2nd Automotive CFD Prediction Workshop: Case 2 – OC DrivAer Notchback

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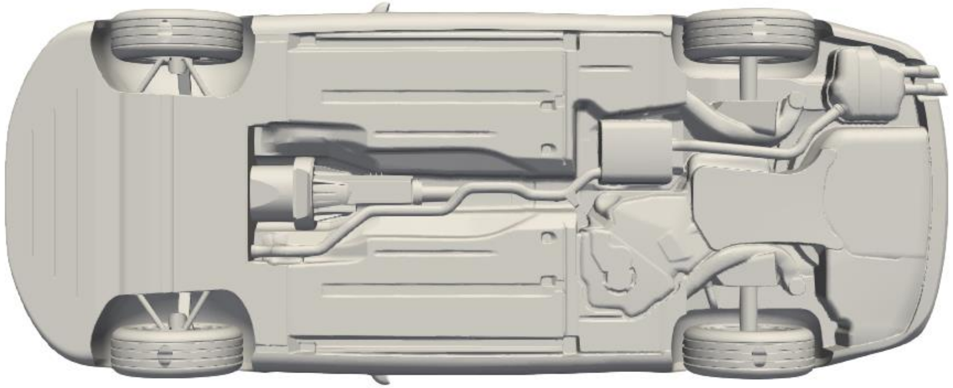
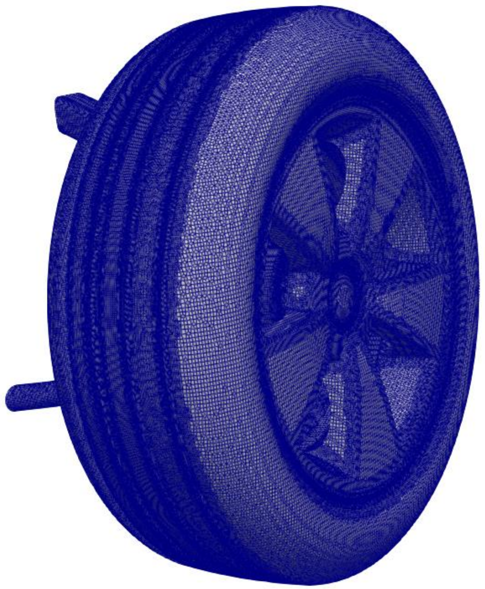
Case

Case n.2, the OC DrivAer Notchback.



One of the motivations is that of gathering data about the complex flow phenomena that develop around wheels and inside the wheel houses.

Mesh

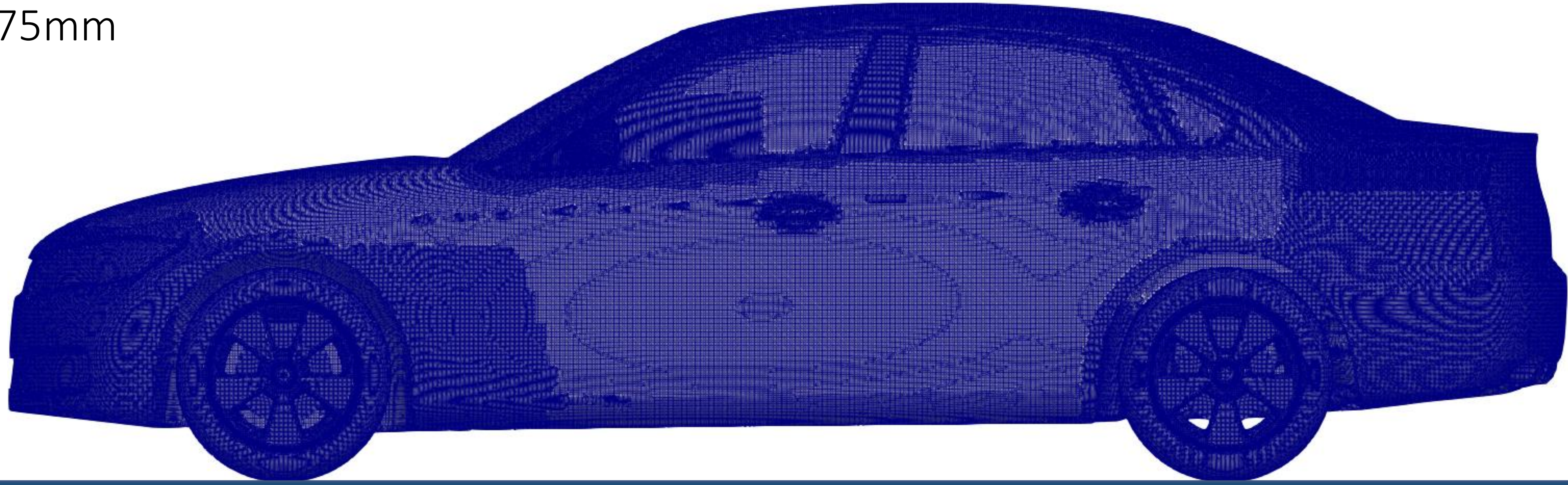


The simulation has been run with the Wall-function grid.

N. cells: 128e6

N. Layers: 7

First cell height: 0.75mm



HPC Setup

To run the simulations, a computational budget of 120000 core hours has been granted by CINECA, the Italian supercomputing Consortium.

- Galileo infrastructure (now replaced by Galileo100):
  - Intel Broadwell
  - 2x Intel Xeon E5-2697
  - v4 @2.3GHz
  - 18 cores each
- Run on 1080 cores
- Averaging from 1.4 to 1.52 s.

CINECA: www.hpc.cineca.it/
New Galileo100: www.hpc.cineca.it/hardware/galileo100

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Solver Setup

The simulation has been run with **OpenFOAM v2012** by **ESI**.

- Incompressible, unsteady flow
- Hybrid RANS-LES method
- SA-DDES (standard OpenFOAM implementation)
- ''backward'' time scheme → (implicit, 2nd order)
- Convection modeled with ''linearUpwind'' scheme → (2nd order, unbounded)
- Fixed time step: 1e-5 s
- No under relaxation
- Averaging from 1.4 to 1.52 s.

Necessity of velocity damping

The simulation has been initialised with a potential solution, but strong velocity fluctuations in the start-up phase of the simulation resulted in an unphysical solution!

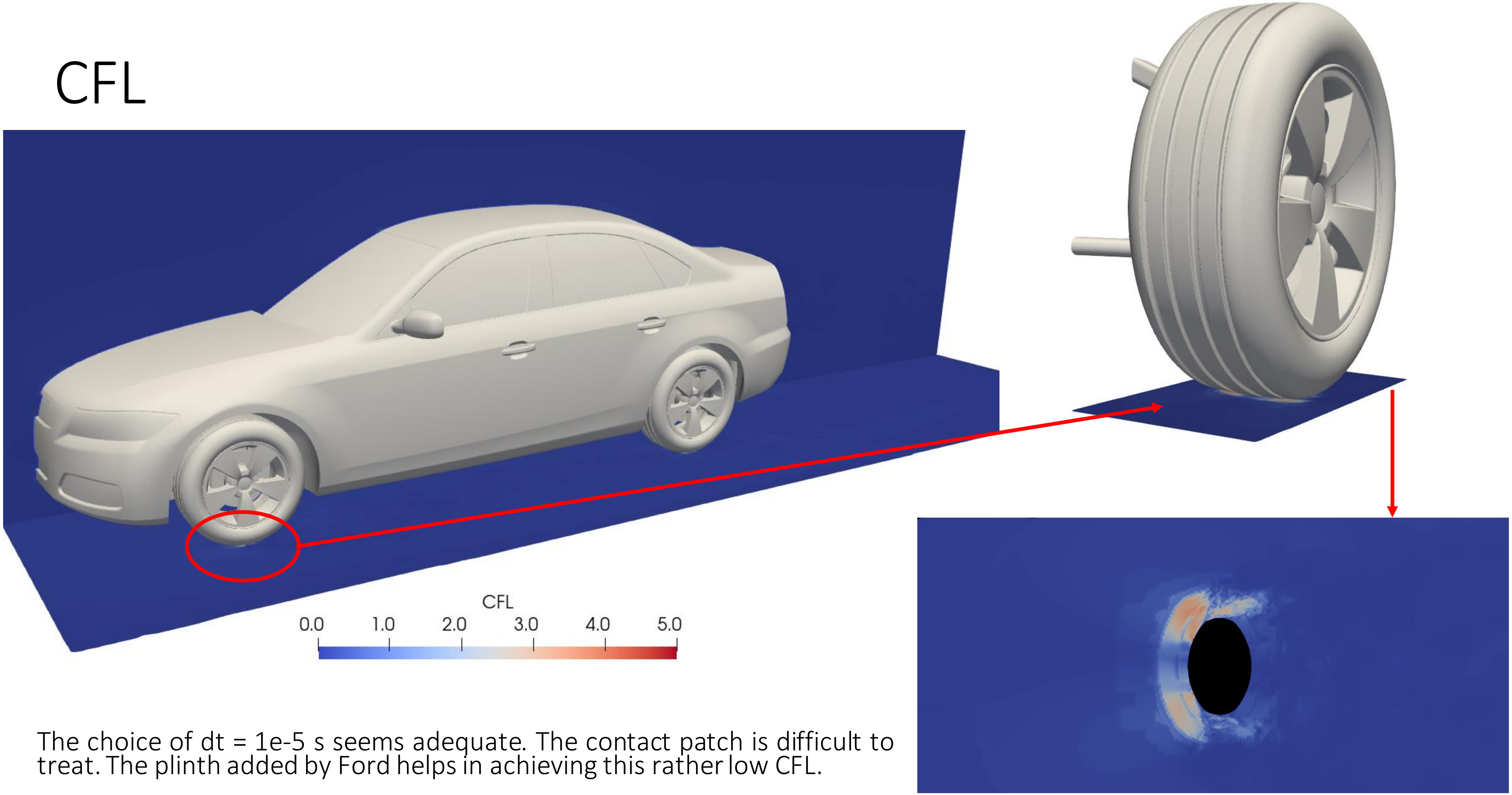
A velocity damping has been introduced in the fvOptions file:

```
velocityDamping
{
        type velocityDampingConstraint;
        selectionMode all;
        UMax 120;
}
```

The presence of a velocity damping helped in keeping the solution stable during the intial iterations. After the start-up phase, the velocity damping effect vanished.

Reference: www.openfoam.com/documentation/guides/latest/doc/guide-fvoptions-constraints-velocity-damping.html

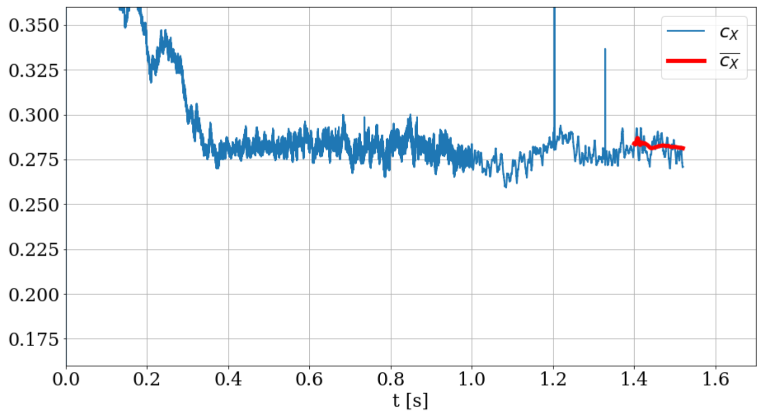
CFL

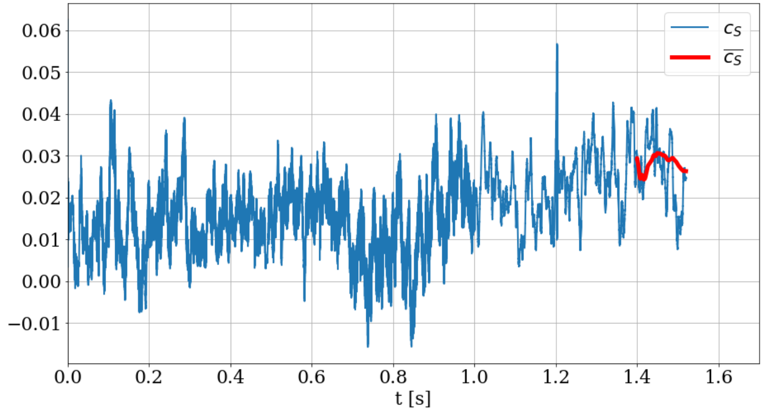


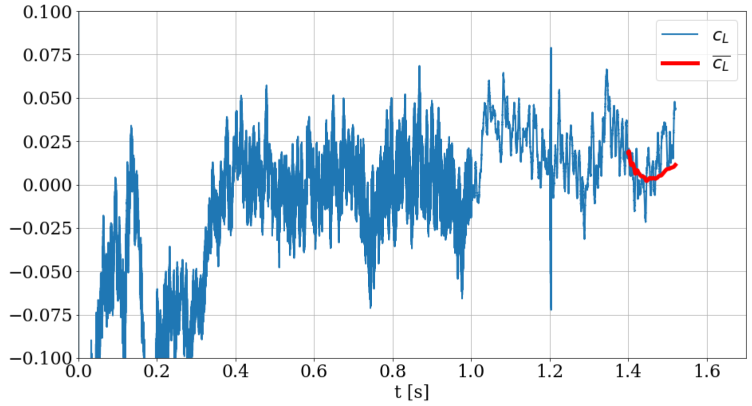
The choice of dt = 1e-5 s seems adequate. The contact patch is difficult to treat. The plinth added by Ford helps in achieving this rather low CFL.

Results

Aero Force Coeff:	C_D	C_L	C_{Lf}	C_{Lr}	C_S
averages	0,2813	0,0115	-0,0764	0,0879	0,0262
Exp [1]	0,255	0.087	-0.023	0.111	-





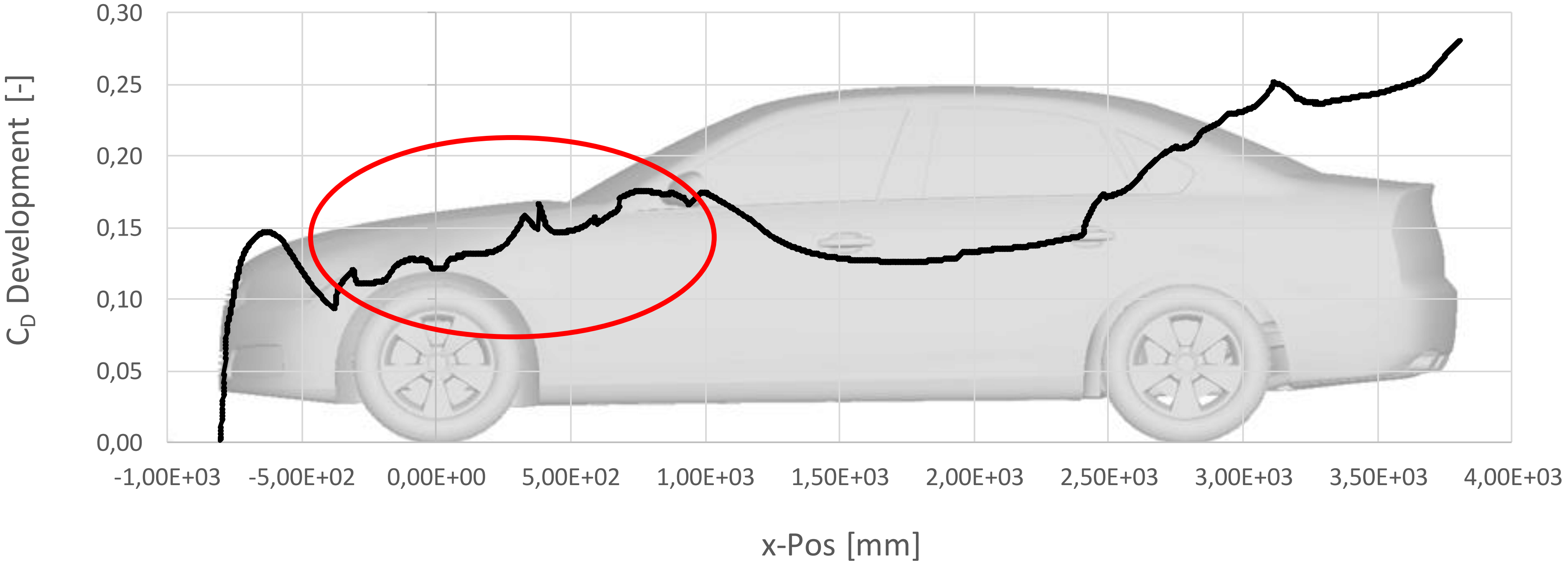


From the above plots, averages are not stable yet. More simulation time is required!

[1] Hupertz, B., Chalupa, K., Krueger, L., Howard, K. et al., "On the Aerodynamics of the Notchback Open Cooling DrivAer: A Detailed Investigation of Wind Tunnel Data for Improved Correlation and Reference," SAE Int. J. Adv. & Curr. Prac. in Mobility 3(4):1726-1747, 2021, https://doi.org/10.4271/2021-01-0958.

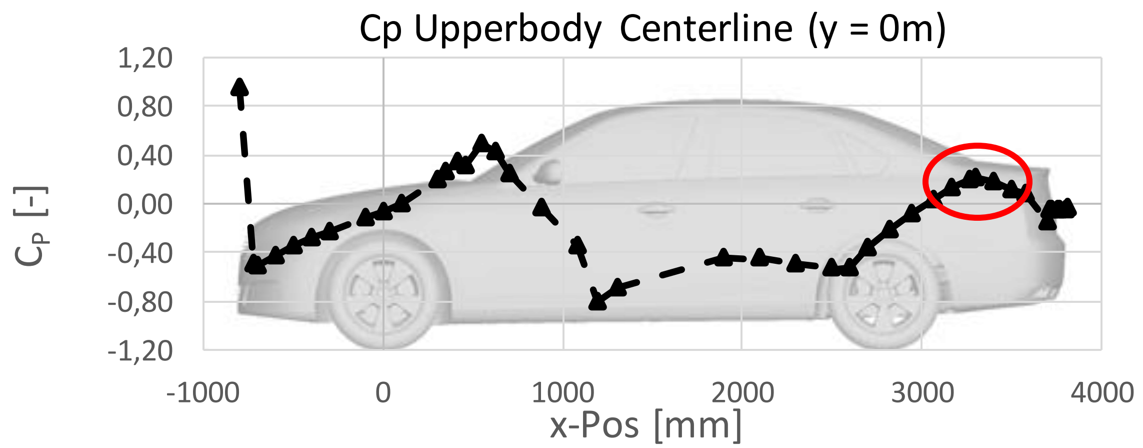
Results

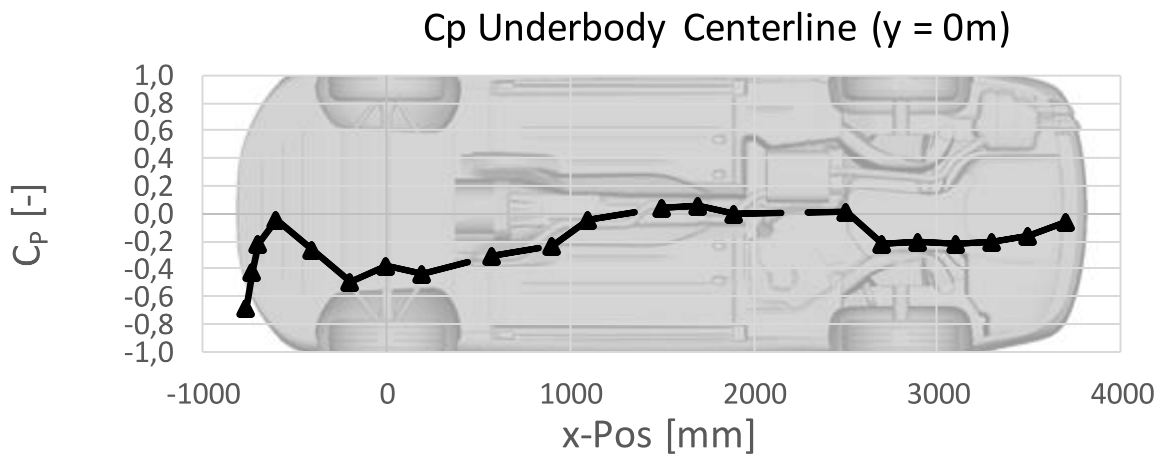
With respect to other simulations run on the DrivAer model, the drag development in the range x = [-500,1000] mm seems to be higher than expected.



Results

The pressure distribution plots are satisfactory. The only significant difference is the lack of a flat zone that should be expected in the rear part of the upperbody centerline profile.

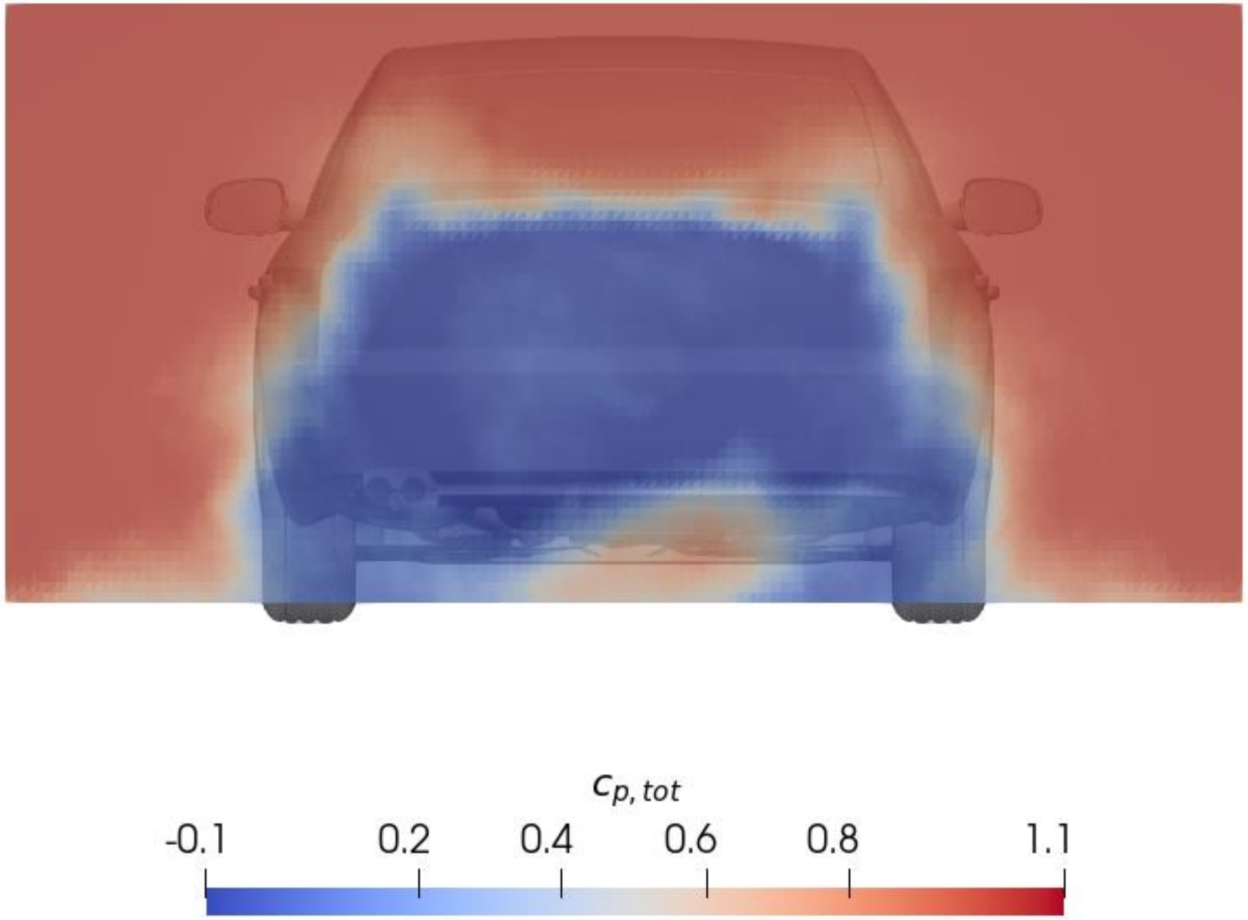




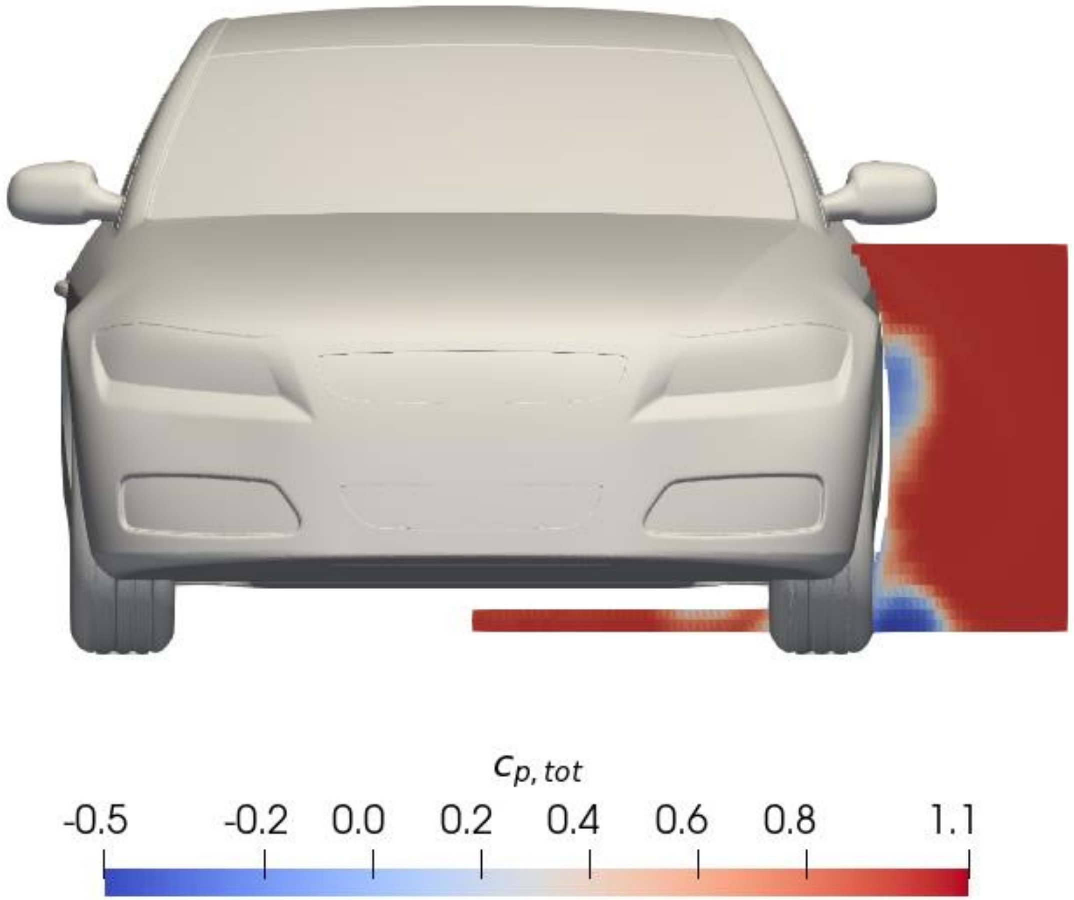
Results

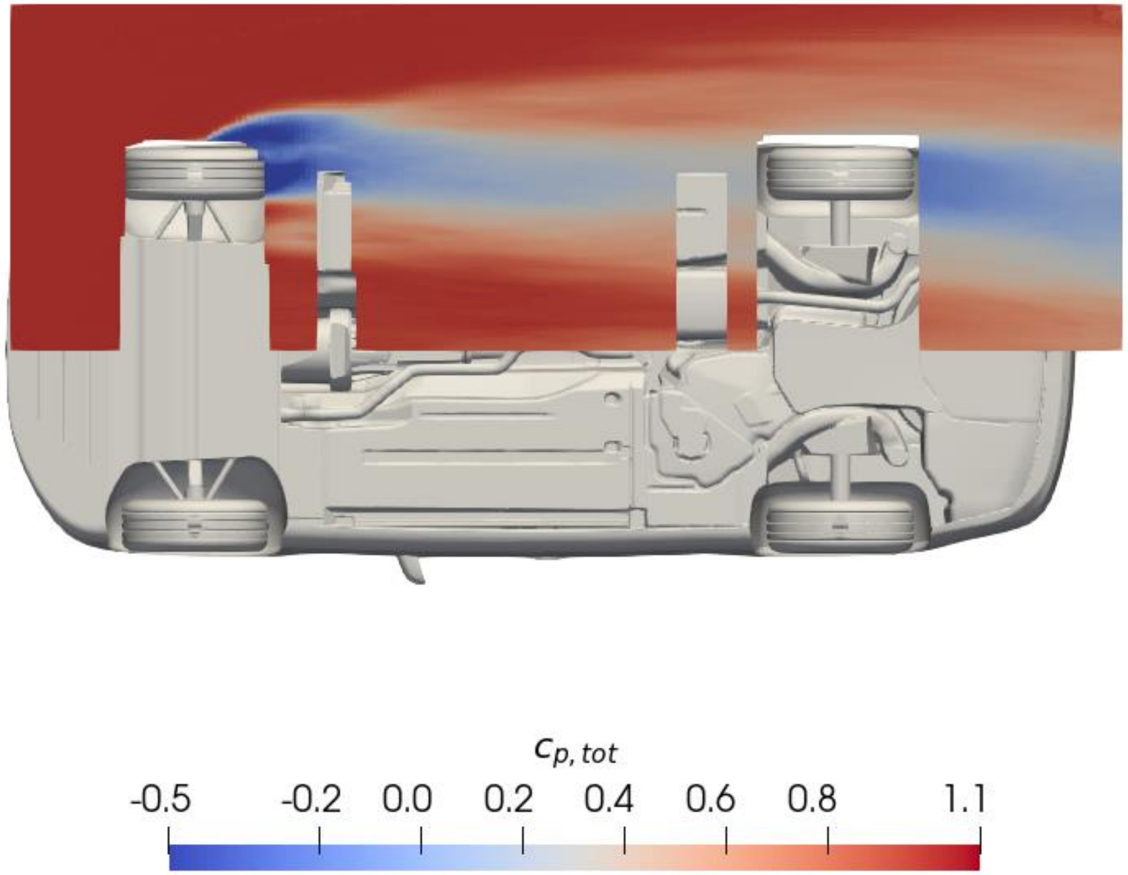
The total pressure coefficient distribution in the wake (plane at X = 4000 mm) shows the footprint of the two C-pillar vortexes.

No separation at the rear window.



Results





Conclusions

The activity has been extremely interesting: managing such a big CFD case with limited resources is challenging!

- The setup proposed cannot be judged completely because the simulation time was limited due to lack of resources.

The team would like to use the data of the workshop as reference and keep simulating the case when additional resources will be available.