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FaSTARによる 30P30Nの定常・非定常解析

Steady and Unsteady Computation of 30P30N by FaSTAR Code

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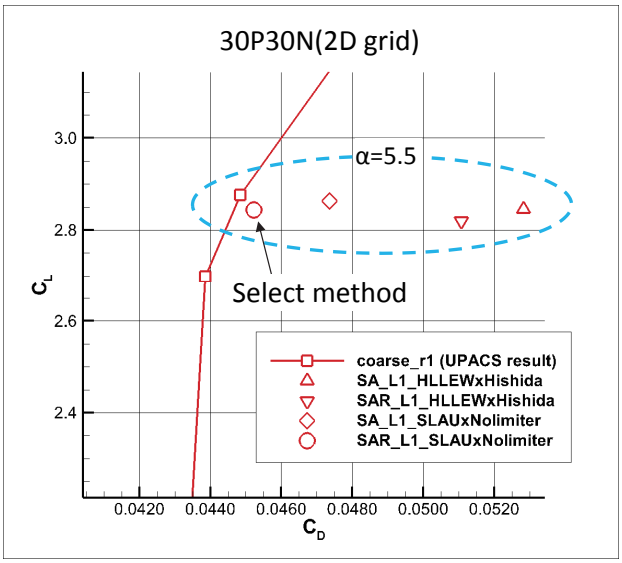
Case 1,2 Computational Method

- Flow solver: FaSTAR
  - Grid: Provided
    - 2D(L1~L5), 2.5D(L2)
    - 30P30N, 30P35N
  - Turbulence model: SA-noft2-R
    - Steady: RANS
    - Unsteady: DDES
  - Discretization: Cell-Center
  - Inviscid flux: SLAU
  - Reconstruction: U-MUSCL(χ=0.5)
  - Gradient: GLSQ
  - Slope limiter: Not use
  - Time integration: LU-SGS
    - Steady: Local time stepping or Global time stepping
    - Unsteady: Dual time stepping
  - Boundary Conditions:
    - Spanwise end surfaces: Periodic



M. Murayama et al., BANC-IV Category7

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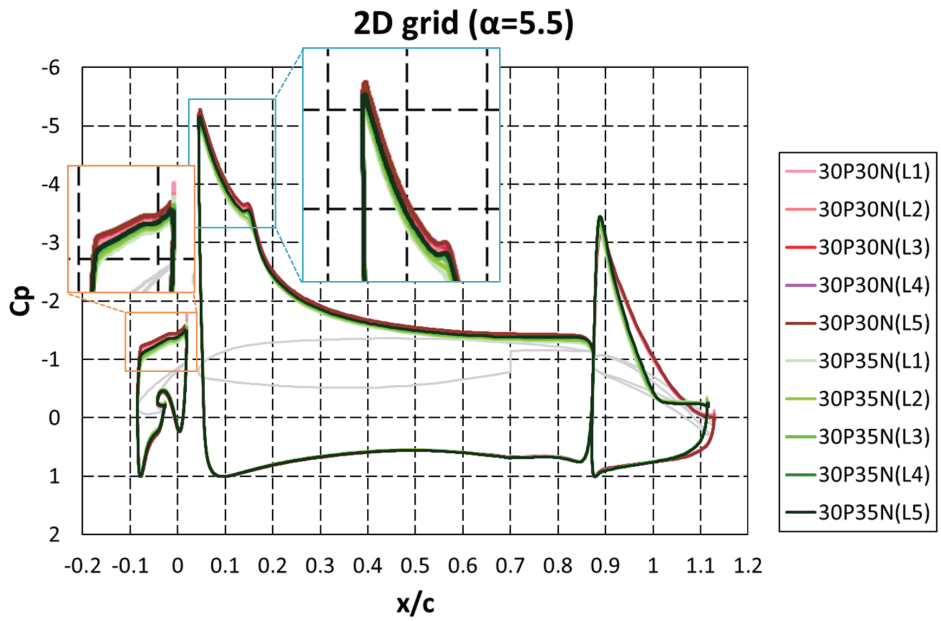
Cp(30P30N vs 30P35N)



- Cp of 30P35N is slightly smaller than 30P30N at Slat and Main-wing.
- This trend is similar for each grids(L1~L5).

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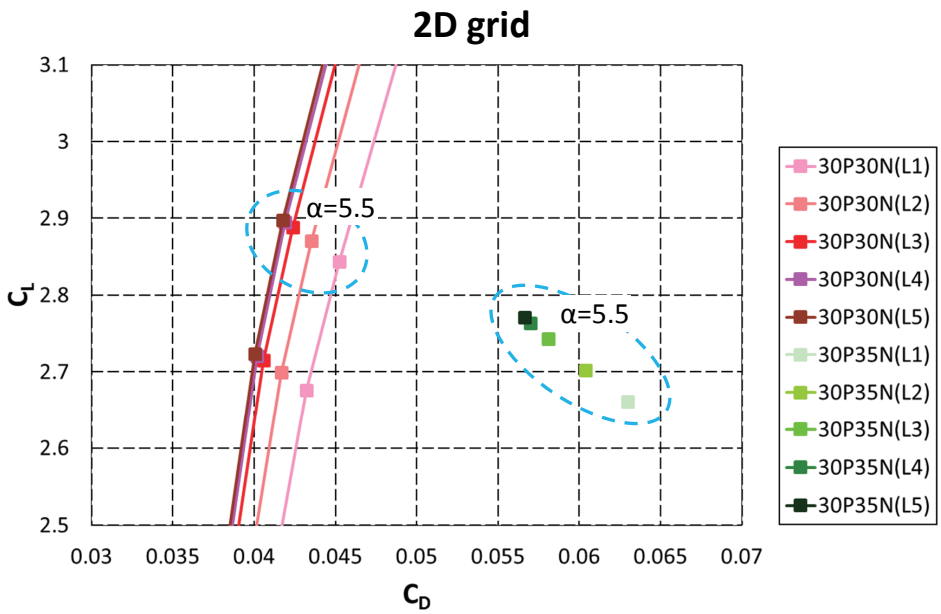
CL-CD(30P30N vs 30P35N)



- Difference(L2): CD about 170 cnt, CL about 6%
- 30P35N's results vary widely in each grids due to large separation at Flap.

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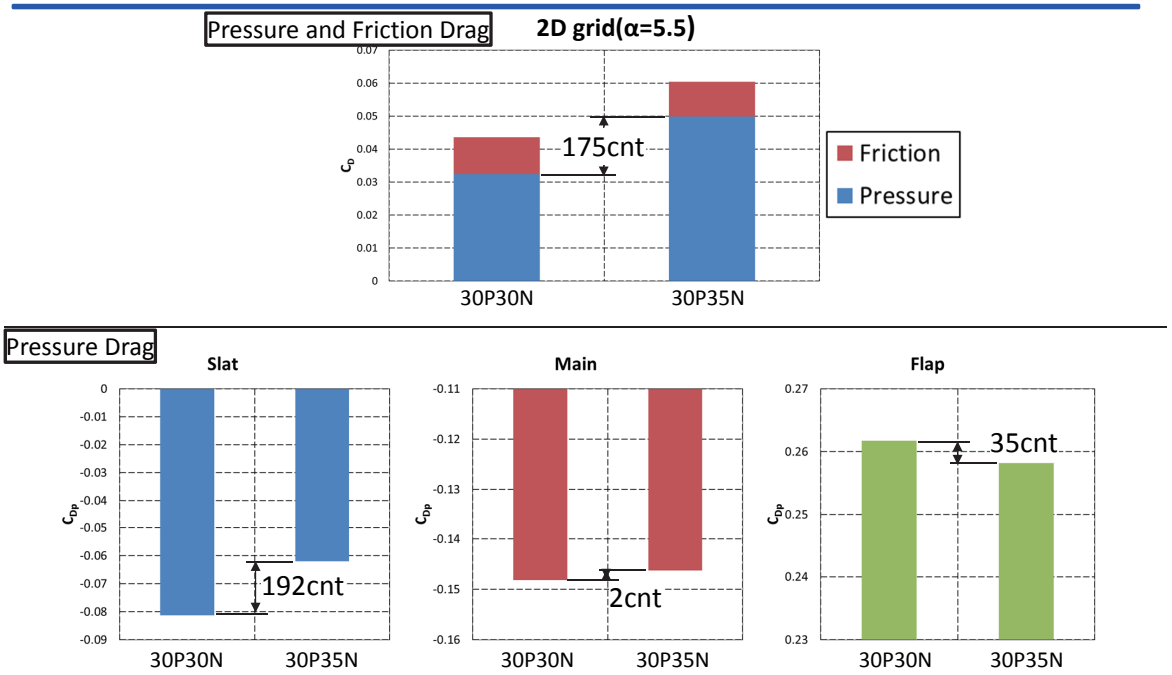
The Caution of the CD's difference



- The difference of CD is almost due to Slat's pressure drag.

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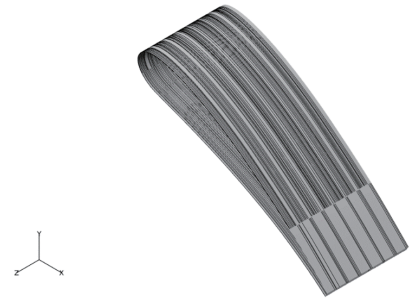
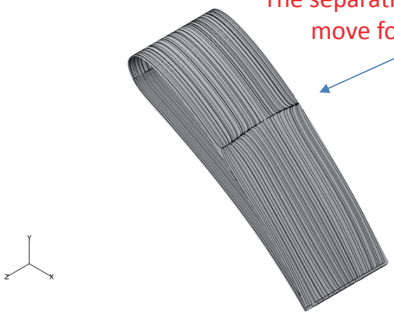
Surface flow of Flap (2.5D grid, α=5.5)

30P30N/RANS



30P35N/RANS

The separation location move forward.

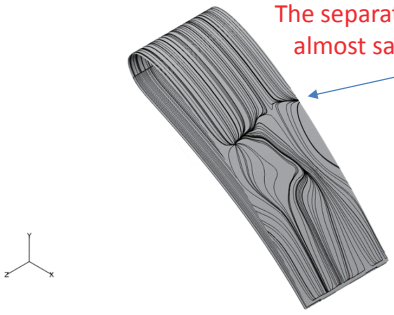


30P30N/DDES(Average)

There is no separation.

30P35N/DDES(Average)

The separation location is almost same as RANS.



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Case 3 Computational Method

- Flow solver: FaSTAR
  - Grid: Provided 2.5D 30P30N L2
  - Angle of Attack: 5.5deg
  - Turbulence model: SA-noft2-R DDES
  - Discretization: Cell-Center
  - Inviscid flux: SLAU
  - Reconstruction: U-MUSCL（χ=0.5）
  - Gradient: GLSQ
  - Slope limiter: Not use
  - Time integration: LU-SGS(Dual time stepping)
    - Inner iteration number: 5, 20, 40, 80
  - Boundary Conditions:
    - Spanwise end surfaces: Periodic

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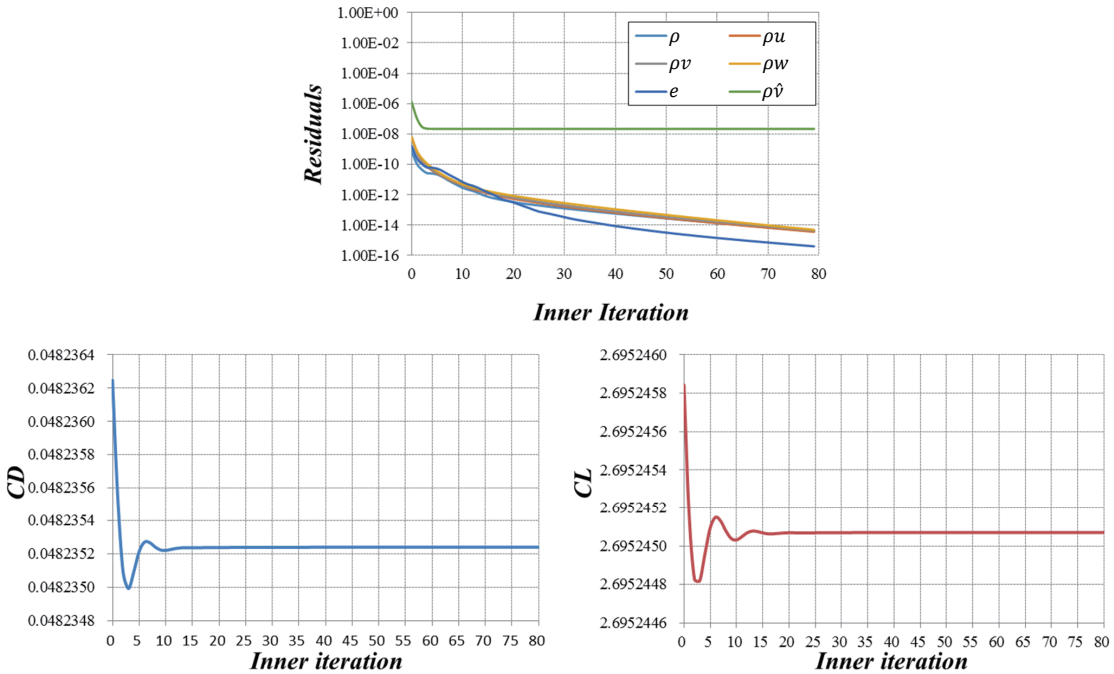
The History of Inner iteration



- The residuals gradually decrease.
- CD, CL are converged by inner iteration number 20.

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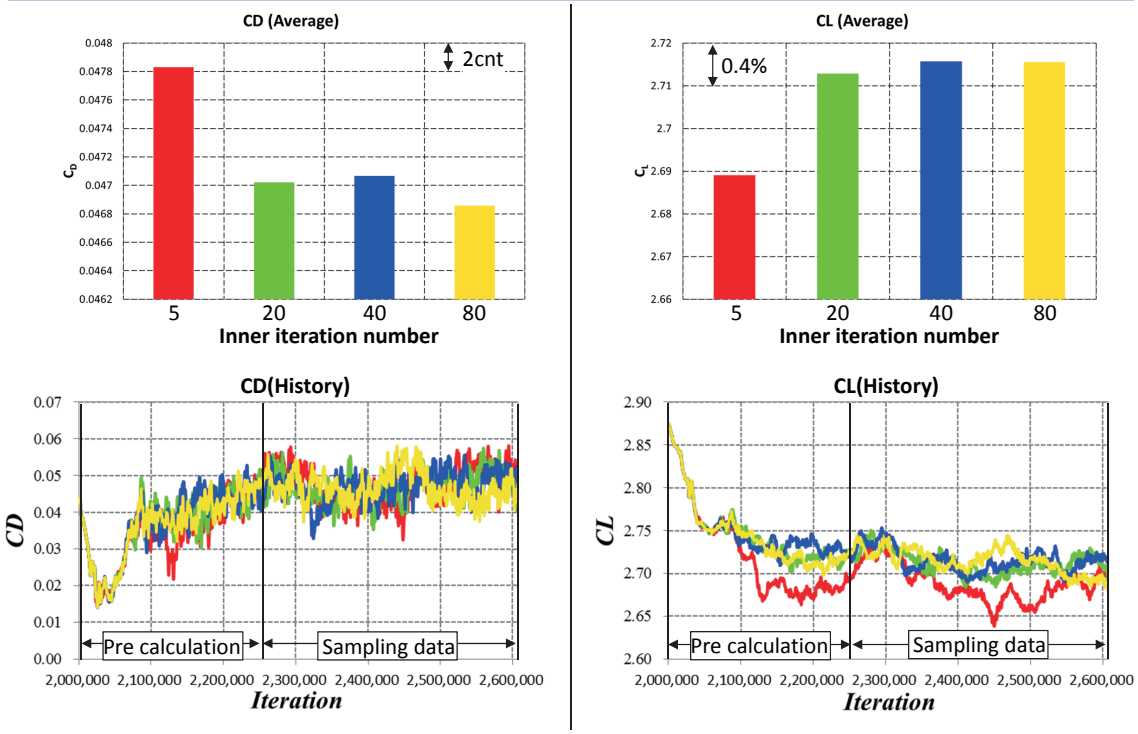
Average and the History of CD, CL



- CD, CL are converged by increasing inner iteration number.

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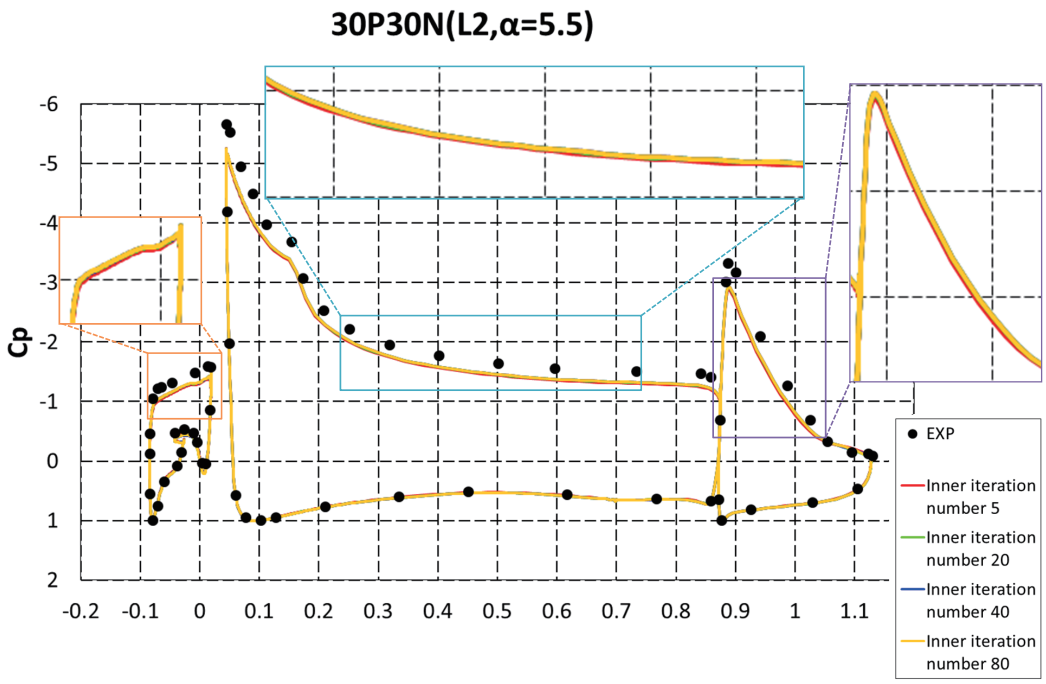
Average of Cp



- Almost same. But, Inner iteration number 5 is slightly smaller than any others.

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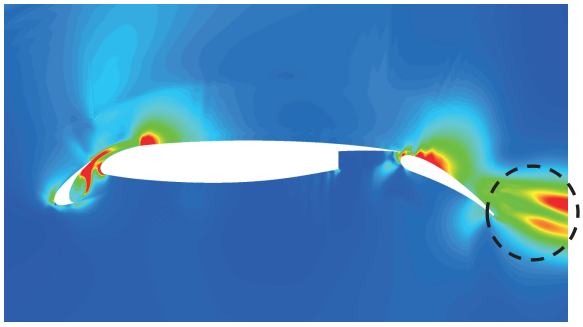
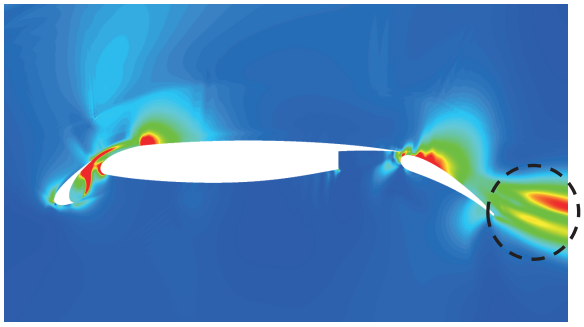
RMS of Cp

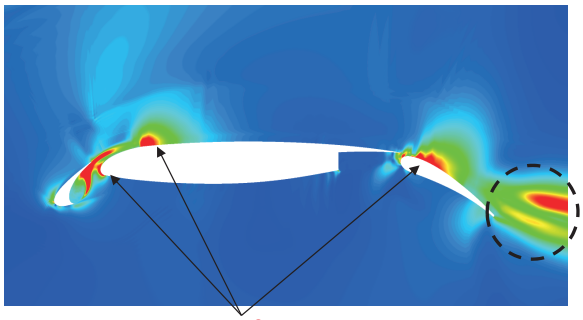
Inner iteration number 5



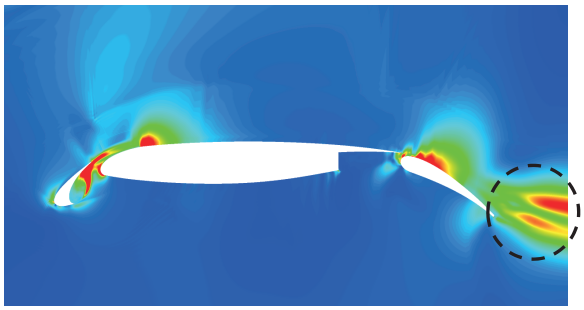
Inner iteration number 20



Inner iteration number 40



Inner iteration number 80



- These anomalous fluctuations are caused by low grid resolution? No limiter influence?
- At wake, there is a difference.

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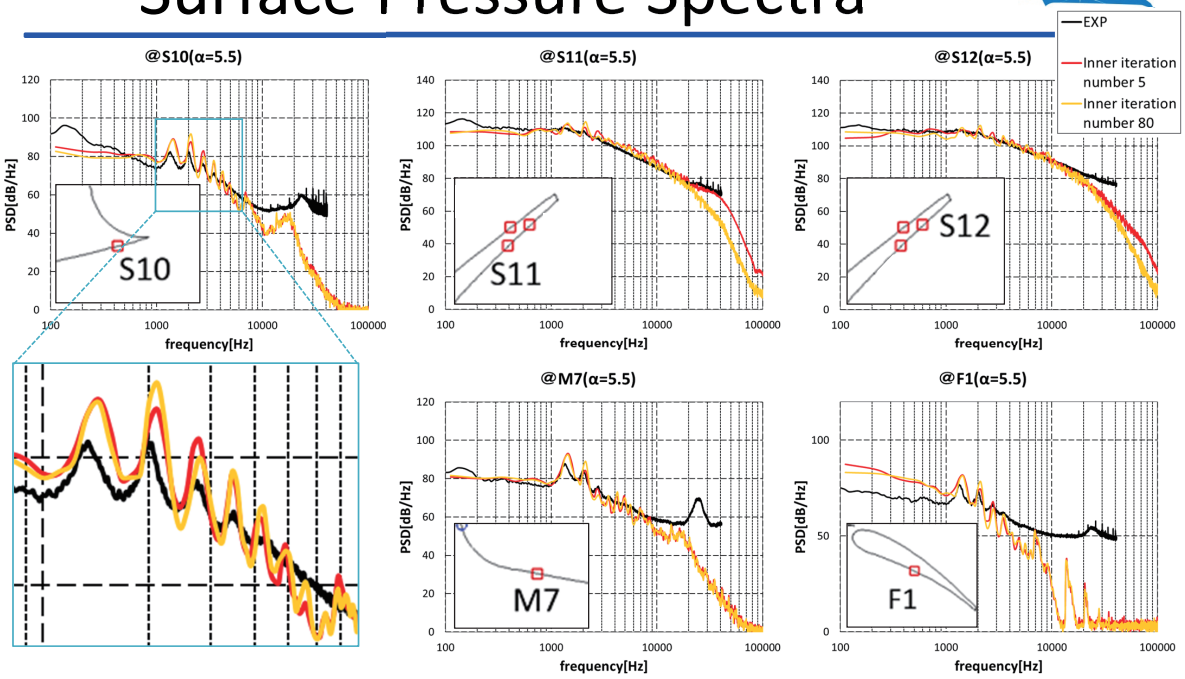
Surface Pressure Spectra



- There is little difference at NBPs and slight difference at high frequency region by inner iteration number.
- Narrow Band Peaks are similar to the EXP.

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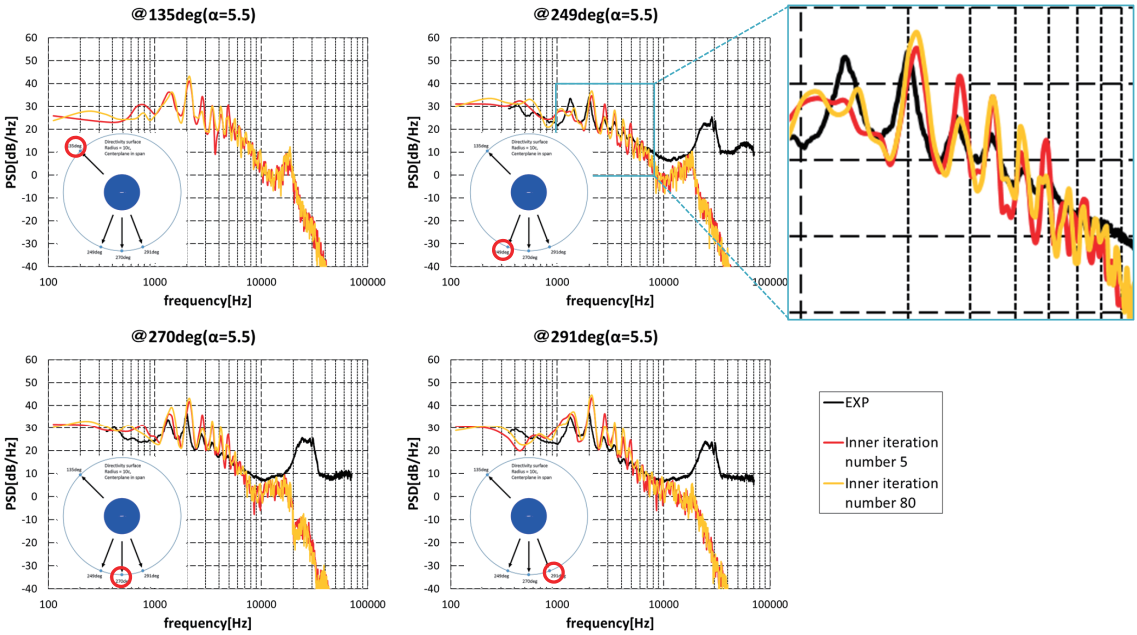
Acoustic Spectra



- There is little difference at NBPs and slight difference at high frequency region by inner iteration number.
- Narrow Band Peaks are similar to the EXP.

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Summary

- 30P30N vs 30P35N
  - Cp of 30P35N is slightly smaller than 30P30N at Slat and Main-wing.
  - 30P35N's results vary widely in each grids due to large separation at Flap.
  - The difference of CD is almost due to Slat's pressure drag.
  - 30P35N's separation location at flap move forward and DDES result is almost same as RANS.
- Comparison inner iteration number
  - The residuals gradually decrease.
  - CD, CL are converged by inner iteration number 20.
  - Average of Cp is almost same.
  - RMS of Cp, there is a difference at wake.
  - Surface Pressure Spectra and Acoustic Spectra, There is little difference at NBPs and slight difference at high frequency region.
  - Narrow Band Peaks are similar to the EXP.
- Future works
  - Improve the grid resolution.
  - Survey influence of limiter.

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