01. RBF-MORPH
FSI-ACTIVITY
MESH MORPHING TOOL
CONCLUSIONS

RBF-MORPH

FSI ACTIVITY: MOTORSPORT APPPLICATION INDY CAR

Indy configuration of the IR5 formula car

It's important to investigate the front wing deformation to:

- Evaluate the influence on the front loads (performance)
- Evaluate the maximum deformation (structural safety and rules book)

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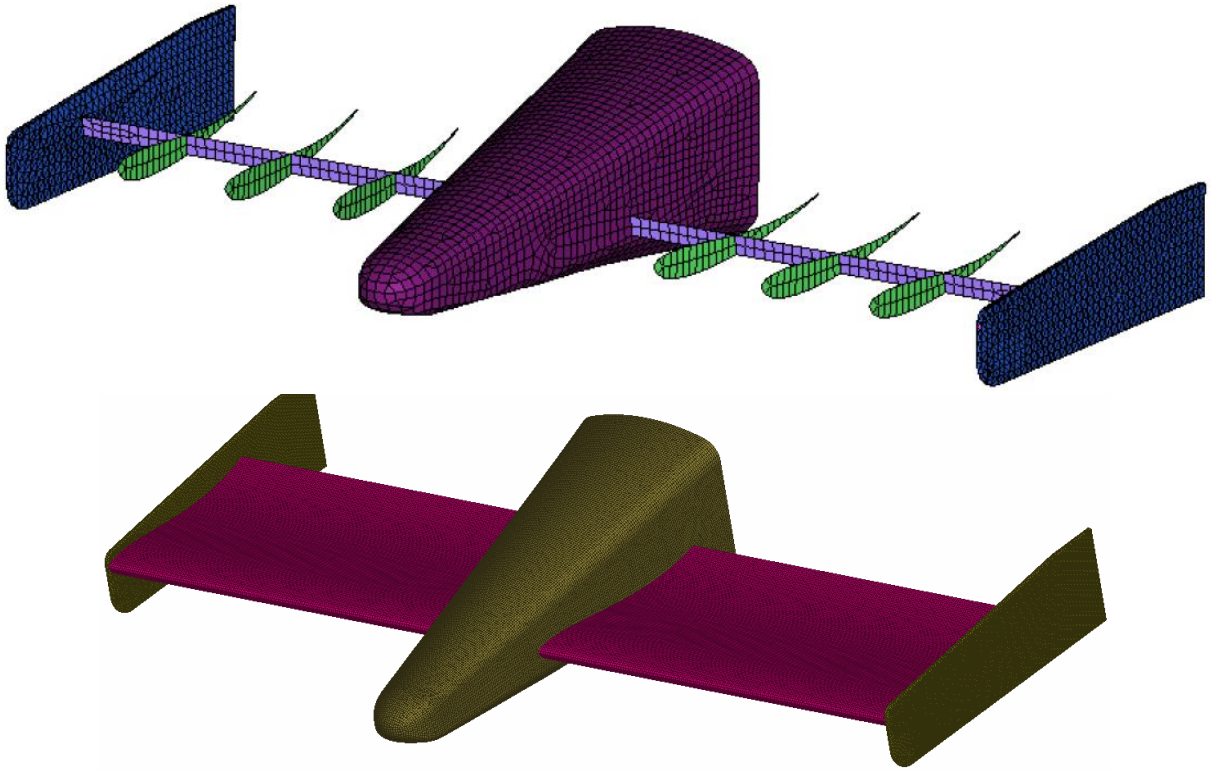
FSI ACTIVITY: INDY CAR IR5, FEM MODEL



Detailed materials description and constraints imposition for each physical component. Particular attention has been taken in order to correctly represent the carbon properties in terms of lamination and fibers orientation.

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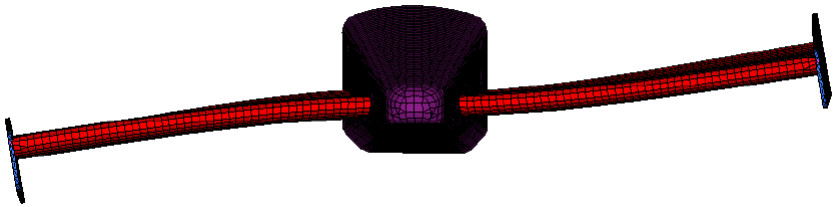
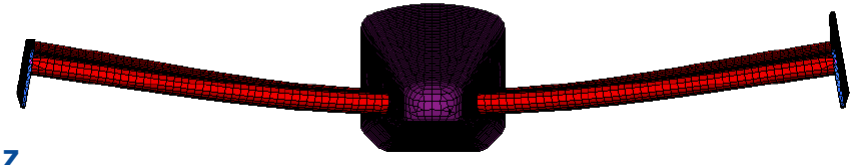
FSI ACTIVITY: INDY CAR IR5, FEM MODES

The modal analysis of the FEA model shows that the first 5 modes are significant (shape and frequency) to describe the deformation of the front wing assembly.

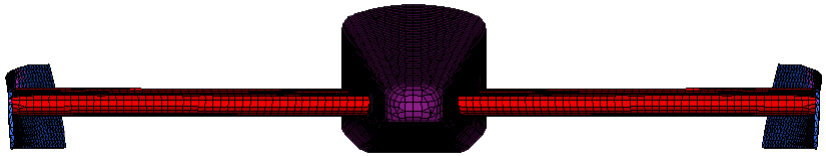
Mode 1: f = 27.29 Hz



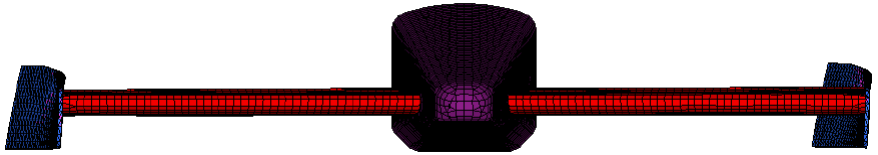
Mode 2: f = 29.04 Hz



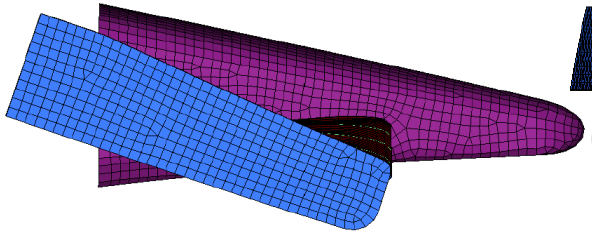
Mode 3: f = 57.84 Hz



Mode 4: f = 57.85 Hz



Mode 5: f = 88.57 Hz



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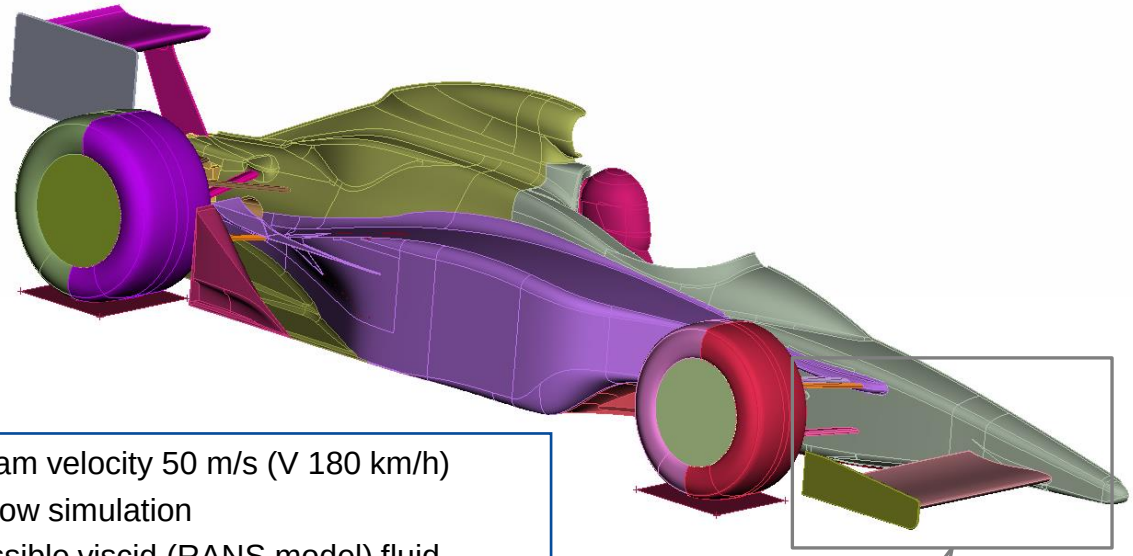
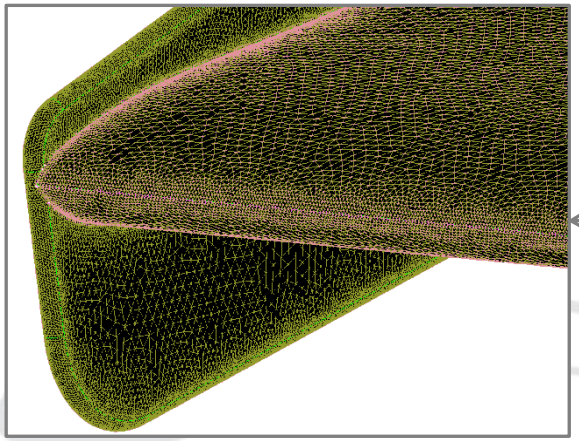
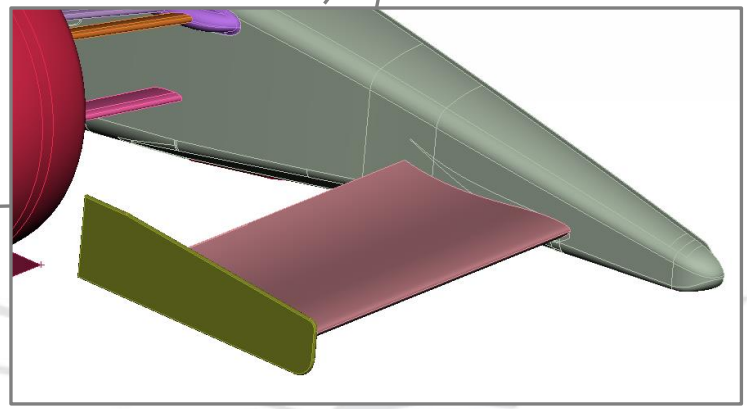
FSI ACTIVITY: INDY CAR IR5, CFD MODEL



Freestream velocity 50 m/s (V 180 km/h)
Steady flow simulation
Compressible viscid (RANS model) fluid





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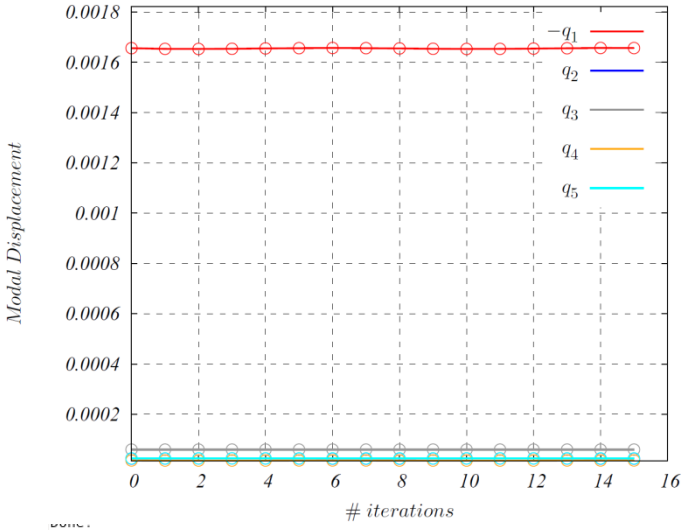
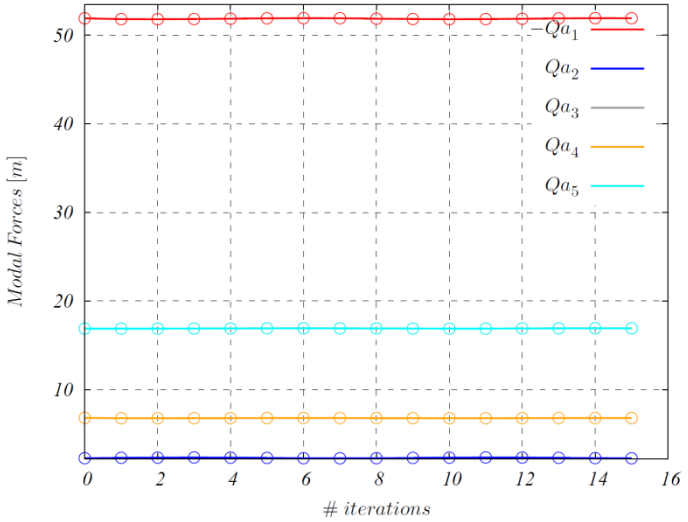
FSI ACTIVITY: INDY CAR IR5

Iterative loop

An iterative loop has been implemented to obtain the static aeroelastic equilibrium.






```
-- Convergence on Mode #1 --
iter     = 1          2          3          4          5          6          7          8          9
Delta Qa = 0.17470%   0.02527%   0.04021%   0.08436%   0.08077%   0.03363%   0.03165%   0.08241%   0.08517%
-- Convergence on Mode #2 --
iter     = 1          2          3          4          5          6          7          8          9
Delta Qa = 1.88489%   1.09139%   0.61667%   0.59139%   1.38882%   1.43591%   0.67074%   0.53028%   1.39858%
-- Convergence on Mode #3 --
iter     = 1          2          3          4          5          6          7          8          9
Delta Qa = 0.00719%   0.02707%   0.03973%   0.08003%   0.07481%   0.03062%   0.03031%   0.07769%   0.08010%
-- Convergence on Mode #4 --
iter     = 1          2          3          4          5          6          7          8          9
Delta Qa = 0.56809%   0.04595%   0.04571%   0.11358%   0.10389%   0.03395%   0.05235%   0.11180%   0.10513%
-- Convergence on Mode #5 --
iter     = 1          2          3          4          5          6          7          8          9
Delta Qa = 0.00720%   0.02708%   0.03974%   0.08002%   0.07482%   0.03062%   0.03031%   0.07770%   0.08010%
```

The modal convergence is achieved after just 4!!

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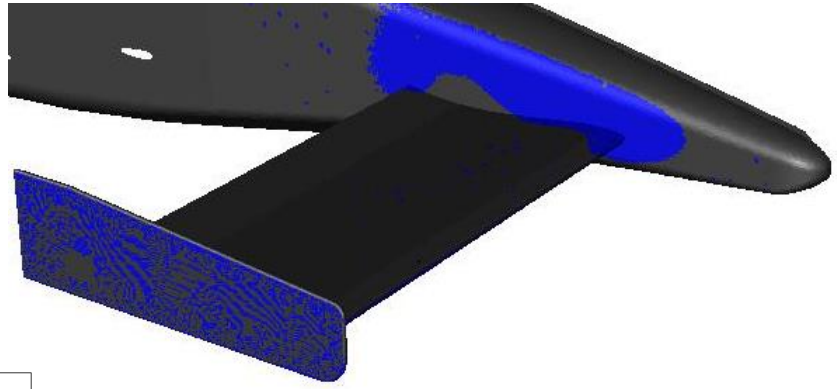
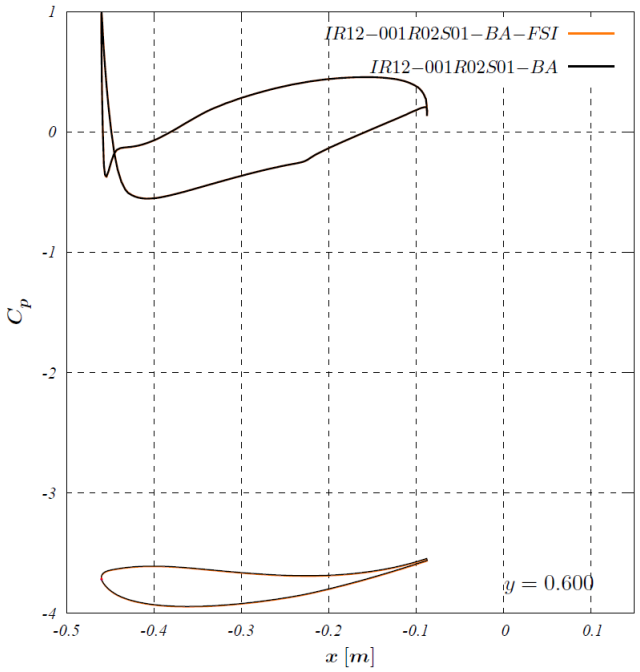
FSI ACTIVITY: INDY CAR IR5





Delta displacement with the 1st iter.	6%
Delta 1st iter – FSI-mapping	5%

PERFORMANCE: The aeroelastic deformation produces a quite small displacement. The aerodynamic performance is not influenced in this front wing configuration.

STRUCTURAL SAFETY: The maximum displacement is complitely acceptable (design and rules check), according to the structural characteristics.

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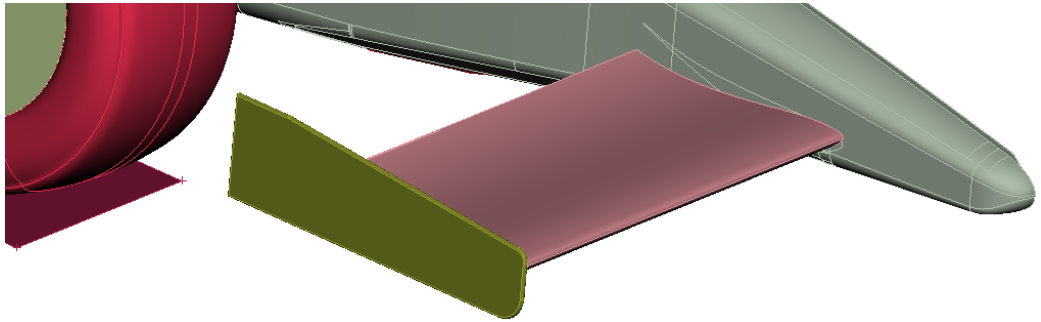
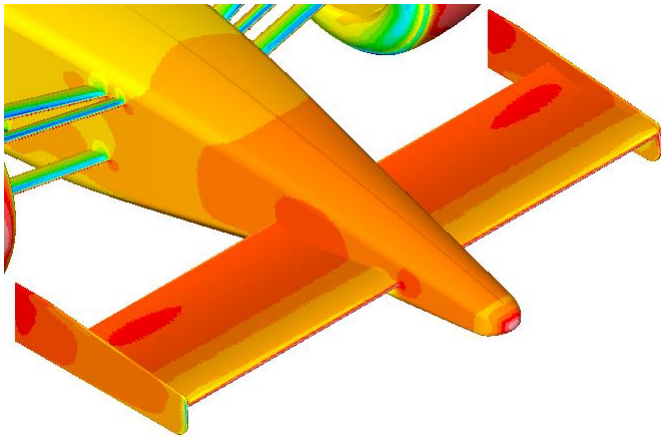
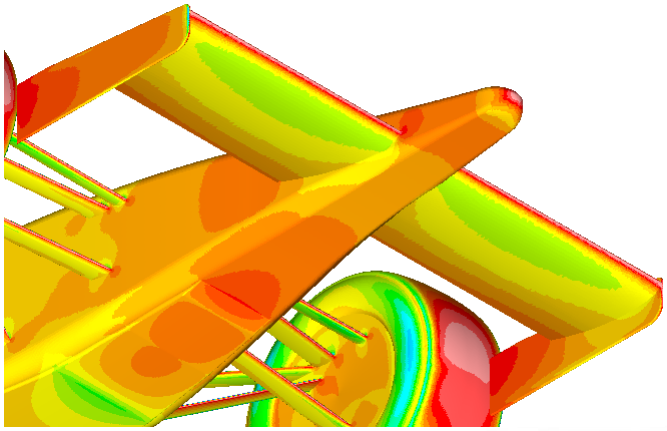
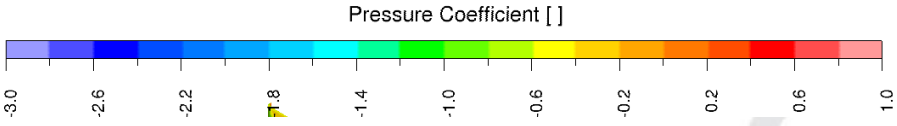
IR5 FRONT WING SLOPE



Ref. angle = -1.5° nose up, Indy configuration







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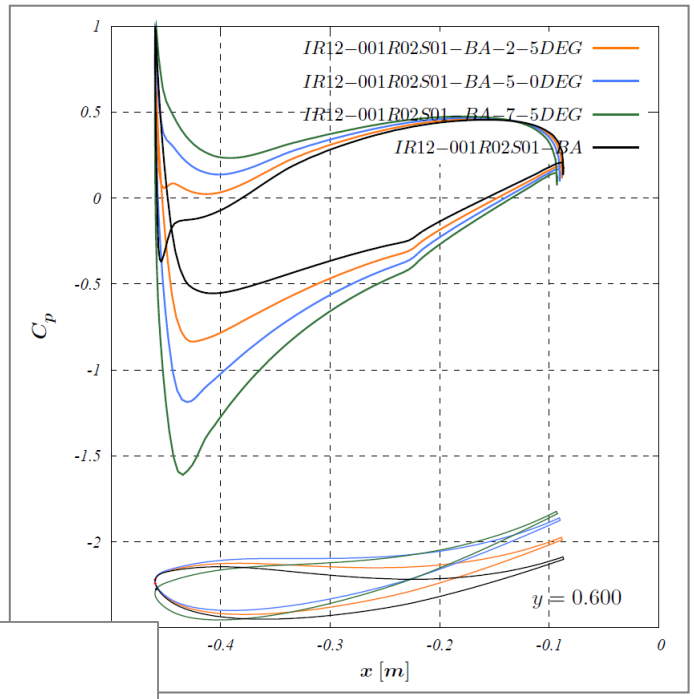
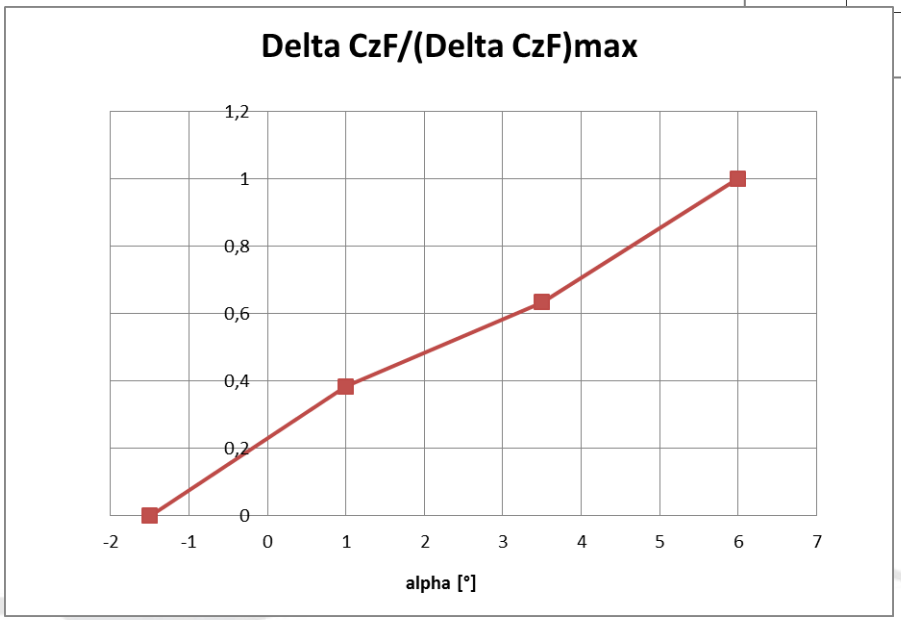
IR5 FRONT WING SLOPE

Thanks to the RBF-morph it has been possible to achieve the rear wing slope results in just 3h of computational time.





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RBF-MORPH
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- The RBF-morph tool has been tested for complex applications and it proves to well perform
- The aeroelastic loop has been implemented thanks to RBF-morph. The resulting displacement solution and loads distributions are consistent with the expectations
- A rear wing slope application has been tested

But remember: limitations!

- RBF-morph is based on the mesh deformation, this means that just “small” perturbation from the original status are allowed.