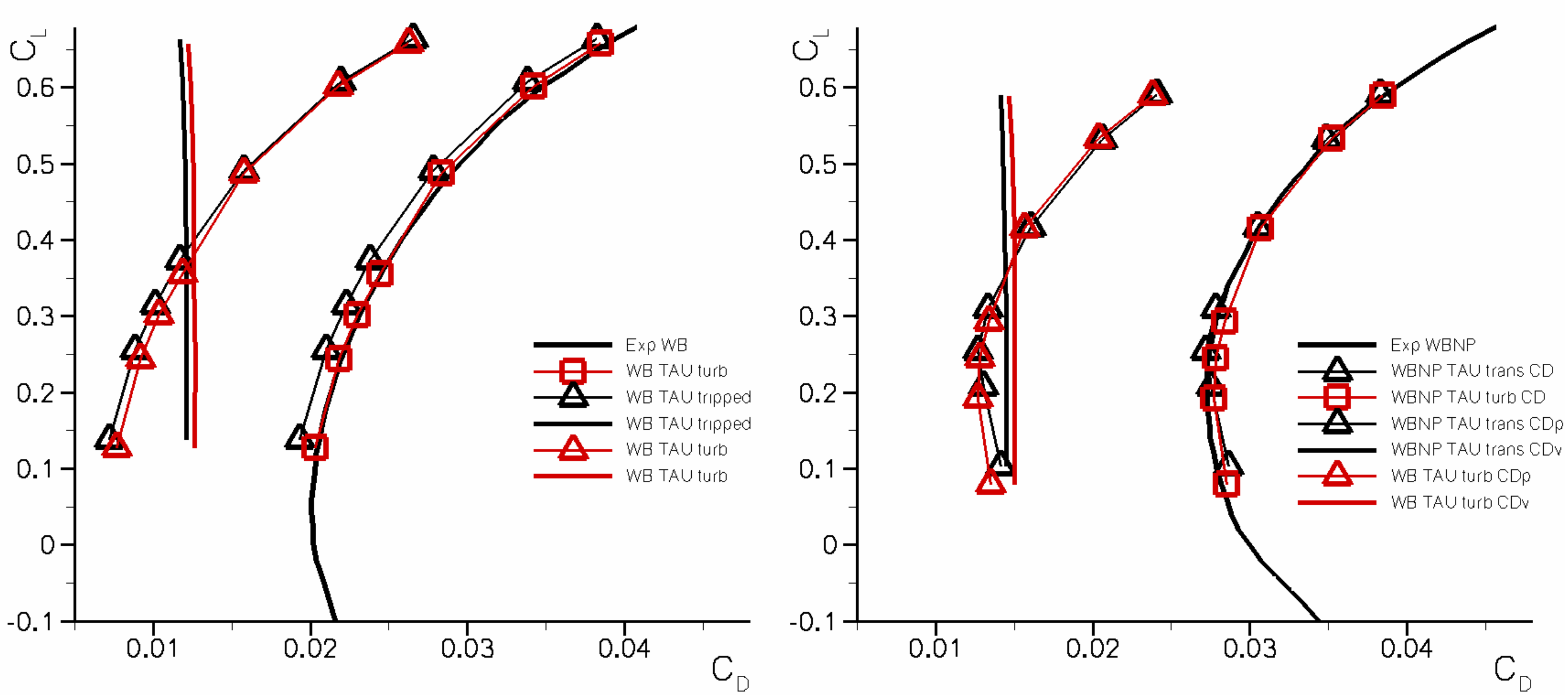
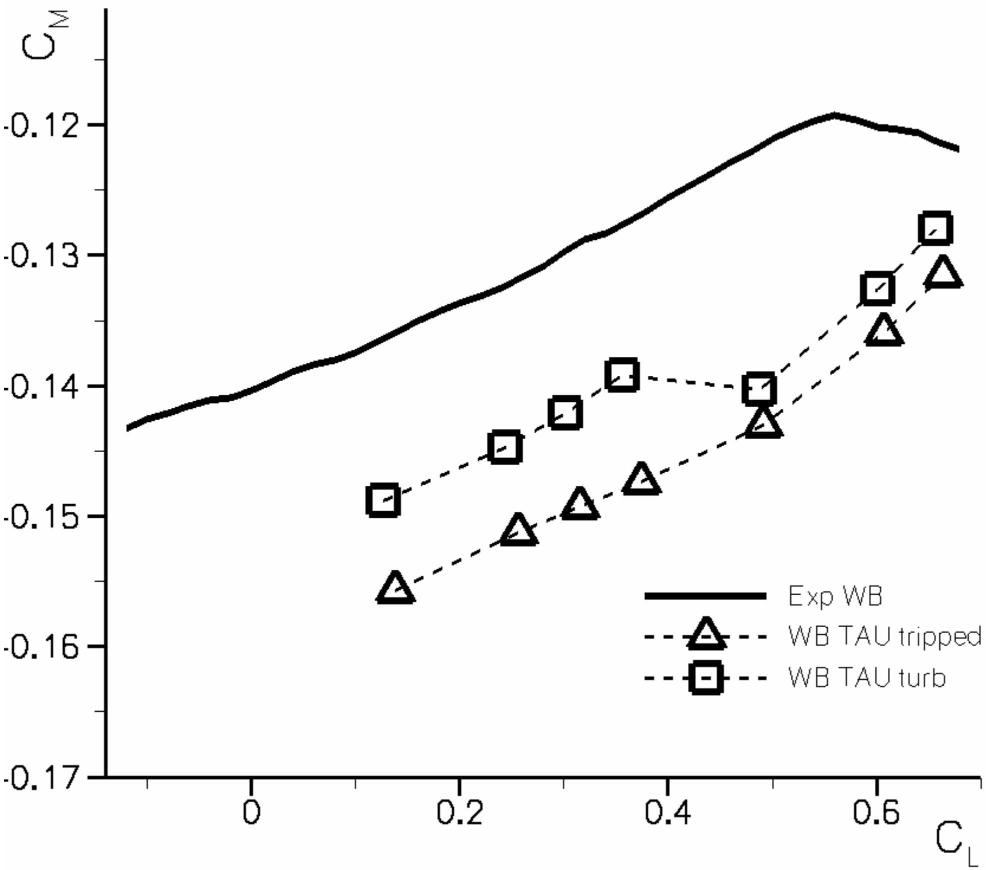


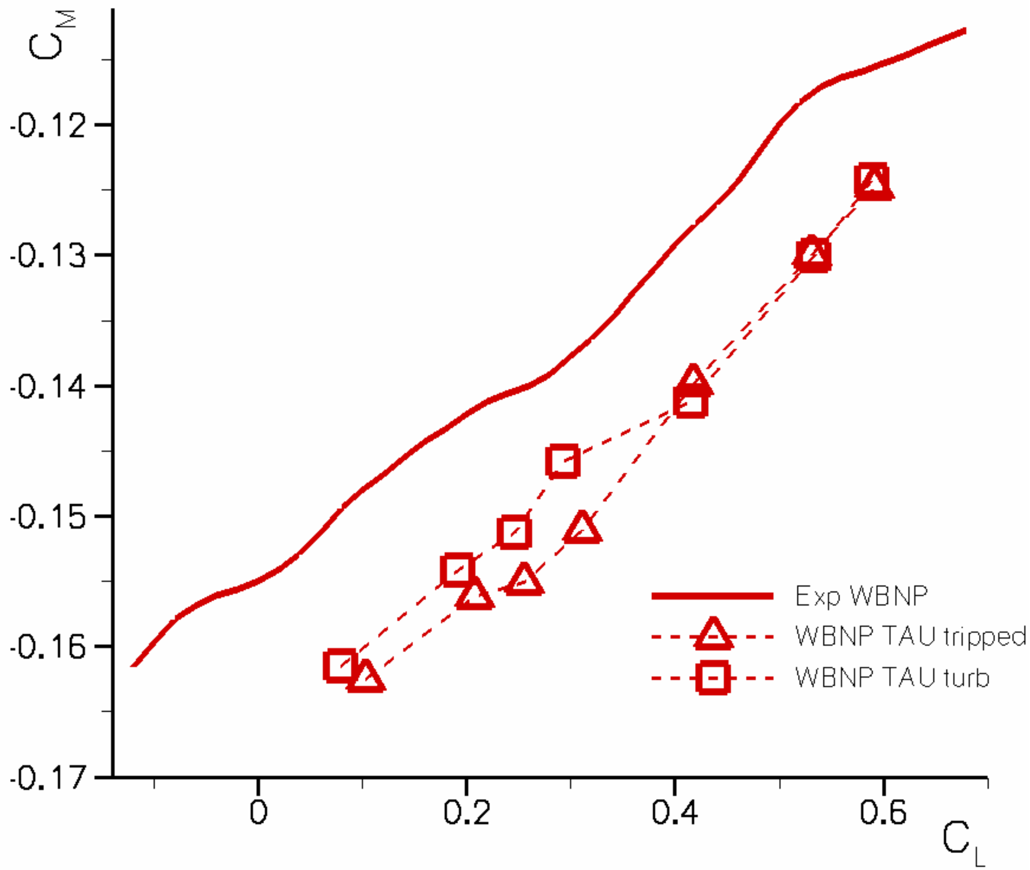


Case 2: Drag Coeffcients

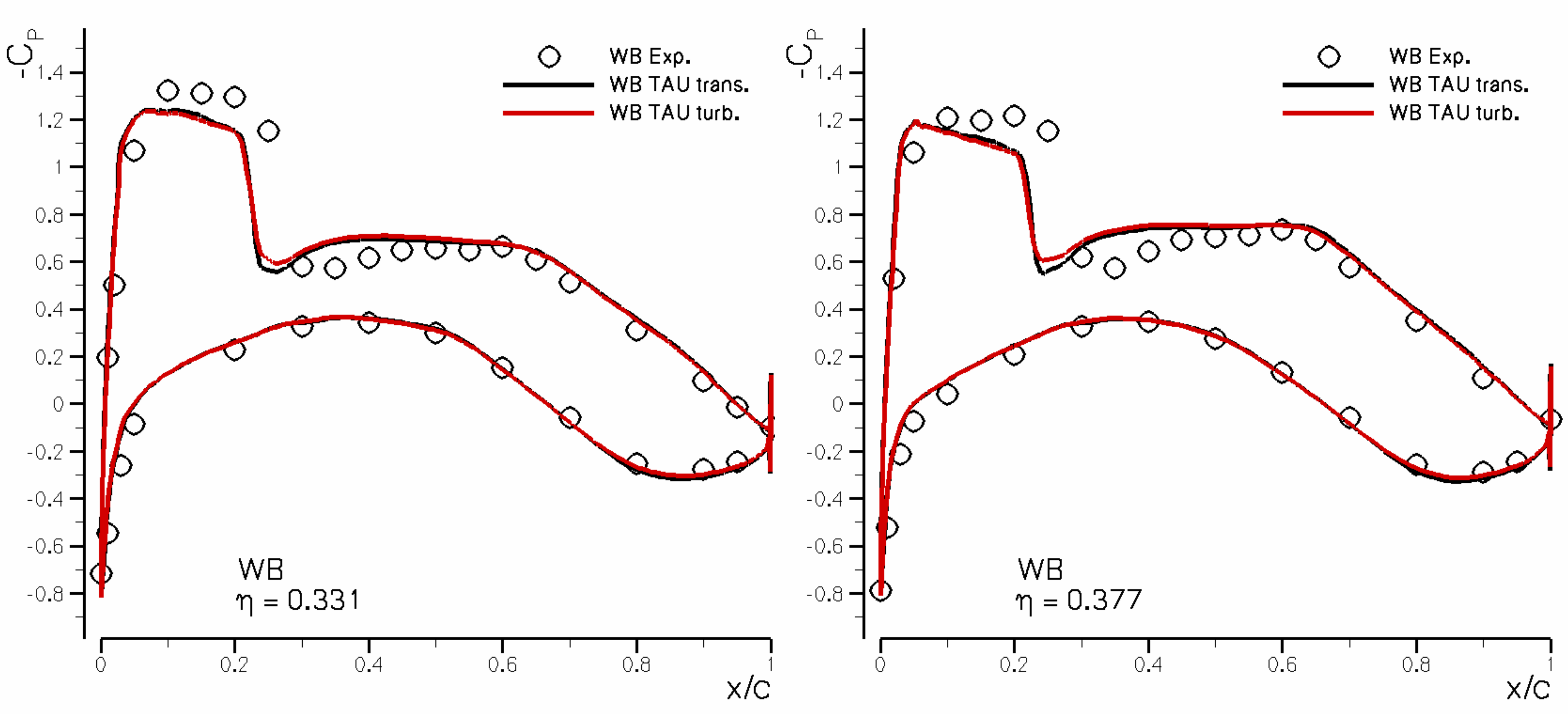


Case 2: Moment Coefficients



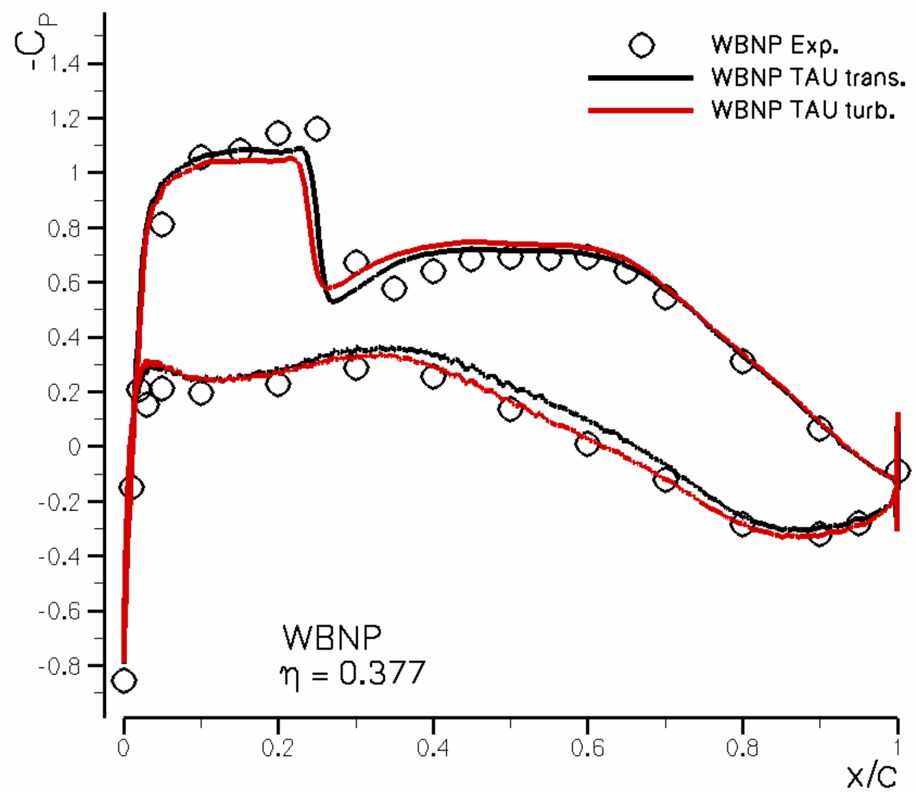


Case 3: Comparison with transition / fully turbulent



Case 3: Comparison with transition / fully turbulent

Conf.	C_D Trans.	C_D Turb.	ΔC_D
WB	287.4	282.1	5.3
WBNP	330.6	329.0	1.6



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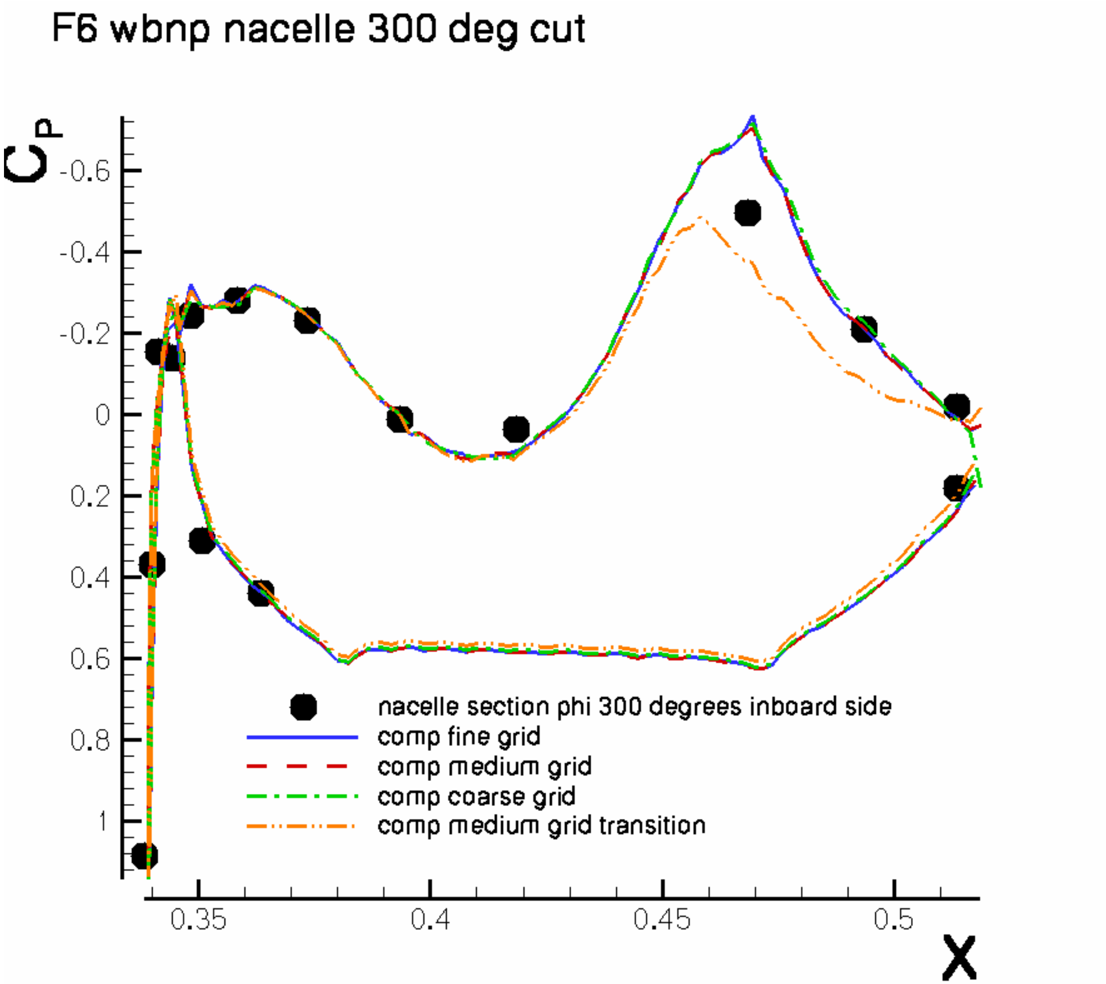
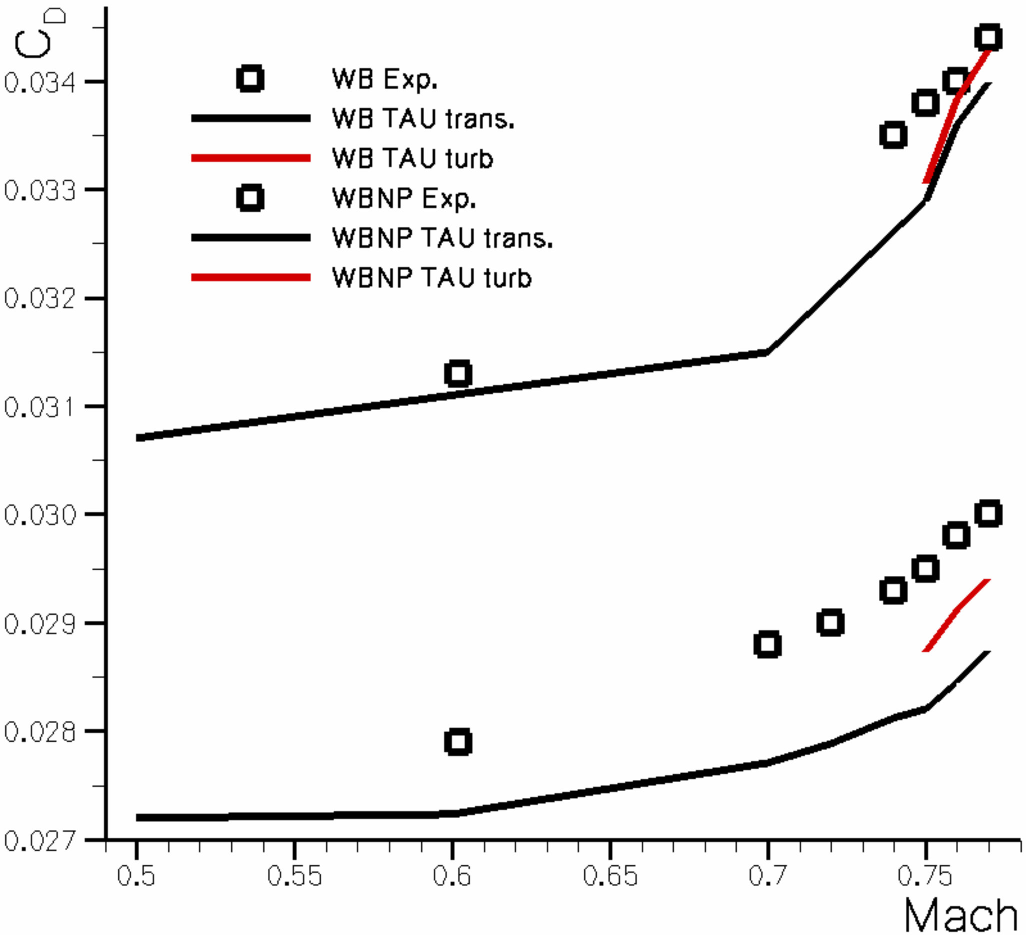


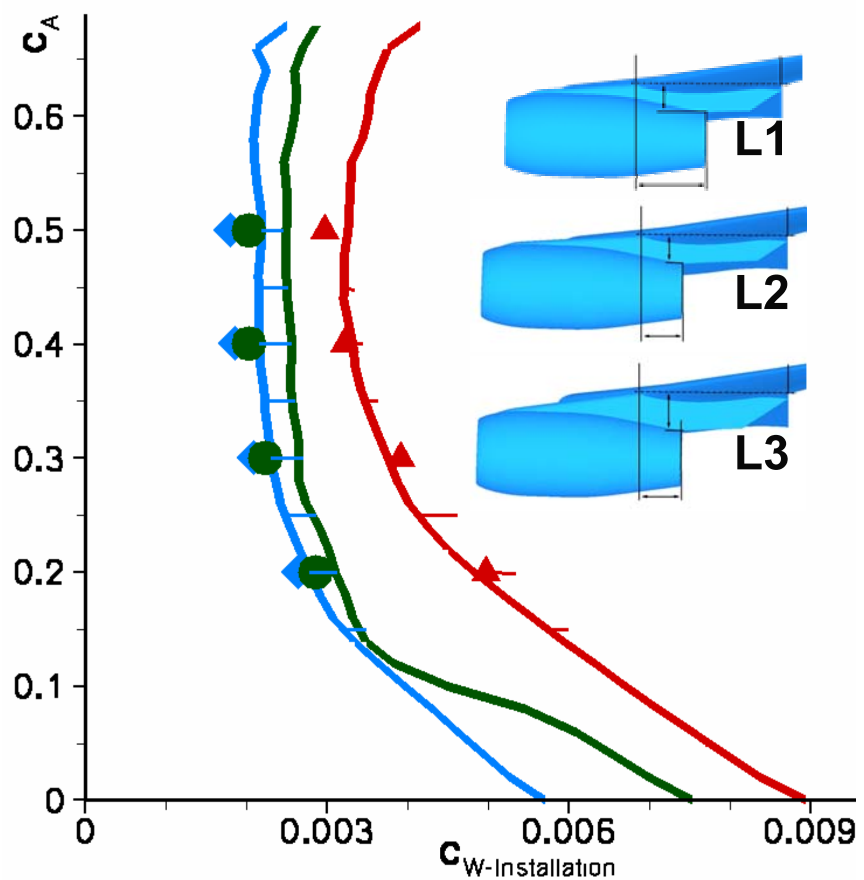
Case 4: Mach Drag Rise



DLR-F6 Cases: Installation drag

(AIAA-Journal Vol. 39, No. 6, Nov-Dec 2002)

$C_{D\text{-Install.}}$	Exp.	TAU
L1 – L2	10.7	11.8
L2 – L3	3.0	2.3



Summary

- Hybrid method (TAU & Centaur) is able to predict drag for DLR-F6 within a range of 5-8% (C_L=0.5)
- Grid adaptations are necessary to reduce discretization errors
- Flow phenomena have to be computed correctly to ensure drag prediction
- Trailing edge geometry of DLR-F6 has an influence on wing upper side flow separations
- Wing lower side transition is of importance
- Drag differences of 1-2 dc can be computed when errors are systematic
- Remaining questions: transition, trailing edge effects