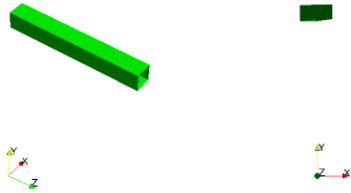
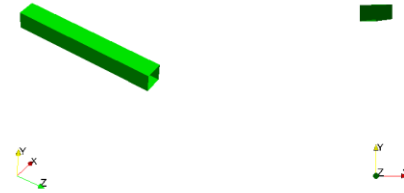


# Vortex shedding past square cylinder

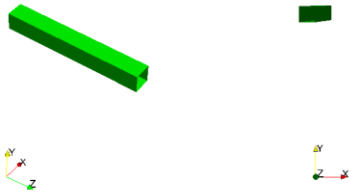
# Vortex shedding past square cylinder



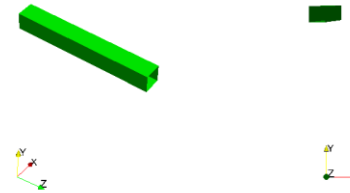
**URANS (K-Omega SST with no wall functions) – Vortices visualized by Q-criterion**  
[www.wolfdynamics.com/wiki/squarecil/urans2.gif](http://www.wolfdynamics.com/wiki/squarecil/urans2.gif)



**LES (Smagorinsky) – Vortices visualized by Q-criterion**  
[www.wolfdynamics.com/wiki/squarecil/les.gif](http://www.wolfdynamics.com/wiki/squarecil/les.gif)



**Laminar (no turbulence model) – Vortices visualized by Q-criterion**  
[www.wolfdynamics.com/wiki/squarecil/laminar.gif](http://www.wolfdynamics.com/wiki/squarecil/laminar.gif)



**DES (SpalartAllmarasDDES) – Vortices visualized by Q-criterion**  
[www.wolfdynamics.com/wiki/squarecil/des.gif](http://www.wolfdynamics.com/wiki/squarecil/des.gif)

# Vortex shedding past square cylinder

Turbulence model	Drag coefficient	Strouhal number	Computing time (s)
Laminar	2.81	0.179	93489
LES	2.32	0.124	77465
DES	2.08	0.124	70754
SAS	2.40	0.164	57690
URANS (WF)	2.31	0.130	67830
URANS (No WF)	2.28	0.135	64492
RANS	2.20	-	28246 (10000 iter)
Experimental values	2.05-2.25	0.132	-

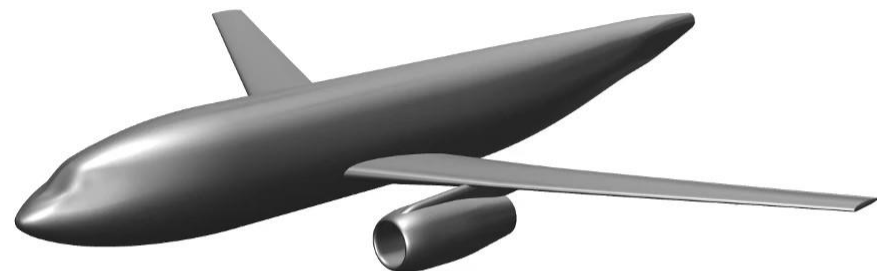
**Note:** all simulations were run using 4 cores.

## References:

D. A. Lyn and W. Rodi. "The flapping shear layer formed by flow separation from the forward corner of a square cylinder". *J. Fluid Mech.*, 267, 353, 1994.  
D. A. Lyn, S. Einav, W. Rodi and J. H. Park. "A laser-Doppler velocimetry study of ensemble-averaged characteristics of the turbulent near wake of a square cylinder". *Report. SFB 210 /E/100*.

# **DLR-F6 aircraft model – RANS simulation**

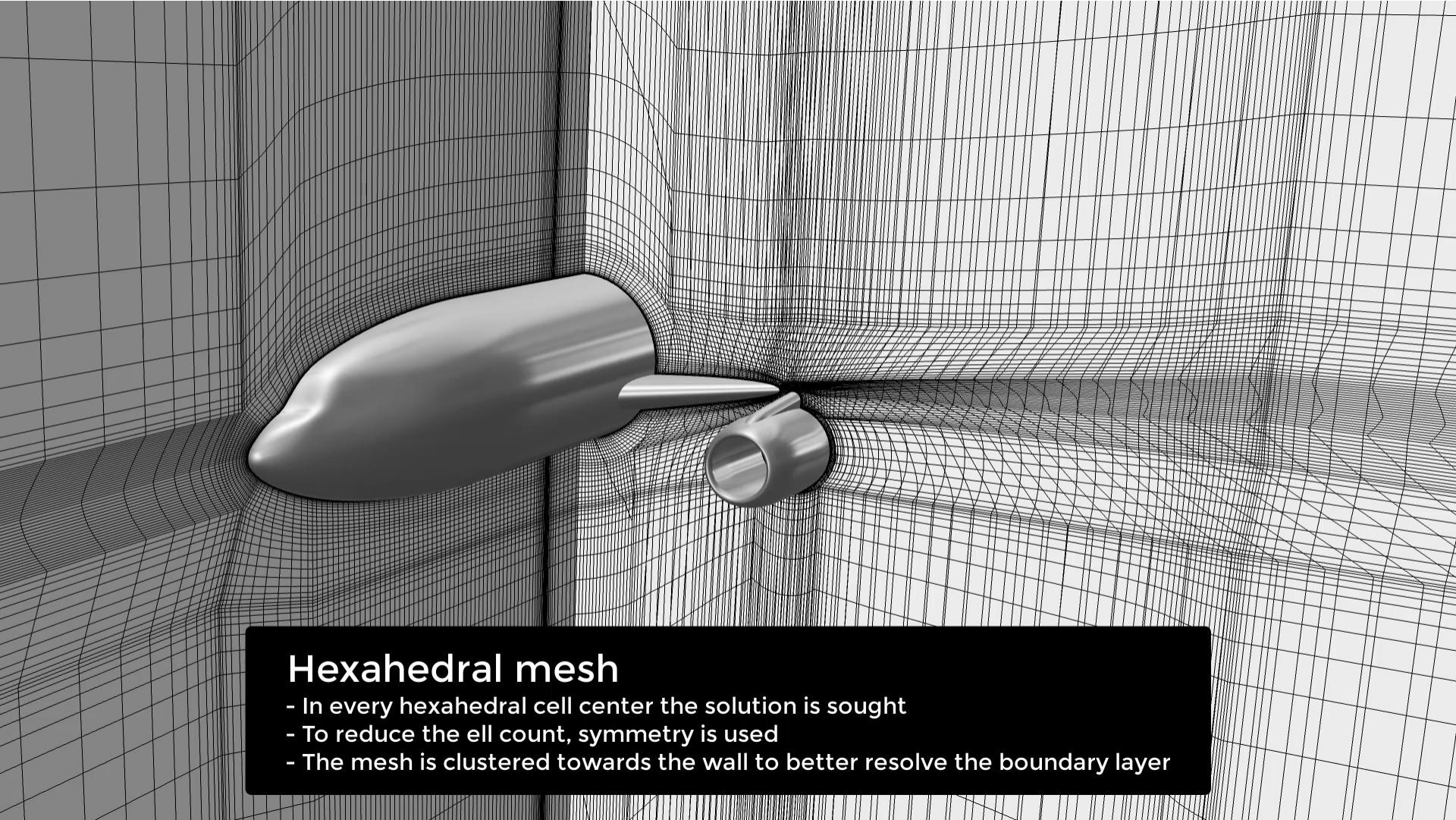
# DLR-F6 aircraft model – RANS simulation



## DLR-F6 aircraft model - CFD validation test case

- Mach number = 0.75
- Angle-of-attack = 0 degrees

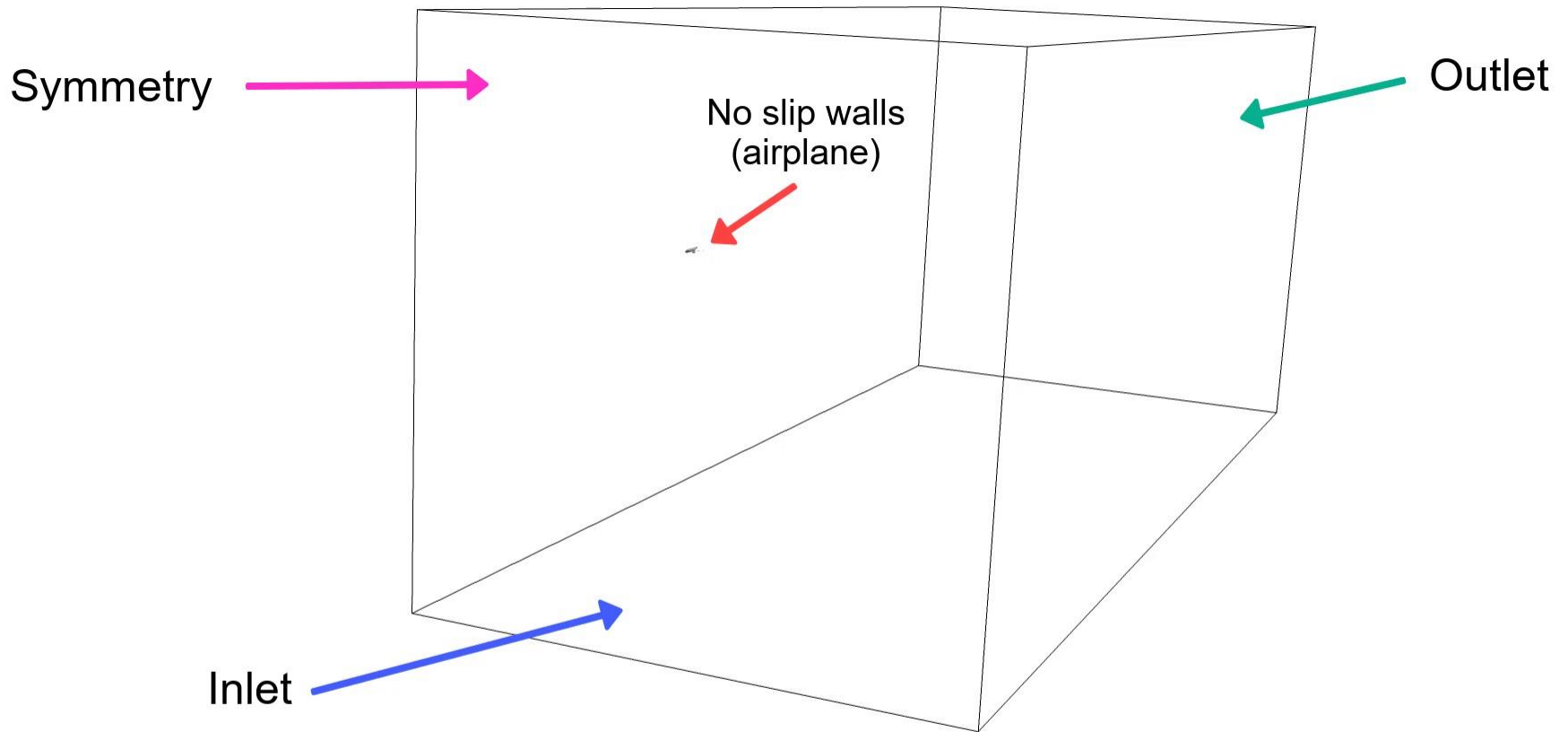
# DLR-F6 aircraft model – RANS simulation



## Hexahedral mesh

- In every hexahedral cell center the solution is sought
- To reduce the cell count, symmetry is used
- The mesh is clustered towards the wall to better resolve the boundary layer

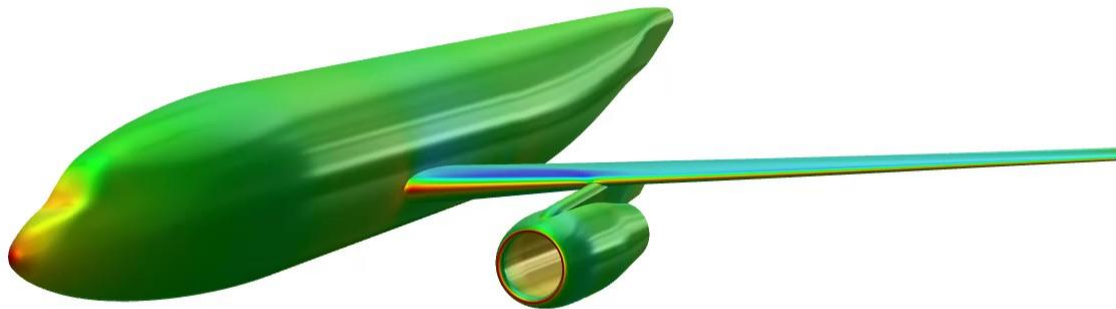
# DLR-F6 aircraft model – RANS simulation



## Computational domain and boundary conditions

- To reduce the cell count, symmetry is used

# DLR-F6 aircraft model – RANS simulation

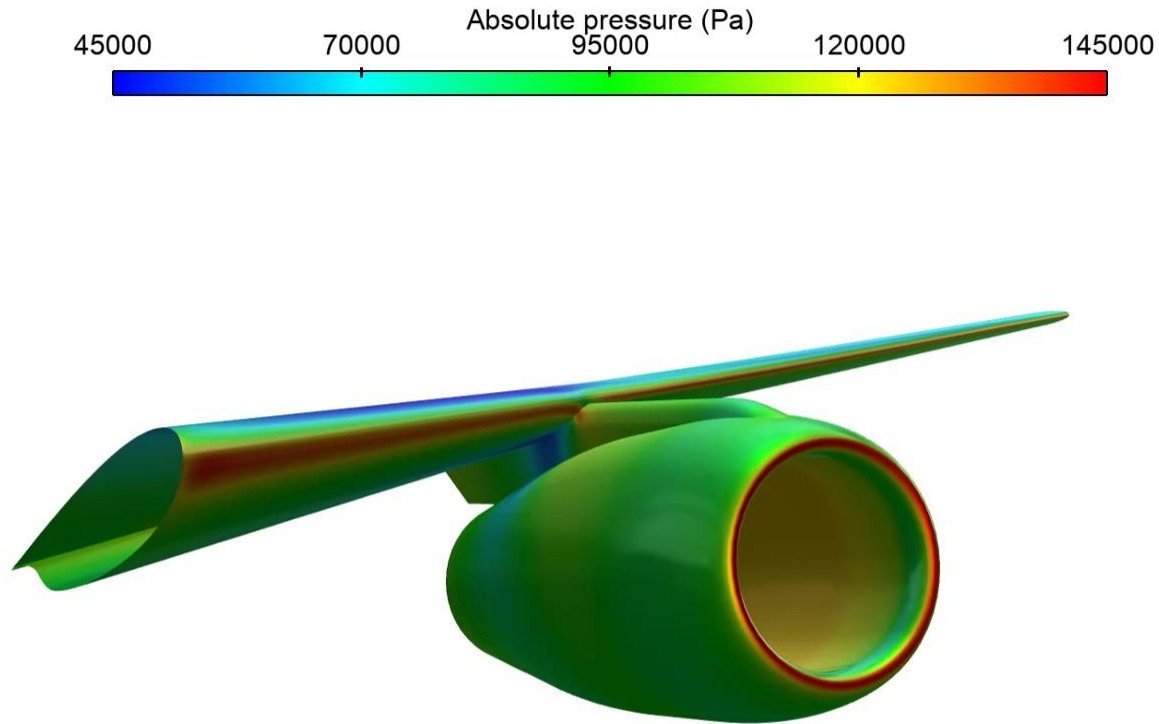


## Pressure contours visualization

- Solution method: Pressure based solver, steady solver, ideal gas, k-omega SST turbulence model with no wall functions



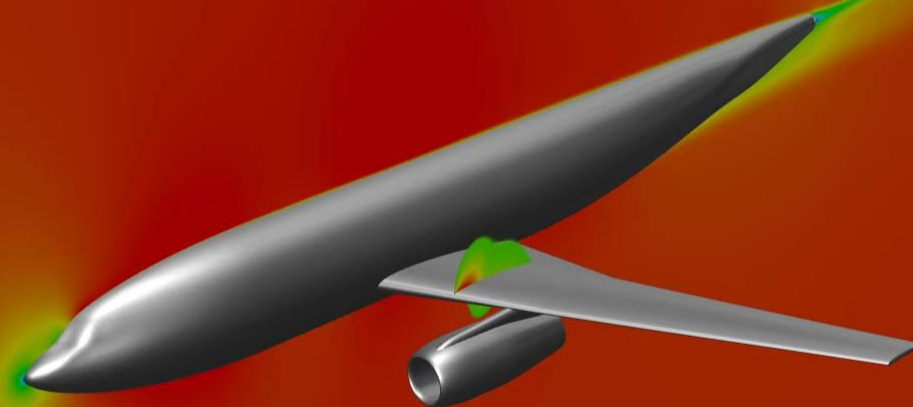
# DLR-F6 aircraft model – RANS simulation



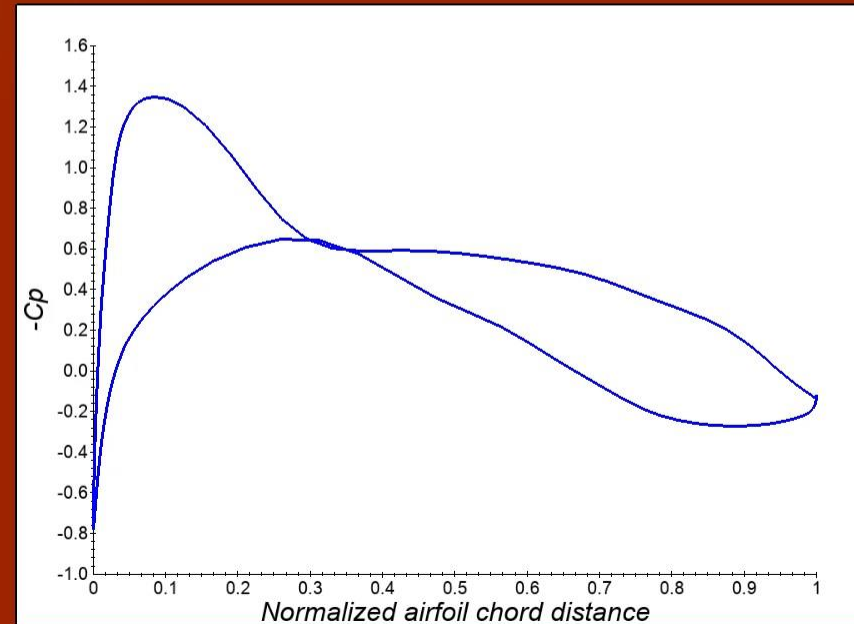
## Pressure contours visualization

- Solution method: Pressure based solver, steady solver, ideal gas, k-omega SST turbulence model with no wall functions

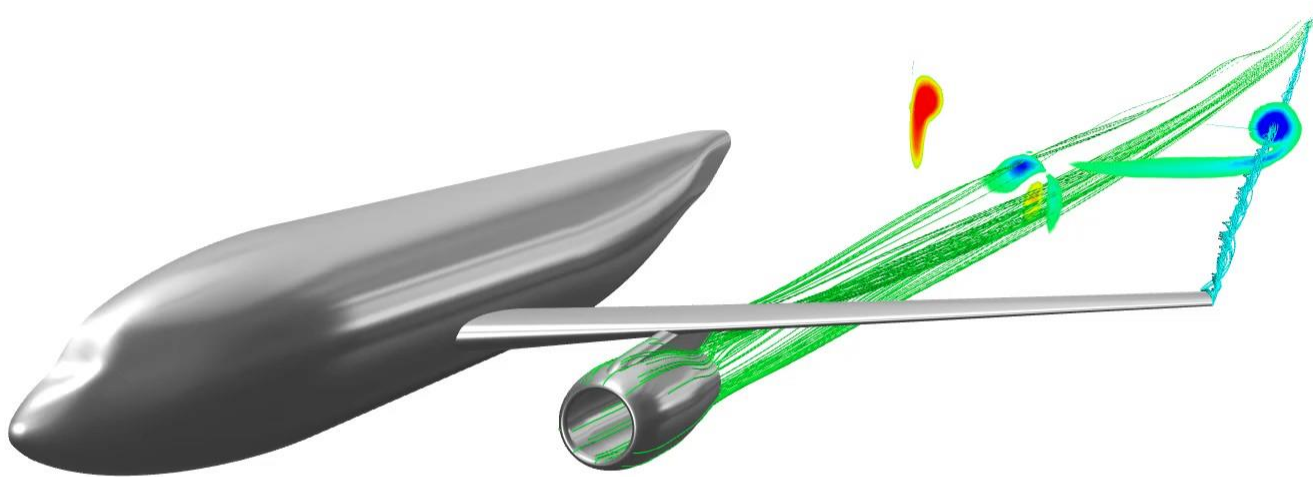
# DLR-F6 aircraft model – RANS simulation



- Symmetry plane colored by Mach number
- Cut-plane over the wing colored by pressure coefficient  $C_p$

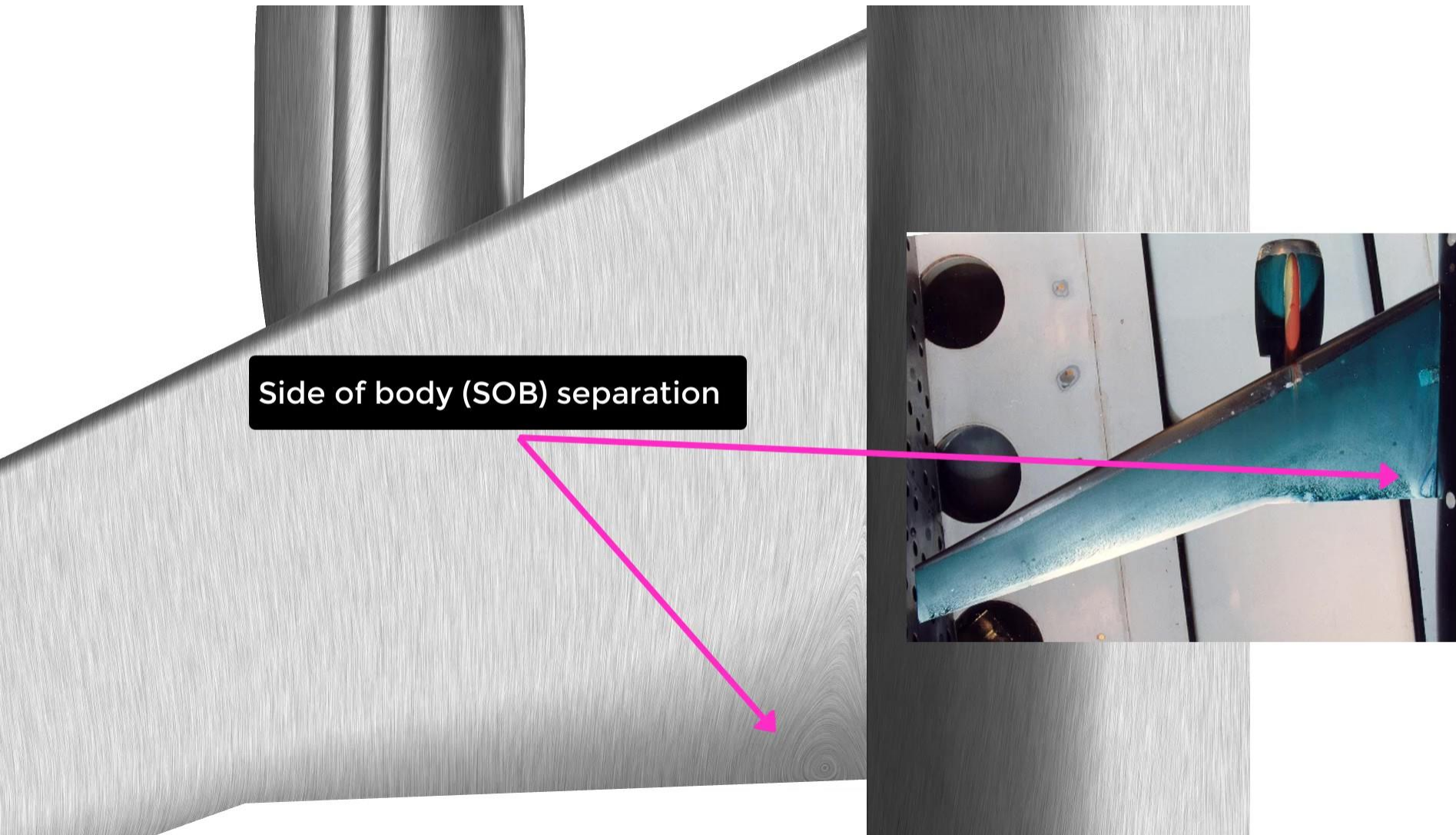


# DLR-F6 aircraft model – RANS simulation

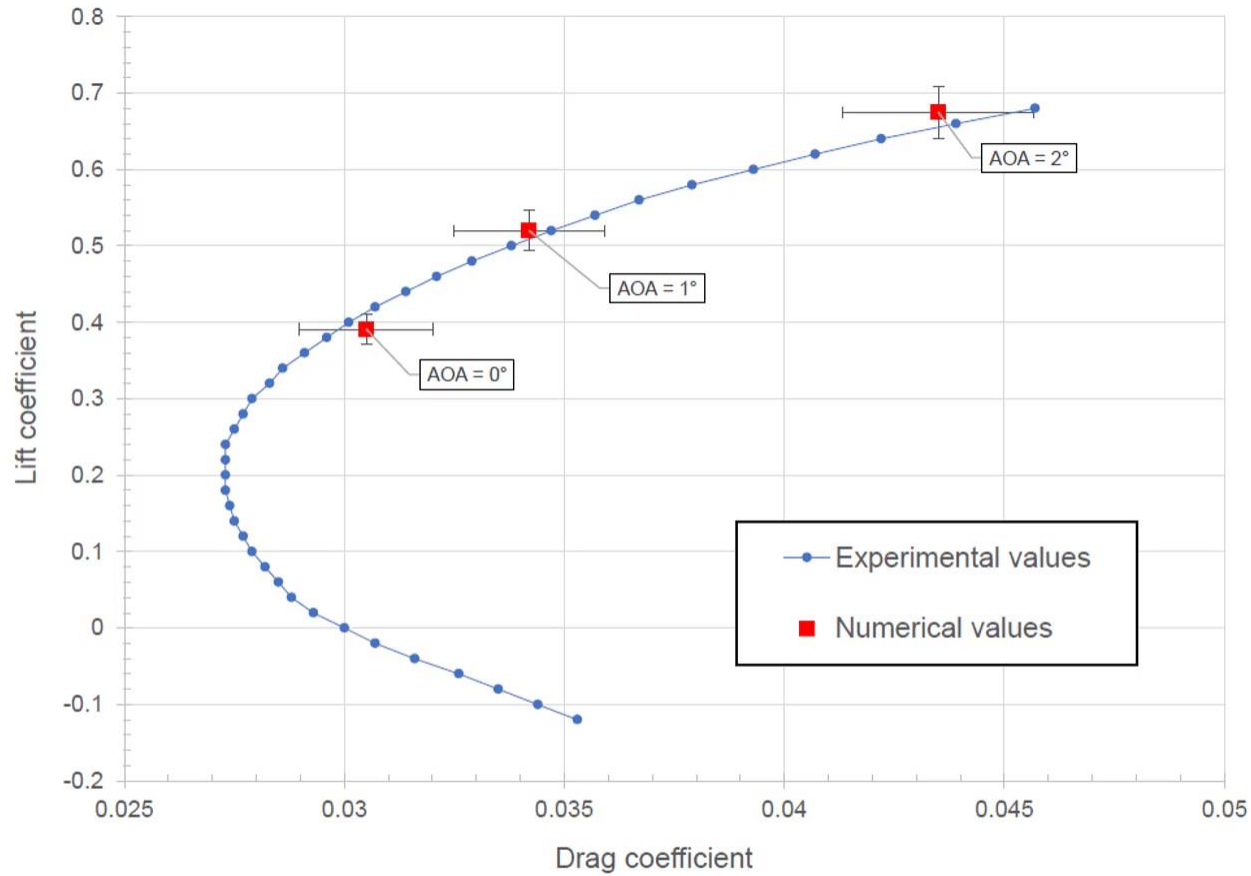


- Streamlines released from the wing-tip (cyan) and engine nacelle (green)
- The Wake behind the airplane is visualized using vorticity contours.
- Blue represents counter-clockwise rotation and red clockwise rotation

# DLR-F6 aircraft model – RANS simulation



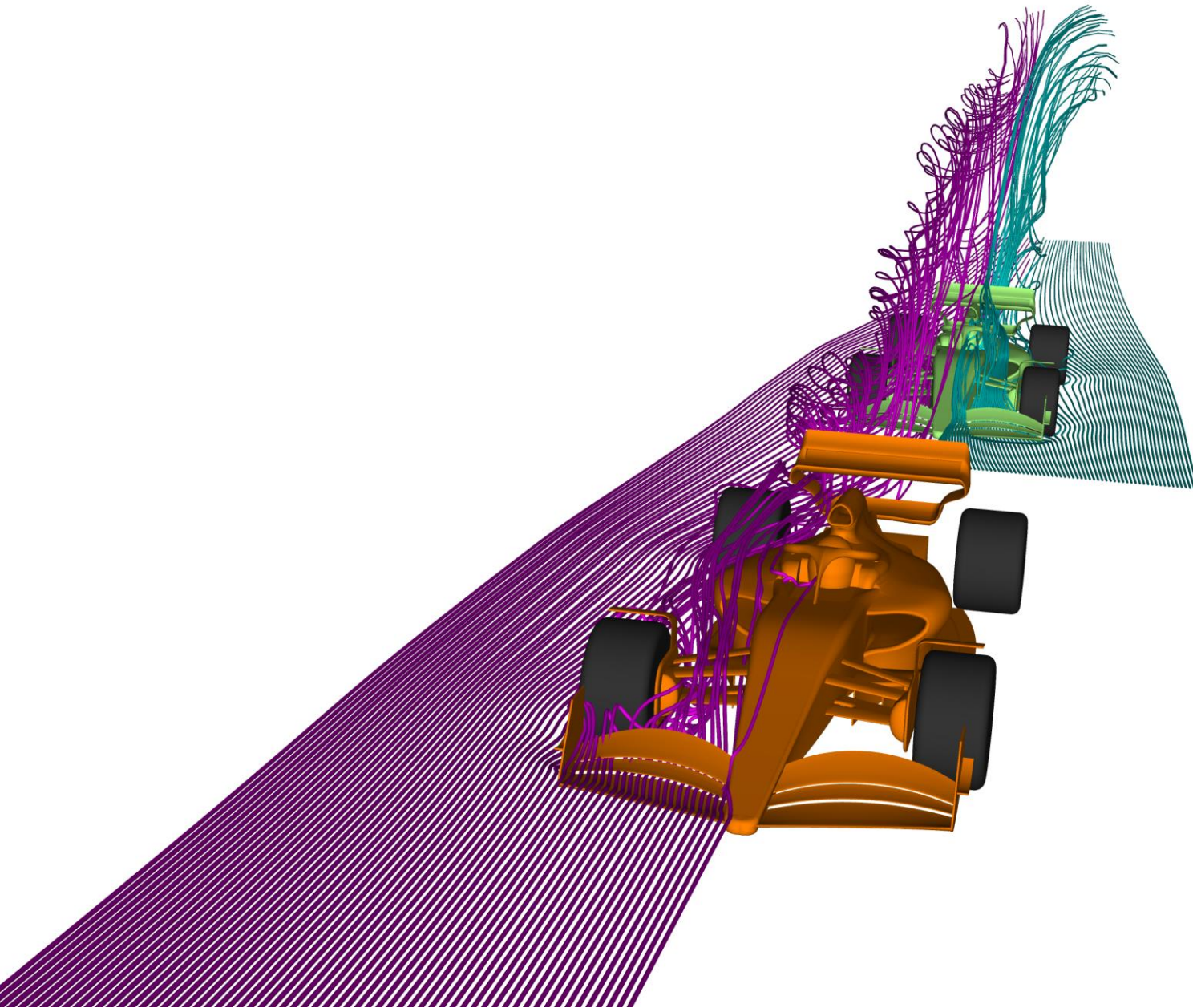
# DLR-F6 aircraft model – RANS simulation



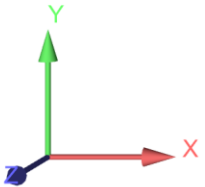
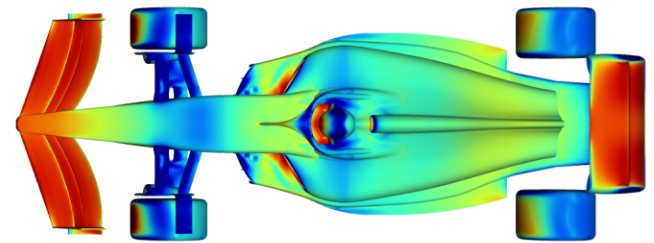
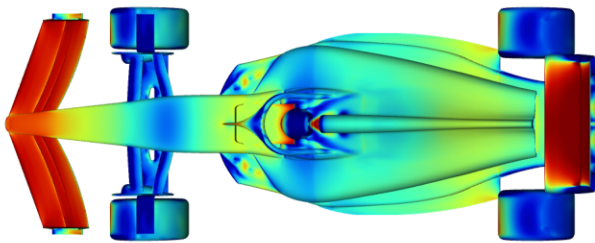
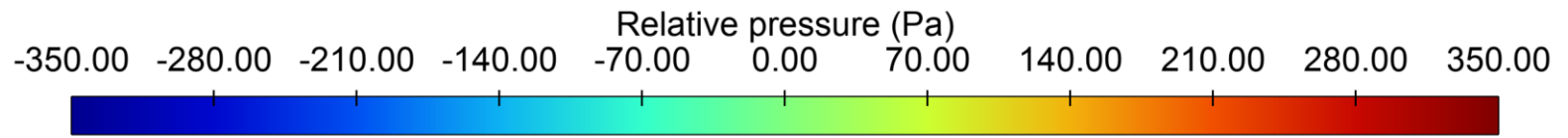
Polar plot (numerical results are plotted with 5% error bars)

# **F1 in platoon formation – RANS simulation**

# F1 in platoon formation – RANS simulation

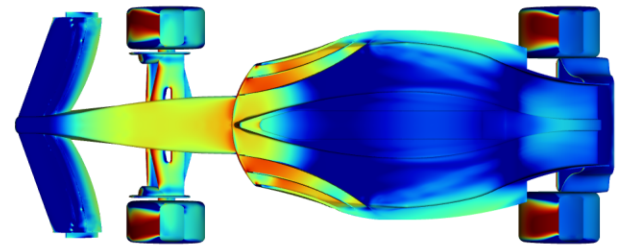
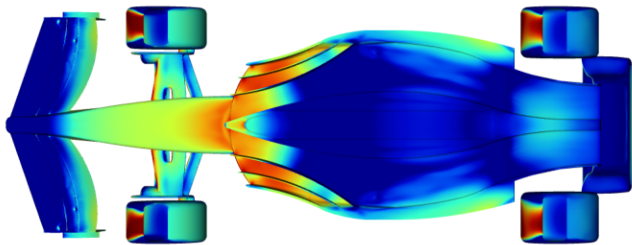
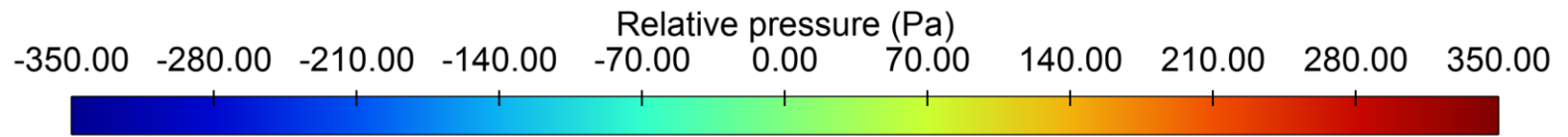


# F1 in platoon formation – RANS simulation

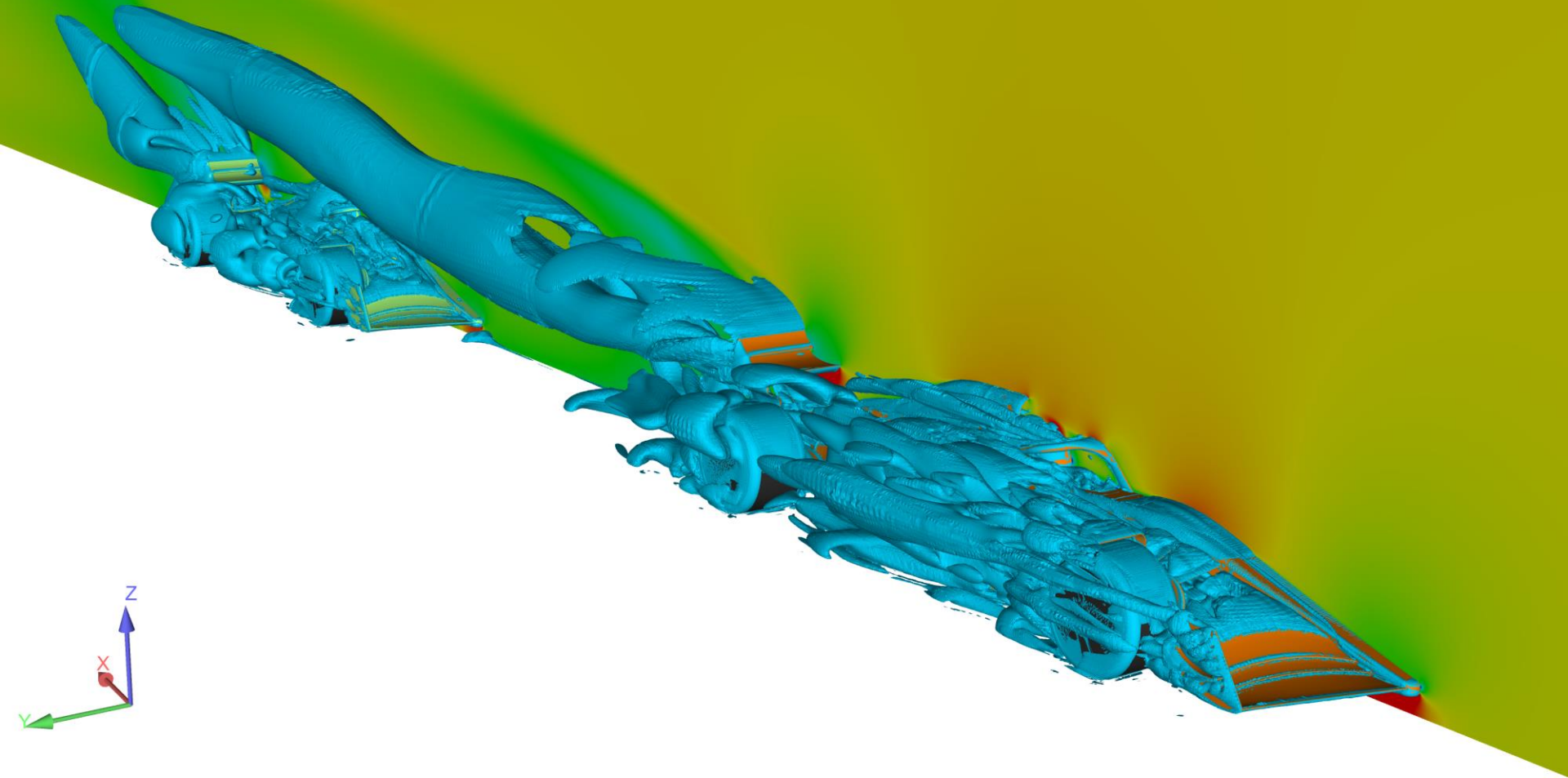
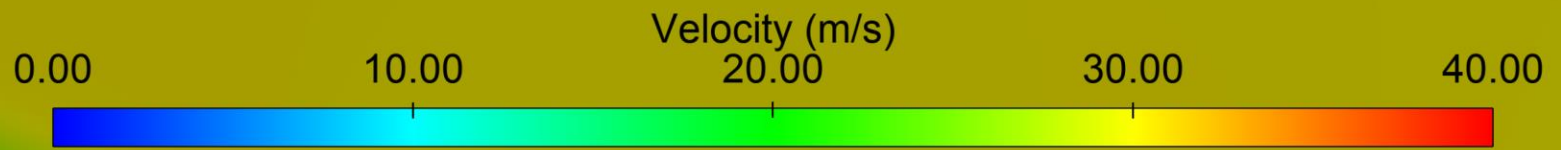




# F1 in platoon formation – RANS simulation



# F1 in platoon formation – RANS simulation



# F1 in platoon formation – RANS simulation

