MFlow results for HiLiftPW-2

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Outline

- Numerical methods description
- Results: Case1/2a/2b/3a/3b
- Conclusions

Numerical methods description

Numerical methods used as follows unless otherwise stated:

- **SA turbulence model (original formulation, no trip terms)**
- Full NS
- Roe
- Gauss-node gradient computation
- Low-Mach-number precondition
- LUSGS for steady-state marching
- **Free stream conditions used as initial conditions**

Results: Case1

- Grid used:

A_uns_1to1 (coarse, medium, fine)

B_uns_mix (coarse, medium)

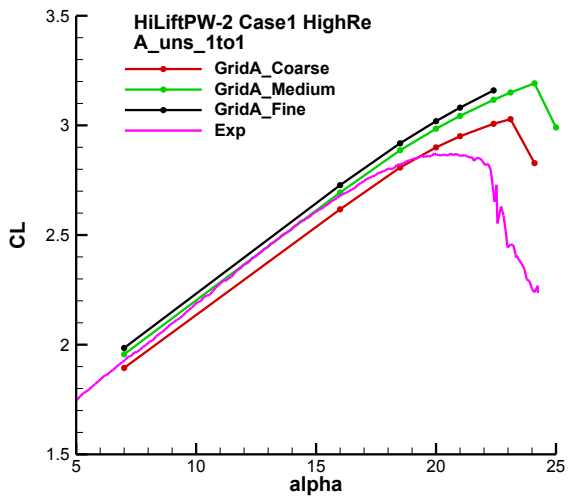
C_uns_mix (extracoarse, coarse)

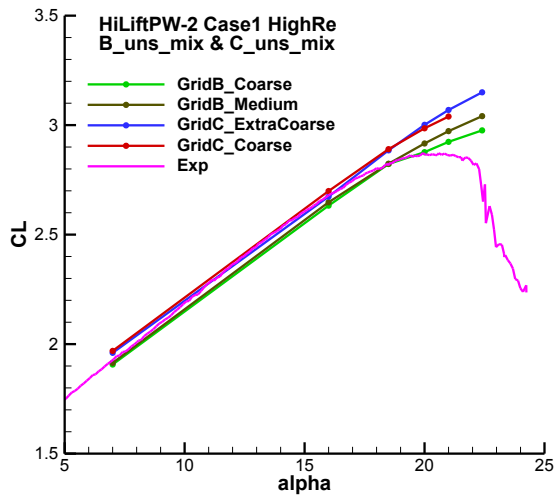
Only for reference, results not submitted

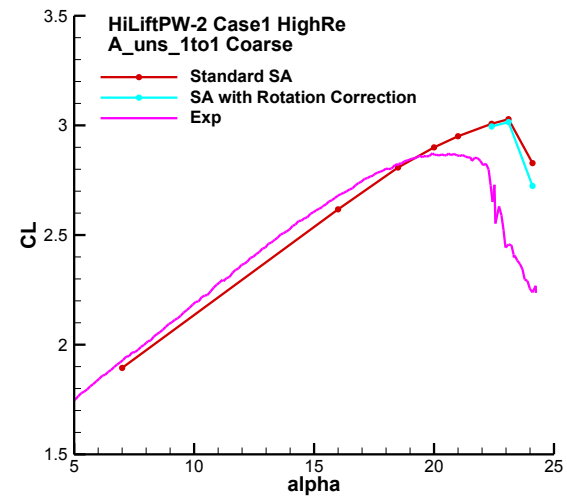
- AoA = 7, 16, 18.5, 20, 21, 22.4

(additional angles 23, 24 computed with coarse and medium grid of A_uns_1to1 series)

Case1: CL-alpha







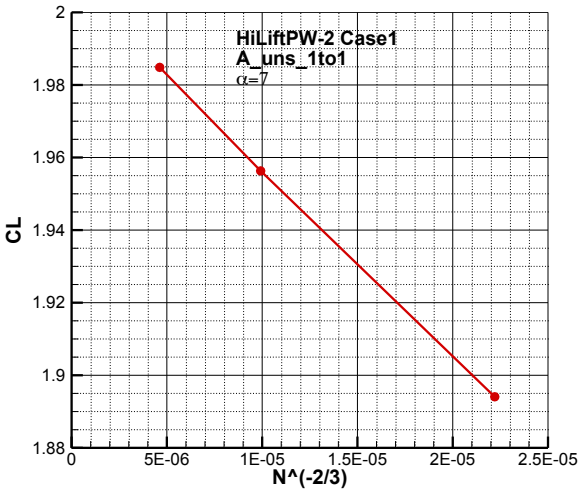
- Same trends are found among different grids:

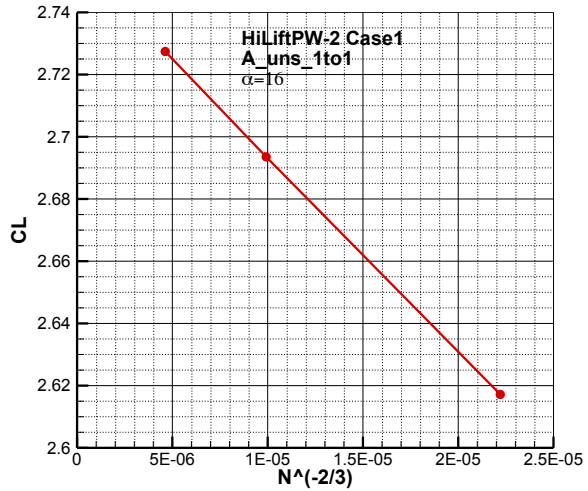
1. delayed stall AoA
2. larger CL_max
3. grid refinement makes 1&2 more evident

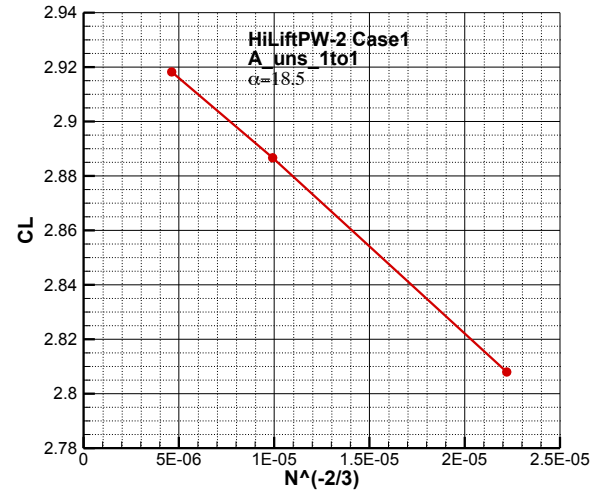
- **Rotation correction of SA model makes little difference to CL curve**

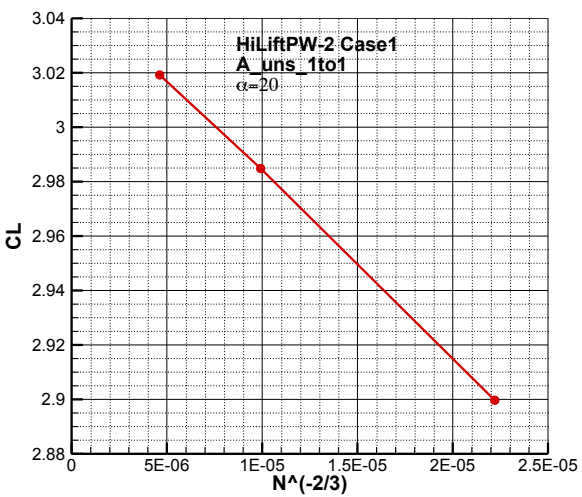
Case1: CL grid convergence

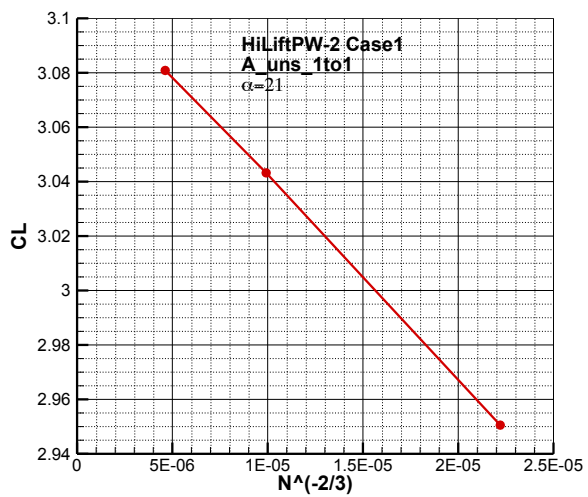
- Nearly linear convergence obtained with grid refinement

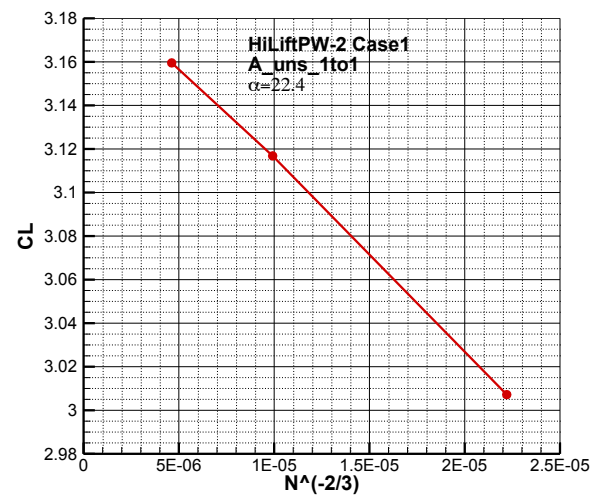




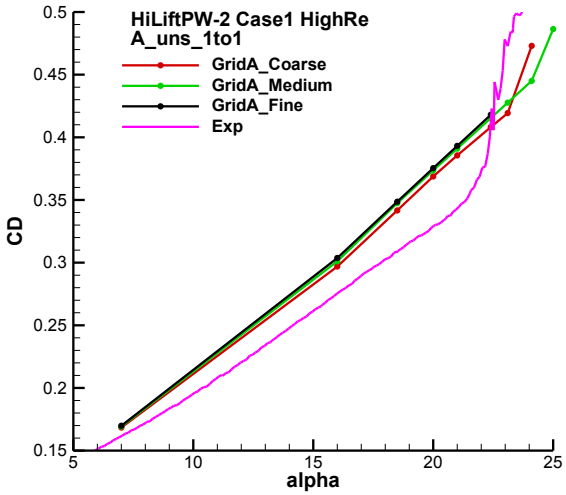


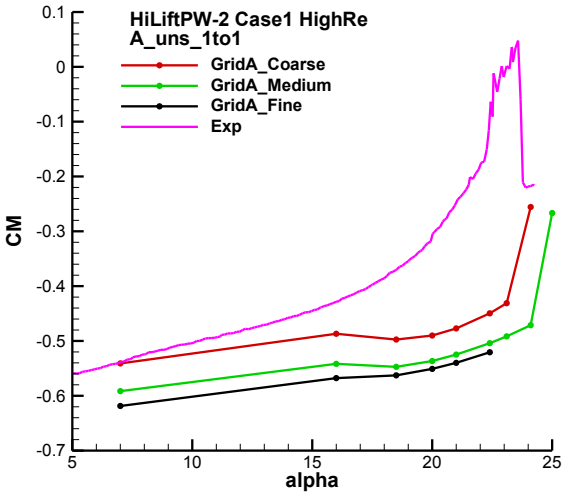






Case1: CD&CM-alpha

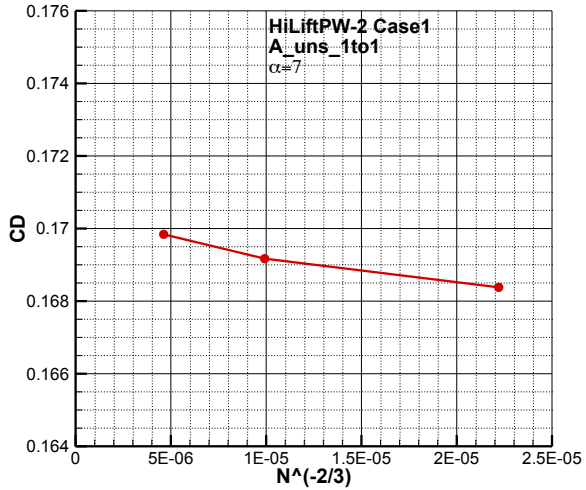


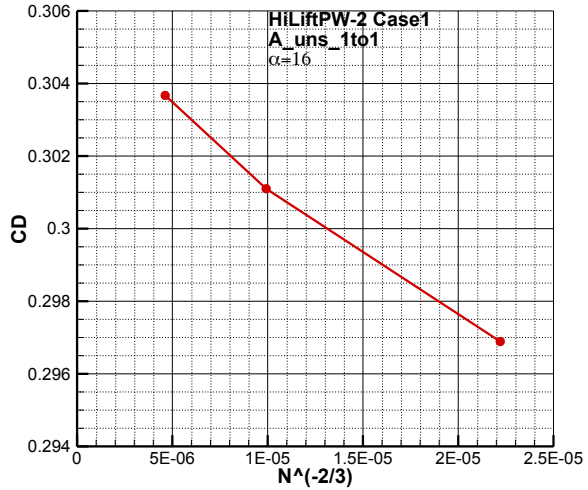


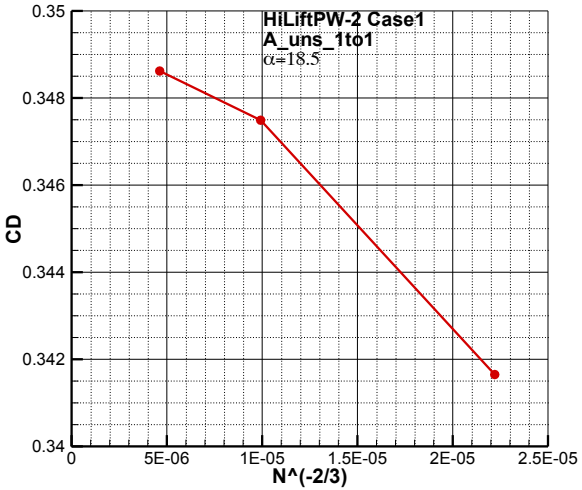
- The CD&CM prediction is unsatisfied and grid refinement doesn't lead to improvement comparing with experiment.

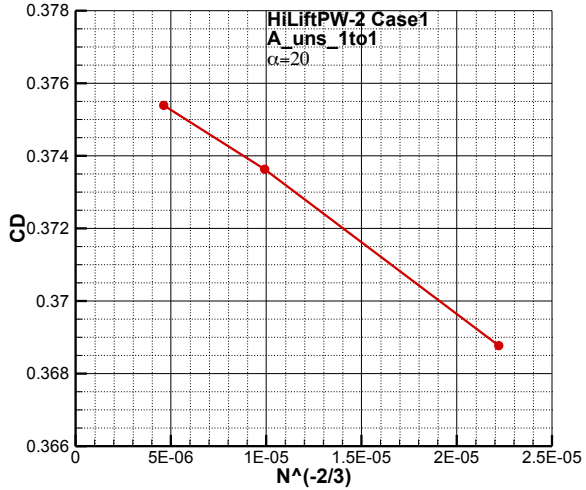
Case1: CD grid convergence

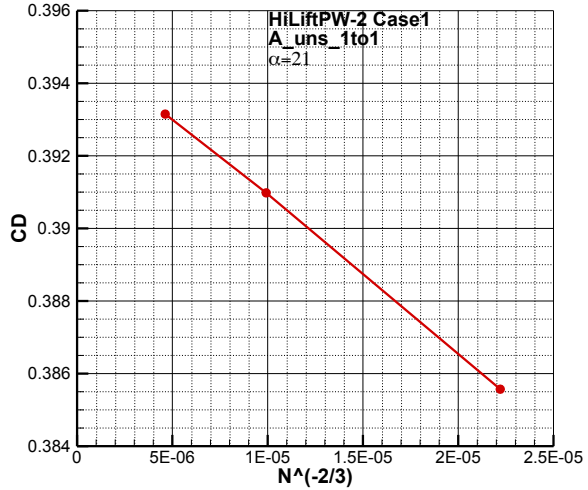
- Nearly linear convergence obtained with grid refinement except at alpha=16, 18.5

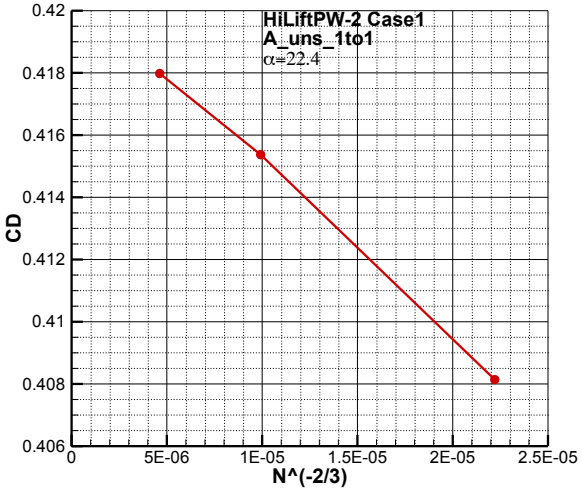






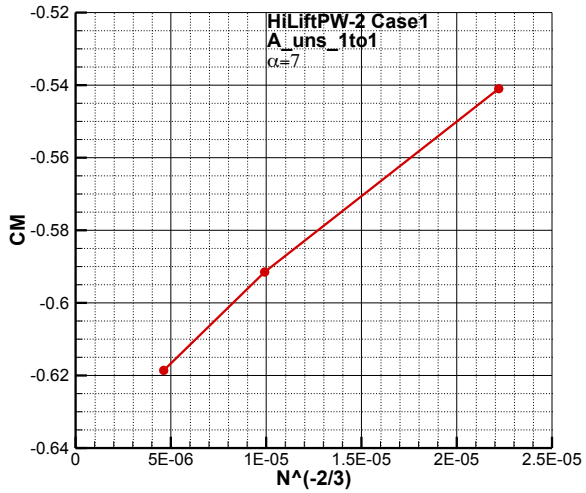


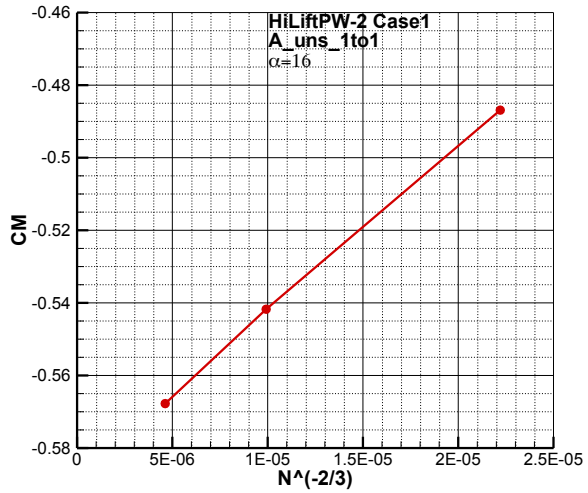


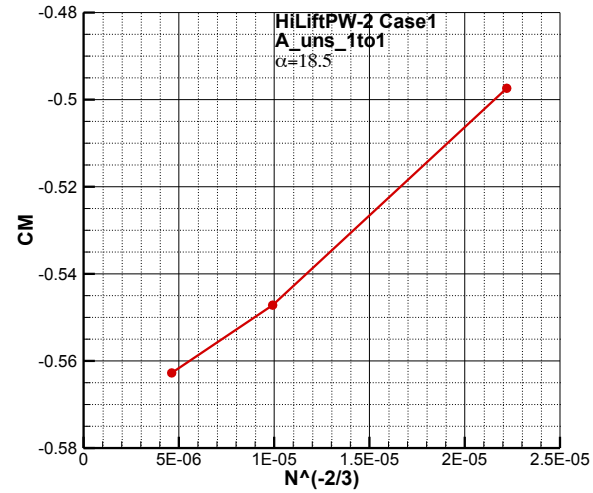


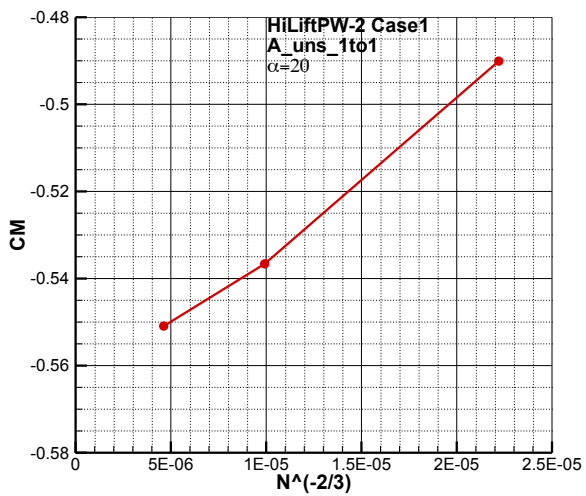
Case1: CM grid convergence

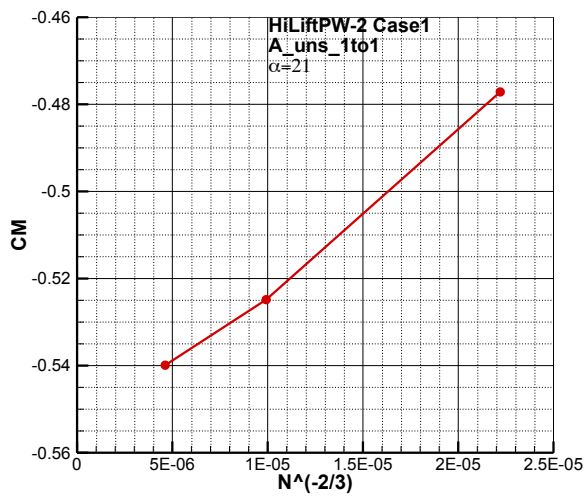
- Nearly linear convergence obtained with grid refinement

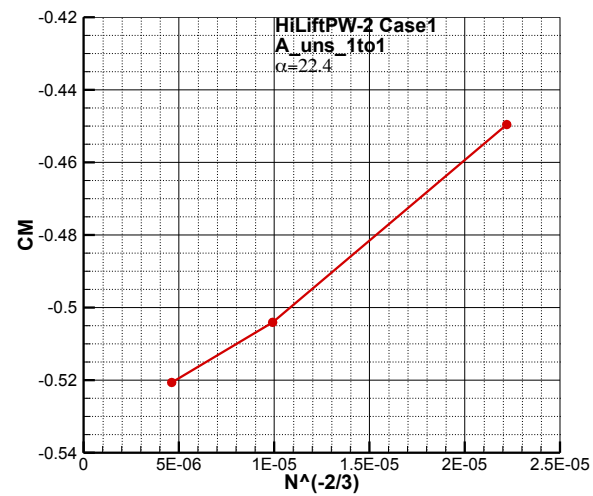






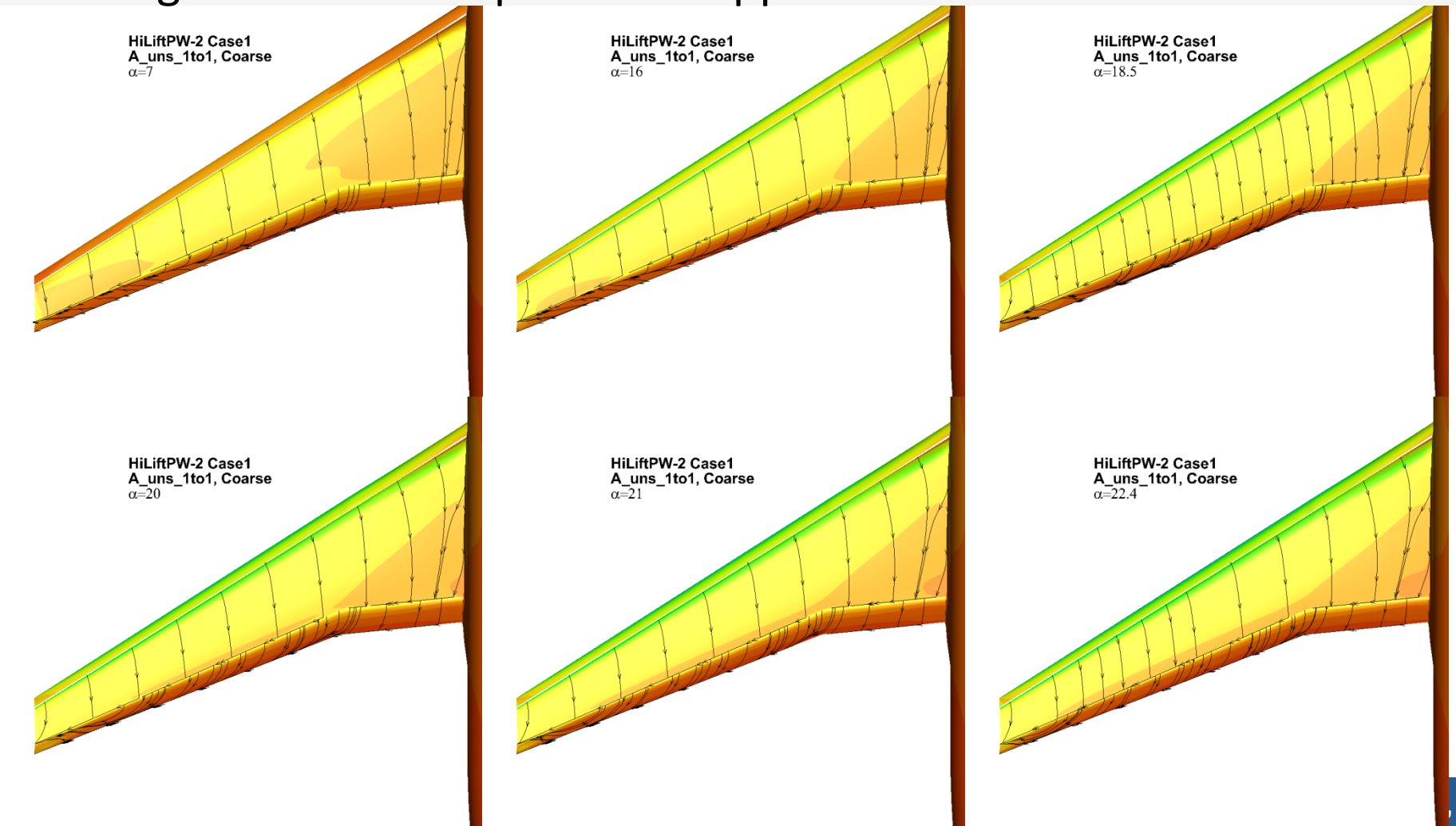




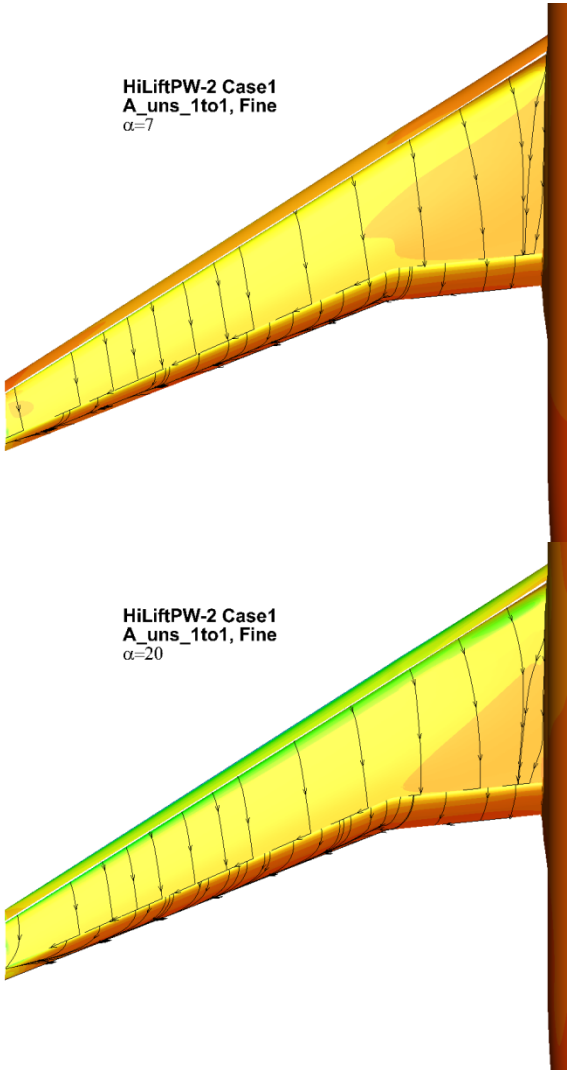


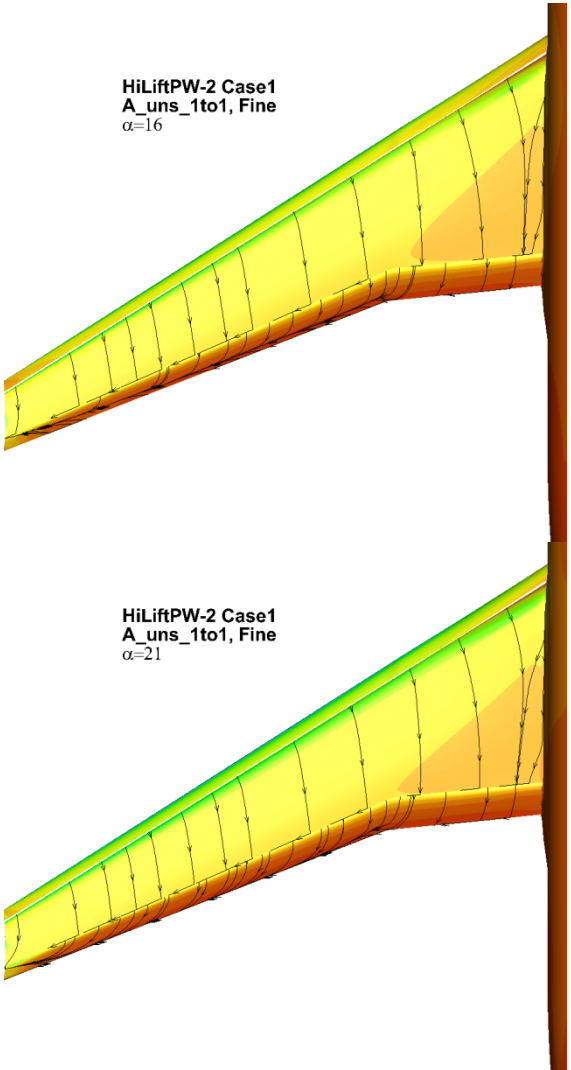
Case1: surface flow/ Coarse Grid

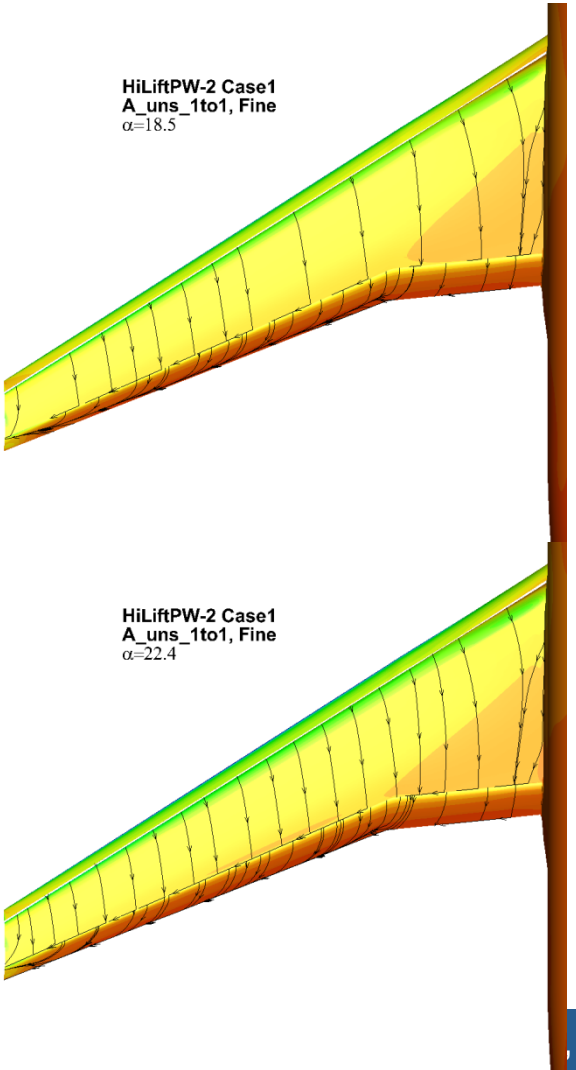
- Flap: TE separation is weakened with the increment of alpha
- Wing: no massive separation happens



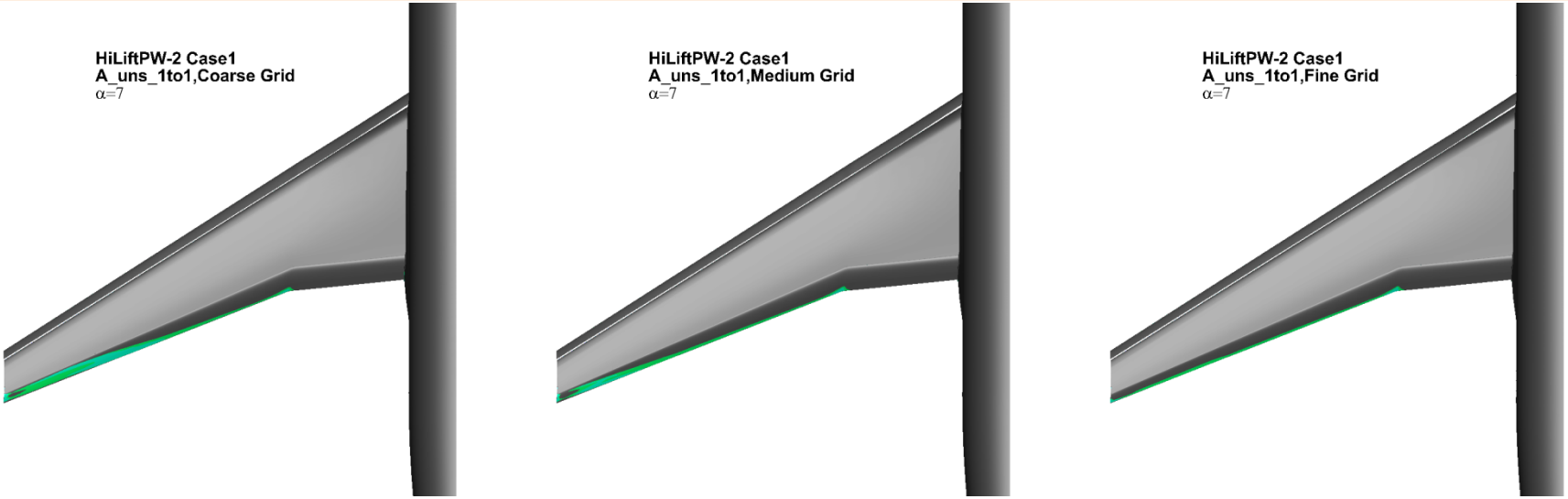
Case1: surface flow/ Fine Grid





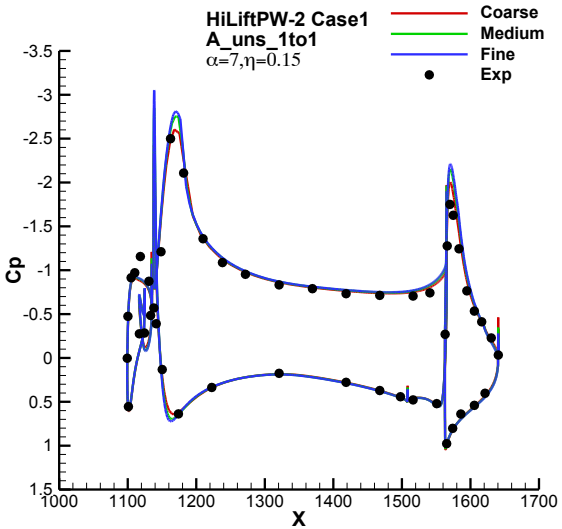


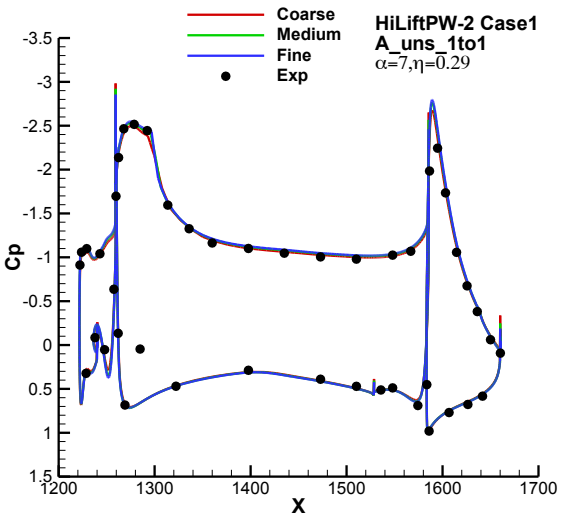
Case1: surface flow/ Grid Effects

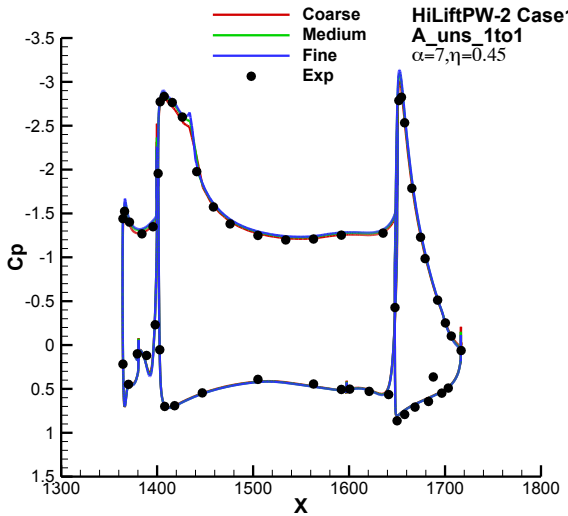


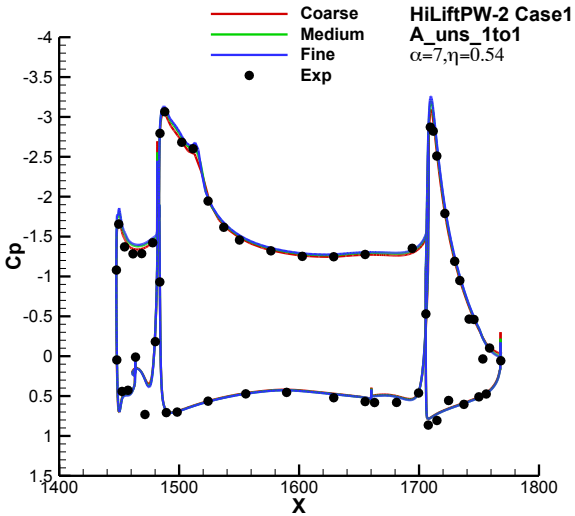
- Green region: cfx<0
- Flap: TE separation is weakened with grid refinement

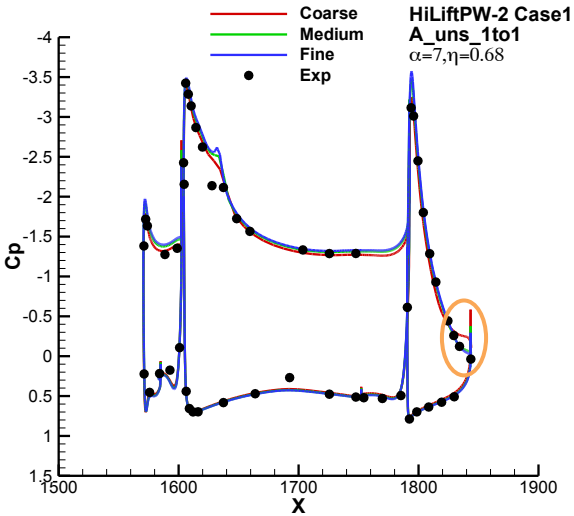
Case1: Cp distribution alpha=7

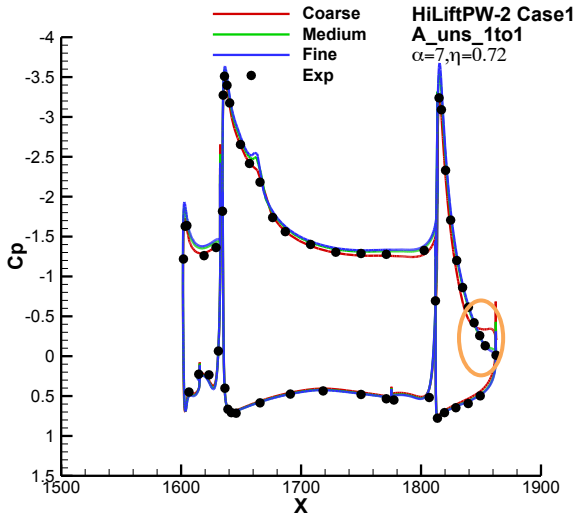




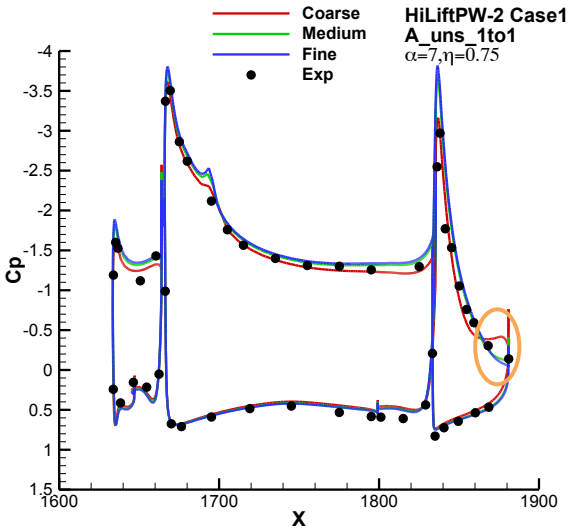


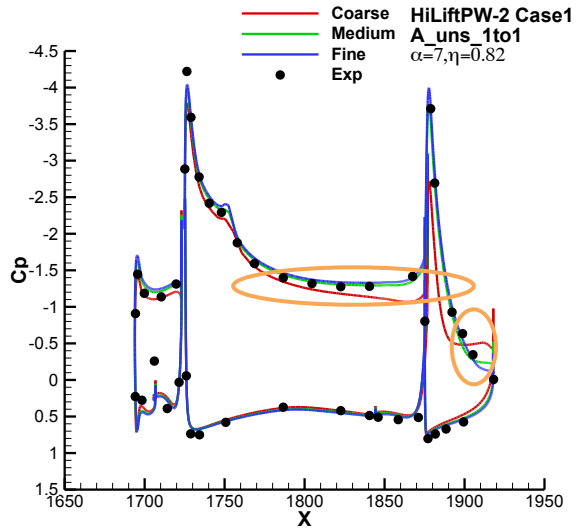


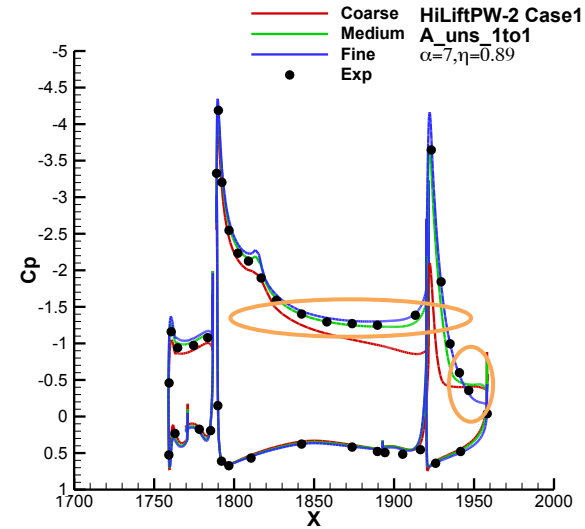


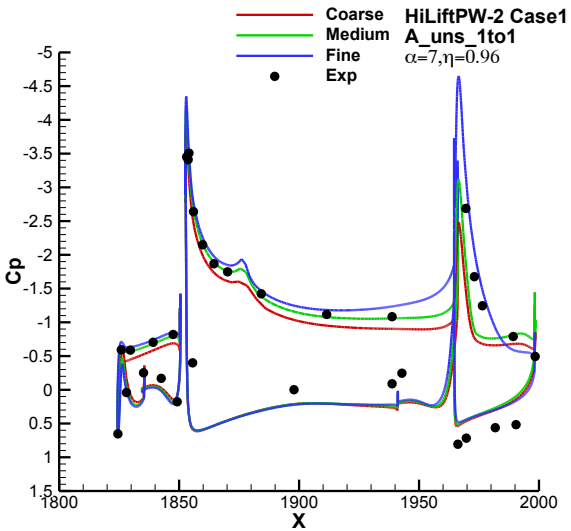


Case1: Cp distribution alpha=7



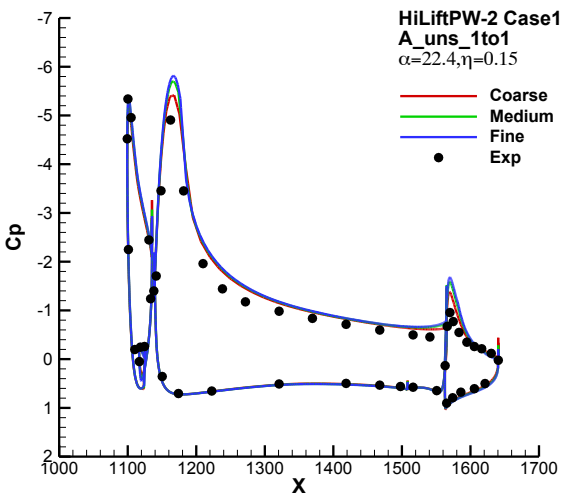


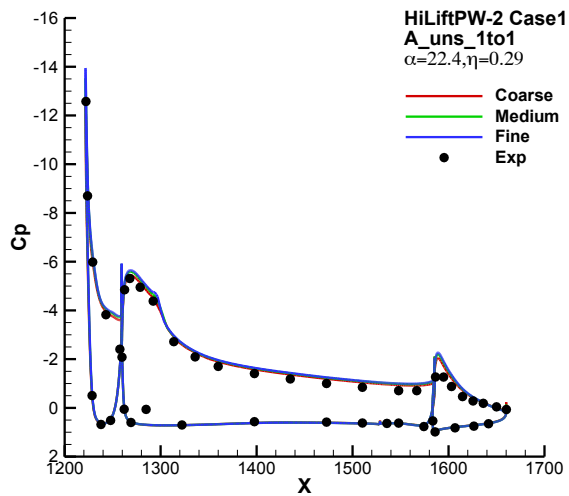


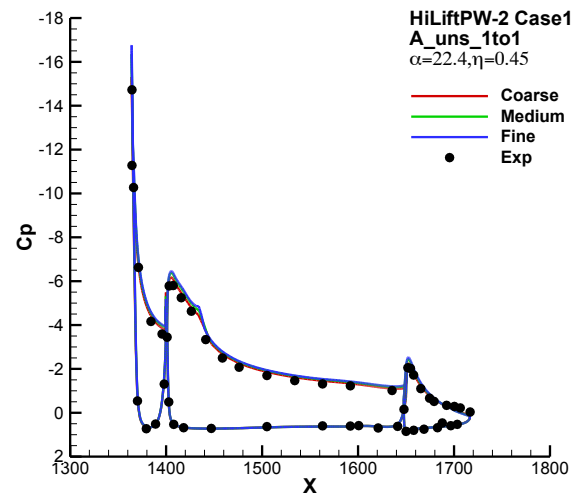


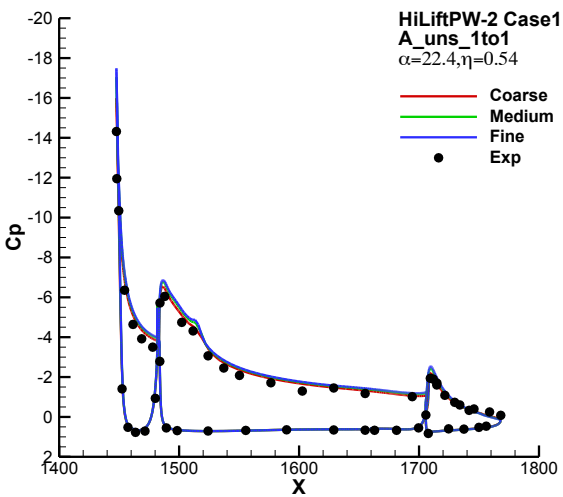
- Grid refinement improves Cp prediction on the wing sections near the tip and on the flap upper surface where actually no separation happens

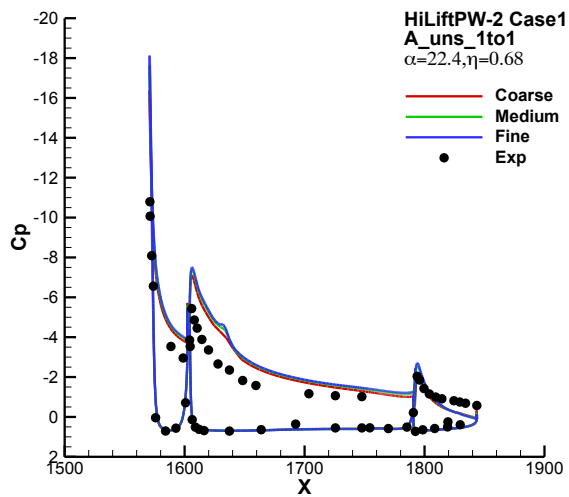
Case1: Cp distribution alpha=22.4

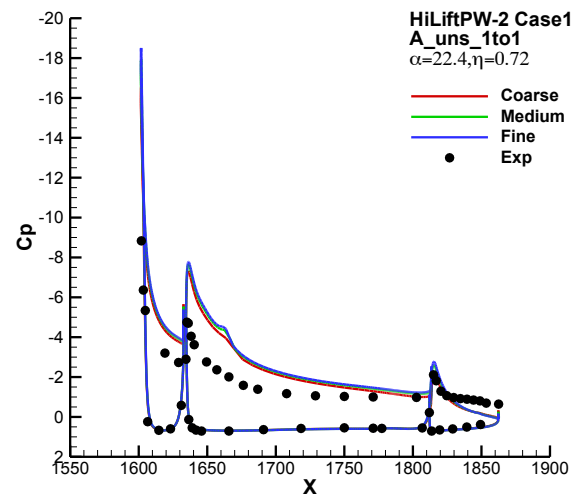




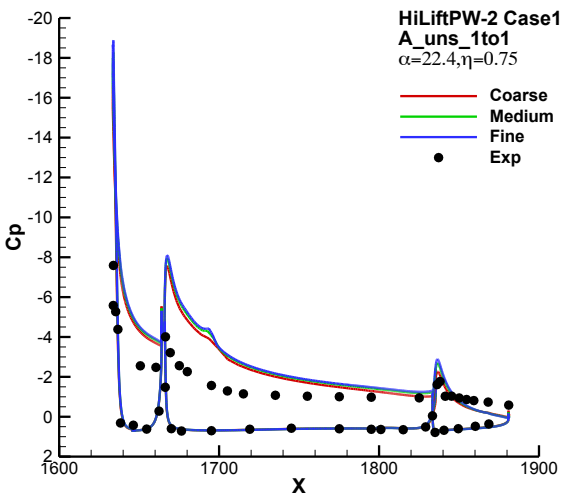


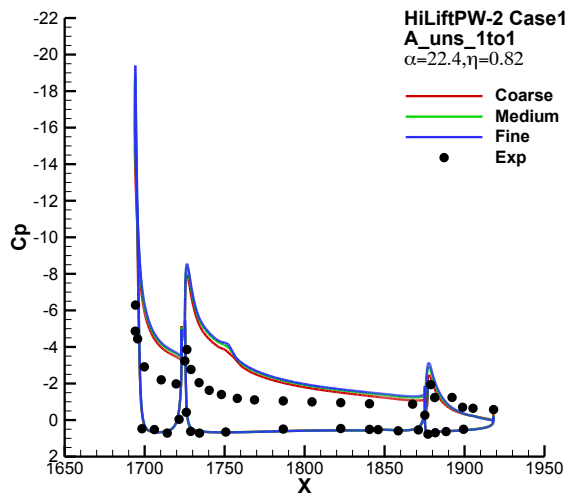


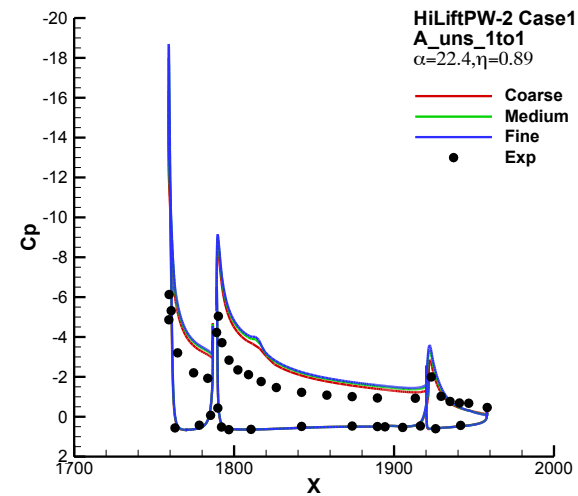


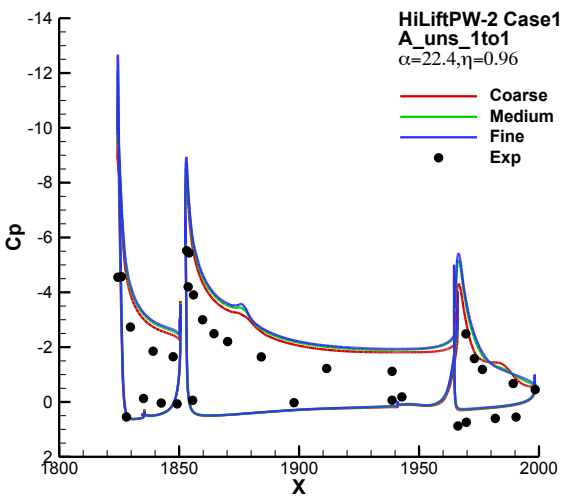


Case1: Cp distribution alpha=22.4





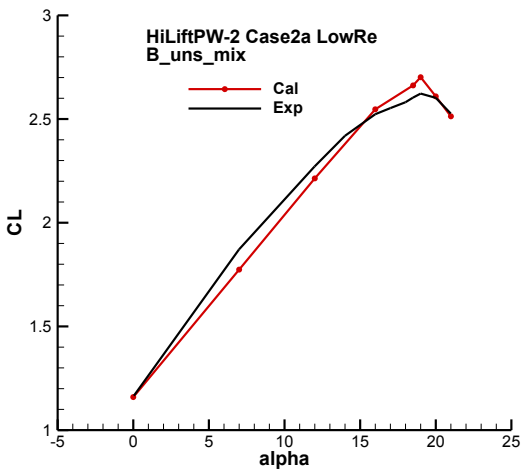


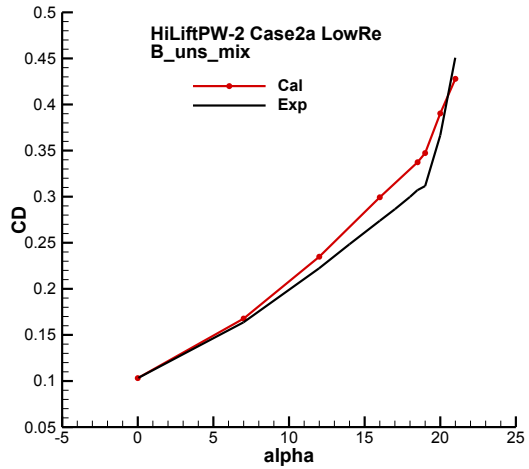


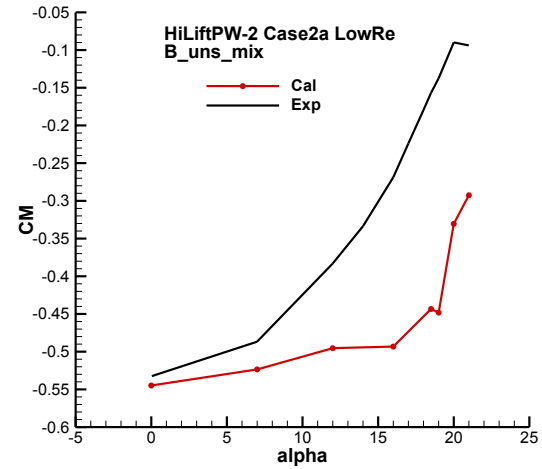
- Cp distribution on suction surface shows much difference with experiment especially on sections near the tip
- Grid refinement does not lead to much improvement.

Results: Case2a LowRe

- Grid used: B_uns_mix



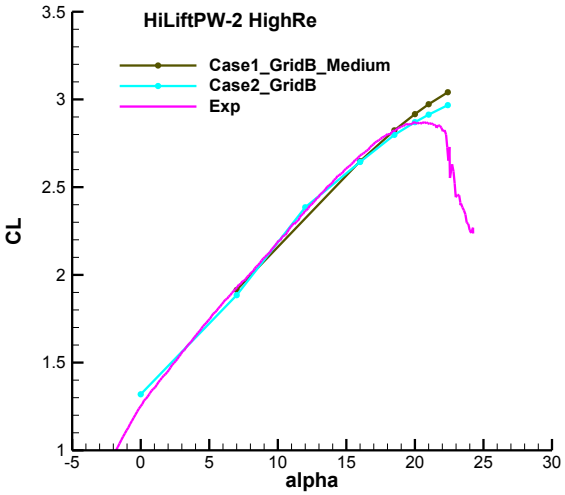


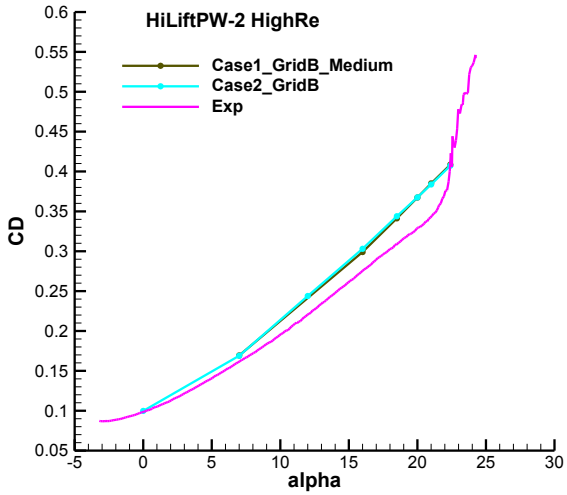


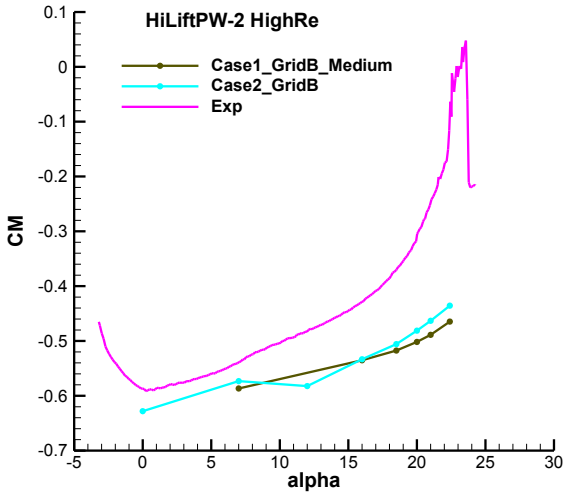
- a difference in CL presents in the linear range of the CL curve
- the stall AoA prediction is satisfied comparing with experiment: alpha=19
- Predicted CL_max is higher than exp

CL_max_Cal	2.70174
CL_max_Exp	2.62277

Results: Case2b HighRe

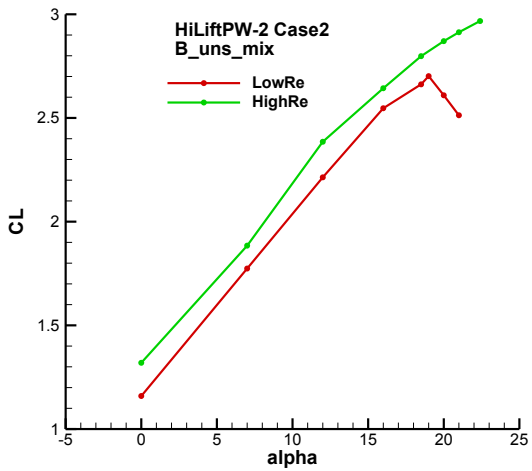


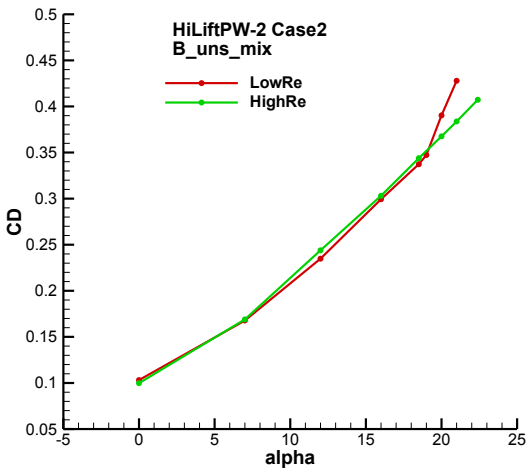




- Almost same trends found comparing with Case1Config2

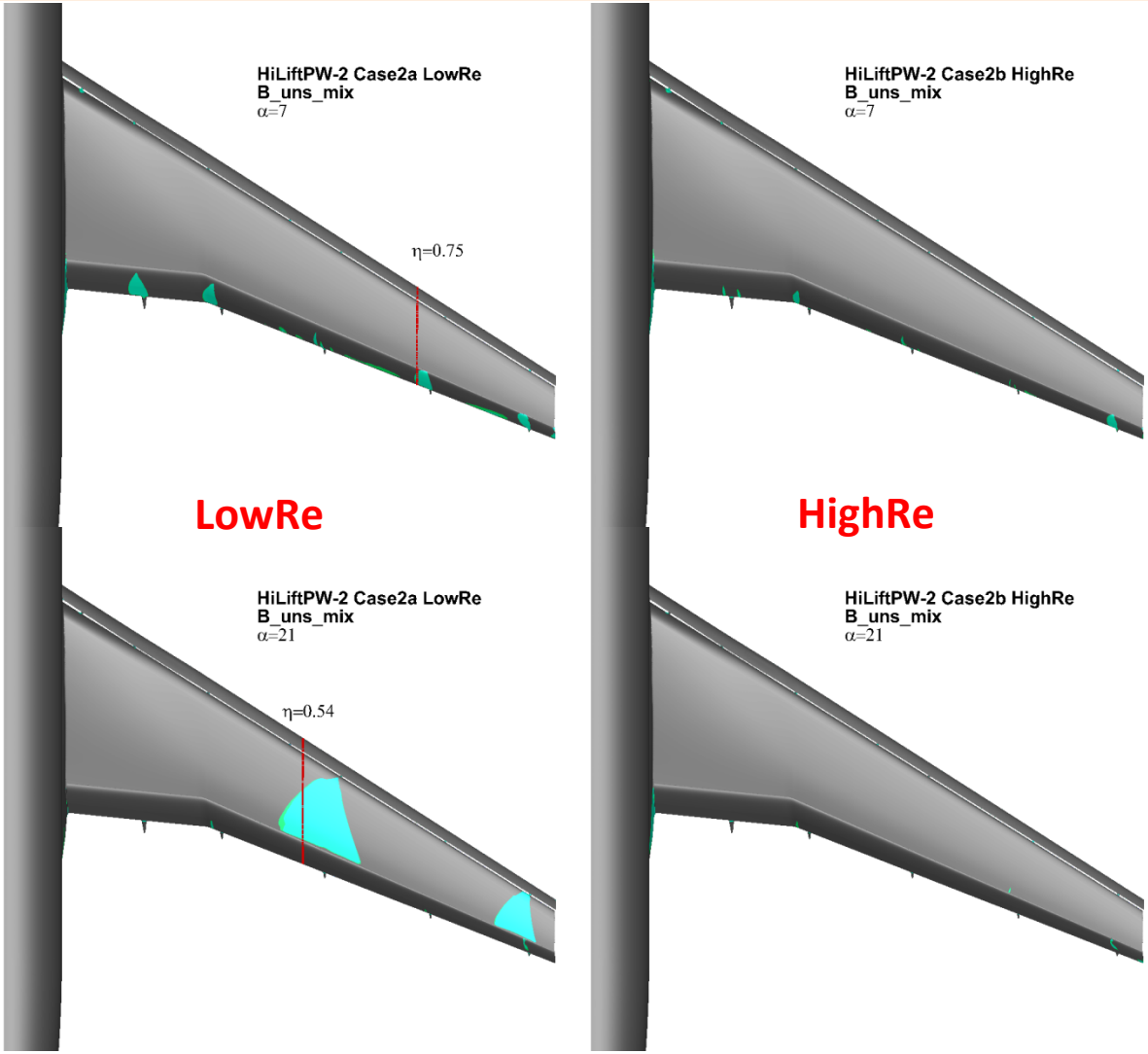
Results: Case2 Re Effects

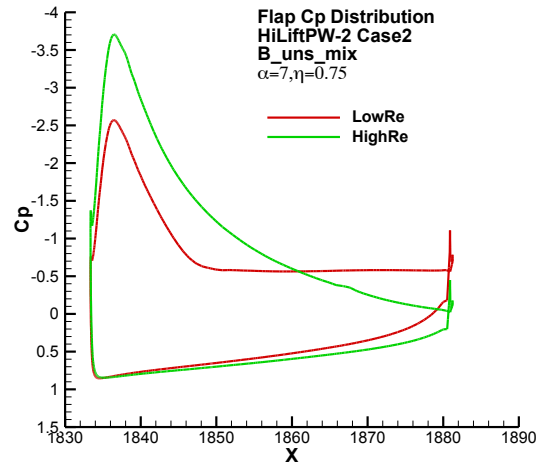


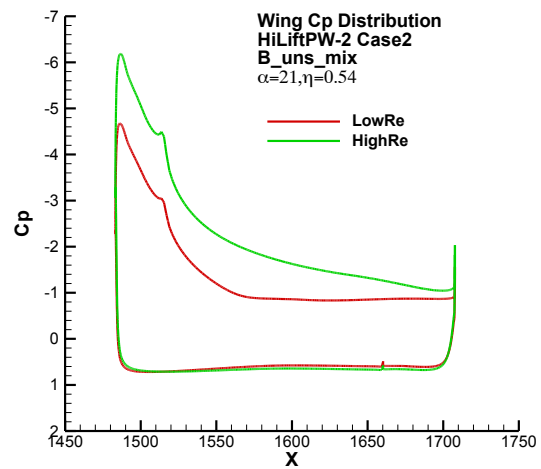


- a shift in CL exists in the linear range of CL curve between Low Re and High Re
- the stall AoA and CL_max prediction shows much difference

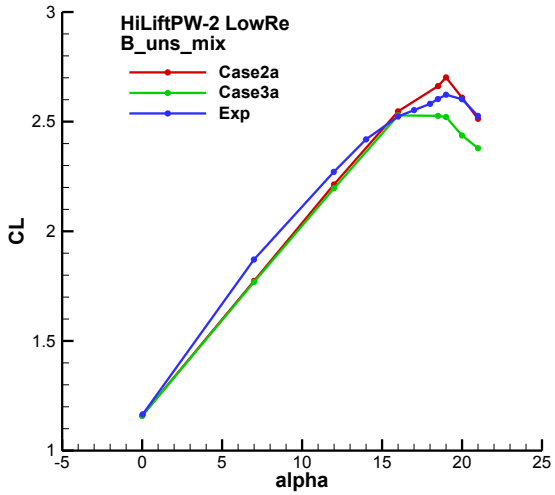
Results: Case2 Re Effects

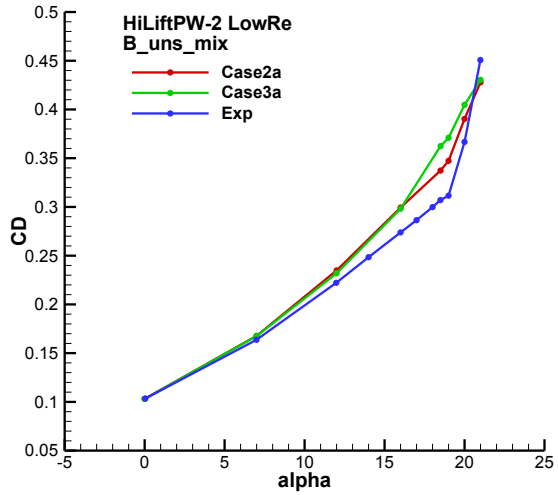


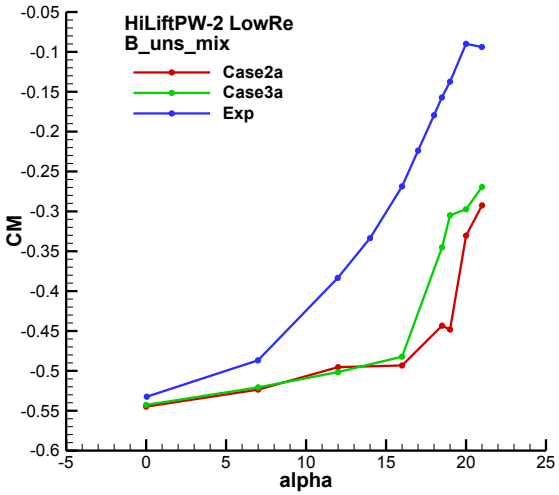


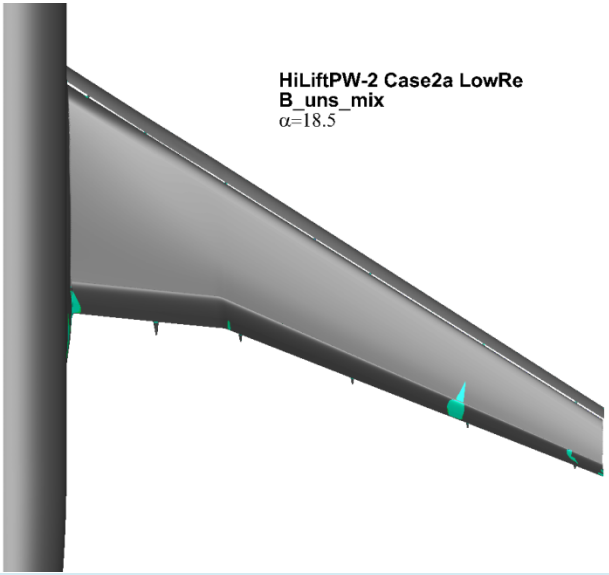


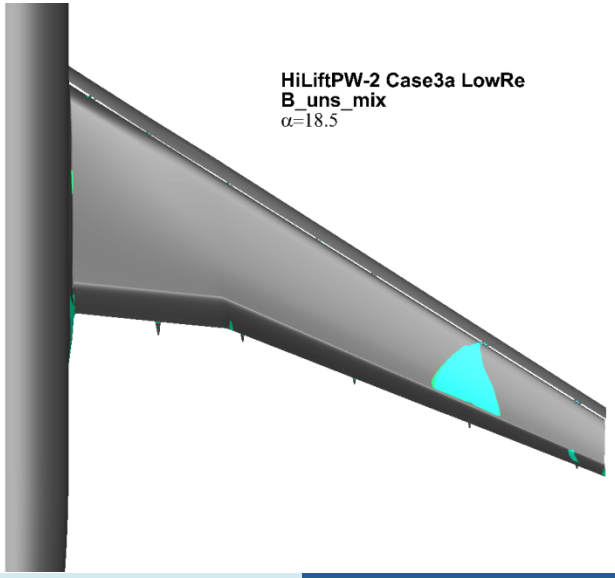
Results: Case3a LowRe FT

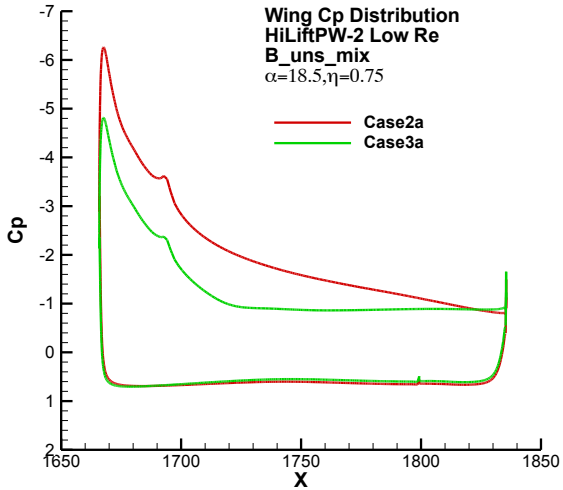




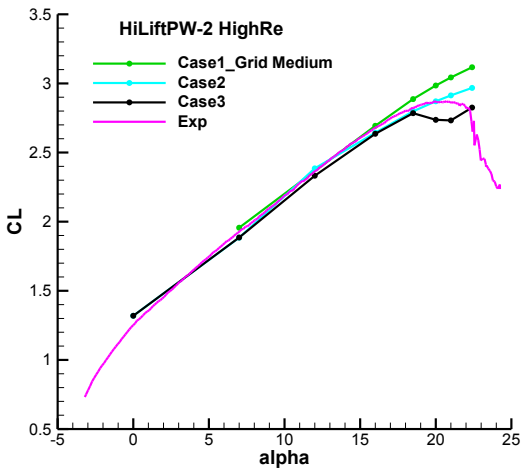


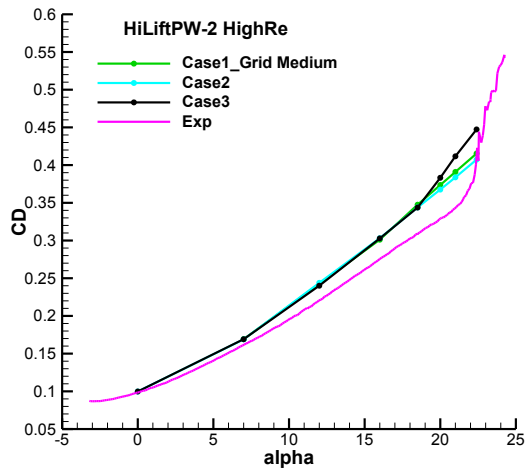


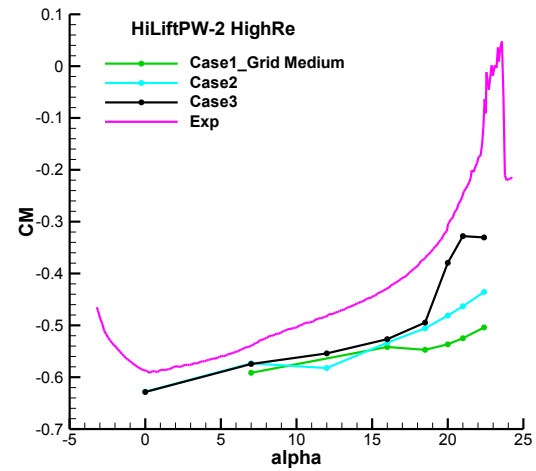




Results: Case3b HighRe FT



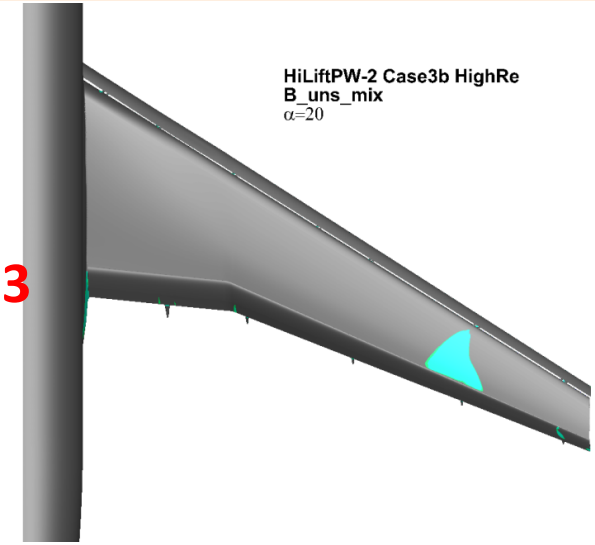


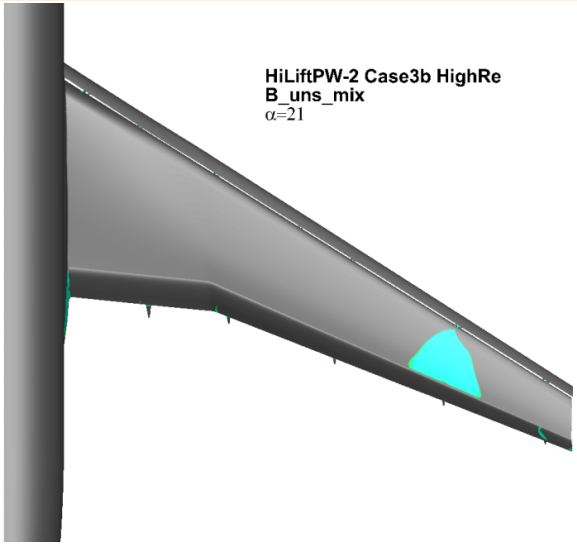


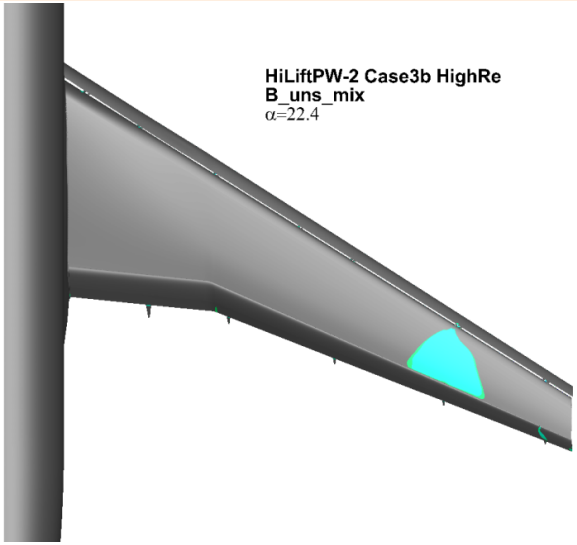
- approximately agreement is reached between the full configuration and two simplified configurations in CL curve, except at alpha=20&21 for the full configuration

Results: Case3b HighRe FT

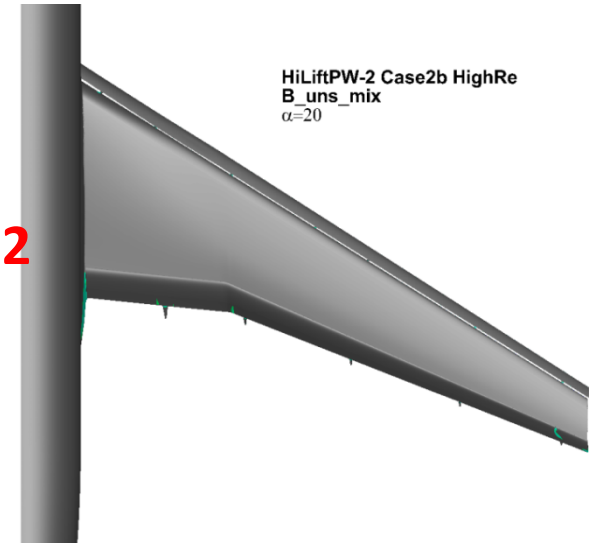
case3

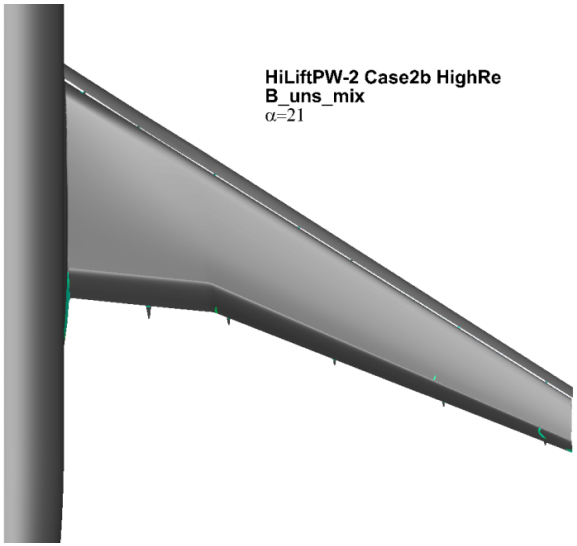


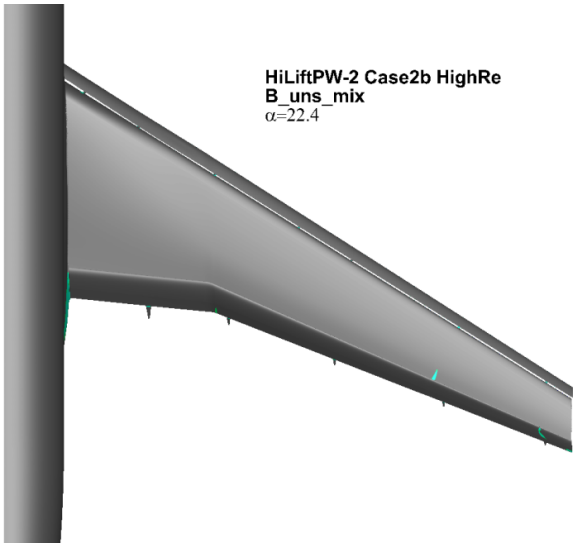




case2







Conclusions

- Nearly linear convergence is obtained with grid refinement for Case1Config2
- Delayed stall AoA and larger CL_max compared to experiment are found for HighRe case
- TE separation is sensitive to grid refinement and Re

Thanks for your attention!