



First Flight of the Inverted Joined-wing Demonstrator and Beyond



Cezary Galiński – Instytut Lotnictwa



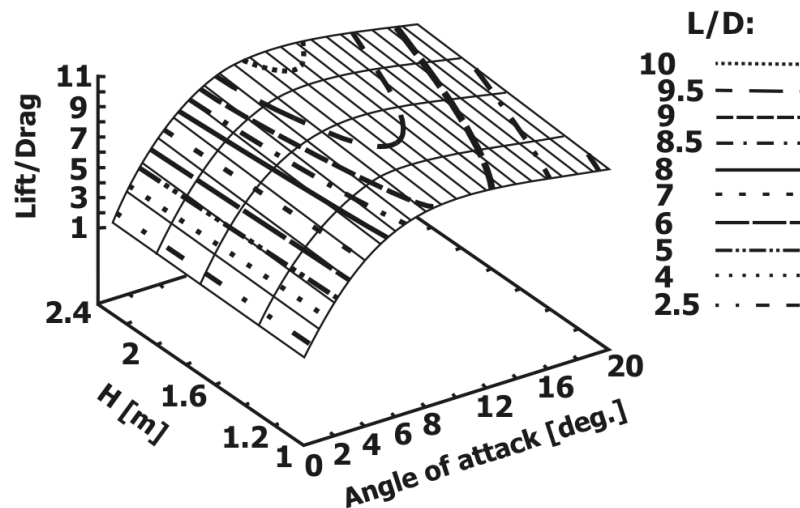
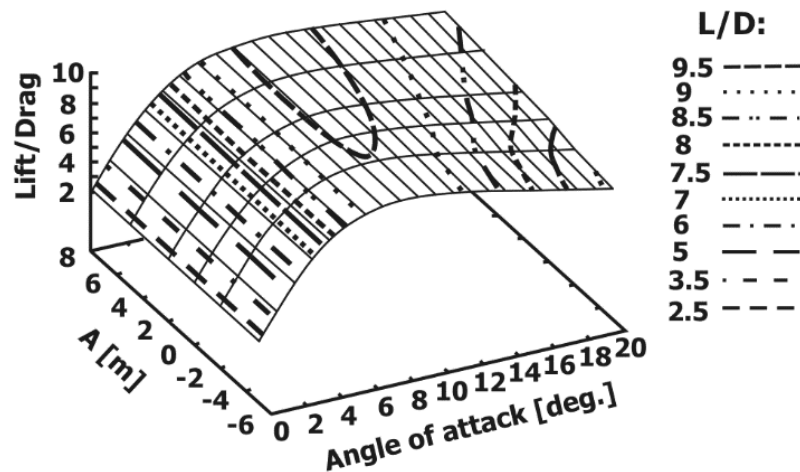
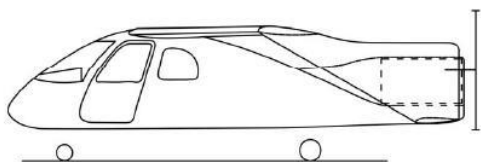
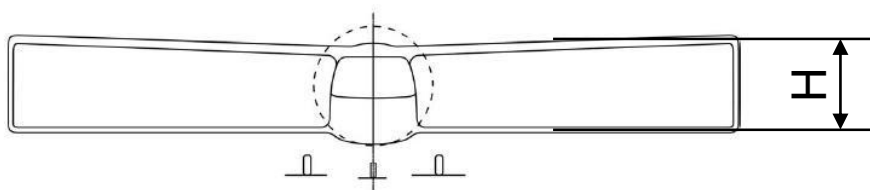
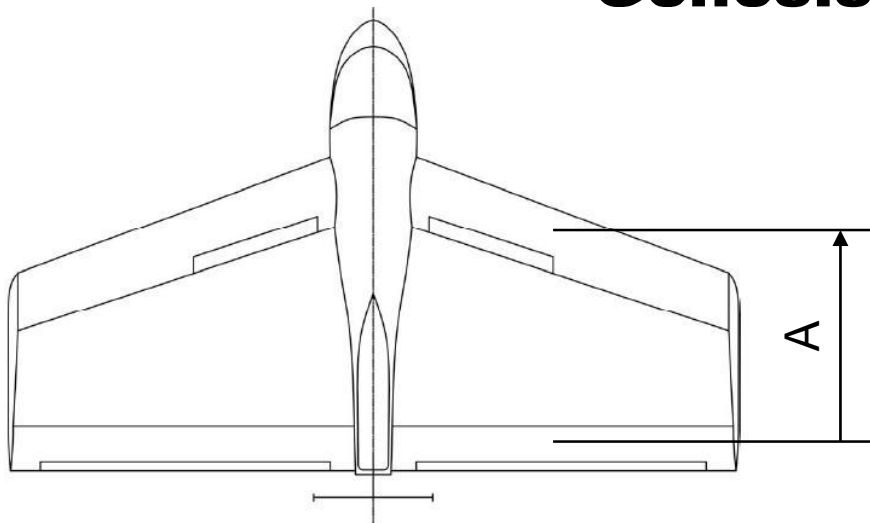
Jarosław Hajduk – Instytut Techniczny Wojsk Lotniczych



Jacek Mieloszyk – Politechnika Warszawska



Genesis of the programme [1, 2]





The goal of the programme

- 1. To learn as much as possible about inverted joined wing configuration**
- 2. To develop tools for multidisciplinary optimization of radical airplane configurations**
- 3. To built flying demonstrator which could be converted into UAV**



Structure of the programme [3]

Multidisciplinary optimization software development

Preparatory experiment

CFD analysis
and optimization

Wind tunnel testing

Flight testing



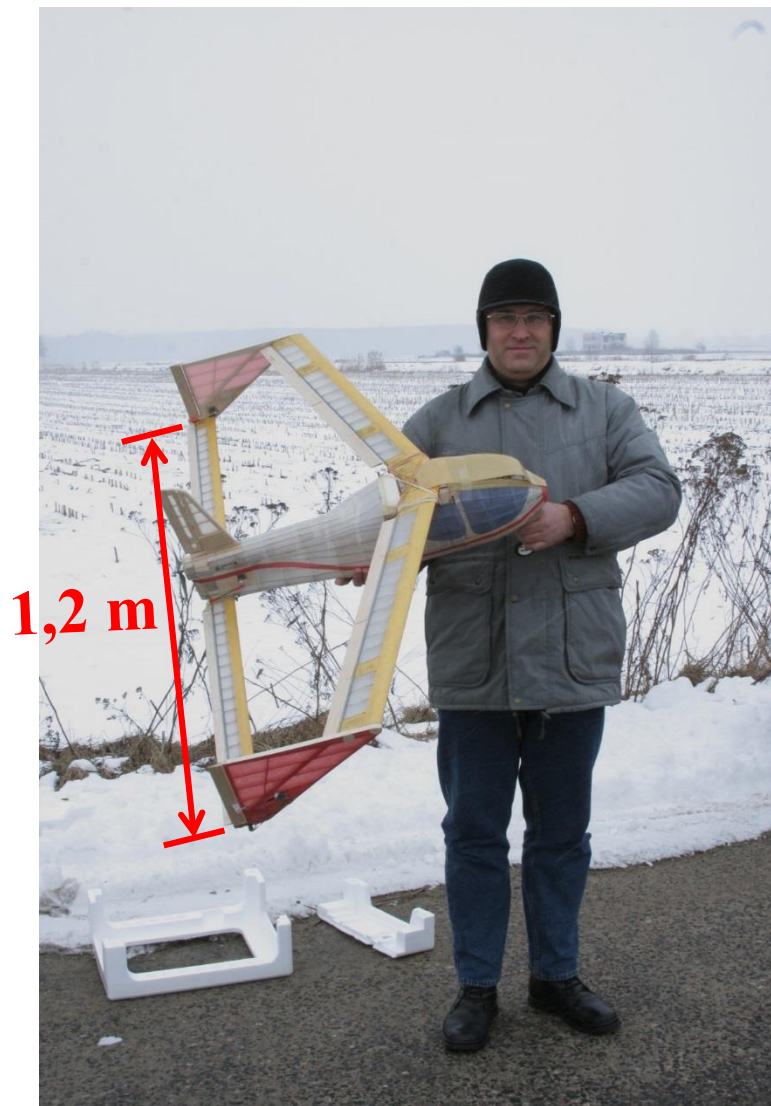
The goal of the flying demonstrator experiment

1.To learn as much as possible about inverted joined wing handling qualities

2.To built flying demonstrator which could be converted into UAV

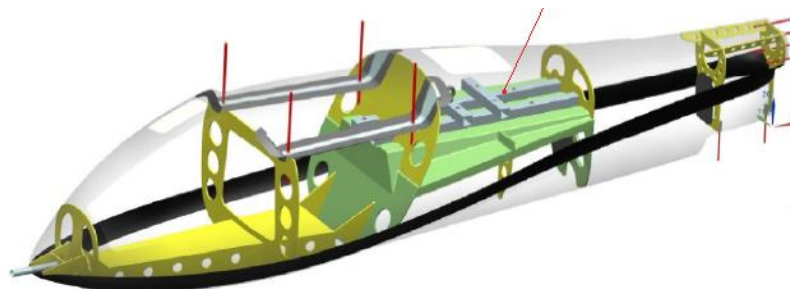
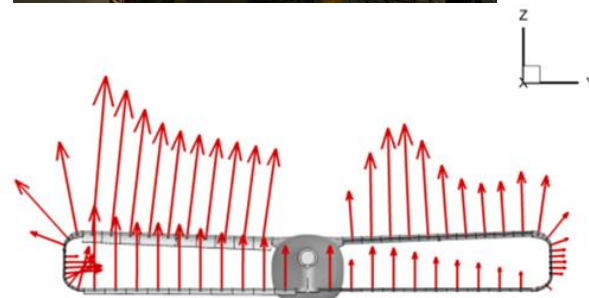
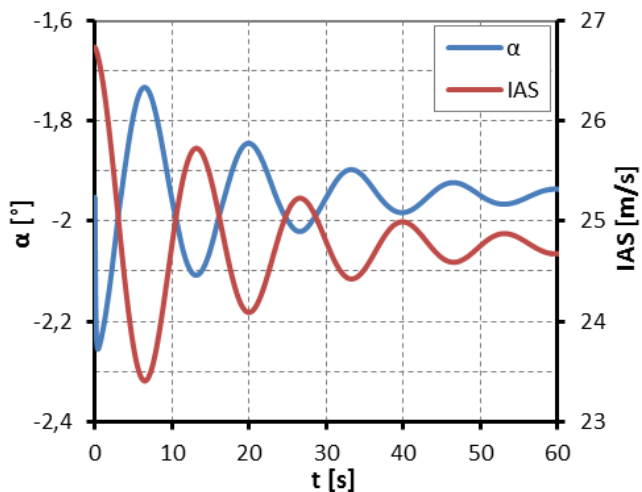
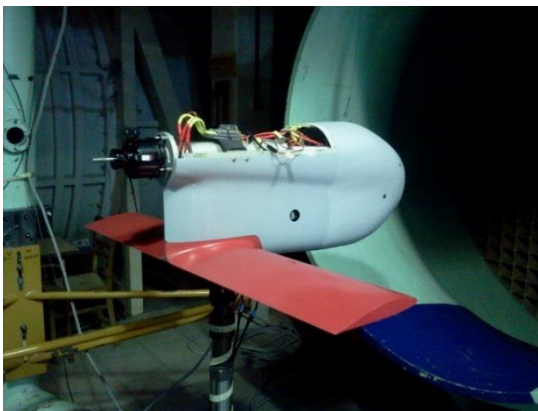
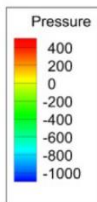
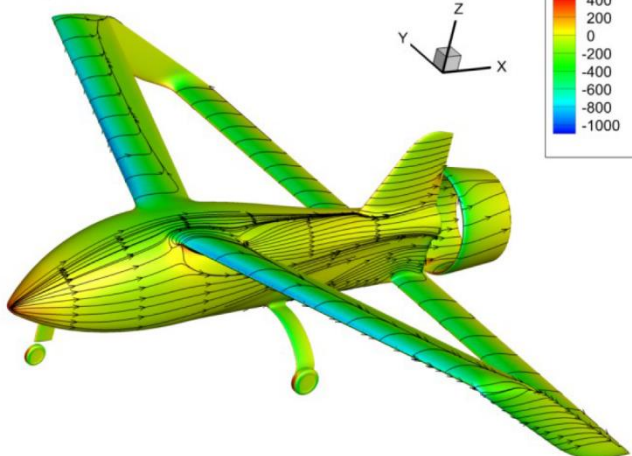


Tested UAVs



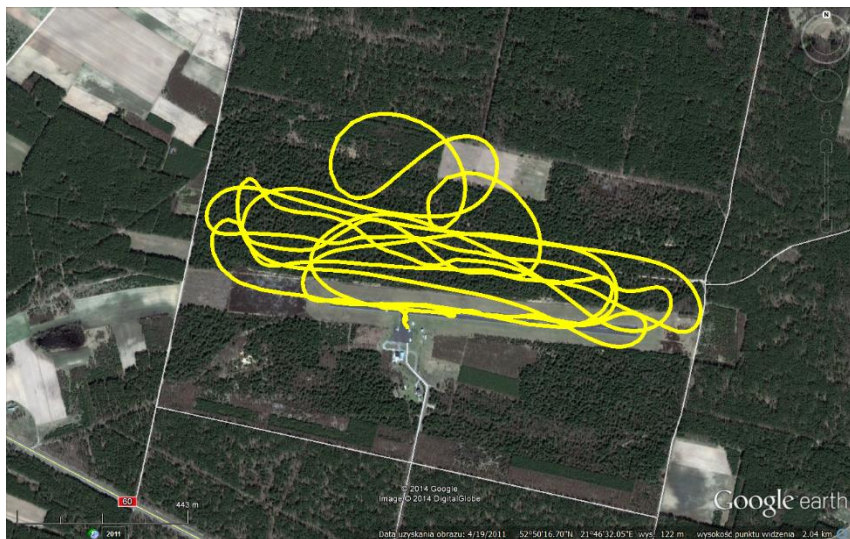
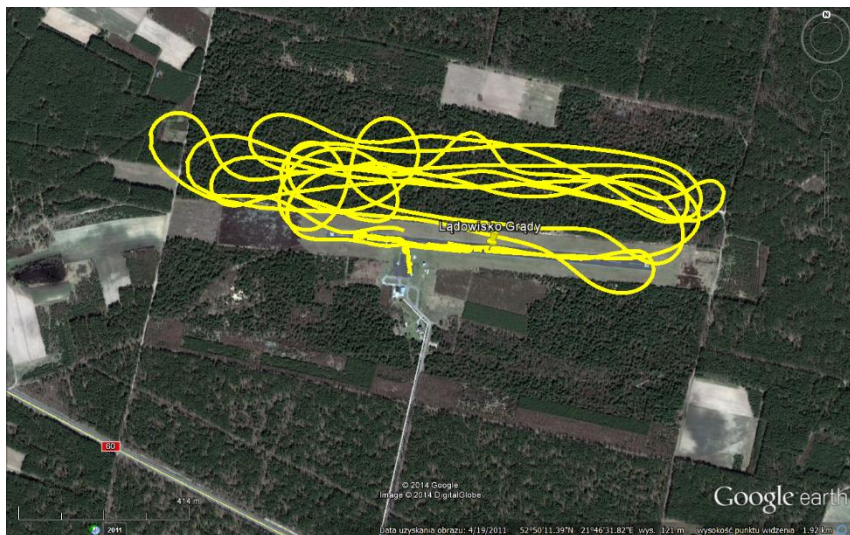
Analyses and laboratory measurements [4, 5, 6, 7]

MOSUPS_20130402_S2027
v=25 m/s h=0 m n.p.m.
Alpha = 8°



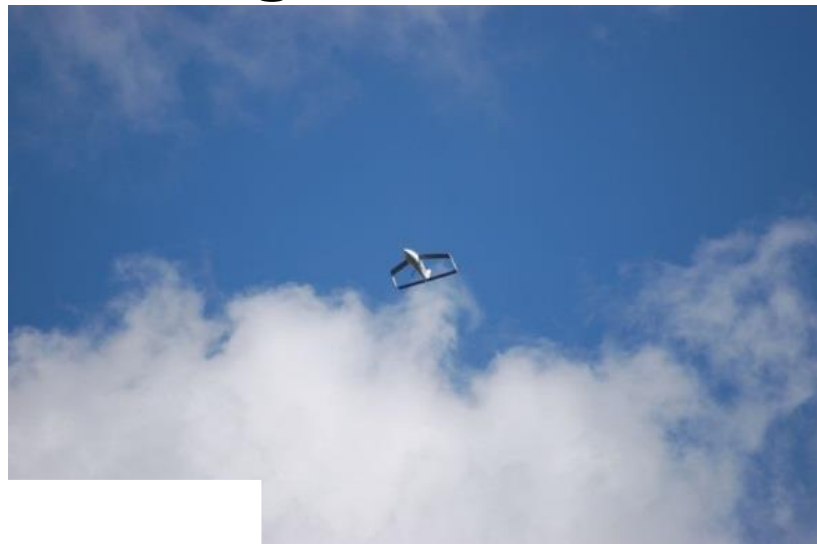


First and second flights





First and second flights

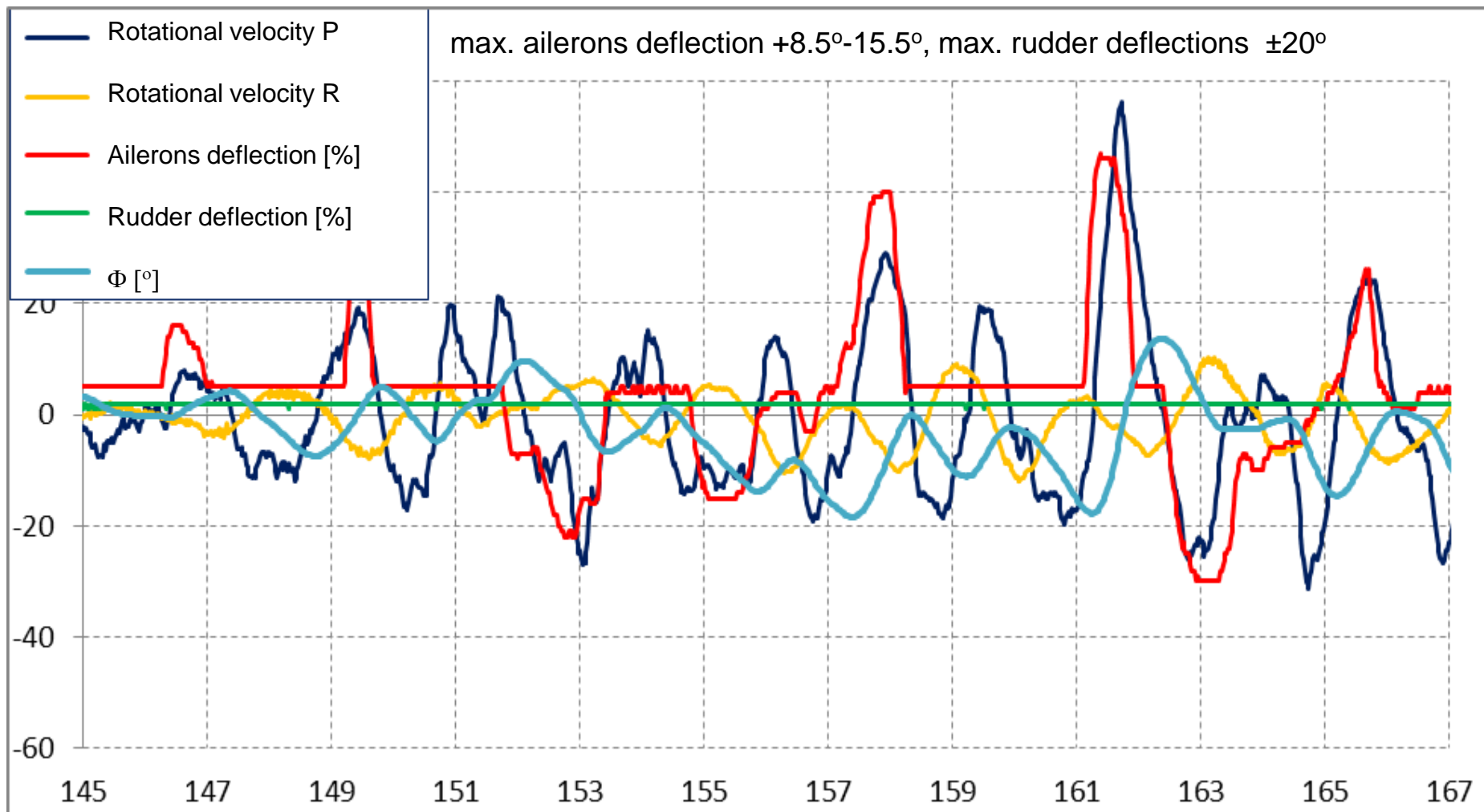


<http://youtu.be/EIXQzPhTayo>





First flight with aft CG and in windy weather





Structure of the programme

Multidisciplinary optimization software development

Preparatory experiment

CFD analysis
and optimization

Wind tunnel testing

Flight testing

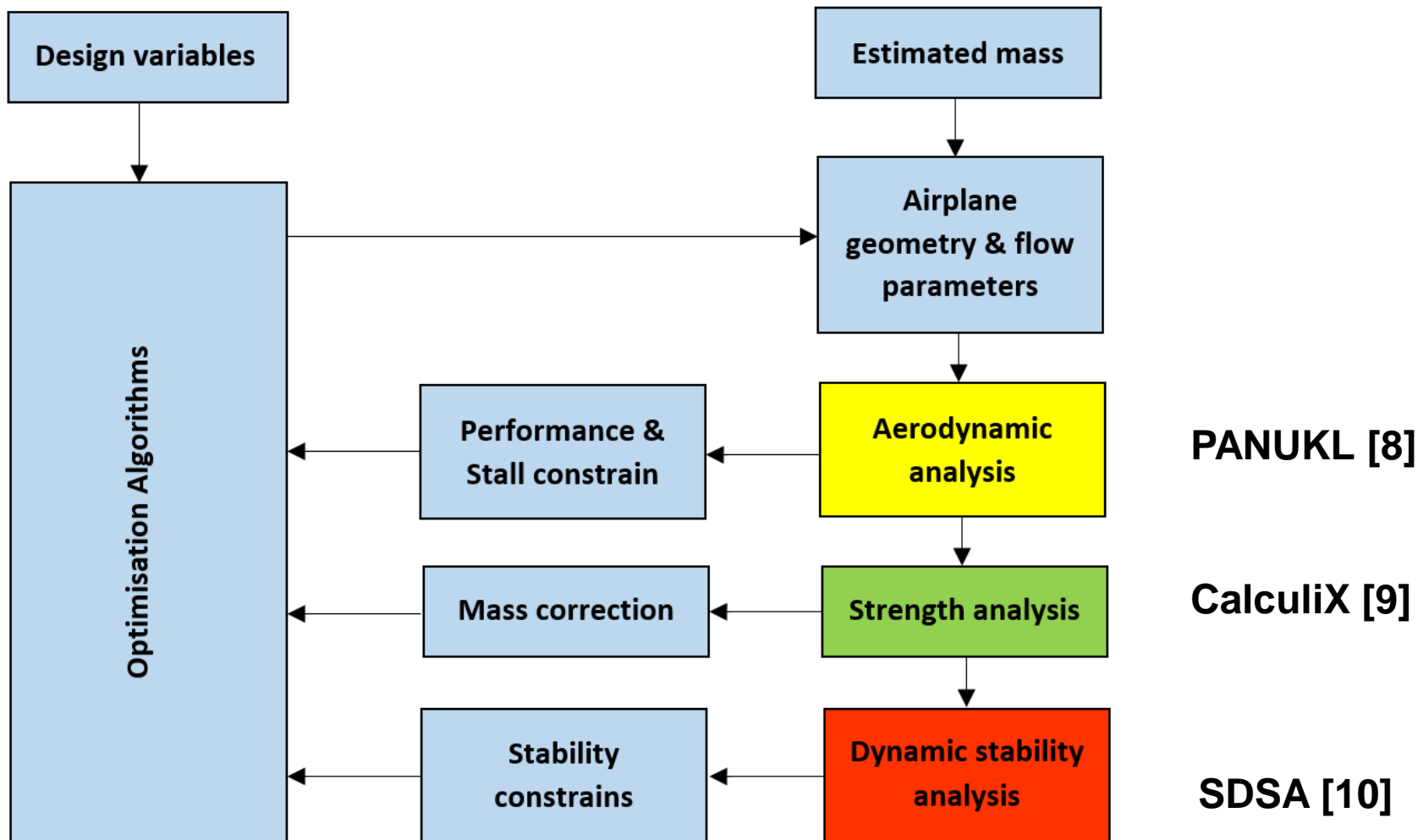


The goal

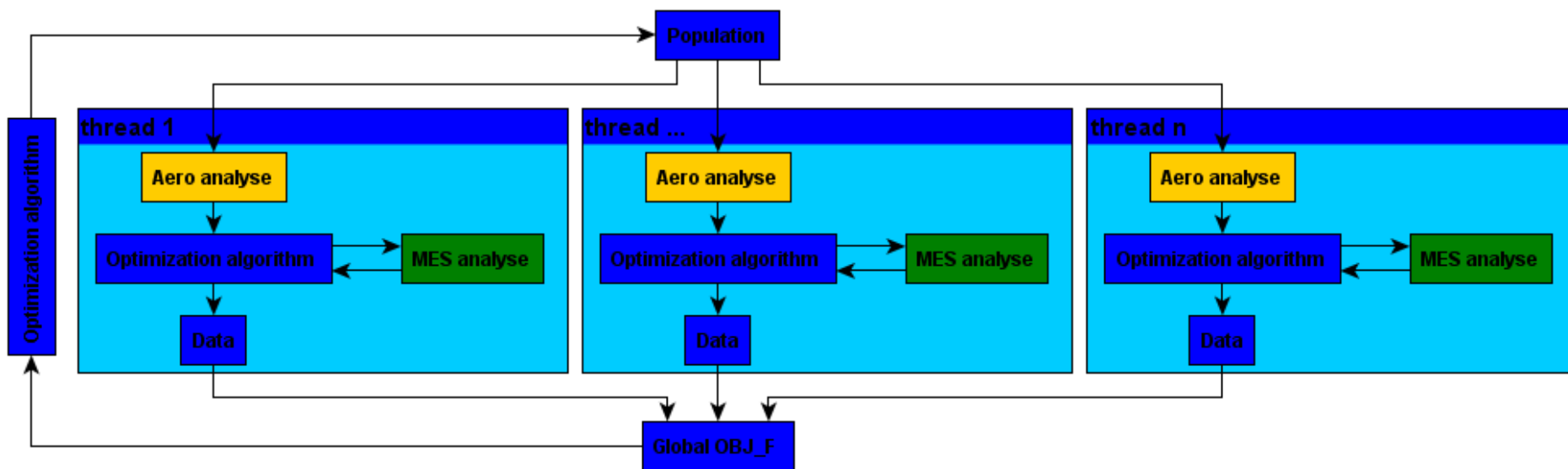
- 1. To develop tools for multi-disciplinary optimization of radical airplane configurations**
- 2. To check how much airplane performance can be improved in comparison to the current configuration**



Multidisciplinary optimization



Parallel processing



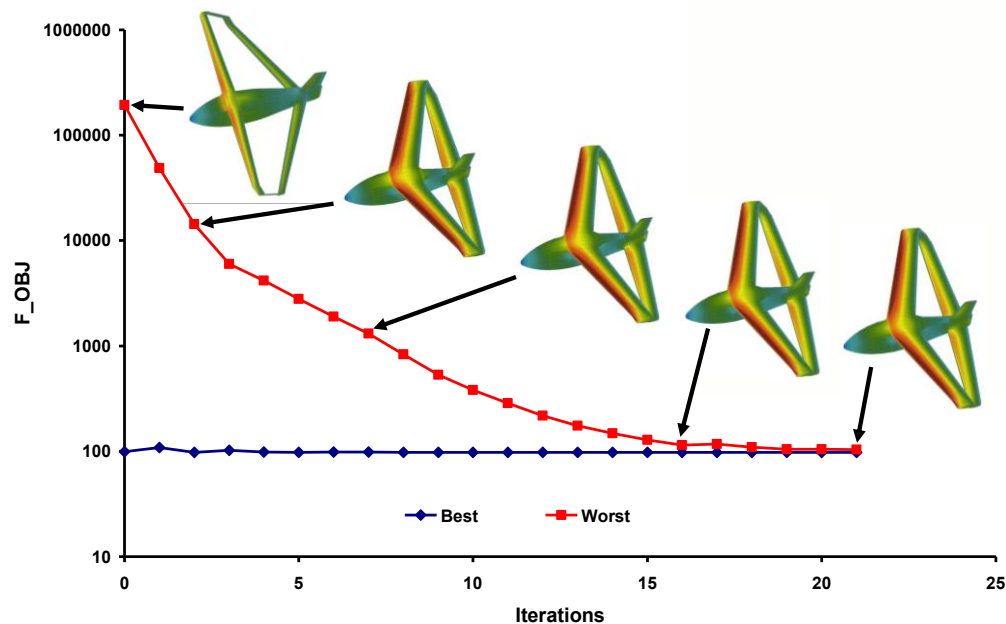
Aerodynamic optimisation

$$F_{obj} = 1000 \cdot C_D / C_L$$

constraints:

$$mg = L$$

$$\sum M_{CG} = 0$$

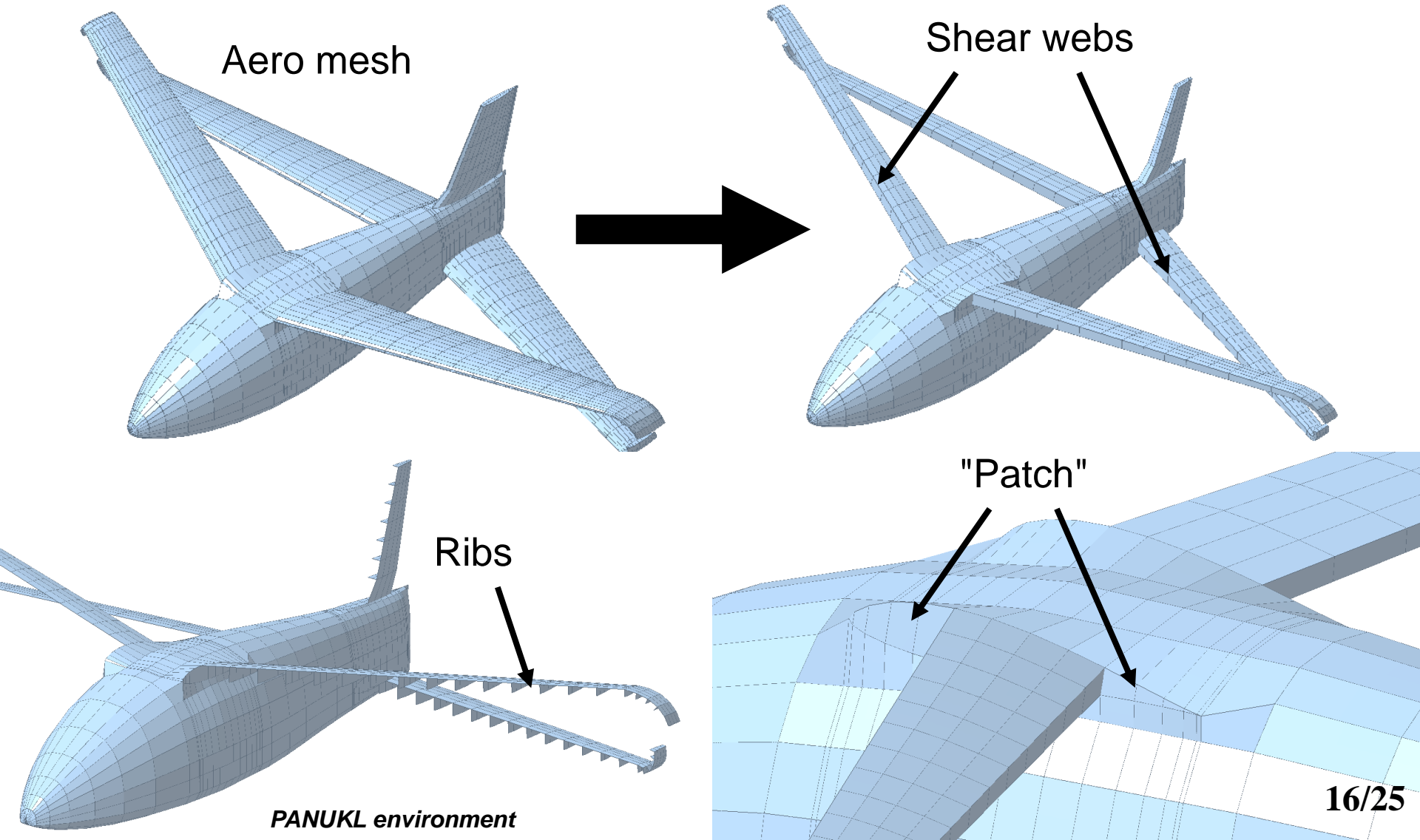


variables: 15 (50)

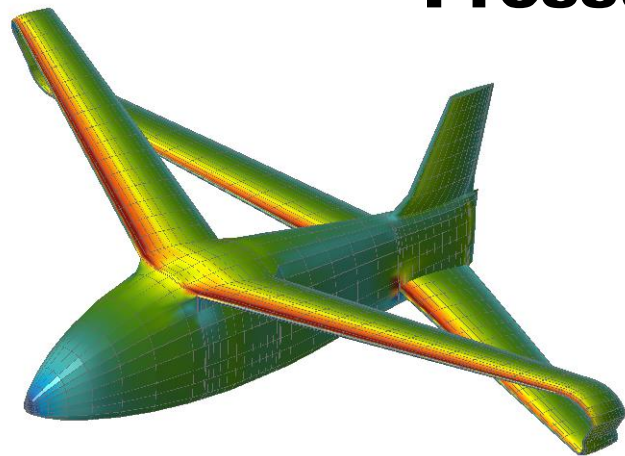
algorithm: Swarming



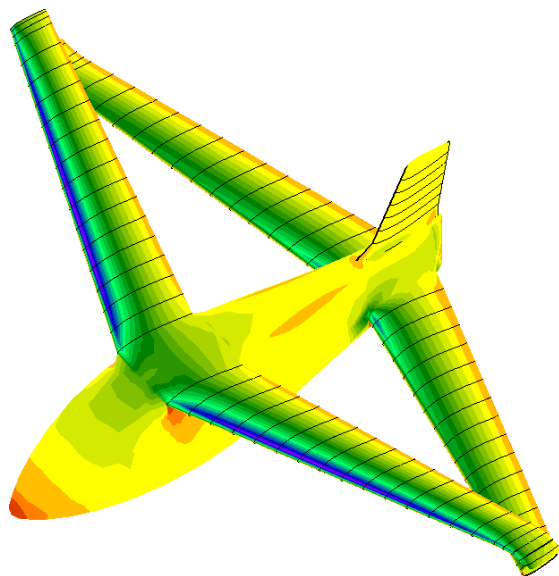
Structural mesh generation



Pressure distribution mapping

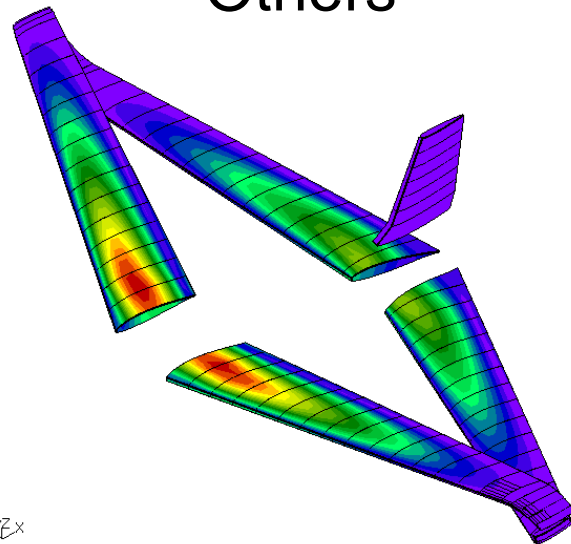


- Geometry
- Pressure distribution



- Loads
- Nodes
- Material
- Others

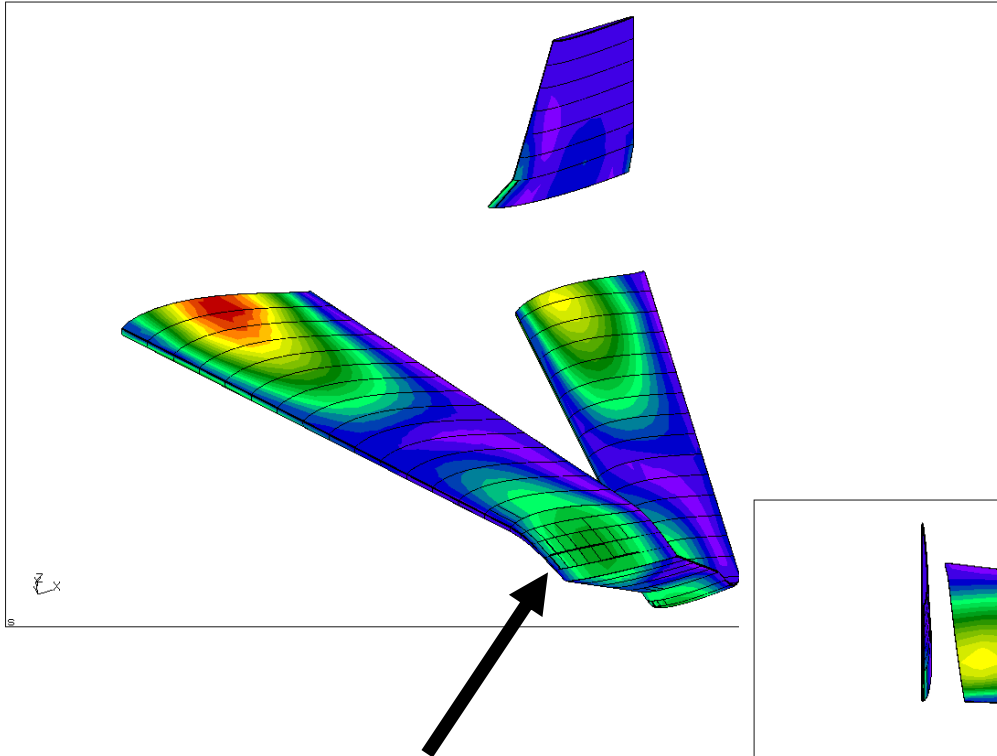
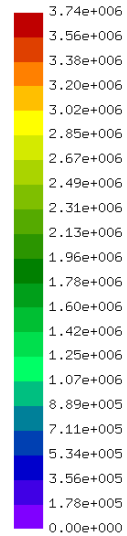
- Stress
- Strain
- Others



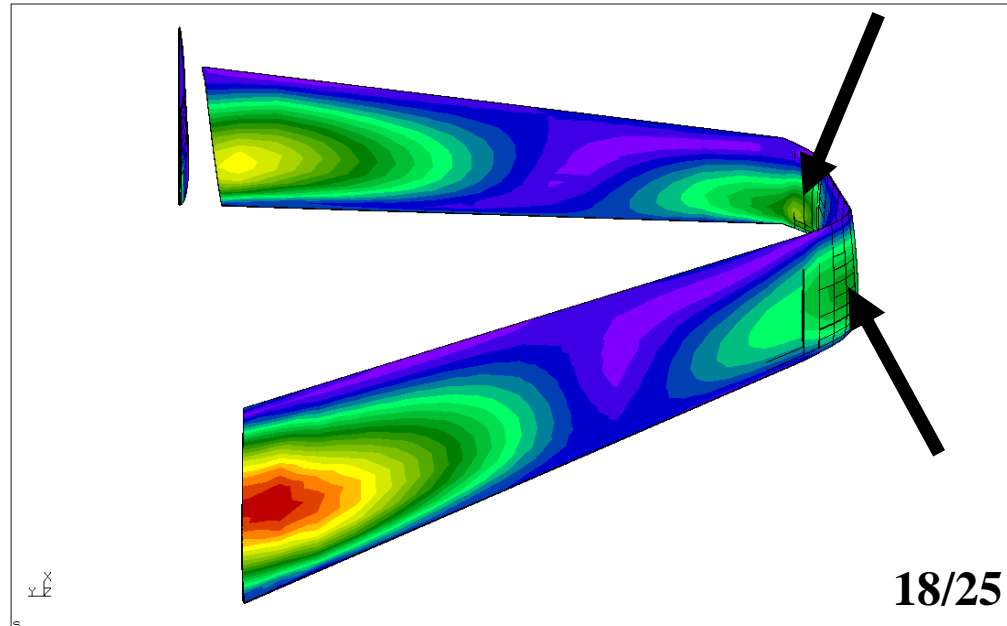
Before structural optimisation

DAT2:STRESS
Time:1.000000
Entity:Mises

max: 3.74e+006
min: 0.00e+000



Large stresses in joints





Structural optimisation assumptions

- Algorithms: Monte Carlo, Nelder-Mead

$$\min_x V(x)$$

- 183 variables – panel thicknesses

$$\varepsilon < \varepsilon_{\max}$$

- Material: aluminum alloy

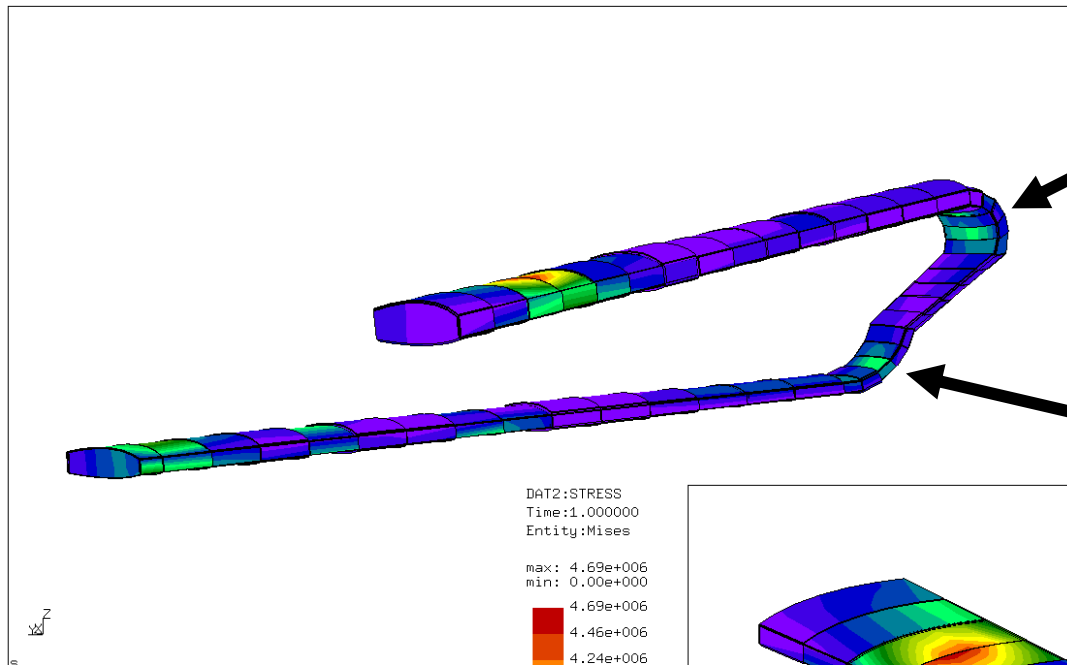
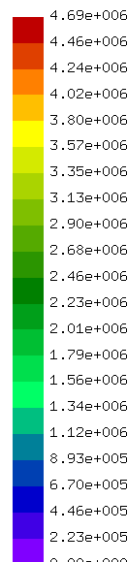
$$\sigma < \sigma_{\max}$$



First attempt to structural optimization

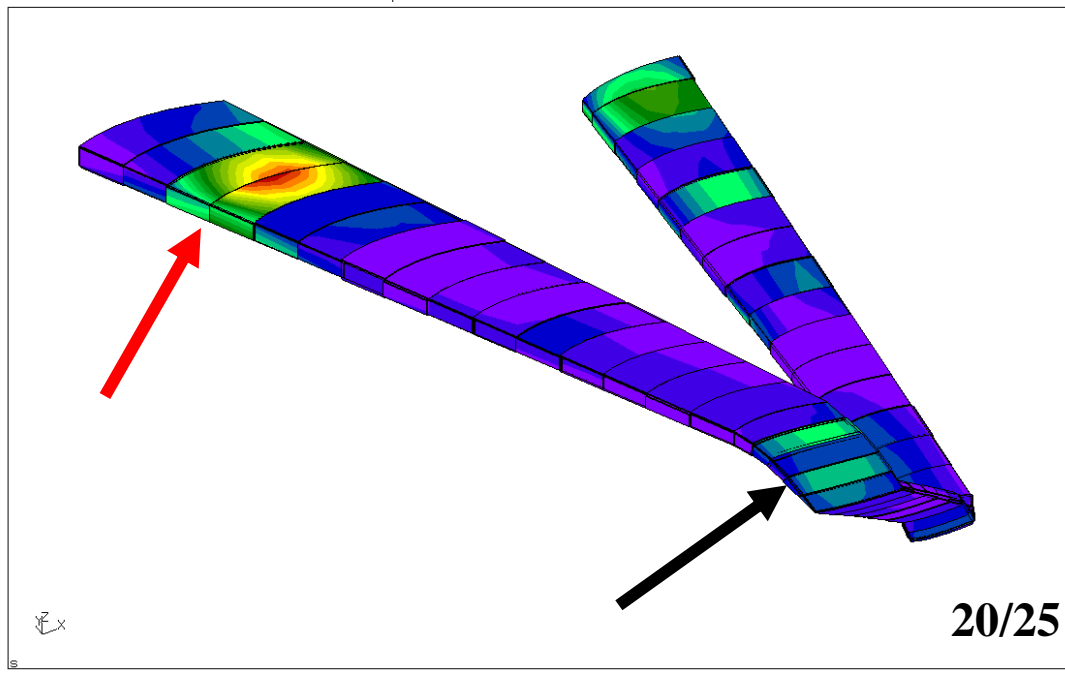
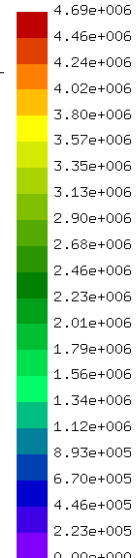
DAT2:STRESS
Time:1.000000
Entity:Mises

max: 4.69e+006
min: 0.00e+000



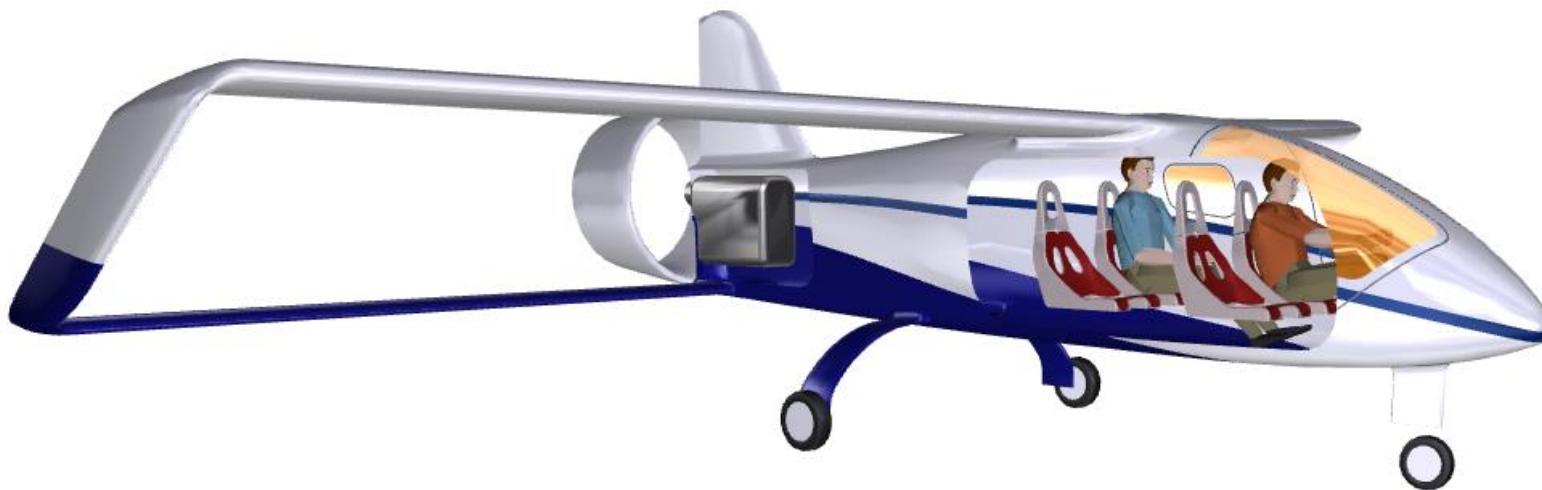
DAT2:STRESS
Time:1.000000
Entity:Mises

max: 4.69e+006
min: 0.00e+000





The extension of the programme?





Summary

- **Airplane is airworthy and suitable for the following flight tests**
- **With aft CG position airplane stability is low but acceptable**
- **Development of the optimisation software is still ongoing**



Acknowledgments

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