

Sixth High-Lift Prediction Workshop (HLPW-6)

RANS Technical Focus Group (TFG)

Boris Diskin and Mike Park

July 1, 2026

Schedules and Deadlines

June 11, 2026:

Mini-workshop 1: Preliminary RANS solutions for TC1;
comparison with SRS TC1 solutions

January 2027:

Mini-workshop 2: Updated RANS solutions for TC1;

Comparison with experiment

Geometric variations of TC1, first application of lessons learned to TC2,
RANS model modifications

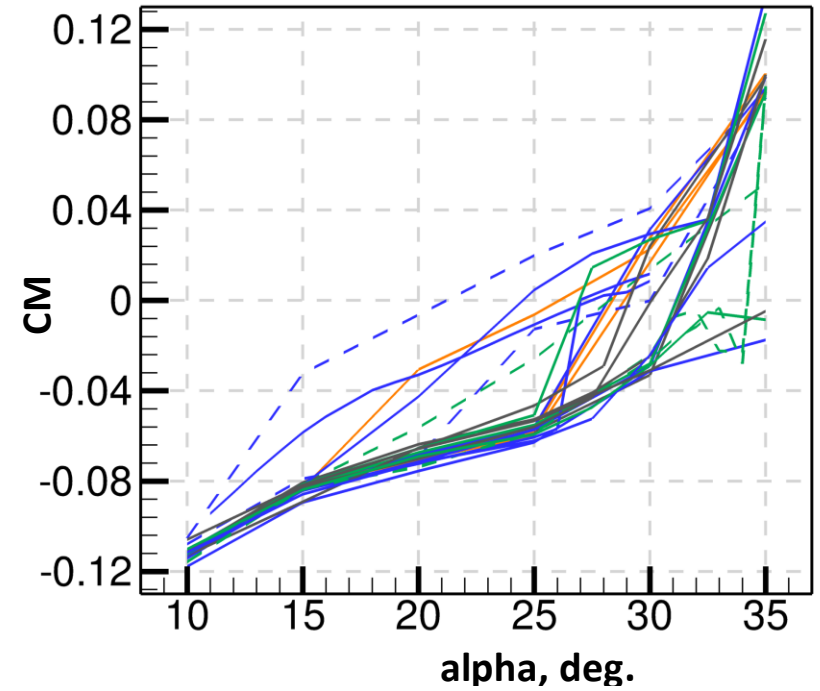
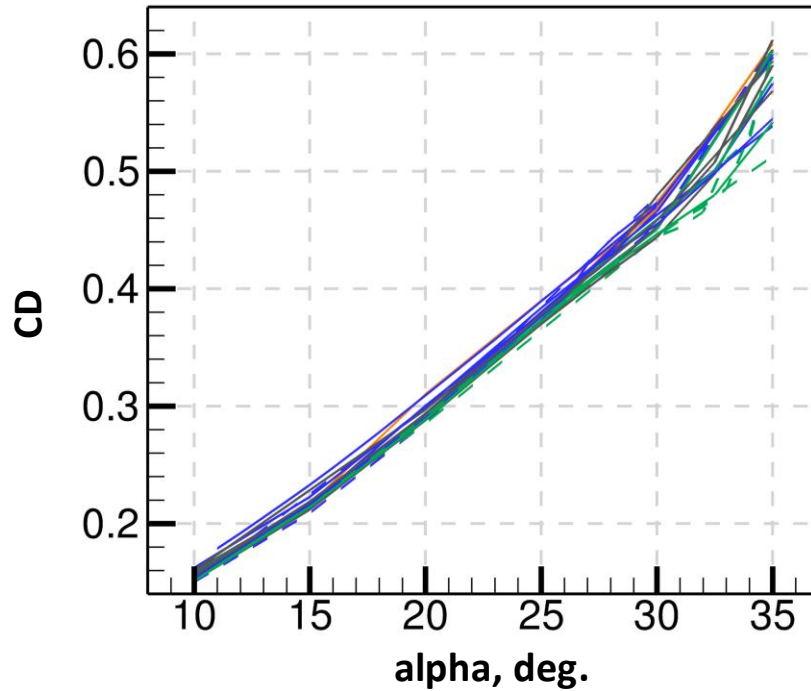
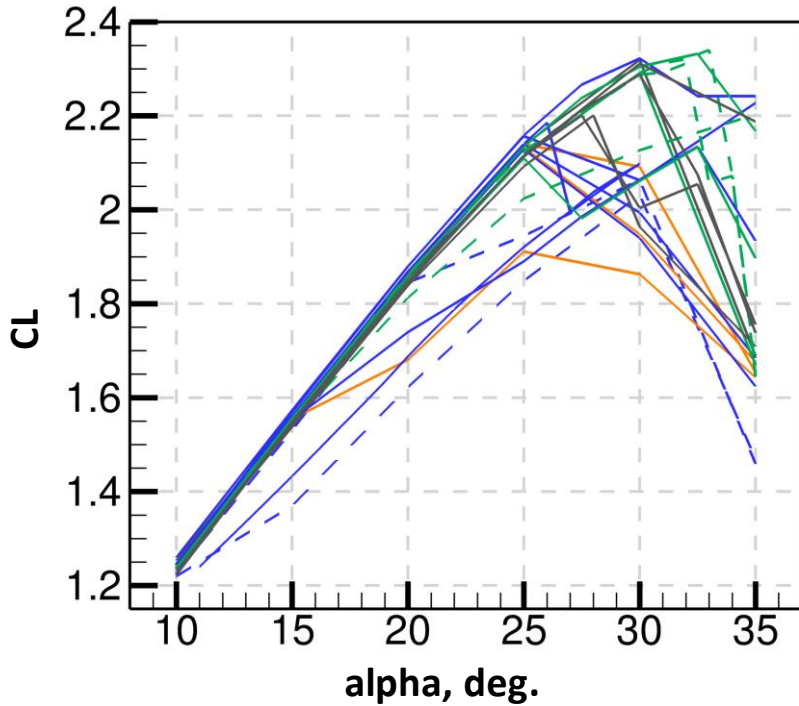
June 2027:

HLPW-6: RANS solutions for TC2 (Config 2.4); single Re,
limited number of angles of attack. Final report

January 2028:

HLPW-6 special sessions at SciTech-28

Forces and Moments – Nominal Grid All Participants



- **23** curves

All data sets uploaded by June 9th included

- Line style by turbulence model

[SA, SA-neg] = solid lines

[SST2003,SSTV2003,kw88,SA-R,SA-R23] = dashed lines

- Color by grid family:

R.1.TC1.01 = blue

R.1.TC1.02 = red

R.1.TC1.03 = green

Custom = black

Large spread may reflect multiple solutions

Without outliers:

$$2.13 \leq CL_{\max} \leq 2.35;$$

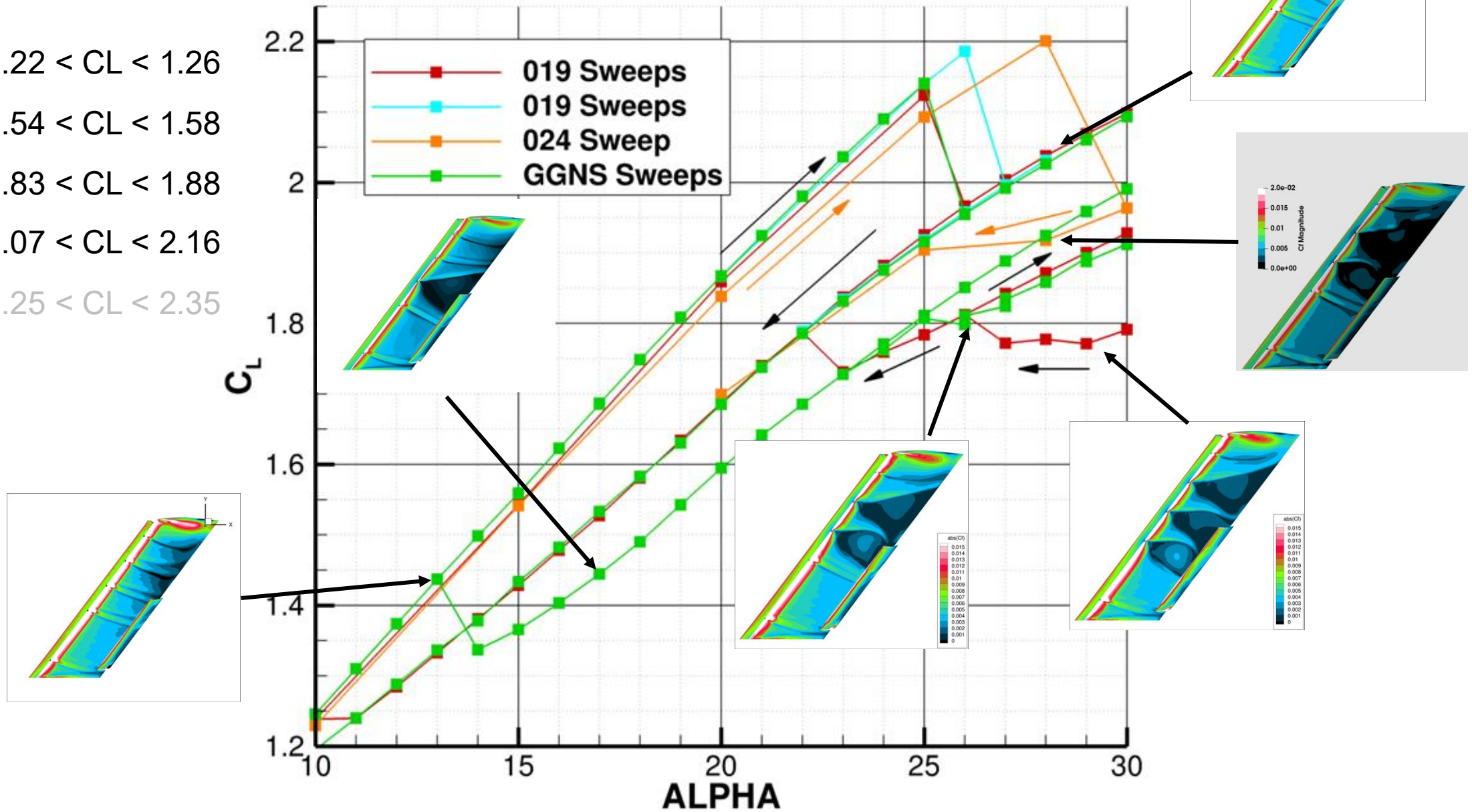
$$25^\circ \leq \alpha \leq 35^\circ$$

- 005 USM3D-ME SA-neg GRID R.1.TC1.02.F
- 015 LAVA SA-neg GRID Custom
- - - 016 FUN3D-FV SST2003 GRID R.1.TC1.01.D
- - - 016 FUN3D-FV SSTV2003M GRID R.1.TC1.01.D
- 016 FUN3D-SFE SA-neg GRID R.1.TC1.02.E Upper Branch
- 016 FUN3D-SFE SA-neg GRID R.1.TC1.02.E Lower Branch
- 016 FUN3D-SFE SA-neg GRID R.1.TC1.01.D
- 016 FUN3D-FV SA-neg GRID R.1.TC1.01.F
- 017 cflow SA-neg GRID R.1.TC1.01.E
- 018 DRAGON SA-neg GRID R.1.TC1.03.D
- - - 018 DRAGON k- ω GRID R.1.TC1.03.C
- 019 CODA SA-neg GRID R.1.TC1.01.D Upper Branch
- 019 CODA SA-neg GRID R.1.TC1.01.C Lower Branch
- 024 OpenFOAM SA-neg GRID Custom
- - - 025 TAS SA-noft2-R(Crot=1) GRID R.1.TC1.03.C
- - - 025 TAS SA-noft2-R23(Crot=1) GRID R.1.TC1.03.C
- 027 Flow360 SA-neg GRID Custom
- 027 Flow360 SA-neg GRID R.1.TC1.01.E
- 027 Flow360 SA-neg GRID R.1.TC1.03.C
- 033 SU2 SA-neg GRID Custom
- 033 SU2 SA-neg GRID R.1.TC1.01.E
- 033 SU2 SA-neg GRID R.1.TC1.03.C
- 034 eLSA SA-neg GRID Custom

Branch Map

High-Lift Branch

- $\alpha = 10^\circ$ $1.22 < C_L < 1.26$
- $\alpha = 15^\circ$ $1.54 < C_L < 1.58$
- $\alpha = 20^\circ$ $1.83 < C_L < 1.88$
- $\alpha = 25^\circ$ $2.07 < C_L < 2.16$
- $\alpha = 30^\circ$ $2.25 < C_L < 2.35$



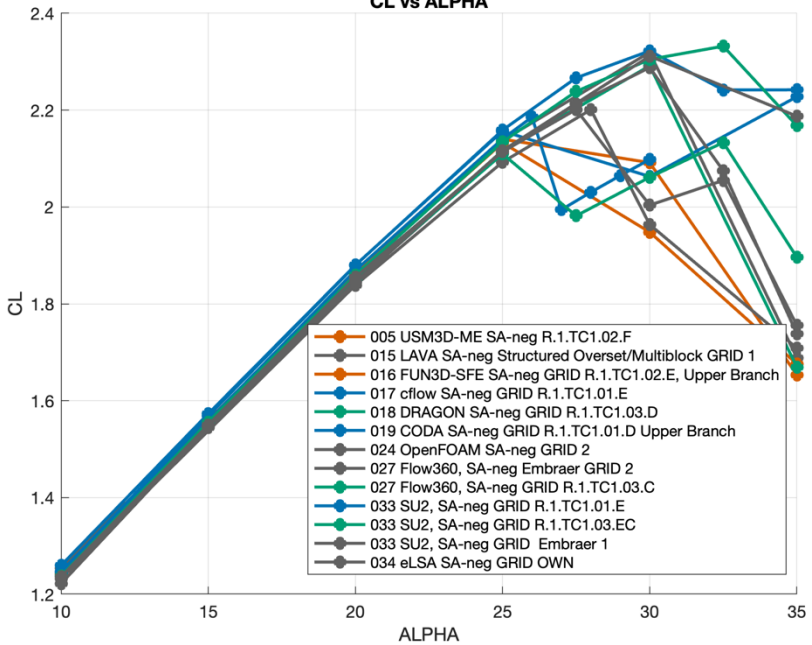
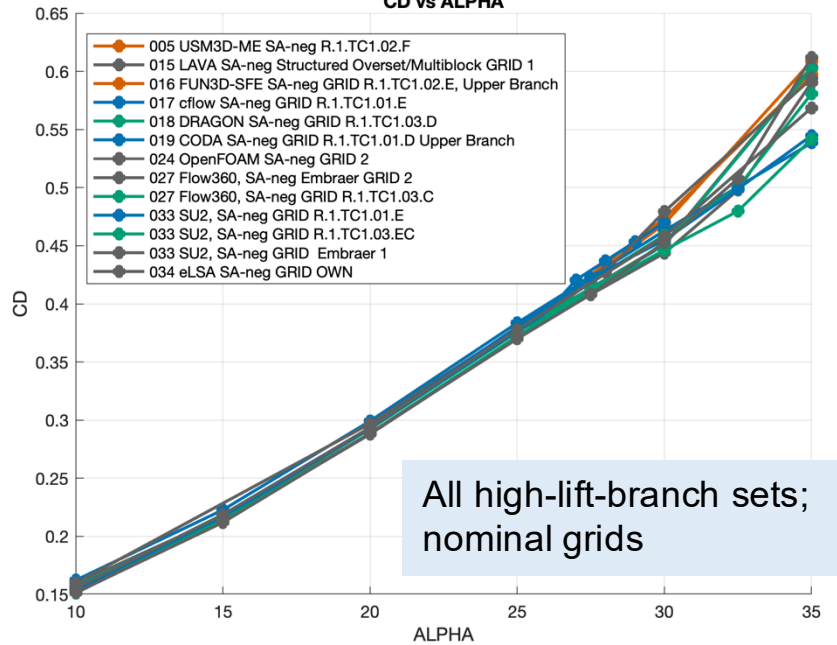
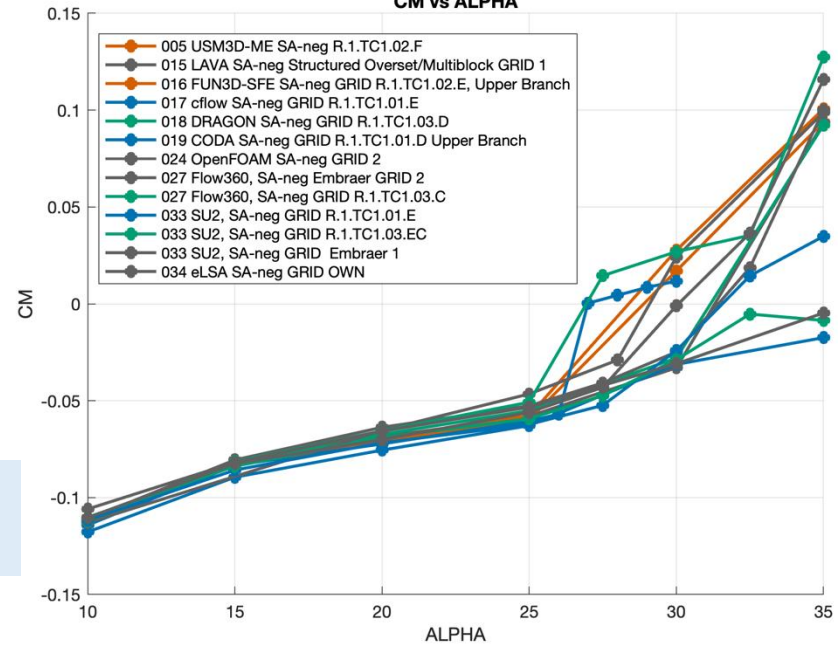
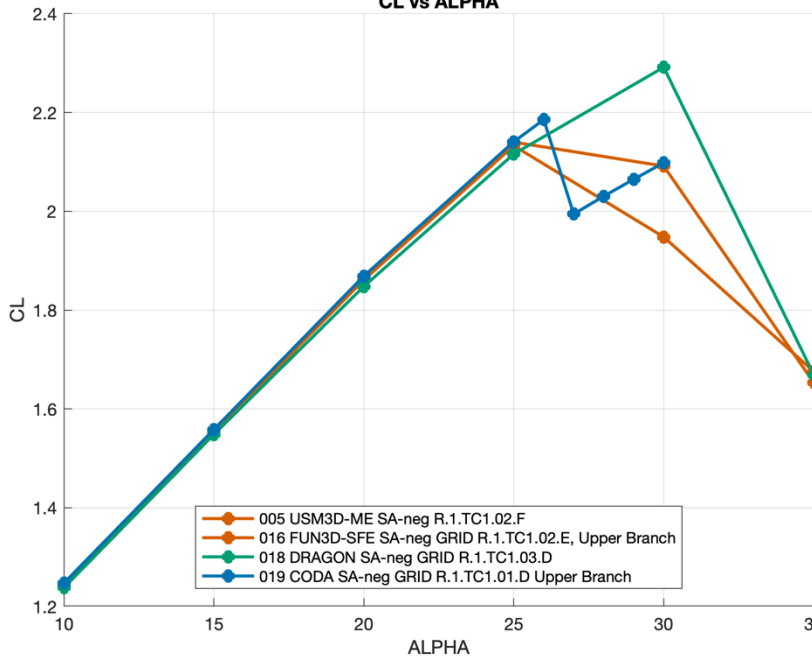
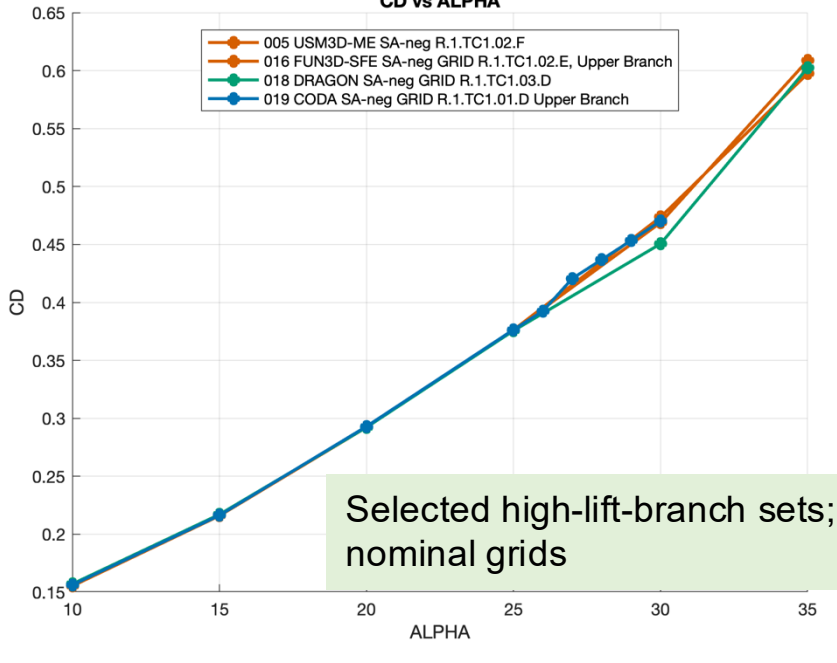
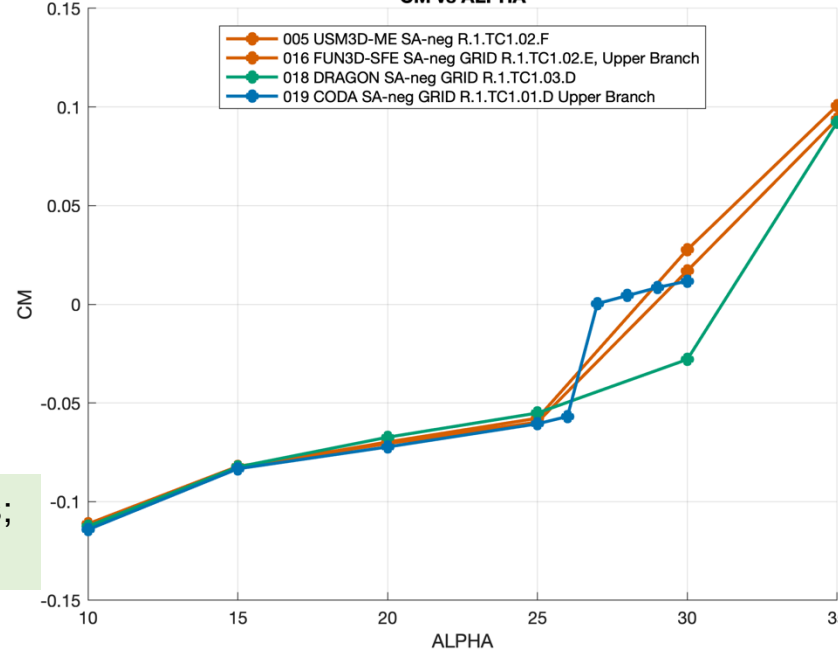
Selected RANS Solution from High-Lift Branch

- **Selection Criteria**

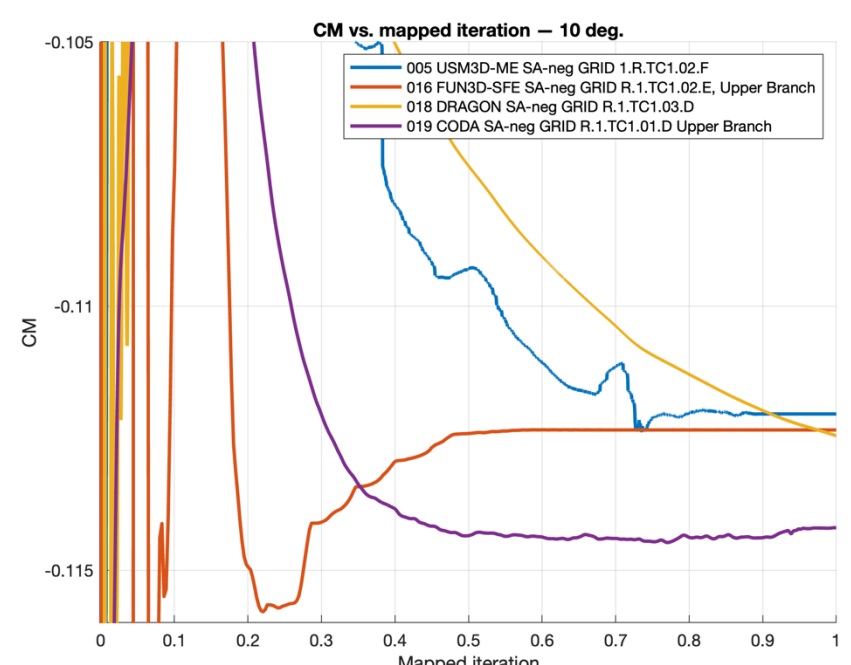
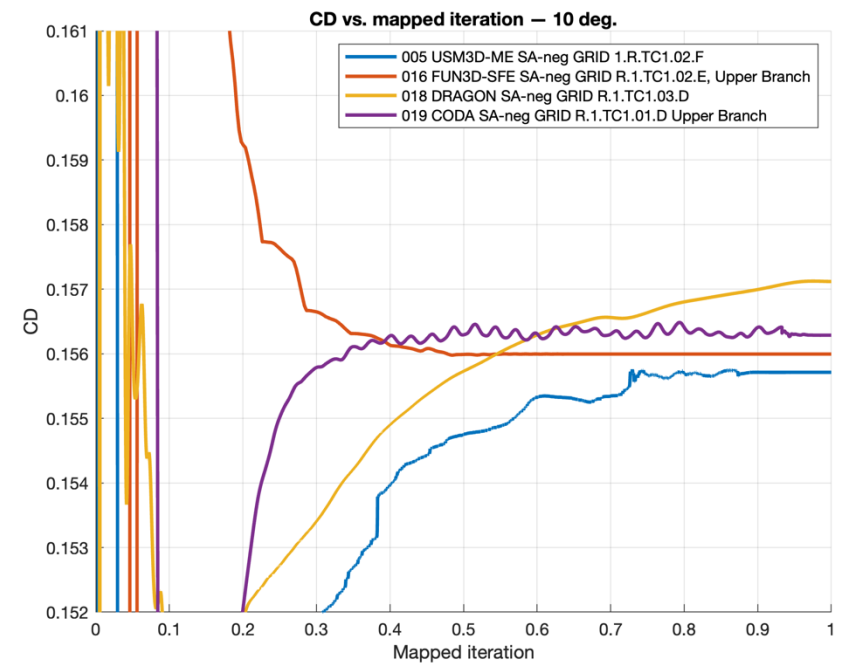
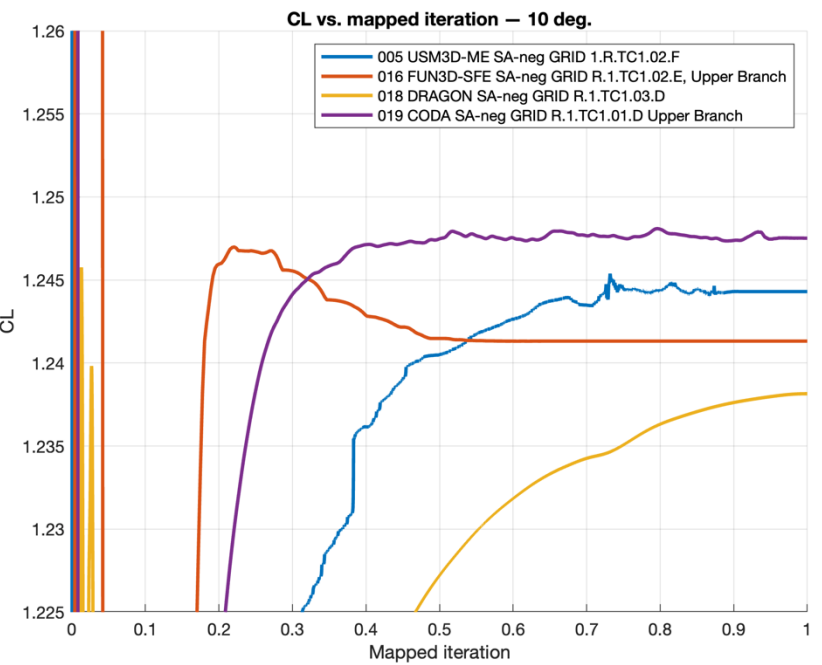
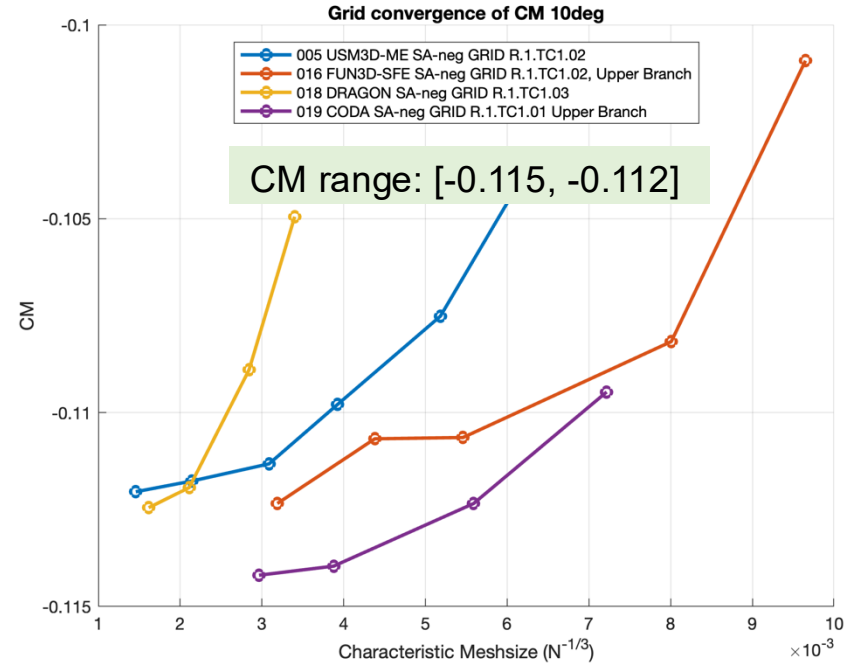
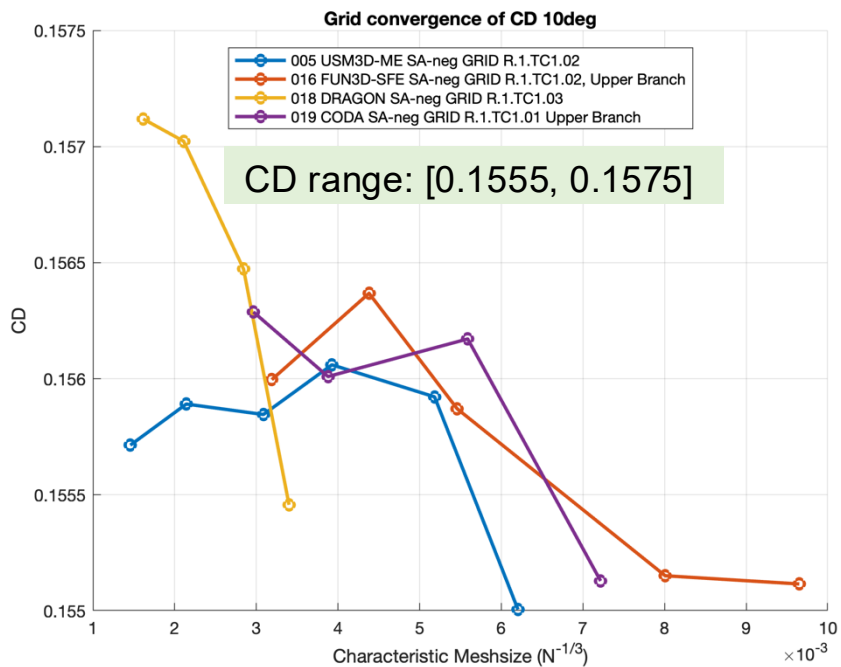
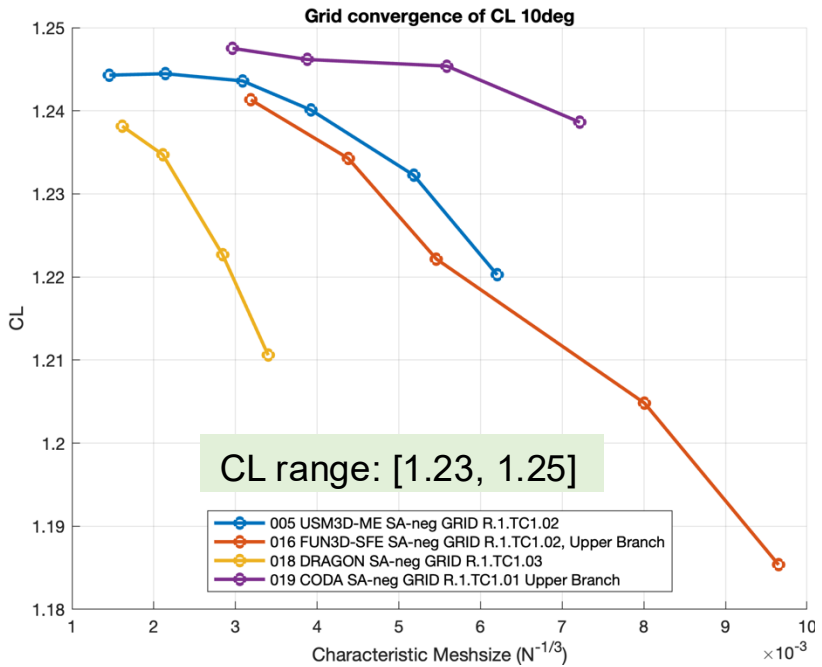
- Submitted TC1 solution set
- SA turbulence model
- High-lift branch for $\alpha = 10^\circ, 15^\circ, 20^\circ, \text{ and } 25^\circ$
- Established grid convergence for each angle of attack
 - ✓ At least 3 grids in a family
 - ✓ Nominal grid with at least 30M dofs
- Iterative convergence on each grid

- **Selected Sets**

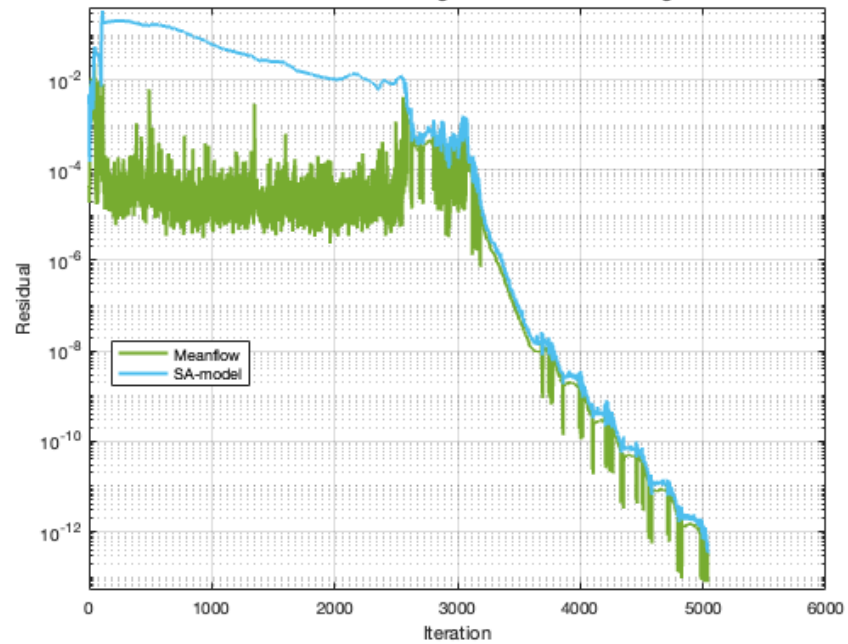
- 005 USM3D-ME, CC-FV, Nominal Grid: 1.R.TC1.02.F (323M cells)
- 016 FUN3D-SFE, NC-FE, Nominal Grid: 1.R.TC1.02.E (31M points)
- 018 DRAGON, CC-FV, Nominal Grid: R.1.TC1.03.D (237M cells)
- 019 CODA, CC-FV, Nominal Grid: R.1.TC1.01.D (38M cells)

CL vs ALPHA**CD vs ALPHA****CM vs ALPHA****CL vs ALPHA****CD vs ALPHA****CM vs ALPHA**

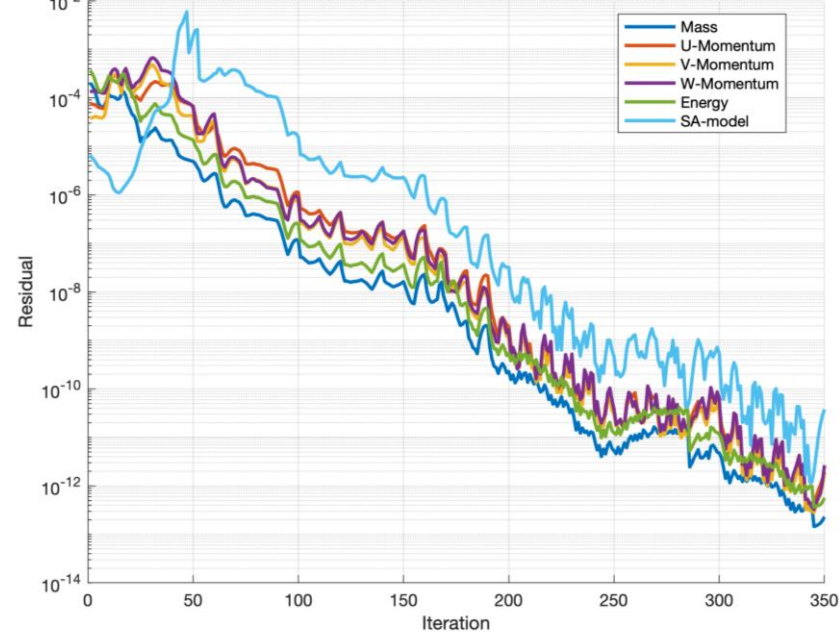
$$\alpha = 10^\circ$$



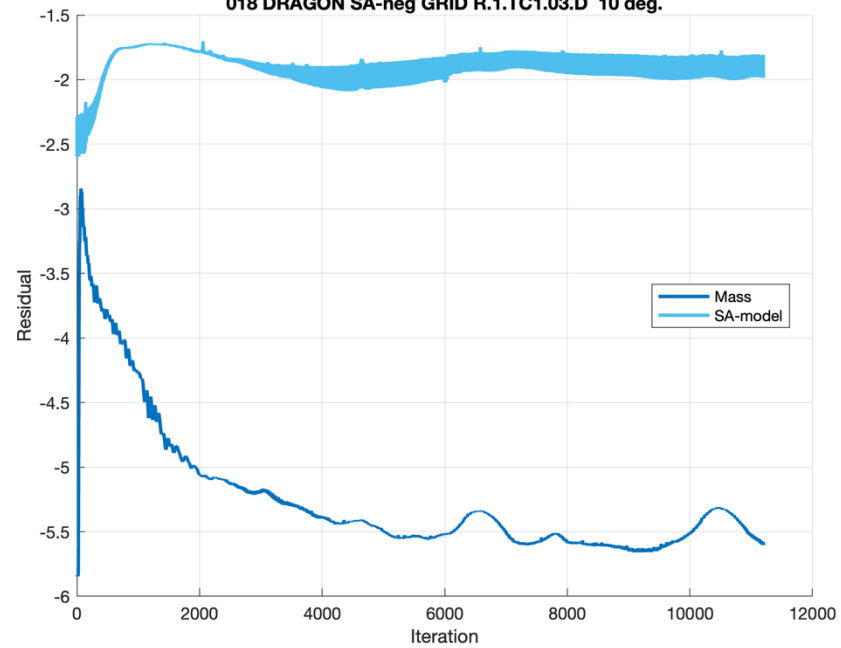
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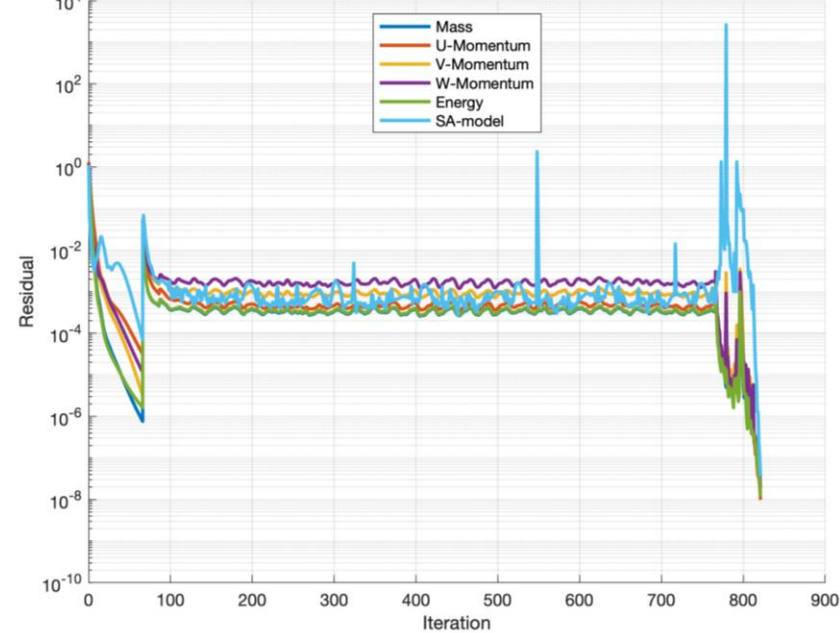
016 FUN3D-SFE SA-neg GRID R.1.TC1.02.E, Upper Branch 10 deg.

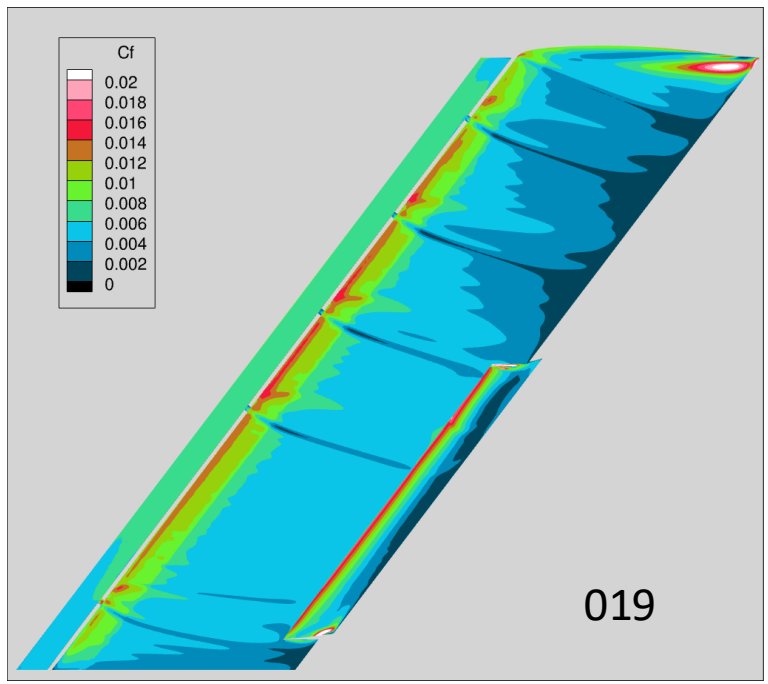
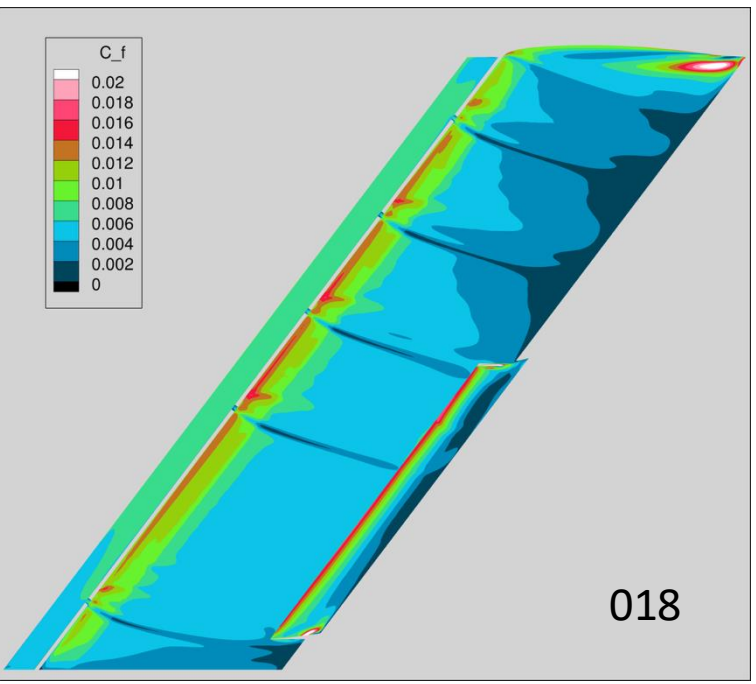
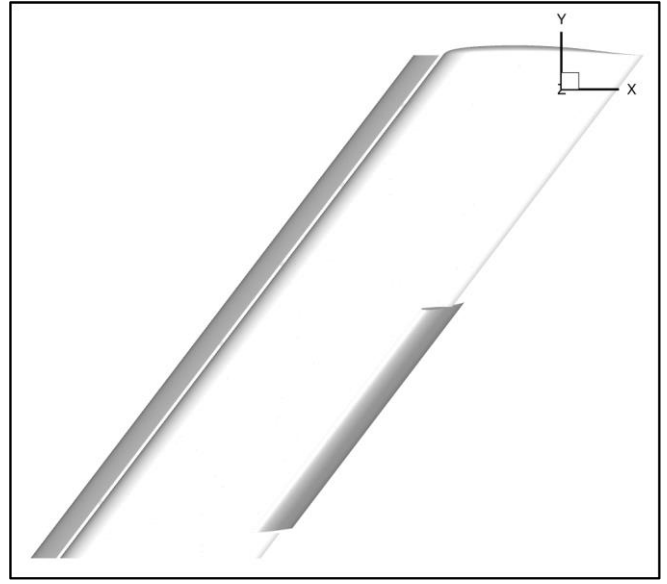
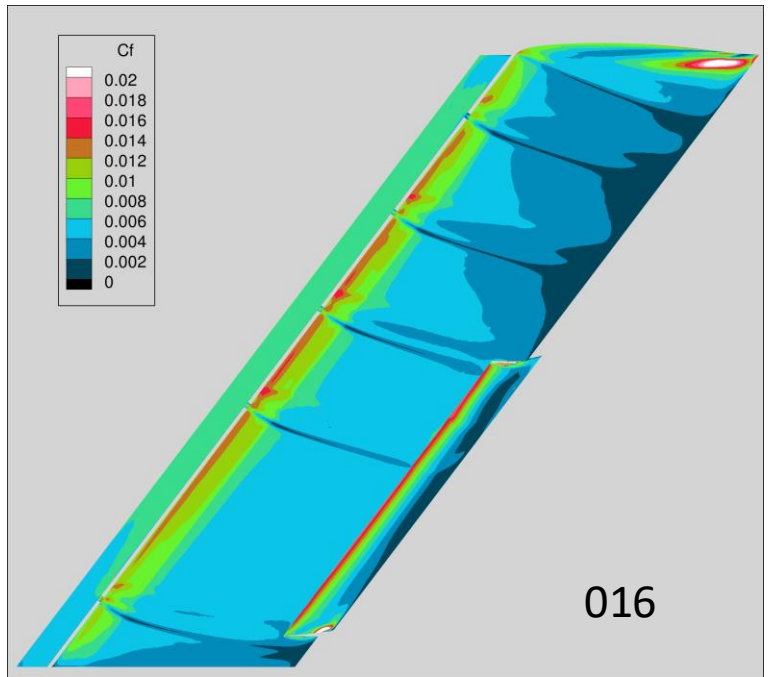
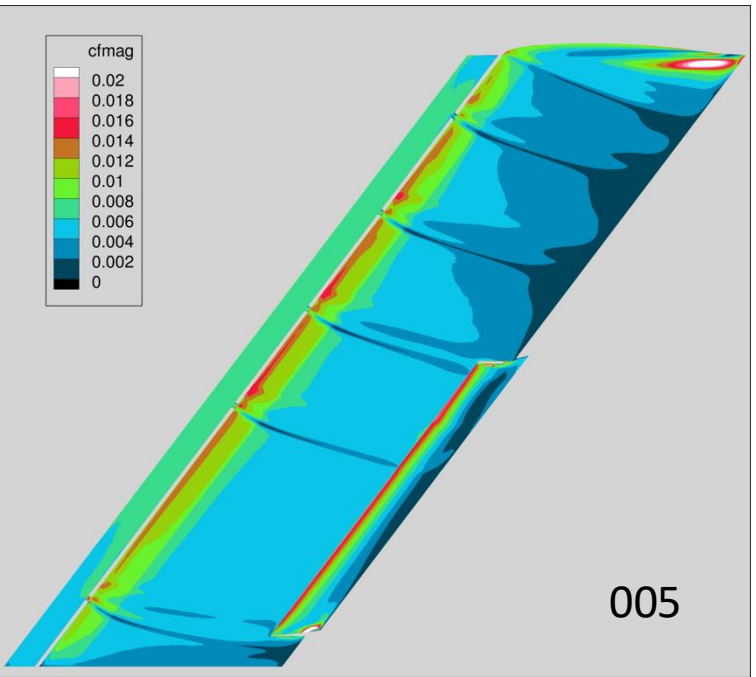


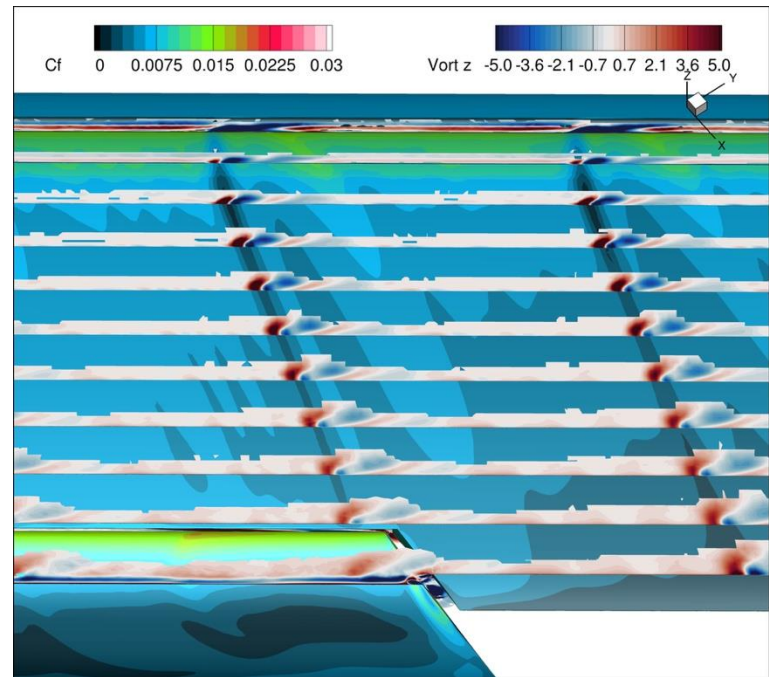
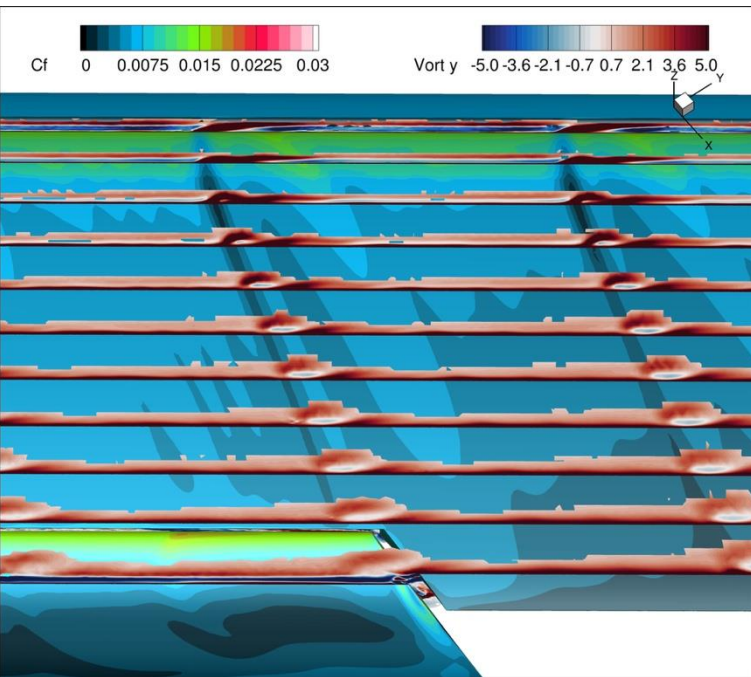
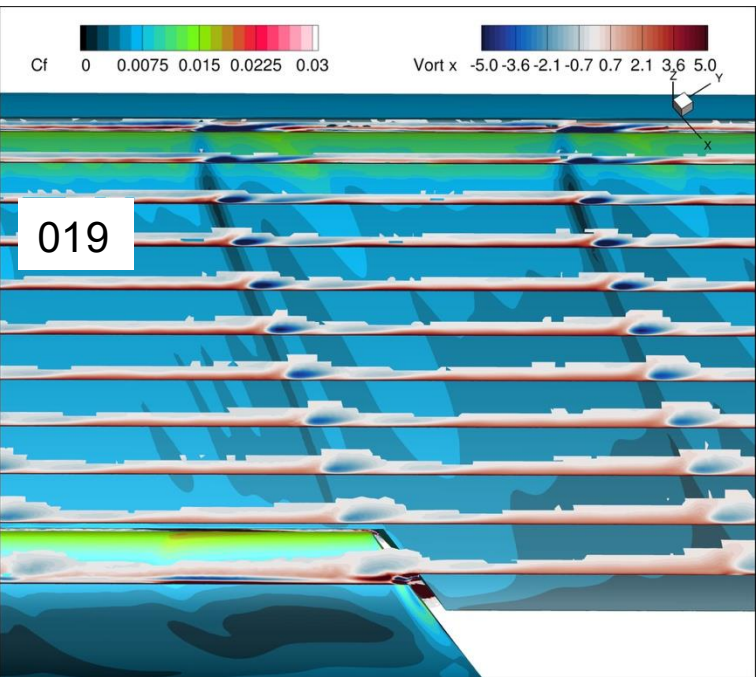
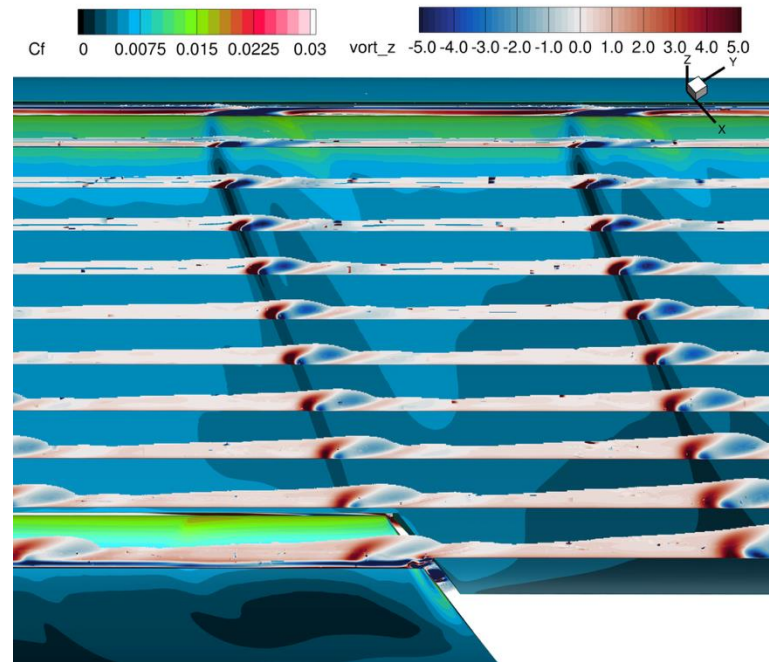
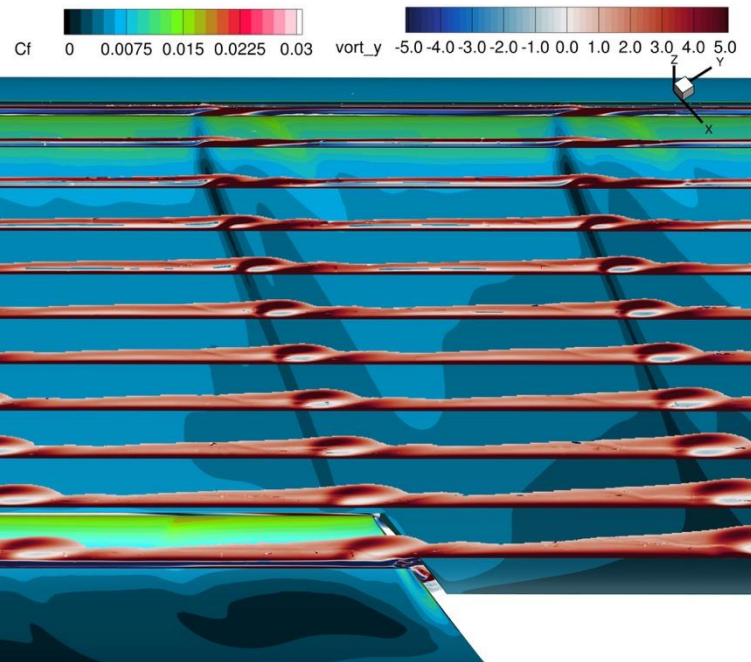
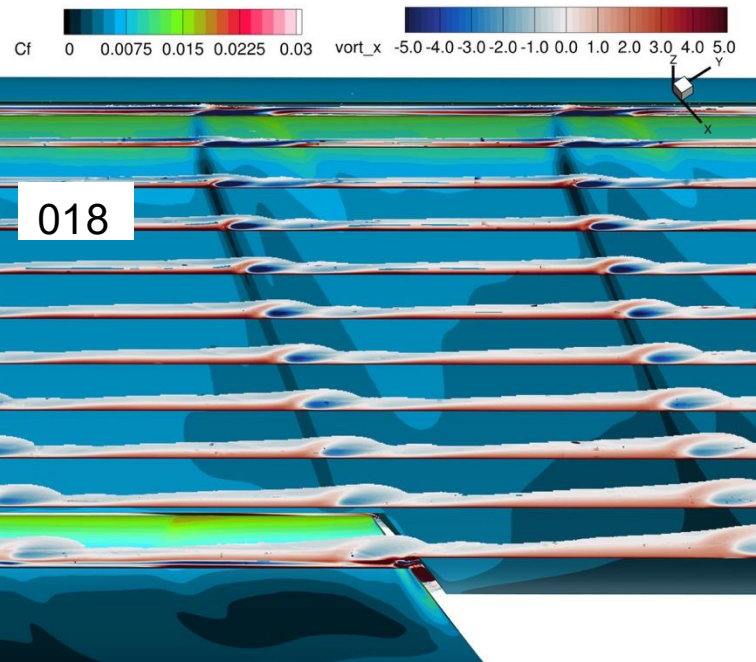
018 DRAGON SA-neg GRID R.1.TC1.03.D 10 deg.



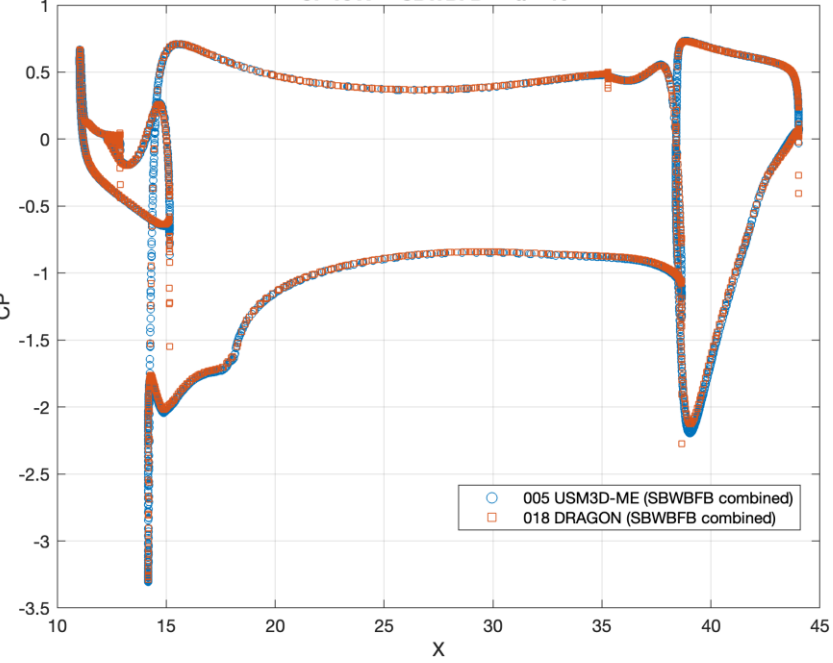
019 CODA SA-neg GRID R.1.TC1.01.D Upper Branch 10 deg.



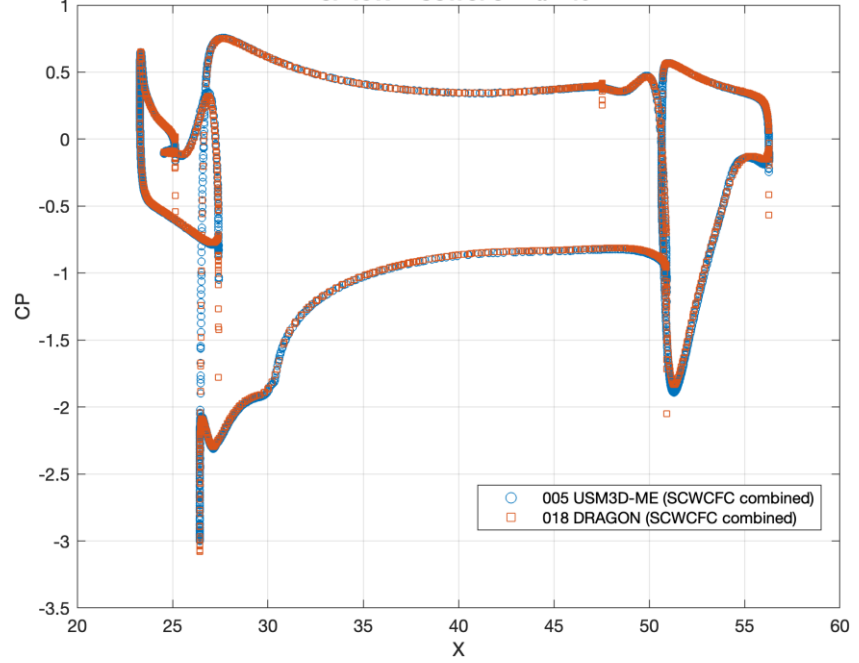




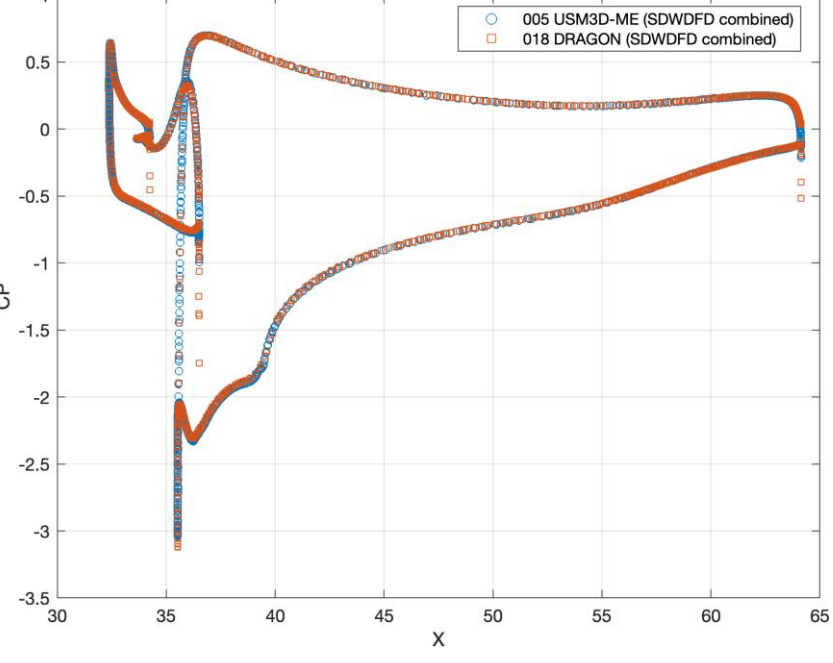
CP vs X – SBWBFB – $\alpha = 10^\circ$



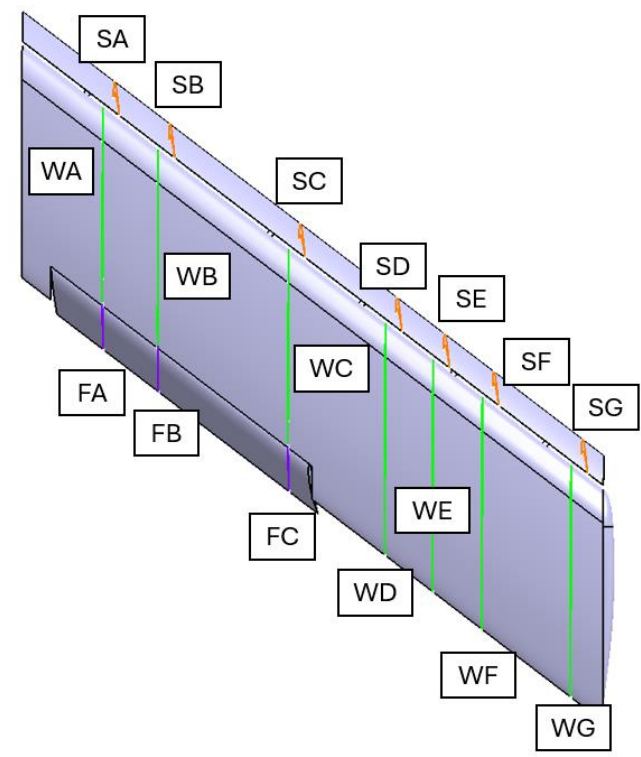
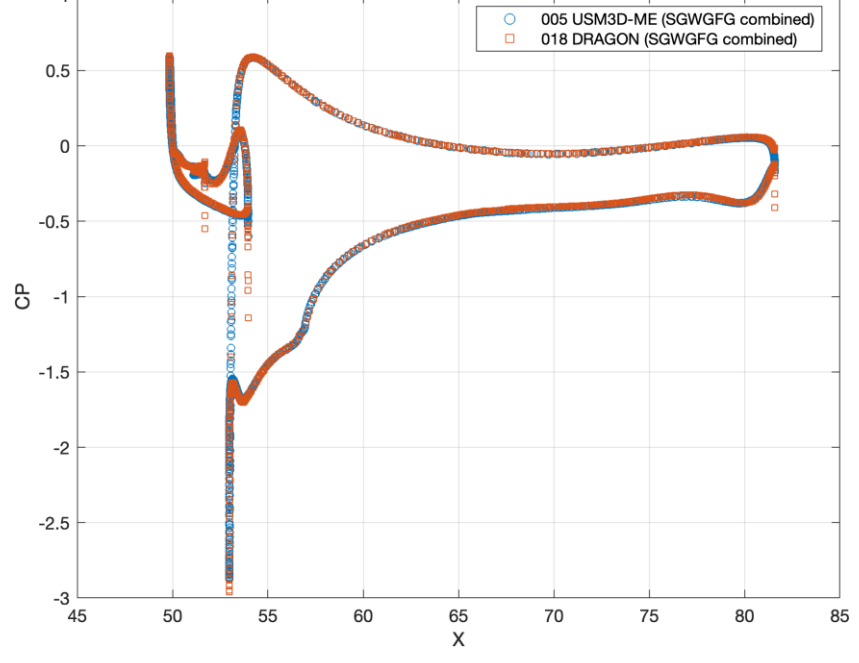
CP vs X – SCWCFC – $\alpha = 10^\circ$

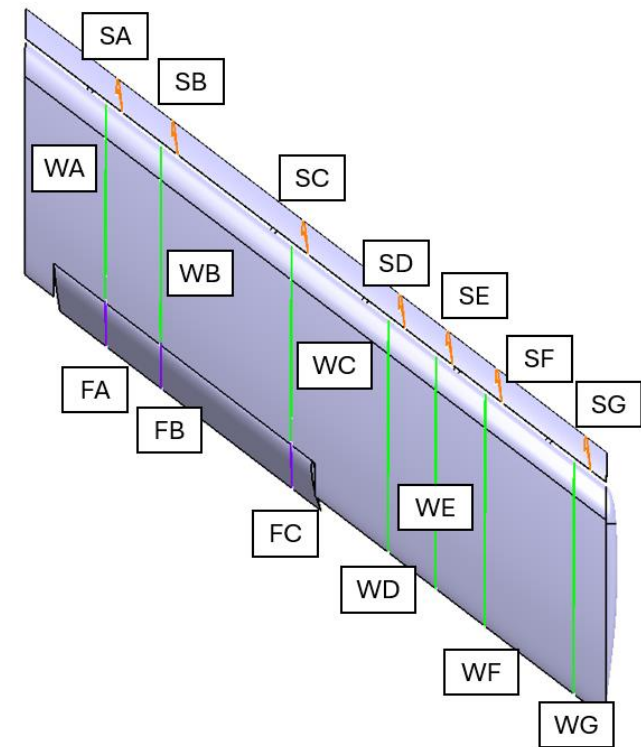
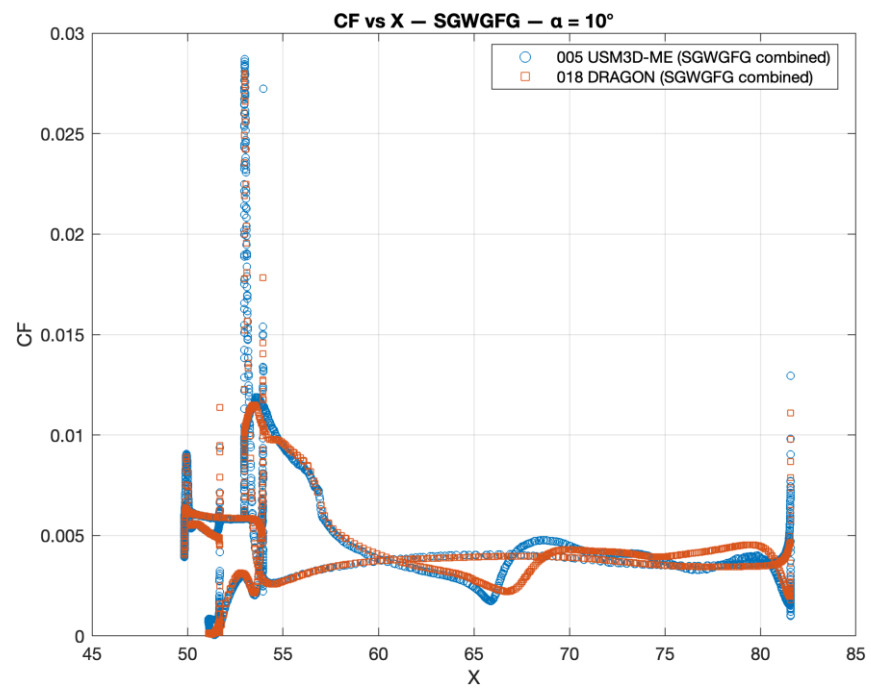
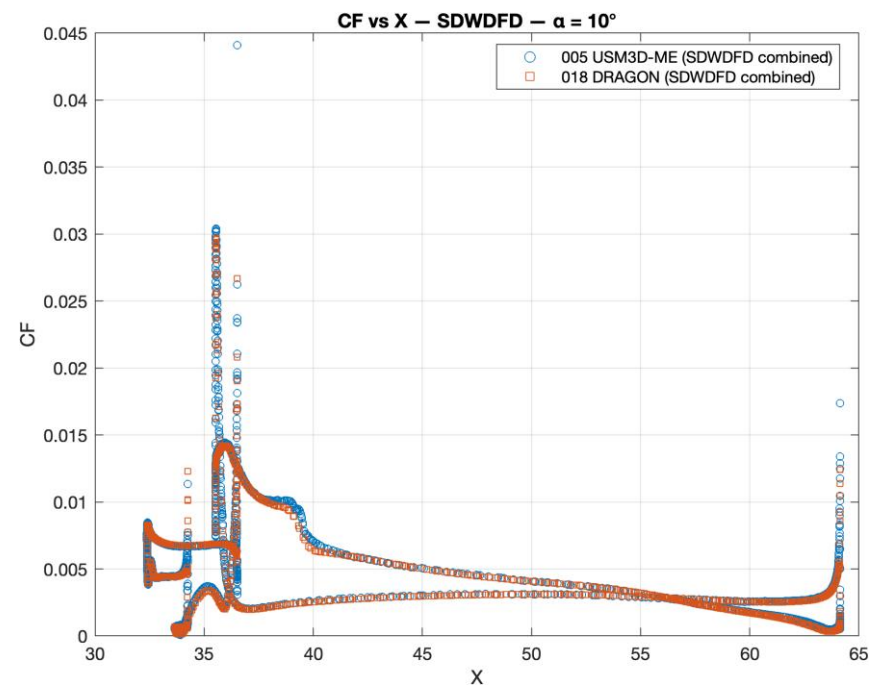
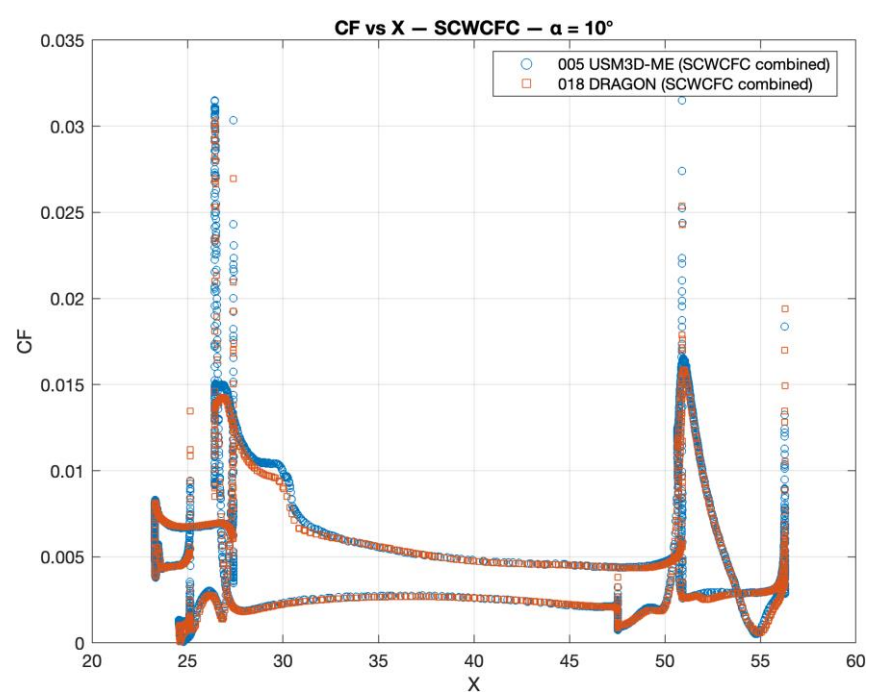
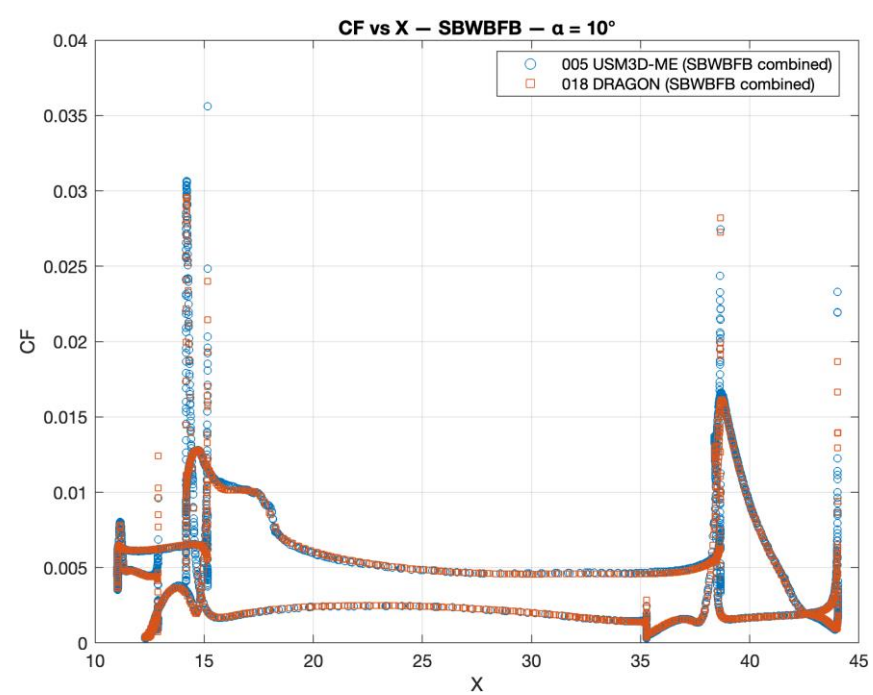


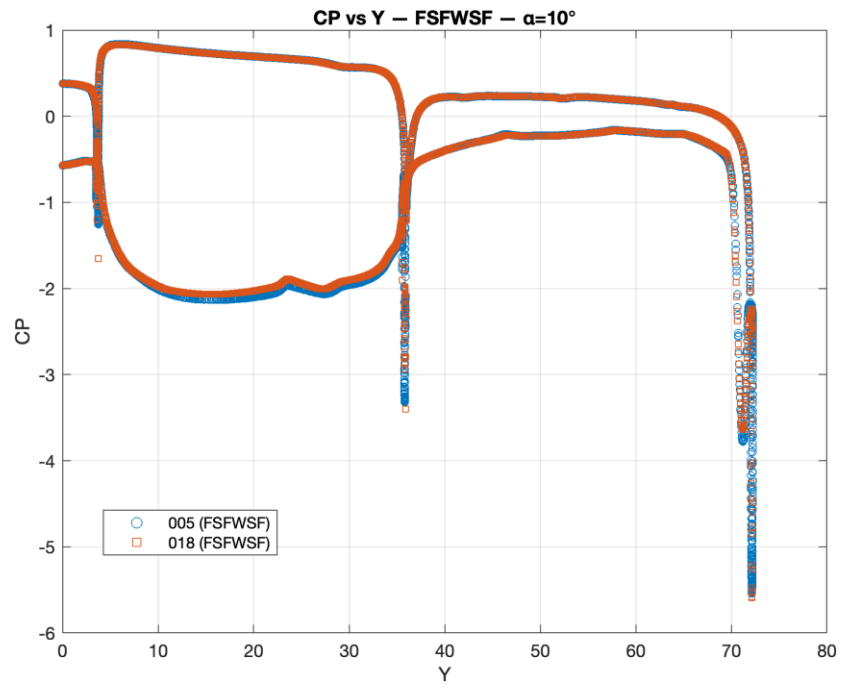
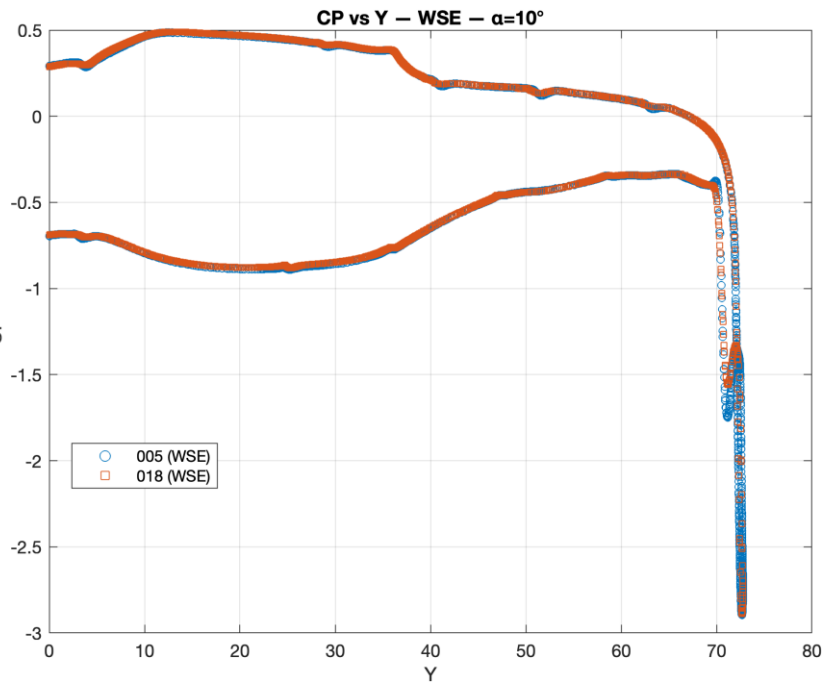
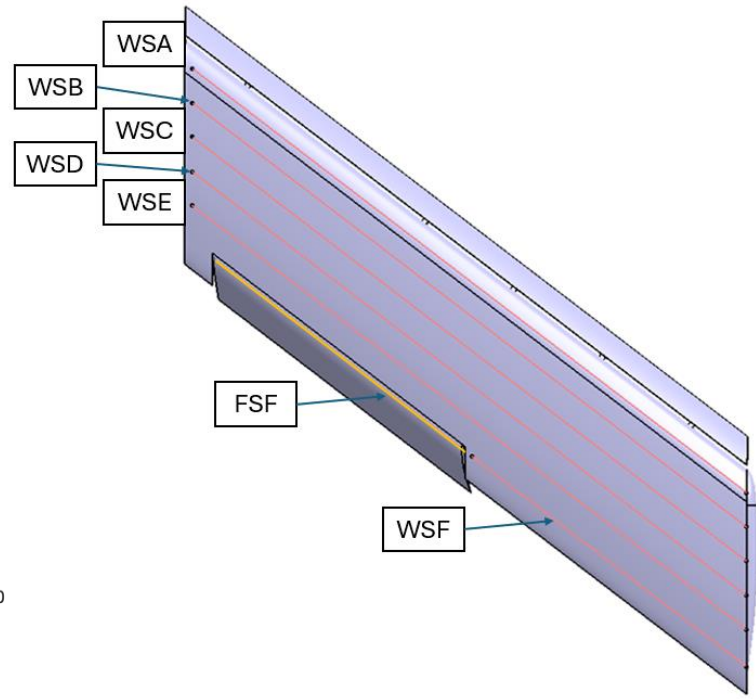
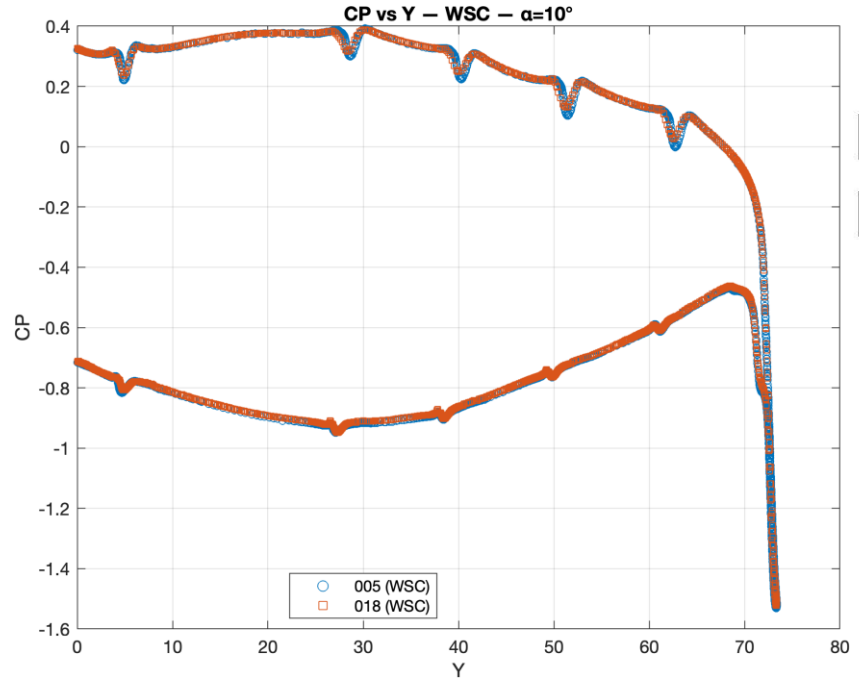
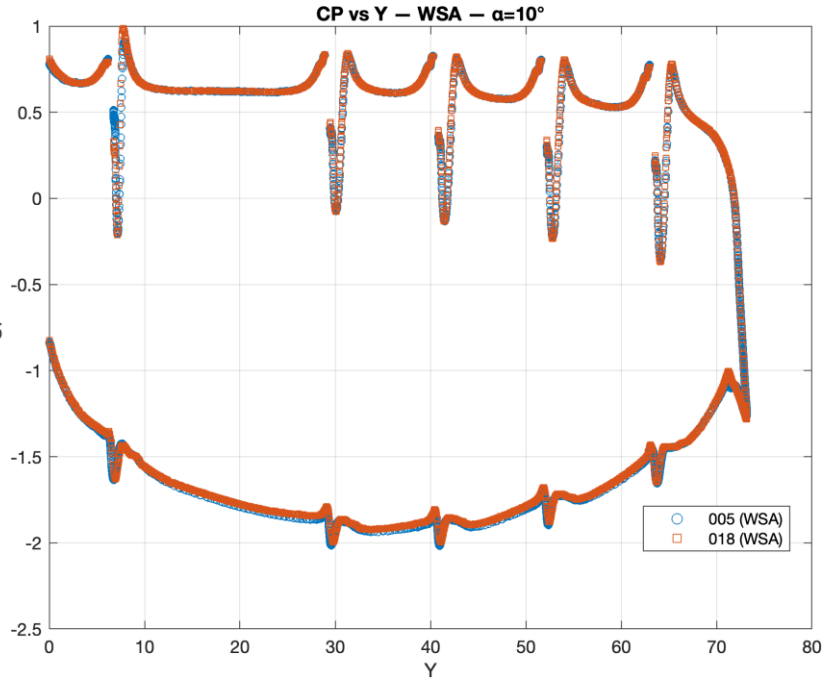
CP vs X – SDWDFD – $\alpha = 10^\circ$

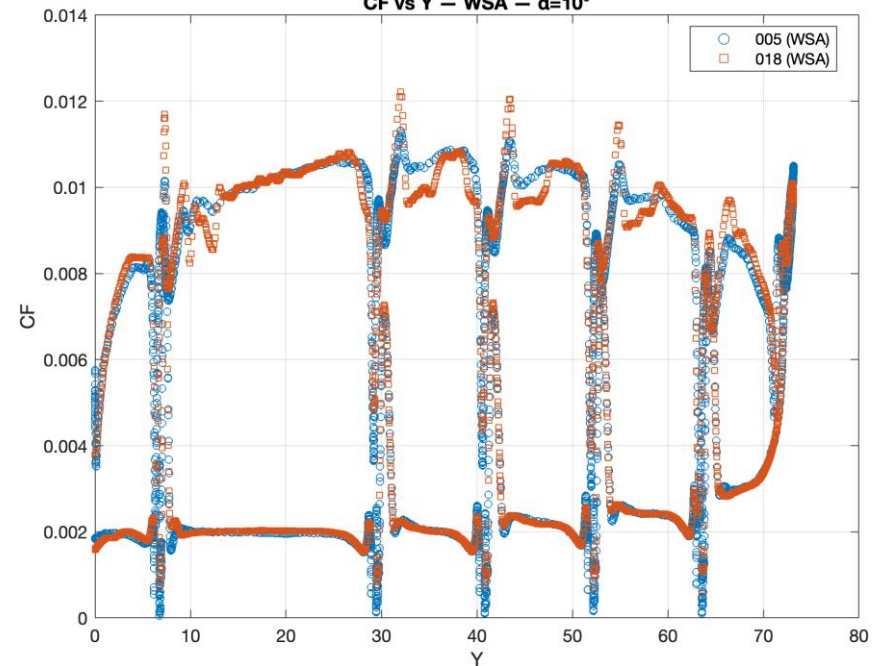
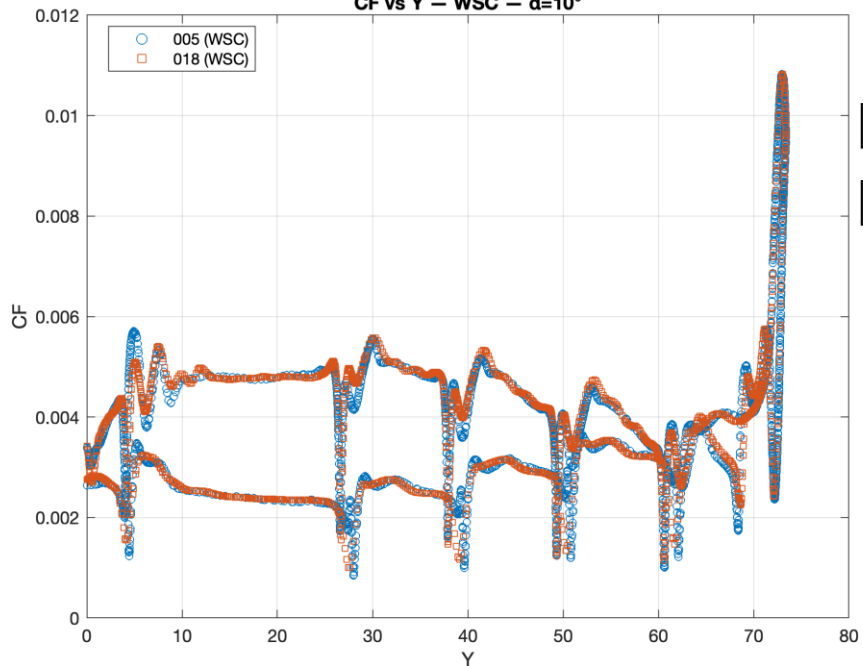
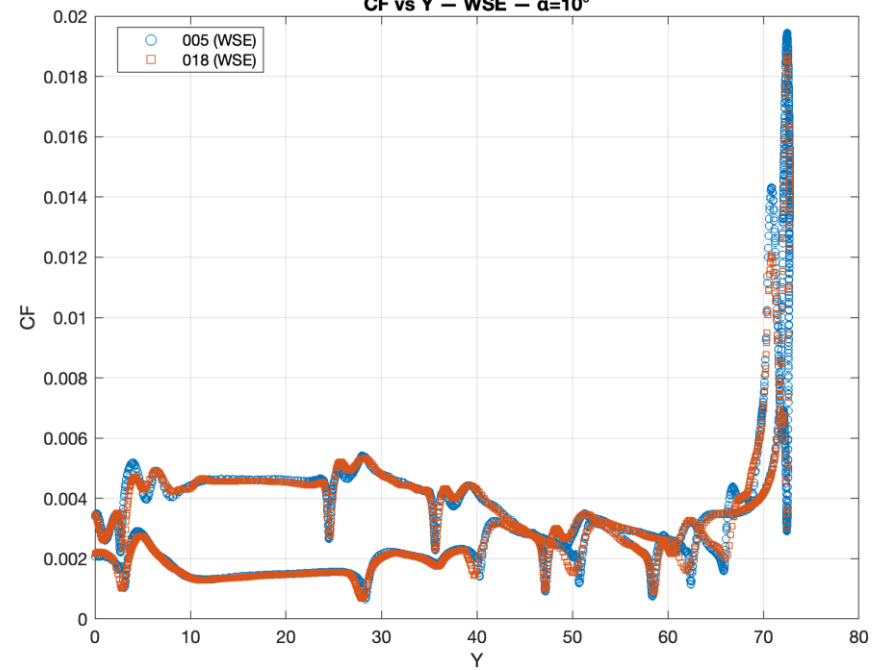
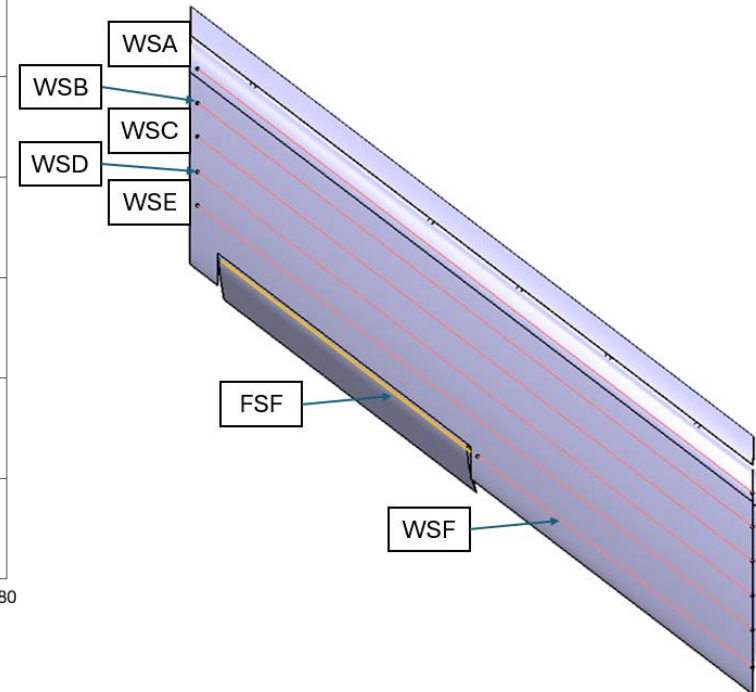
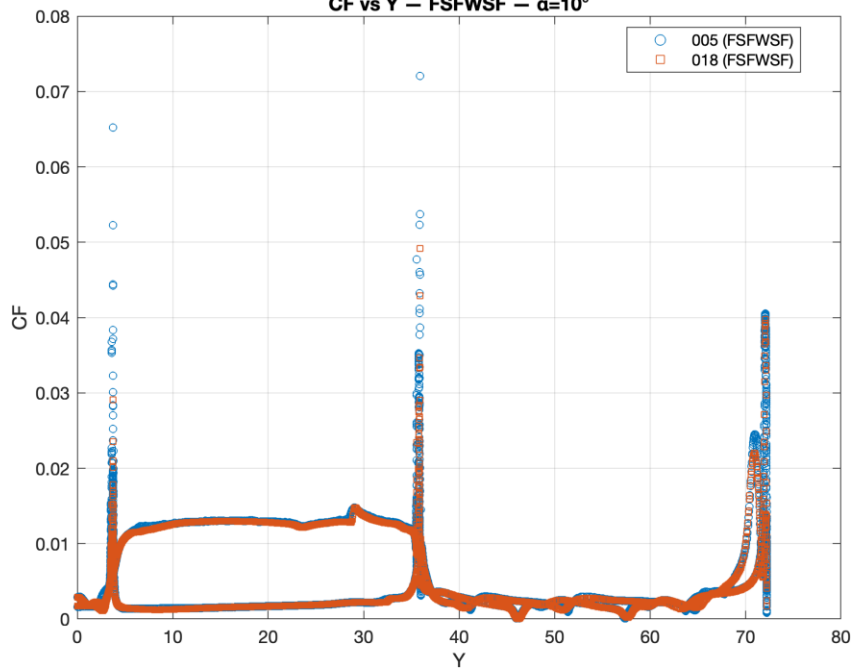


CP vs X – SGWGFG – $\alpha = 10^\circ$

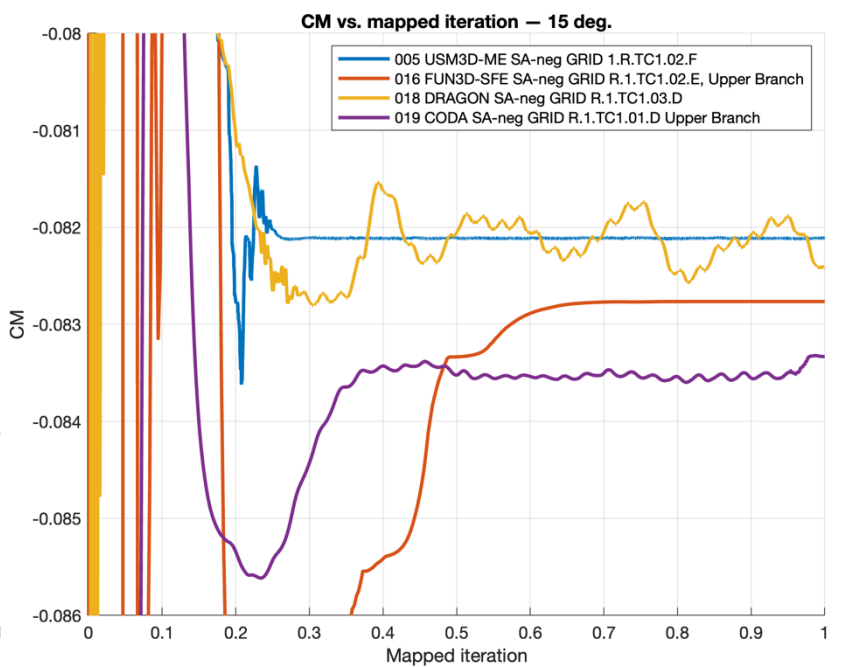
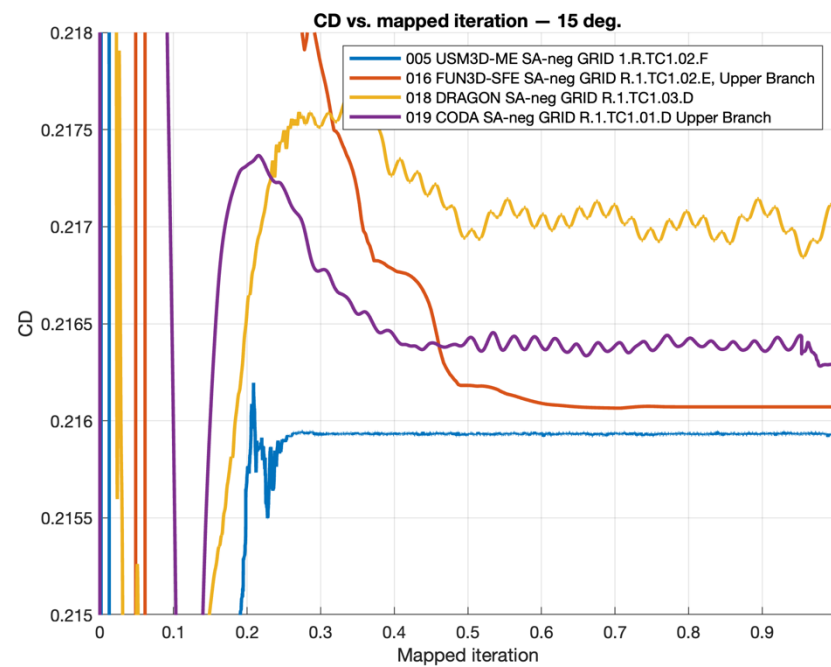
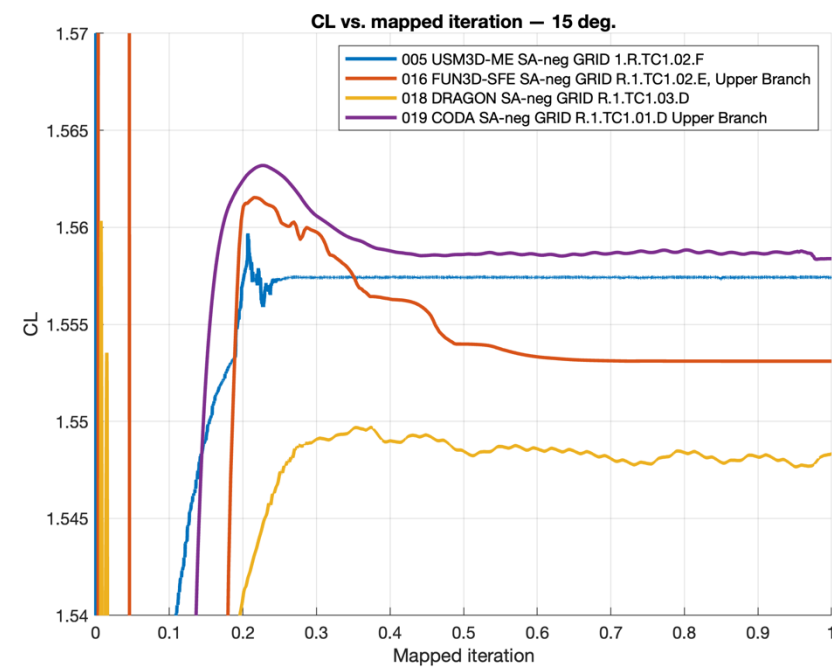
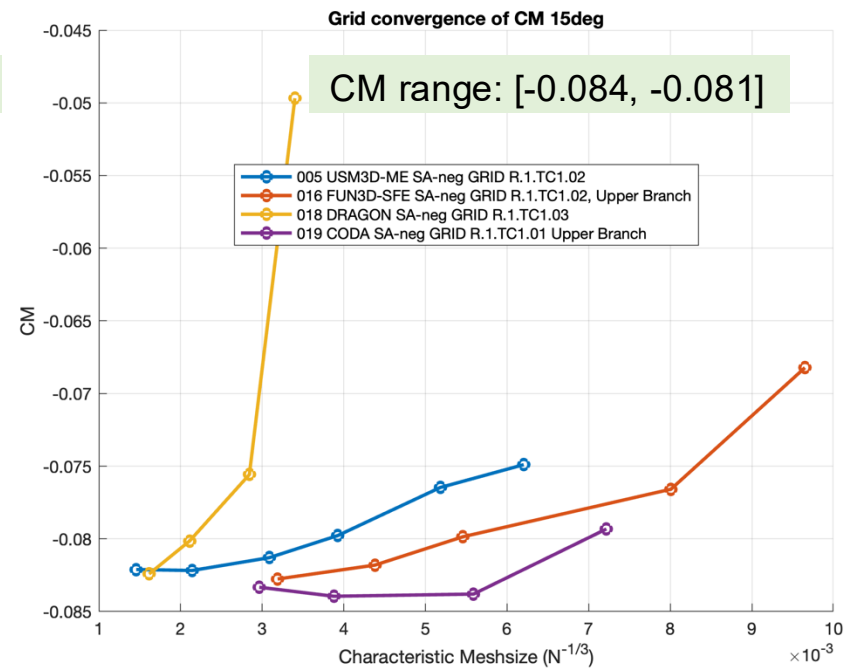
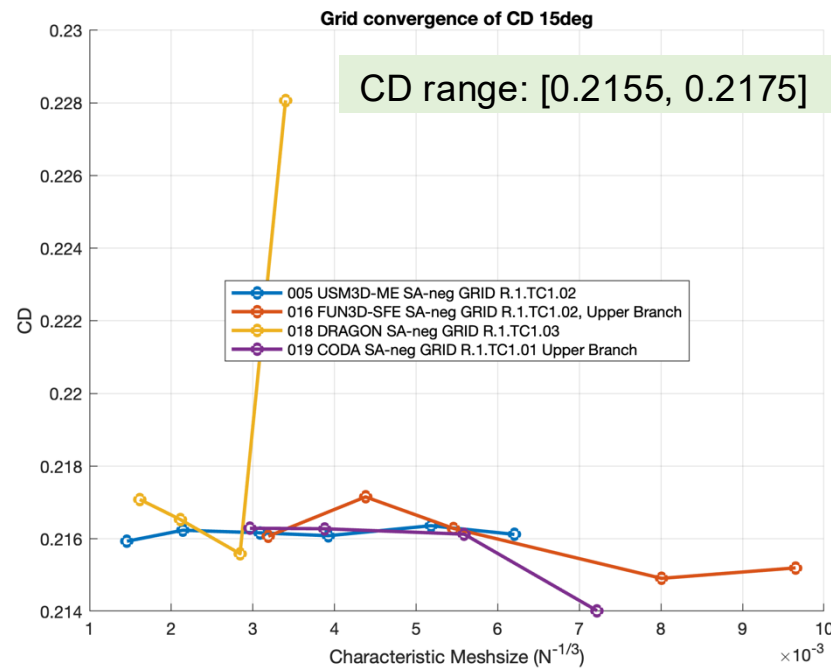
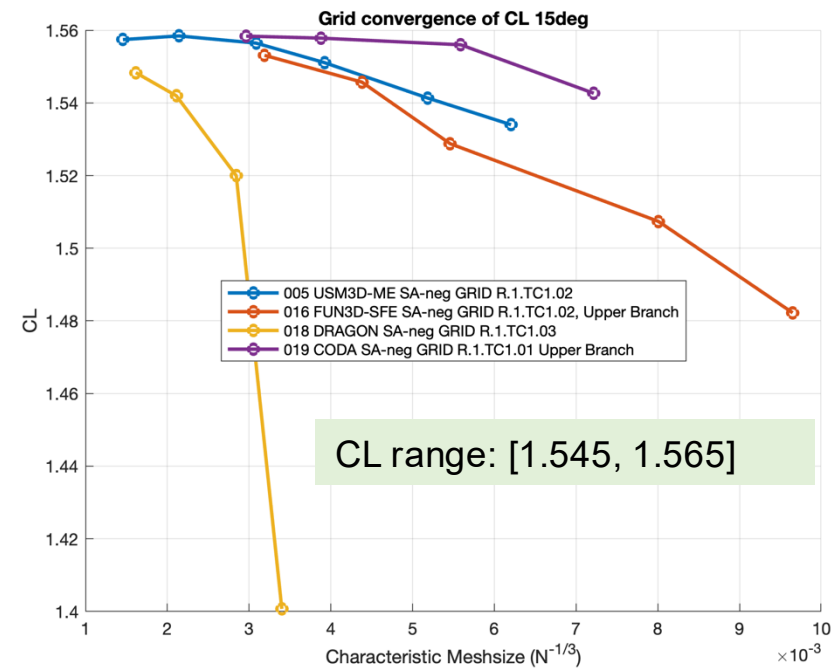


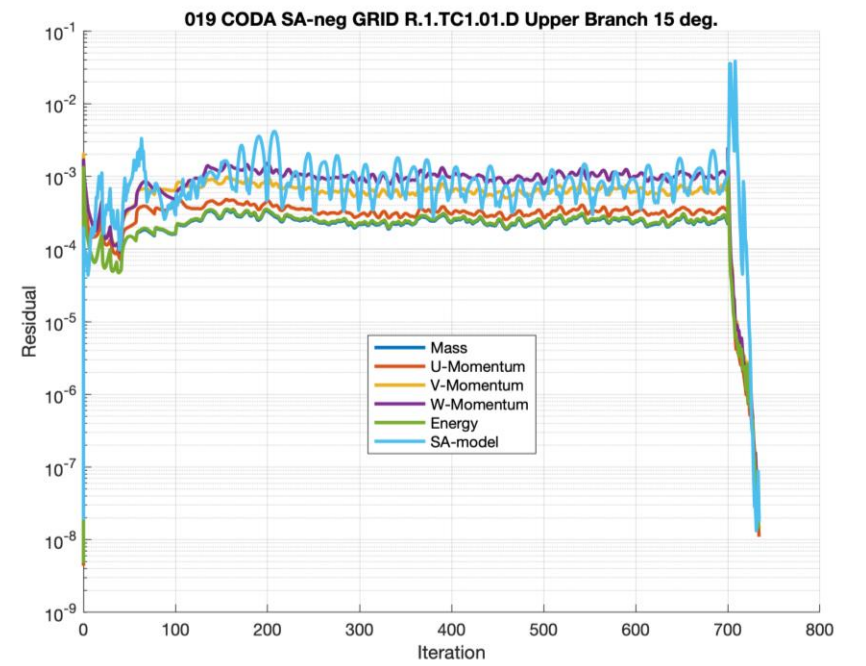
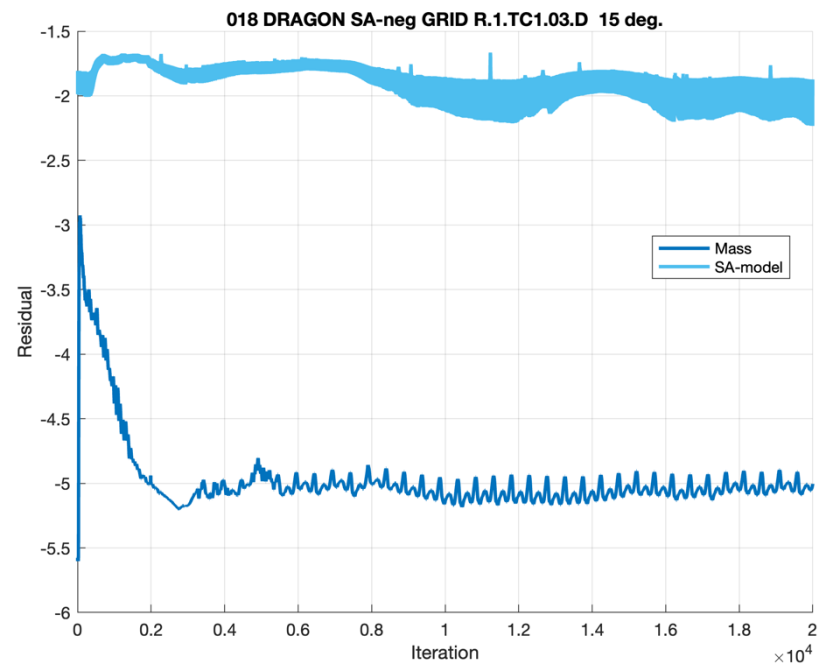
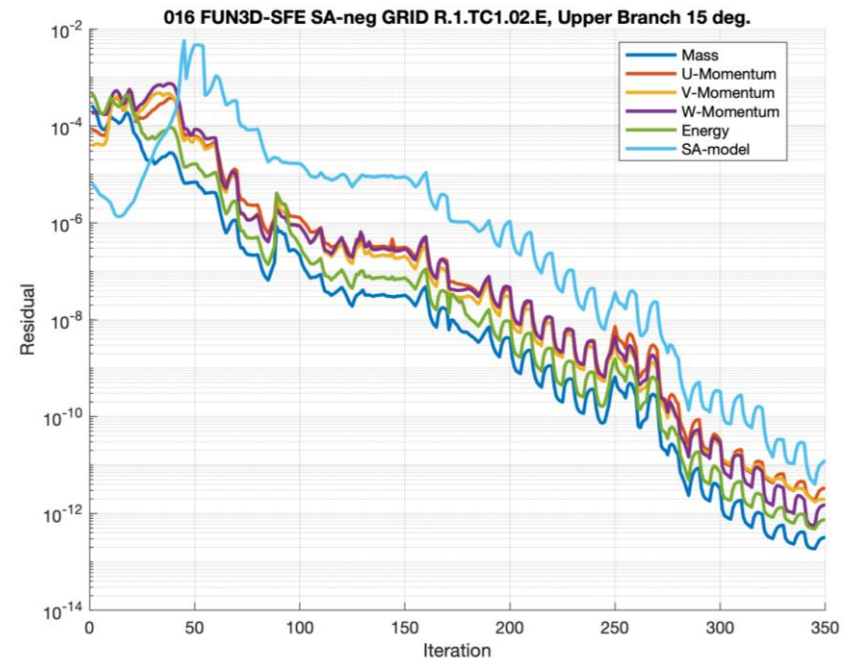
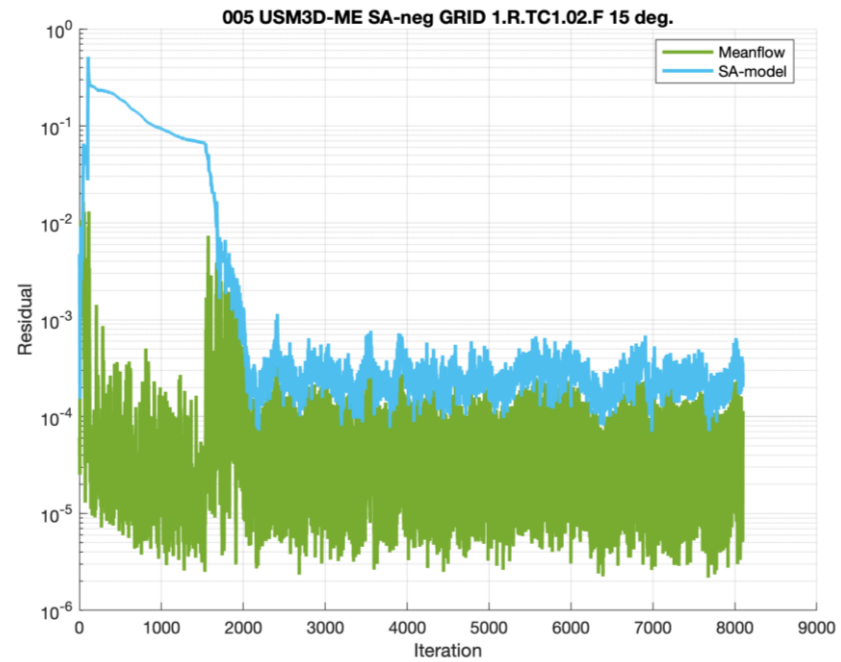


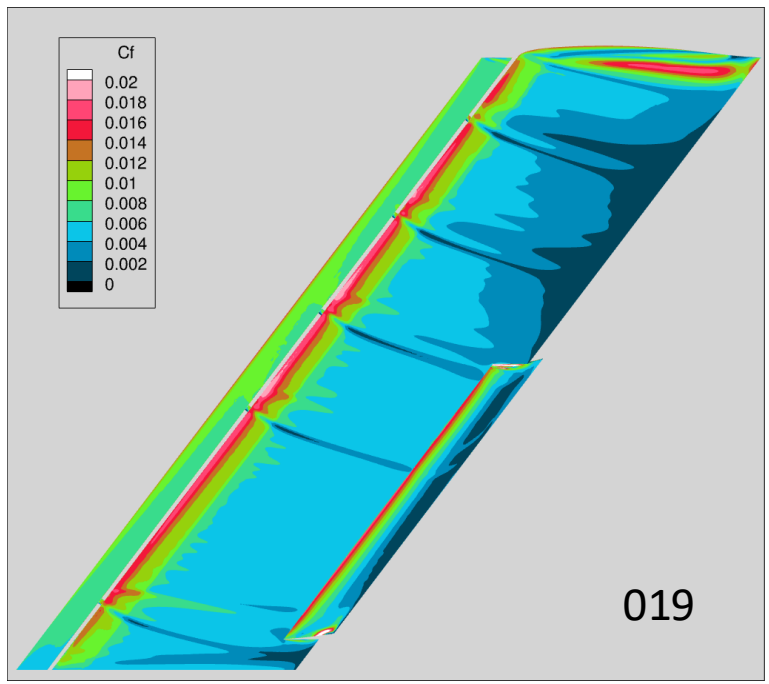
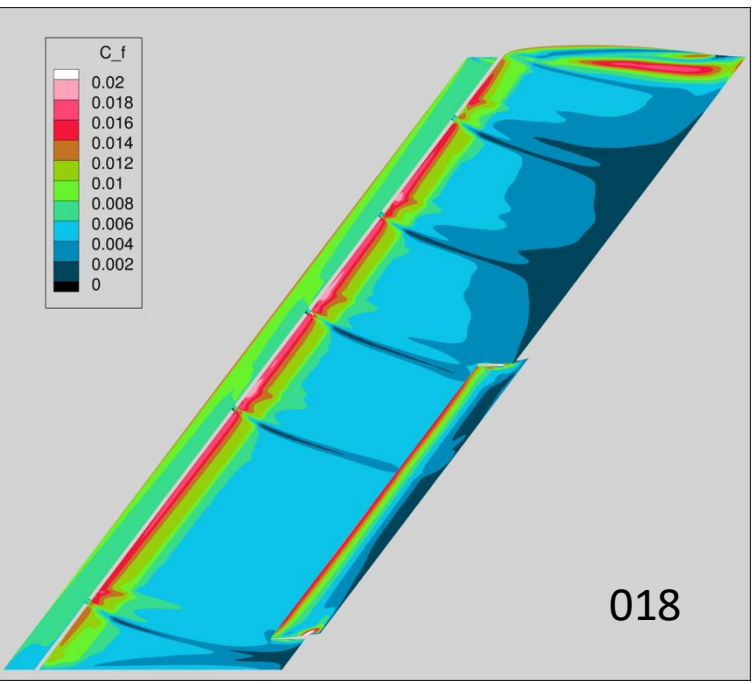
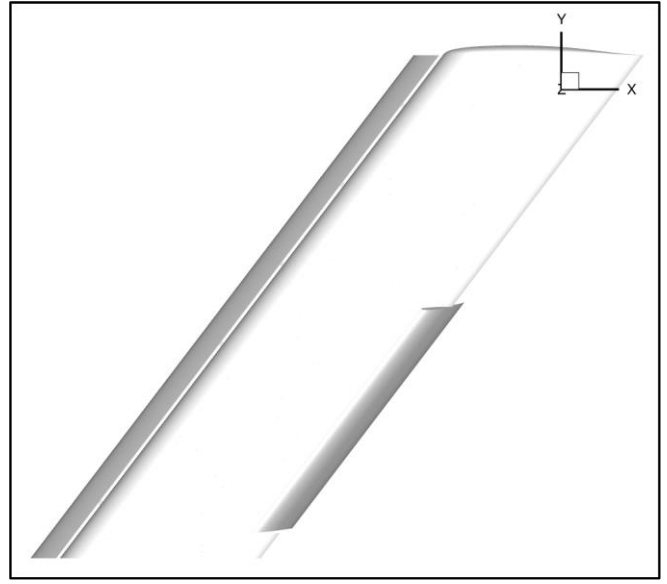
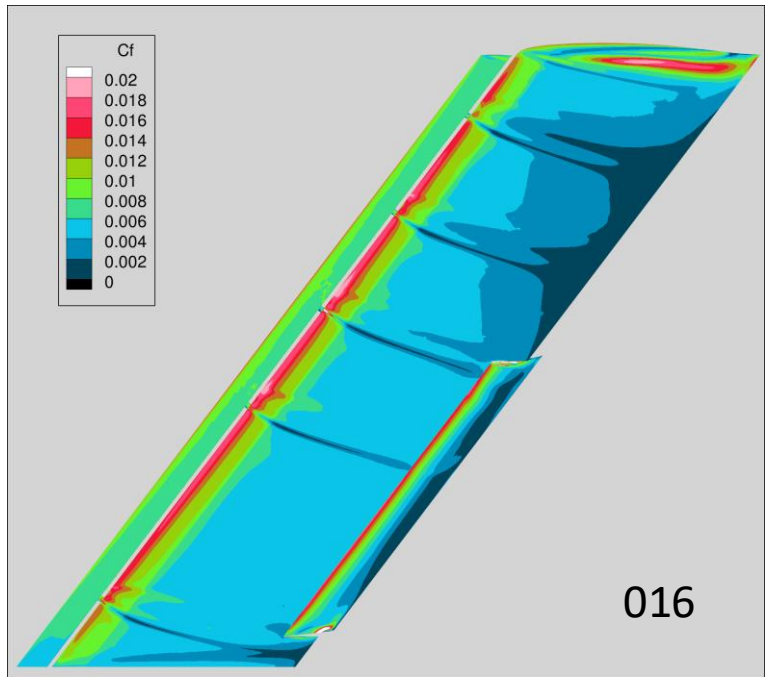
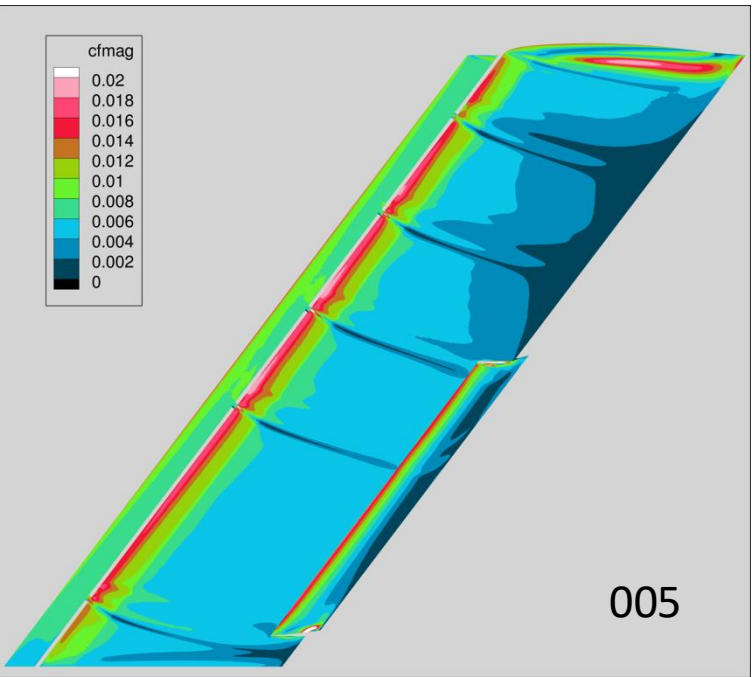


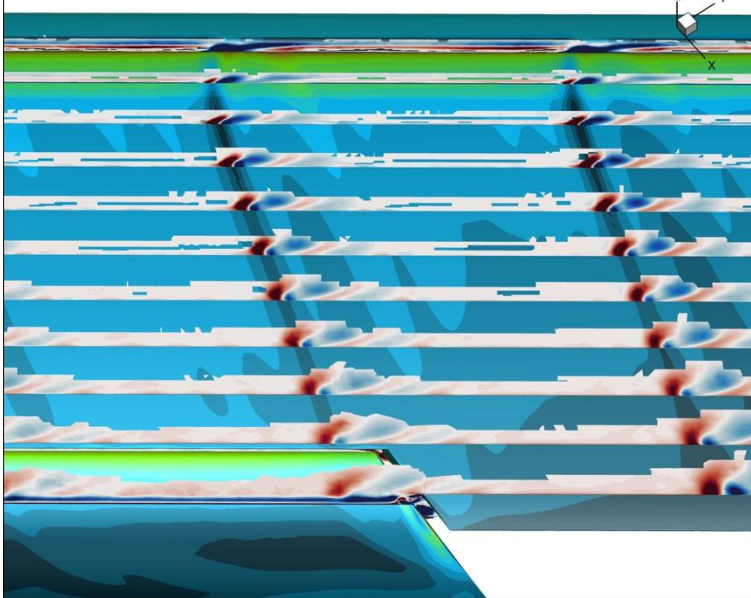
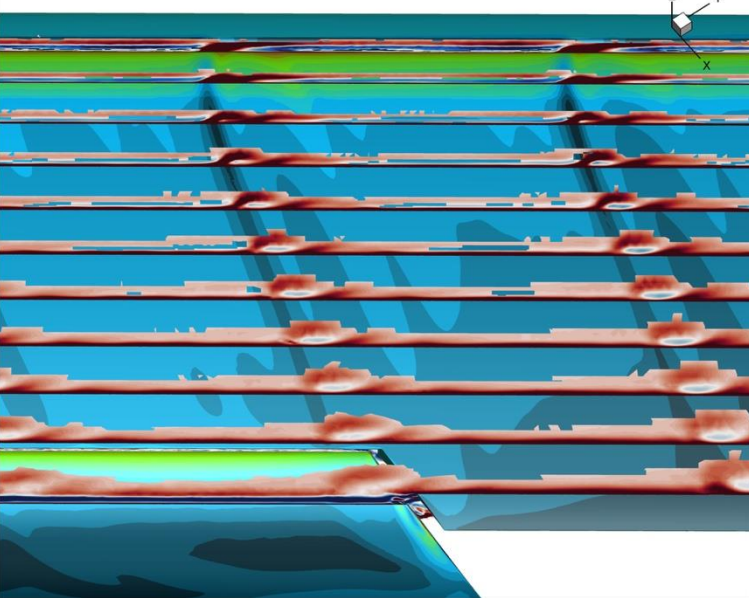
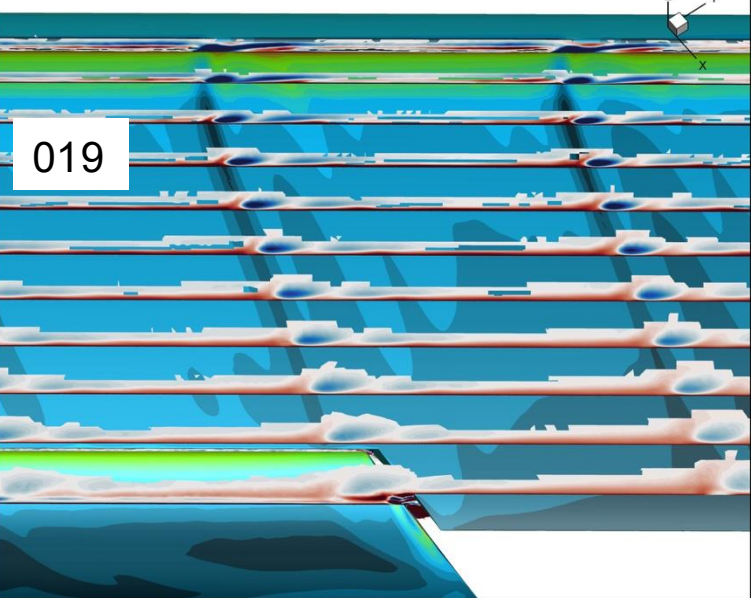
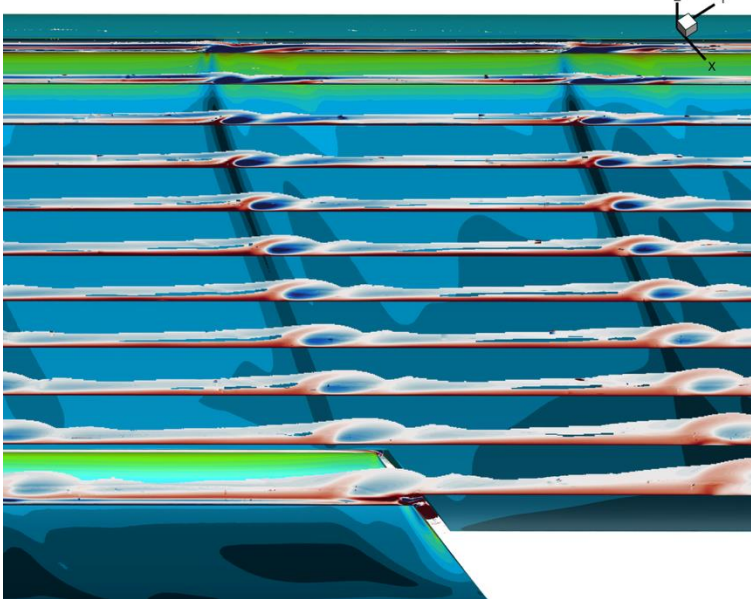
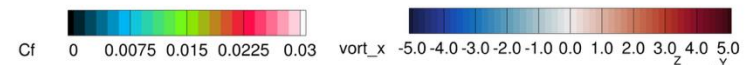
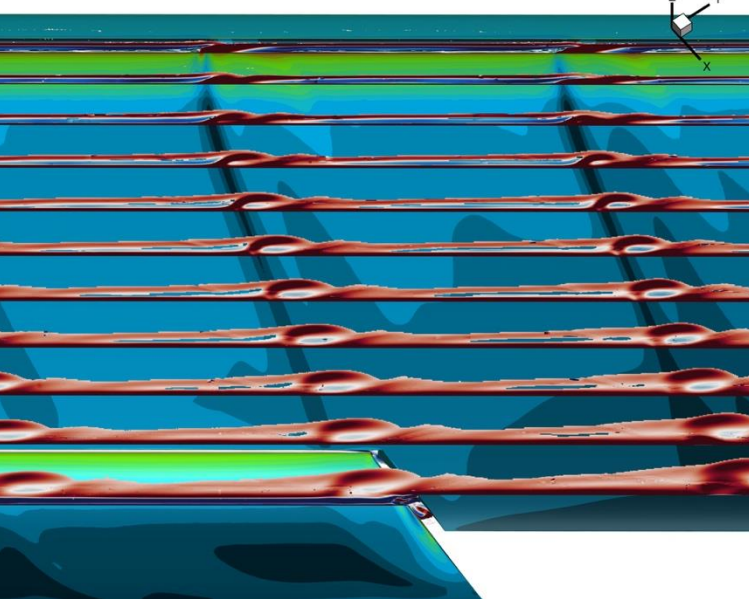
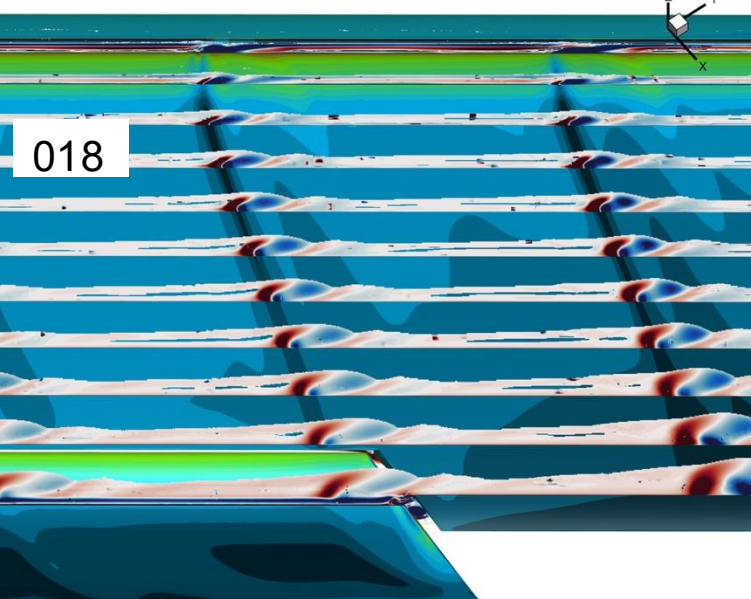
CF vs Y – WSA – $\alpha=10^\circ$ **CF vs Y – WSC – $\alpha=10^\circ$** **CF vs Y – WSE – $\alpha=10^\circ$** **CF vs Y – FSFWSF – $\alpha=10^\circ$** 

$$\alpha = 15^\circ$$

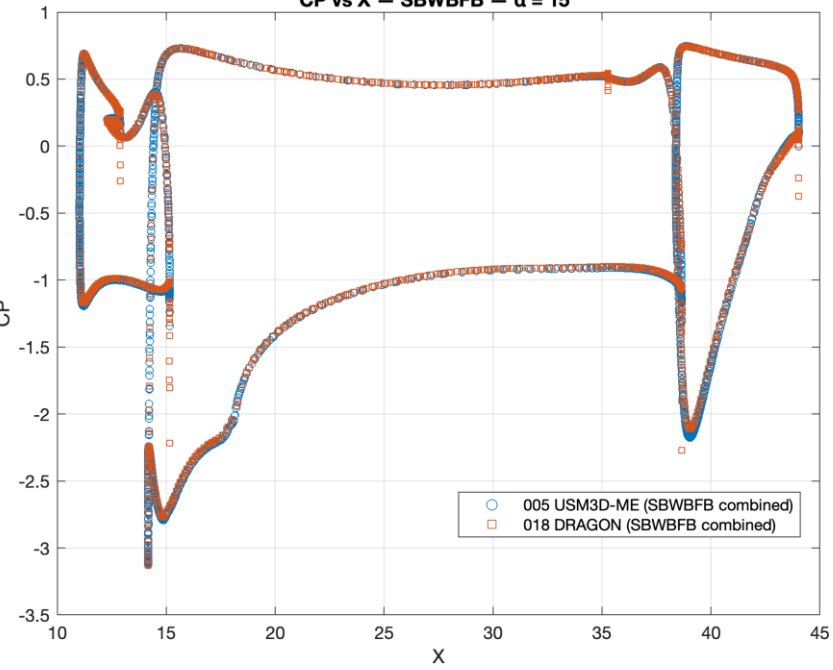




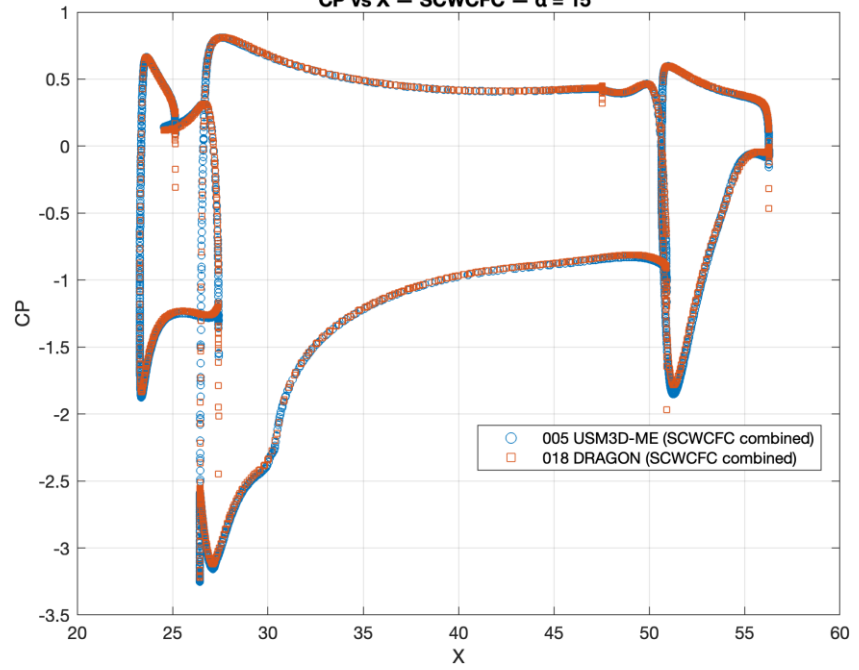




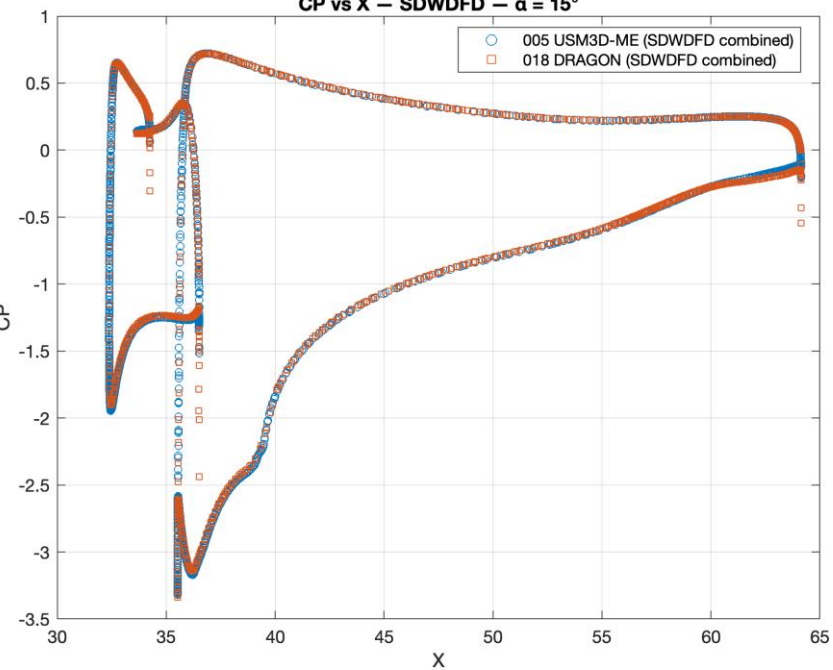
CP vs X – SBWBFB – $\alpha = 15^\circ$



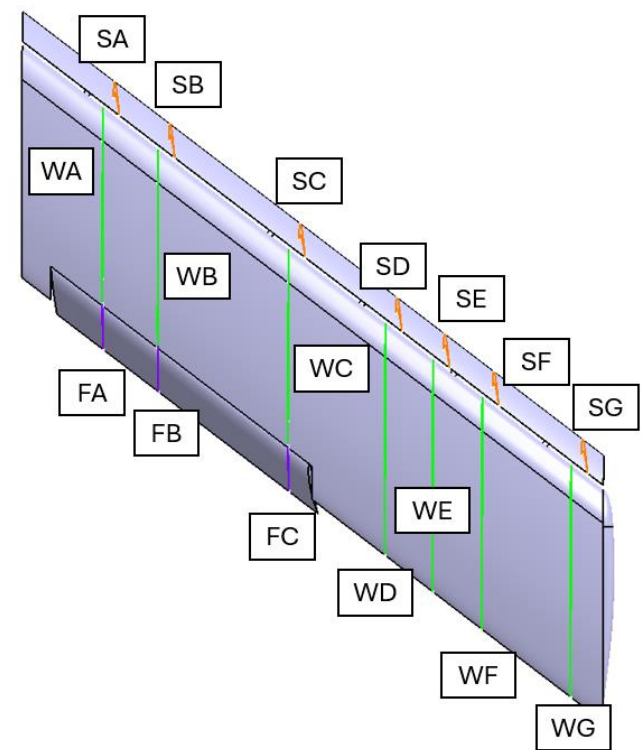
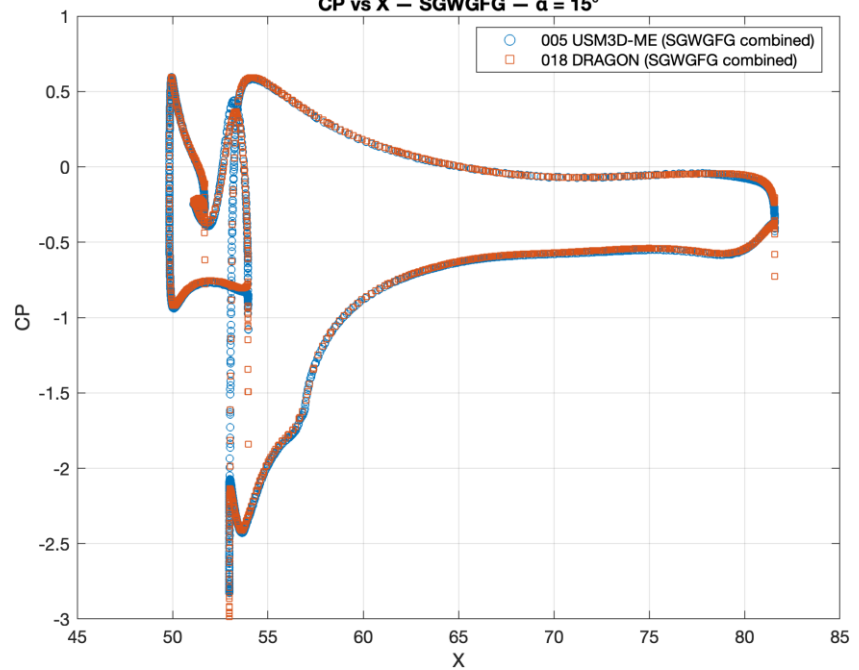
CP vs X – SCWCFC – $\alpha = 15^\circ$

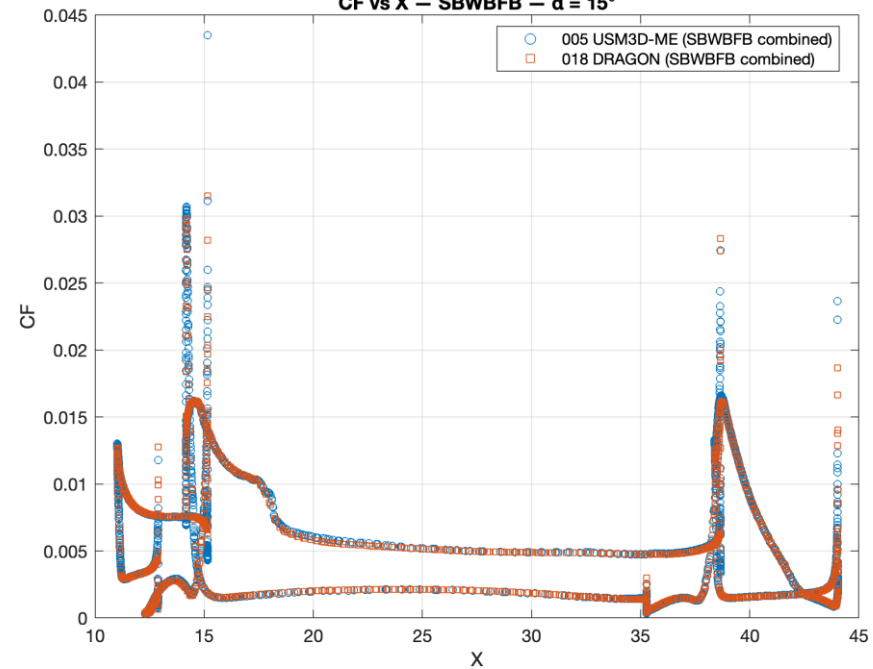
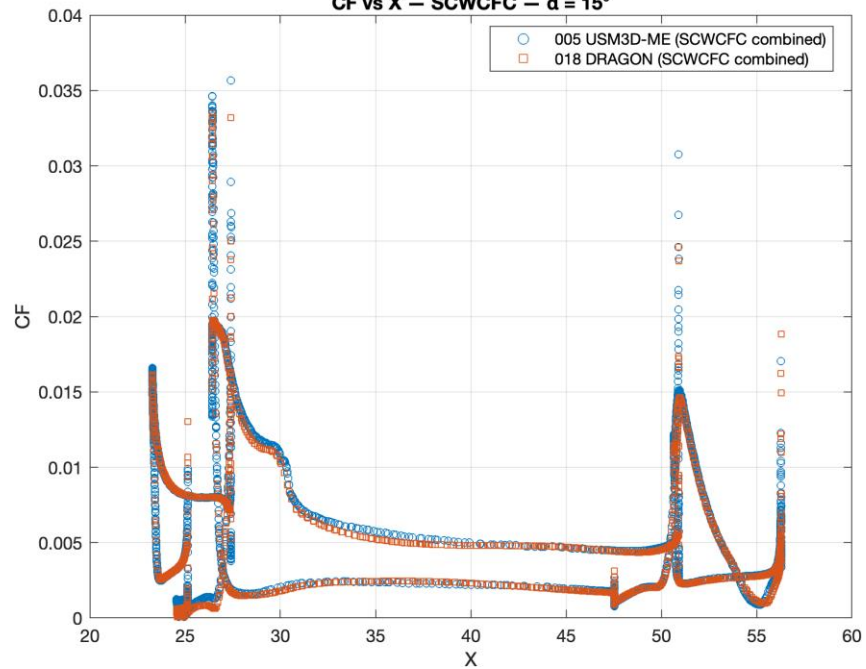
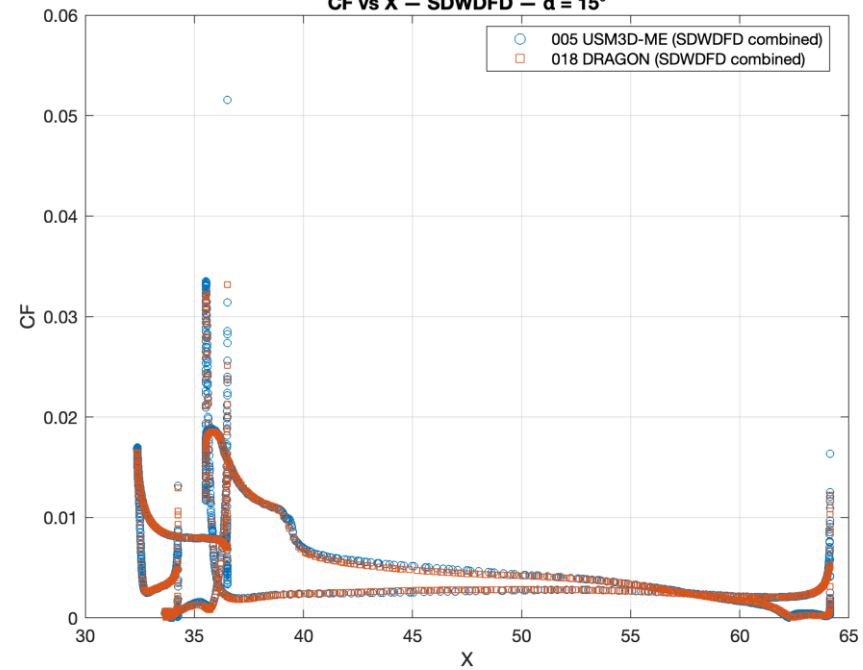
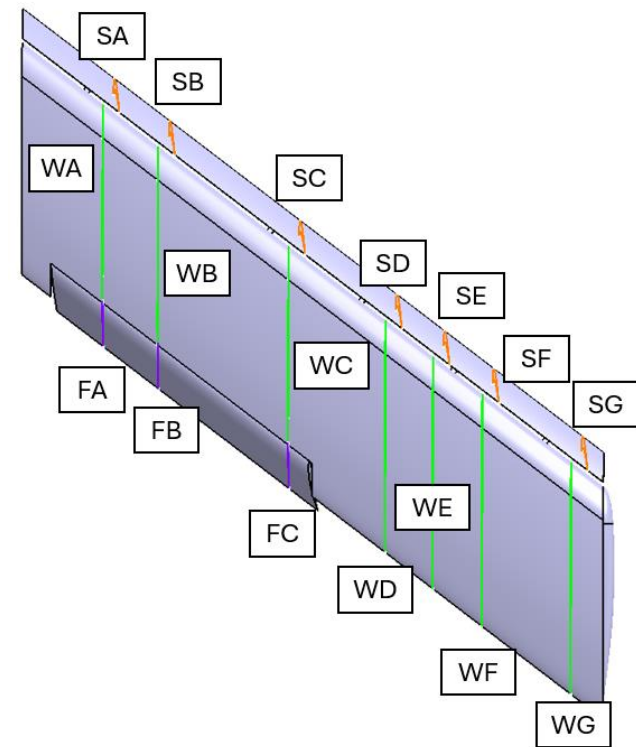
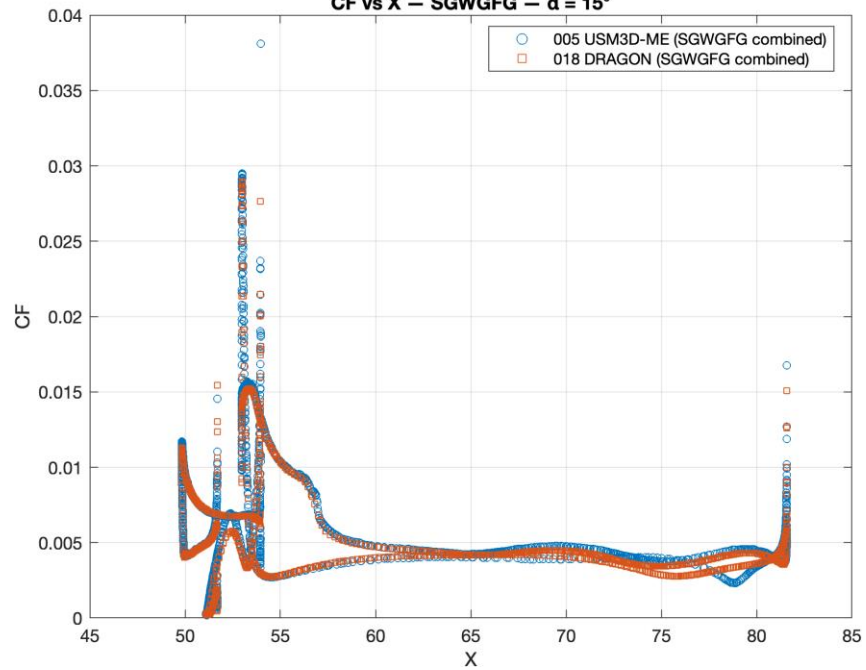


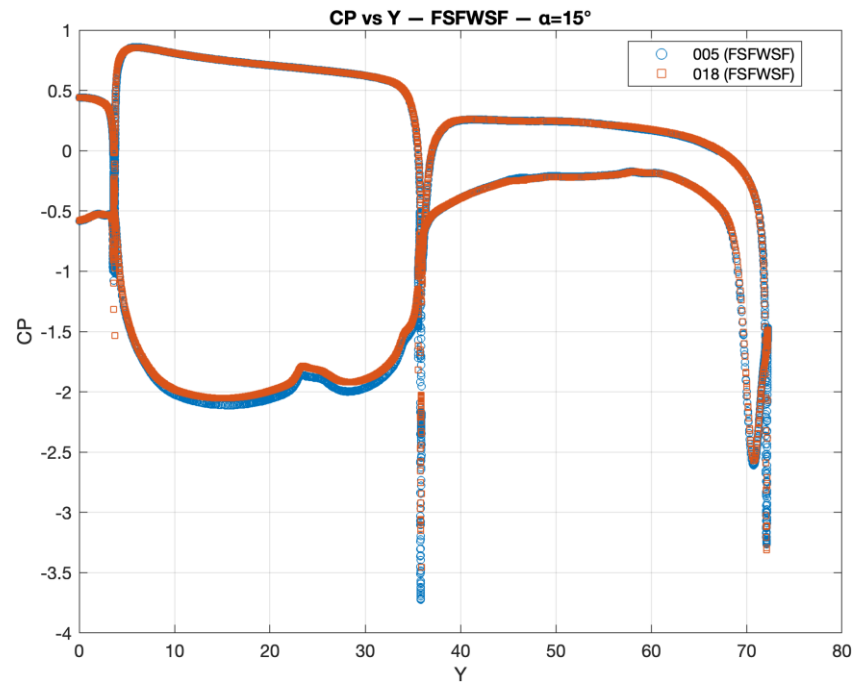
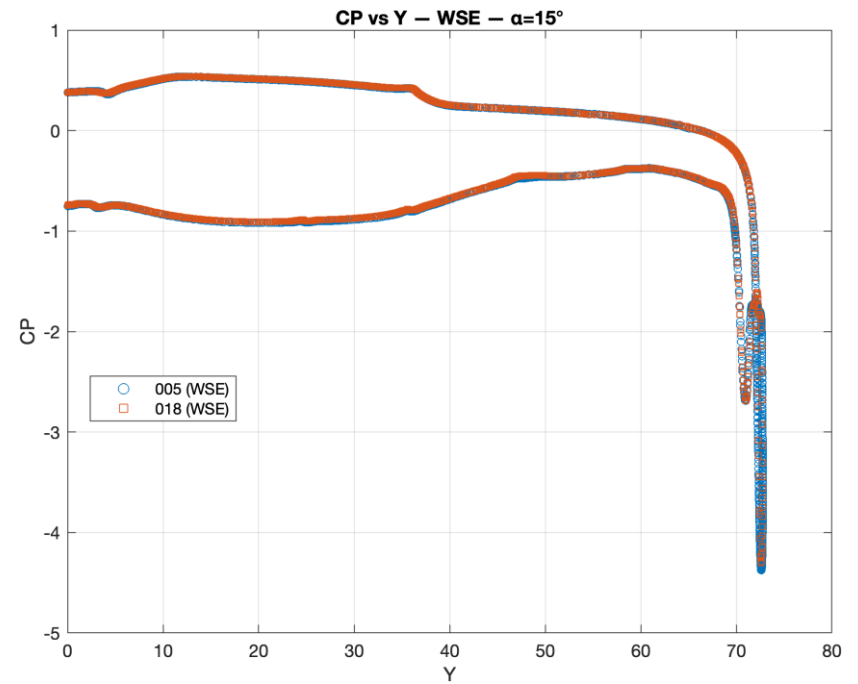
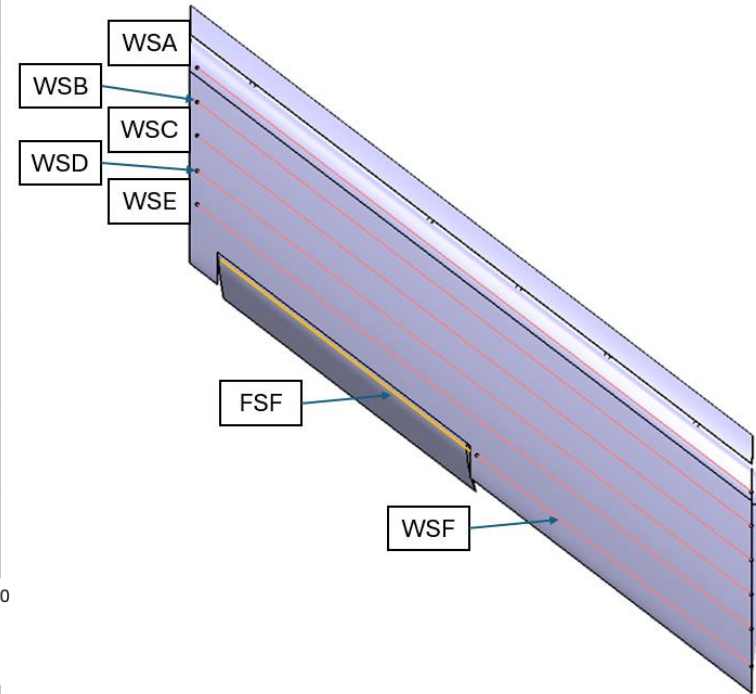
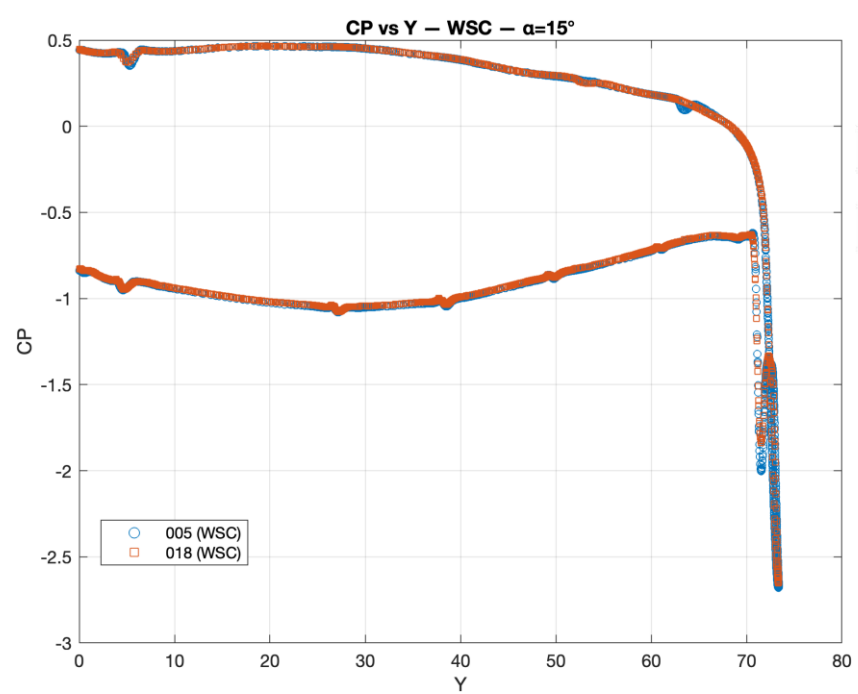
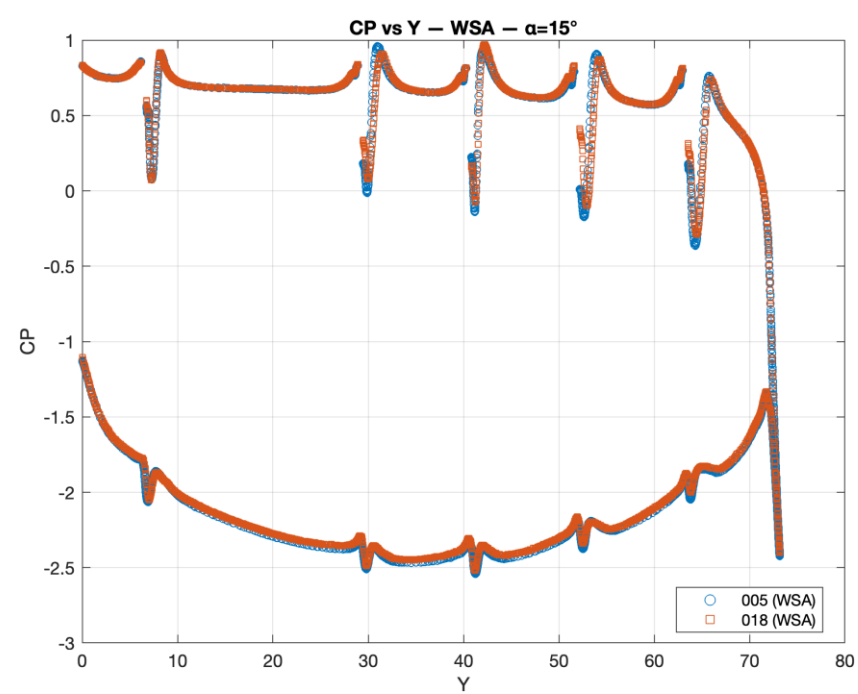
CP vs X – SDWDFD – $\alpha = 15^\circ$

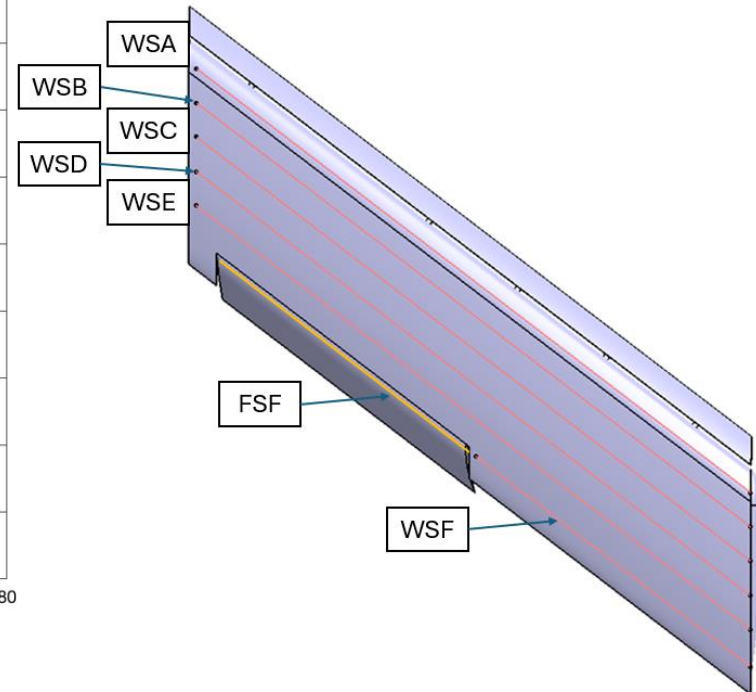
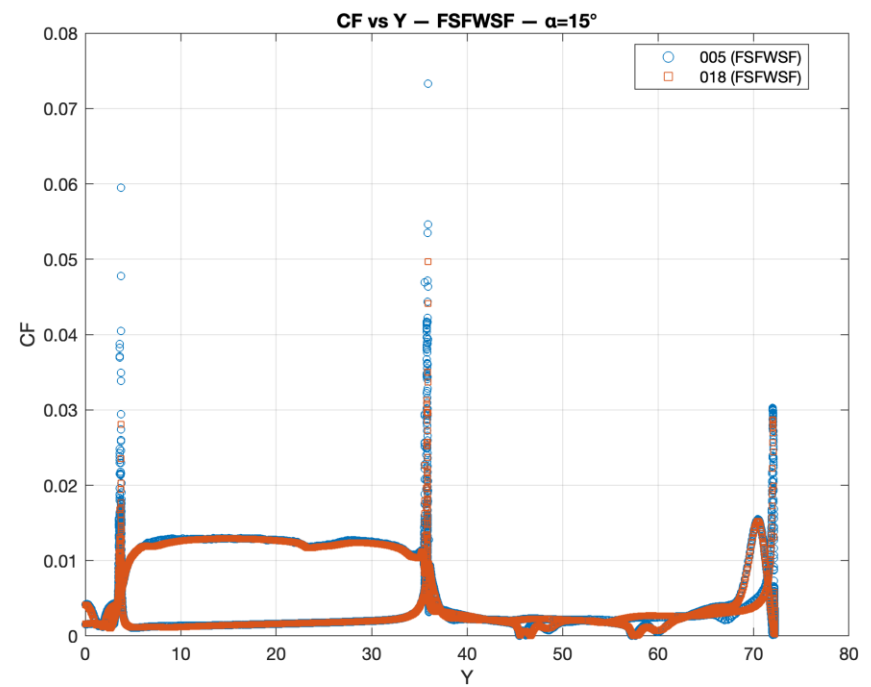
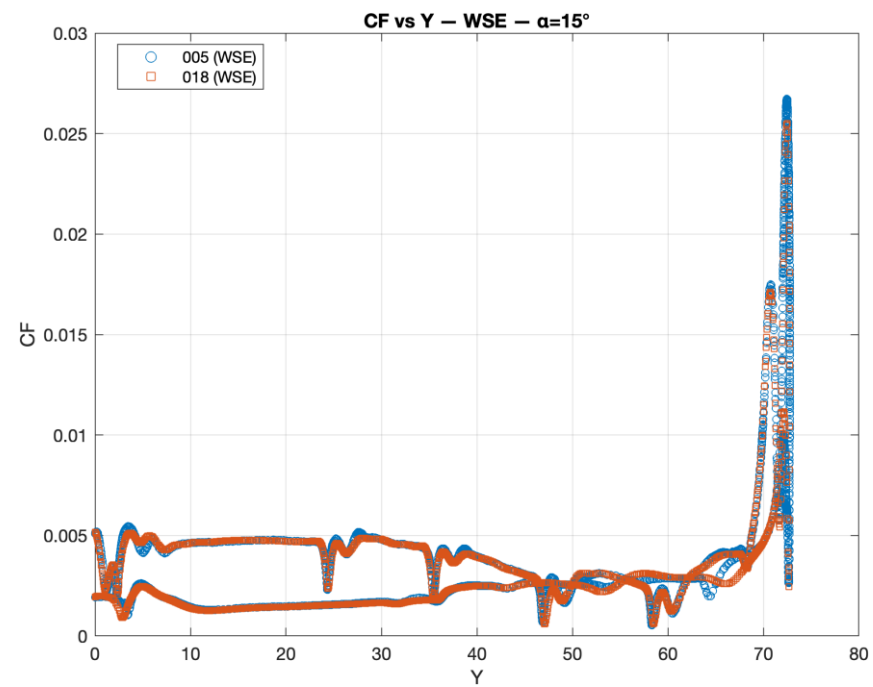
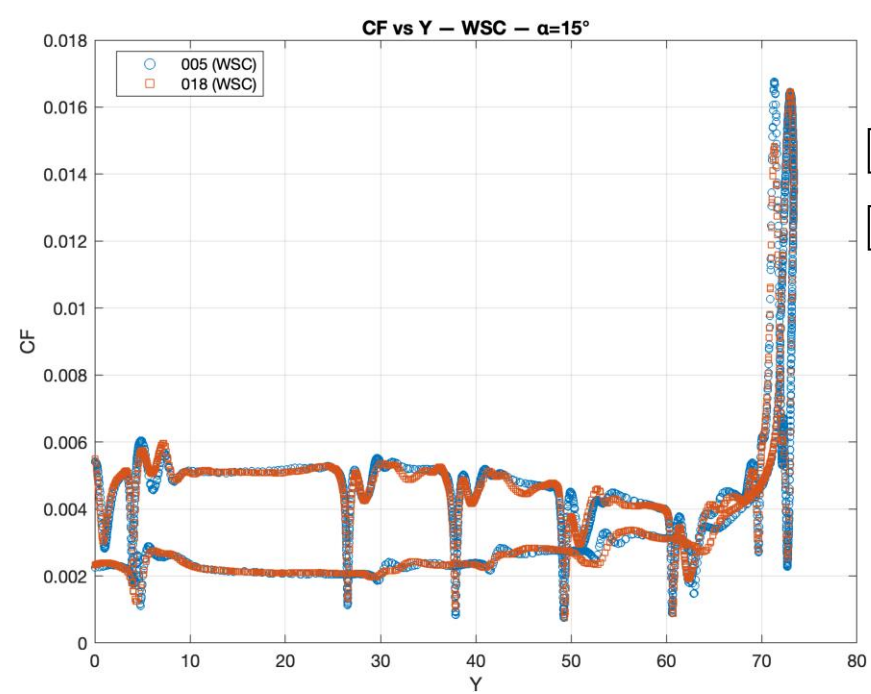
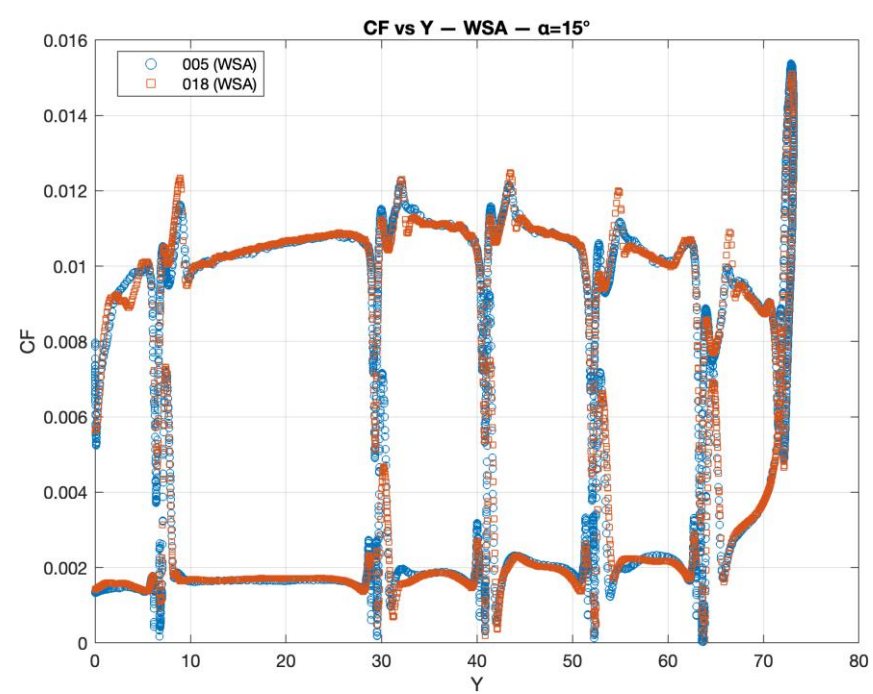


CP vs X – SGWGFG – $\alpha = 15^\circ$



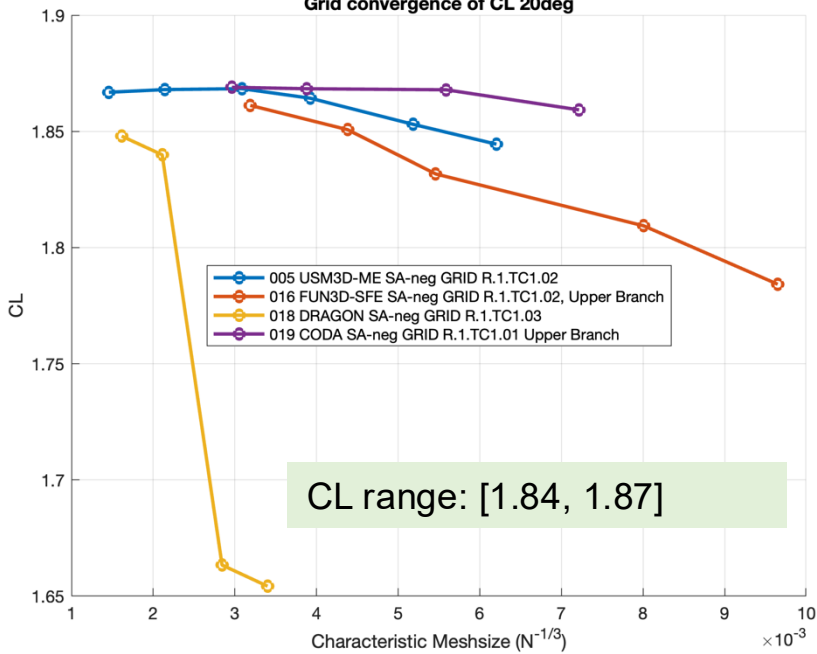
CF vs X – SBWBFB – $\alpha = 15^\circ$ **CF vs X – SCWCFC – $\alpha = 15^\circ$** **CF vs X – SDWDFD – $\alpha = 15^\circ$** **CF vs X – SGWGFG – $\alpha = 15^\circ$** 



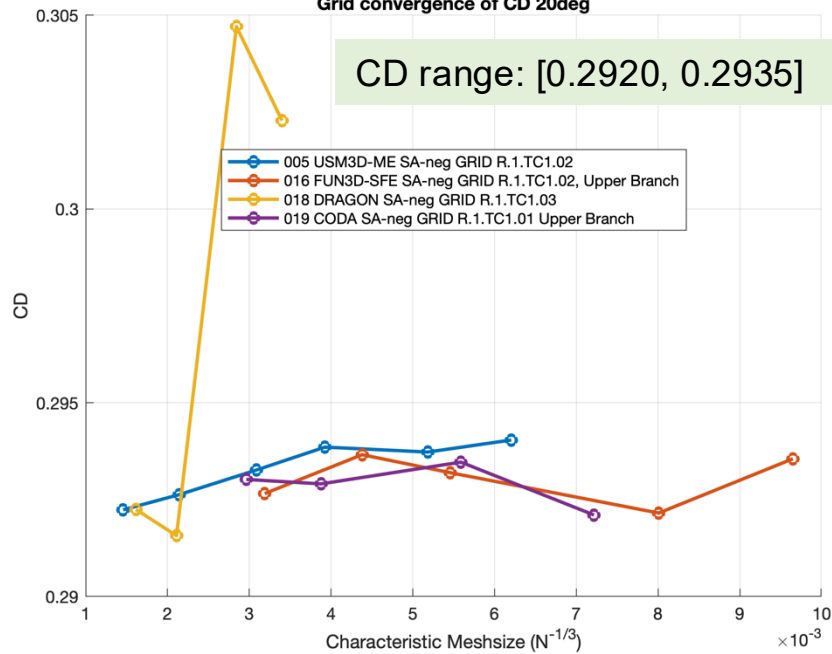


$$\alpha = 20^\circ$$

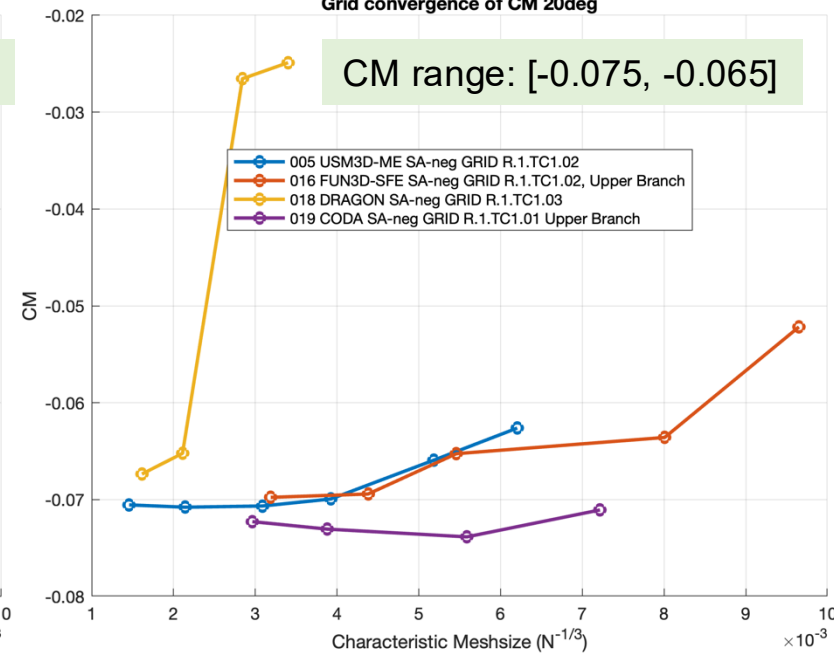
Grid convergence of CL 20deg



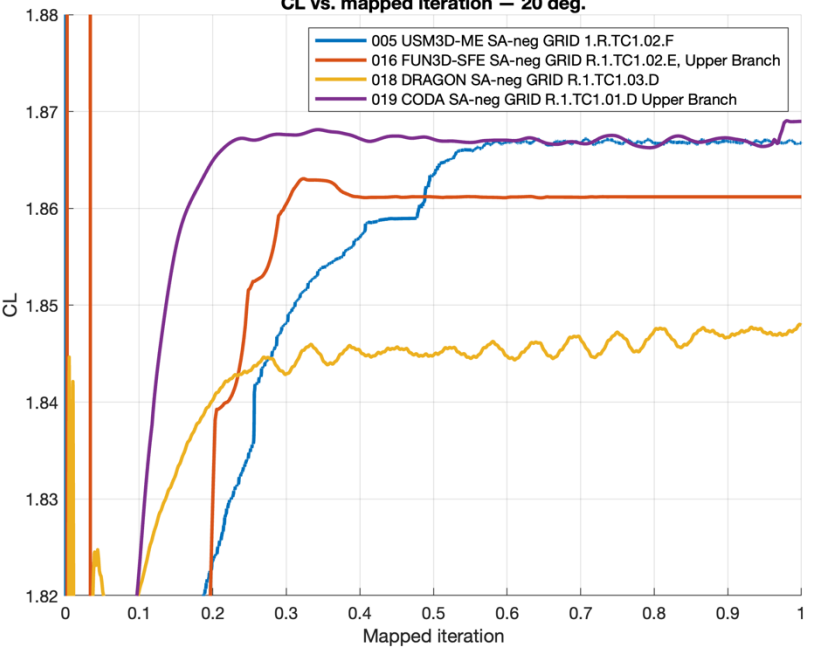
Grid convergence of CD 20deg



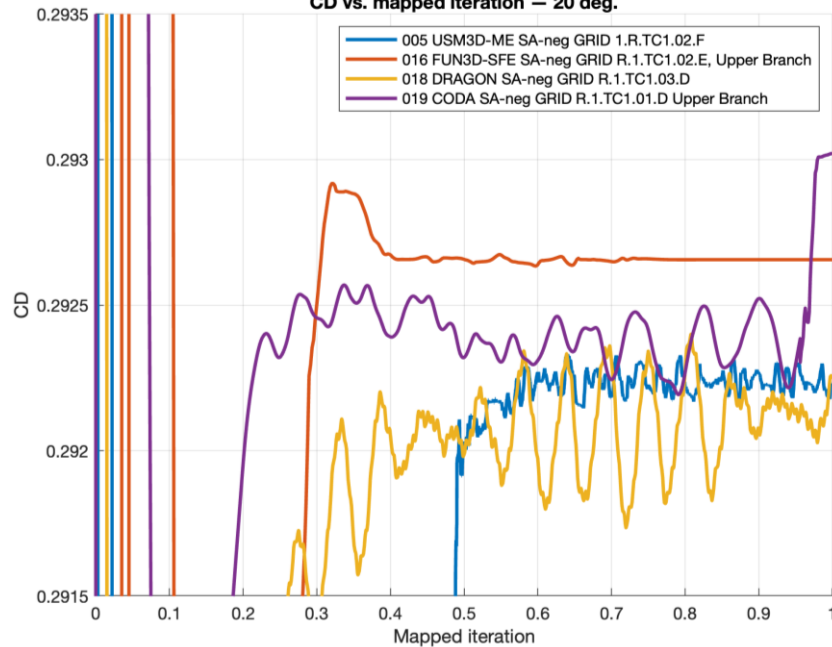
Grid convergence of CM 20deg



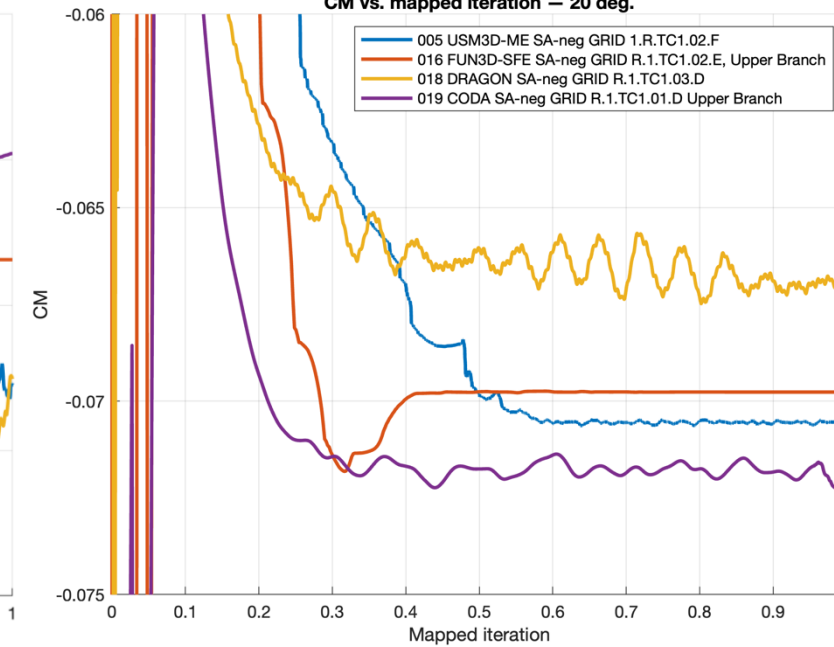
CL vs. mapped iteration — 20 deg.

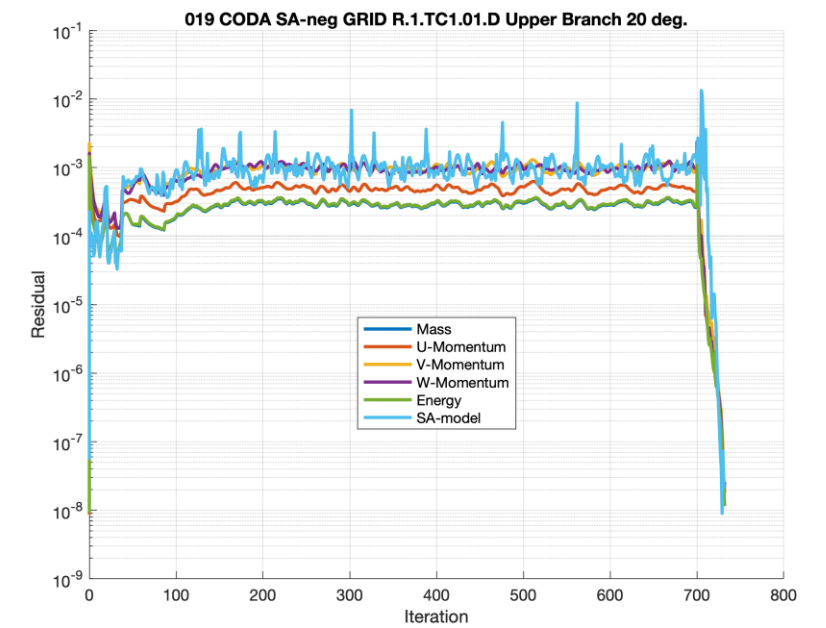
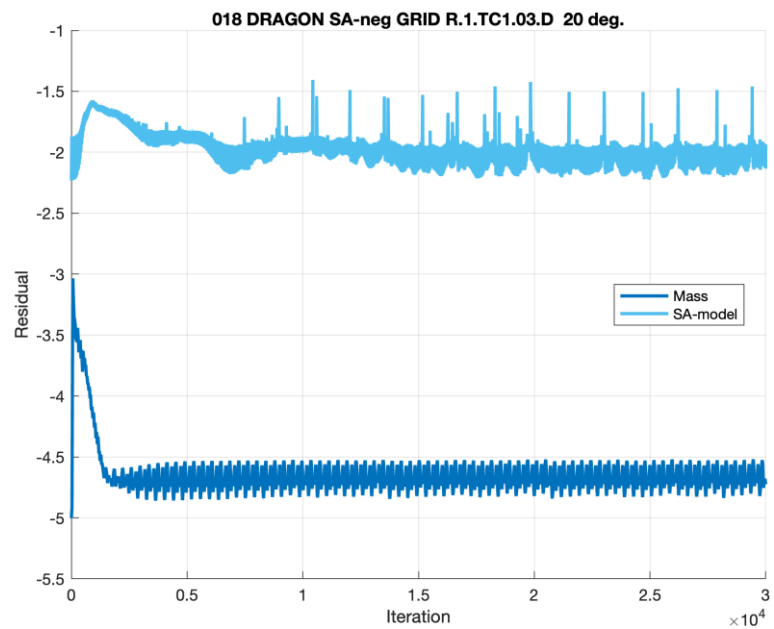
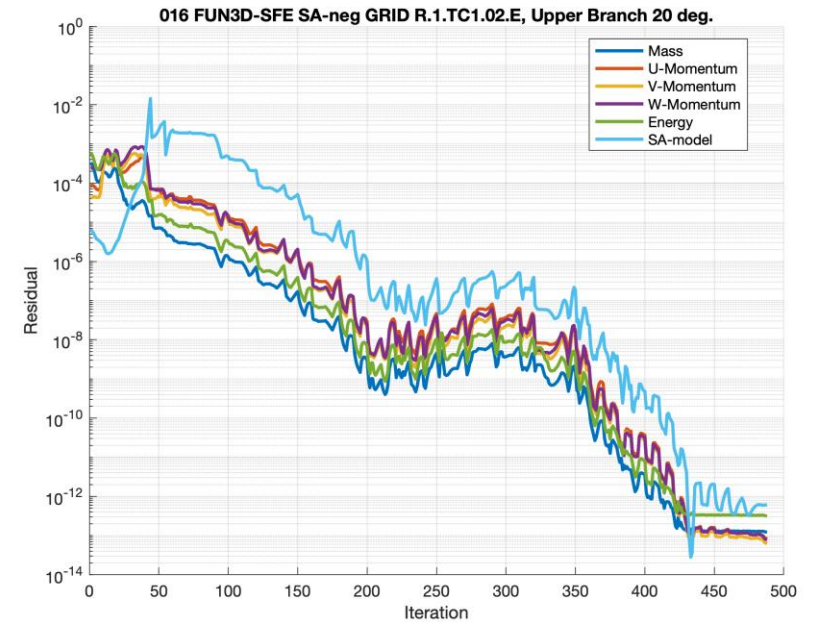
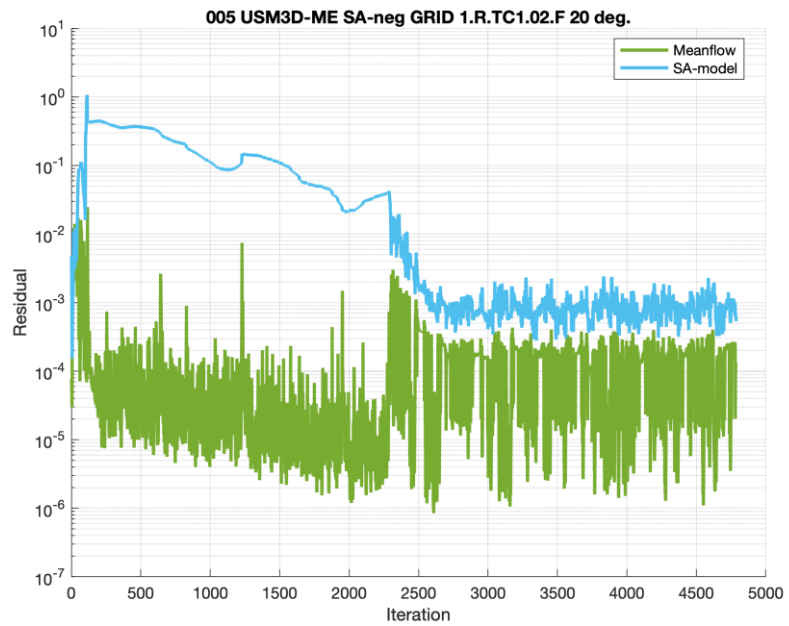


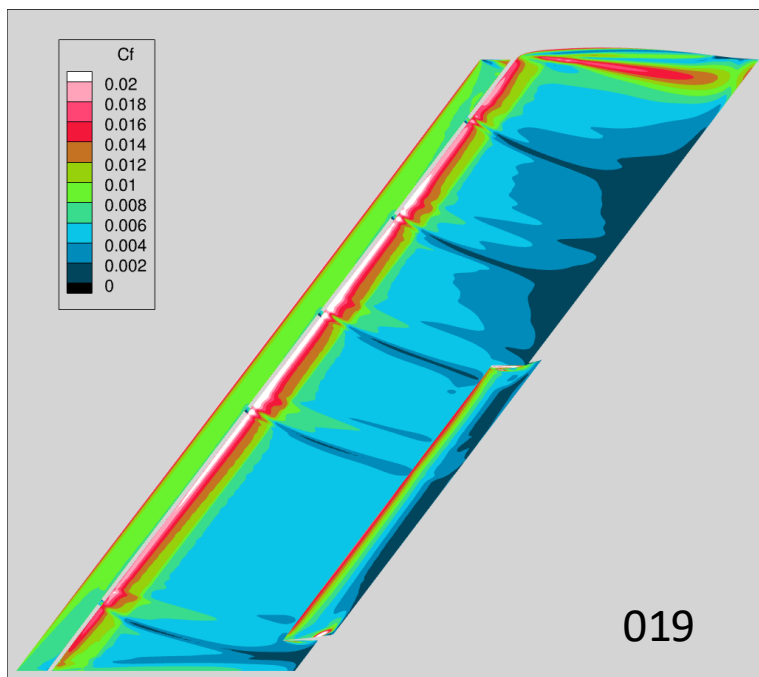
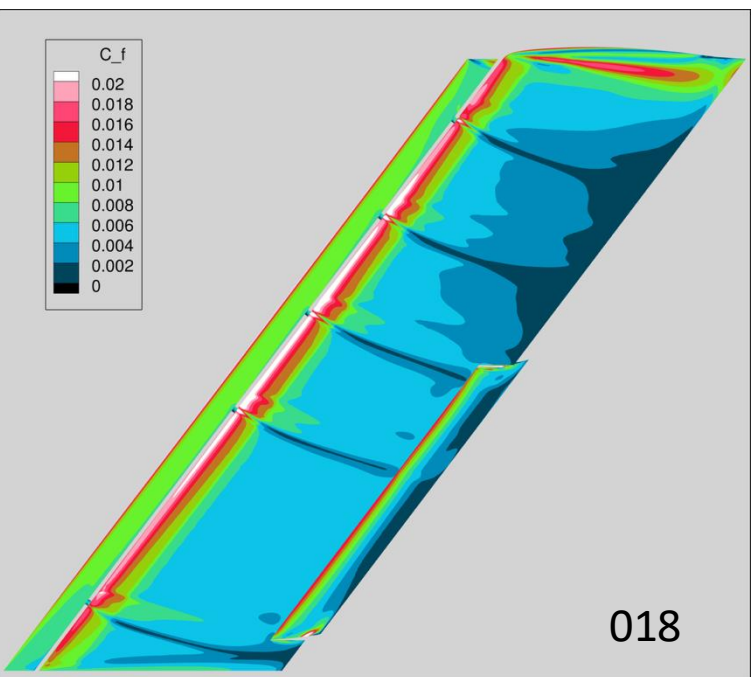
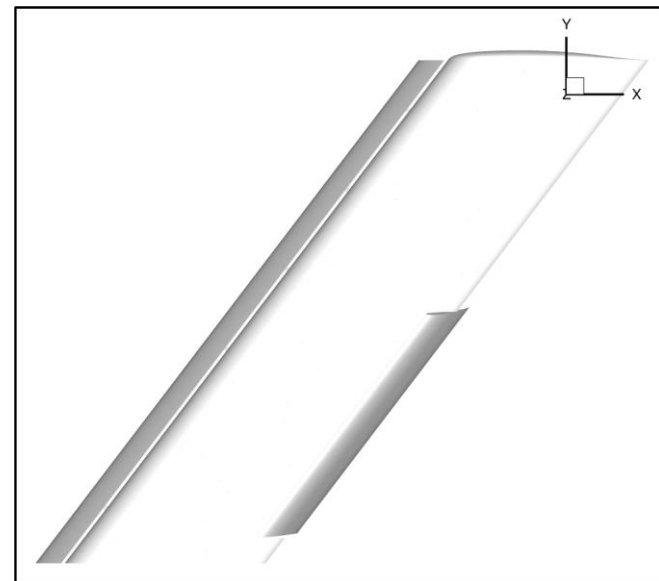
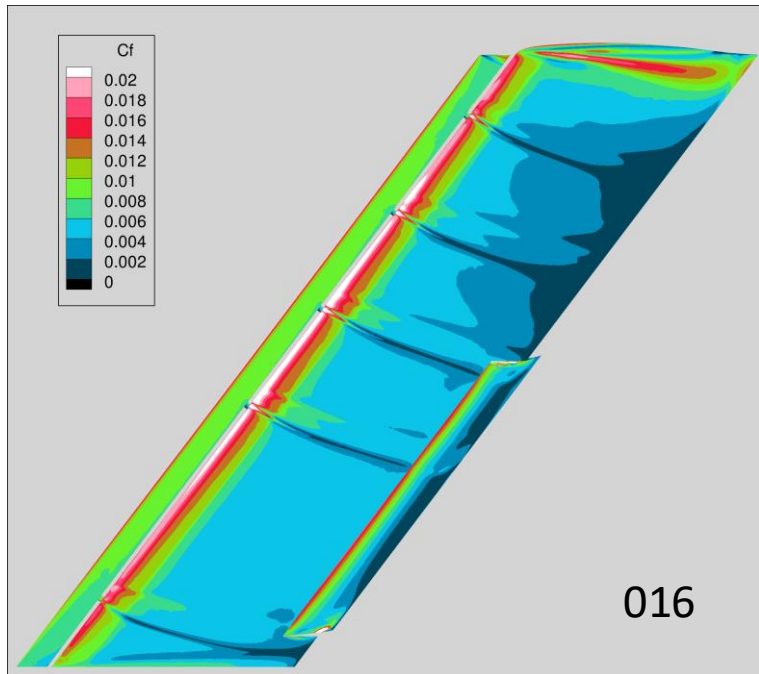
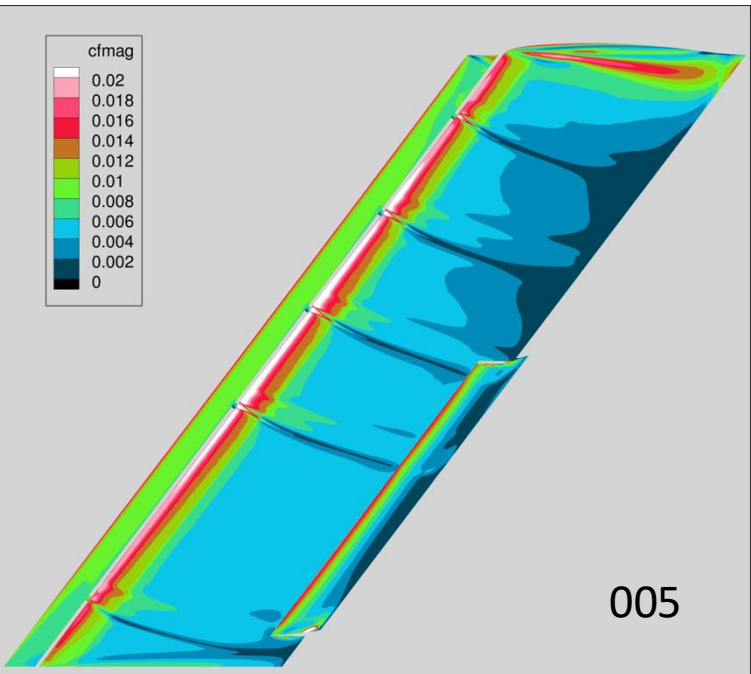
CD vs. mapped iteration — 20 deg.

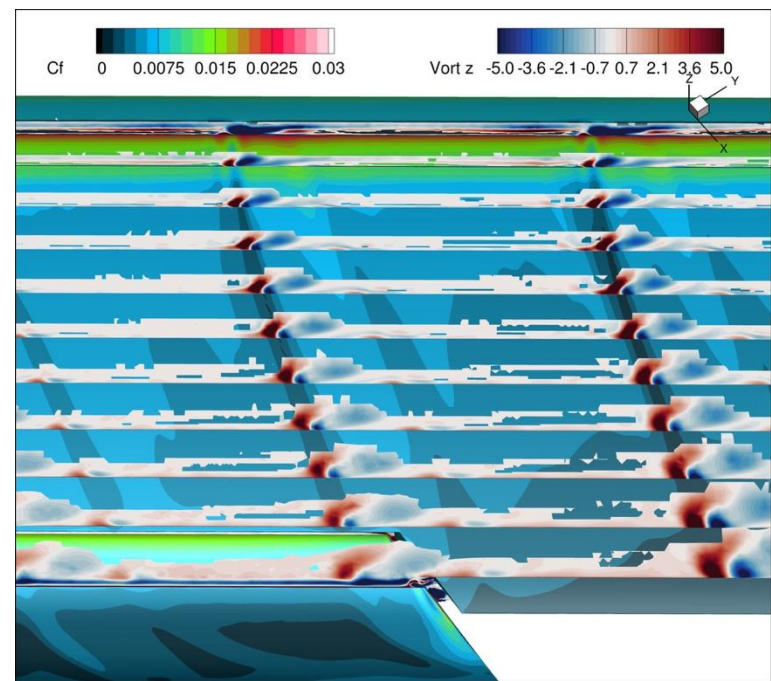
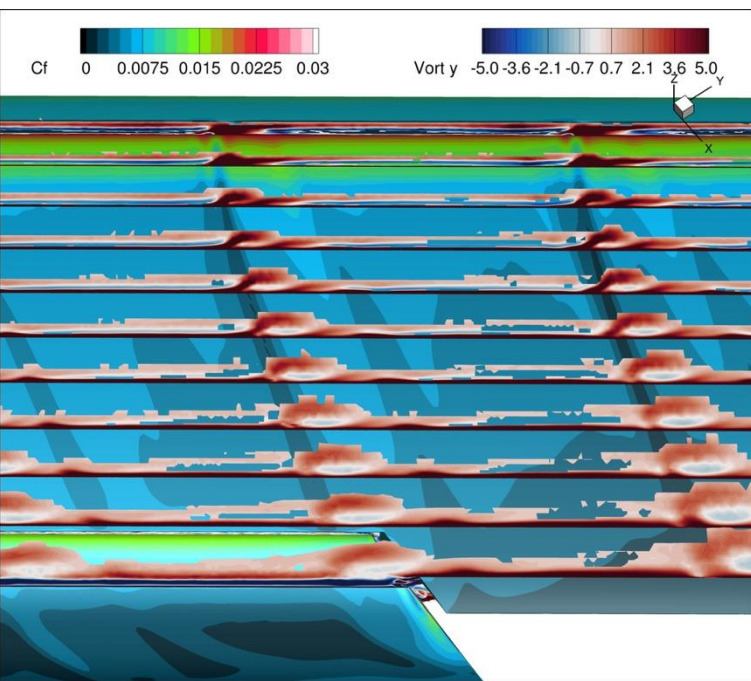
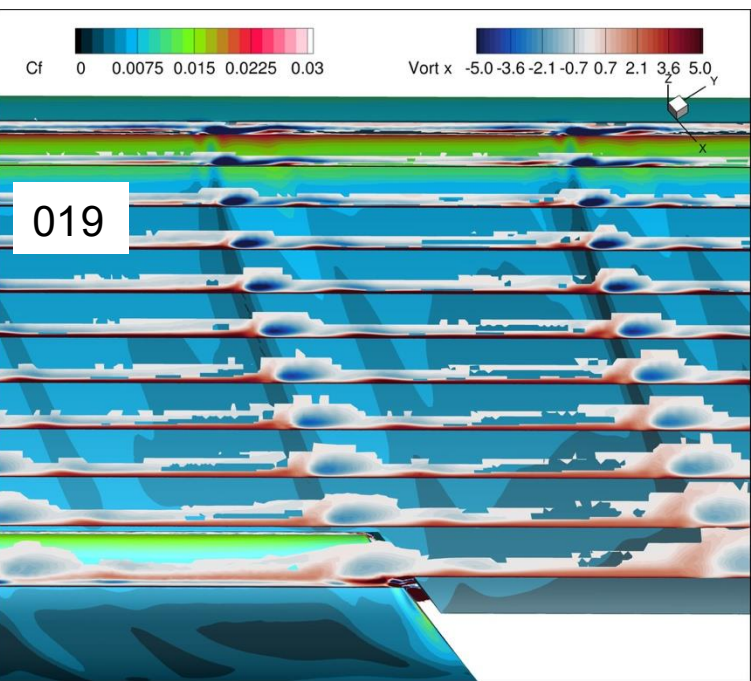
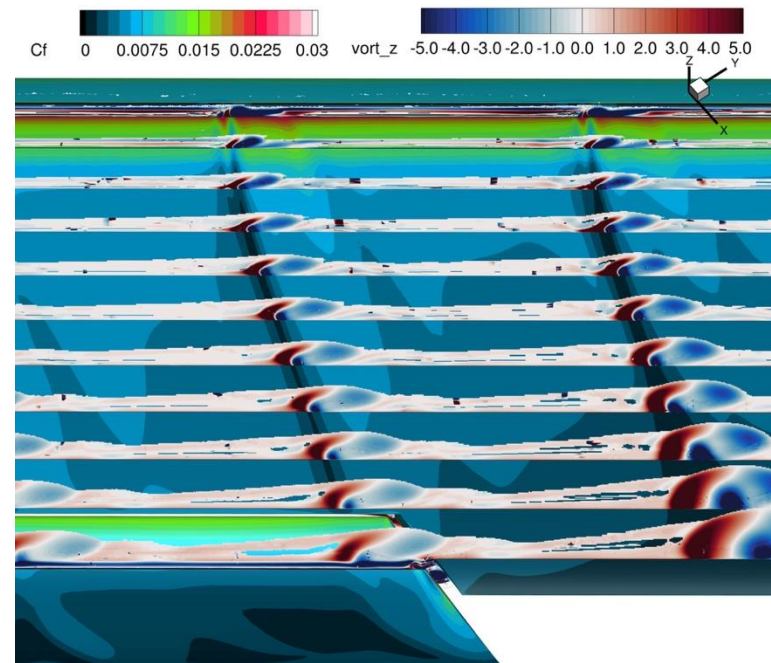
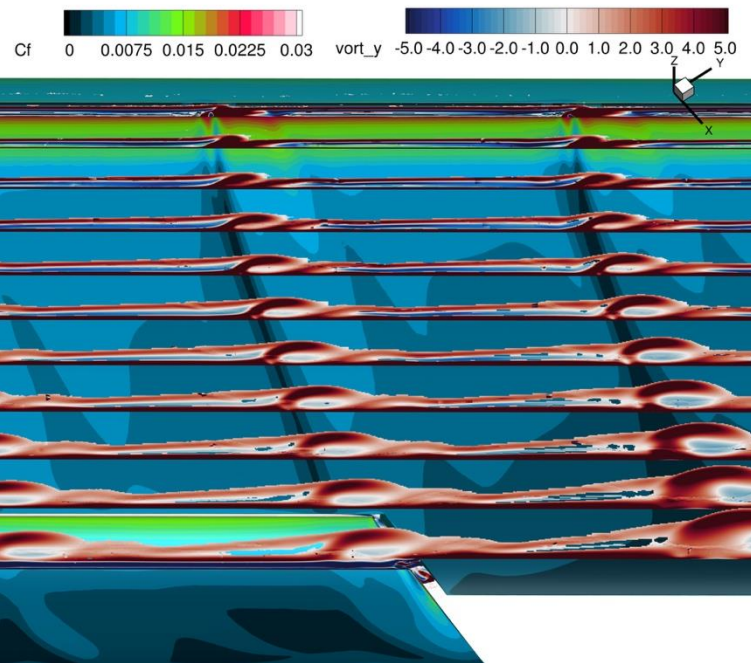
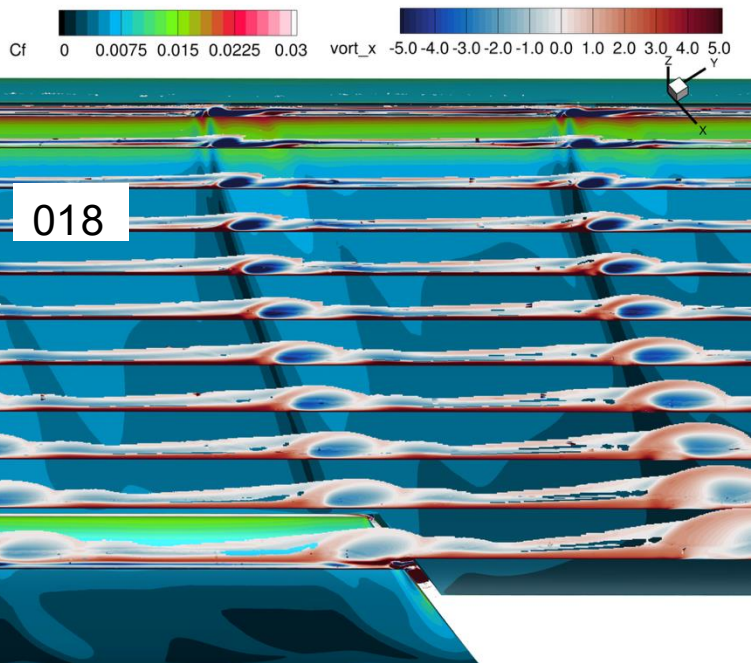


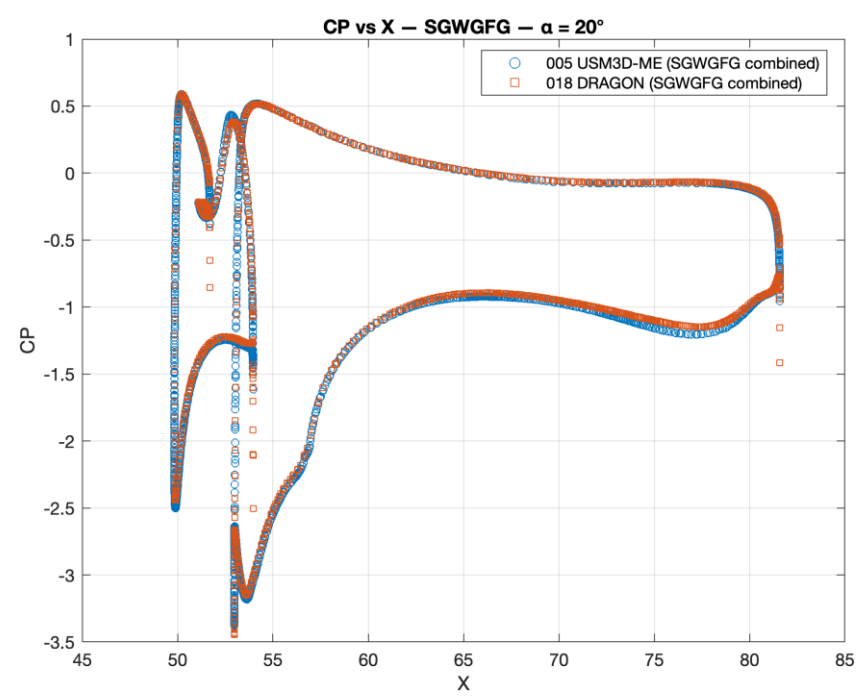
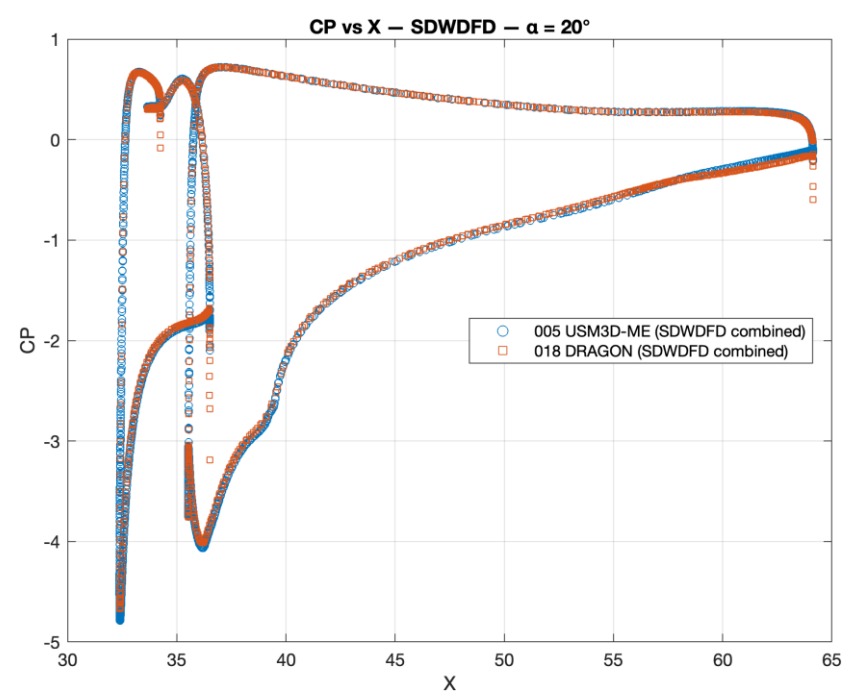
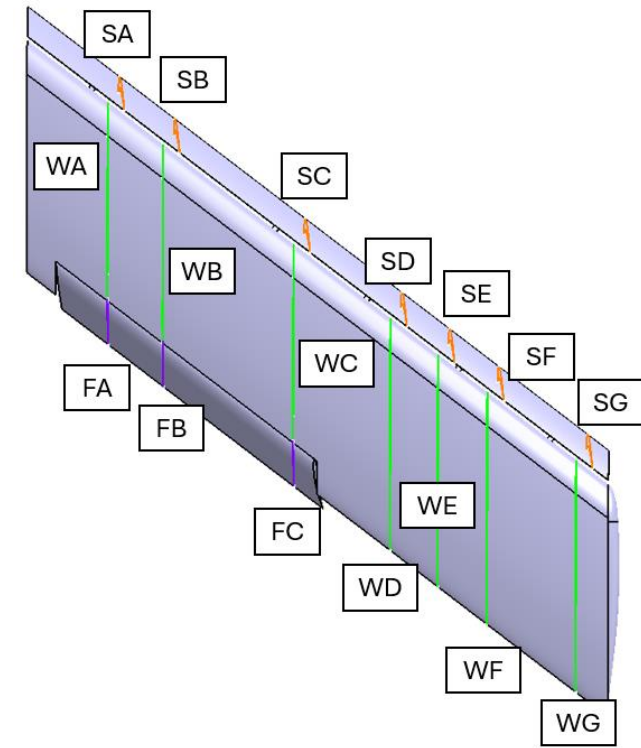
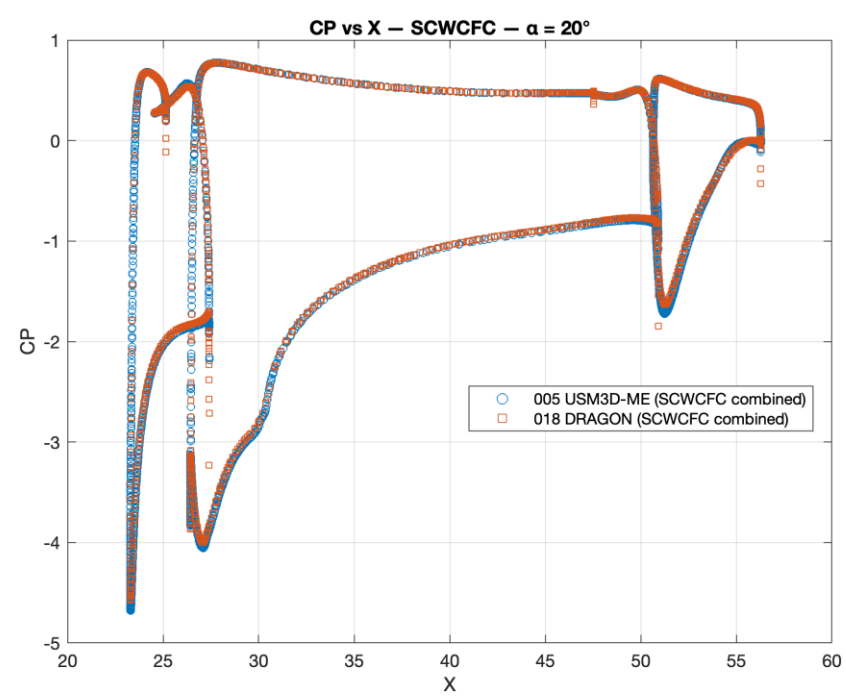
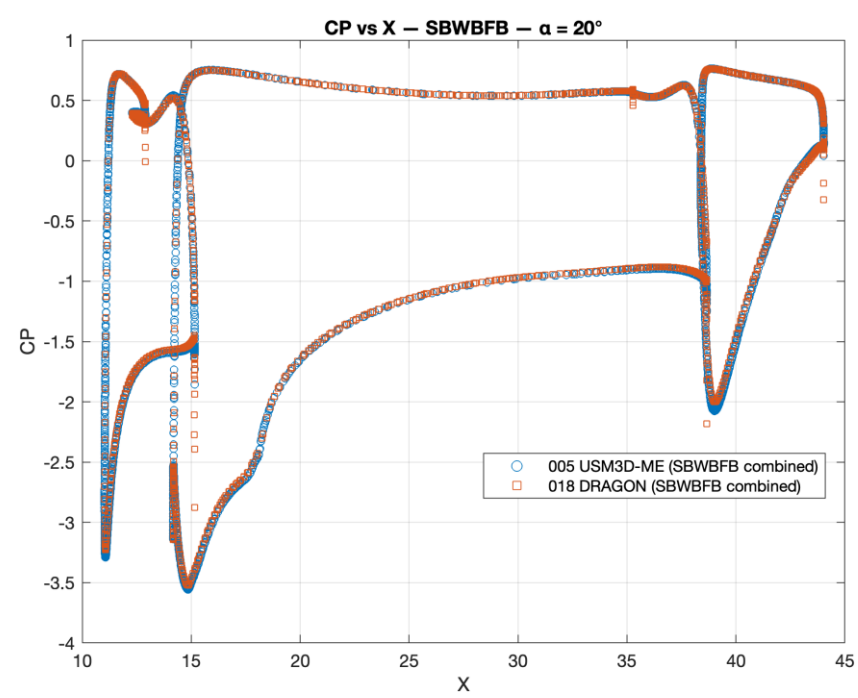
CM vs. mapped iteration — 20 deg.

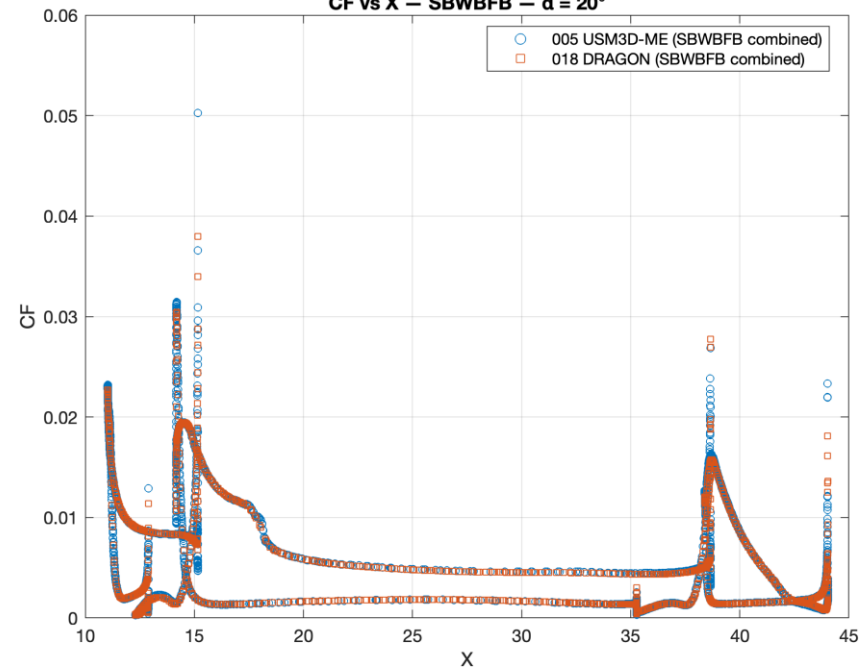
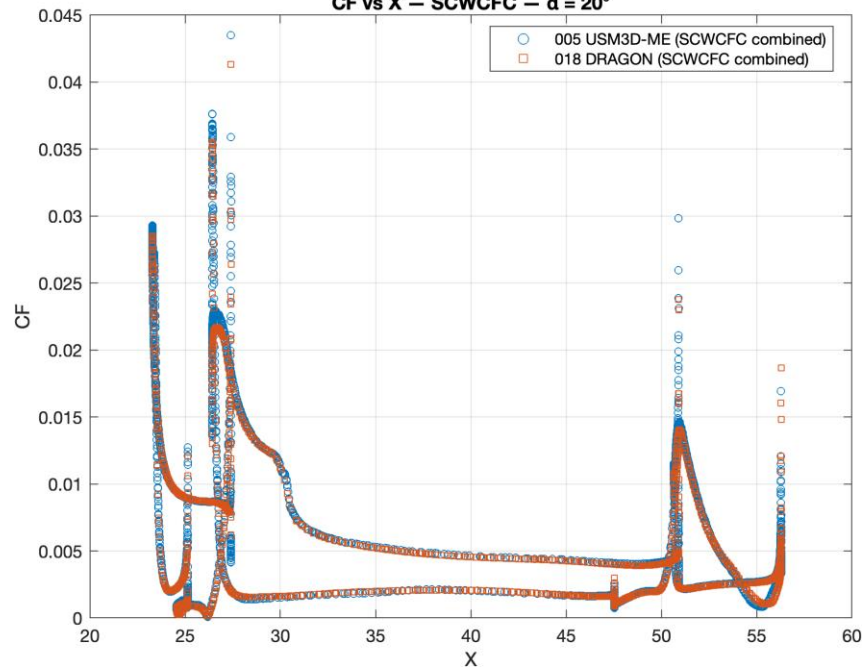
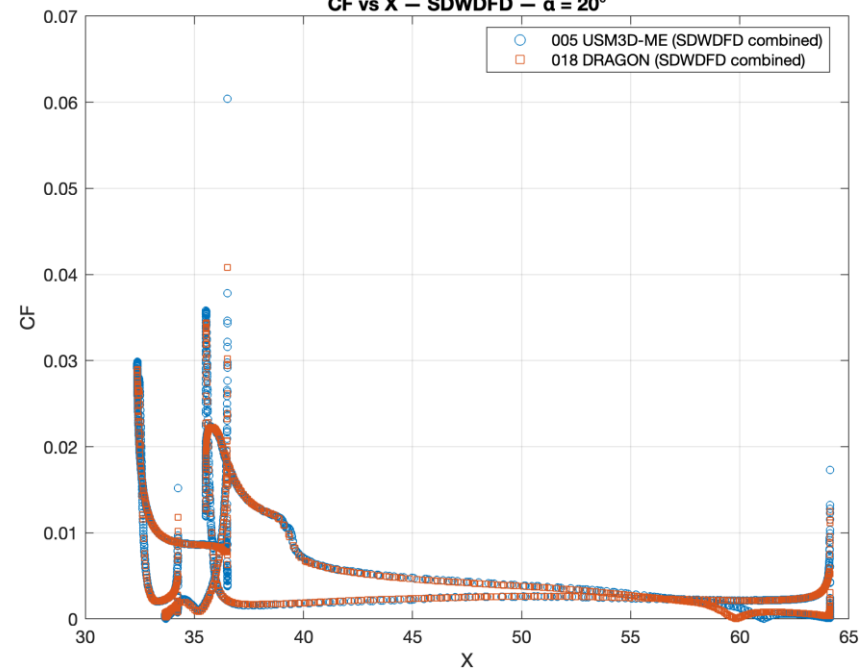
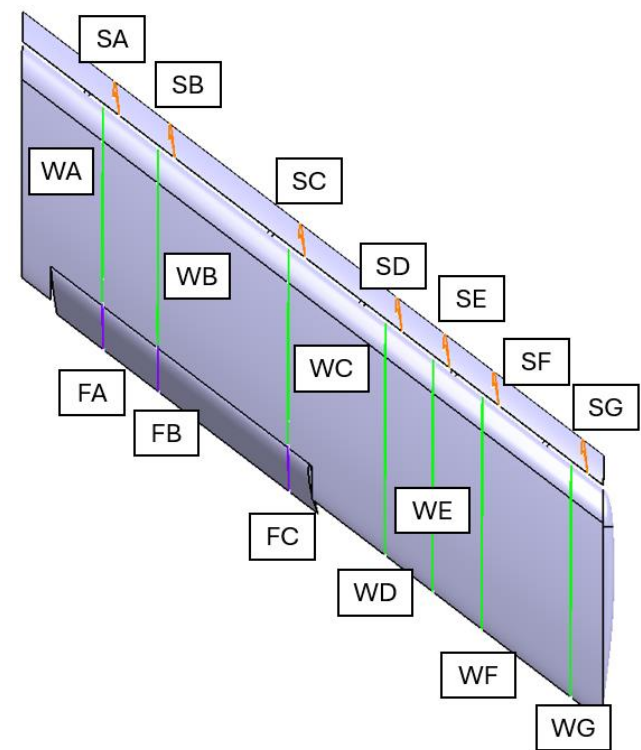
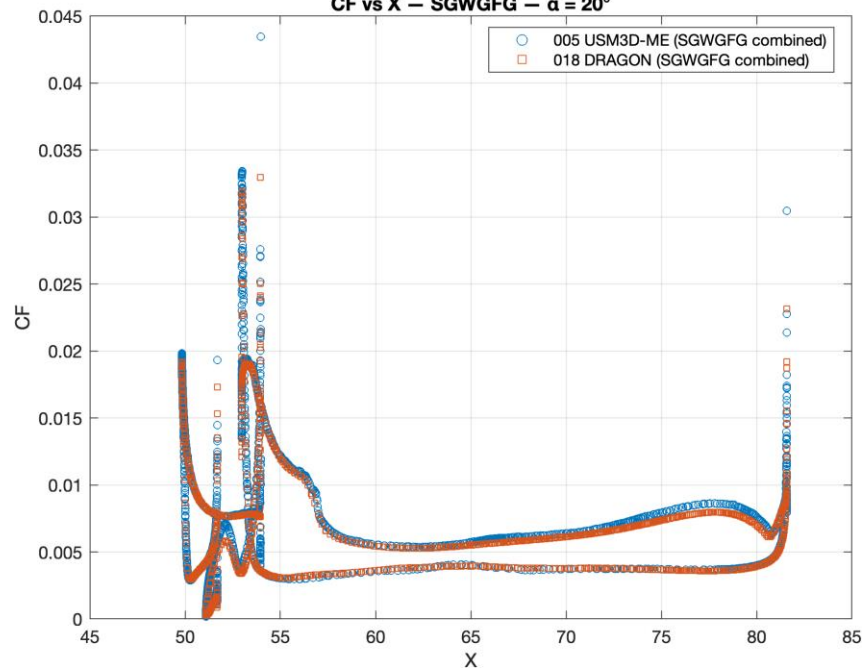


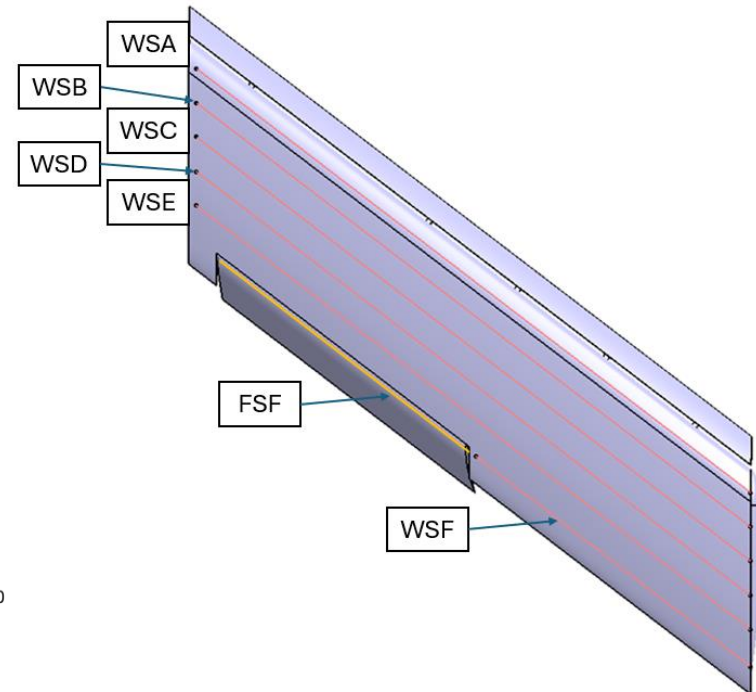
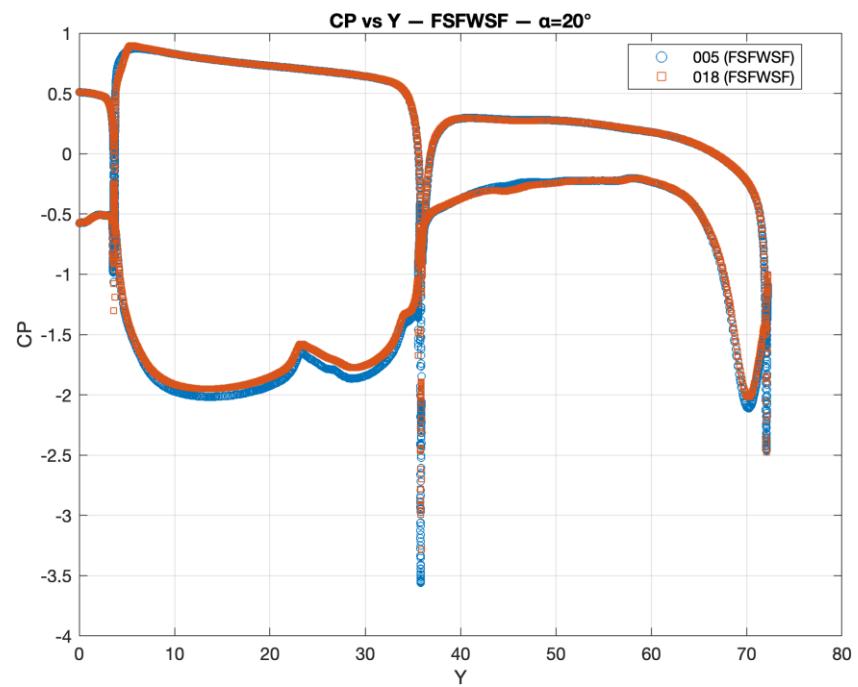
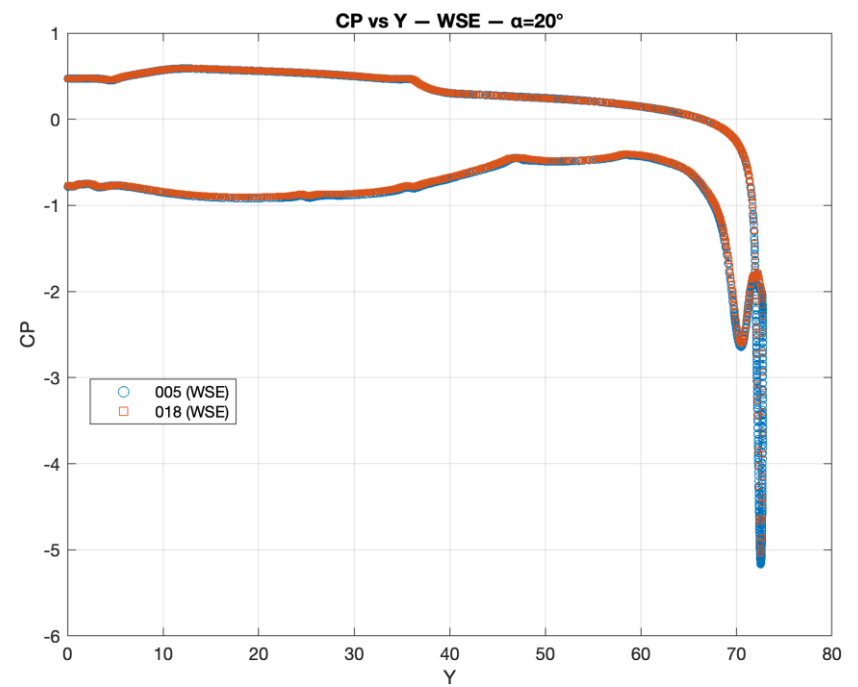
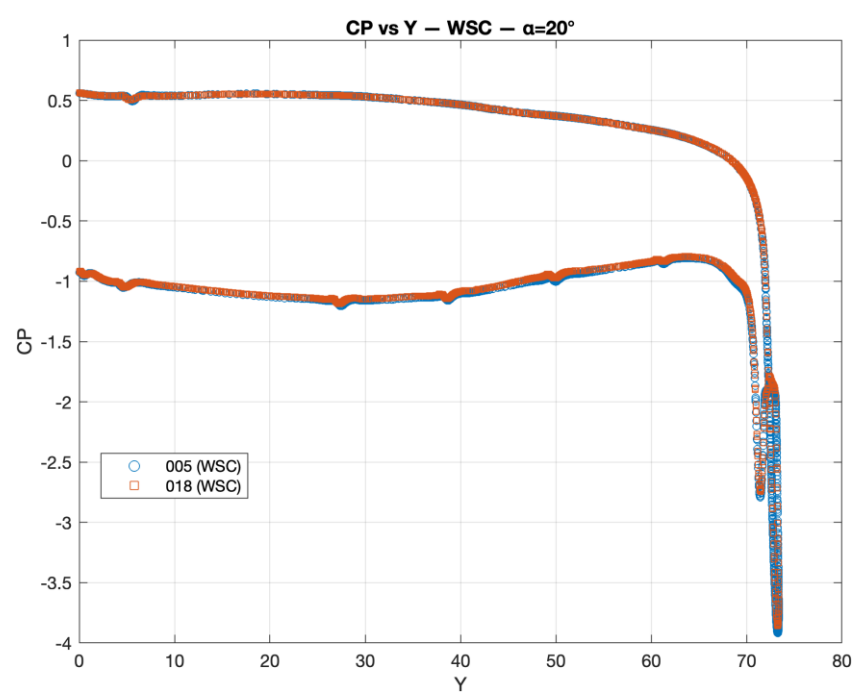
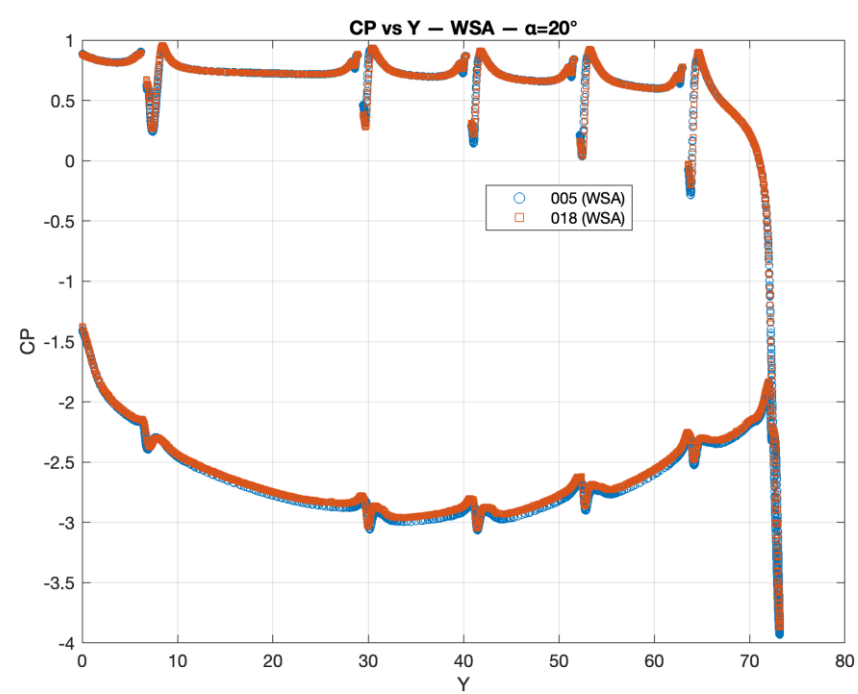


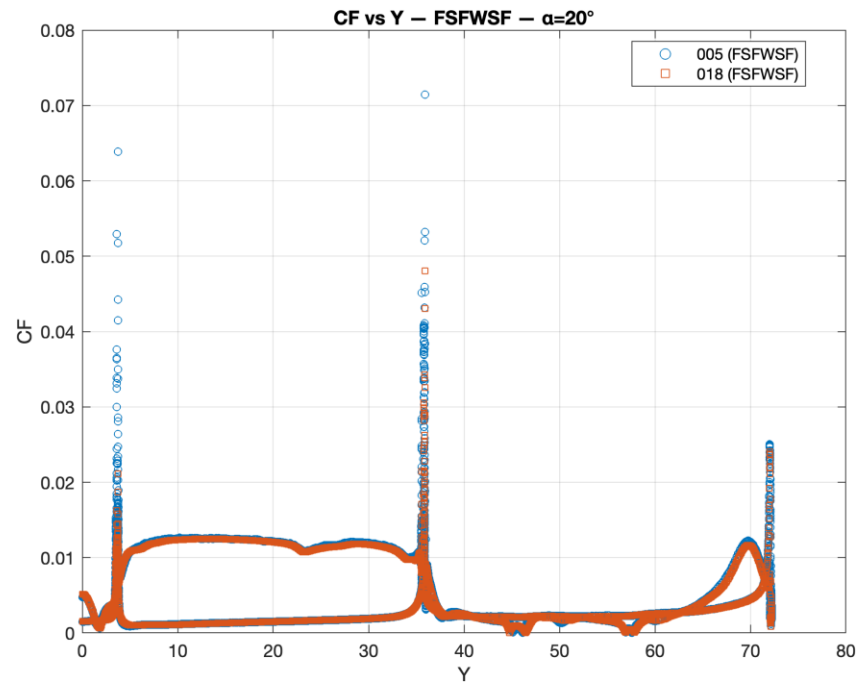
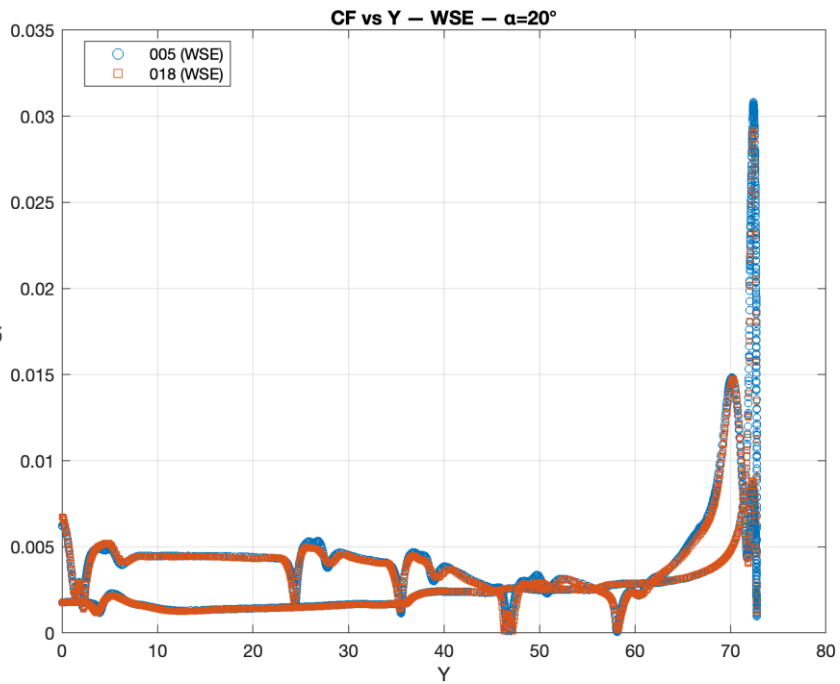
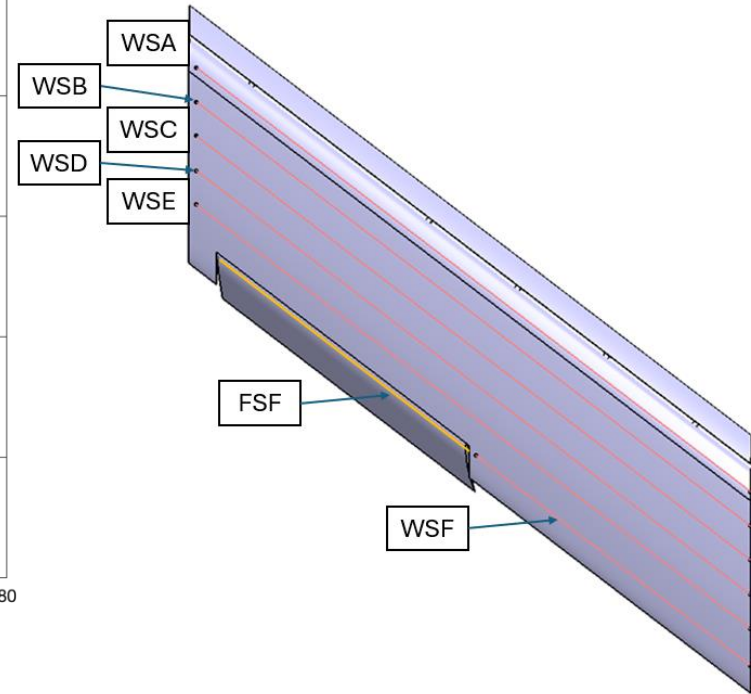
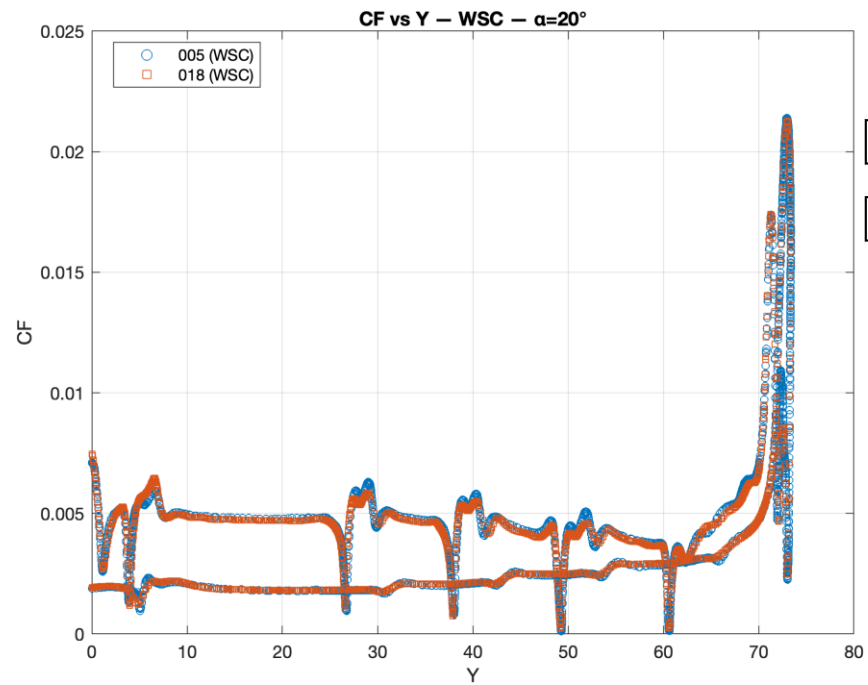
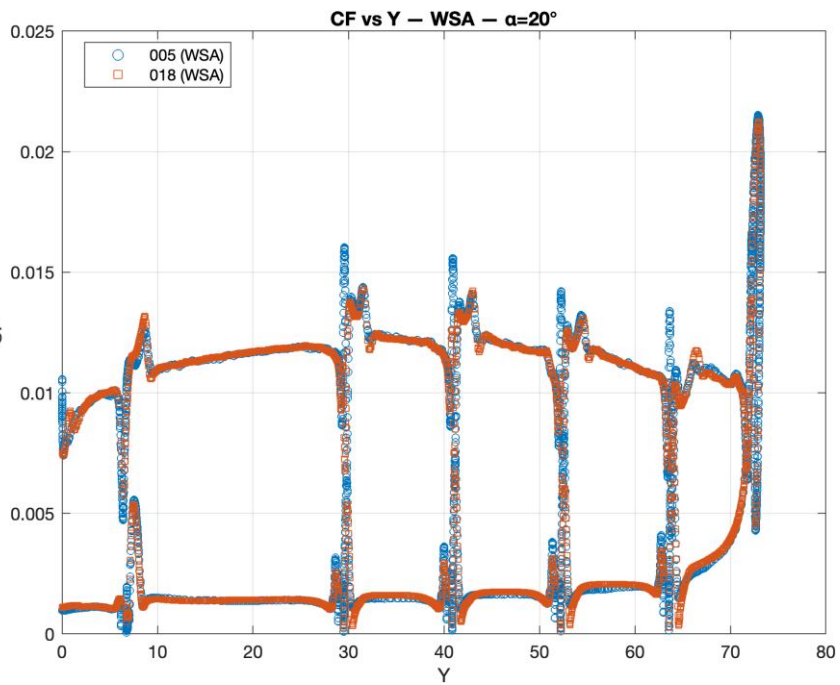




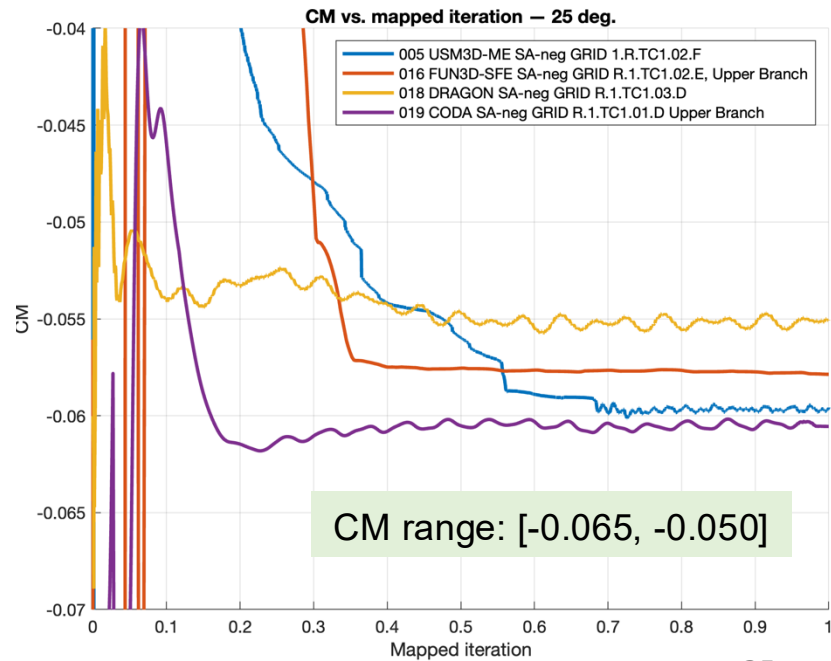
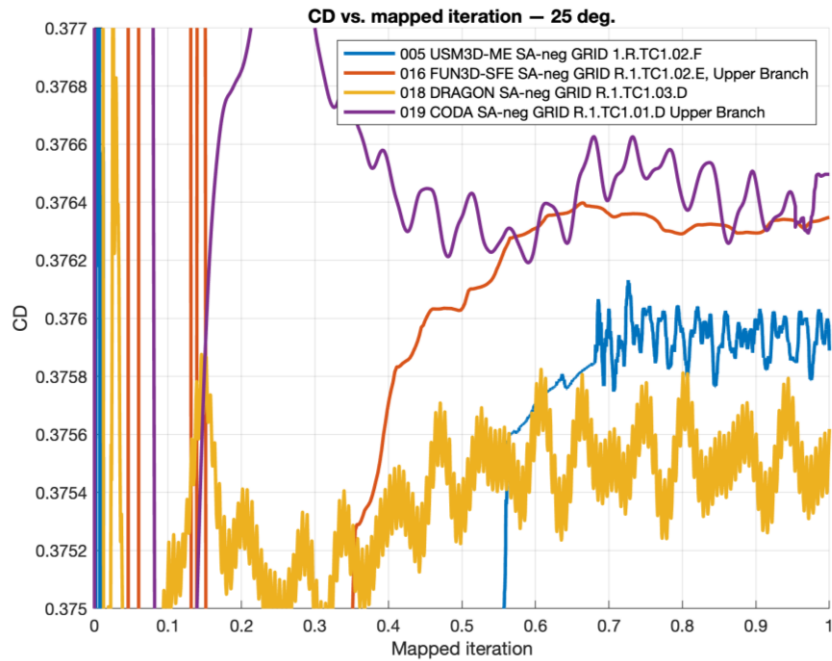
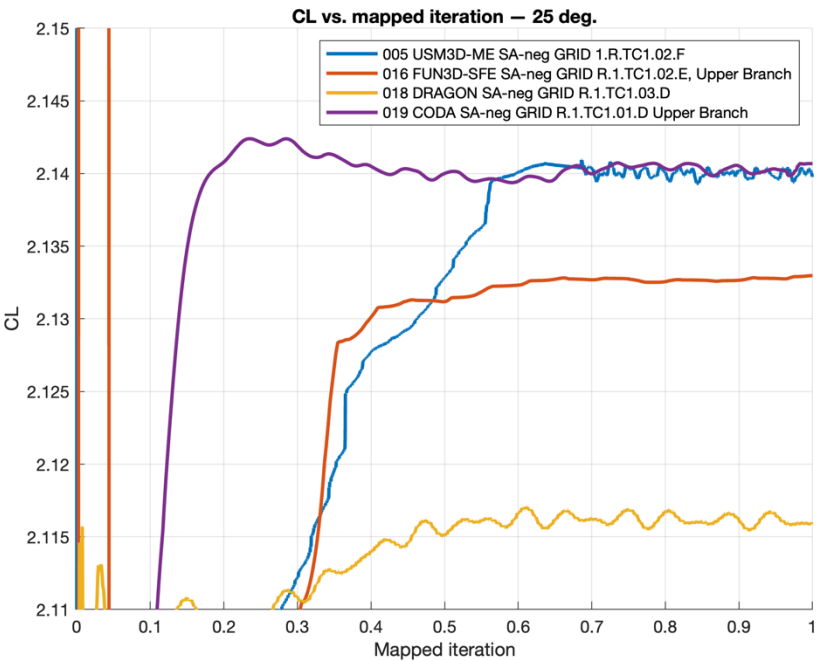
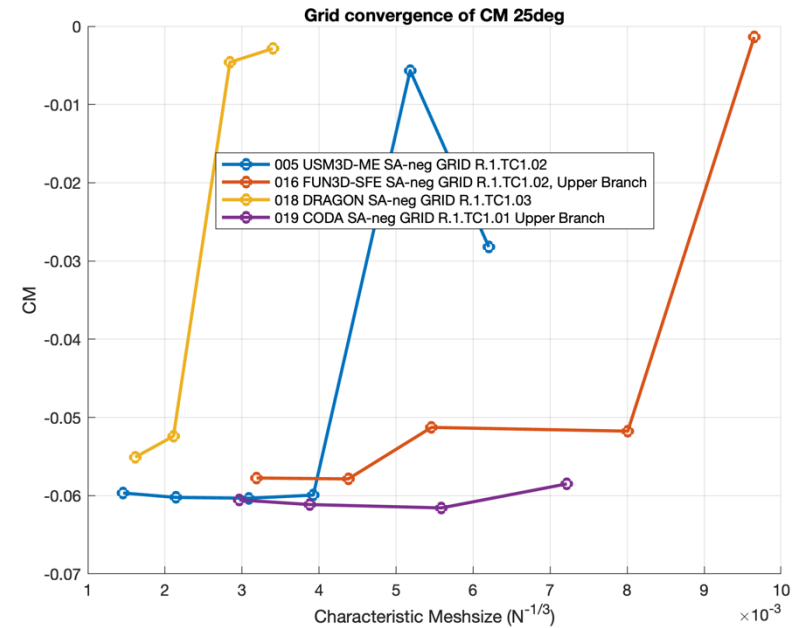
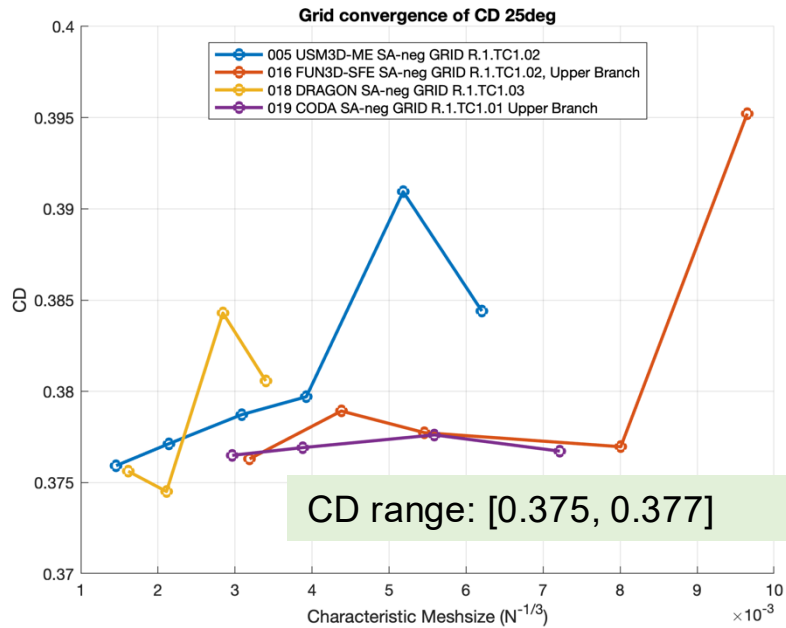
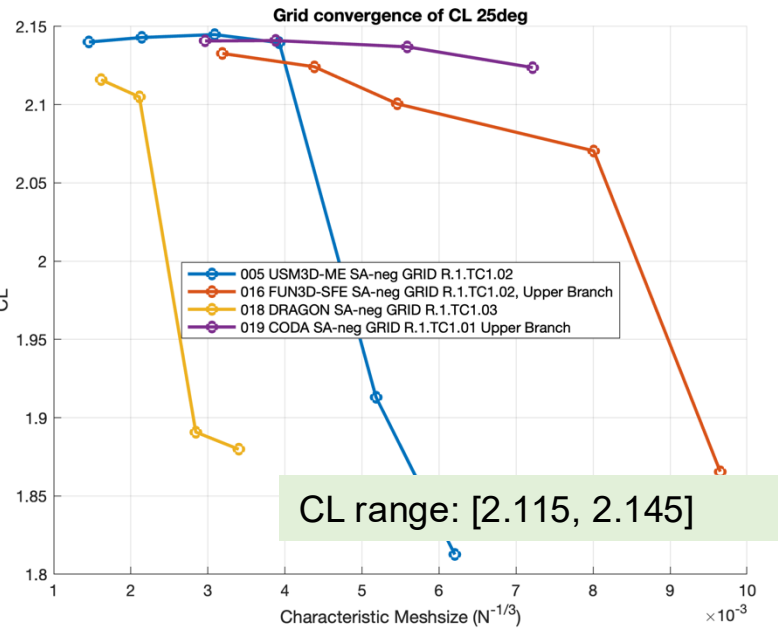


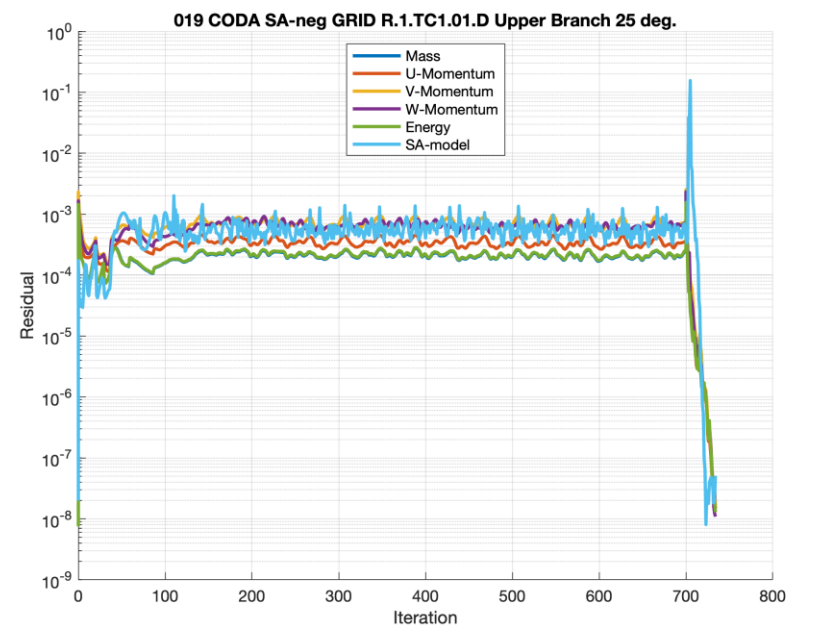
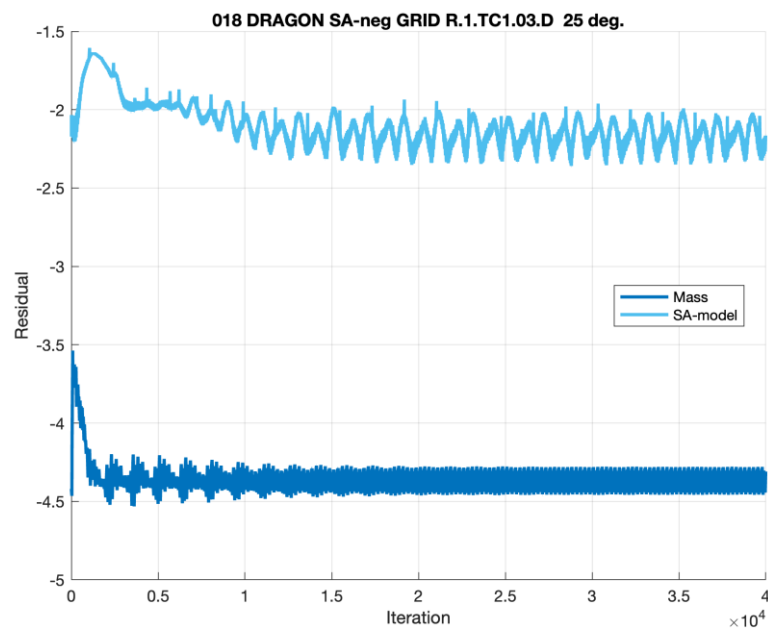
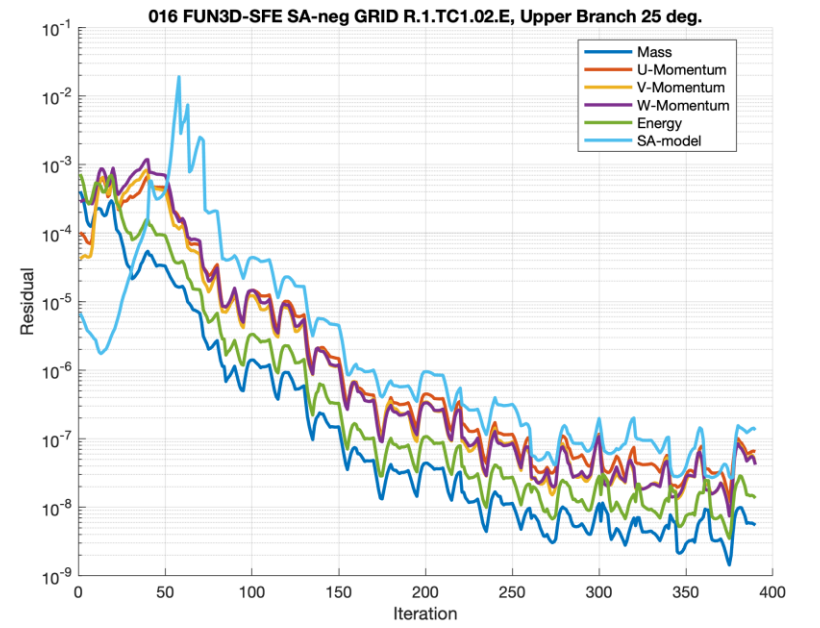
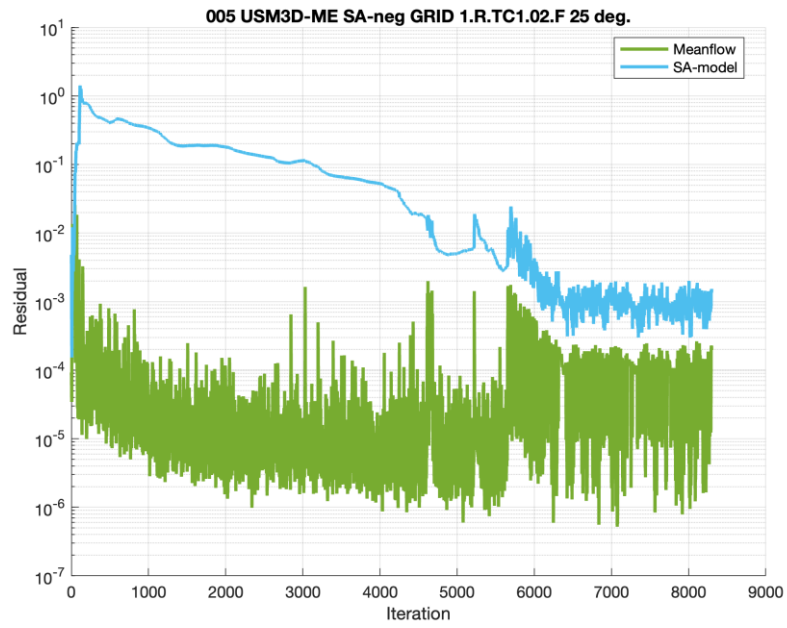
CF vs X — SBWBFB — $\alpha = 20^\circ$ **CF vs X — SCWCFC — $\alpha = 20^\circ$** **CF vs X — SDWDFD — $\alpha = 20^\circ$** **CF vs X — SGWGFG — $\alpha = 20^\circ$** 

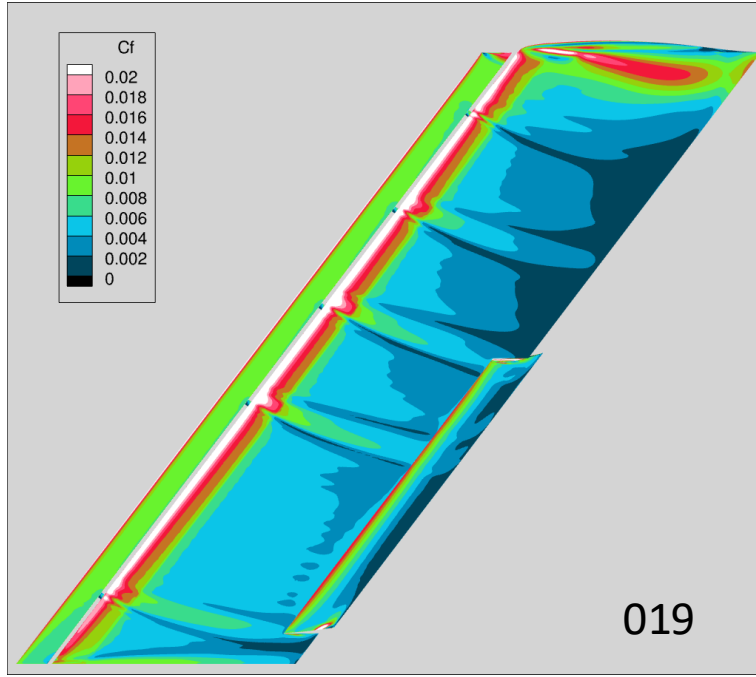
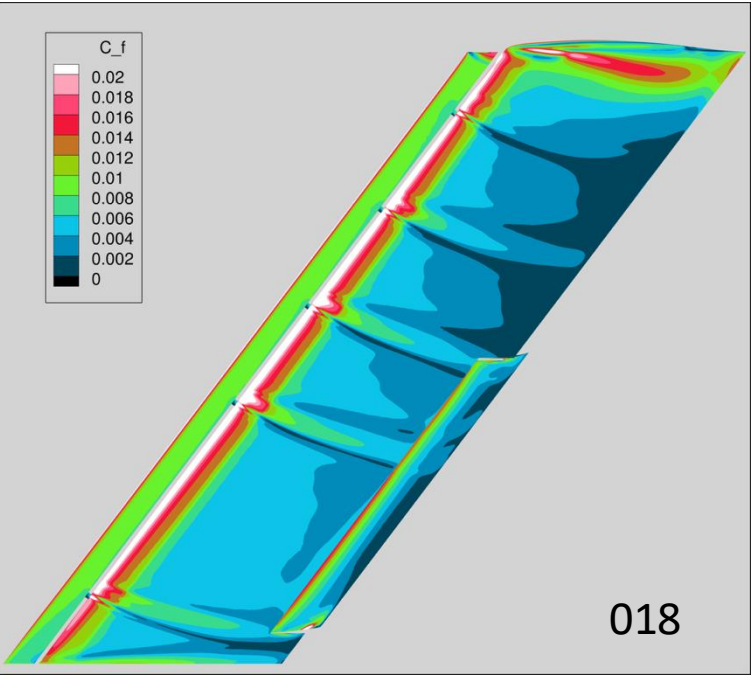
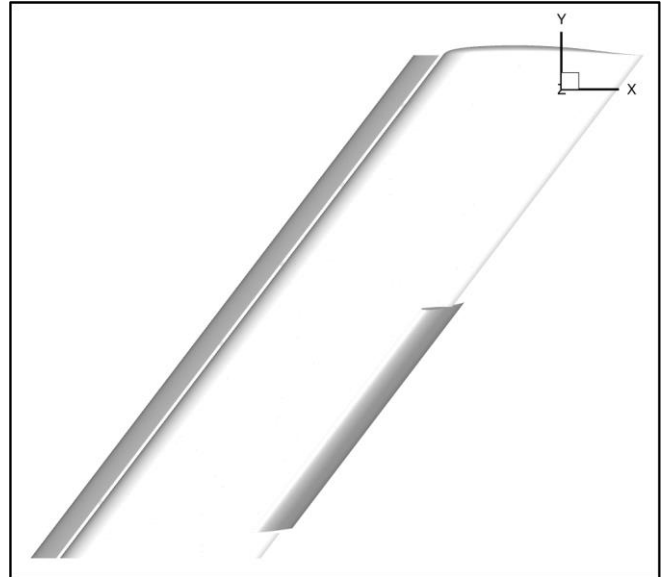
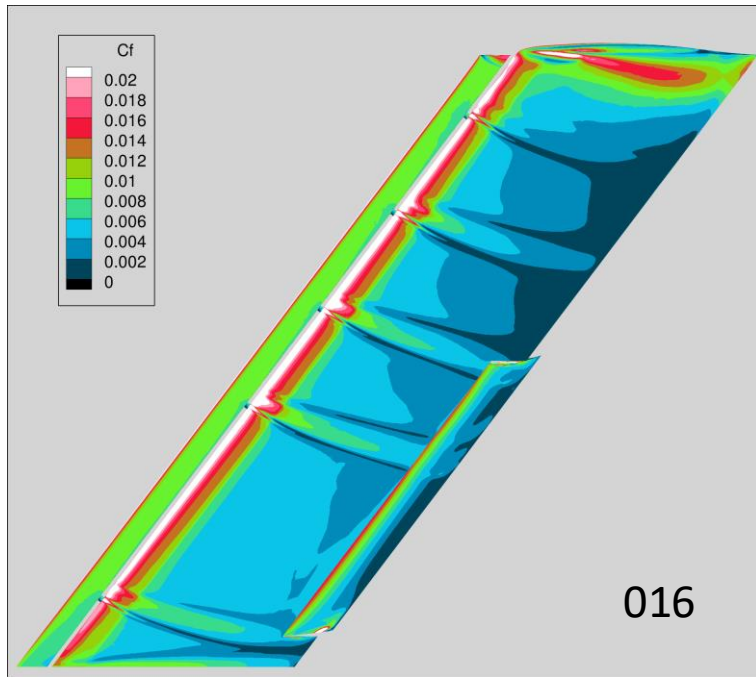
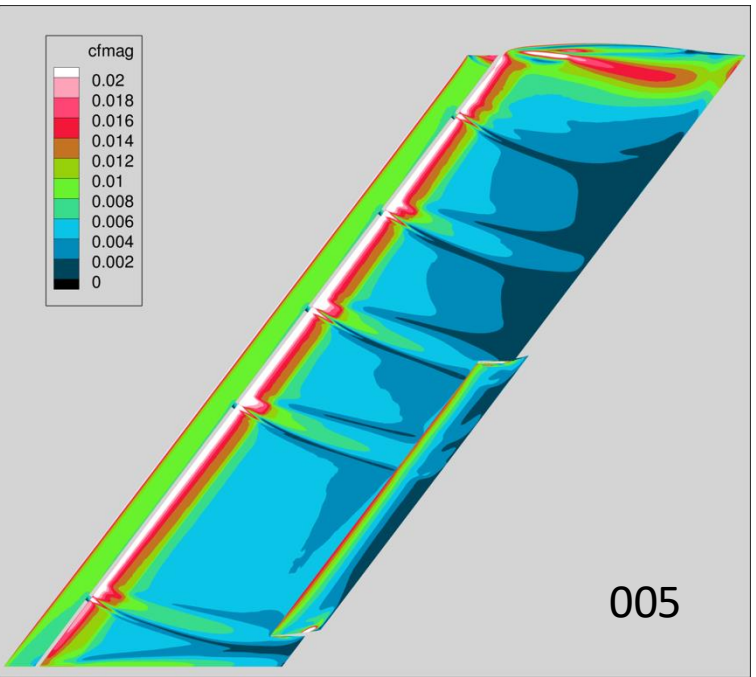


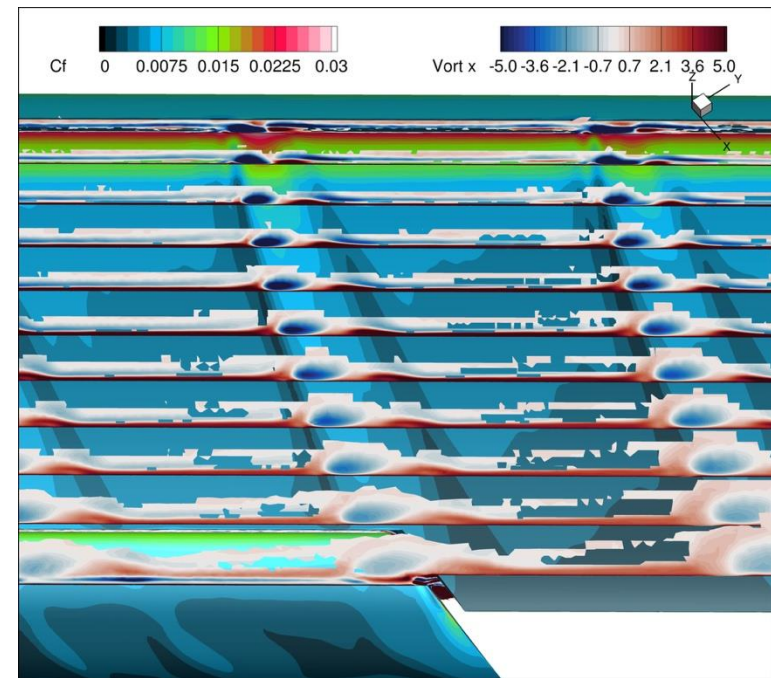
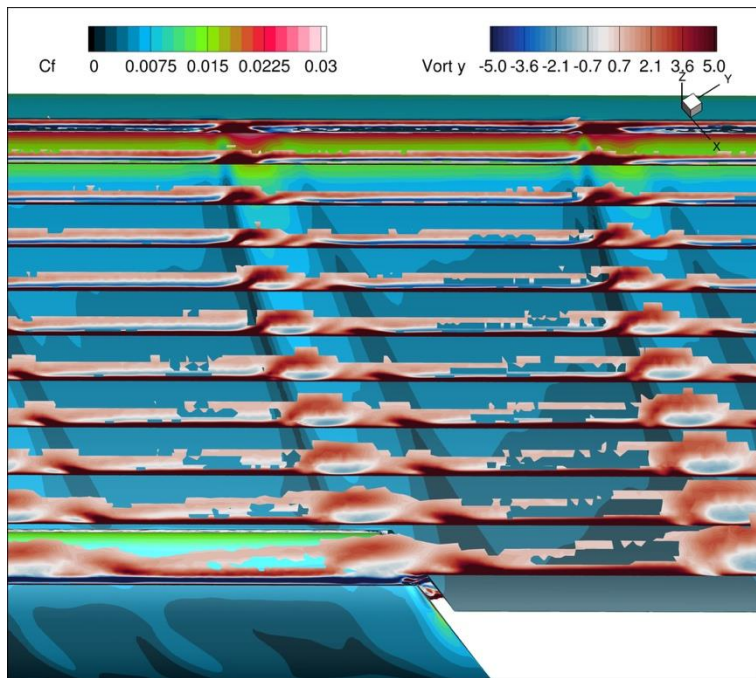
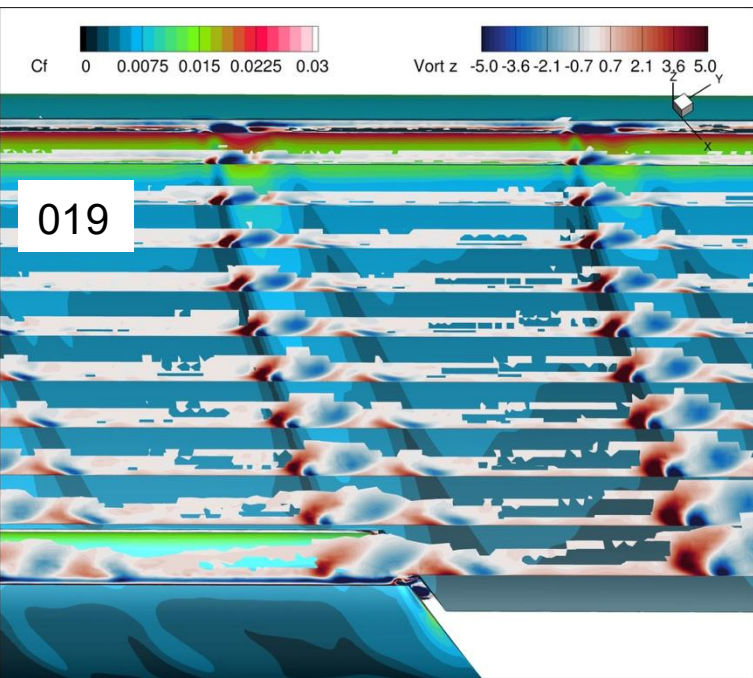
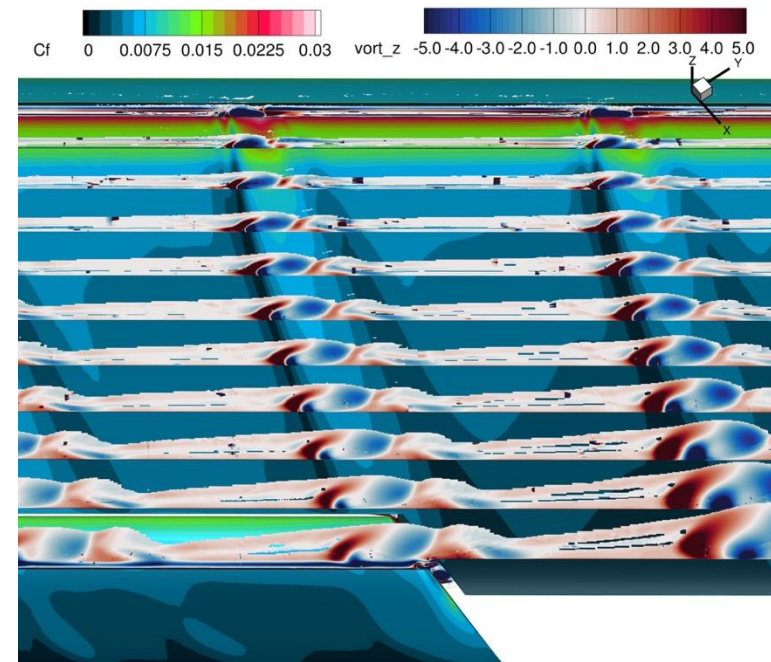
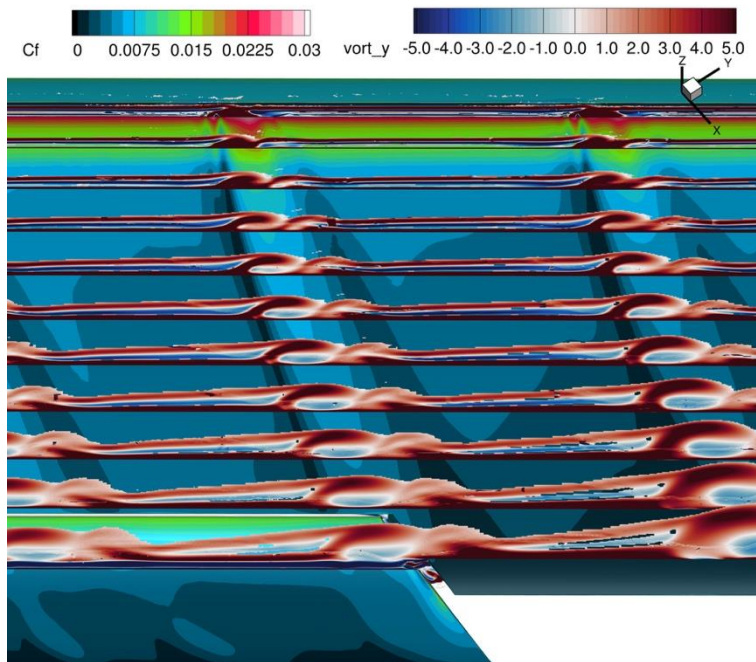
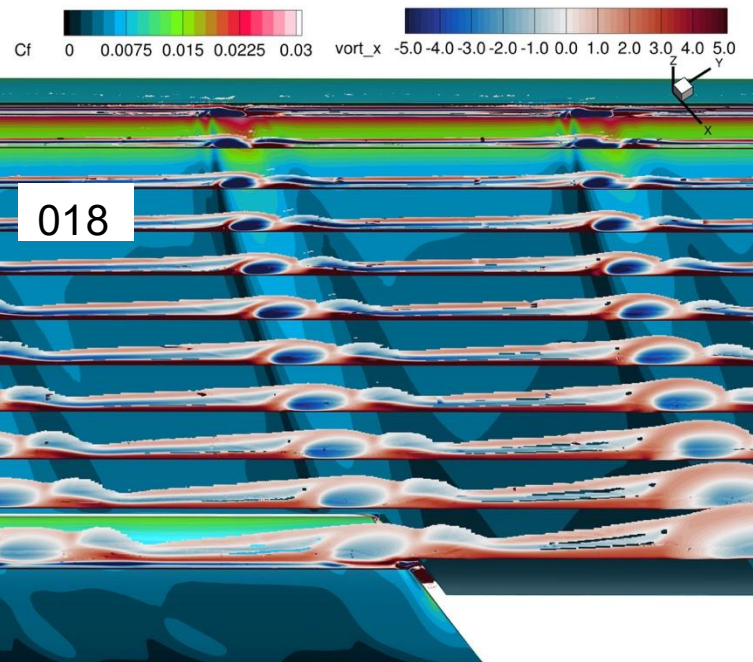


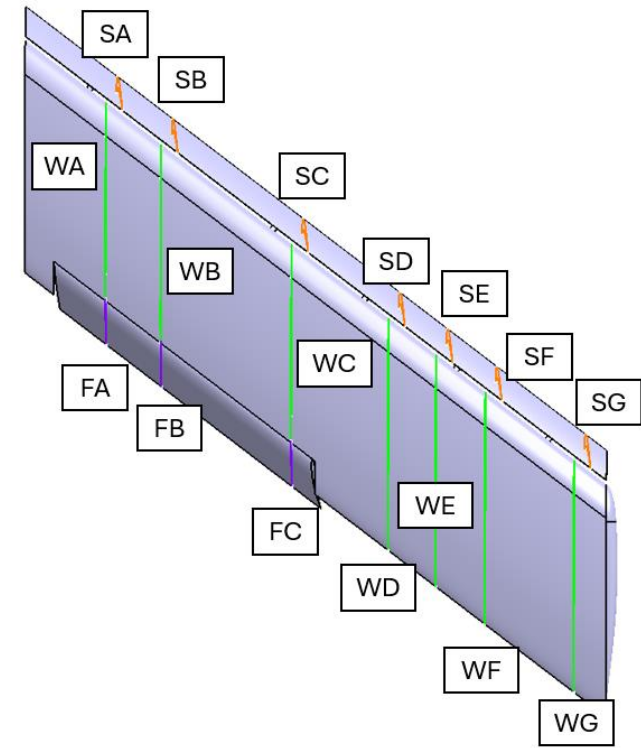
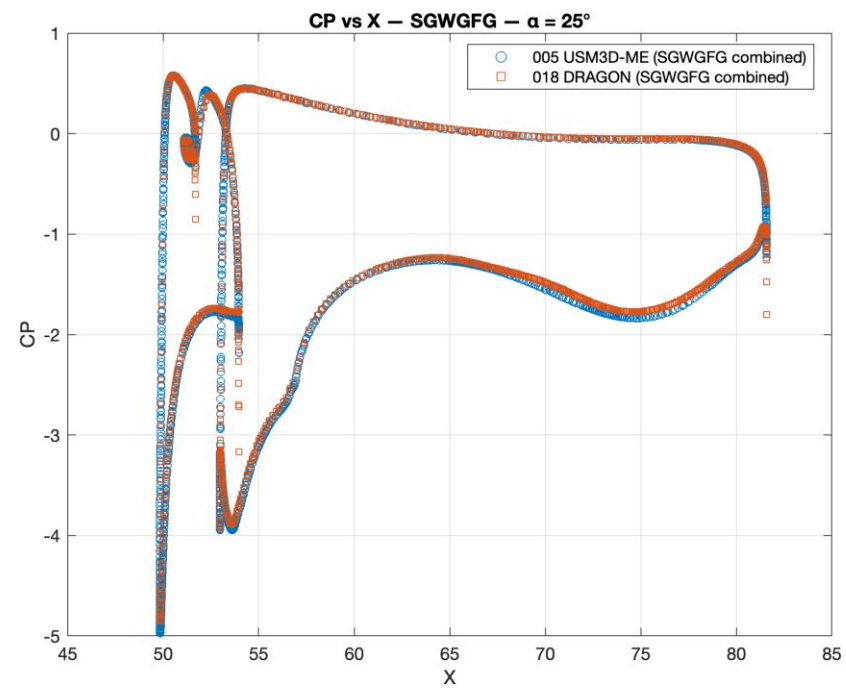
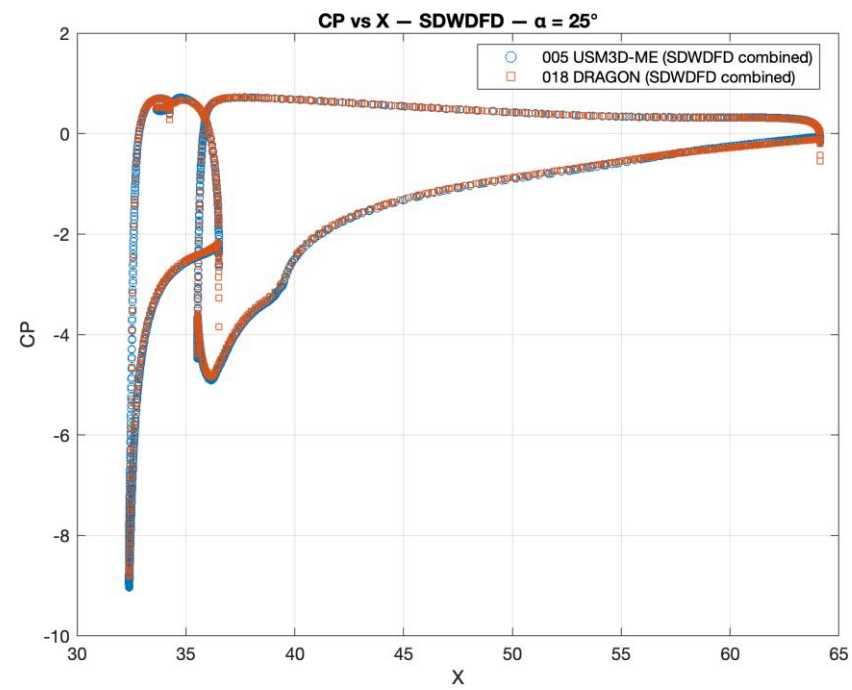
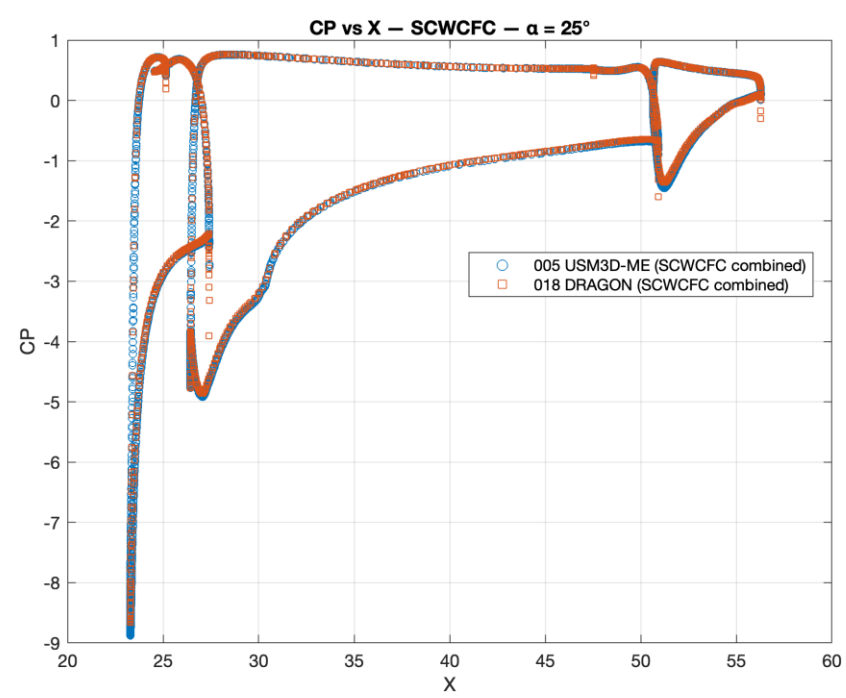
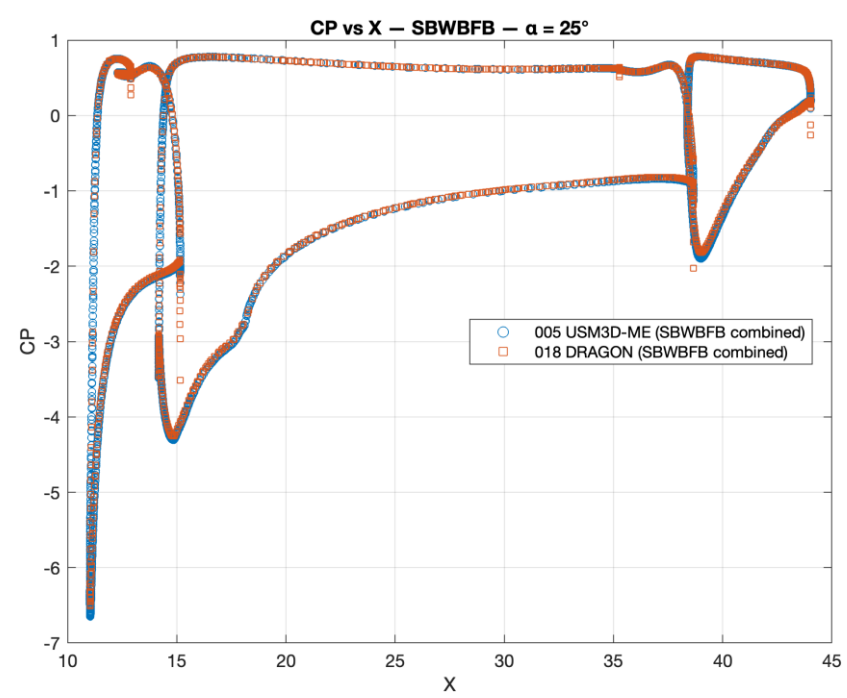
$$\alpha = 25^\circ$$

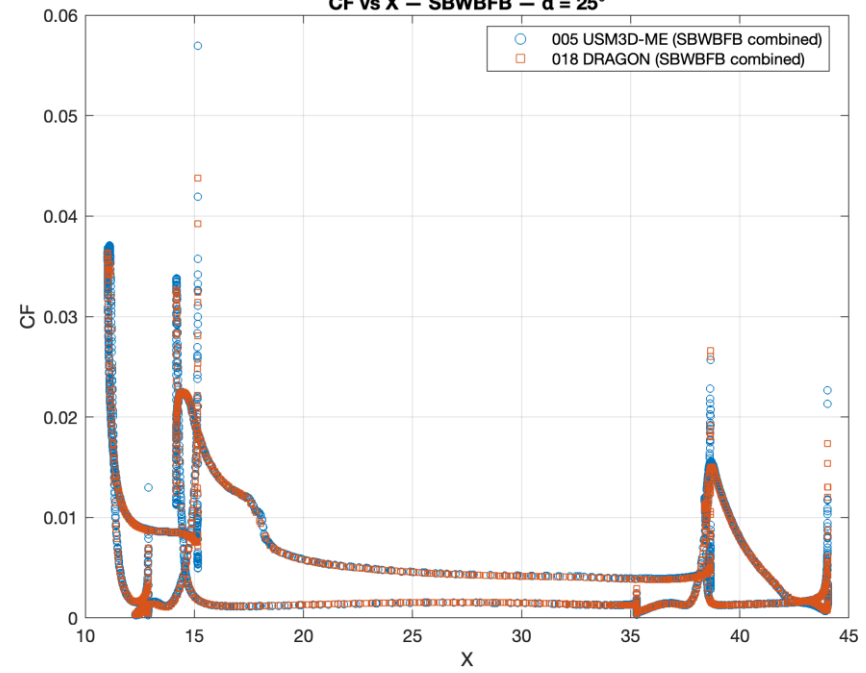
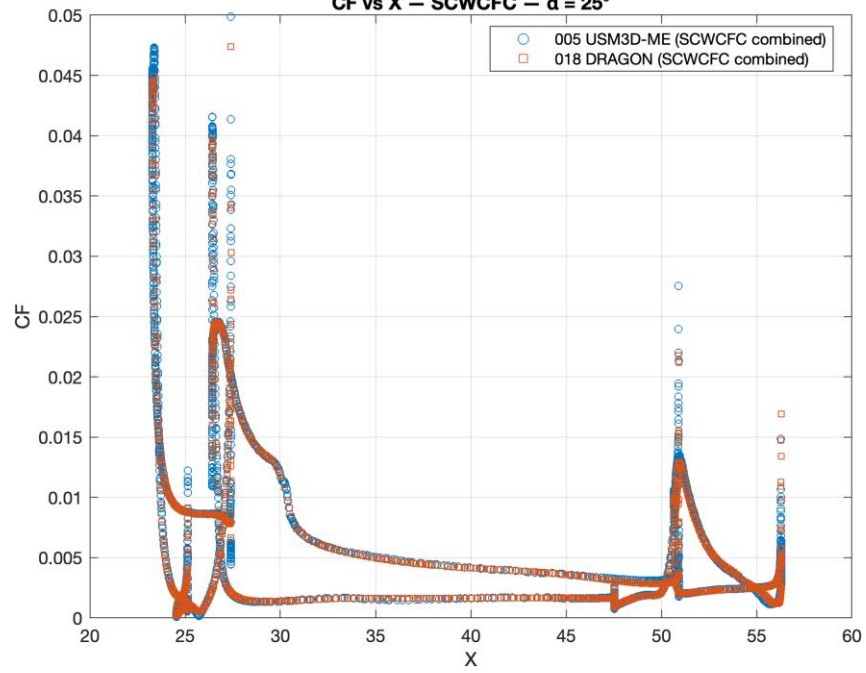
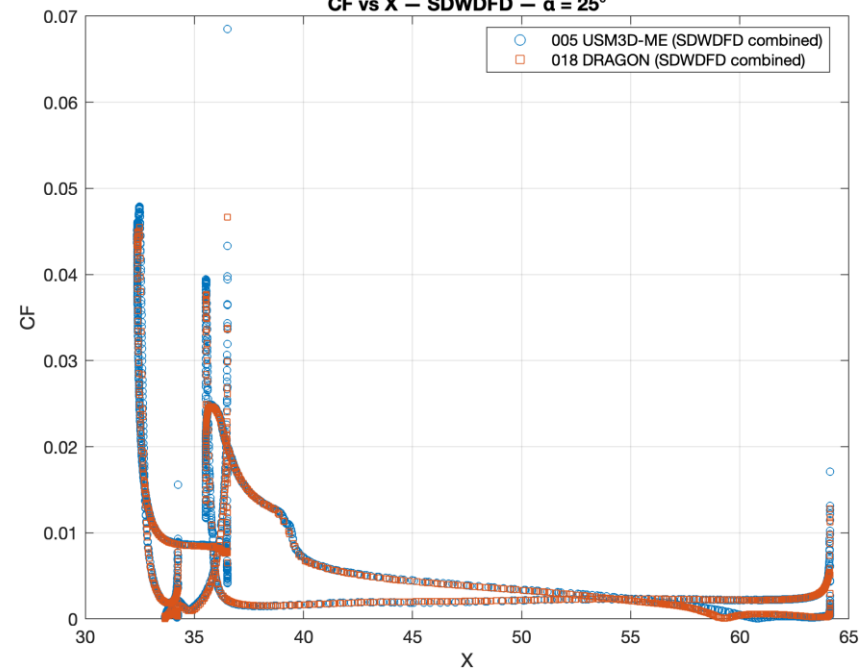
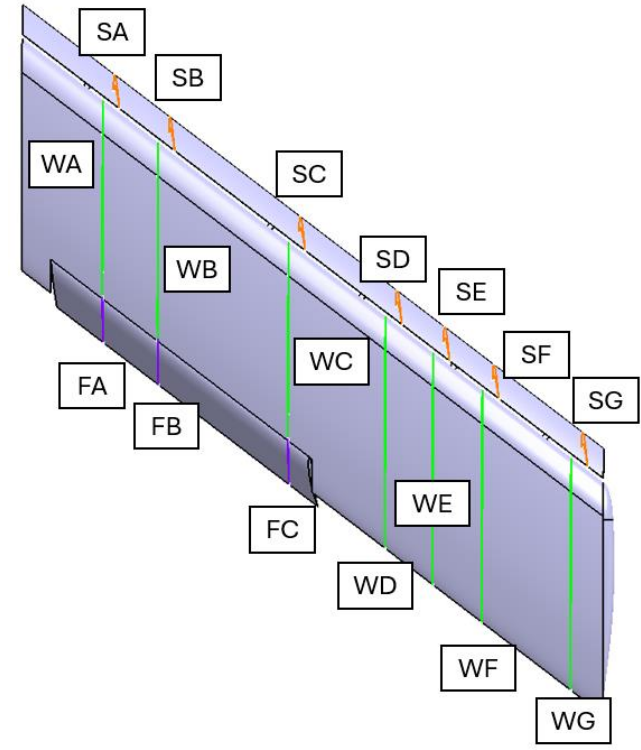
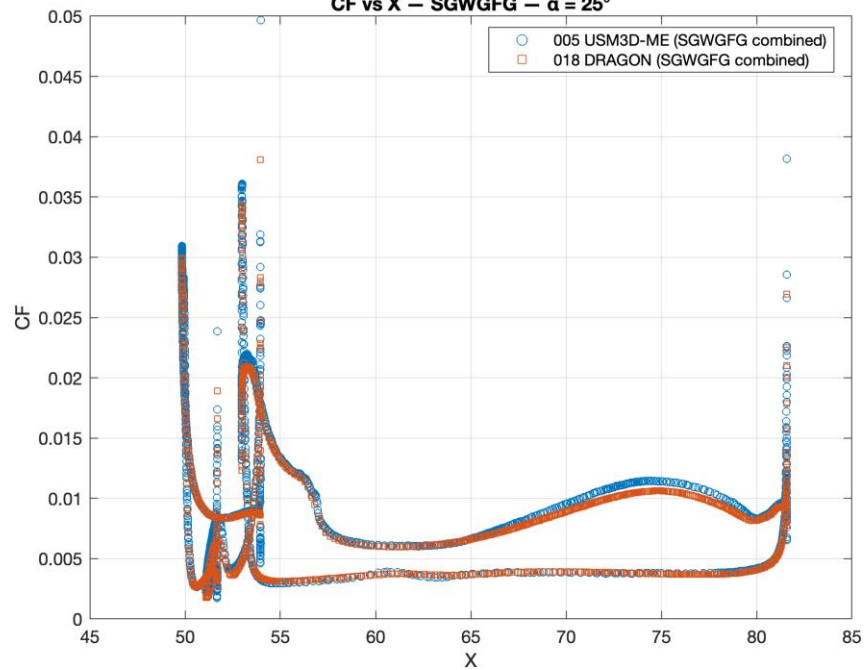


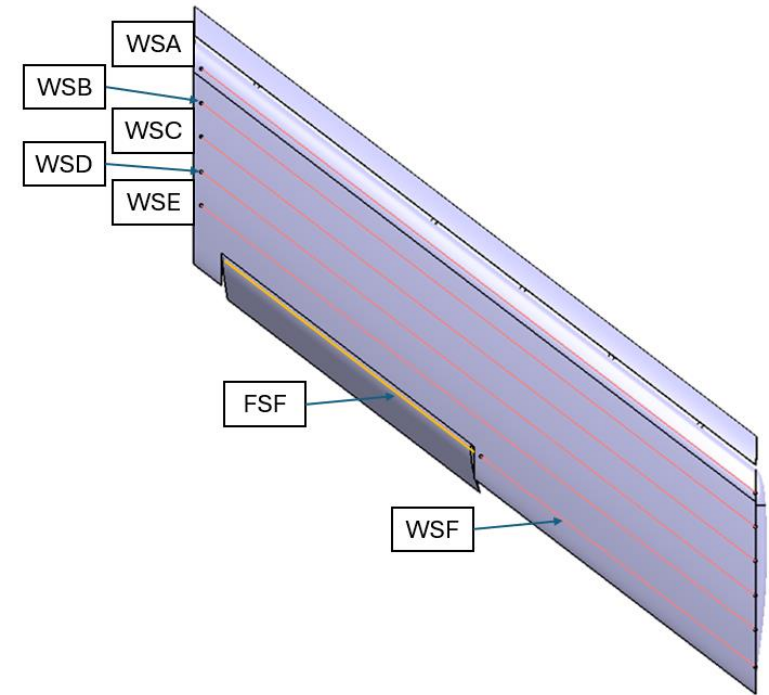
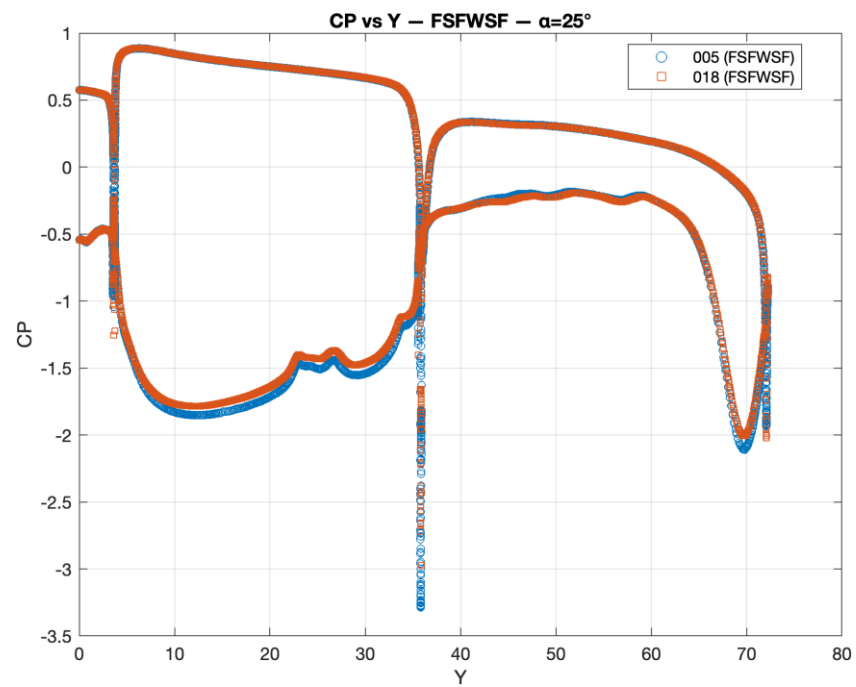
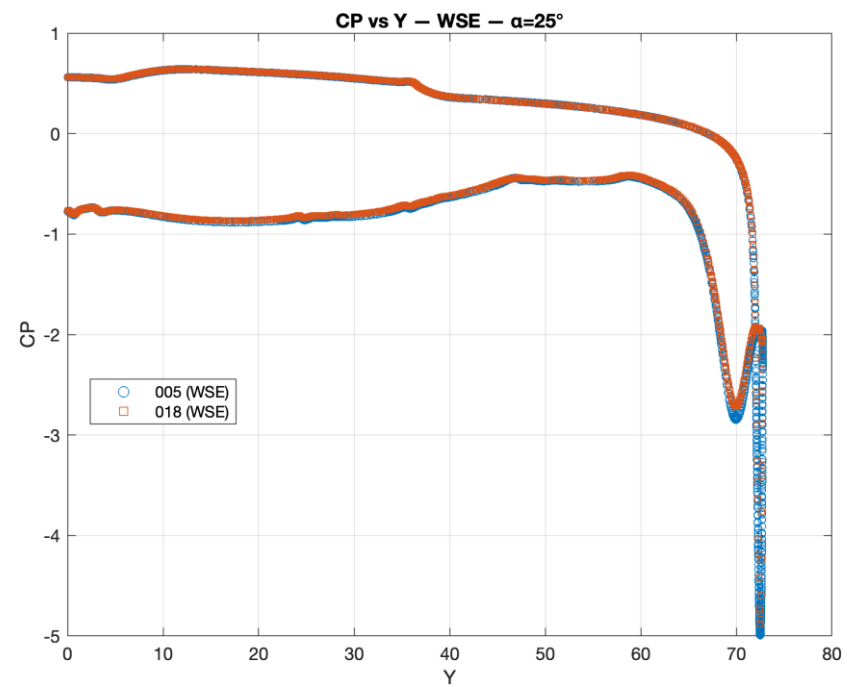
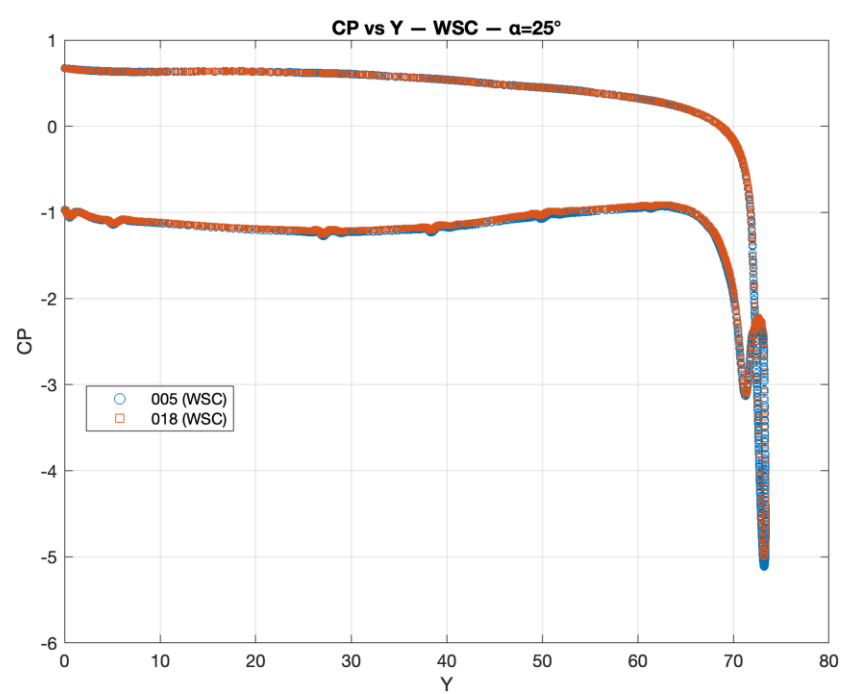
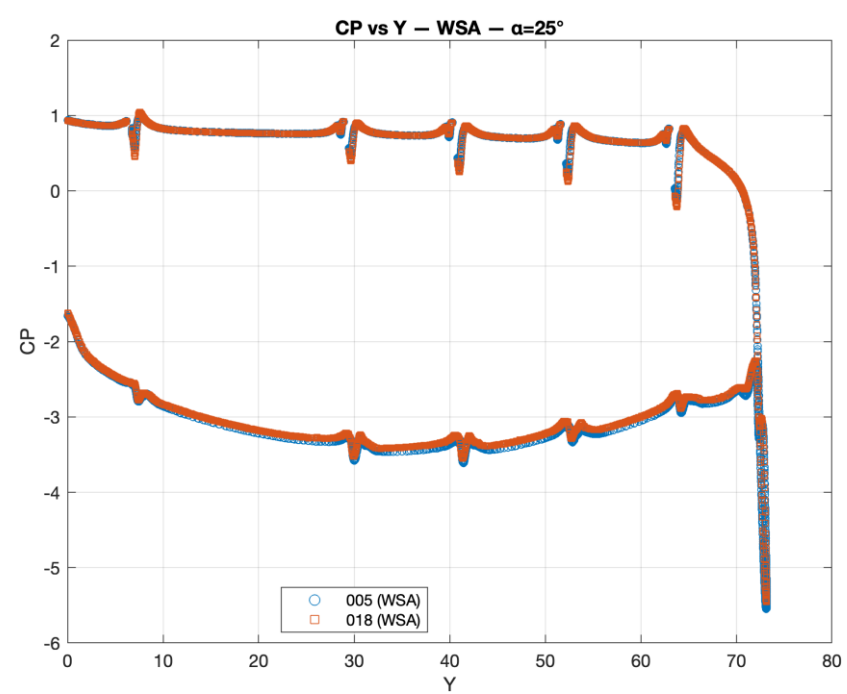


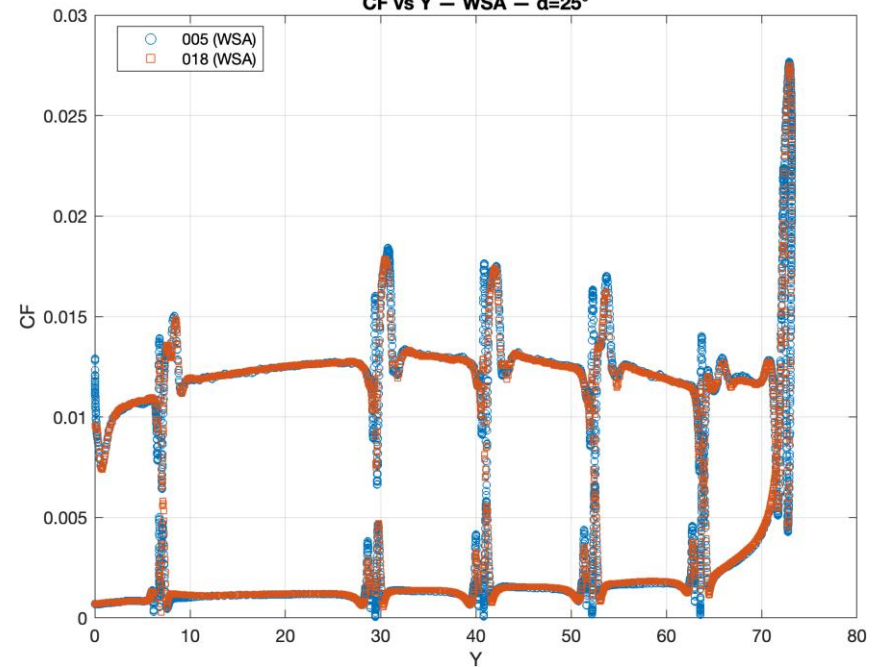
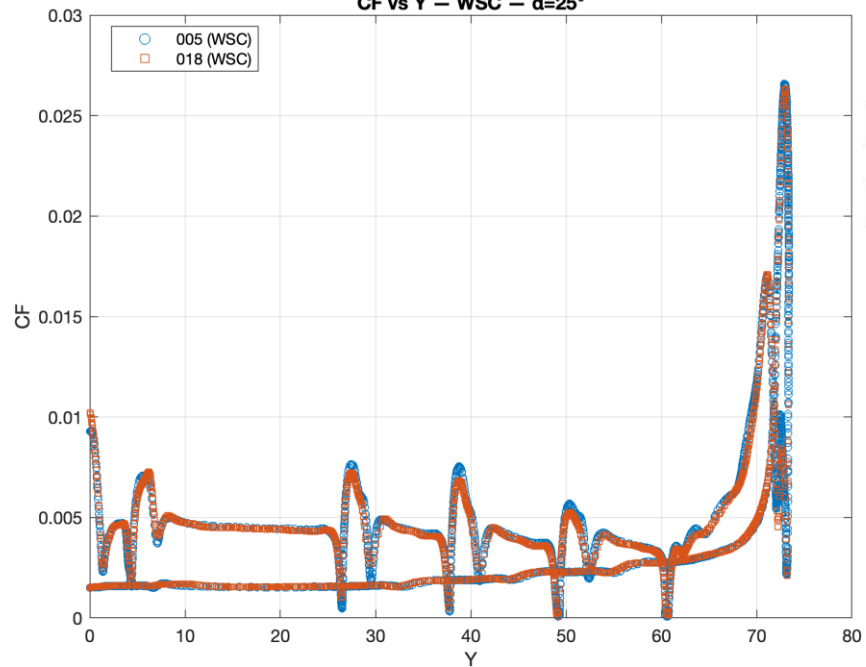
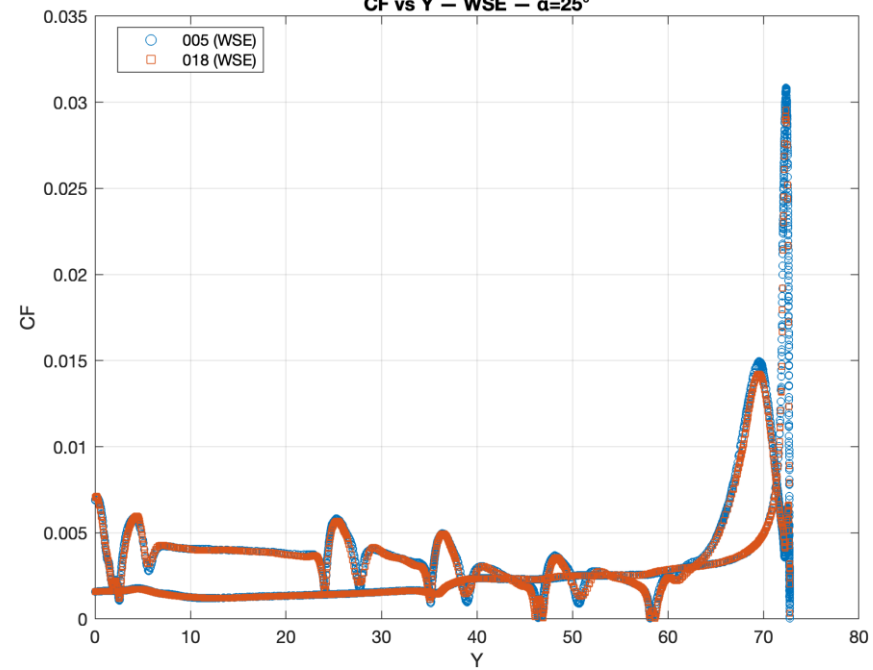
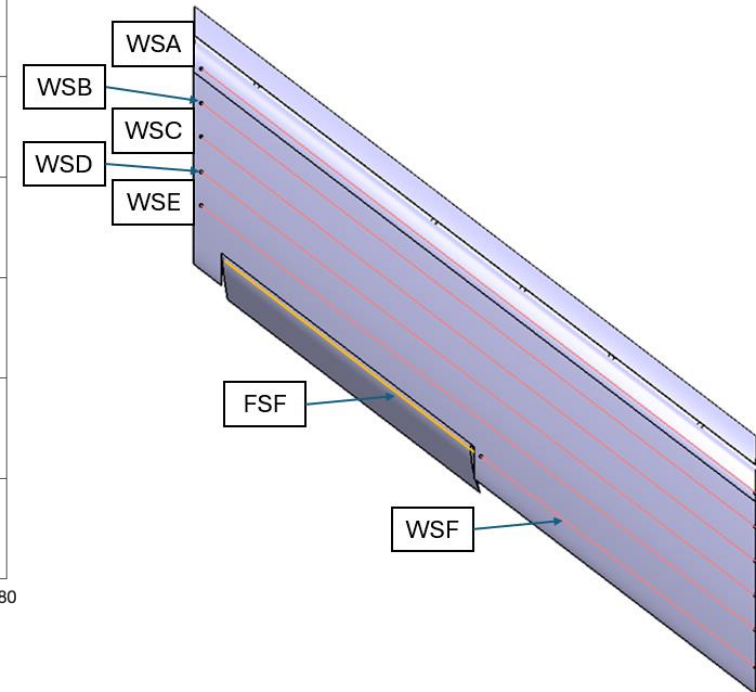
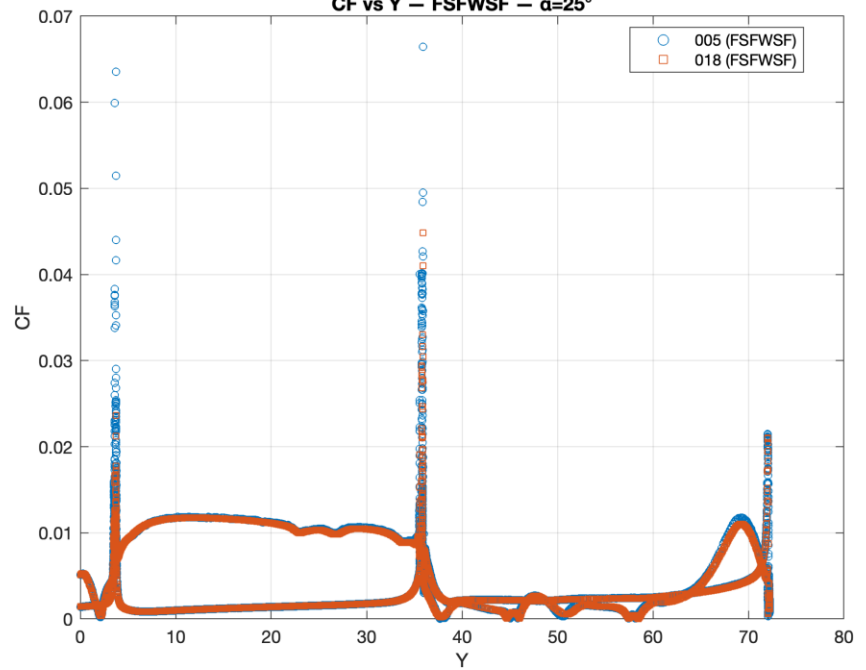






CF vs X — SBWBFB — $\alpha = 25^\circ$ **CF vs X — SCWCFC — $\alpha = 25^\circ$** **CF vs X — SDWDFD — $\alpha = 25^\circ$** **CF vs X — SGWGFG — $\alpha = 25^\circ$** 



CF vs Y – WSA – $\alpha=25^\circ$ **CF vs Y – WSC – $\alpha=25^\circ$** **CF vs Y – WSE – $\alpha=25^\circ$** **CF vs Y – FSFWSF – $\alpha=25^\circ$** 

Questions, Comments,
Suggestions?