NSMB contribution to the 2nd Aeroelastic Prediction Workshop

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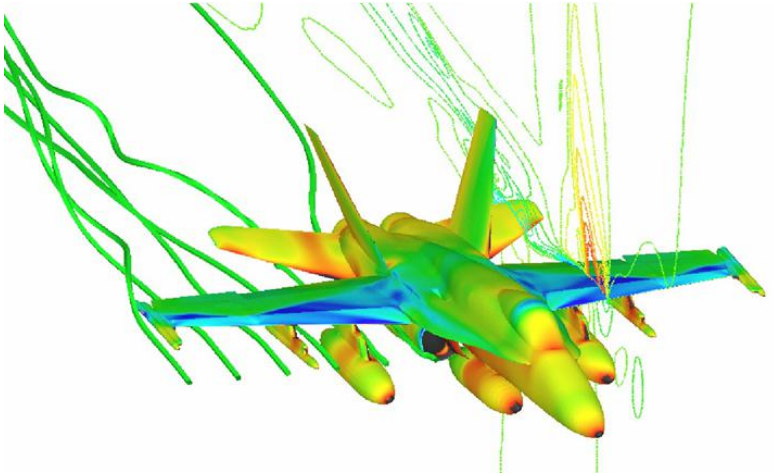
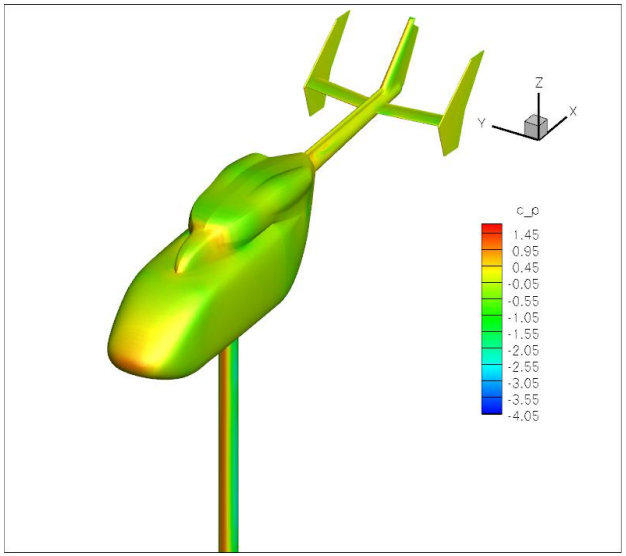
2nd Aeroelastic Prediction Workshop
2-3 January 2016, San Diego, USA

Outline

The Navier-Stokes Solver NSMB

- Both compressible and incompressible Navier-Stokes solver, multi-blocks and parallel
- Developed in the NSMB consortium which included several universities and industries
- Large application area (external/internal aerodynamics, combustion, fluid/structure interaction, chemistry, ...)
- Large choice of discretisation and numerical modeling

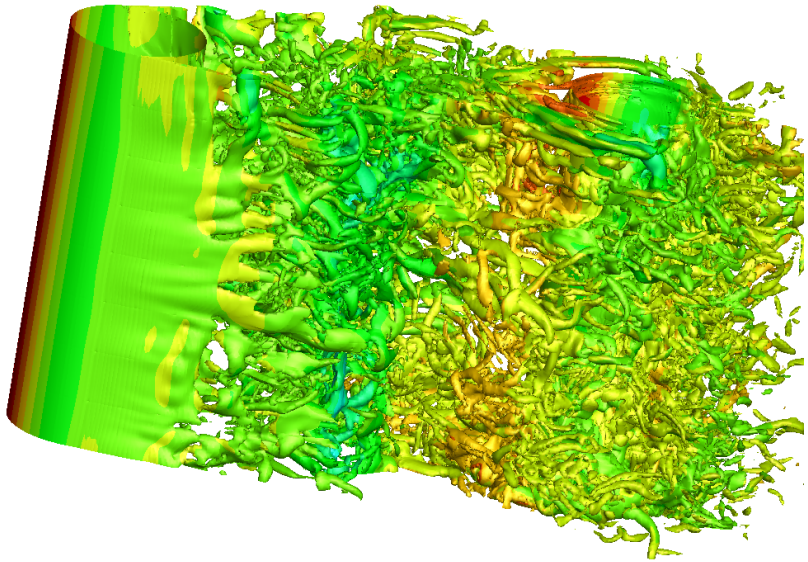




Discretisation and modeling in NSMB

- Spatial discretisation
- Temporal discretisation
- Incompressible scheme
- Turbulence
- Chemistry
- Grid Motion
- Moving Chimera
- Moving Immersed Boundary Method
- Cavitation
- Icing modeling

- Central schemes (2nd and 4th order)
- Upwind schemes (1st up to 5th order)



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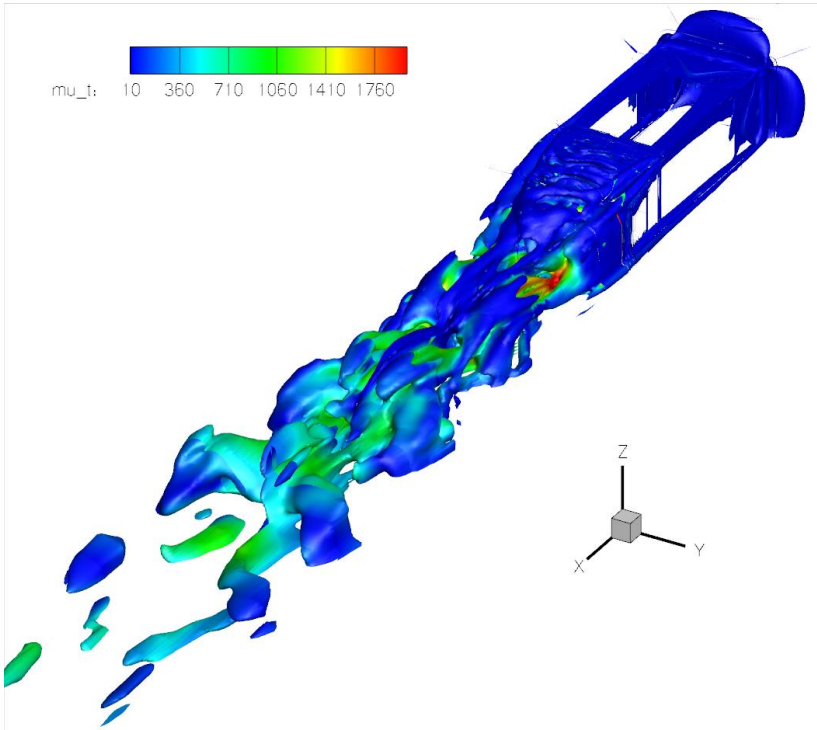
- *Steady flows* :
  explicit Runge Kutta or implicit LU-SGS
- *Unsteady flows* :
  explicit Runge Kutta, Dual-time stepping, LU-SGS



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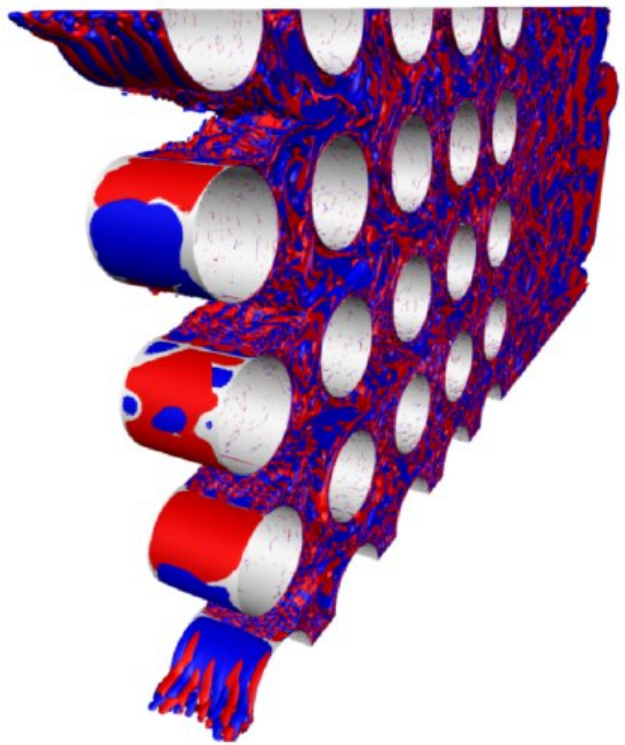
- *Pressure velocity coupling* : SIMPLE, SIMPLEC, PISO, Braza
- *Rhie and Chow* stabilisation
- *Linear solver* : PSBLAS library



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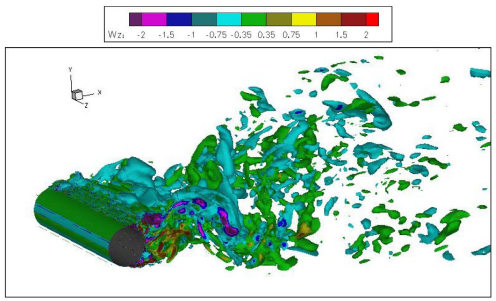
- Algebraic model
- Spalart-Allmaras and variants
- k-ϵ Chien, OES
- k-ω Menter, Wilcox, LLR, BPD
- EARSM Girimagi, GS, AJL
- NLEVM SZL, WJ
- DES, DDES, WMLES, IDDES, SAS
- Tensorial OES
- RSM SSG
- LES Smagorinsky, FS, FSF, WALE, ADM



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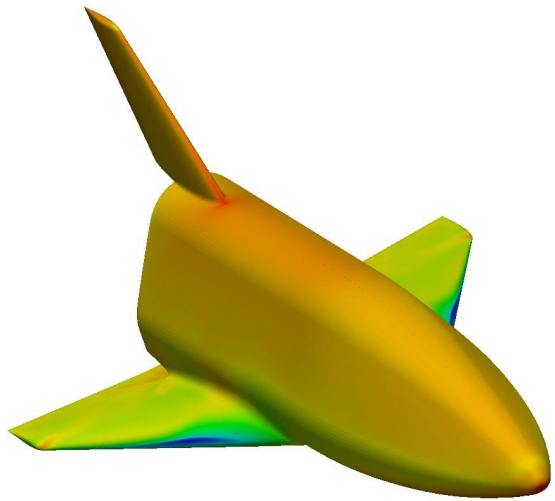
- Air/N2-chemistry
- Diffusion Flame model
- General Non-equilibrium Chemistry : CHEMKIN II coupling



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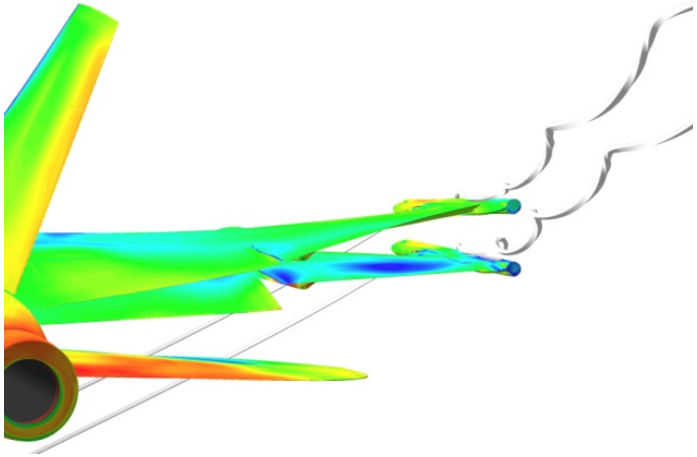
- ALE (Arbitrary Lagrangian Eulerian) and remeshing techniques



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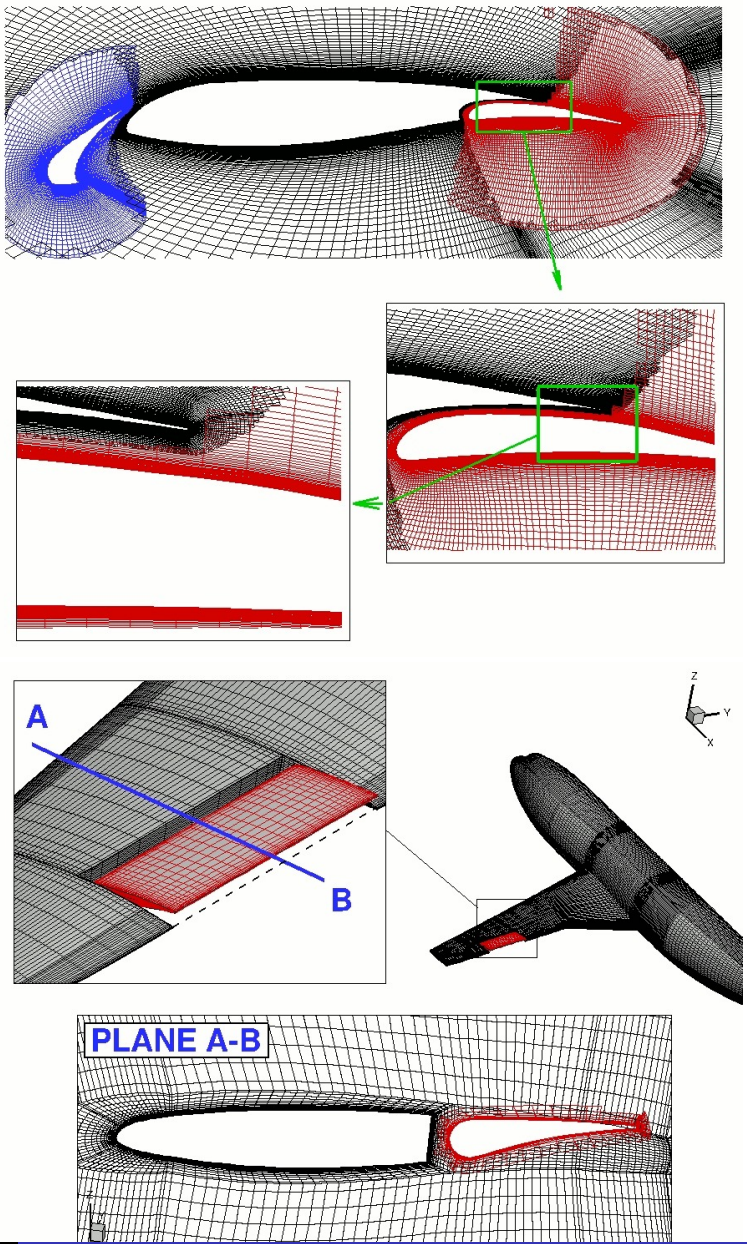

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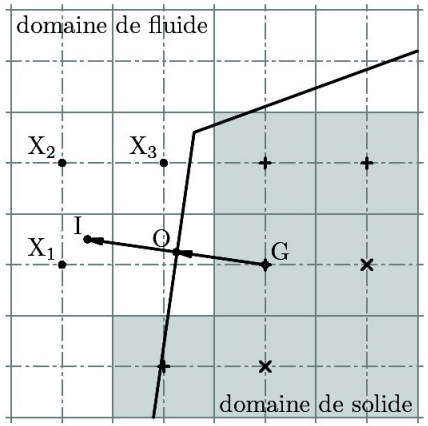

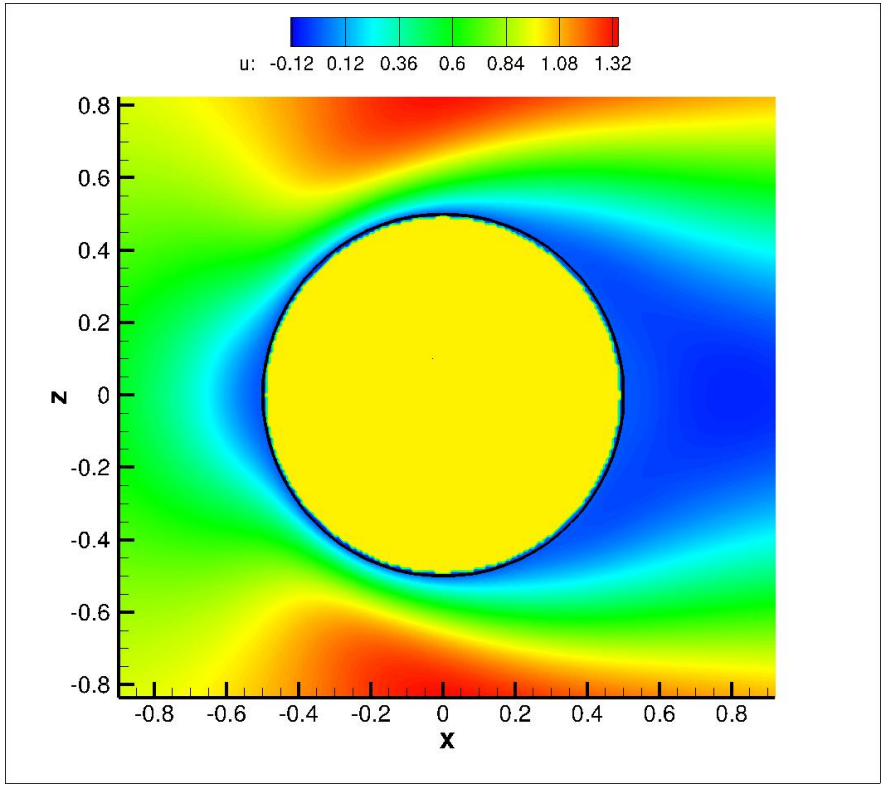

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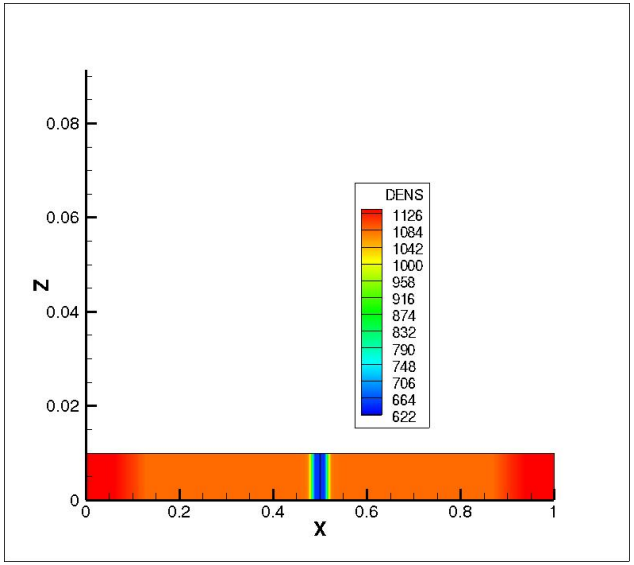

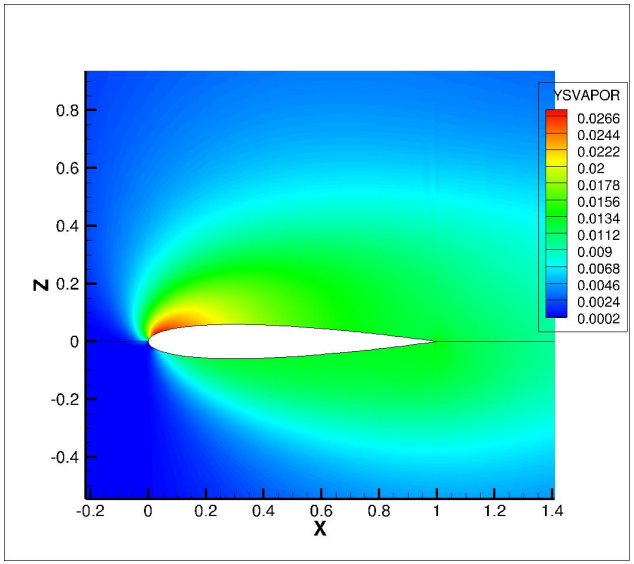

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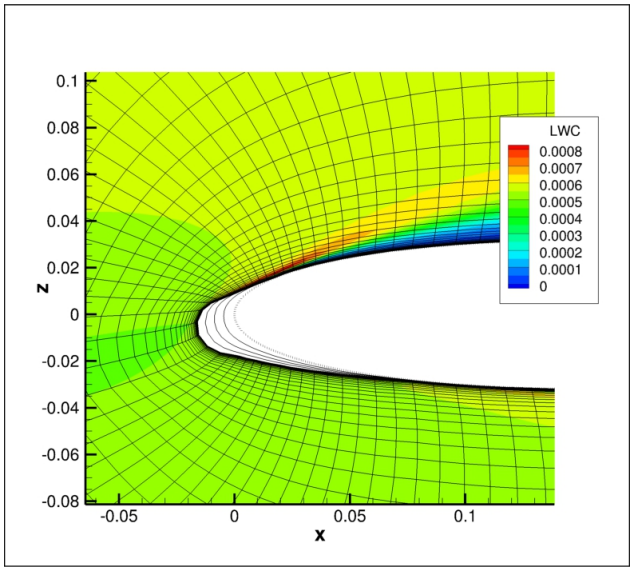


Outline

Simulation description

Case simulated

- Case 1 : steady and forced oscillation
- Case 2 : steady and flutter
- Case 3 : steady, unsteady and forced oscillation
- Ansys grids (coarse, **medium**, fine)

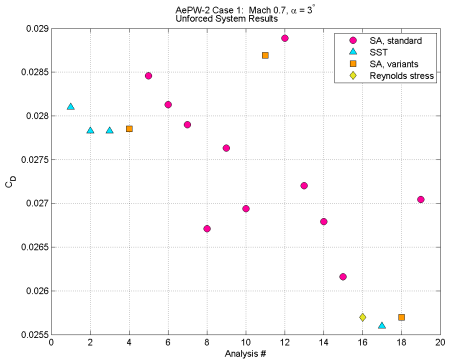
Numerical schemes

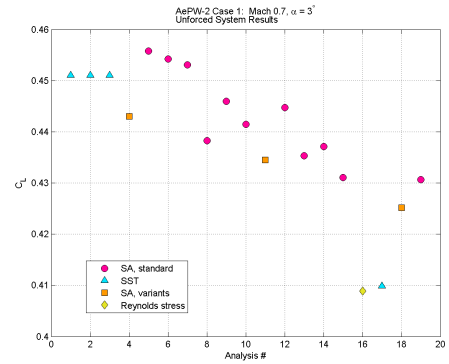
- Fourth order central scheme
- Implicit scheme (LU-SGS) : max 300 inner iterations to 10^{-3}
- Dual time stepping, second order backward Euler, $dt = 10^{-3}s$
- SA QCR 2013 - DDES, $k-\omega$ SST - DDES, $k-\varepsilon$ Chien - OES

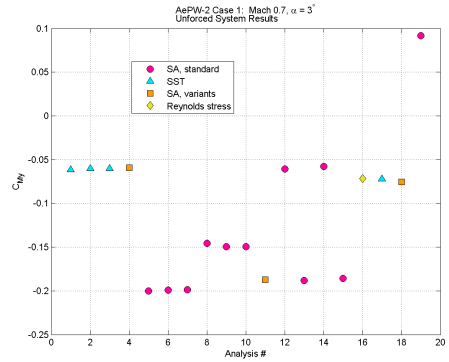
Outline

Case 1 simulation

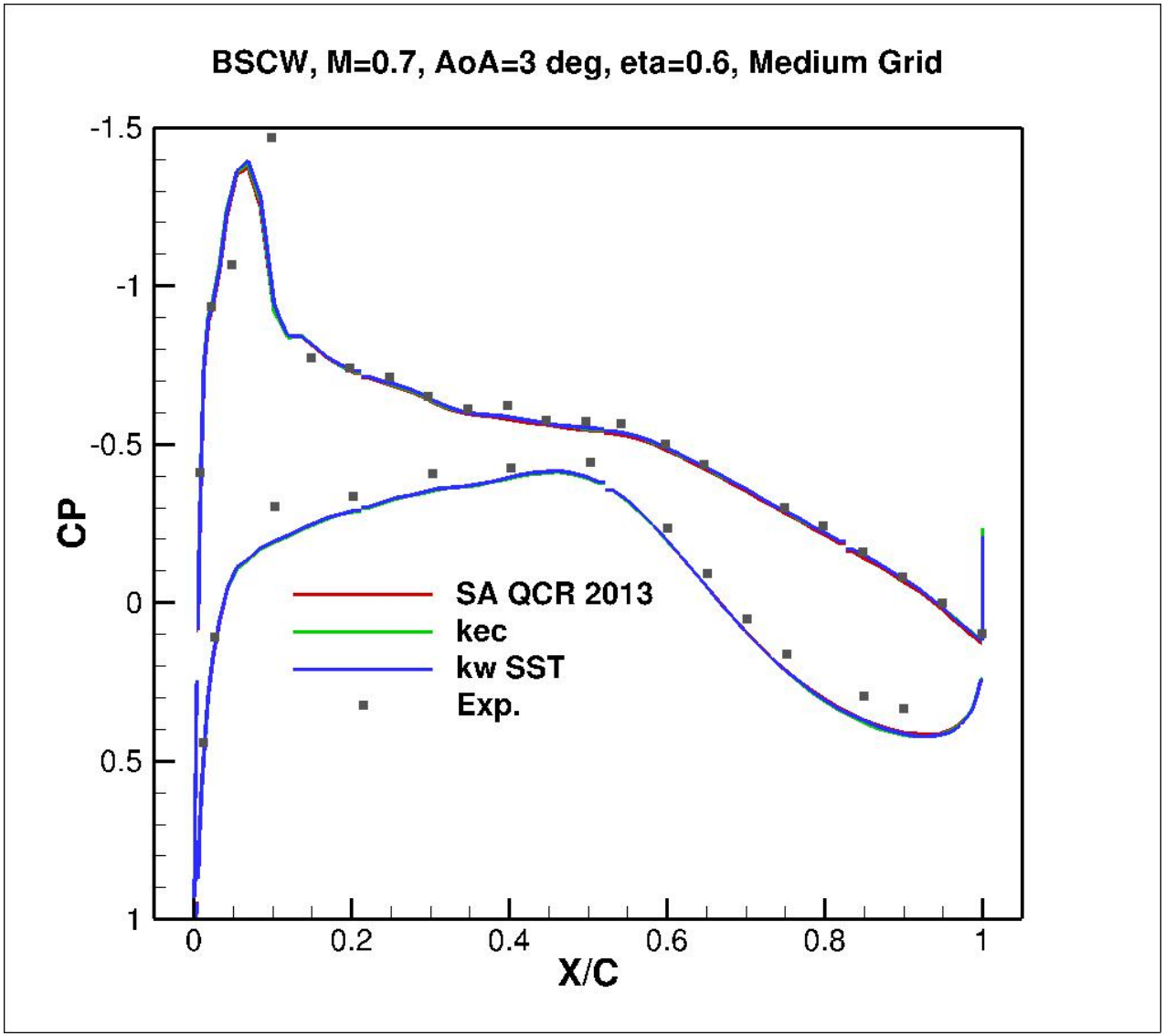
Model	C_D	C_L	C_{My}
SA coarse	0.29256	0.43823	-0.209037
SA medium	0.028363	0.43301	-0.20623
SA fine	0.0283597	0.433032	-0.2095703
$k-\varepsilon$ coarse	0.029657	0.45291	-0.218236
$k-\varepsilon$ medium	0.028683	0.44155	-0.211002
$k-\varepsilon$ fine	0.0281834	0.429251	-0.203264
$k-\omega$ coarse	0.0291214	0.449171	-0.215831
$k-\omega$ medium	0.028686	0.4391	-0.2093
$k-\omega$ medium	0.0281261	0.4305	-0.19182







Case 1 simulation



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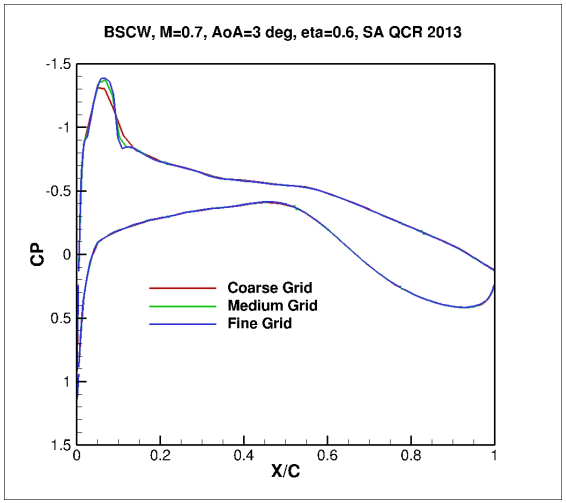
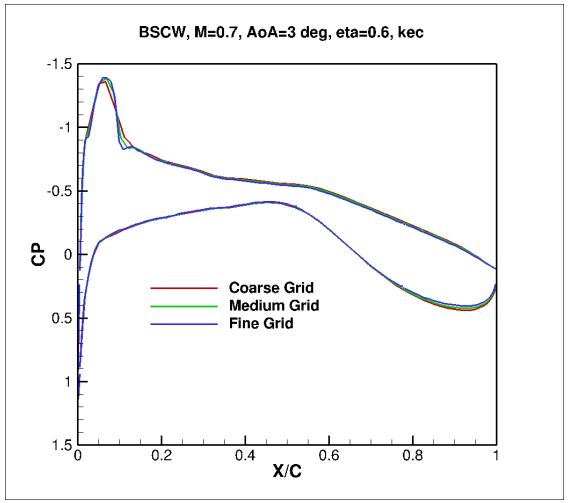
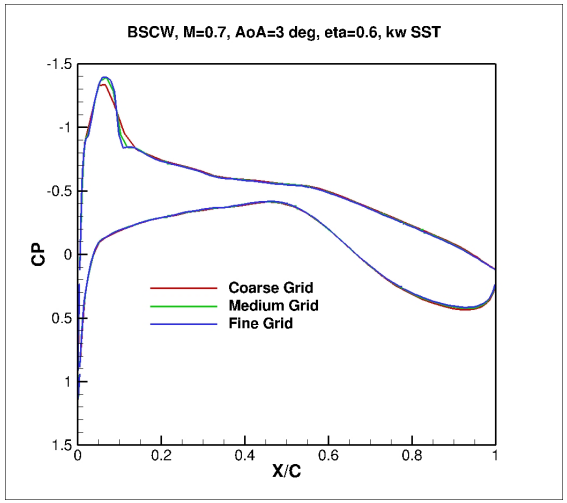
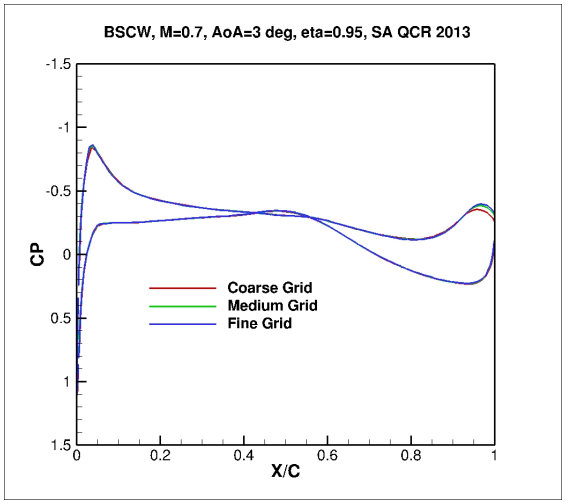
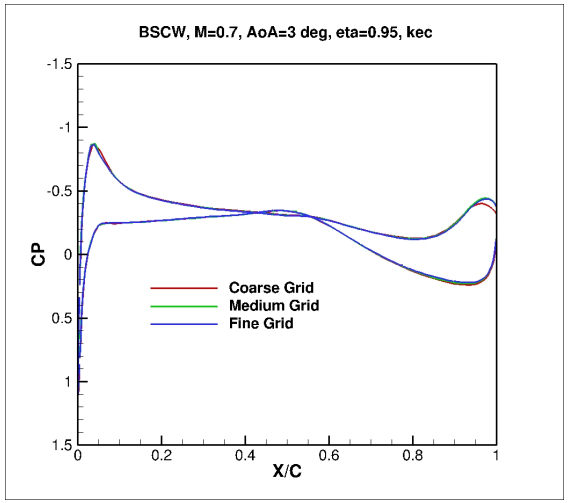
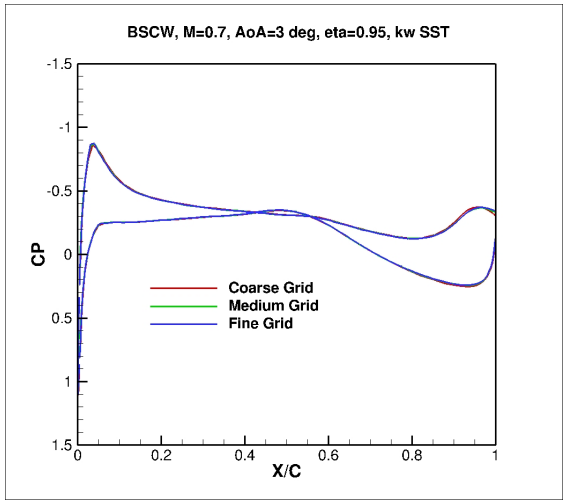




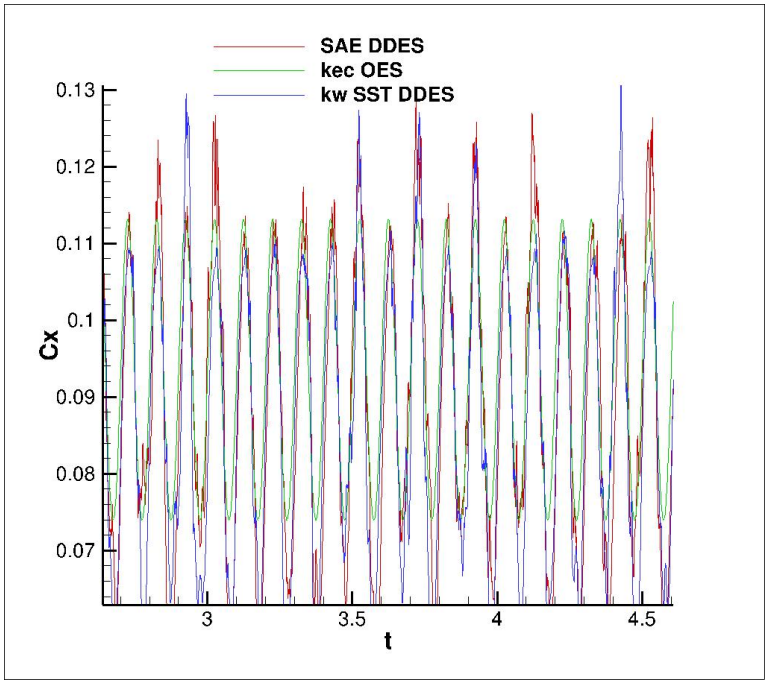


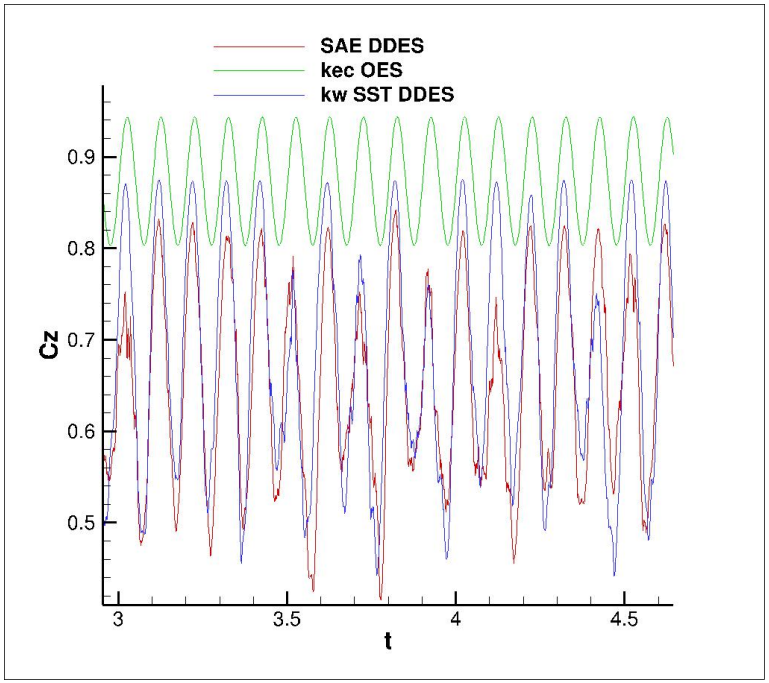






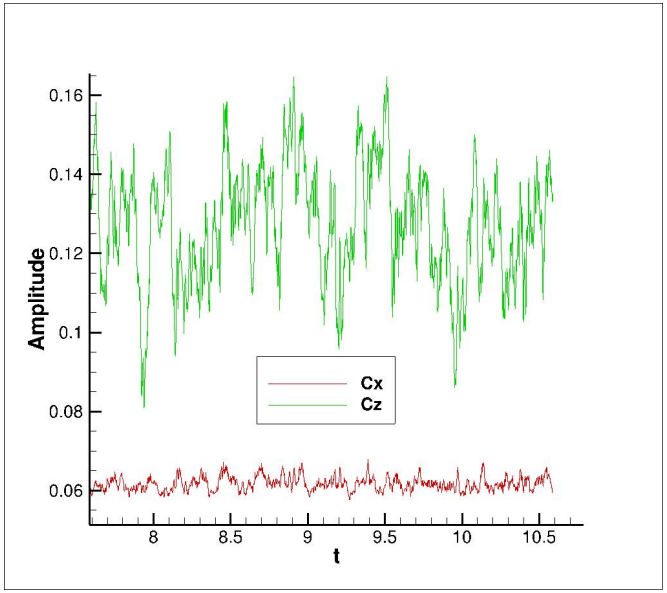
Case 1 ALE simulation

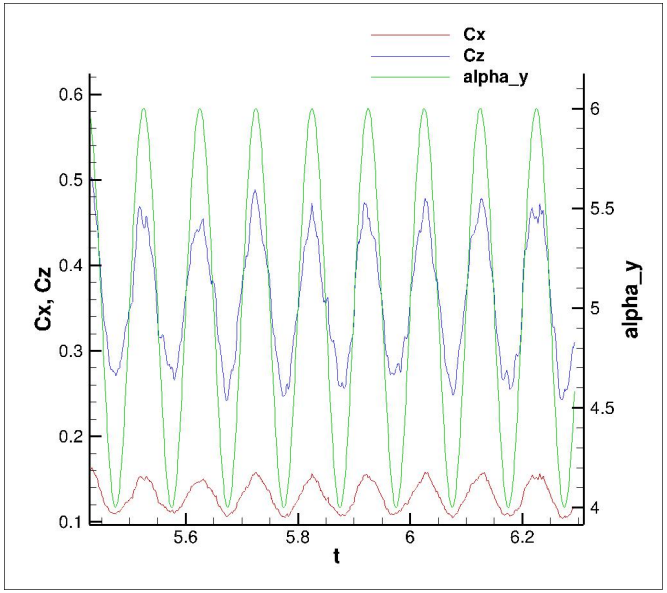


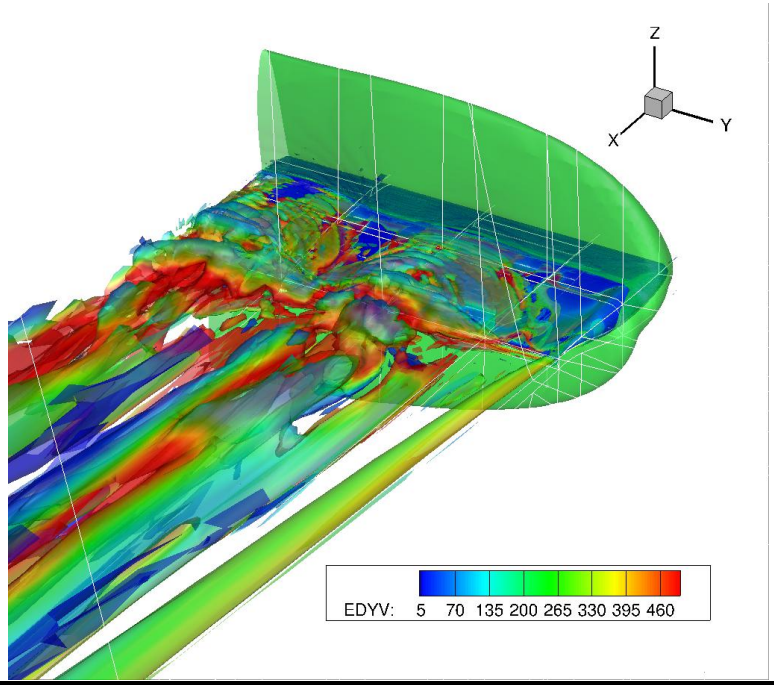


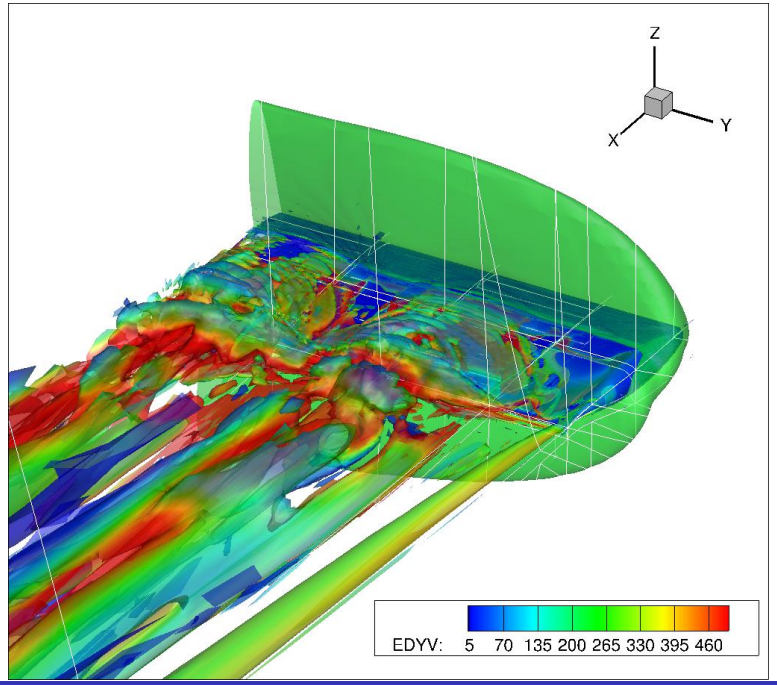
Outline

Case 3 simulation



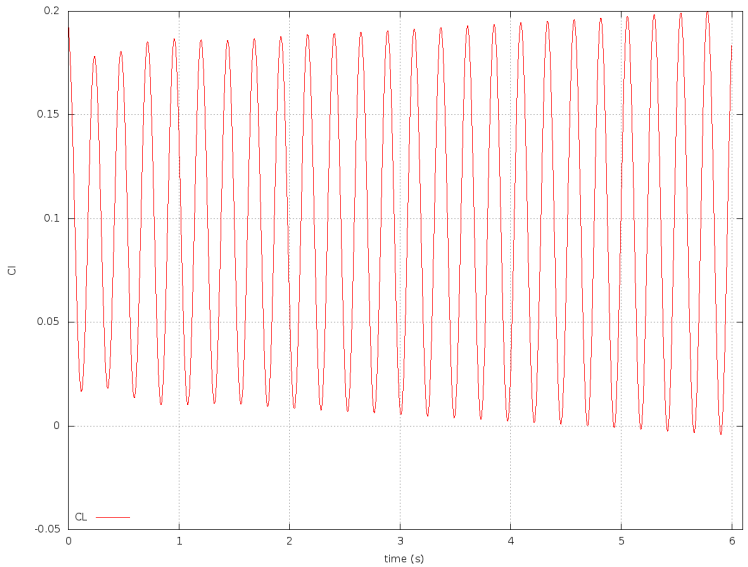


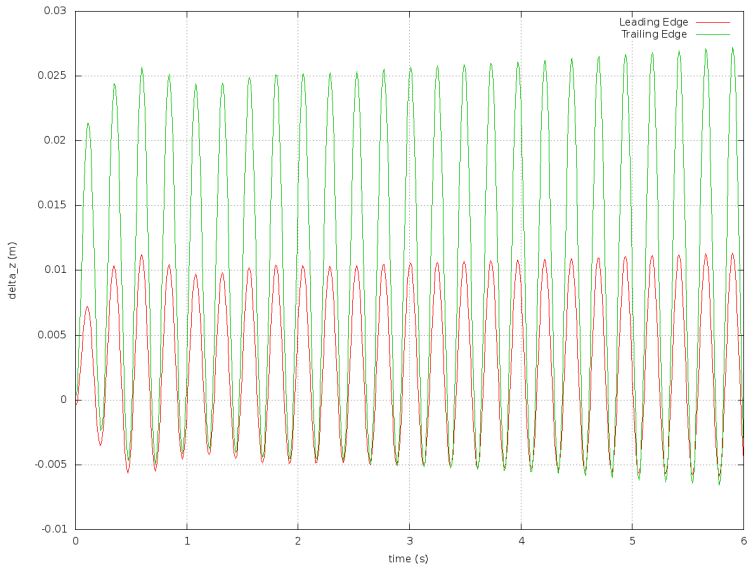




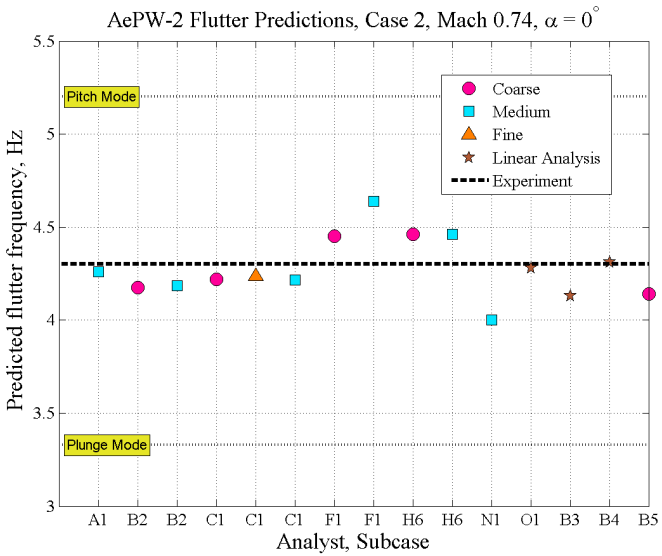
Outline

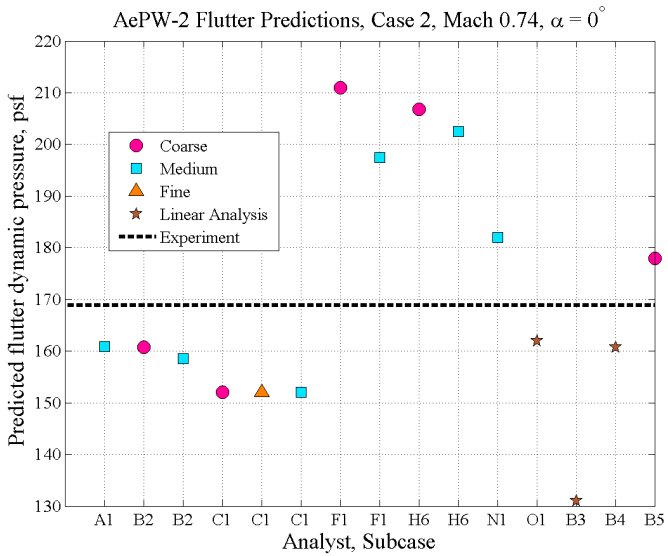
Flutter case





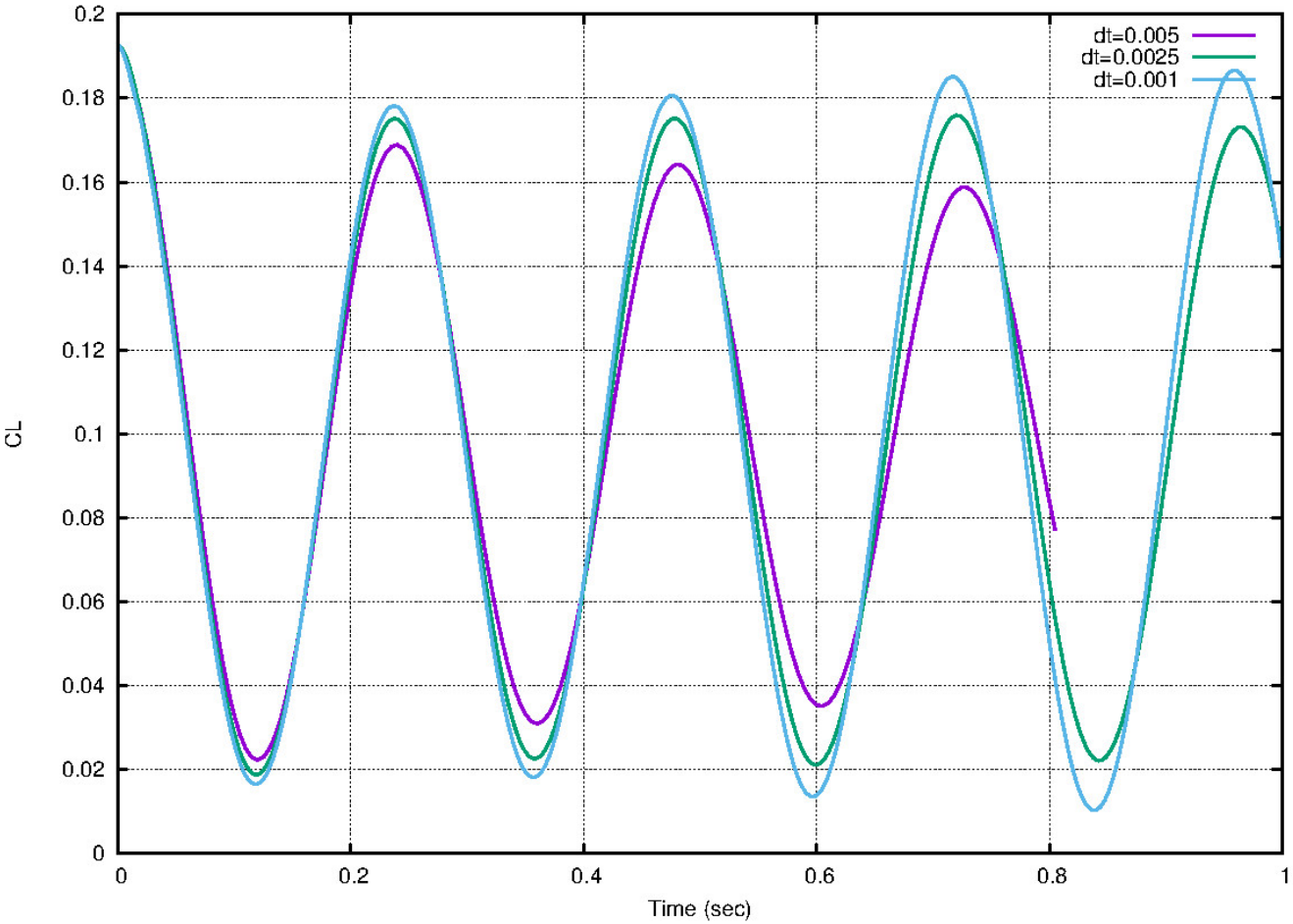
Flutter case



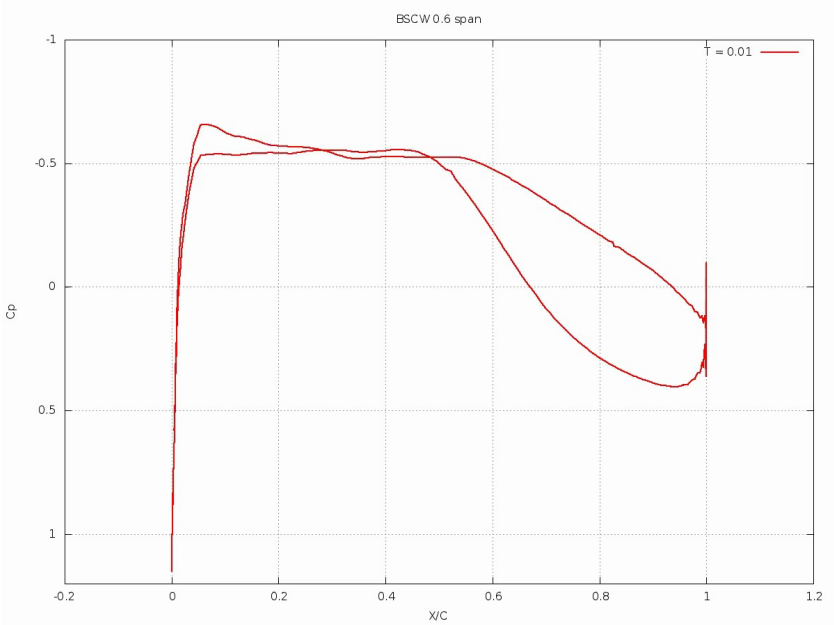


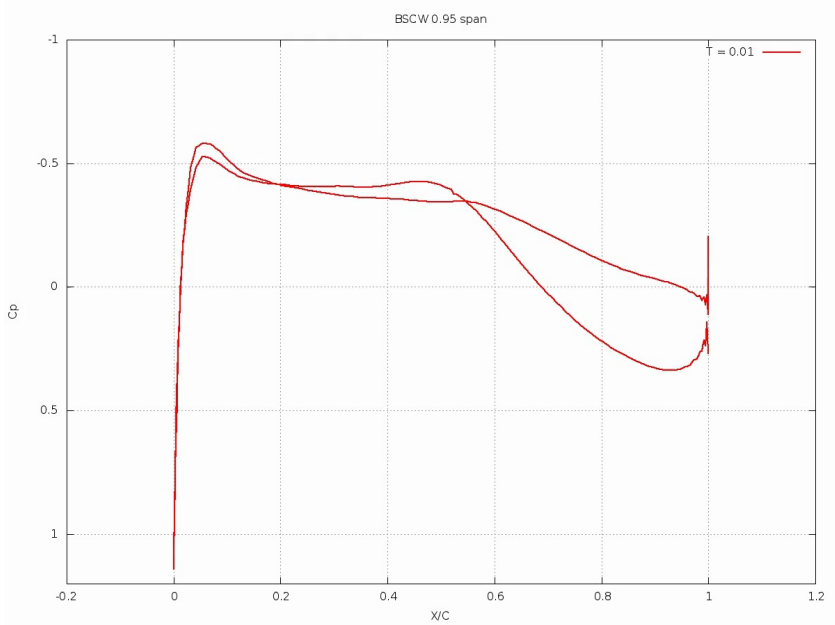
$$f = 4.149\text{Hz},\ q = 169\ \text{pst}$$

Flutter case



Flutter case





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Conclusion and Perspective

- Preliminary state study, many simulations, few post-processing!
- Case 1 : steady case OK, forced oscillation need post-processing
- Case 3 : require more post-processing
- Case 2 : flutter obtained at q=169pst, f =4.15Hz

- Influence of the model on the flutter
- Influence of the grid on the flutter
- Investigate other dynamic pressure
- Flutter on case 3

Thanks

Thanks for your attention

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6th Symposium on Hybrid RANS-LES Methods, Strasbourg, France
26-28 September 2016
http://hrlm6.sciencesconf.org