1st AIAA Sonic Boom Prediction Workshop

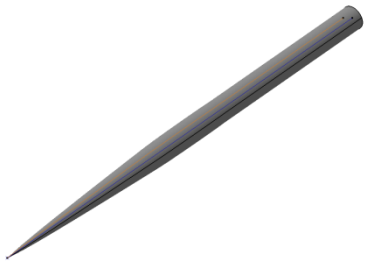
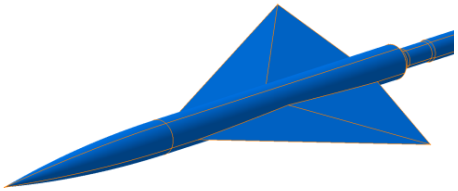
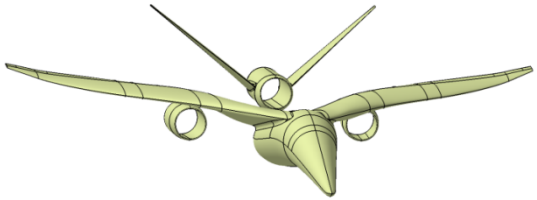
January 11, 2014 National Harbor, Maryland

Franck DAGRAU

HIGHER TOGETHER™

DASSAULT AVIATION

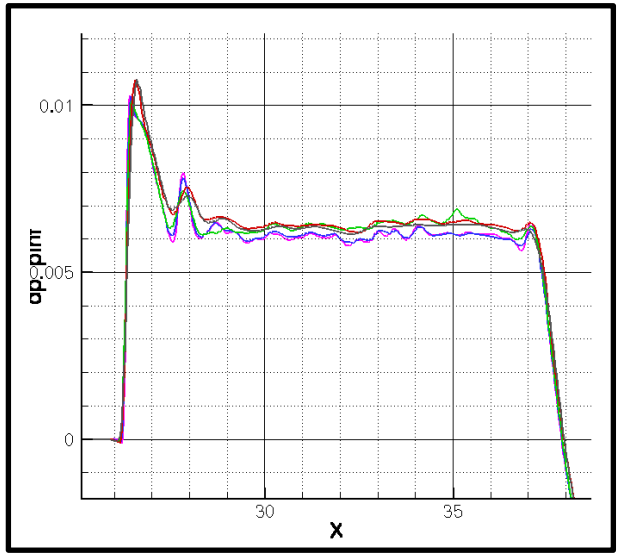
Summary of cases analyzed

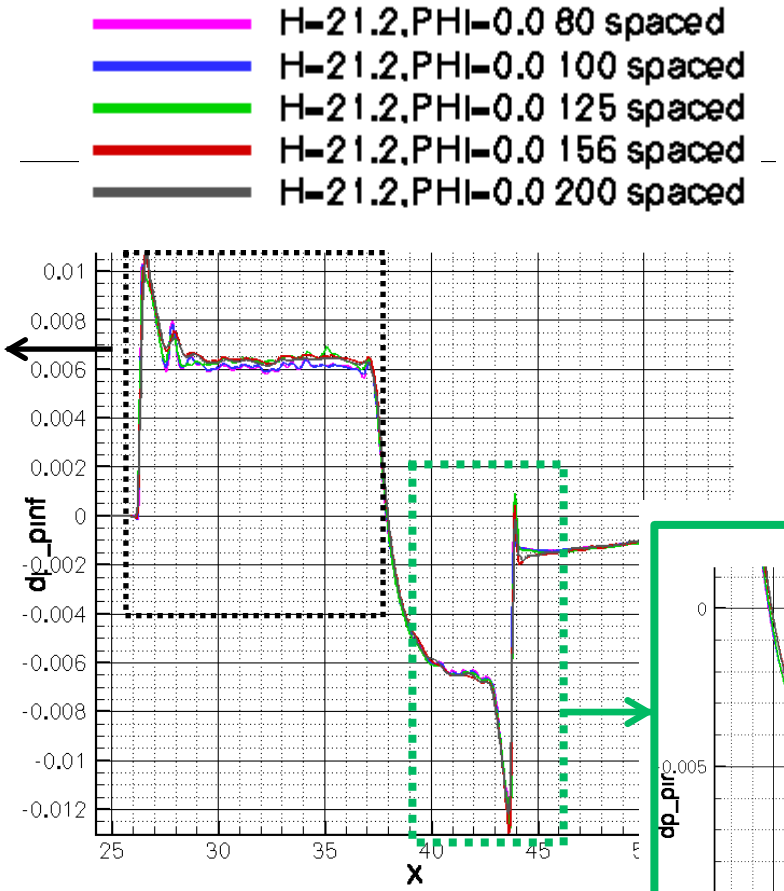
	Body Of Revolution	***69 degrees delta wing body***	***Lockheed Martin 1021***
Test cases			
Simulations conditions	• Euler, Osher-Muscl flux M=1.6, AoA=0°, β=0°	• Euler, Osher-Muscl flux M=1.7, AoA=0°, β=0°	• Euler, Osher-Muscl flux M=1.6, AoA=0°, β=0° • NS, Turbulent, Wall law, K-ε 212.470 Reynolds number per grid unit
Grids	*Workshop provided grids* • Tetrahedra – 2 in spaced • Tetrahedra – 1.56 in spaced • Tetrahedra – 1.25 in spaced • Tetrahedra – 1. in spaced • Tetrahedra – 0.8 in spaced	*Workshop provided grids* • Tetrahedra – 2 in spaced • Tetrahedra – 1.56 in spaced • Tetrahedra – 1.25 in spaced • Tetrahedra – 1. in spaced	*Workshop provided grids* • 1 unstructured grid available 2 millions nodes

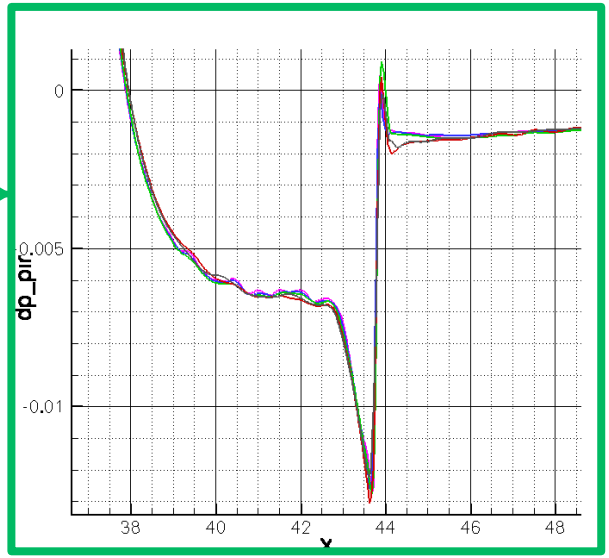
Dassault Aviation in-house Flow solvers

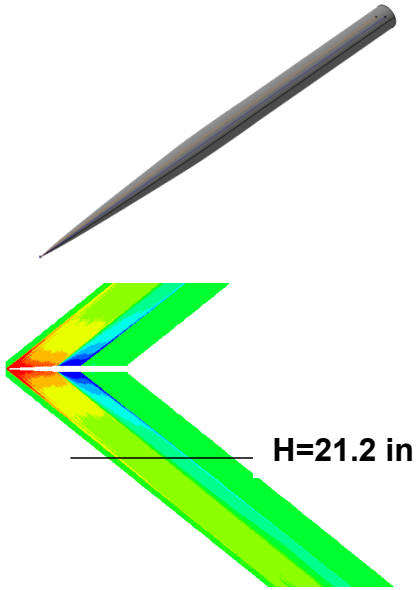
	EUGENIE	AETHER
• **Solver equations**	Euler	Navier Stokes
• **Grids**	Unstructured tetrahedral elements	
• **Domain decomposition**	Fully Parallelized using MPI	
• **Convergence to steady state algorithm**	Fully implicit iterative time-marching procedure based on GMRES algorithm	
• **Formulation**	Galerkin-Finite Volume cell vertex	Streamline Upwind Petrov Galerkin (SUPG) Stabilized finite element approach
• **Flux**	Lax-Wendroff, Jameson, Osher-MUSCL, Roe…	SUPG + Discontinuity Capturing operator
• **Turbulence modelling**		Wall-Law, Spalart-Allmaras,K-ε, K-ω, K-l, K-KL, LES, DES…

Signature convergence with grid resolution



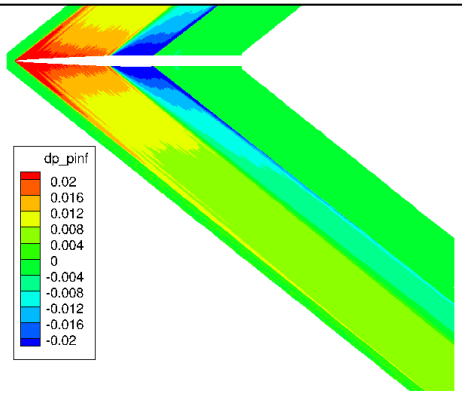


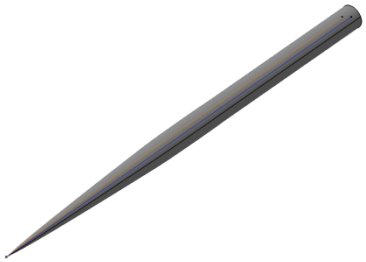




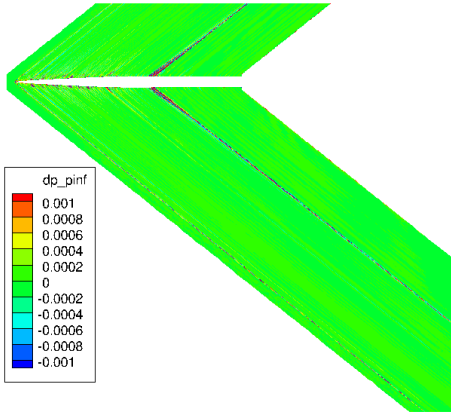
Absolute difference Dp/p symmetry plane cartography

Dp/p symmetry plane cartography for 0.8 in spaced grid

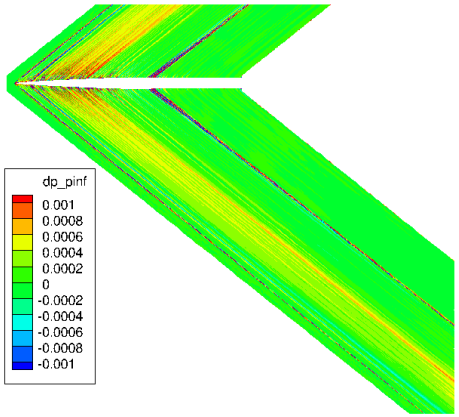




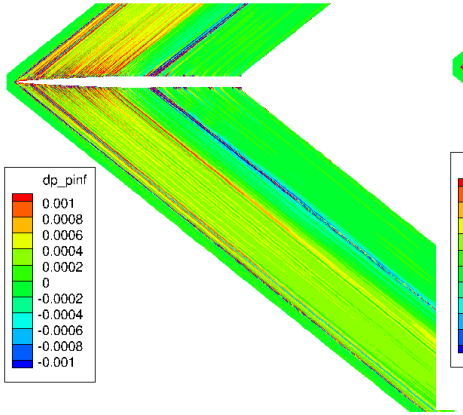
1 in spaced grid compared to 0.8 in spaced



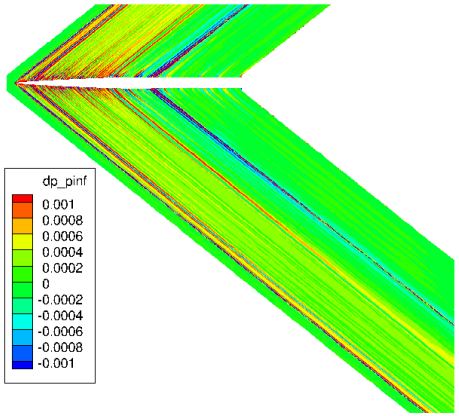
1.25 in spaced grid compared to 0.8 in spaced



1.56 in spaced grid compared to 0.80 in spaced

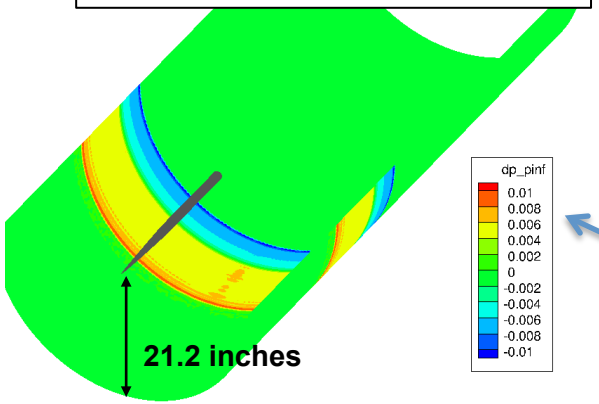


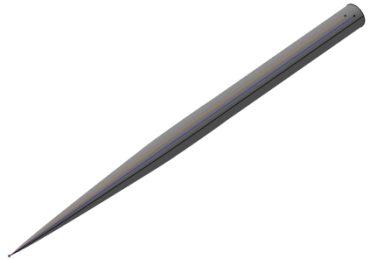
2. in spaced grid compared to 0.8 in spaced



Absolute difference Dp/p cylinder cartography

Dp/p cylinder cartography for 0.8 in spaced grid





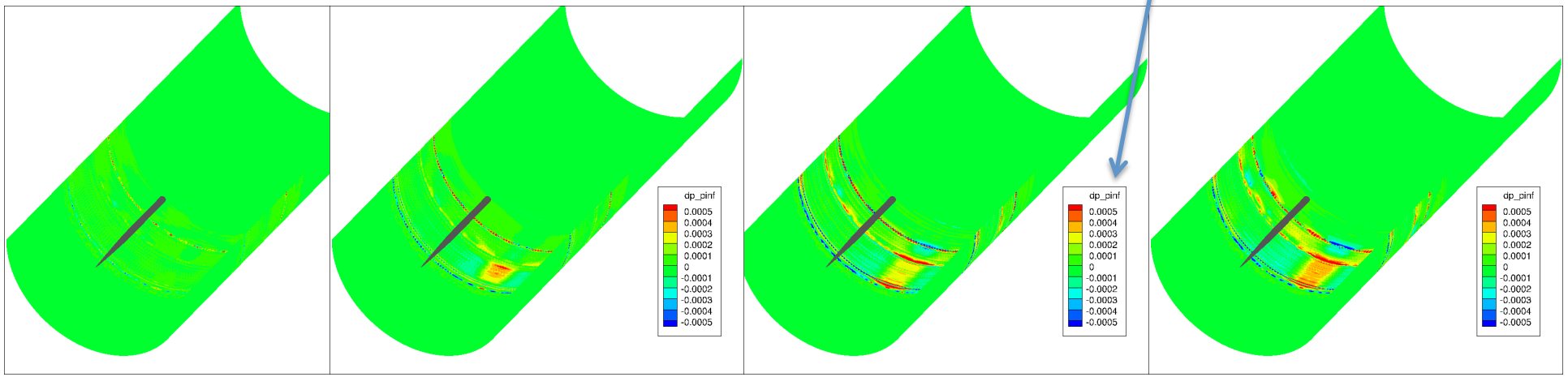
Ratio of 20 between the color scale level

1 in spaced grid compared to 0.8 in spaced

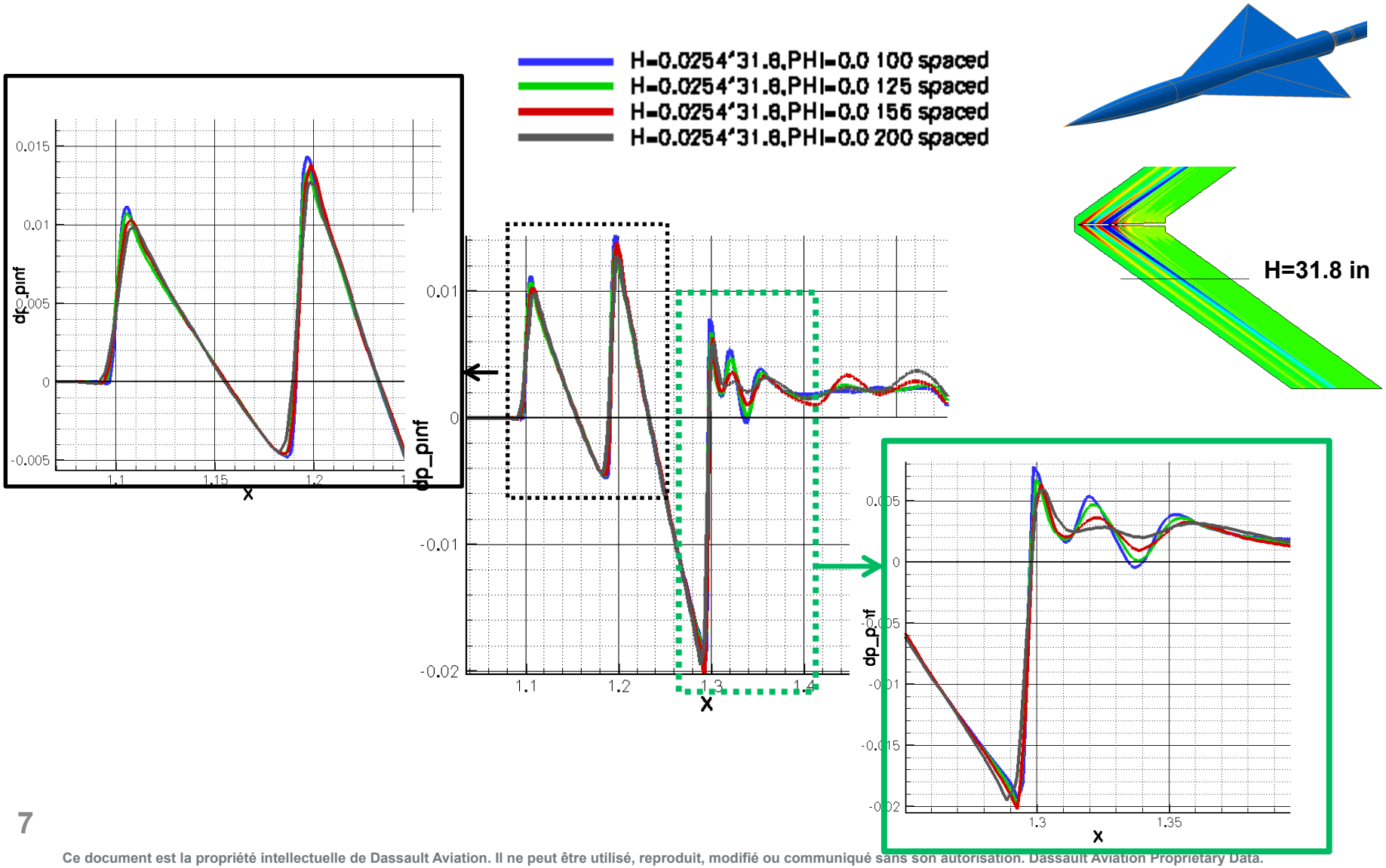
1.25 in spaced grid compared to 0.8 in spaced

1.56 in spaced grid compared to 0.80 in spaced

2. in spaced grid compared to 0.8 in spaced

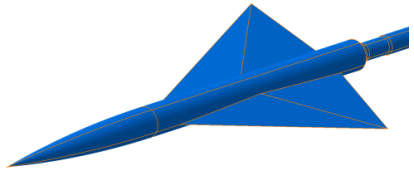


Signature convergence with grid resolution

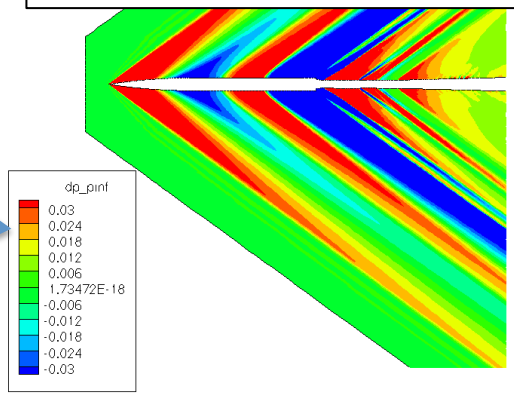


Absolute difference Dp/p symmetry plane cartography

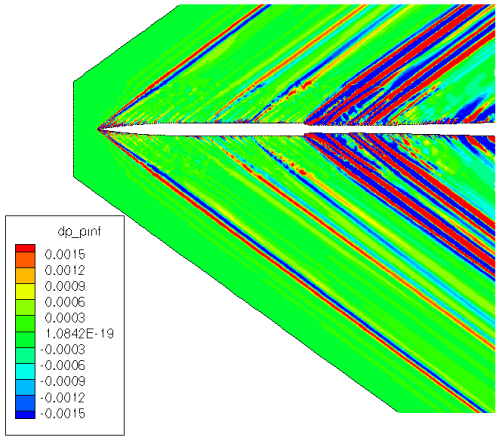
Dp/p symmetry plane cartography for 1 in Spaced grids



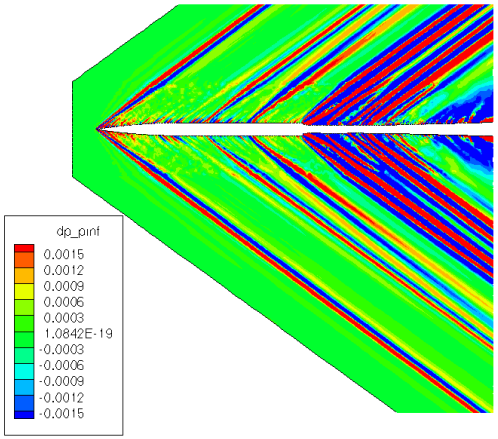
Ratio of 20 between the color scale level



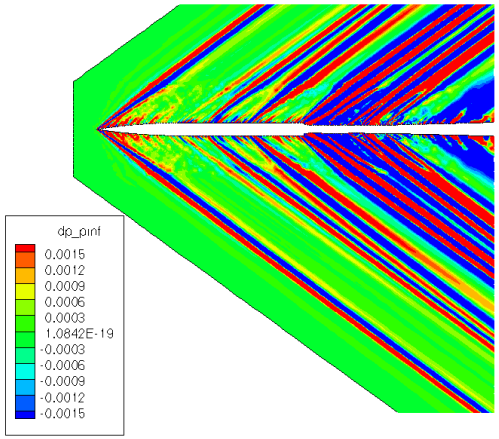
1.25 in spaced grid compared to 1 in spaced



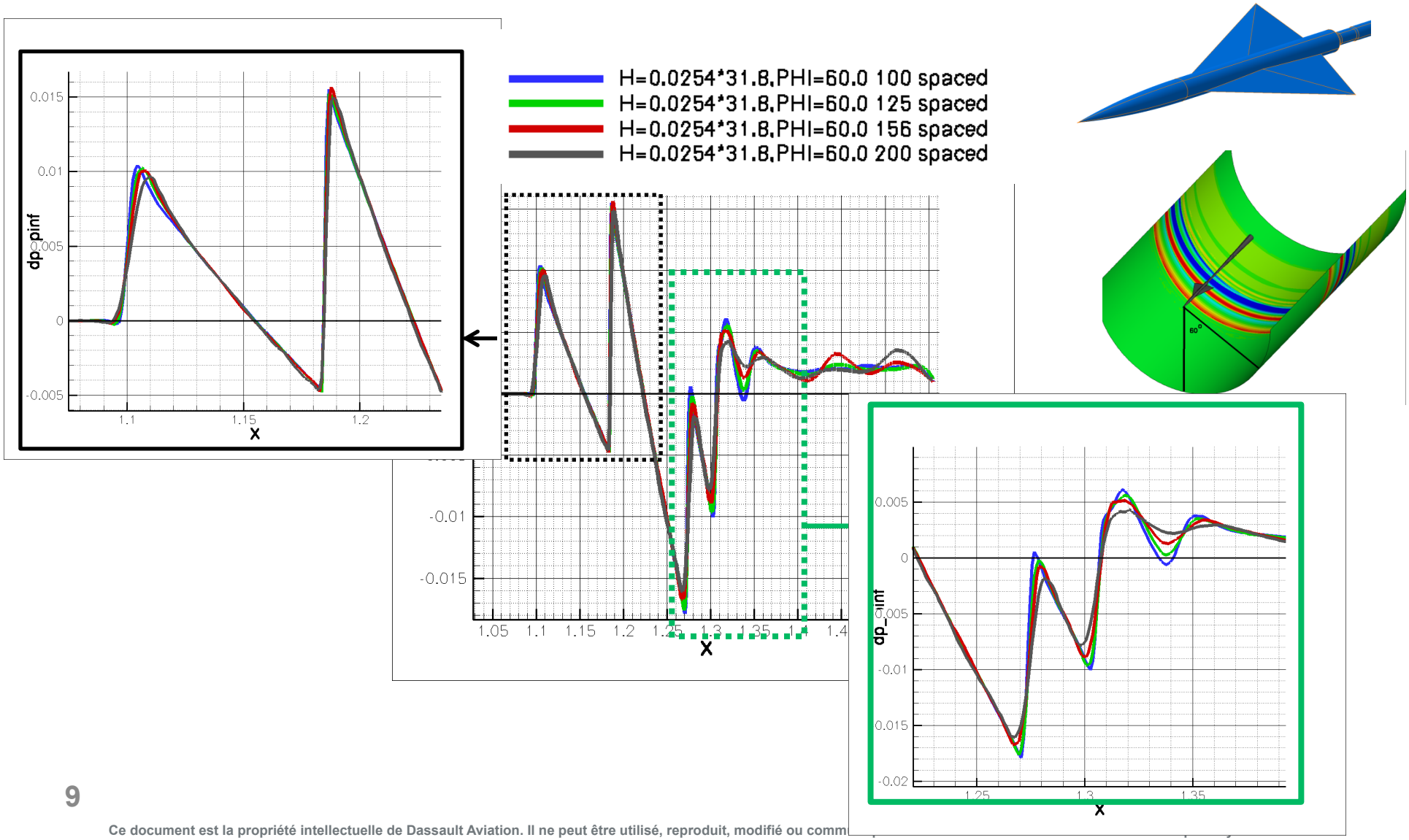
1.56 in spaced grid compared to 1 in spaced



2 in spaced grid compared to 1 in spaced

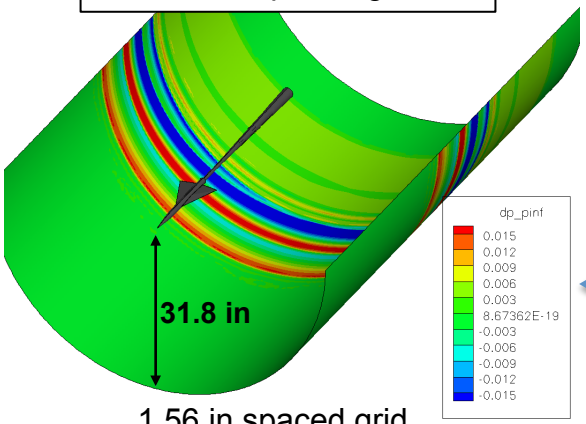


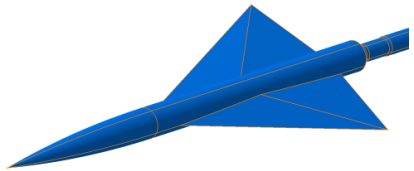
Azimuthal Signature convergence with grid resolution



Absolute difference Dp/p cylinder cartography

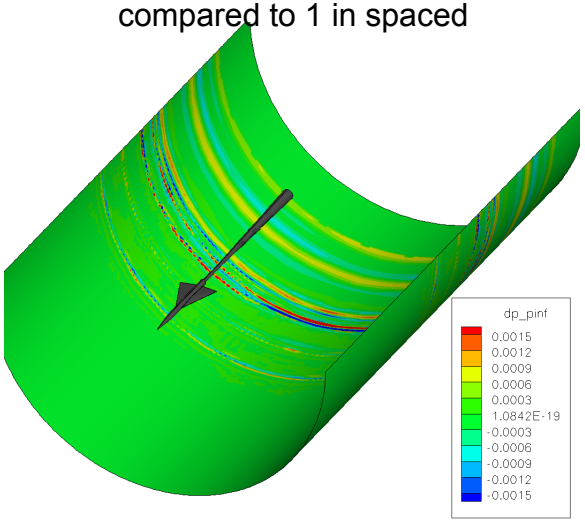
Dp/p cylinder cartography for 1 in Spaced grids



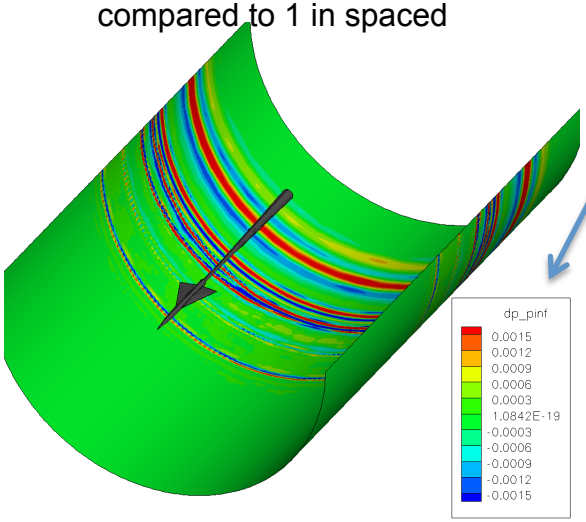


Ratio of 10 between the color scale level

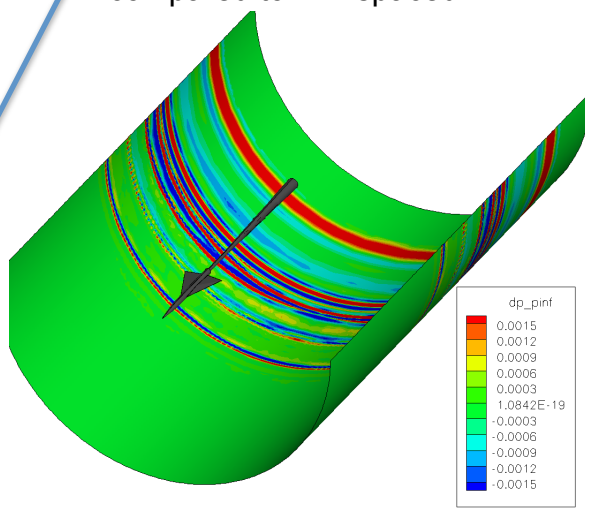
1.25 in spaced grid compared to 1 in spaced



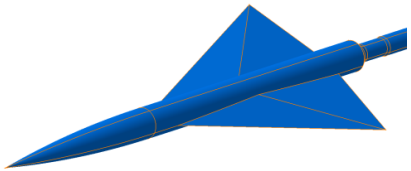
1.56 in spaced grid compared to 1 in spaced



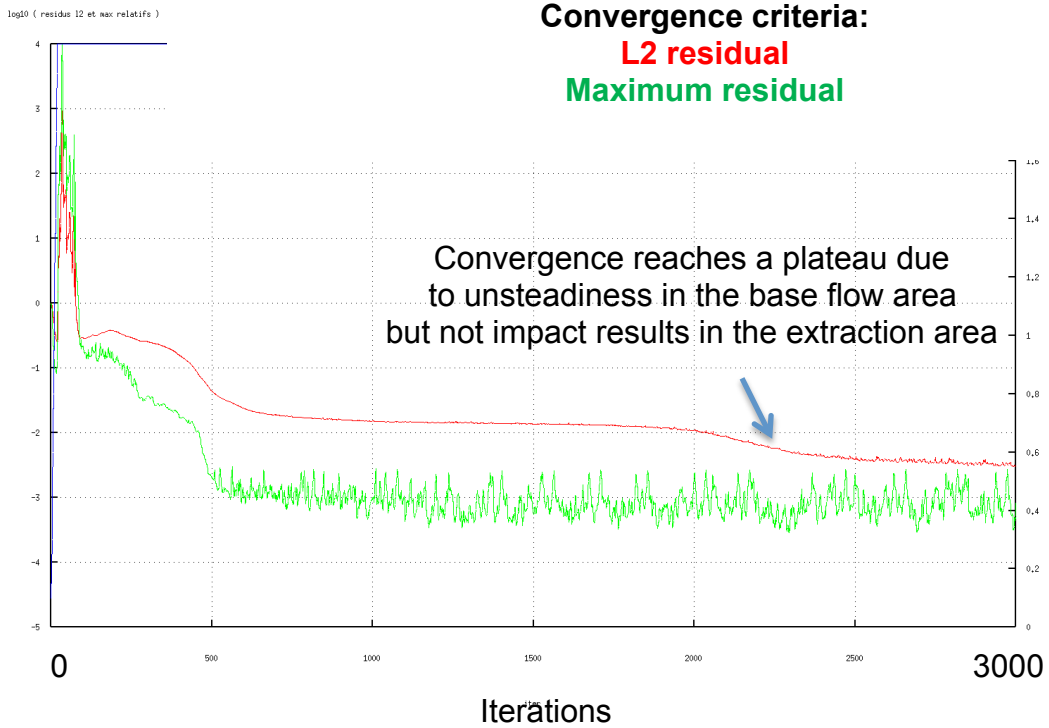
2. in spaced grid compared to 1 in spaced



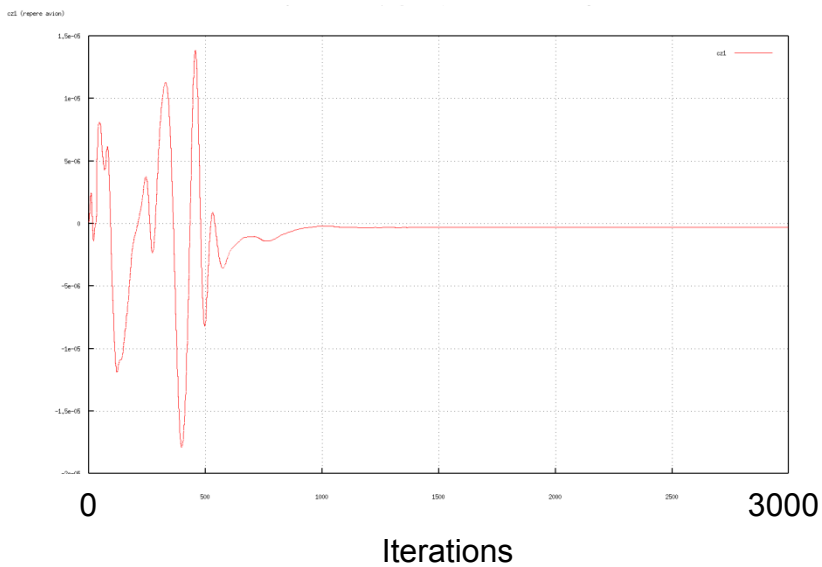
Flow solver typical convergence



Convergence criteria:
L2 residual
Maximum residual

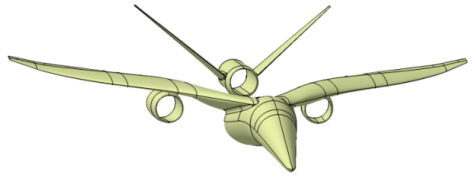


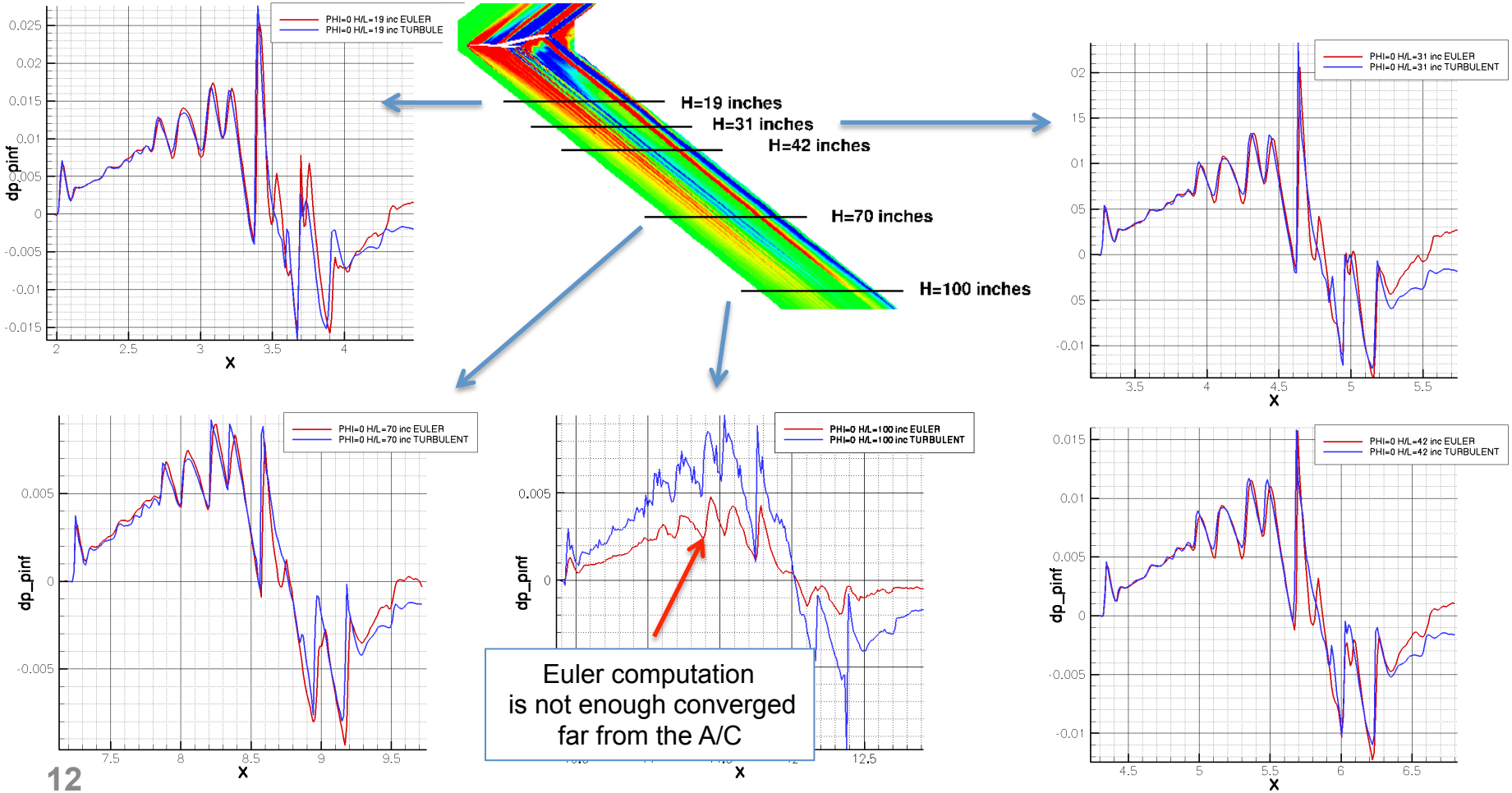
Lift coefficient history convergence



Signature extraction at different H

Comparing Euler and Navier Stokes near field extraction





Conclusions

- All test cases have been computed
- All unstructured grids provided by the workshop have been used
- Accurate results have been obtained with the proposed grids
- Good robustness observed on all meshes
- Acceptable prediction even with coarser mesh
- Proposed grids allow good convergence study
- Mesh technology well suited to the near field prediction