Contribution to HiLiftPW-3

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#018

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Summary of cases completed:

Case	Alpha=8, Fully turb, grid study	Alpha=16, Fully turb, grid study	Other
1a (full gap)	yes	yes	
Other			

GRIDS : **Committee_Grids/B2-HLCRM_UnstrPrismTet_PW/FullGap/CGNS/**

- Woeber_Pointwise_HLCRM_FullGap_PrismTets_Coarse.cgns
- Woeber_Pointwise_HLCRM_FullGap_PrismTets_Medium.cgns
- *Woeber_Pointwise_HLCRM_FullGap_PrismTets_Fine.cgns (*)*

(*) : Computations still running – Results not provided at that time but will be shared when available.

Case	2D Verification study	Other
3	yes	
Other		

GRIDS : CGNS grids

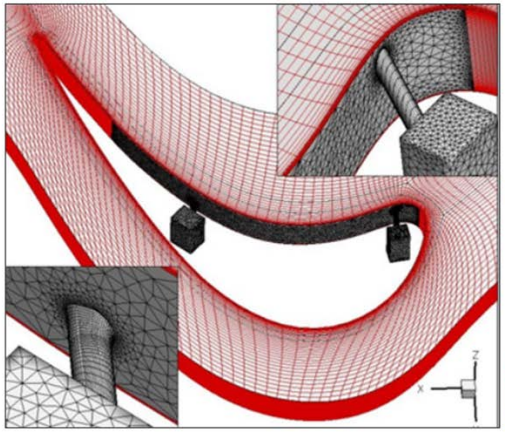
Code : elsA – v3.7.03
Unstructured solver
Turbulence : Spalart-Allmaras
No QCR correction

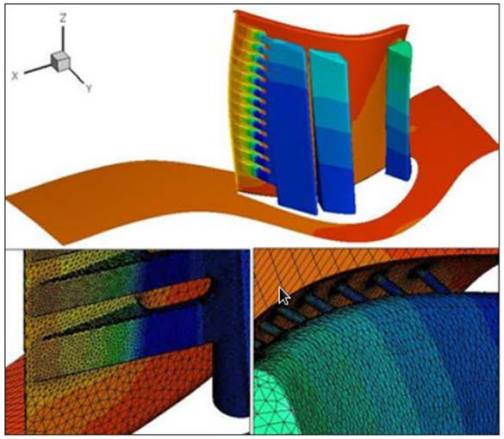
Solver used : elsA v3.7.03

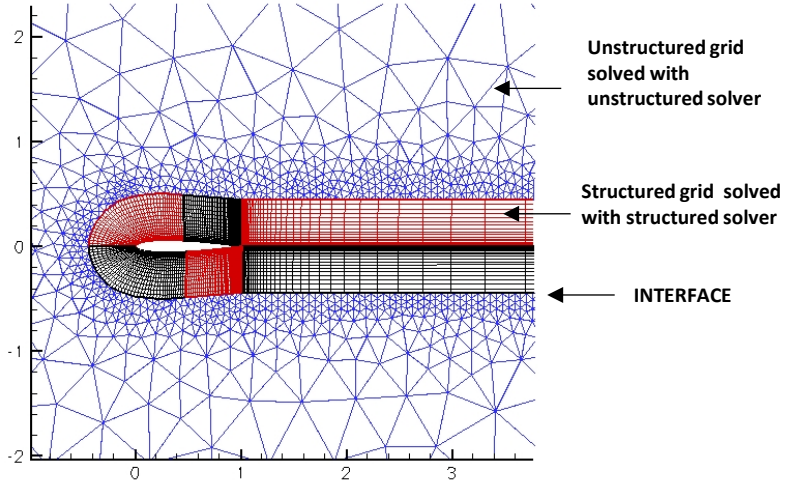
elsA is the ONERA software for complex external and internal flow simulations and for multi-disciplinary applications involving aerodynamics. It is basically based on the structured multi-block grid techniques, including chimera-overset. Recently, a new fully integrated environment for compressible flow simulation on structured and unstructured zones coexisting within the same hybrid mesh has been introduced in its capabilities.

Structured zones are kept for sake of accuracy in boundary layers, wall clock efficiency and low memory consumption.

Unstructured zones enable an easier mesh generation / adaptation process / detailed technology effects. In the hybrid capability, structured zones are solved using structured solvers, and unstructured zones with unstructured solver.







However, in order to have the full potential of the hybrid capabilities, some inputs have to be provided in the cgns file into account at the grid generation process.

At that time, most of the applications carried out with this hybrid capabilities are for turbomachinery. For aircraft applications, we are mostly considering the unstructured solver capabilities.

Solver used : elsA v3.7.03 : UNSTRUCTURED SOLVER

Cell-centered finite volume spatial discretization

Explicit : Roe (Jameson JST also available)

Limiter used : Venkatakrishnan

Implicit : **LUssor** scheme associated with an **Euler backward** time integration scheme

Cfl =10.0

Turbulence model : Spalart-Allmaras (no QCR)

Run on parallel (256 or 480 cores) on the Onera super-scalar computer

No parametric study of the effect of the different coefficients (limiters, dissipations, turbulence models, …) at present. This will come in a future phase of the project.

It is also planned to compute the fully structured grids provided using the “standard setups” in order to have a “good” CFD reference for comparisons.

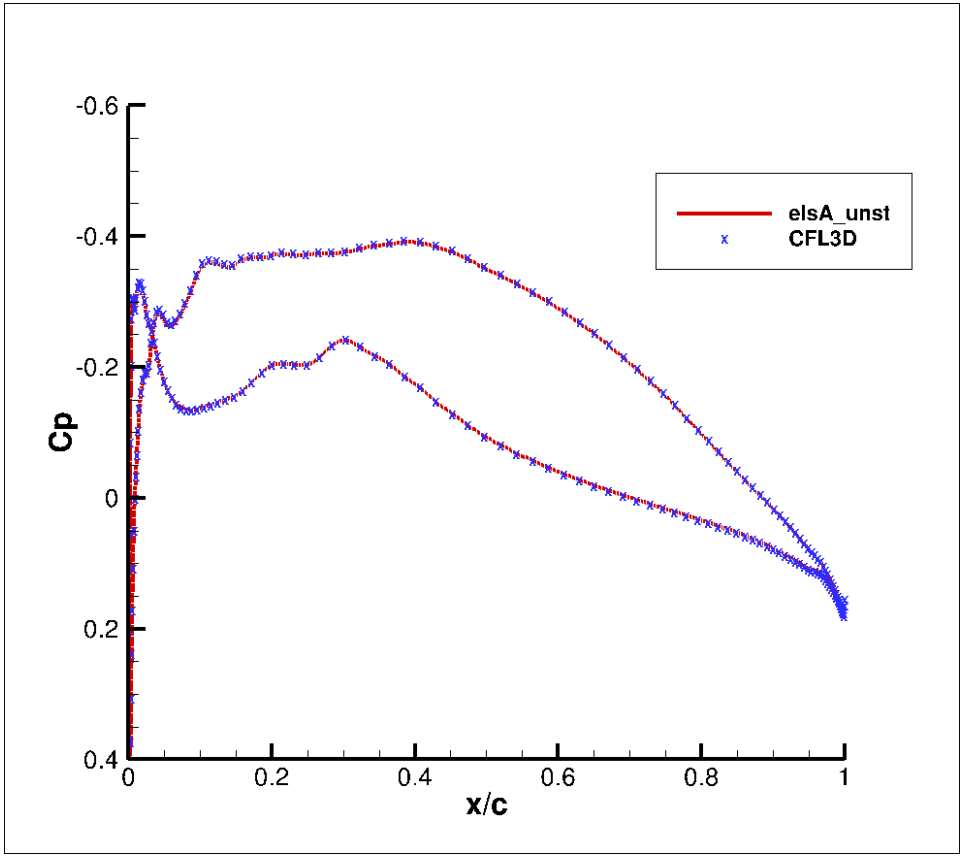
All calculations performed without MG (capability not yet validated for unstructured grid in the version of elsA used for this exercise)

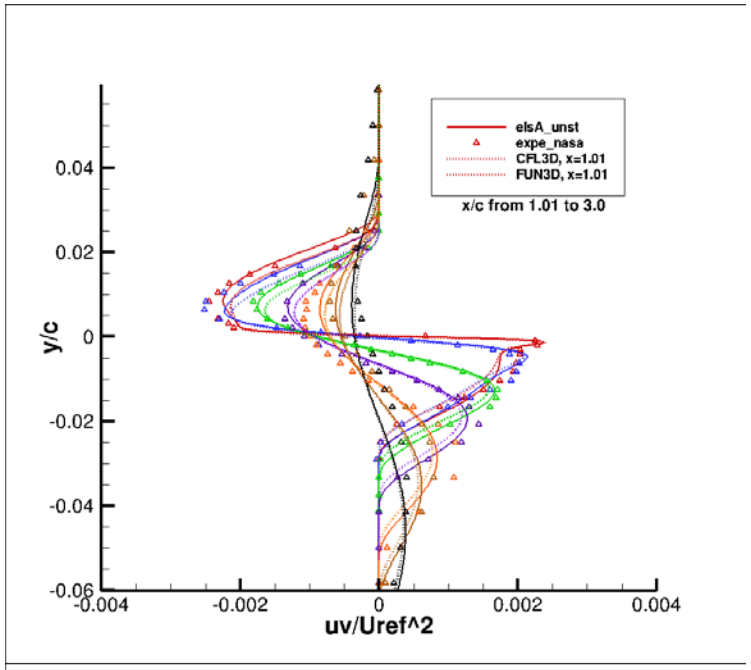
REFERENCES

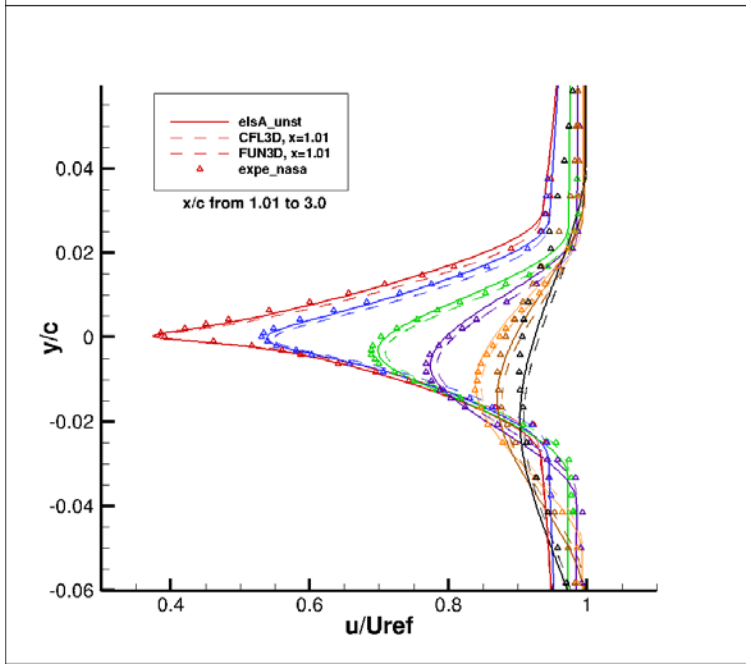
L. Cambier, S. Heib, S. Plot : ***The Onera elsA CFD software : input from research and feedback from industry***, Mechanics & Industry, 14(3): 159-174, doi:10.1051/meca/2013056, 2013.

M. de la Llave Plata, V. Couaillier, M.-C. Le Pape, C. Marmignon, and M. Gazaix : ***elsA-HYBRID: An all-in-one Structured/Unstructured Solver for the Simulation of Internal and External Flows. Applications to Turbomachinery***. *Progress in Propulsion Physics* **4** (2013) : 417-444.
doi: 10.1051/eucass/201304417 © Owned by the authors, published by EDP Sciences, 2013

Verification study results (Case 3)







Results from Onera DAAA/CLEF
(C. Caillaud / B. Michel / M. Soismier)

Grid system used

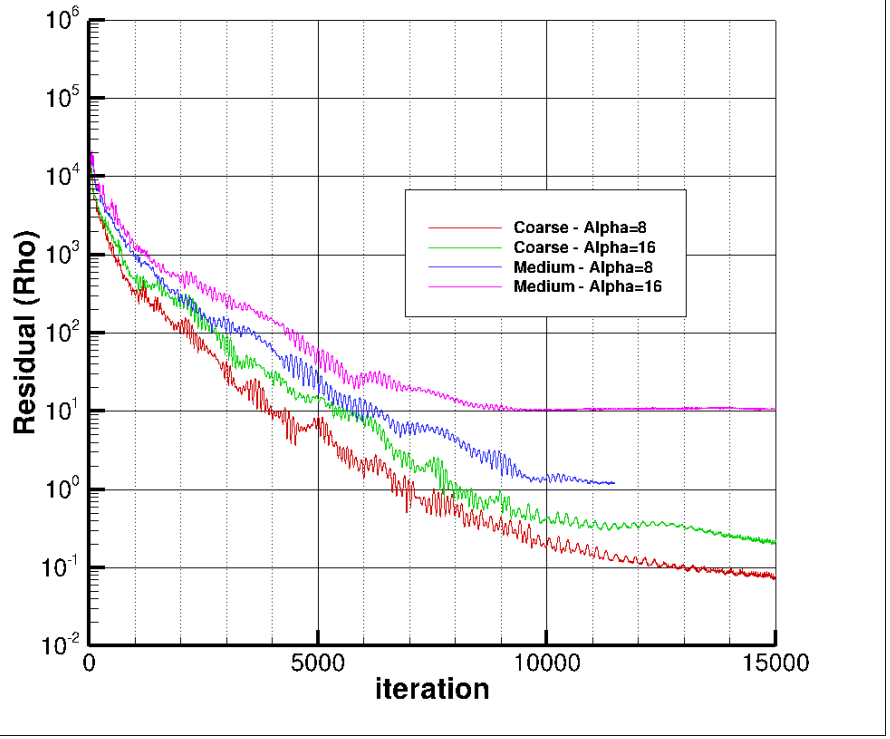
For case 1 : Onera used the provided committee grids for **B2-HLCRM** referred as "**UnstrPrismTet** " as it seems close (in term of topology) to an hybrid grid.

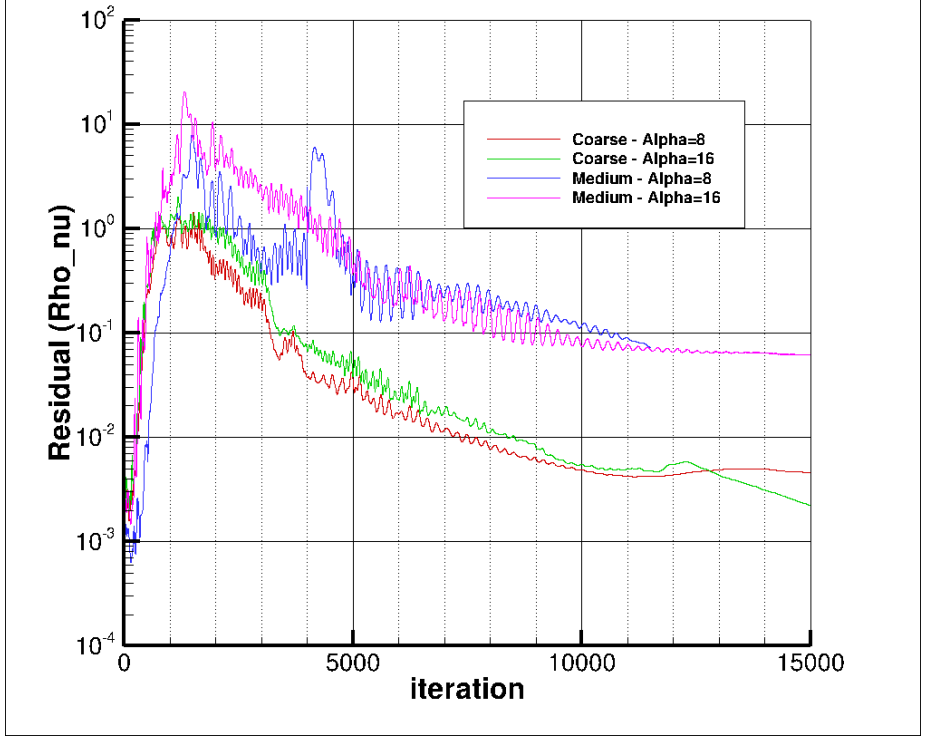
The only modification done for the computations was to transform the x/y/z provided from inches to meters. This was in order to work in S.I. units for flow initialization …

Special thanks to B. Maugars from Onera DAAA/CLEF for the support on HL-CRM computations

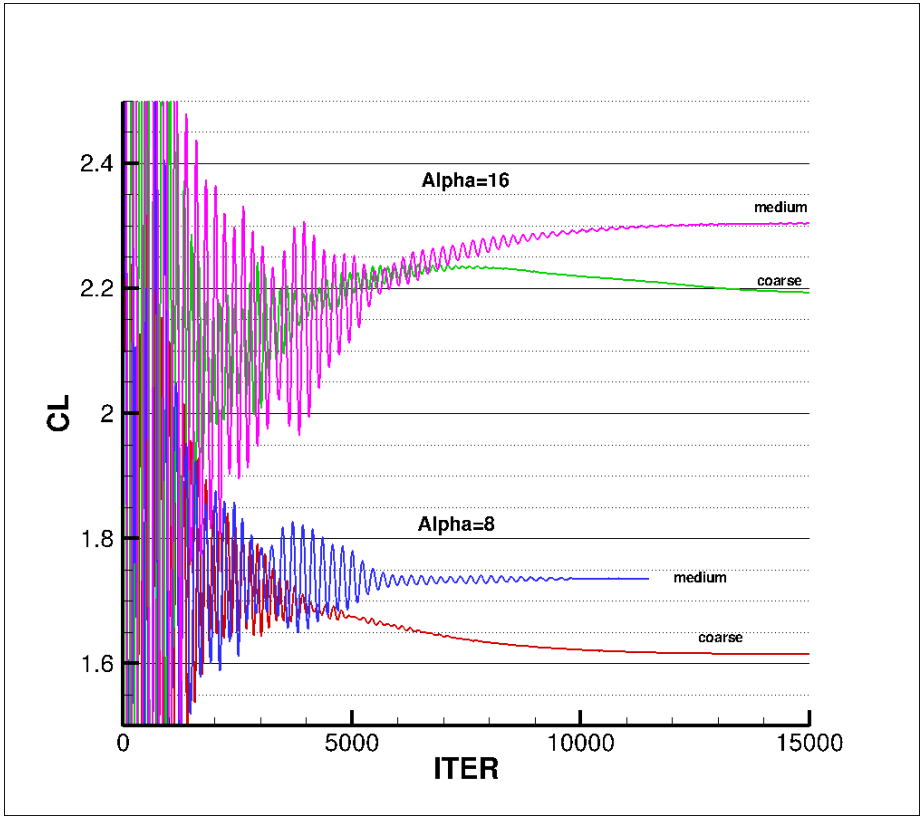
```
-----------------
Aero conditions :
-----------------
Mach number                    = 0.2
Angle of attack                = 8.0 ( 0.13962634016 rad)
Angle of sideslip              = 0.0 ( 0.0 rad)
Reynolds unitaire              = 464986.610894
Reynolds length                = 7.00532
Reynolds number                = 3257380.00503

-----------------
 STATIC CONDITIONS
-----------------
Reference density  (Road)      = 1.21732391748
Reference temperature (Tsad)   = 286.706349206
Reference pressure  (Pad)      = 100167.160404
Reference velocity (Vad)       = 67.8818417874
Sound velocity     (Soundad)   = 339.409208937

MomentumX    (RoUad)           = 81.829999318
MomentumY    (RoVad)           = 0.0
MomentumZ    (RoWad)           = 11.5004564078

------- -----
 FORCE COEFF
------- -----
Reference Surface              (Sref)= 191.8447776
Reference for force coeff.     (FluxCoeff)= 1.85851737245e-06
Reference for pressure coeff.  (Qoad)     = 2804.68049132

----------------------
 STAGNATION CONDITIONS
----------------------
Stagnation pressure  (Piad)    = 103000.0
Stagnation temperature (Tiad)  = 289.0
Stagnation energy density      = 253222.581502
Stagnation enthalpy            = 290300.5

------------
 SUTHERLAND
------------
Sutherland constant (Csad)       = 110.4
Reference viscosity (SuthMuad)   = 0.0001711
Reference temperature (SuthTad)  = 273.15

------------
 MODEL GAZ
------------
Gas constant cv     (Cvad)     = 717.5
Gas constant r      (Rgasad)   = 287.0
Gas constant Gamma             = 1.4

------------
 TURBULENCE
------------
Reference Viscosity : Muad              = 0.00017771305159
SA Model : Ro*NuTilde                   = 1.7771305159e-07
```

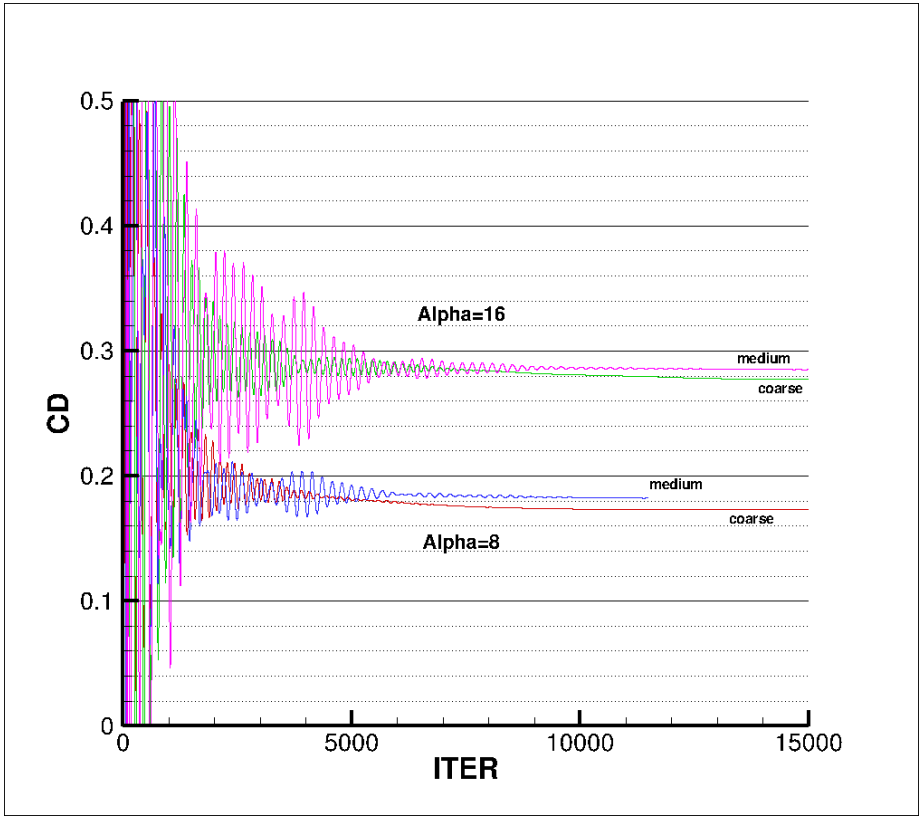
HL-CRM case
Convergence (Residuals)



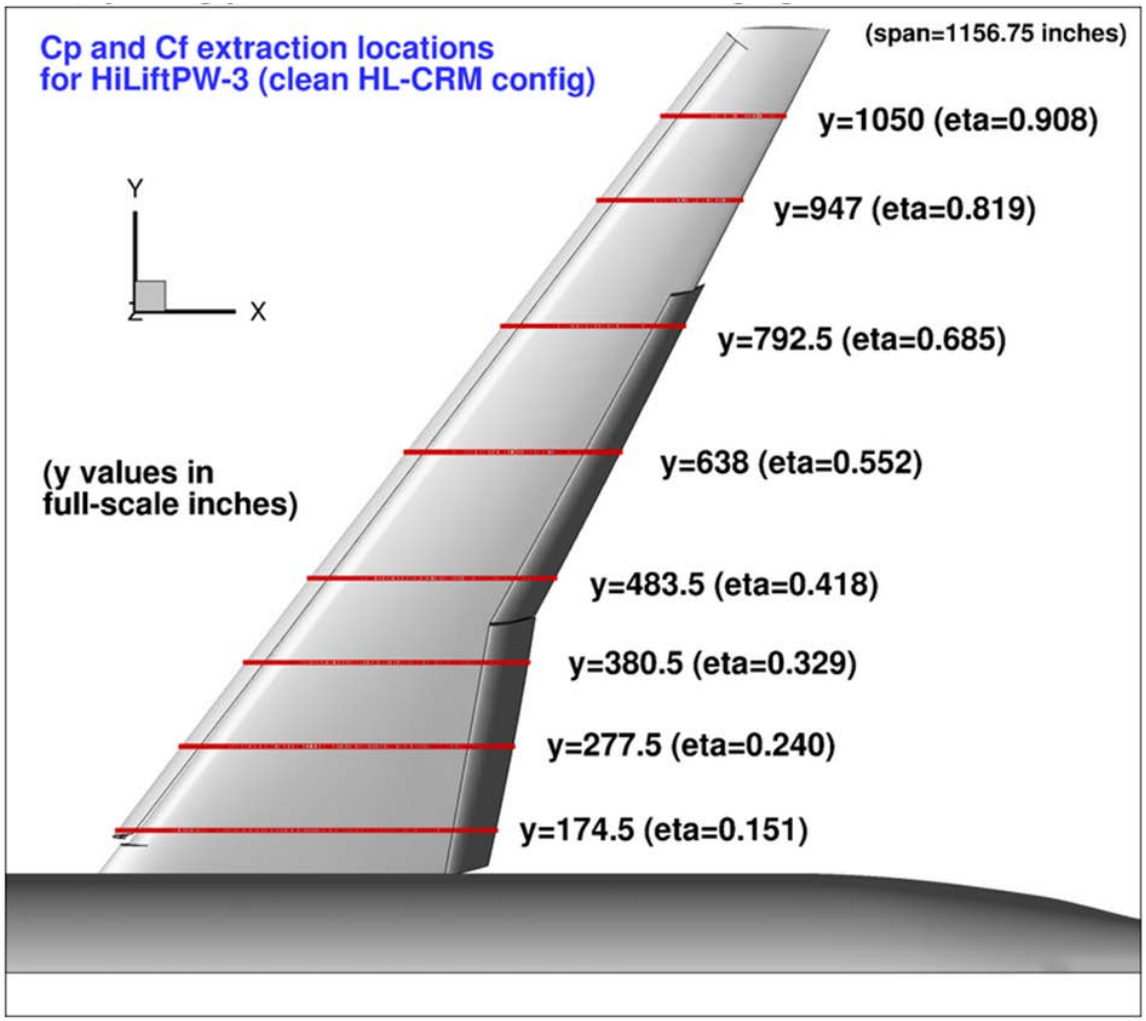


HL-CRM case
Convergence (Force Coefficients)





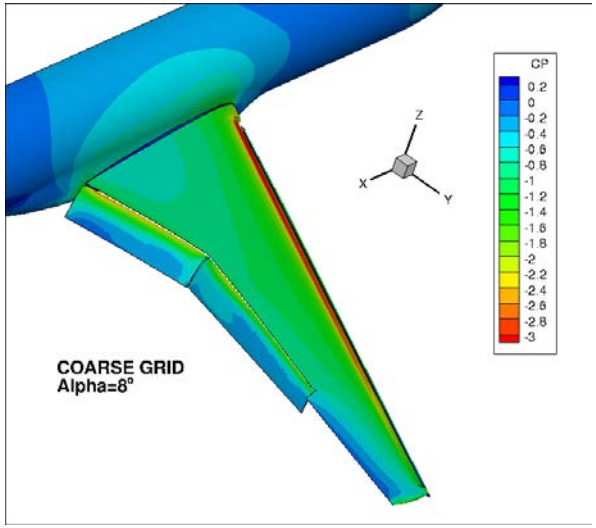
HL-CRM wing sections used

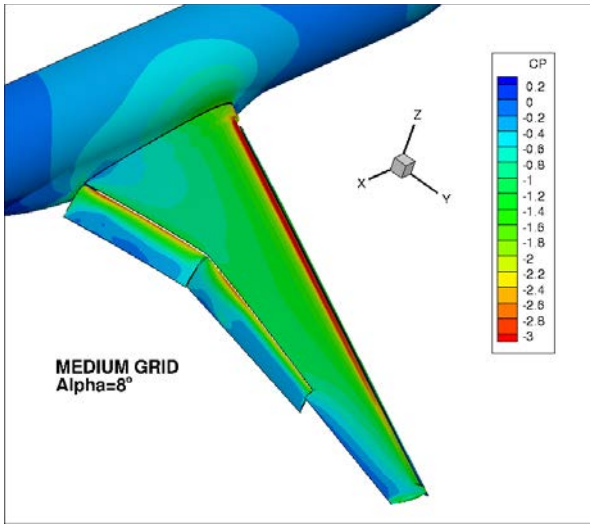


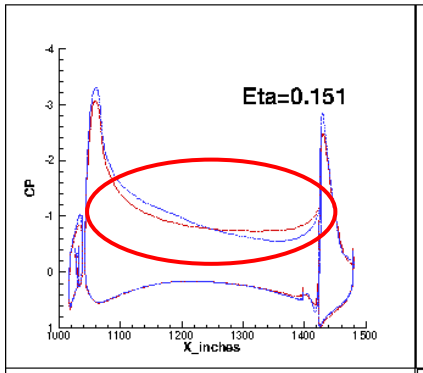
Picture from HLPW3 web site

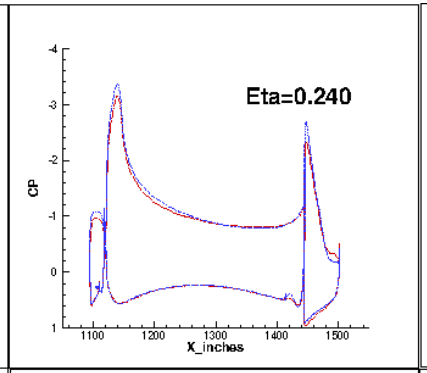
HL-CRM results – Alpha=8°
Effect of grid density (Coarse / Medium)

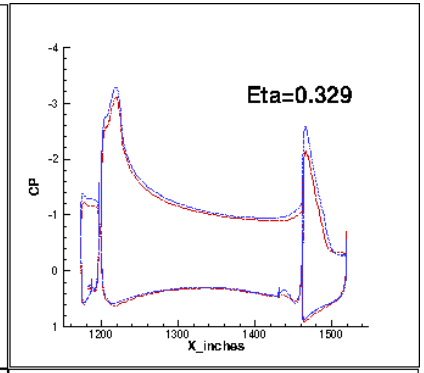
Computed pressure coefficients

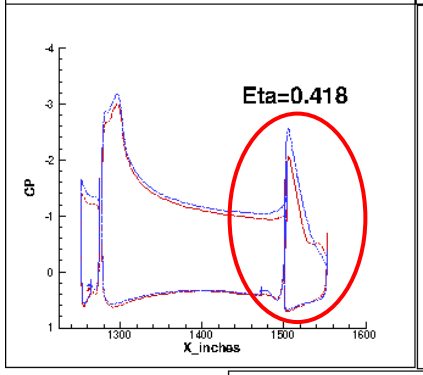


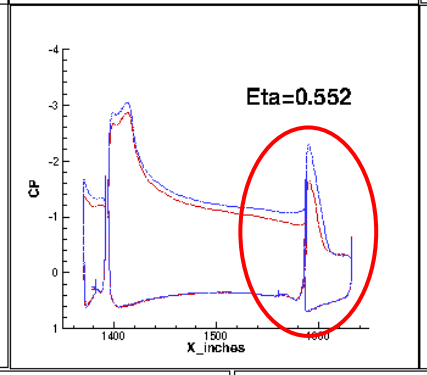


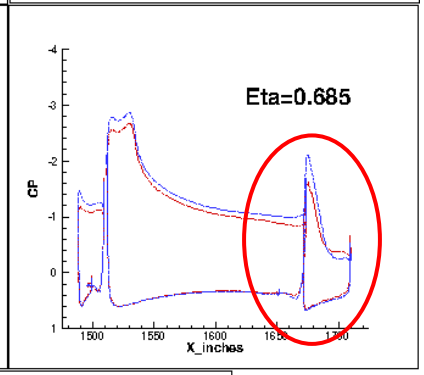


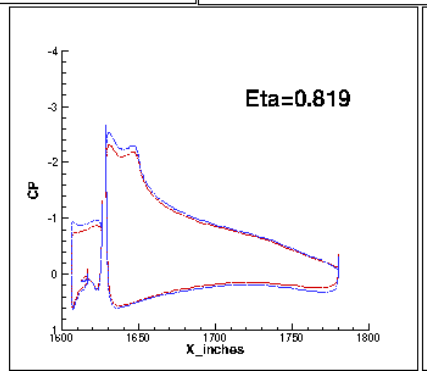


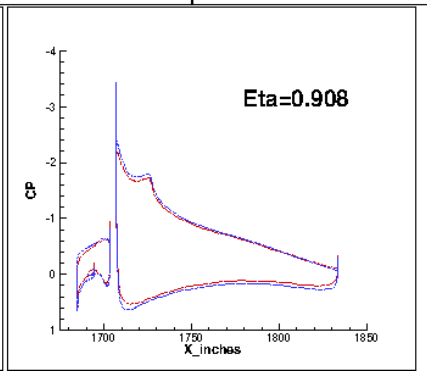






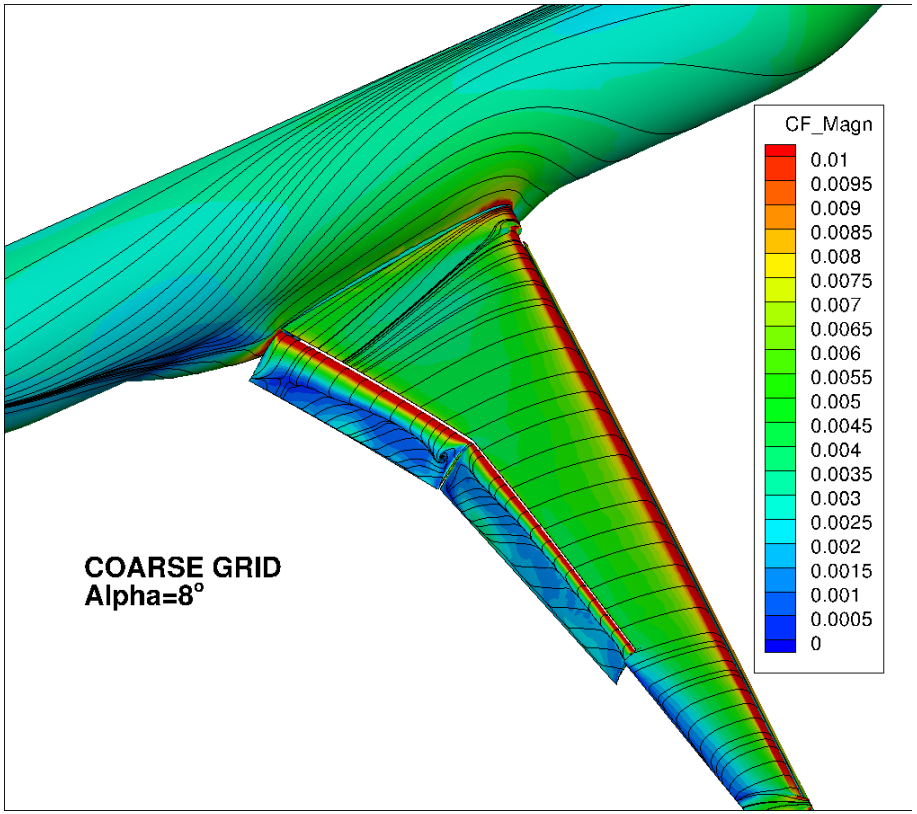


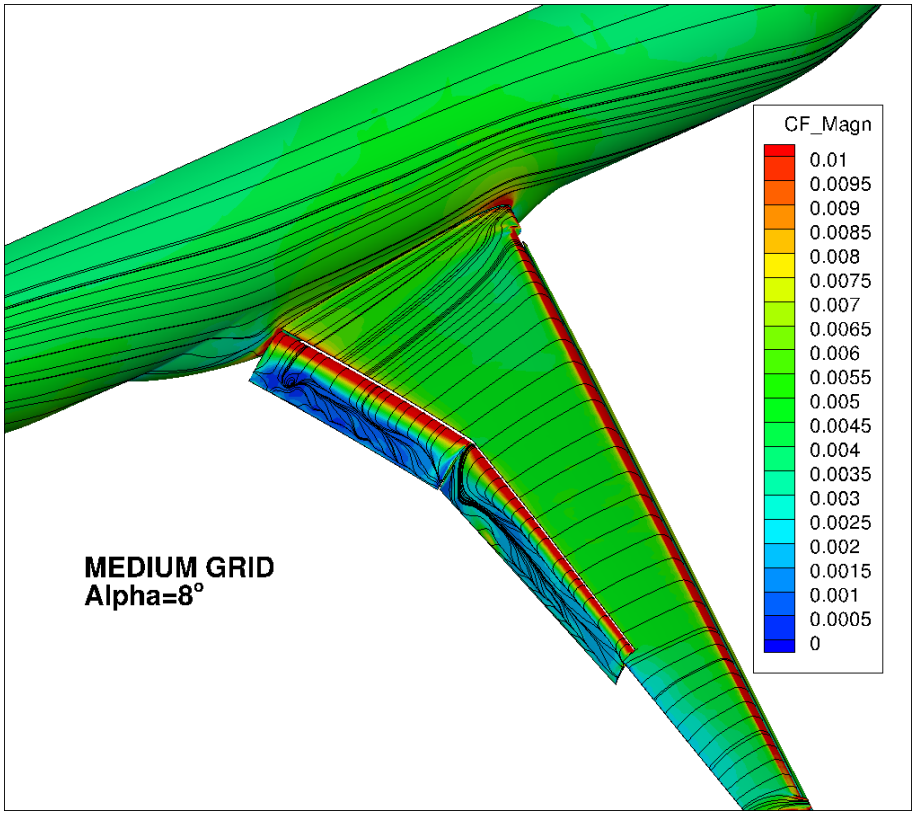




HL-CRM results – Alpha=8º
Effect of grid density (Coarse / Medium)

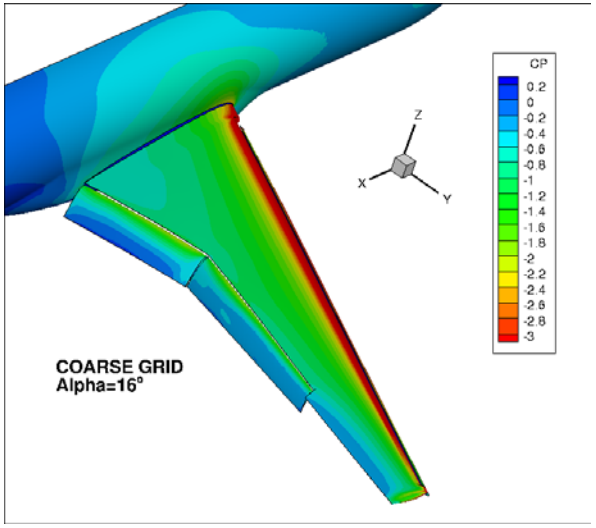
Computed friction lines

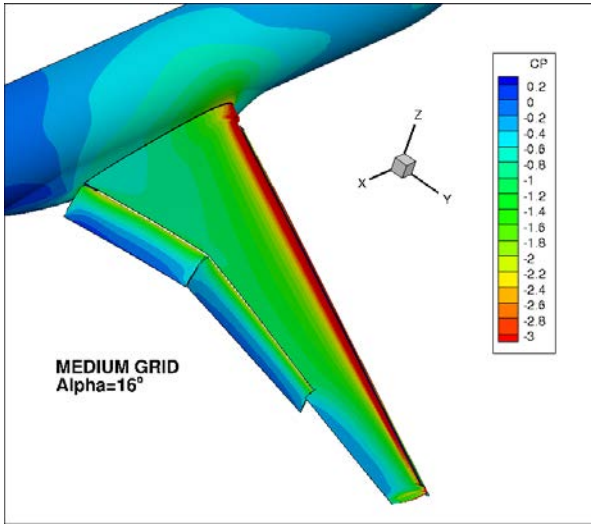


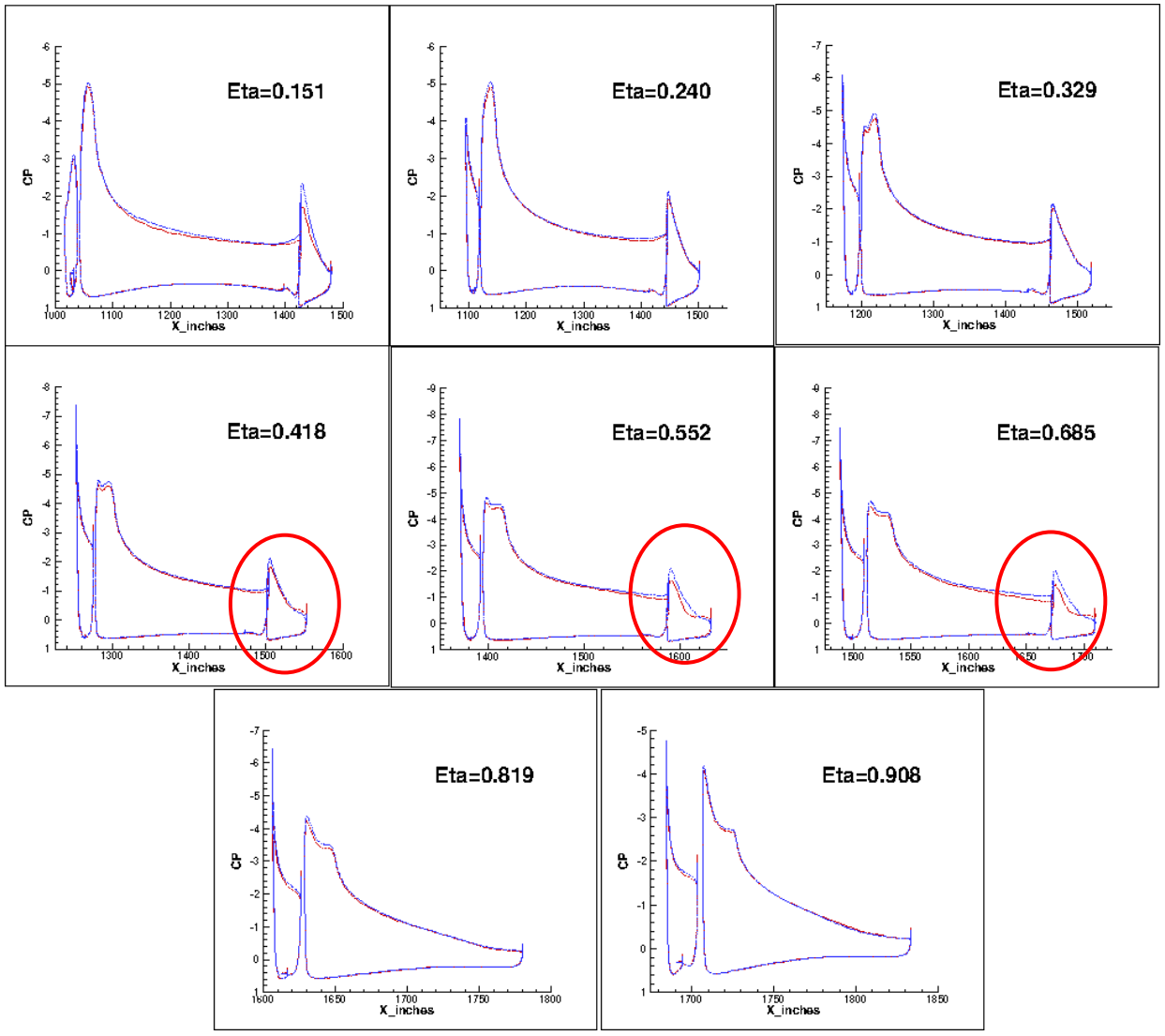


HL-CRM results – Alpha=16º
Effect of grid density (Coarse / Medium)

Computed pressure coefficients

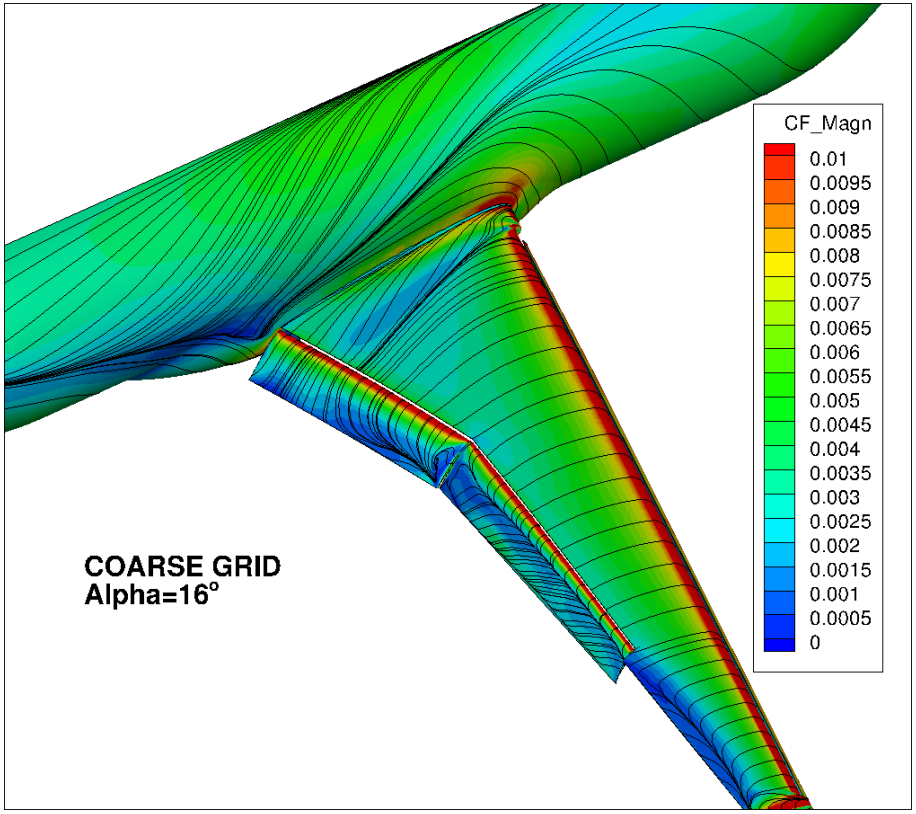


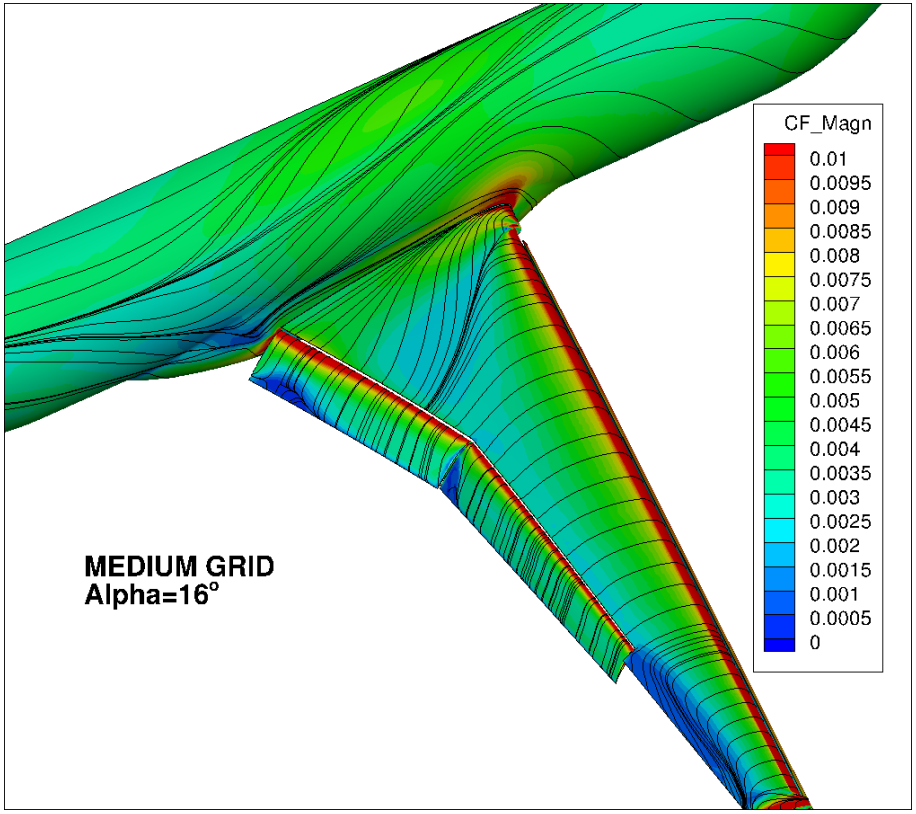




HL-CRM results – Alpha=16º
Effect of grid density (Coarse / Medium)

Computed friction lines





HL-CRM computations by Onera
Summary

Effects of grid density observed on flow solution computed on the flap:

Due to Mesh ? Numerics ?

Computation on Fine grid to be completed.

As there are no experimental data available (yet), it is planned to carry out computations on the structured multi-block grids provided in order to have reference numerical solutions.

No major difficulties encountered to run computations on cgns grid provided.