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Preliminary results of multi-fidelity analysis of HiReNASD wing

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Analysis tools

Non Linear Full Potential **NLFP**

- Unstructured, node-based, finite volume approximation, with linear/quadratic shape functions
- 1st/2nd order implicit integration schemes
- Unsteady entropy correction and embedded wake generation

Euler and RANS **AeroFoam**

- First density-based ALE RANS solver in OpenFOAM
- Coupled formulation in conservative variables
- 2nd order accurate limited Roe's Approximate Riemann Solver (ARS)
- Multi-Grid (MG) and parallel acceleration

HiReNASD wing

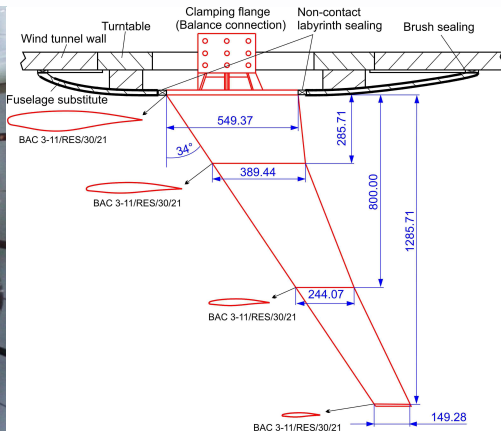
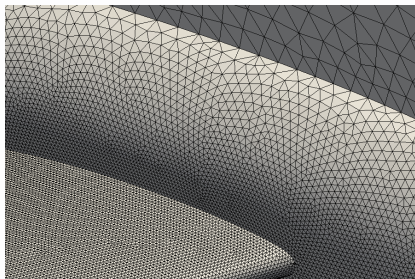
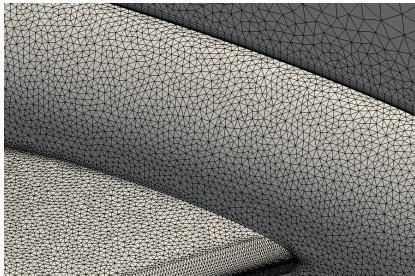


Figure: Experimental set-up for the HiReNASD project

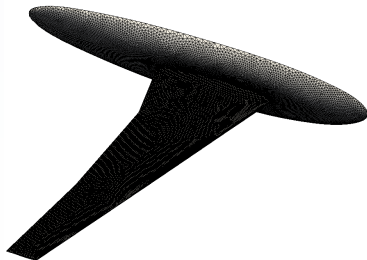
HiReNASD wing — Aerodynamic model



a)



b)



Multi-fidelity simulations:

a) NLFP and Euler

- 1M volume nodes
- 80K boundary nodes on wing

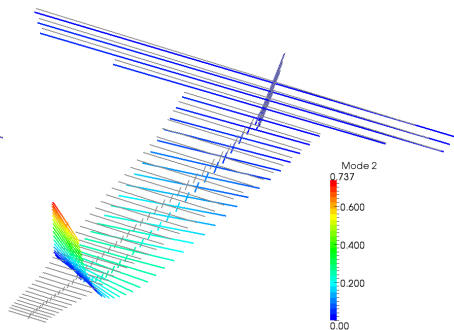
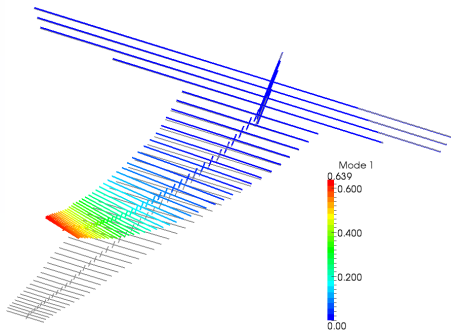
b) RANS + SA + WF

- 2M volume nodes
- 200K boundary nodes on wing

HiReNASD wing – Structural model

Mode	f [Hz]	Description
1	25.95	1 st bending
2	82.42	2 nd bending
3	117.58	1 st in-plane bending
4	168.42	1 st bending-torsion

Mode	f [Hz]	Description
5	258.38	3 rd bending
6	273.20	4 ^h bending
7	275.29	2 nd in-plane bending
8	275.29	2 nd bending-torsion



$M_\infty = 0.8, \alpha = 1.5^\circ$ – NLFP results

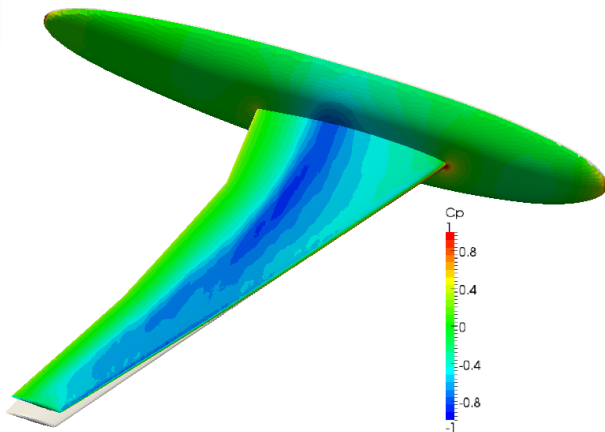


Figure: Pressure coefficient distribution C_p for NLFP model

$M_\infty = 0.8, \alpha = 1.5^\circ$ – Euler results

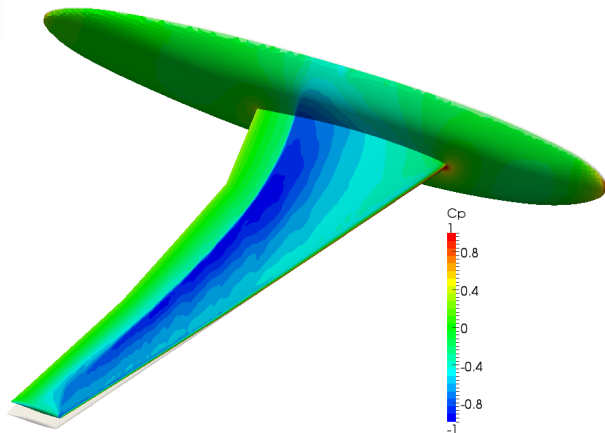


Figure: Pressure coefficient distribution C_p for Euler model

$M_\infty = 0.8, \alpha = 1.5^\circ$ – RANS results

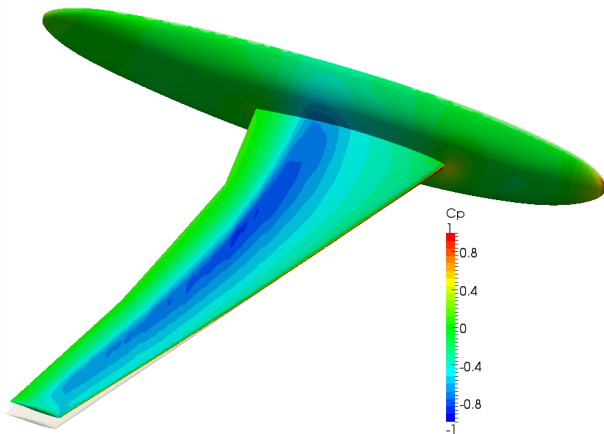


Figure: Pressure coefficient distribution C_p for RANS model

$M_\infty = 0.8, \alpha = 1.5^\circ$ – Pressure coefficient

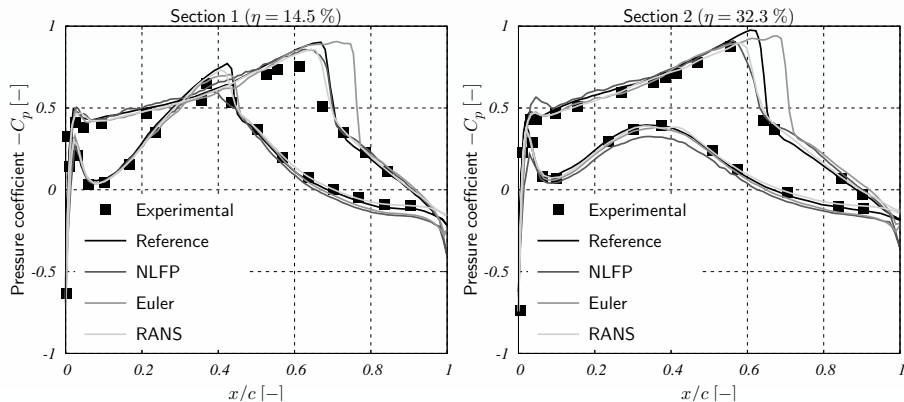


Figure: Pressure coefficient distribution C_p at Section #1 (left) and #2 (right)

$M_\infty = 0.8, \alpha = 1.5^\circ$ – Pressure coefficient

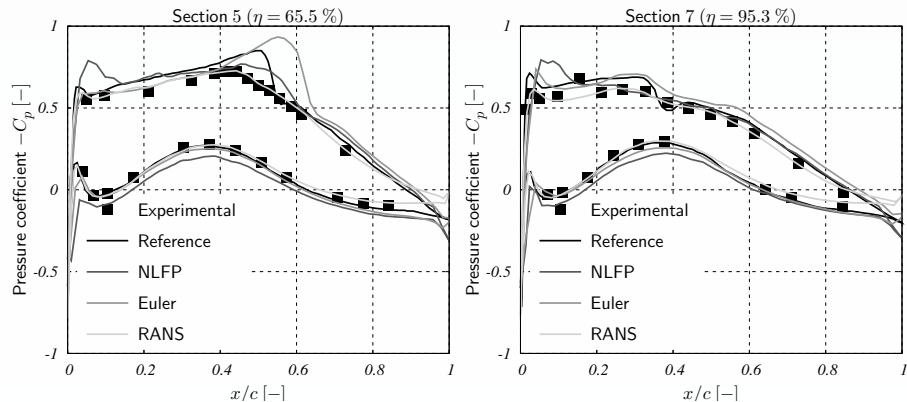


Figure: Pressure coefficient distribution C_p at Section #5 (left) and #7 (right)

$M_\infty = 0.8, \alpha = 1.5^\circ$ – NLFP results

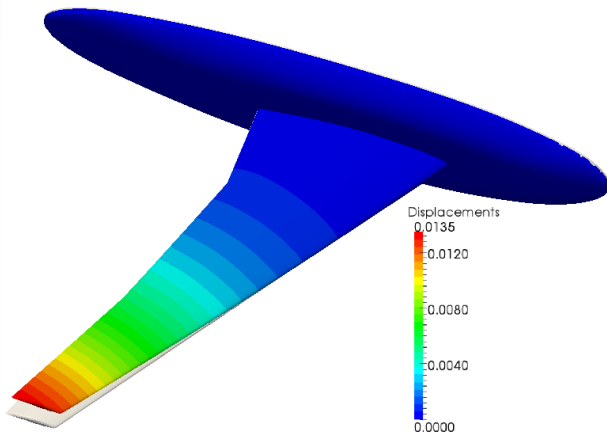


Figure: Structural displacements $|s|$ for NLFP model

$M_\infty = 0.8, \alpha = 1.5^\circ$ – Euler results

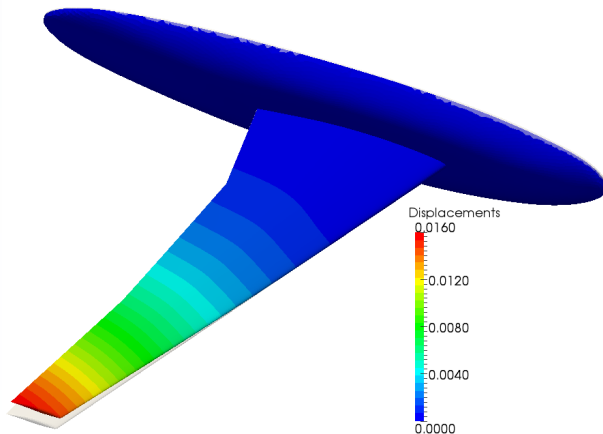


Figure: Structural displacements $|s|$ for Euler model

$M_\infty = 0.8, \alpha = 1.5^\circ$ – RANS results

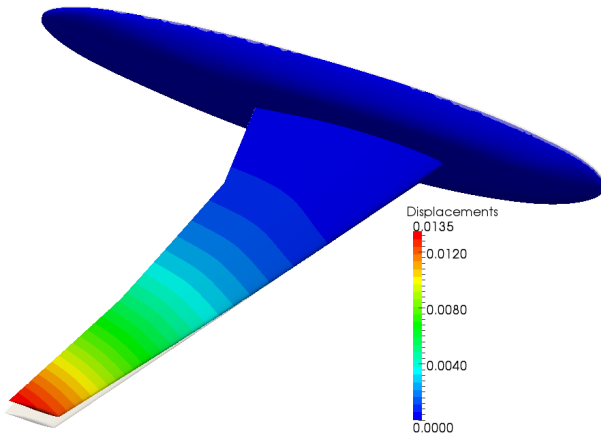


Figure: Structural displacements $|s|$ for RANS model

Angle-of-attack sweep

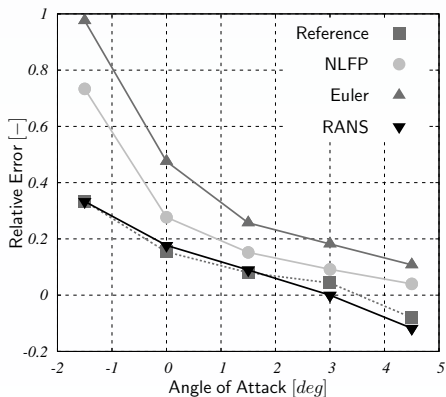
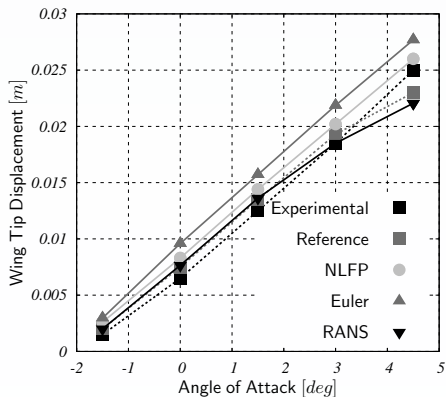


Figure: Wing tip displacement (left) and relative error with experimental data (right)