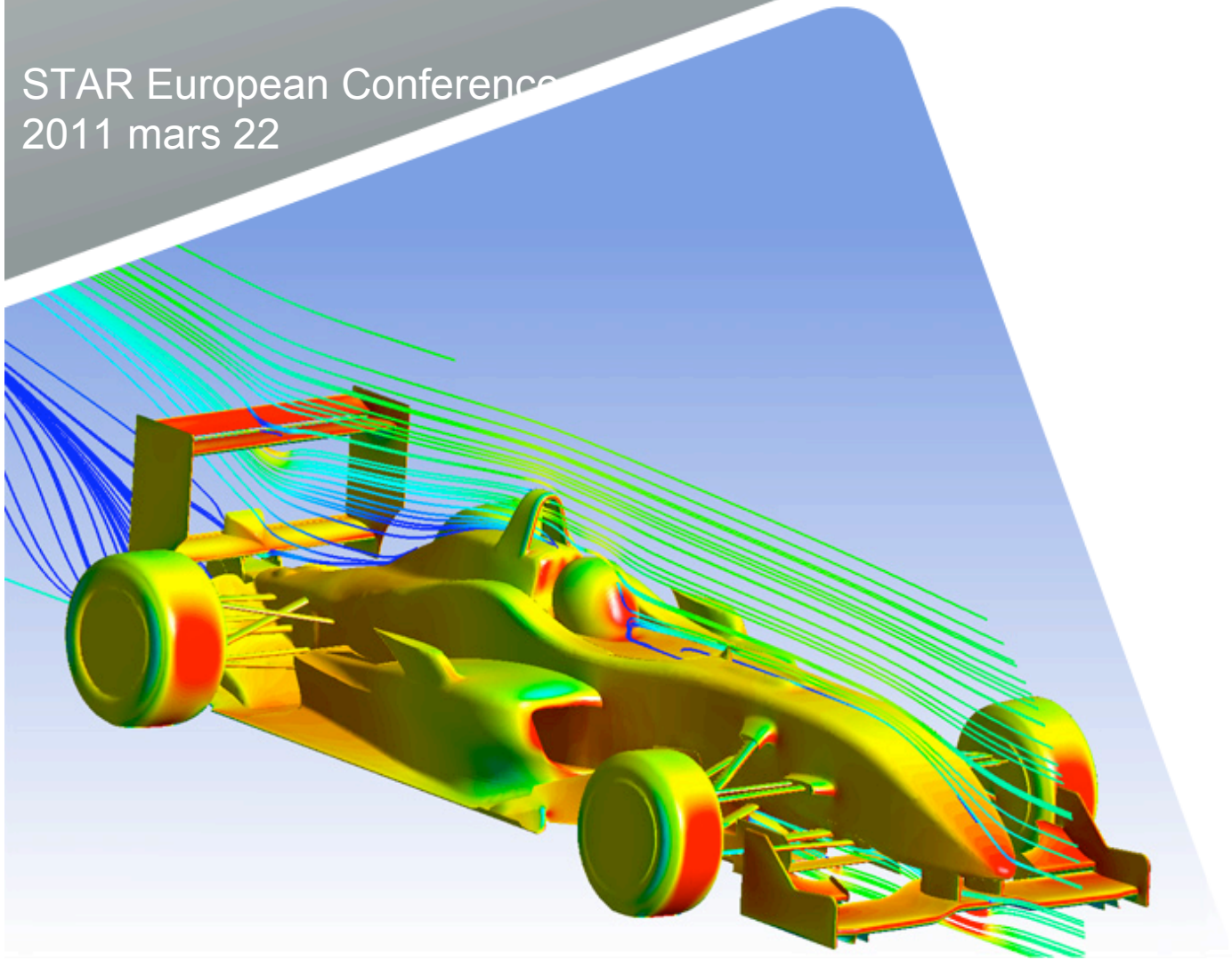
Experimental correlation of CFD results on the Formula 3

STAR European Conference
2011 mars 22



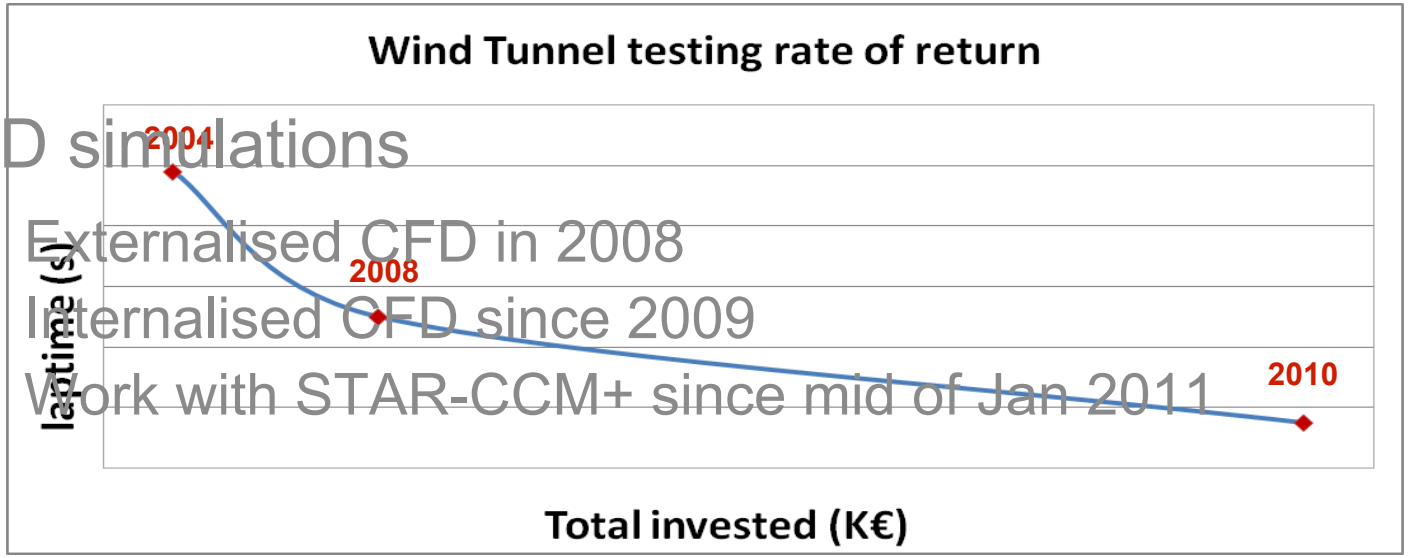
ART Grand Prix Presentation

- Junior Formulae Racing Team
  - Around 35 persons (Racing Team + Development)
  - Involved in Formula 3, GP3, GP2
  - 6 times F3 Euroseries Champion, 3 times GP2 Champion, 1st GP3 Champion
  - Vettel, Hamilton, Rosberg, Sutil, Kobayashi, Hulkenberg

- F3 positioning within Motorsport categories
  - Go Kart → FR2.0 → F3/GP3 → GP2 → F1

Aerodynamics Background

- Wind tunnel testing
  - Full scale wind tunnel from 2004 to 2007
  - Model scale wind tunnel from 2008
  - 375k€ invested in wind tunnel testing



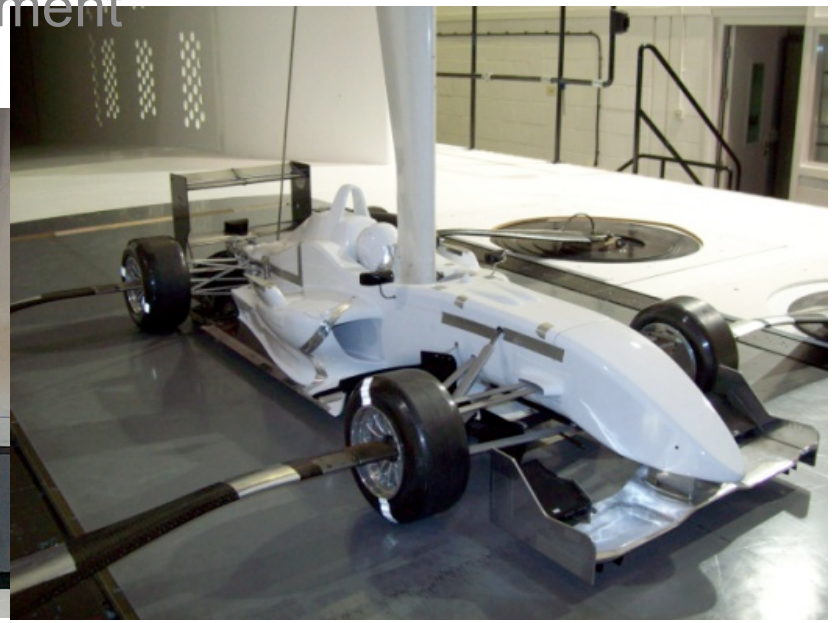
- CFD simulations
  - Externalised CFD in 2008
  - Internalised CFD since 2009
  - Work with STAR-CCM+ since mid of Jan 2011

Aim & Objectives

- Obtaining an accurate F3 CFD model in order to perform efficient aerodynamic developments
  - Use of experimental wind tunnel results
  - Mesh and Model fine tuning
  - Correlation between CFD and experimental results over several configurations

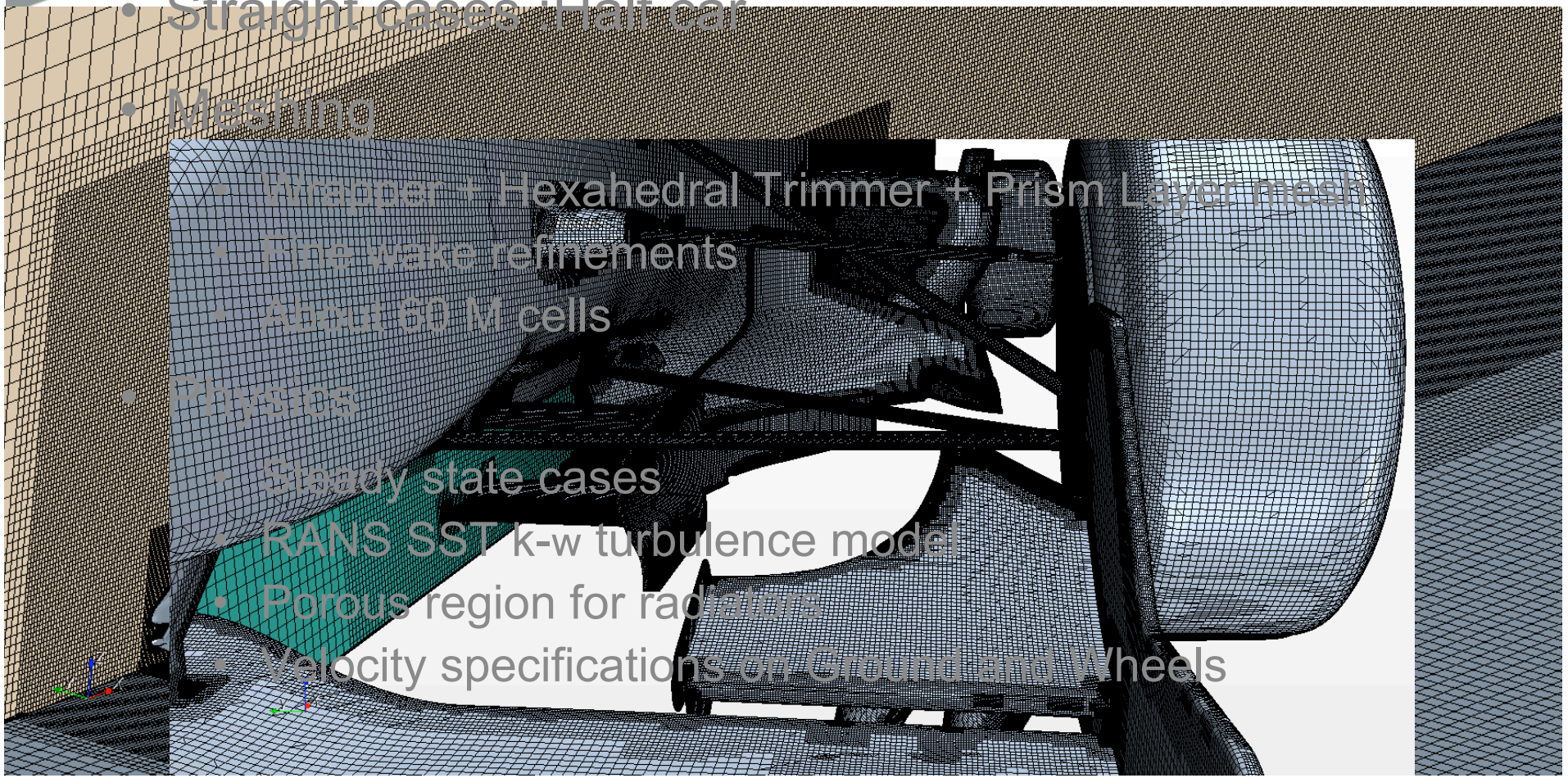
Experimental testing description

- Mercedes GP Petronas F1 Team wind tunnel
  - State of the art wind tunnel
  - Moving belt, boundary layer suction
  - Wheels lift and drag measurement
  - Air conditioned testing room
- Testing specifications
  - 45% scale model
  - 40 $m.s^{-1}$
  - Tolerance of measurement :
    - ±0.001 X / ± 0.003 in Z



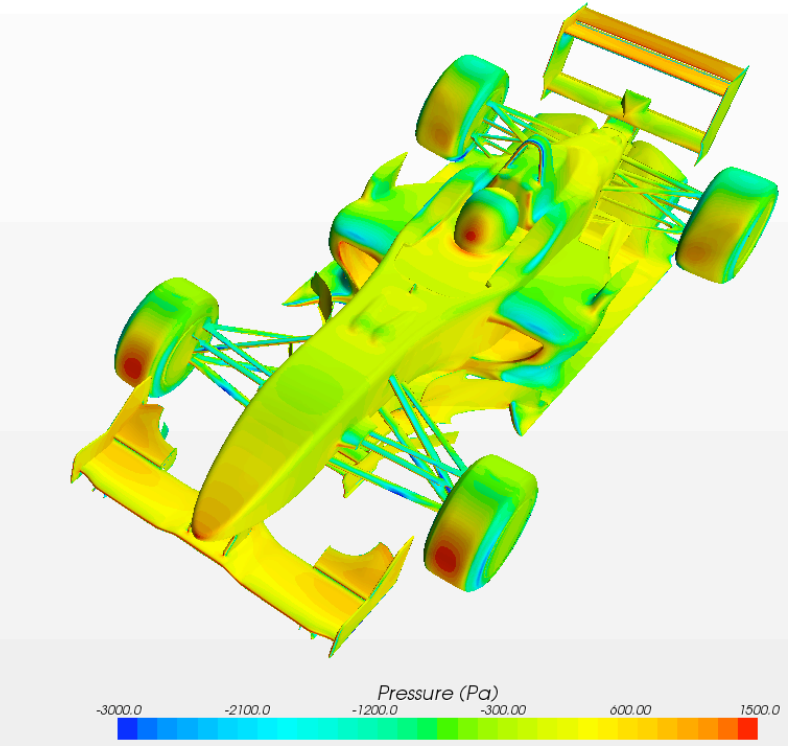
CFD model highlights

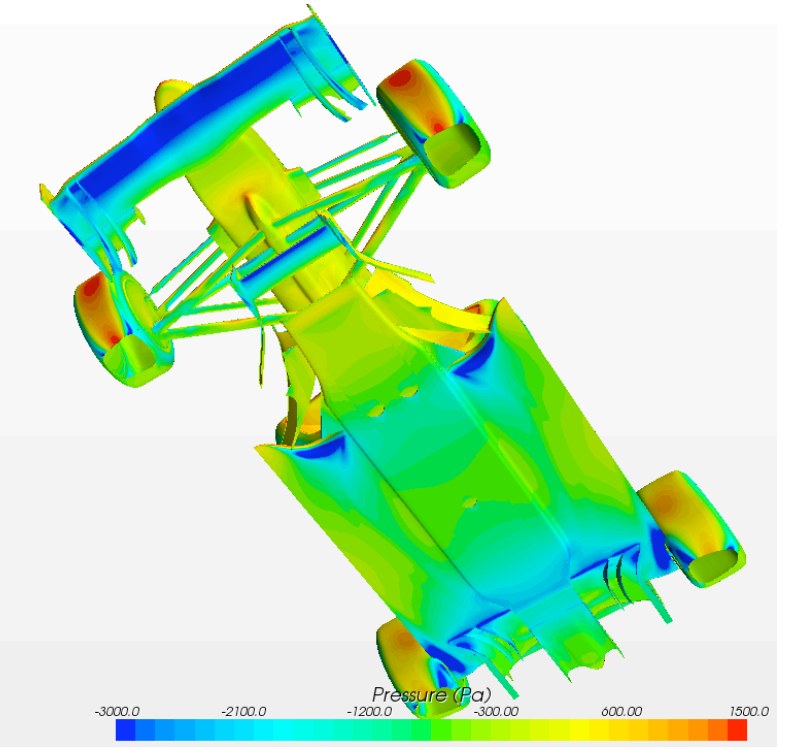
- Straight cases :Half car
- Meshing
  - Wrapper + Hexahedral Trimmer + Prism Layer mesh
  - Fine wake refinements
  - About 60 M cells
- Physics
  - Steady state cases
  - RANS SST k-w turbulence model
  - Porous region for radiators
  - Velocity specifications on Ground and Wheels



CFD Baseline post-processing

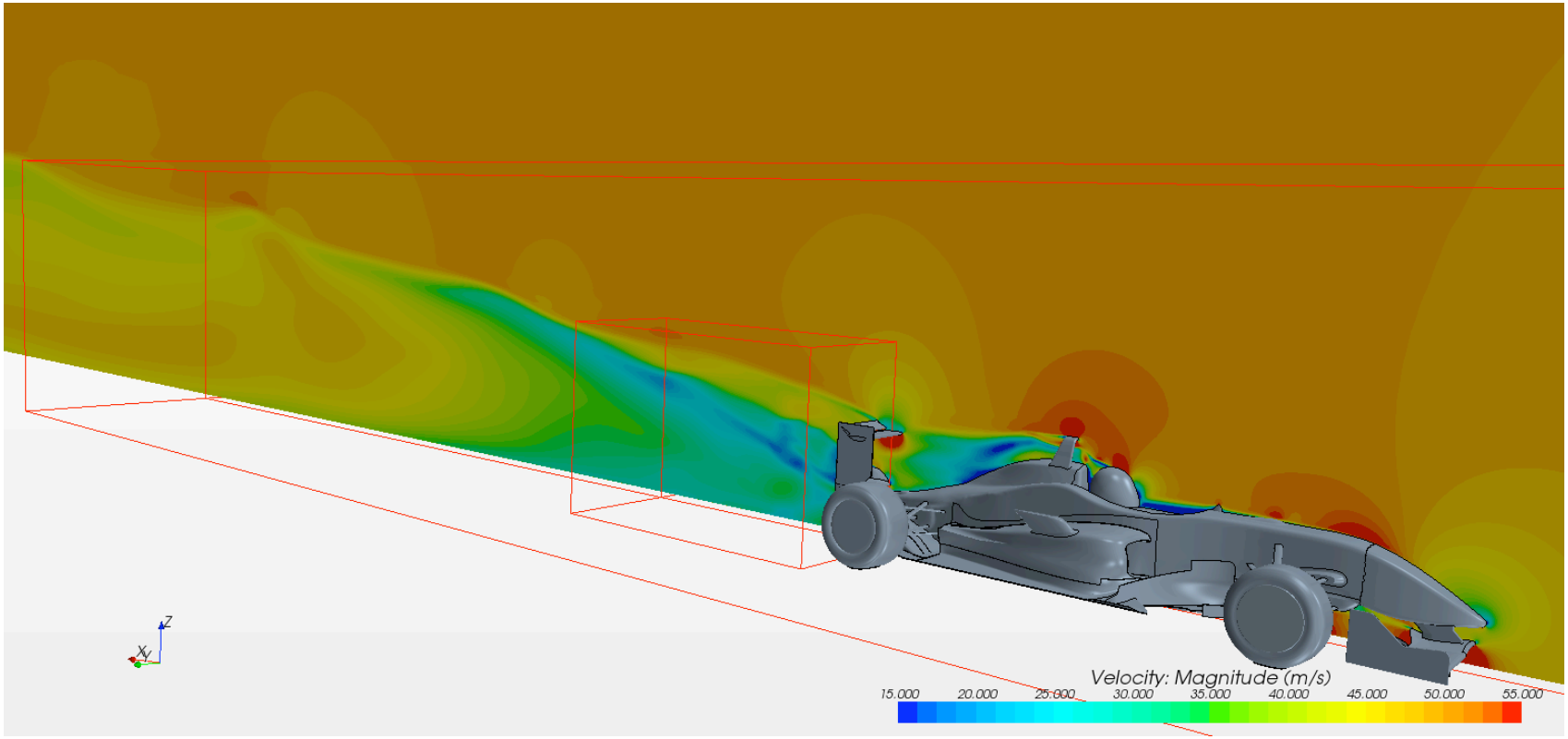
- Pressure contours on/under car





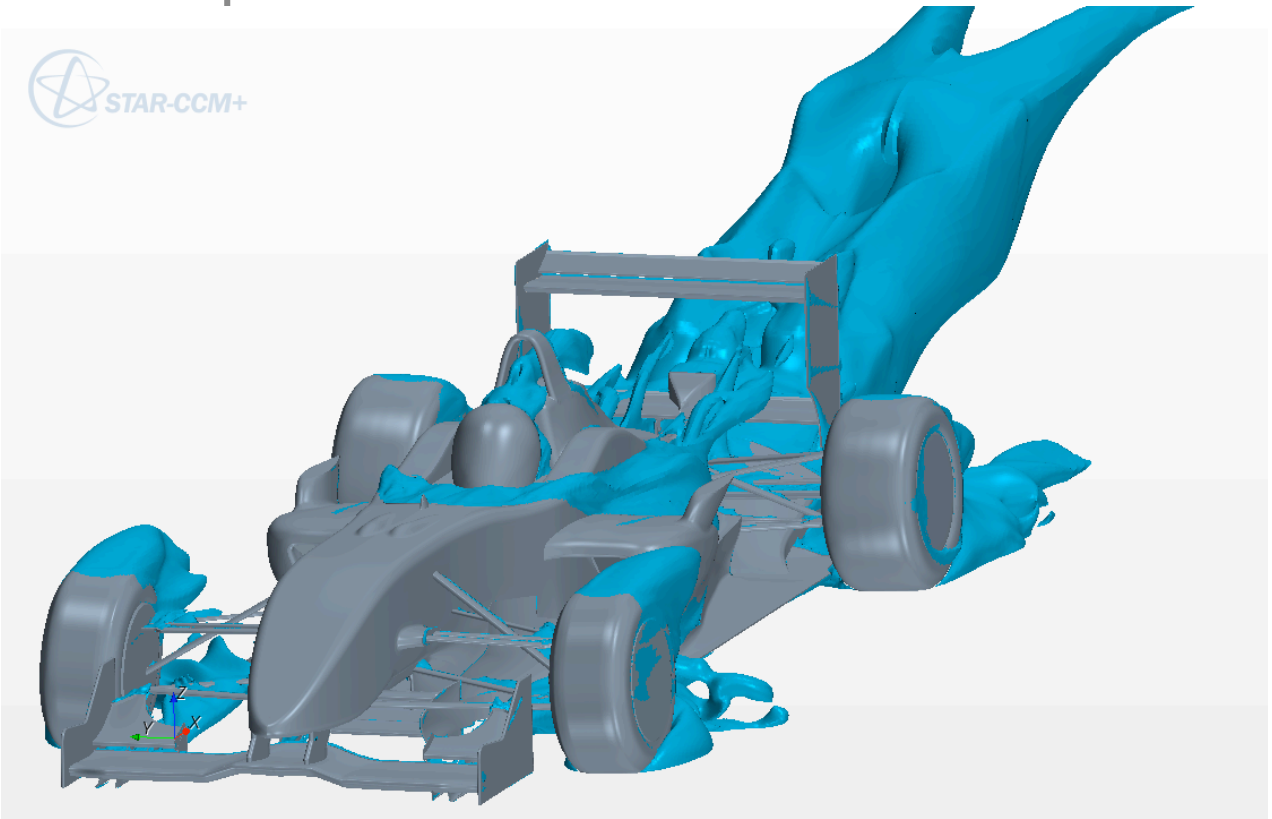
CFD Baseline post-processing

- Velocity Y-section



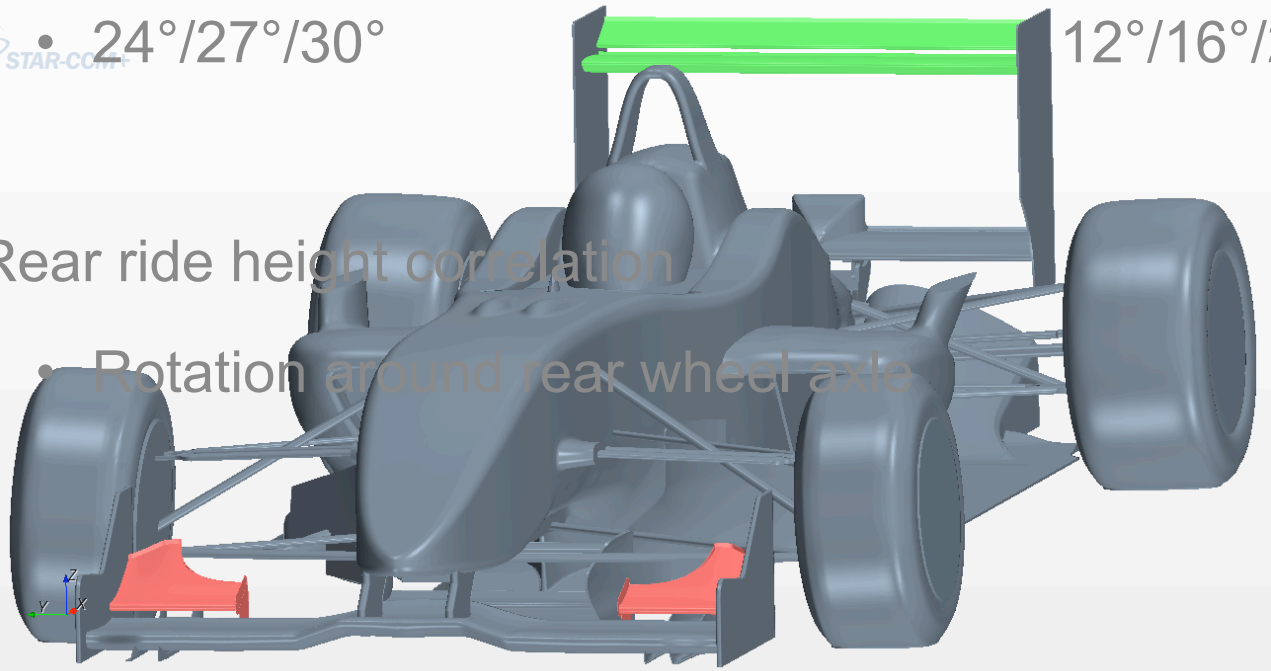
CFD Baseline post-processing

- Wake Iso-Cp Tot



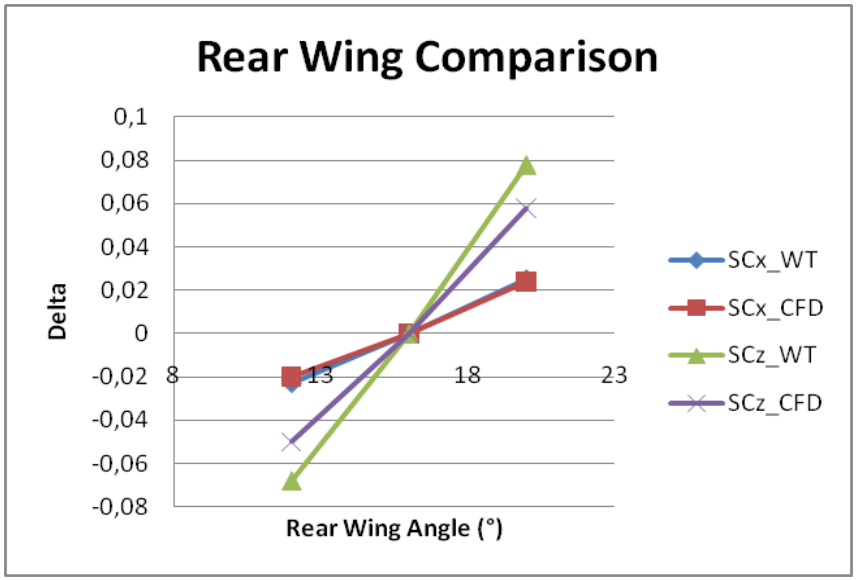
Correlation study presentation

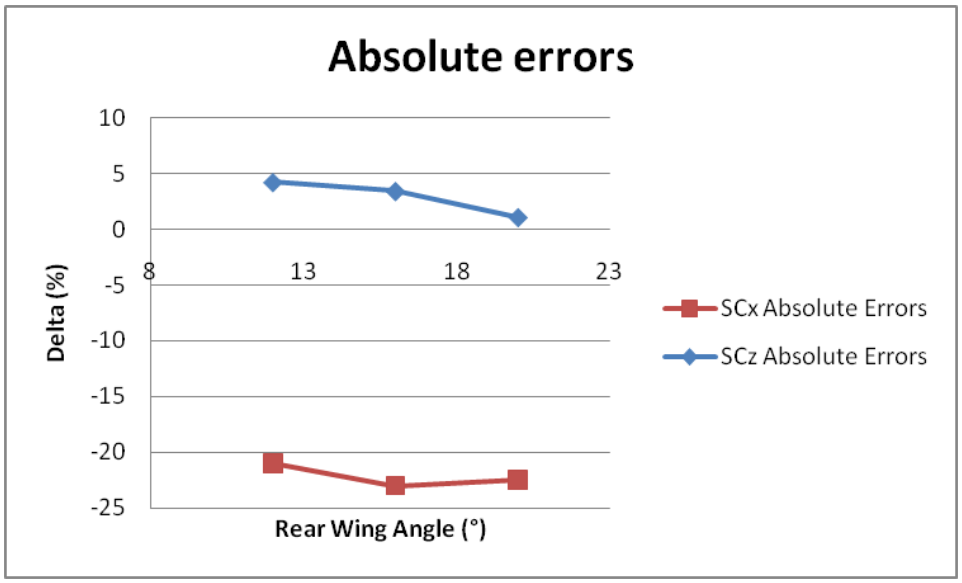
- Simple Correlation based on “sure” data:
- Front Wing correlation
  - 24°/27°/30°
- Rear Wing correlation
  - 12°/16°/20°
- Rear ride height correlation
  - Rotation around rear wheel axle



Correlation study results

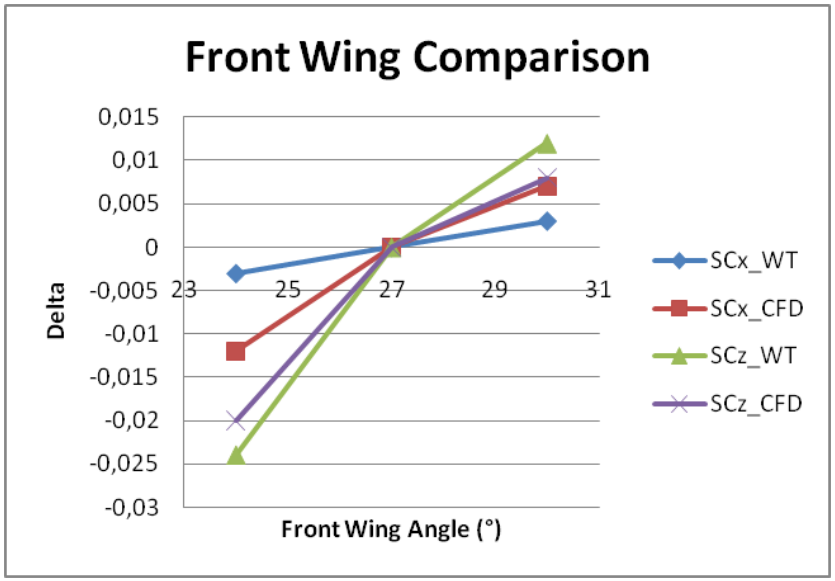
- Rear Wing configurations

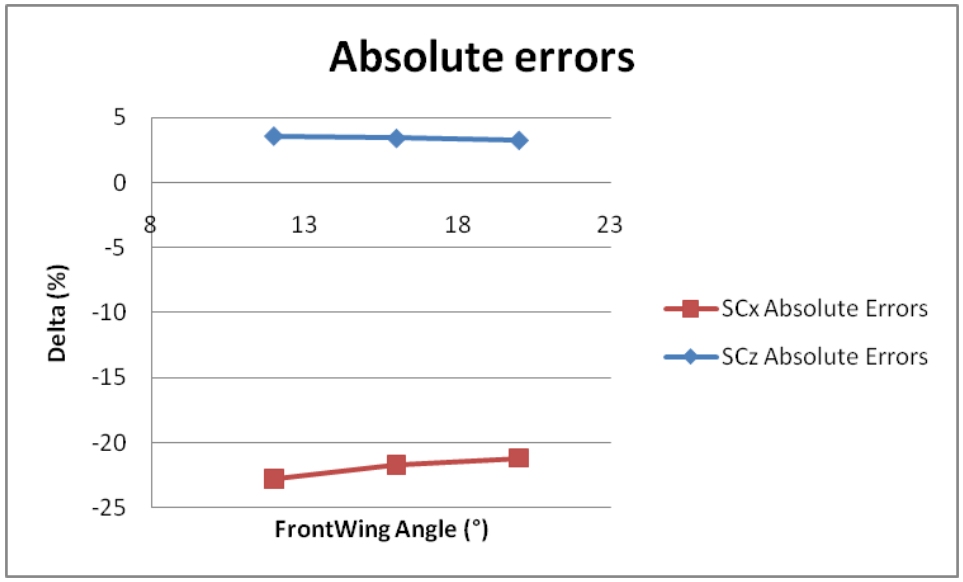




Correlation study results

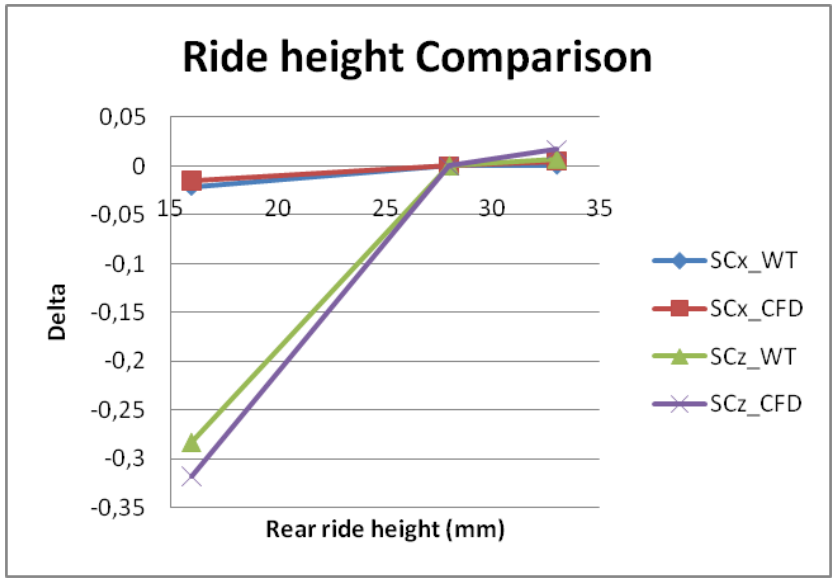
- Front Wing configurations

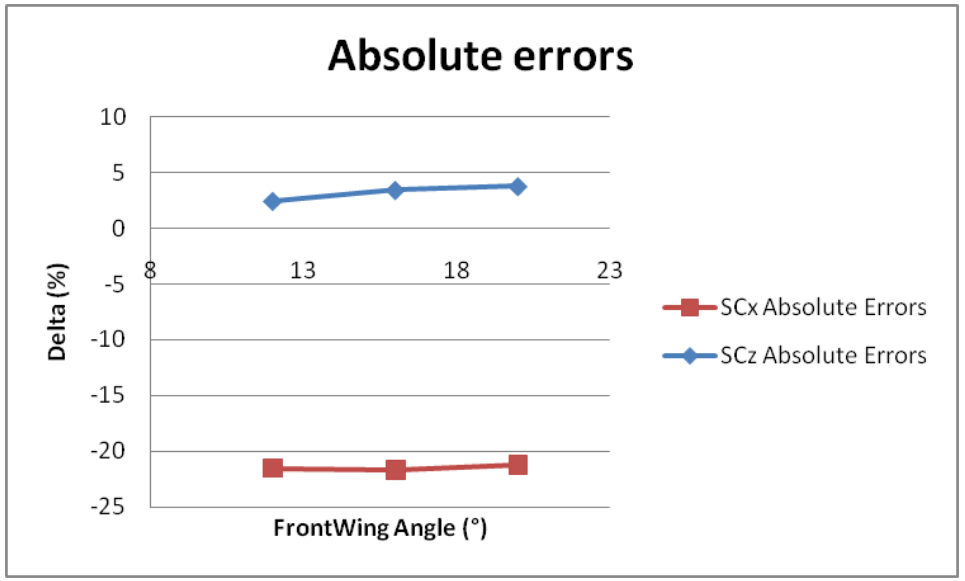




Correlation study results

- Rear ride height configurations





Timetable

- Mid Jan 2011
  - Started with Star CCM+ from a surface mesh
- End Jan 2011
  - First mesh created
- End Feb 2011
  - Satisfactory simulation convergence
- March 2011
  - Start of correlation study

Computational resources

- 2 Intel Xeon 6 cores @ 3.47Ghz 64Go RAM
  - Meshing Time : 3h00

- 4 Intel Xeon 4 cores @ 3.06Ghz 48Go RAM
  - Calculation Time : 70 it/h

Conclusion

- Results are generally quite good, achieved in 2 months (close to tolerance of measurement in wind tunnel in most of the case)
- Absolute errors good in downforce (less than 5%) but still far in drag (more than 20%).
- Relative offsets in drag seem to be interesting
- Correlation with experimental results show that our model still need to be improved.

Acknowledgments
Questions

- Many thanks to Mr. Fauchier, Mr. Thomas, Mr. Dufournet for CD-Adapco for their efficient support

- Thanks for your attention

- Any questions?