iconCFD®
3.3.X / 4.0.X

New & UPCOMING FEATURES

A summary of the new features available in iconCFD 3.3.X.
Development plans for iconCFD 4.0.X

Your True Partner for
CAE ✕ CFD
ICSC2016
IDAJ CAE Solution Conference

Dr. Kyle Mooney
k.mooney@iconcfd.com
November 2016

Technology • Process • Consulting

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AGENDA

Overview

App & Platform Integration

- Process / Platform Applications / Geometry Tool

Module Development

- New Features & Future Capability
- Case Studies & Validation Efforts
- Testing Framework

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SUPPORTED CFD WORKFLOW

Modularized ● Industrialized ● Customized

iconCFD Process
- GUI
- MultiCase

iconCFD Wrap

iconCFD Mesh

iconCFD Cold
iconCFD Thermal
iconCFD Optimize
iconCFD VOF
iconCFD ... etc.

iconCFD Support & Documentation

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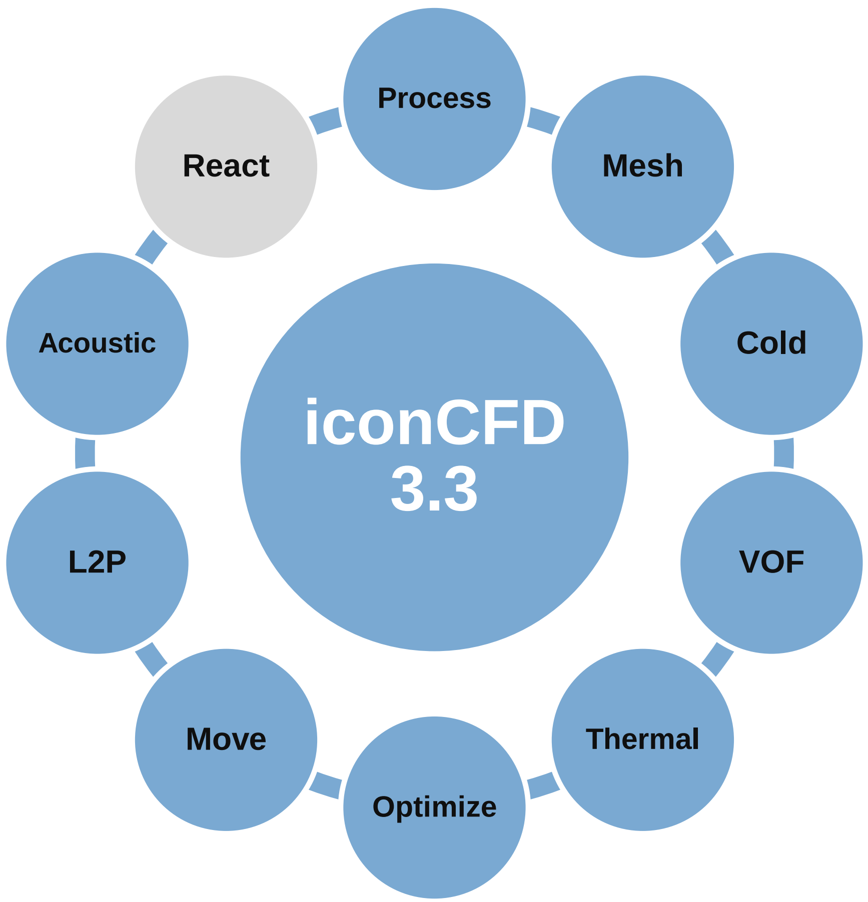
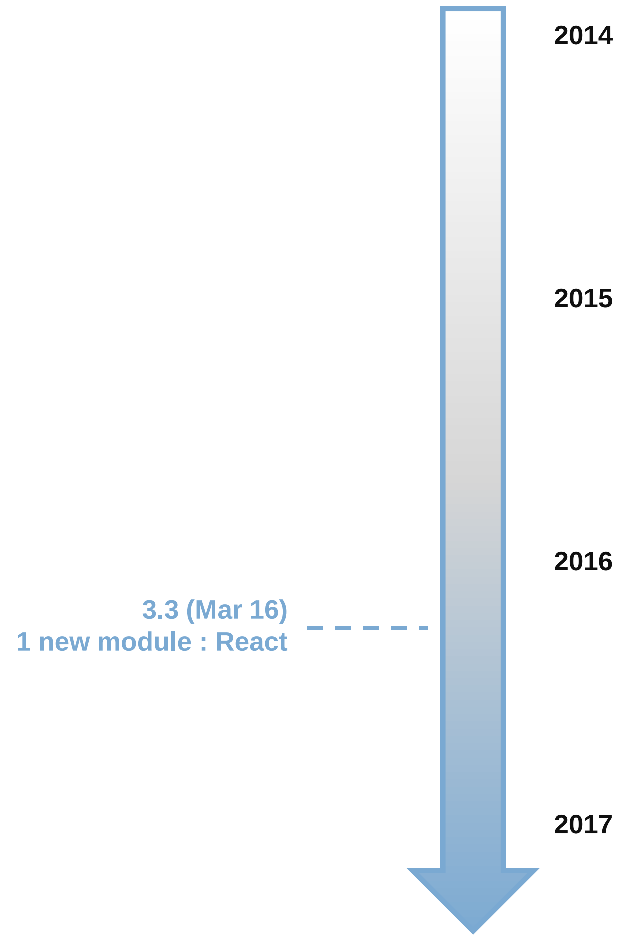
iconCFD EVOLUTION





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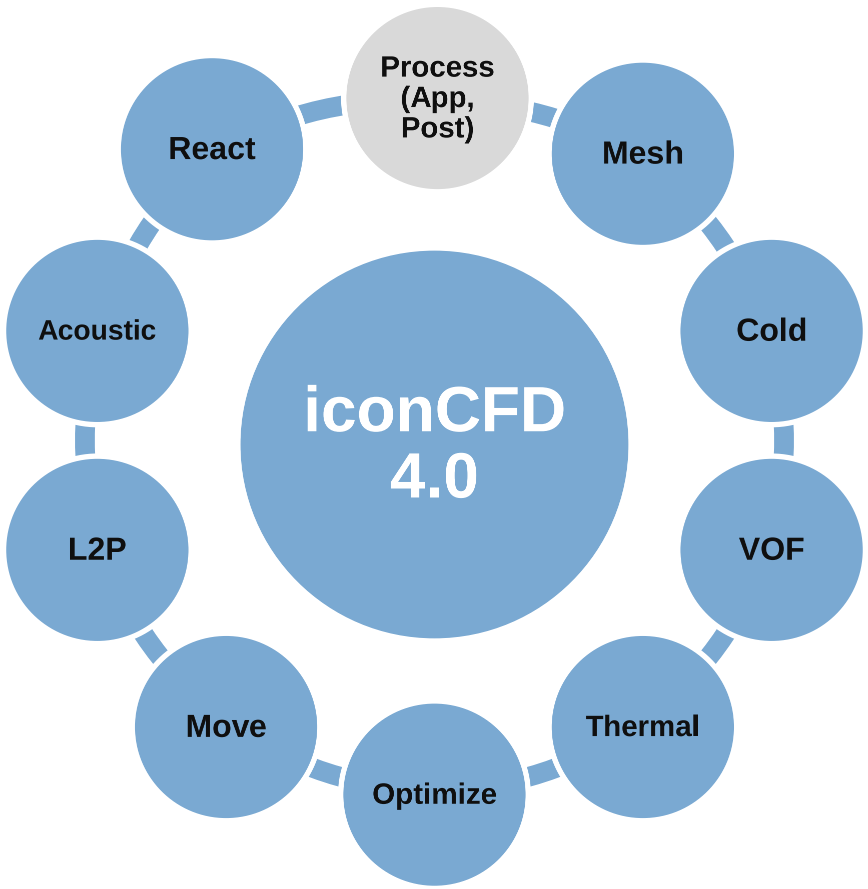

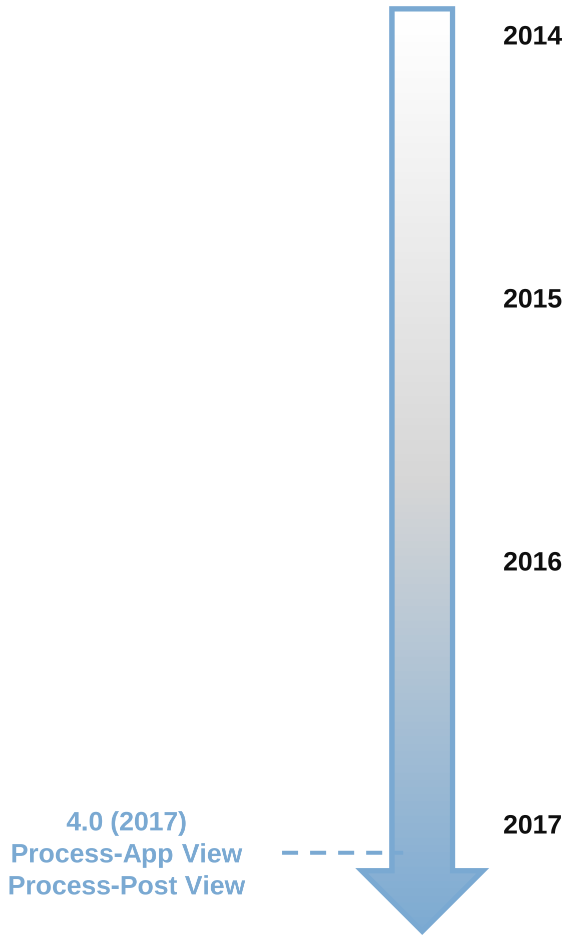

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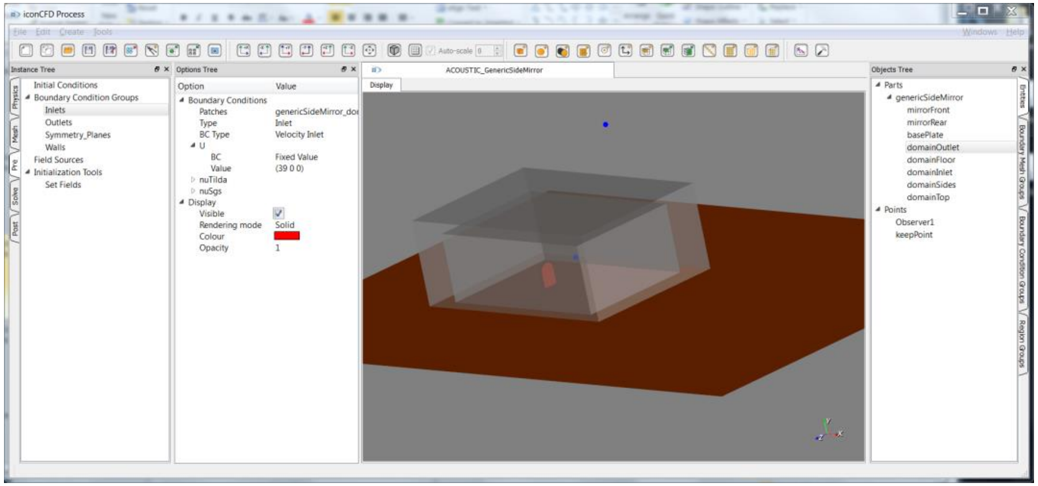
iconCFD PROCESS

NEW/UPCOMING FEATURES

- New Features:
  - More intuitive and structured design
  - Separated geometry (or objects) tree
  - New mesh/boundary conditions/region groups
  - New panel to show mesh, boundary conditions and region groups hierarchy
  - Integrated documentation with search capability



- Upcoming Features:
  - Resource manager
  - Run/job manager
  - Workflow manager
  - Morphing capability

1| Setup

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iconCFD Process/iconPlatform

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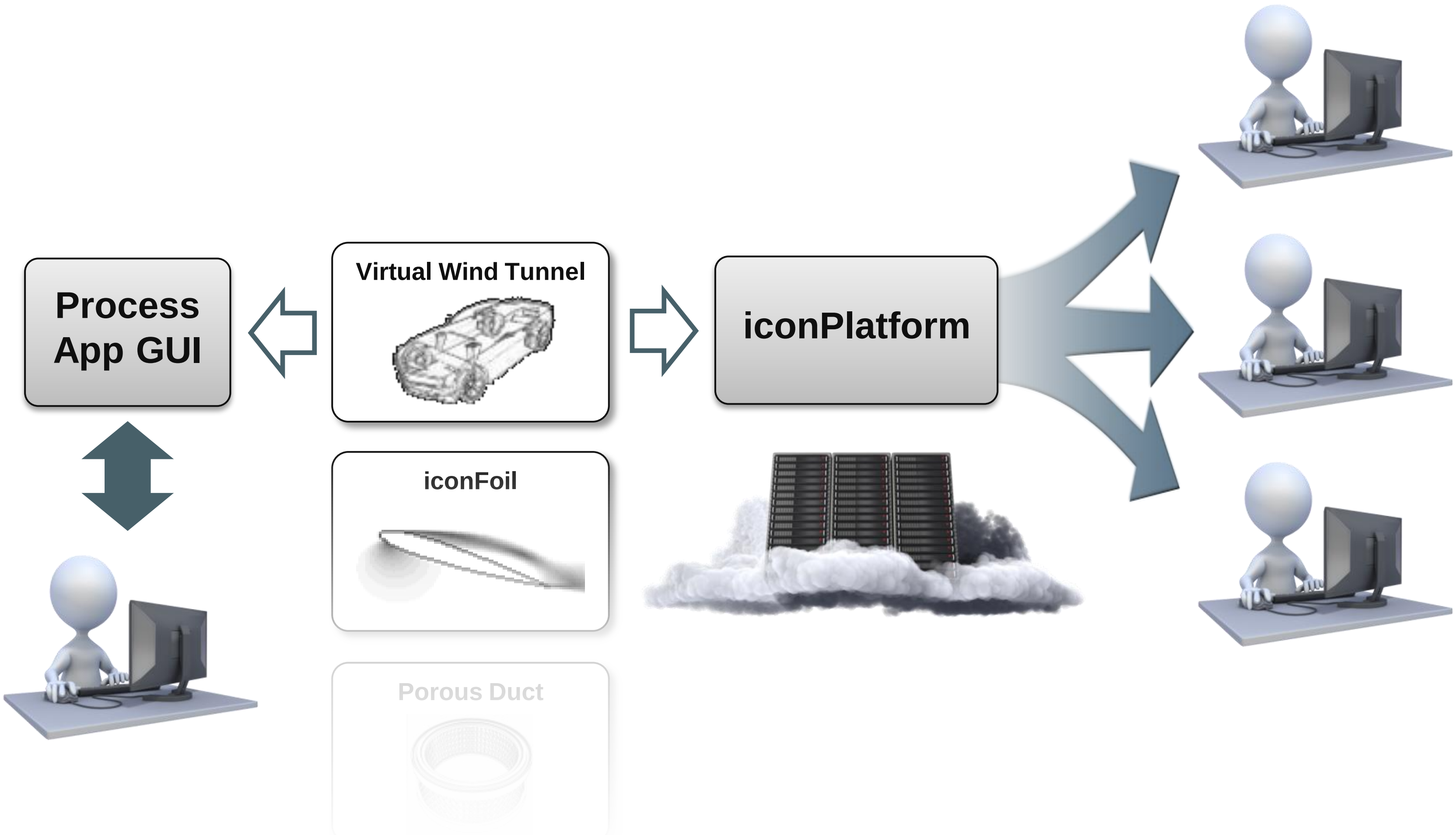
App Deployment



iconCFD PROCESS
APP & GEOM INTEGRATION

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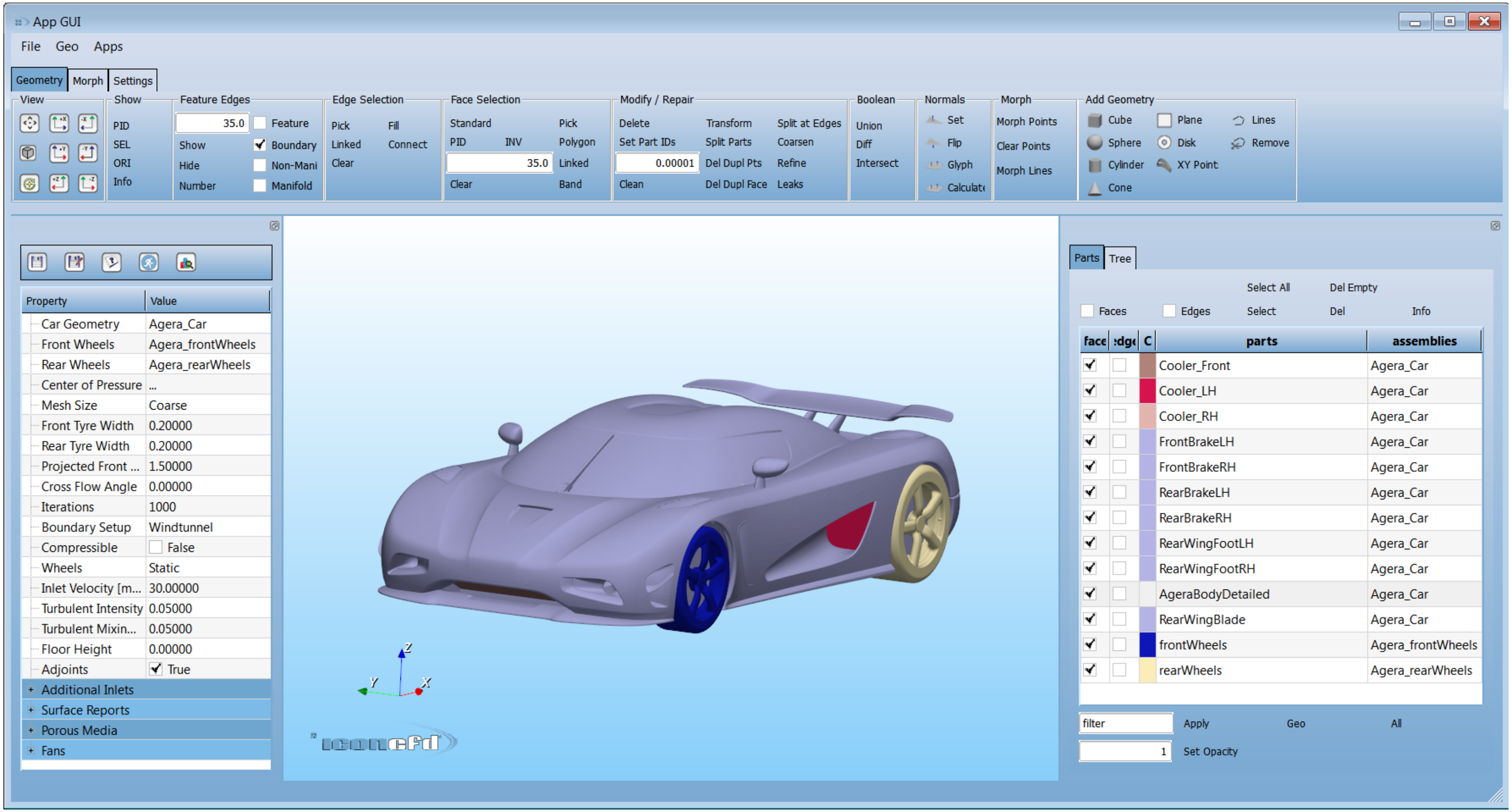

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iconCFD PROCESS
APP SETTINGS

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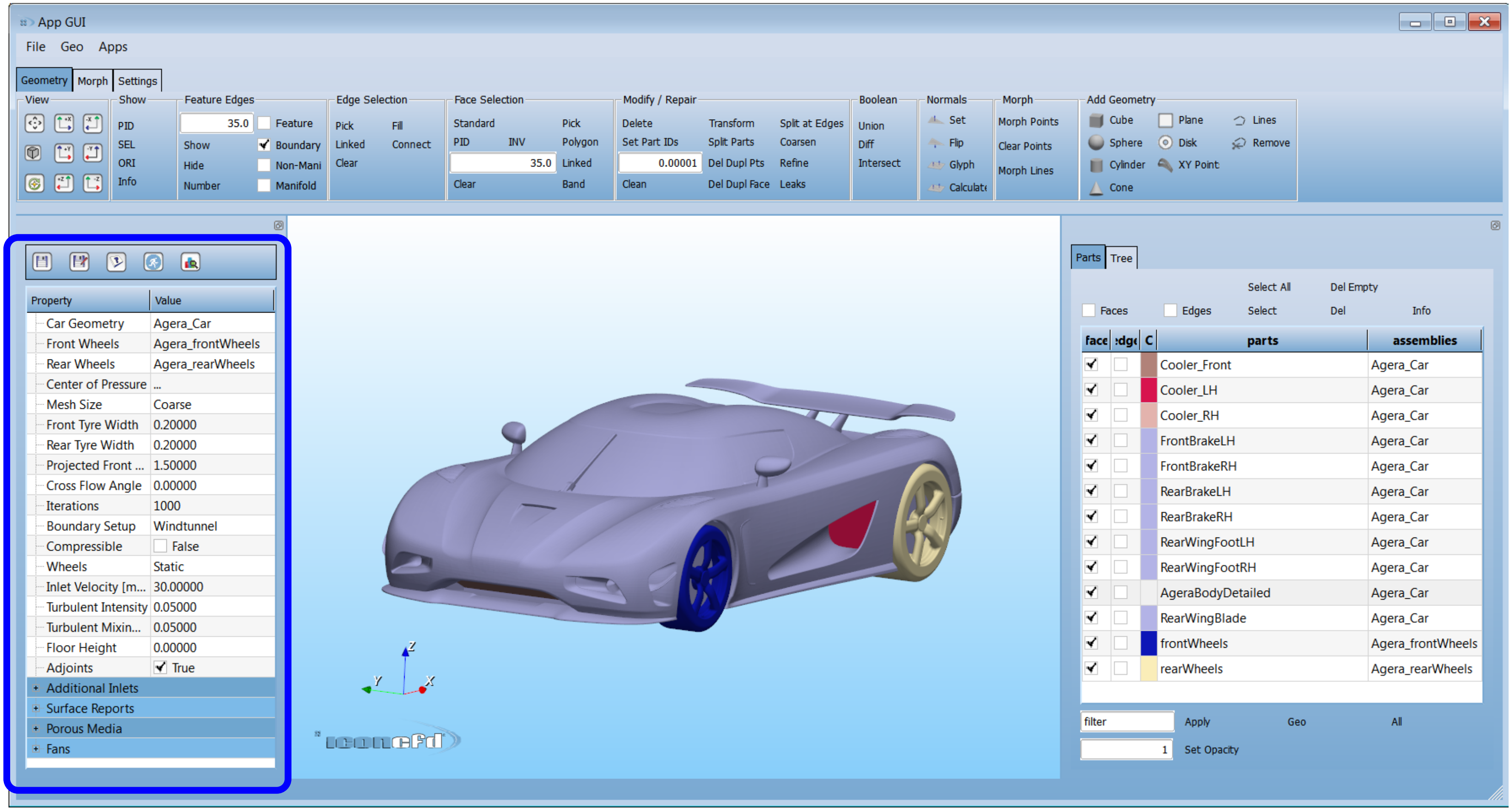

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iconCFD PROCESS
ASSEMBLY TREES

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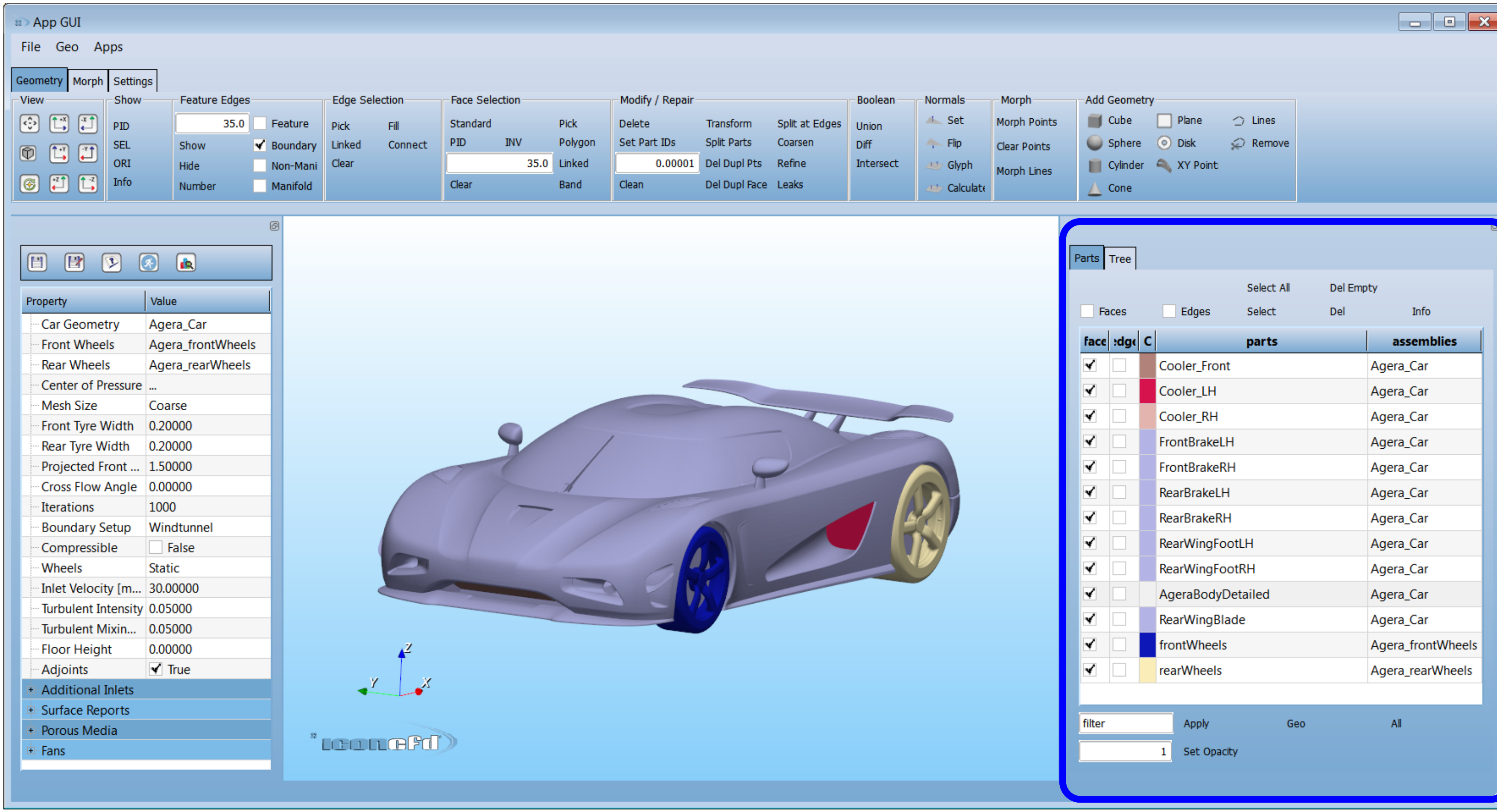

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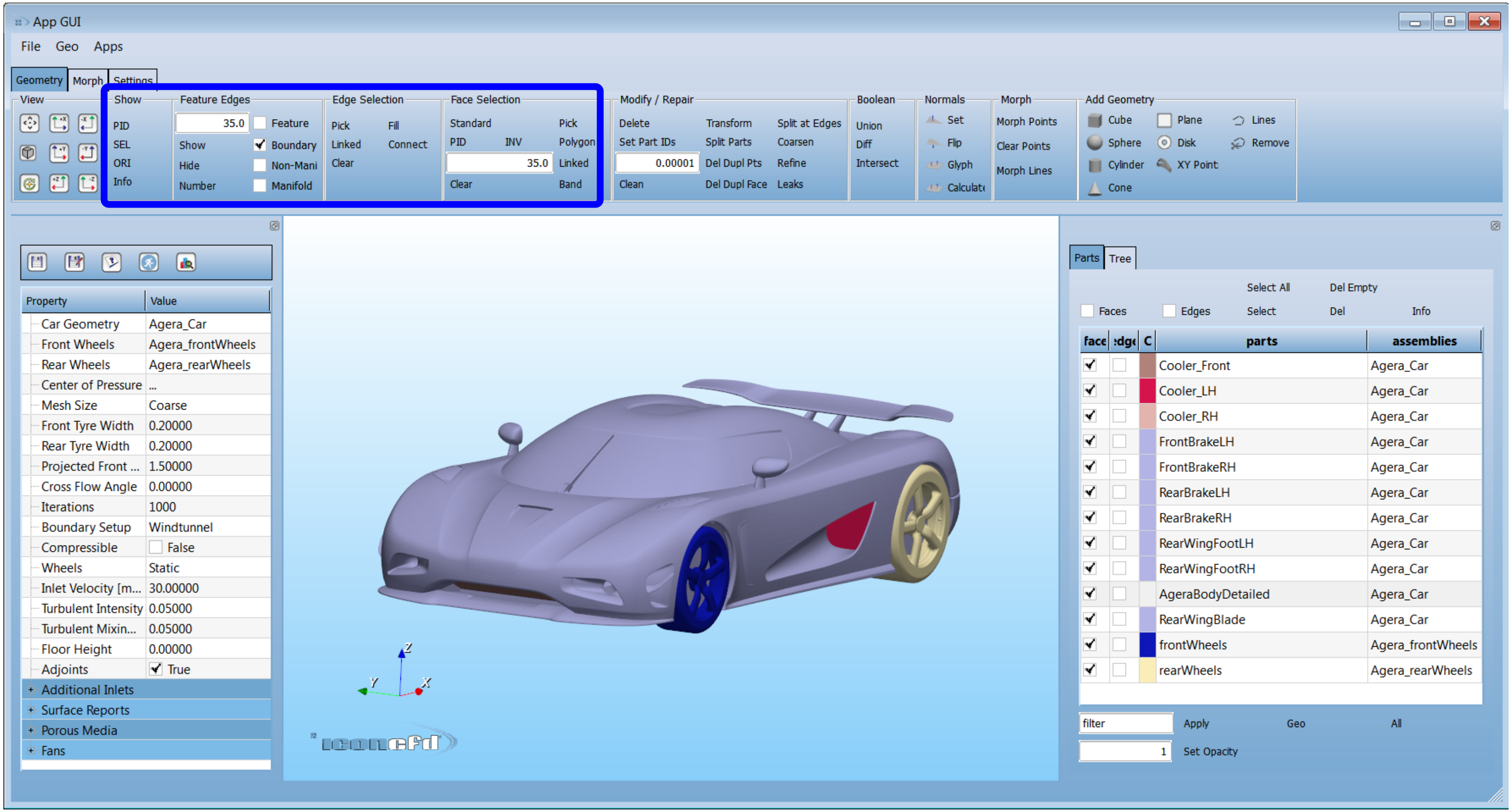
EDGE & FACE SELECTION METHODS



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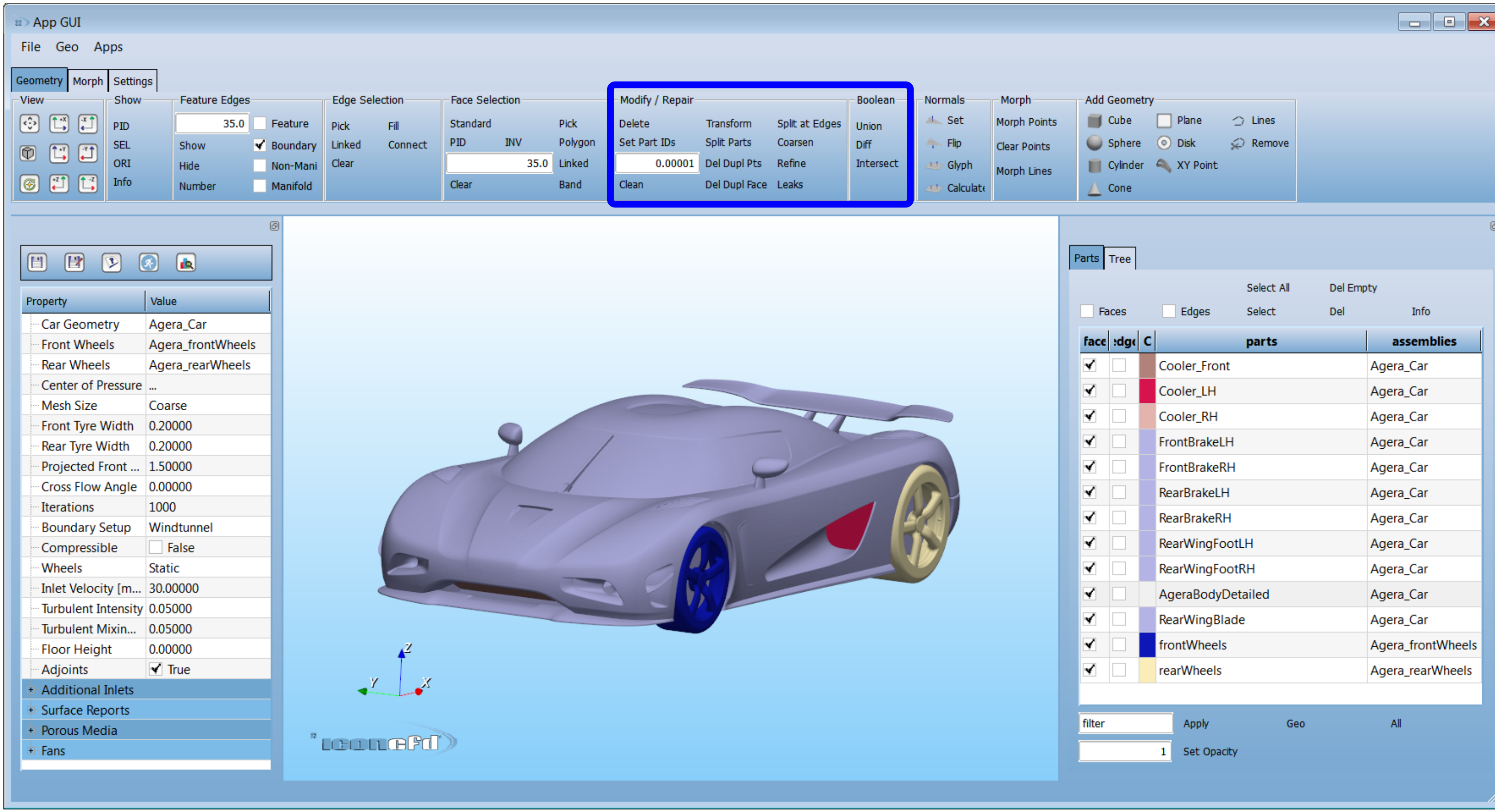
GEOMETRY MODIFICATION / REPAIR



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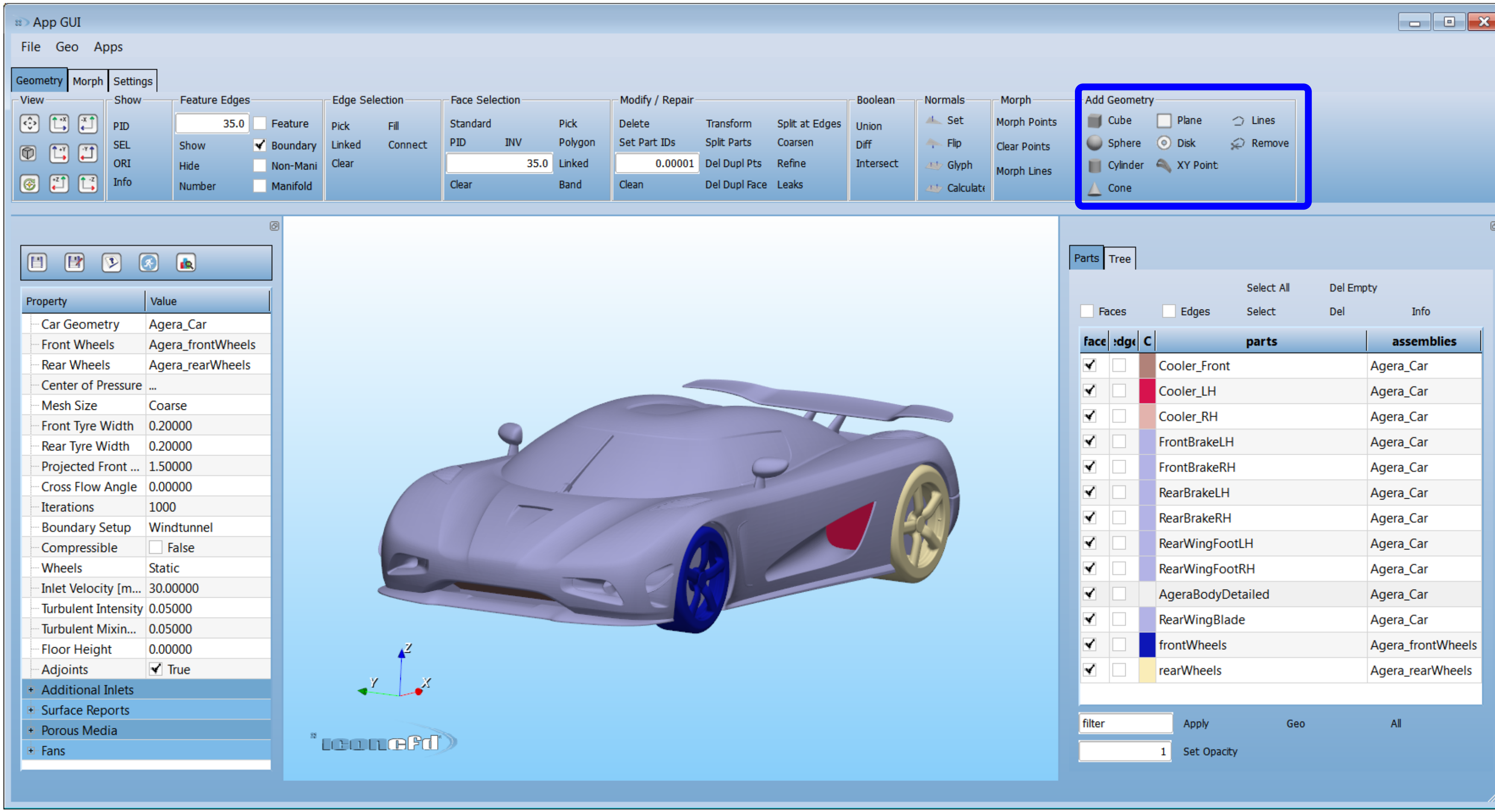
GEOMETRY CREATION



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iconCFD PROCESS
MORPHING

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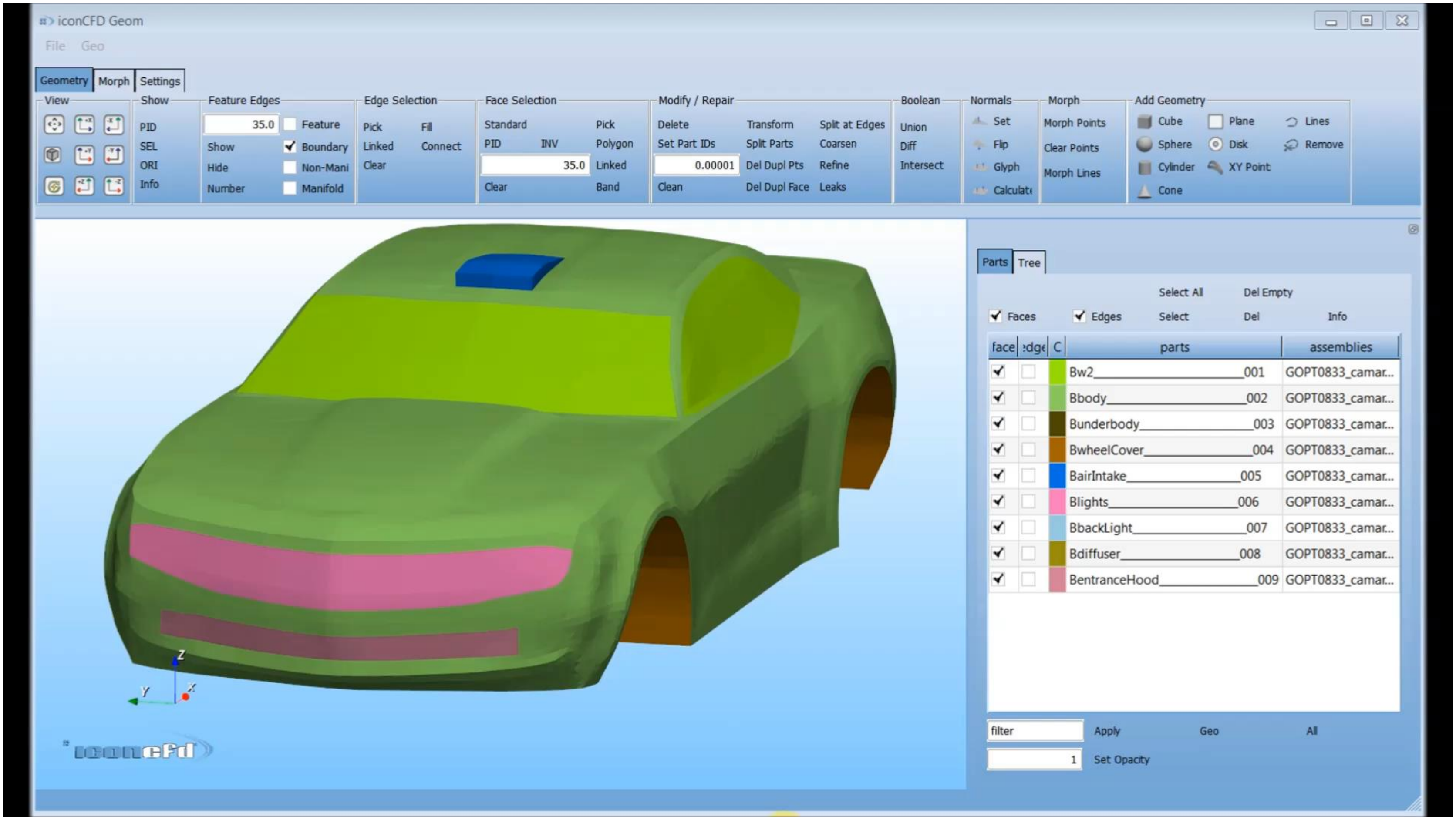

iconCFD PROCESS

POST VIEW

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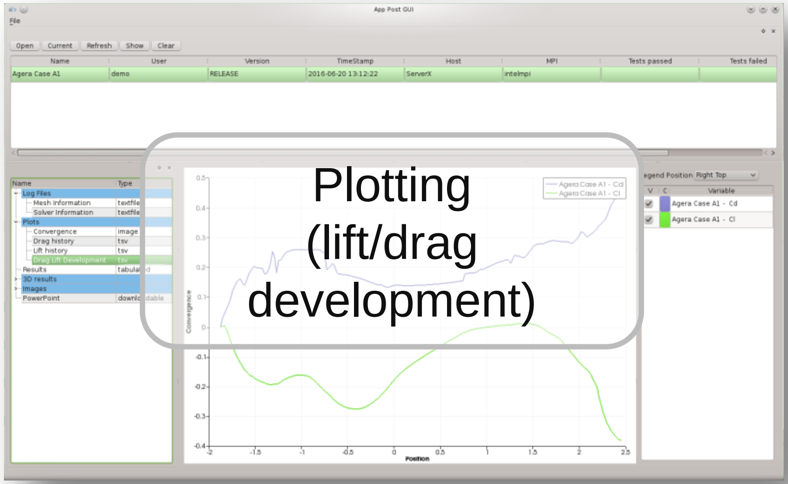

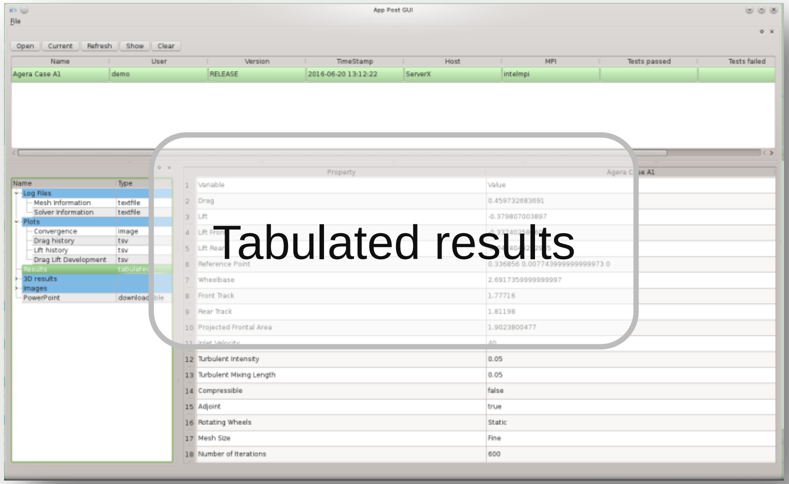

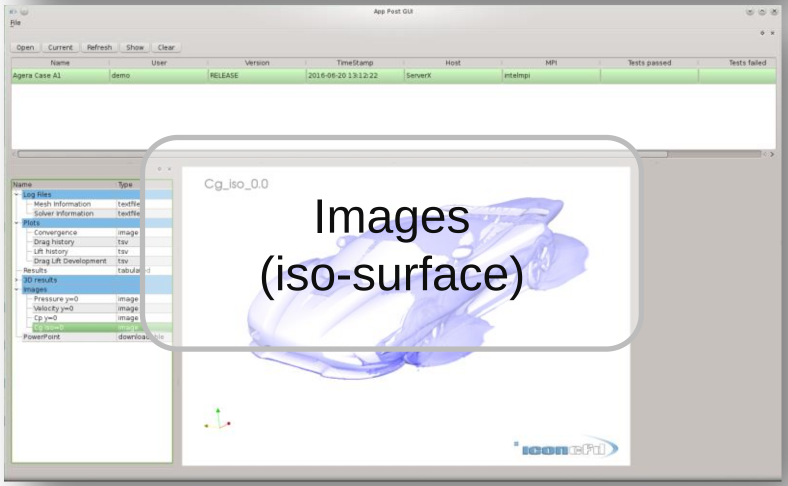

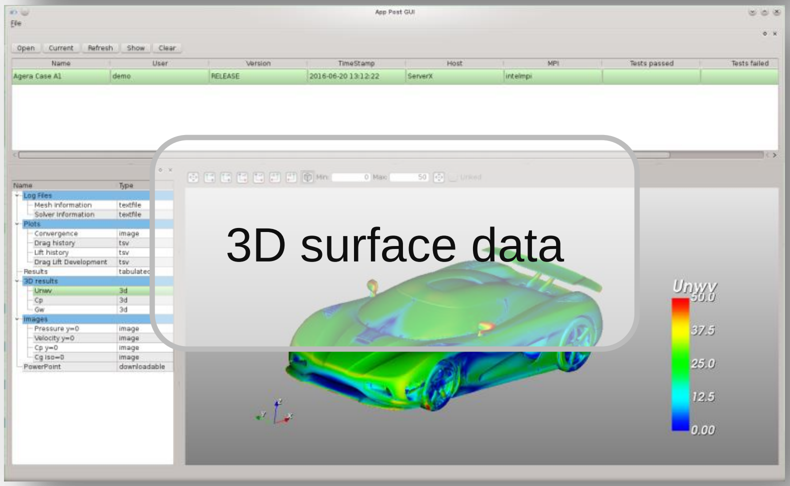

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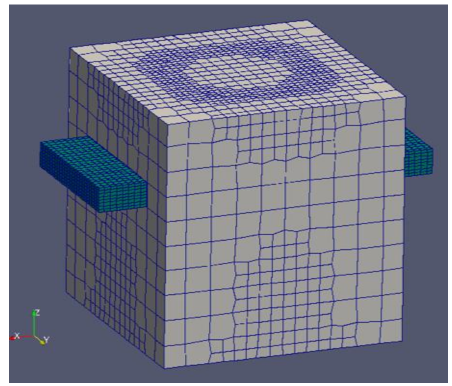
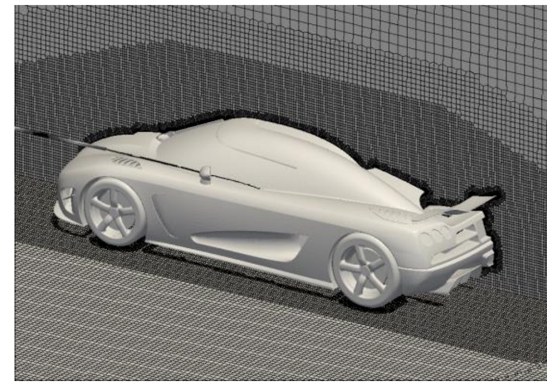
iconCFD MESH

NEW FEATURES / IMPROVEMENTS

- Enabled use of autoBlockMesh with geometries consisting entirely of analytical shapes (e.g. searchableBox, searchableCylinder)
- Added ability to generate either conformal or non-conformal CHT interfaces between two regions
- Enabled creation of 2D multi-region meshes
- Generate point zones during meshing using searchable surfaces or closed STLs as in cell zone construction
- Improved snapping on face zones
- Upcoming:
  - Improved snapping and layer coverage without decreasing mesh quality





3| Meshing

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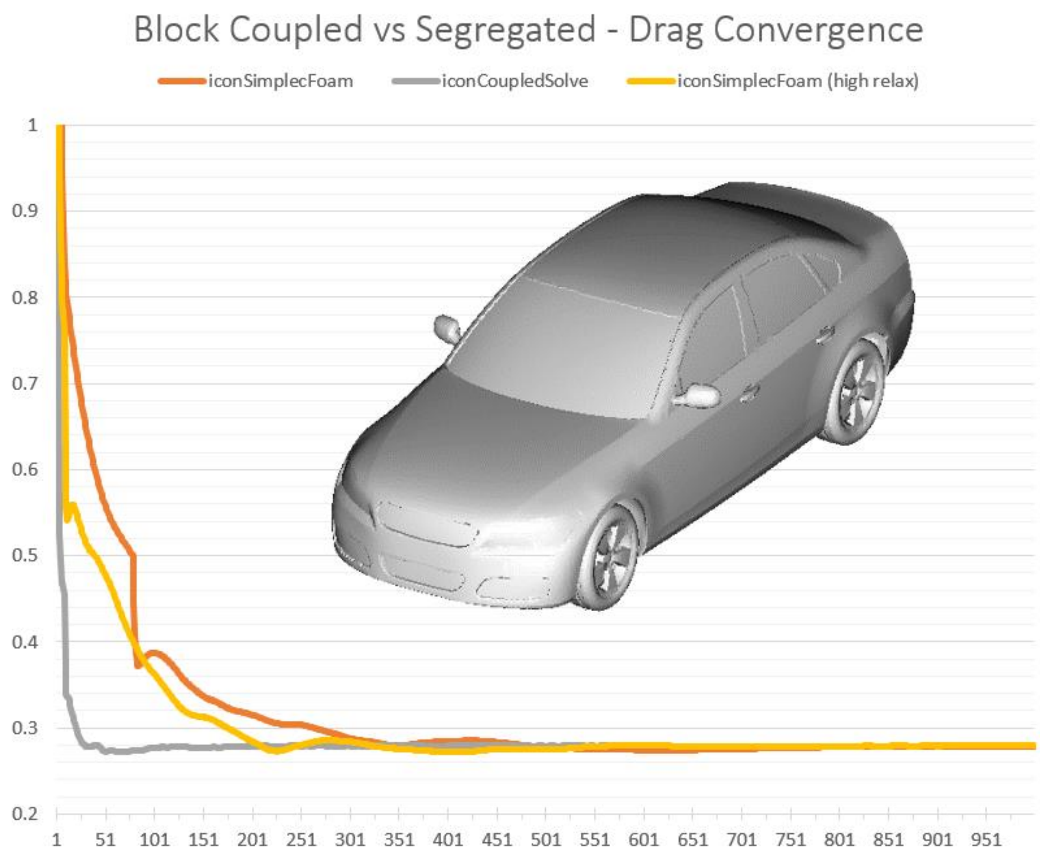
iconCFD COLD
P-U BLOCK COUPLED SOLVER

- New incompressible solver with block coupled support
- Significantly reduce number of iterations required for convergence for steady cases.
- **77%** reduction in turn around time in initial benchmarks



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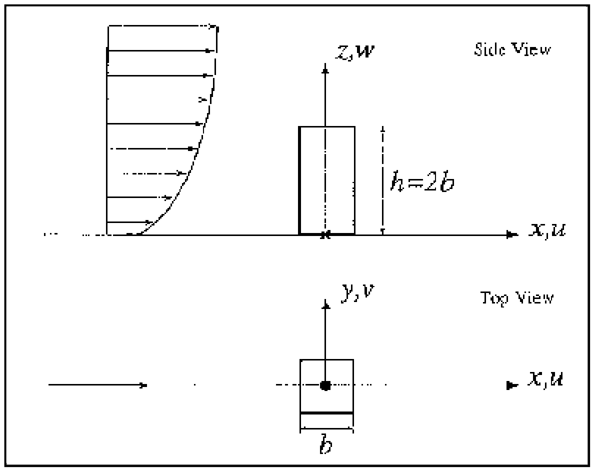
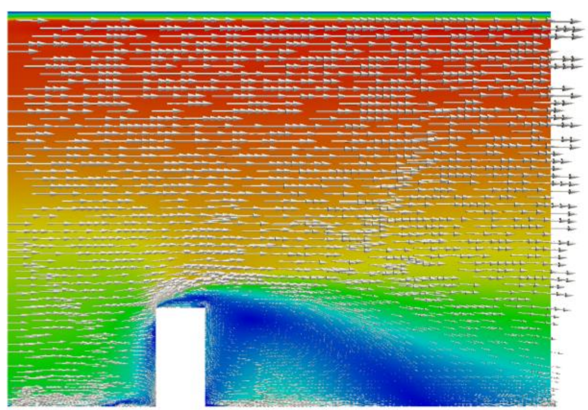
iconCFD COLD

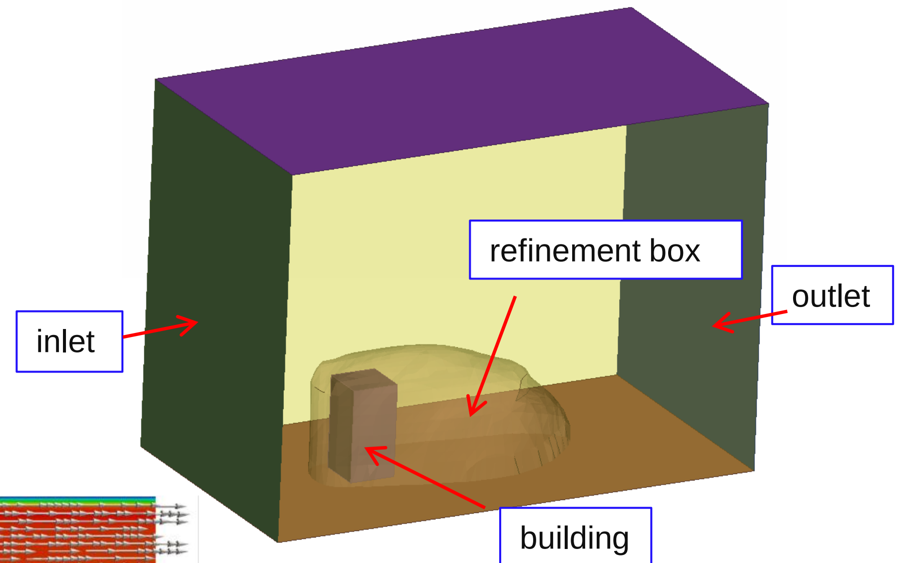
CASE STUDY: FLOW OVER BUILDING

- Large spatial scale case study
- Compare to experimental measurements





CFD model



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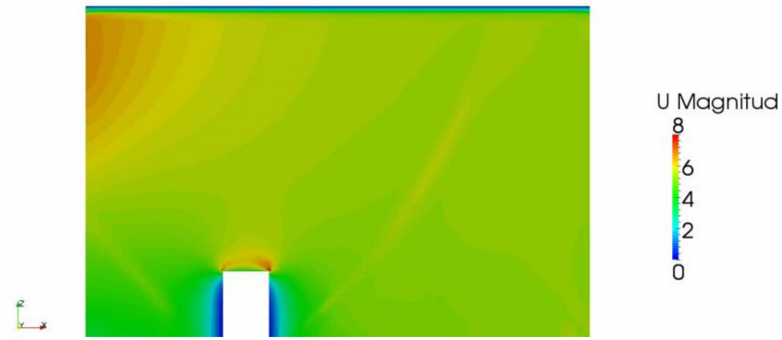
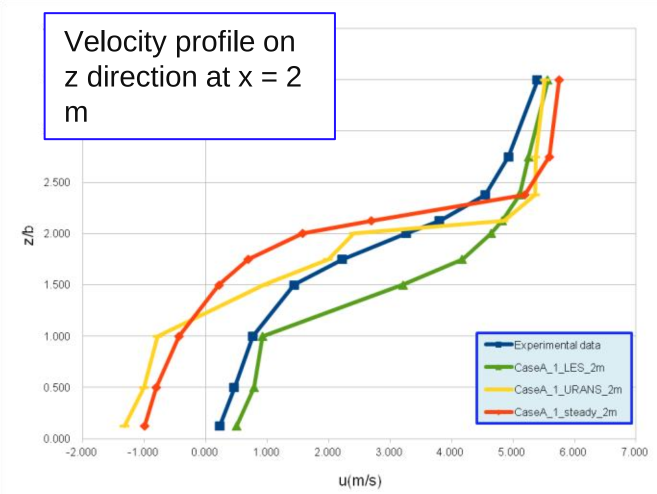
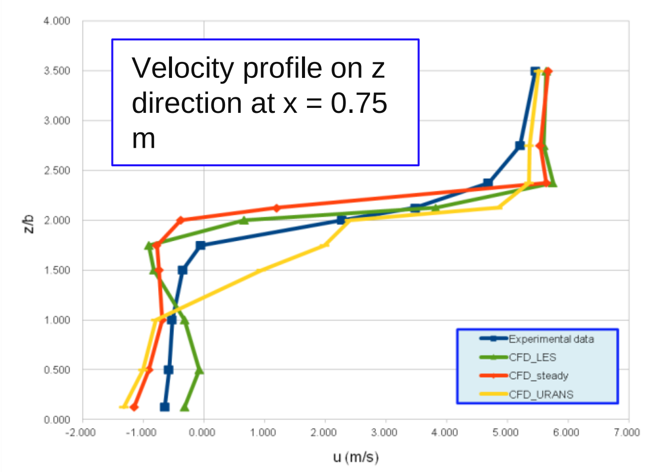
CASE STUDY: FLOW OVER BUILDING

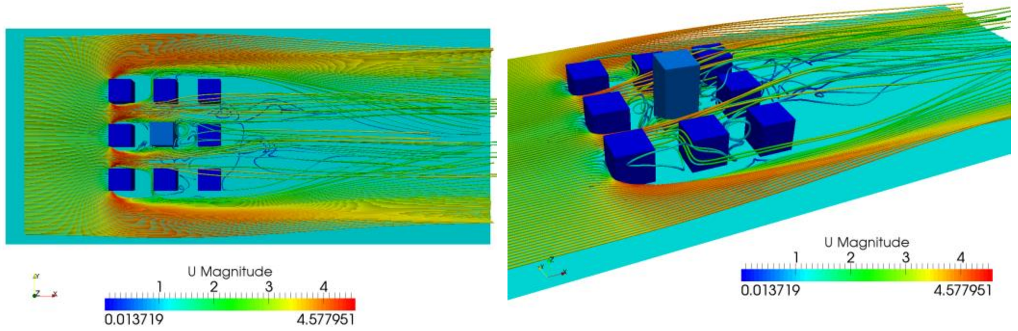


LES simulation: transient U field





Next steps, larger scale:



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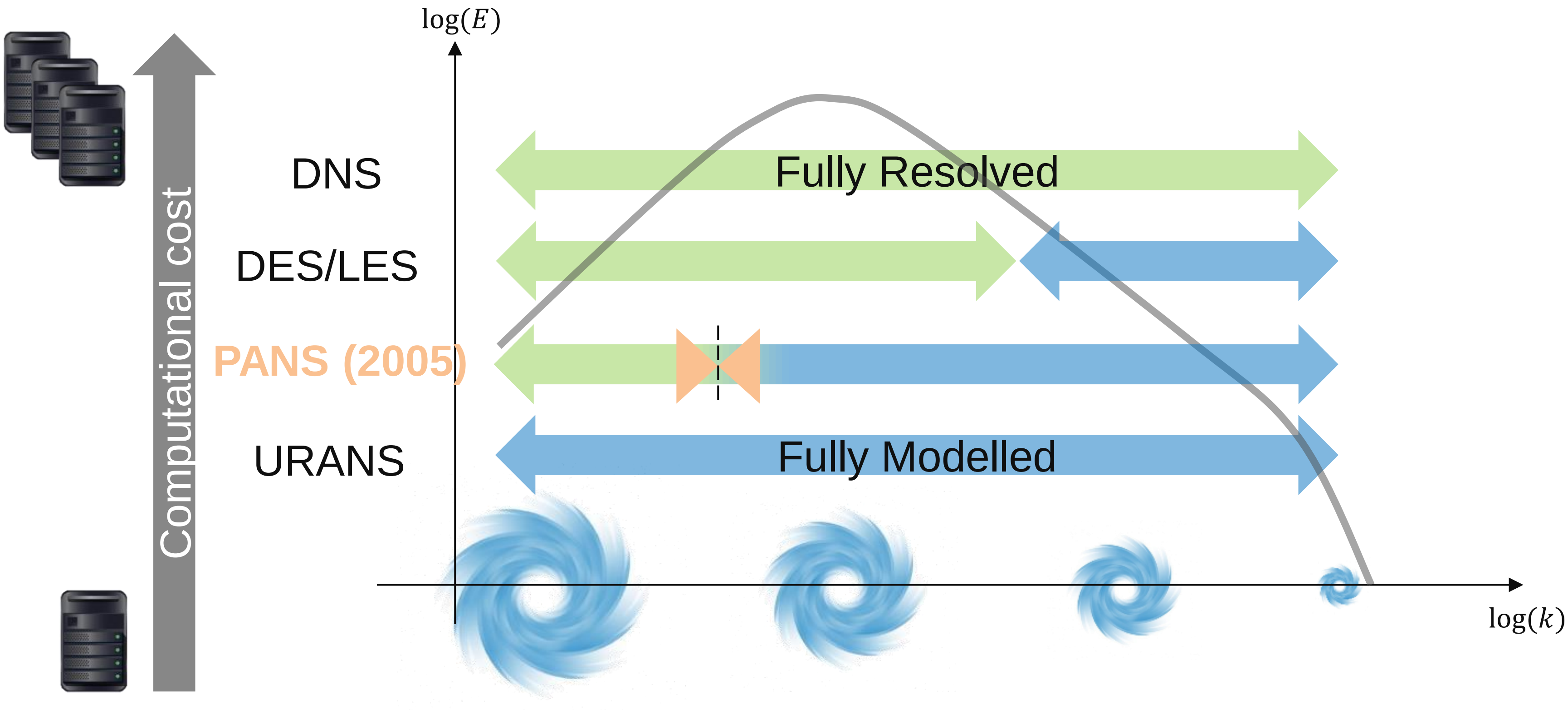
iconCFD COLD

CASE STUDY: PANS VALIDATION

- The **P**artially **A**veraged **N**avier **S**tokes approach can deploy its full resolution potential on any computational grid



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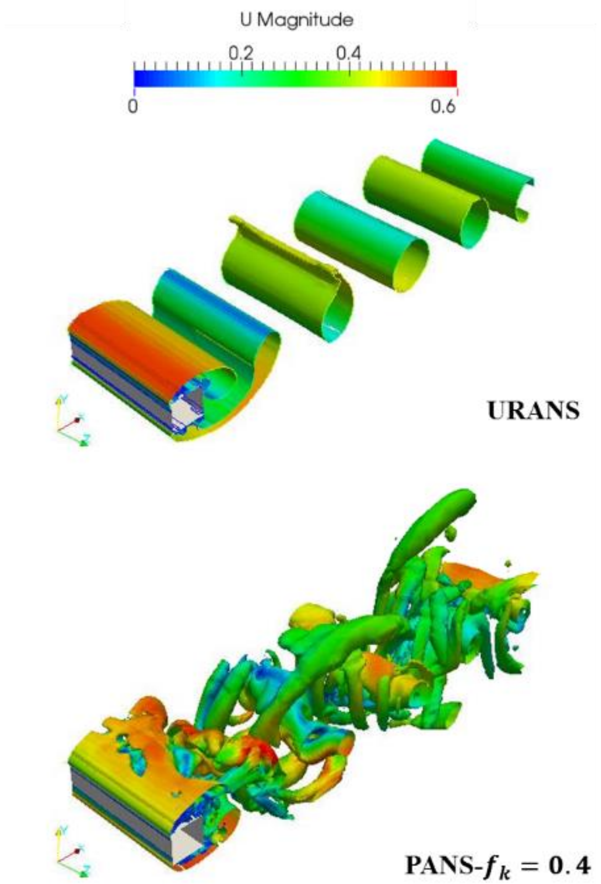
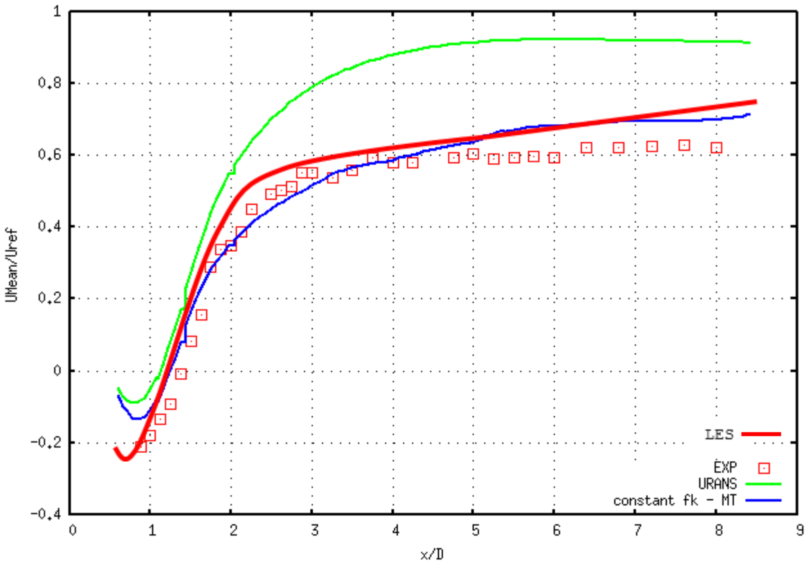
CASE STUDY: PANS VALIDATION





- Only spanwise vortices are captured in URANS
- Development of both spanwise and streamwise coherent vortical structures in PANS simulation
- Close to experiment (Lyn et al.) & LES solution (Ochoa et al.)

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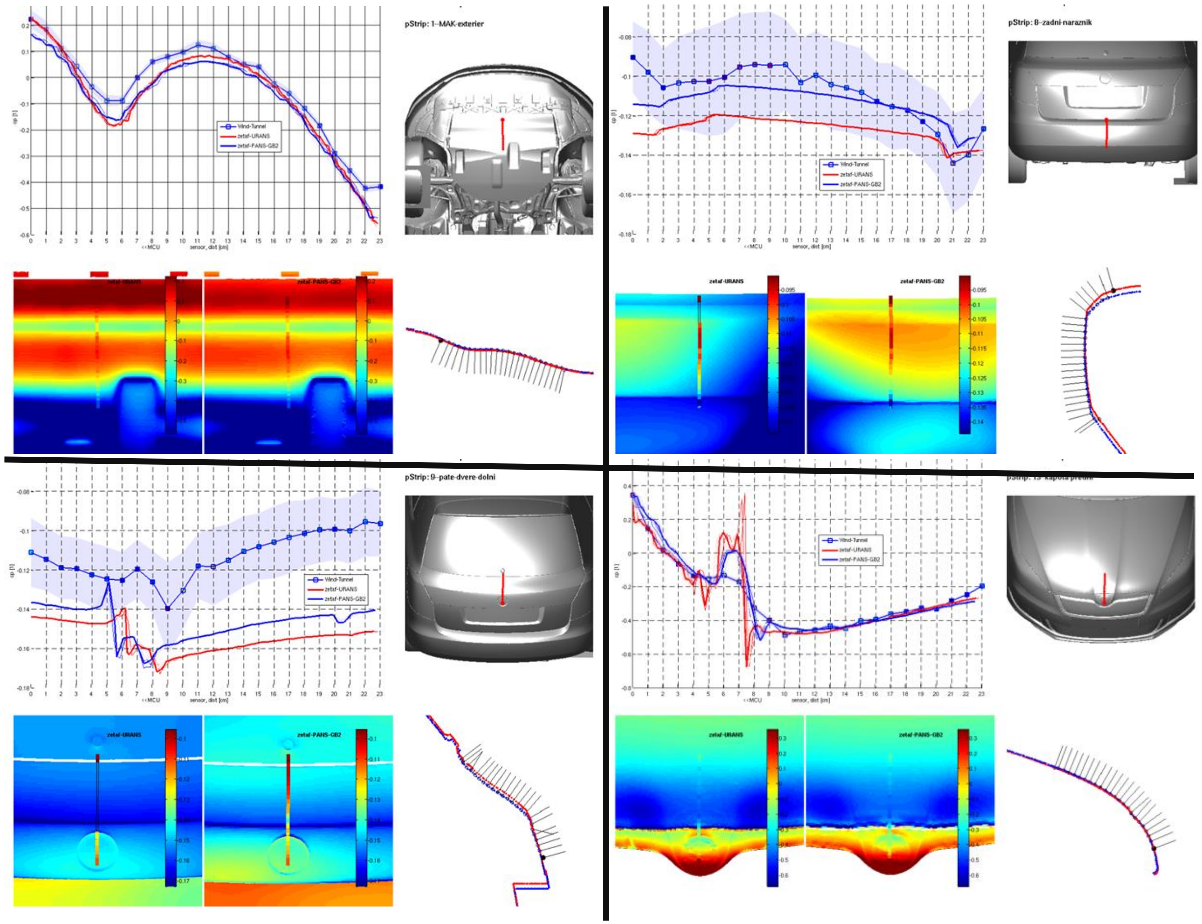
iconCFD COLD

CASE STUDY: PANS VALIDATION

- Plot of C_p coefficient at different locations on the car
- Similar results for URANS and PANS $\zeta - f$

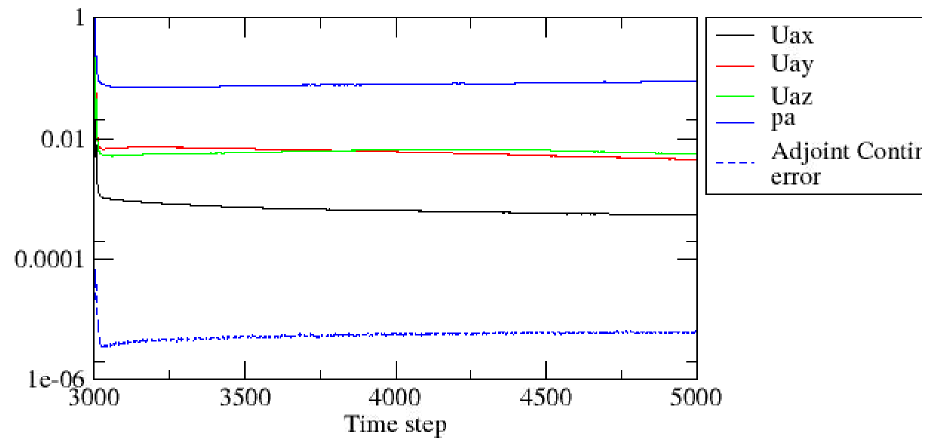


Courtesy of Škoda Auto

iconCFD OPTIMIZE

NEW FEATURES

- Enhanced stability and convergence through:
  - Localised damping
  - Ability to use averaged flow variables
- Smoothed sensitivities by removing dependency on surface mesh element size
- Ability to optimize mass flow through internal boundaries
- Post-processing:
  - Utility to calculate the geometric component of sensitivities
  - Improved, automatic cost function monitoring
  - Run-time surface sensitivity monitoring



4| Solving

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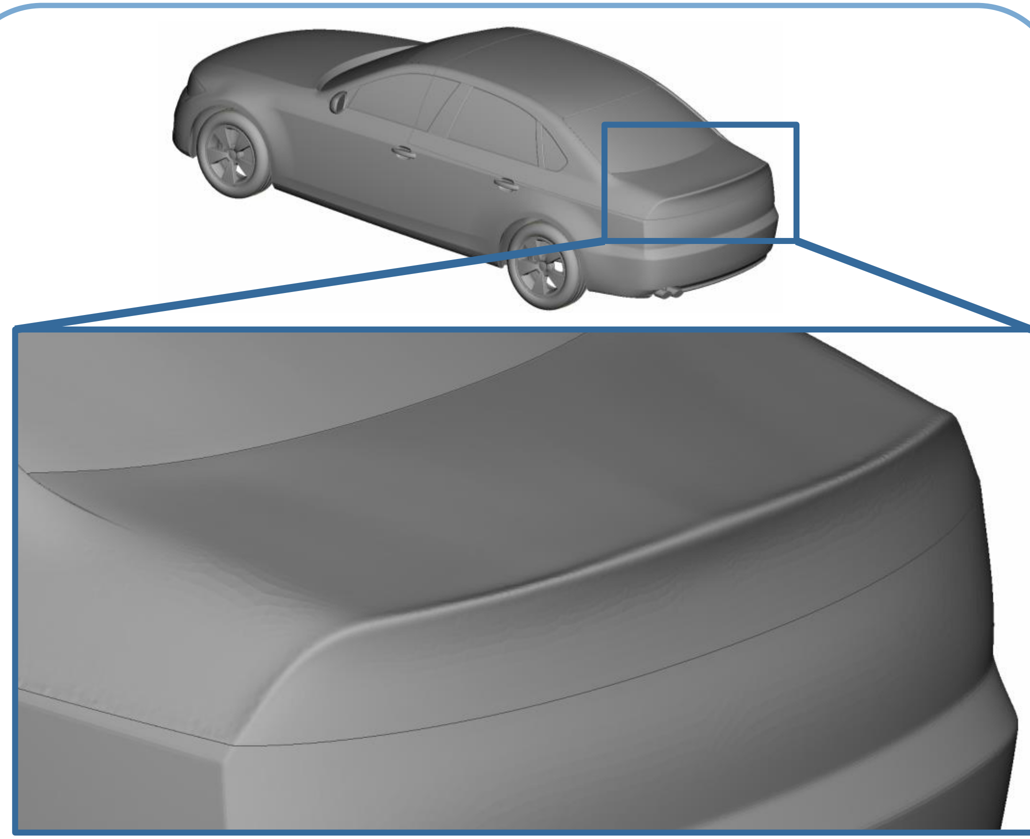
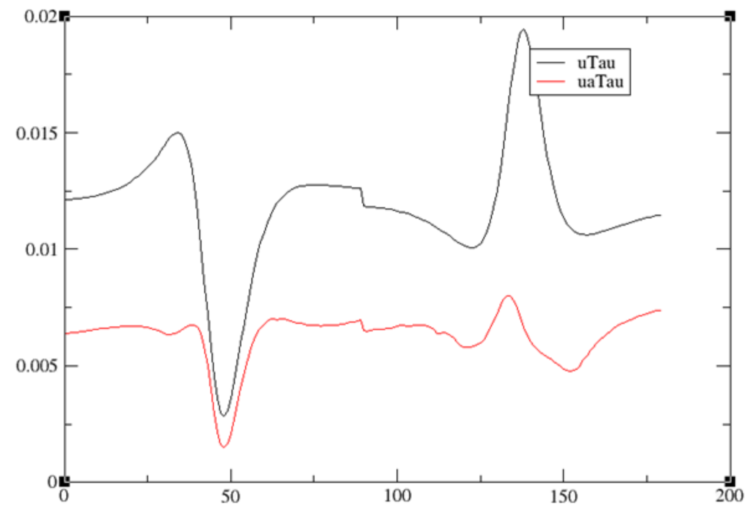
iconCFD OPTIMIZE
NEW FEATURES

- Improved geometry morpher capability
  - Improved smoothing functionality
  - Improved surface normal calculation
  - Curvature smoothing for feature preservation
  - Improved mapping on the geometry
  - Improved smoothness of interpolation
  - Forcing symmetry of geometry modifications
  - Maintaining geometry connectivity.
  - Option to define static, moving and following patches
  - Adhere to total maximum displacement through adjoint iterations
  - Thin wall treatment



iconCFD OPTIMIZE
UPCOMING FEATURES

- Adjoint turbulence models (with wall functions)
  - K-epsilon
  - RKE
- Coupled adjoint solver support



4| Solving

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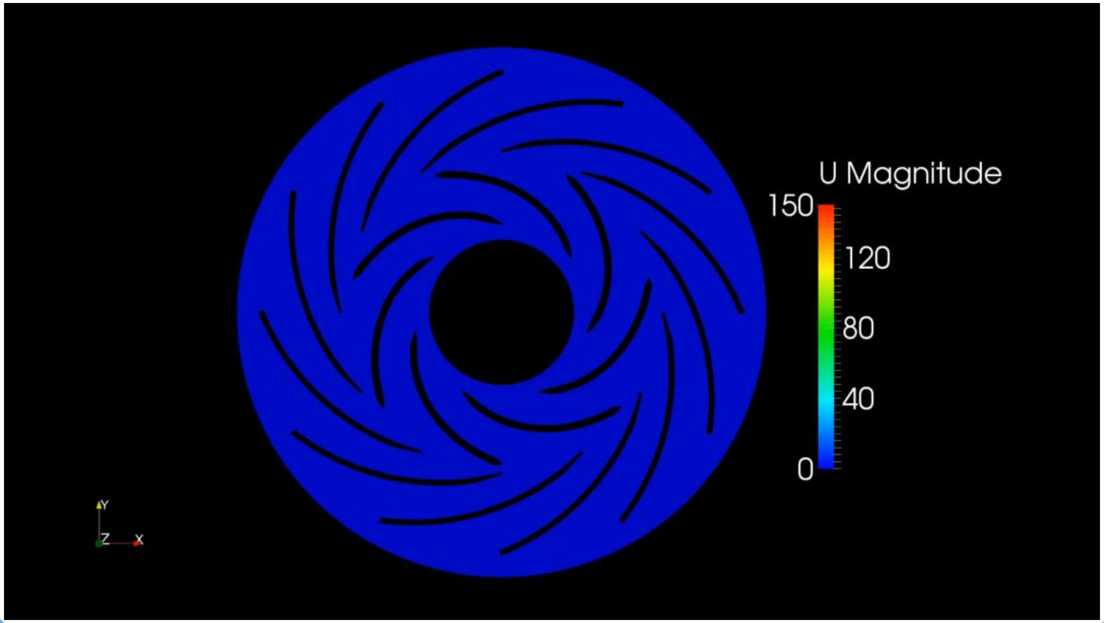
iconCFD MOVE
Case Study: Impeller Pump

- ERCOFTAC centrifugal pump
- Incompressible flow
- Solid body rotation
- Sliding AMI interface
- Animation:
    - Initial pump start up



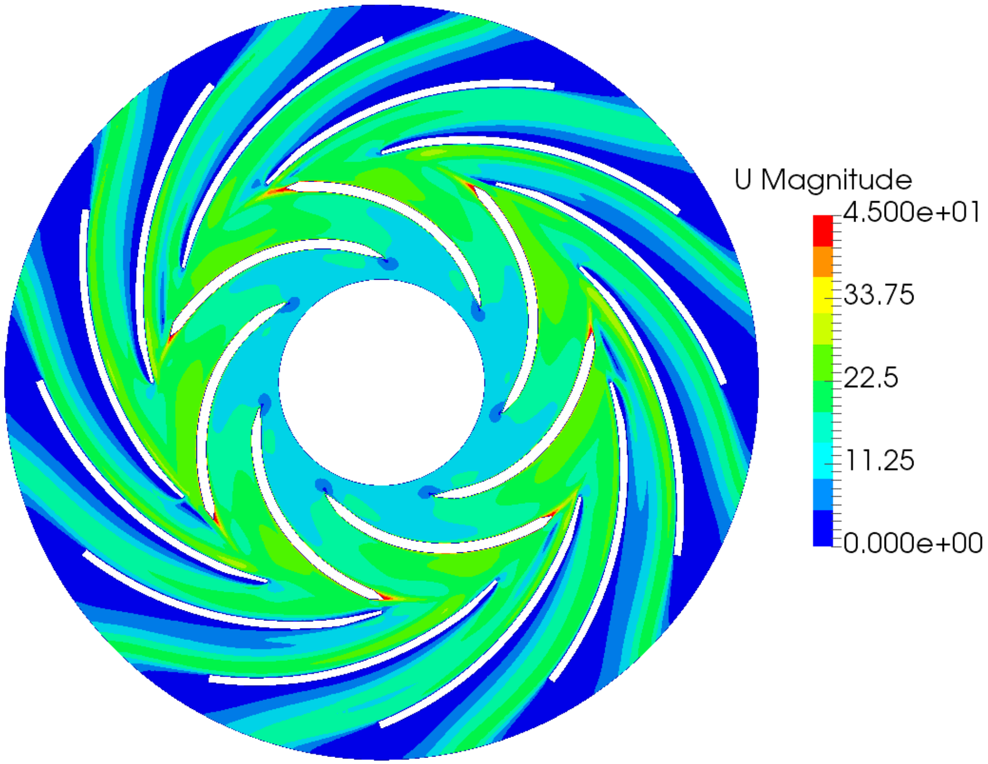
4| Solving

[1] Ubaldi, Zunino, et al., LDV Investigation of the Rotor-Stator Aerodynamic Interaction in a Centrifugal Turbomachine, 1996.
[2] Adapting OpenFOAM for Turbomachinery Applictions. Maryse Page and Martin Beaudoin IREQ, Hydro-Québec's Research Institute. Second OpenFOAM Workshop, Zagreb, 7 Workshop, Zagreb, 7-9 June 2007

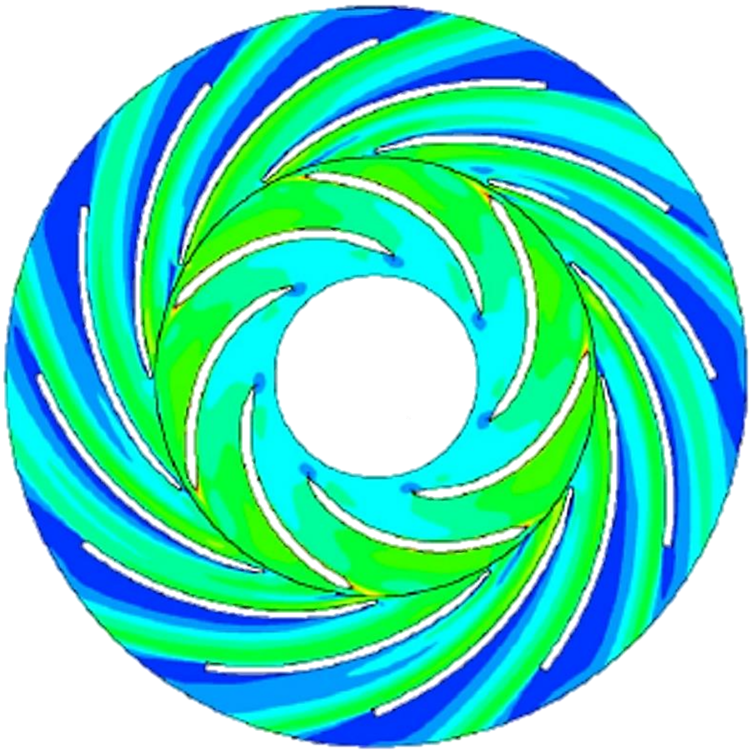
iconCFD MOVE

Case Study: Impeller Pump

iconCFD



Other Commercial Solver[2]



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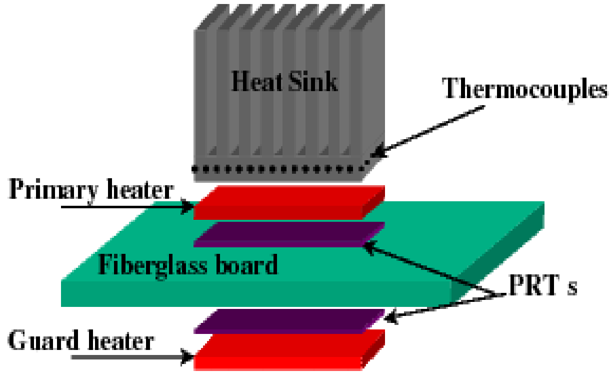
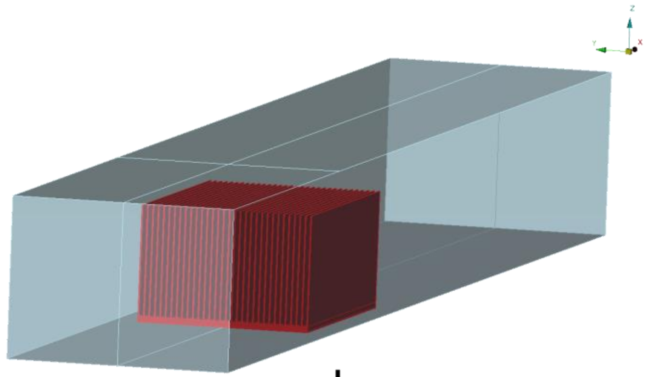
iconCFD THERMAL

CASE STUDY: HEAT DISSIPATOR

- Turbulent flow through a heat sink with Conjugate Heat Transfer
- Using iconCFD Thermal to predict pressure drop through heat sink fins
- Predict heat flux removed from cooling fins and adjacent thermal barriers





ΦTEC INGEGNERIA

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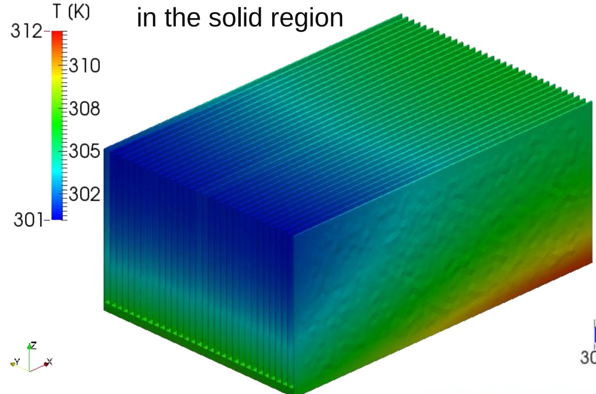
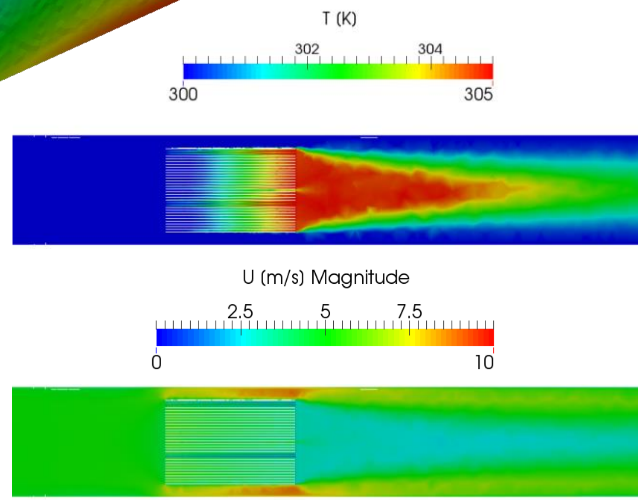
iconCFD THERMAL

CASE STUDY: HEAT DISSIPATOR

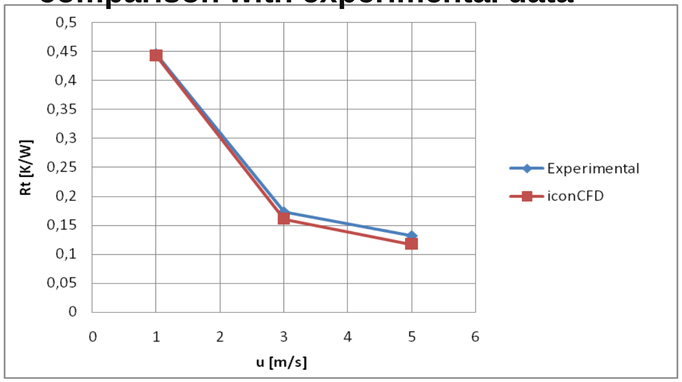
- Good experimental agreement

Temperature distribution
in the solid region

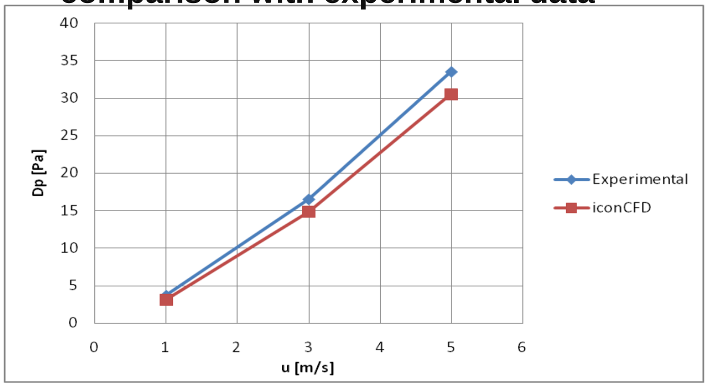




Thermal resistance as a function of inlet velocity: comparison with experimental data



Pressure drop as a function of inlet velocity: comparison with experimental data



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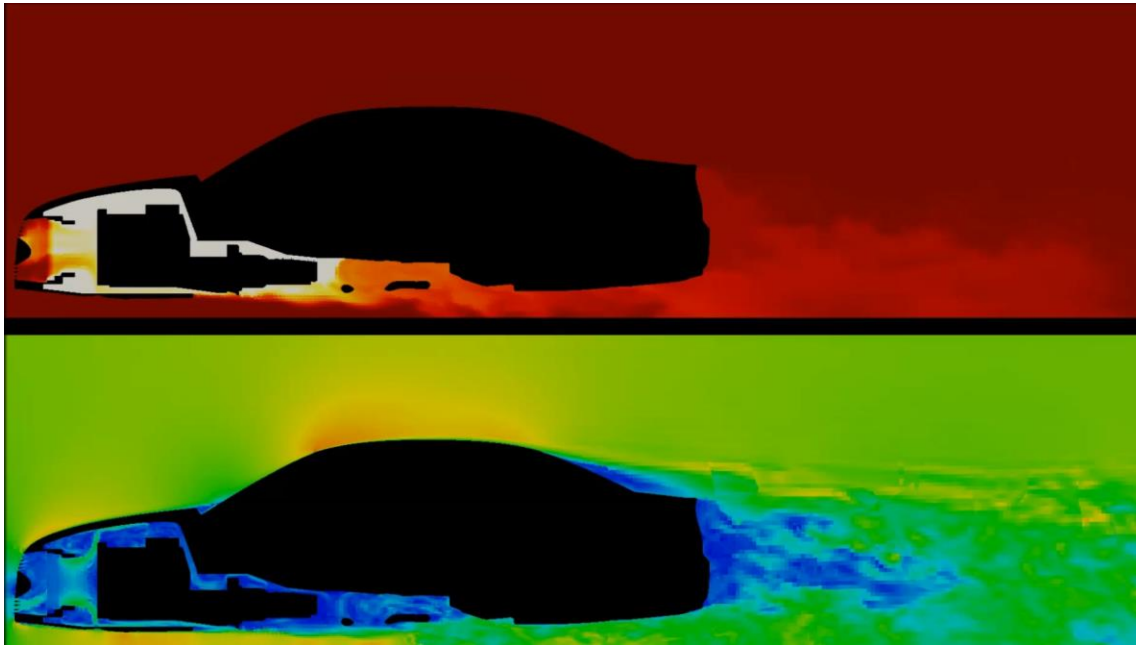
DEMO: RADIATOR HEAT DISSIPATION

Transient DES with buoyancy effects and heat sources (iso-surface of zero total pressure)



Transient heat transport from radiator through engine compartment

Centre-line engine bay flow and wake structures.

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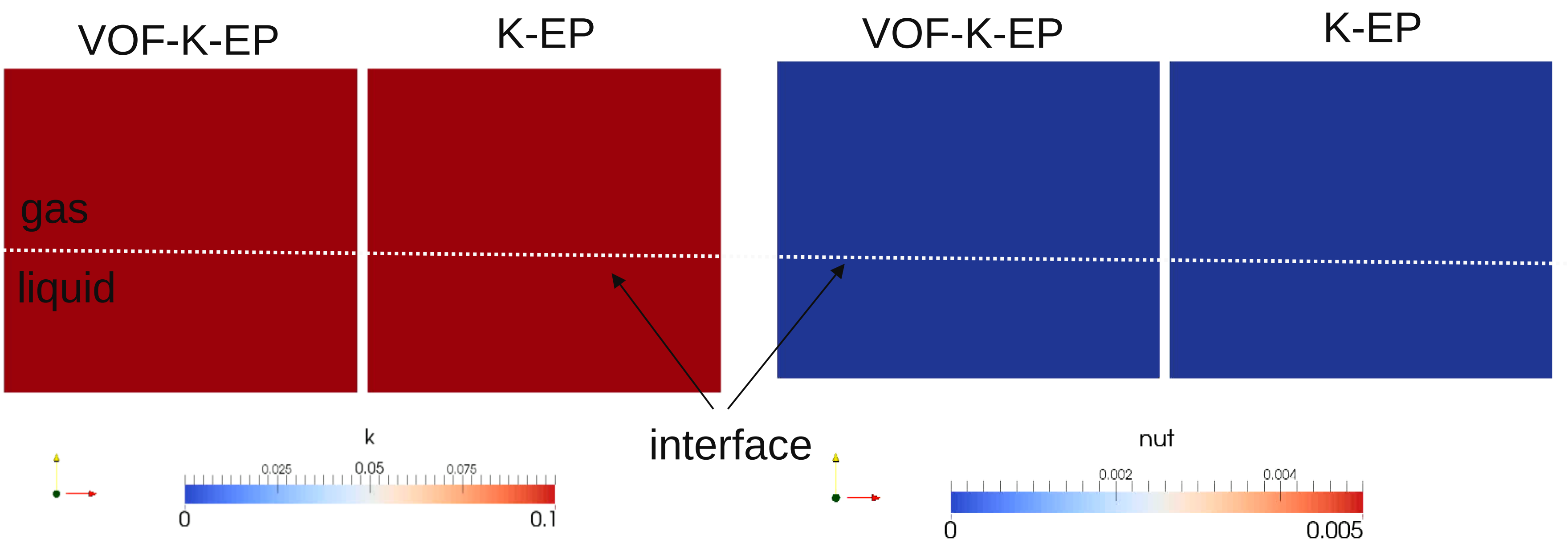
iconCFD VOF
NEW FEATURES / IMPROVEMENTS

- VOF specific K-Epsilon turbulence model
- Support solving turbulent quantities in gas phase, laminar treatment in liquid phase
- Upcoming Features:
  - Improved non-Newtonian viscosity modelling
  - Support for steady state multiphase simulations



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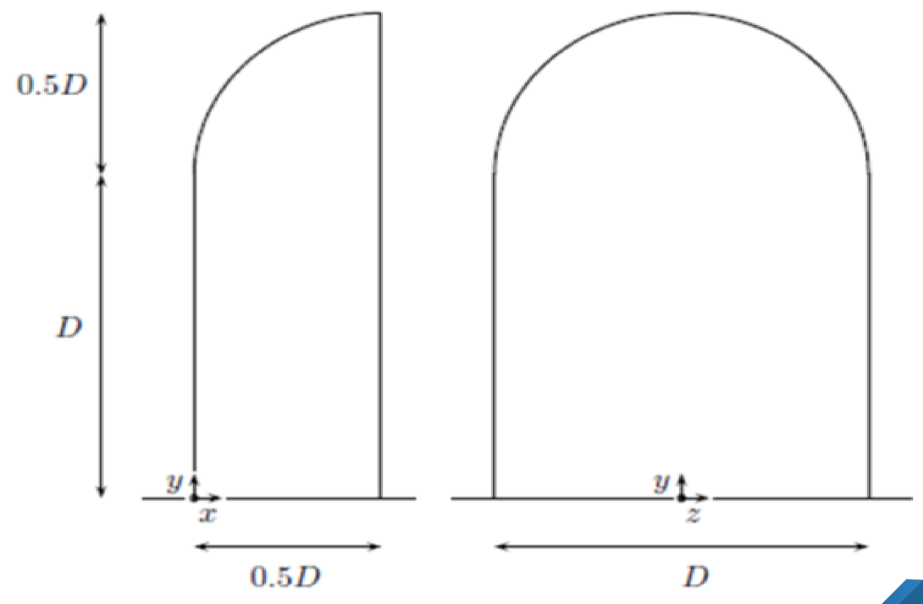
iconCFD ACOUSTIC

CASE STUDY: WING MIRROR

- Development
  - Both FWH and LC implemented as function objects
  - Post-processing utility to compute FFT
  - New function object (acousticFields) to post-processed acoustic data
    - Lighthill-Curle source terms
    - Mesh cut-off frequency
    - Lighthill Stress Tensor
    - Proudman's acoustic power
    - Curle's acoustic power
    - User can switch on/off output as required
- CFD Simulation
  - Geometry
    - D = 0.2m
  - Initial Conditions
    - U0 = 39m/s, Re = 5.2e5, M = 0.11
  - CFD Setup
    - Δt = 0.0001s, Δx = 4mm



- Mesh cut-off frequency = 1kHz
- Initialized with URANS; local time-stepping for 1000 steps.
- DES-SA, Initial transient ~ 0.25s
- T ~ 1s

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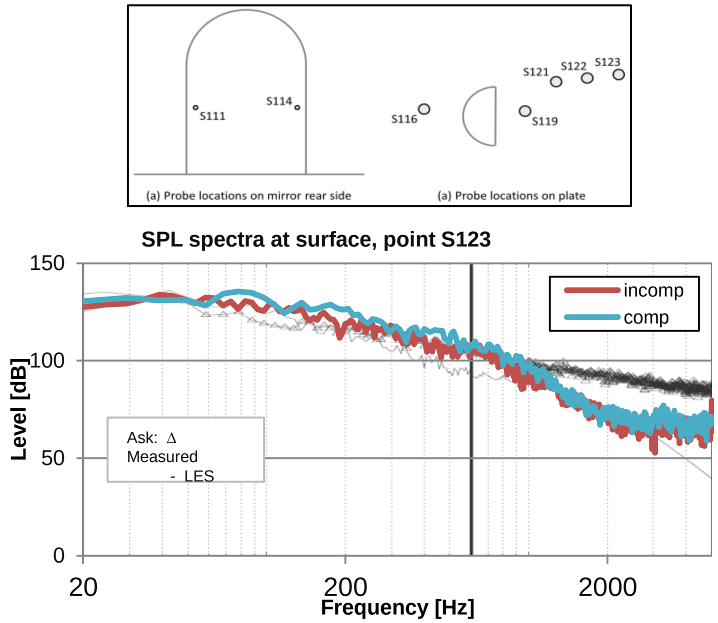
CASE STUDY: WING MIRROR

- Results/discussion
  - Time-averaged pressure coefficient on mirror surface
  - SPL spectra on wing mirror surfaces
- Concluding remarks
  - Good comparison against measured data



Jonas Ask and Lars Davidson. *The Sub-critical Flow past a Generic Side Mirror and its Impact on Sound Generation and Propagation.* 12th AIAA/CEAS Aeroacoustics Conference. Cambridge, Massachusetts, 8-10 May 2006 AIAA 2006-2558

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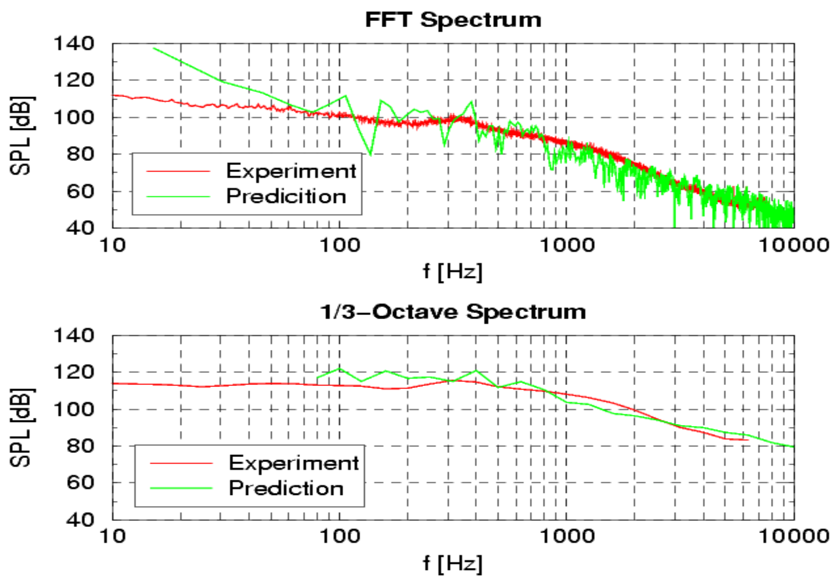
AERO-ACOUSTICS

CASE STUDY: AUDI A2

- Study for flow around Audi A2 wing mirror with aeroacoustic analysis
- Wing mirror mesh domain
- Comparison of predicted & measured surface-pressure fluctuations (noise sources)
- Results
  - Velocity streamlines (LES)
  - Surface Pressure Fluctuations (SPL) for microphone #4



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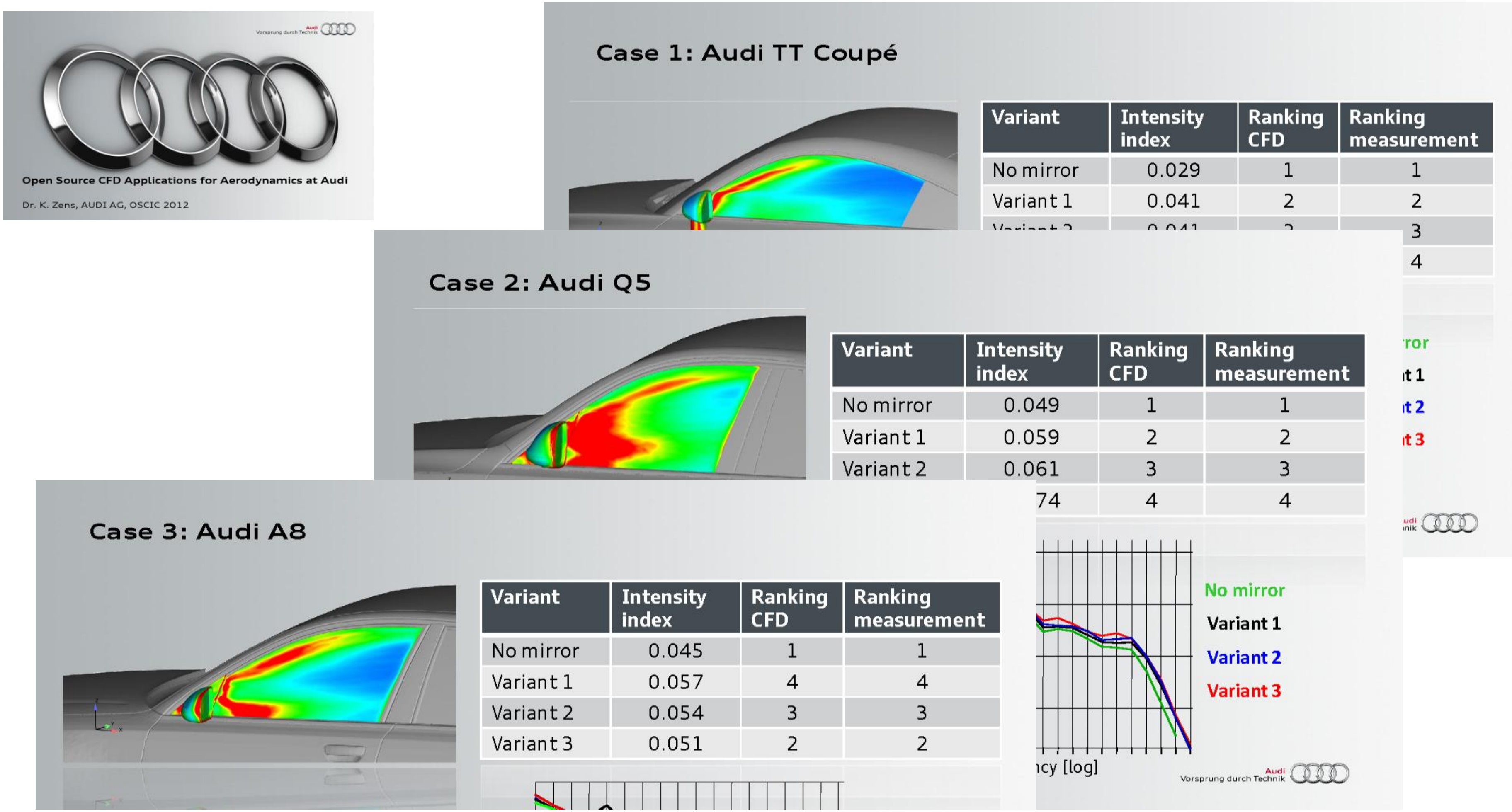
CASE STUDY: AUDI INDUSTRIAL VALIDATION



Case 1: Audi TT Coupé

Variant	Intensity index	Ranking CFD	Ranking measurement
No mirror	0.029	1	1
Variant 1	0.041	2	2
[illegible]	[illegible]	[illegible]	3
[illegible]	[illegible]	[illegible]	4

Case 2: Audi Q5

Variant	Intensity index	Ranking CFD	Ranking measurement
No mirror	0.049	1	1
Variant 1	0.059	2	2
Variant 2	0.061	3	3
[illegible]	[illegible]74	4	4

No mirror
Variant 1
Variant 2
Variant 3
Vorsprung durch Technik

Case 3: Audi A8

Variant	Intensity index	Ranking CFD	Ranking measurement
No mirror	0.045	1	1
Variant 1	0.057	4	4
Variant 2	0.054	3	3
Variant 3	0.051	2	2

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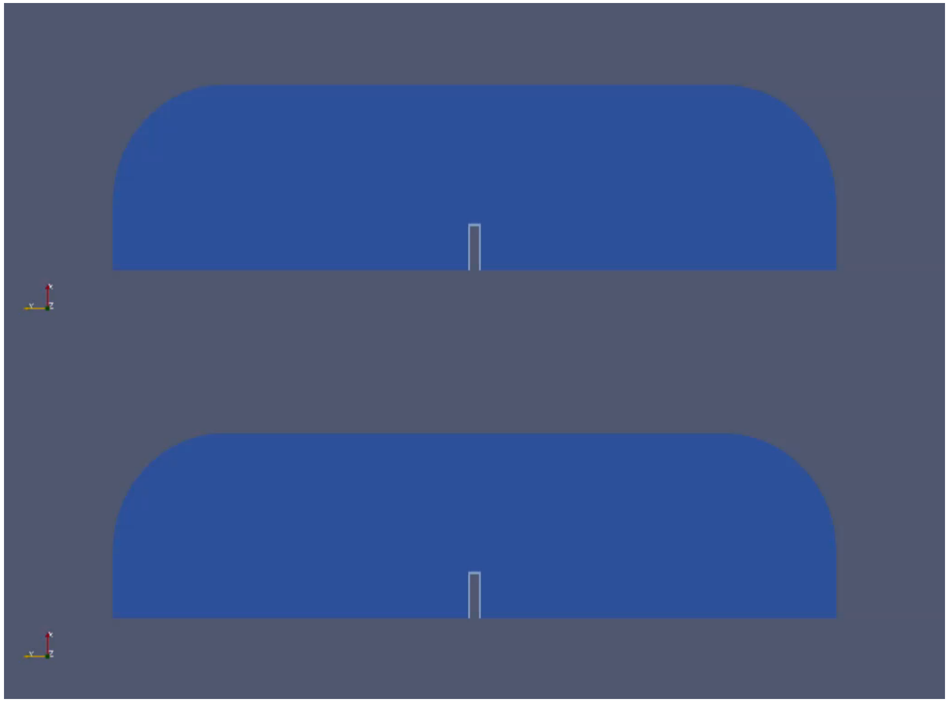
iconCFD REACT
NEW FEATURES

- Laminar reaction rates using the Arrhenius rate model
- Infinitely fast chemistry
- Multi-species diffusion model
- Eddy breakup model (reaction limited by turbulent micromixing)
- Coupling to L2P heat and mass transfer



Validation case: iconCFD React vs. alternative chemistry solver. H2 detonation.

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QUESTIONS?
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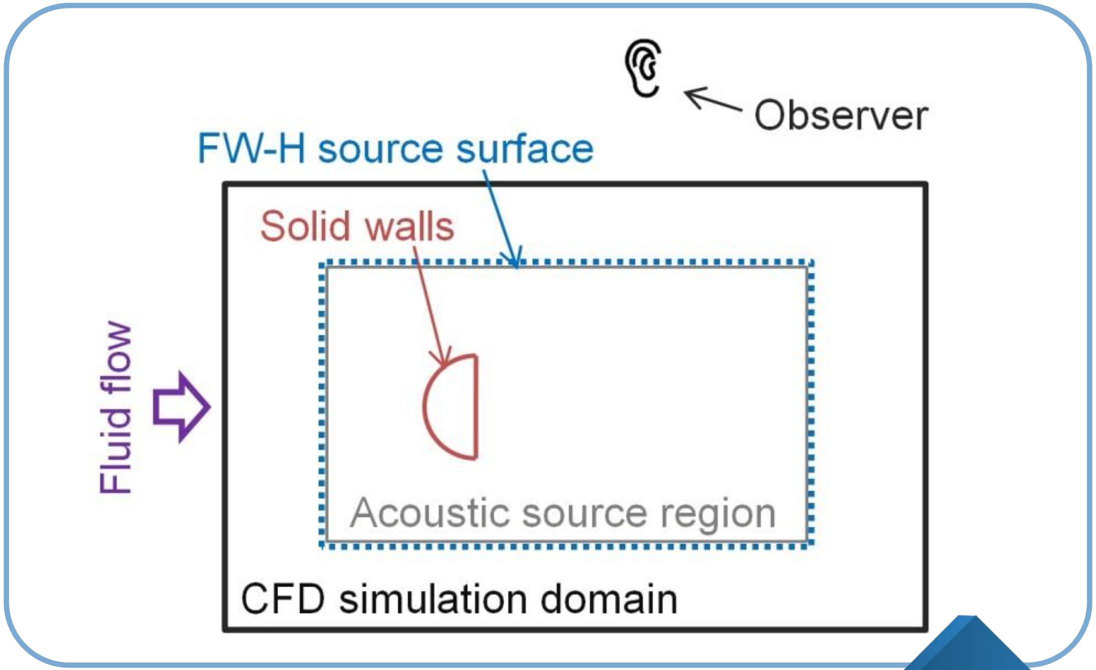
iconCFD ACOUSTIC
OVERVIEW

- Sound propagation modelling
  - Ffowcs-Williams Hawkings
  - Lighthill-Curle
- Acoustics post-processing
  - Post-processing utility to compute FFT data
  - acousticFields function object
- Acoustics optimization
  - Noise reduction can be achieved using a shape optimization process



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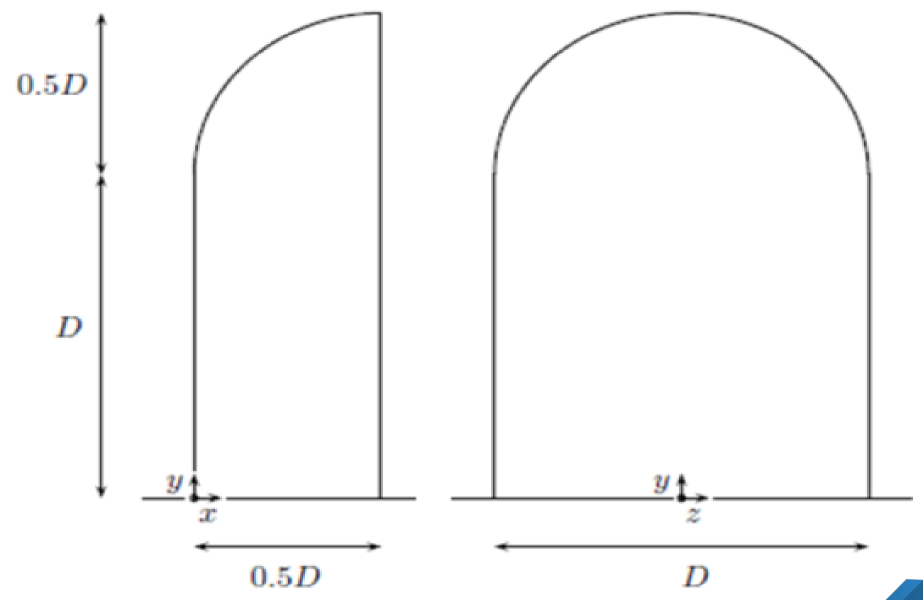
CASE STUDY: WING MIRROR

- Development
  - Both FWH and LC implemented as function objects
  - Post-processing utility to compute FFT
  - New function object (acousticFields) to post-processed acoustic data
    - Lighthill-Curle source terms
    - Mesh cut-off frequency
    - Lighthill Stress Tensor
    - Proudman's acoustic power
    - Curle's acoustic power
    - User can switch on/off output as required
- CFD Simulation
  - Geometry
    - D = 0.2m
  - Initial Conditions
    - U0 = 39m/s, Re = 5.2e5, M = 0.11
  - CFD Setup
    - Δt = 0.0001s, Δx = 4mm



- Mesh cut-off frequency = 1kHz
- Initialized with URANS; local time-stepping for 1000 steps.
- DES-SA, Initial transient ~ 0.25s
- T ~ 1s

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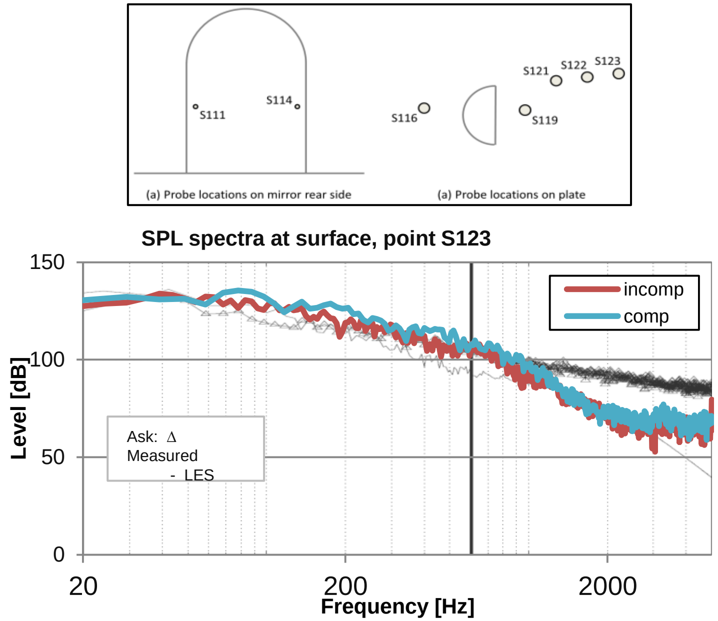
CASE STUDY: WING MIRROR

- Results/discussion
  - Time-averaged pressure coefficient on mirror surface
  - SPL spectra on wing mirror surfaces
- Concluding remarks
  - Good comparison against measured data



Jonas Ask and Lars Davidson. *The Sub-critical Flow past a Generic Side Mirror and its Impact on Sound Generation and Propagation.* 12th AIAA/CEAS Aeroacoustics Conference. Cambridge, Massachusetts, 8-10 May 2006 AIAA 2006-2558

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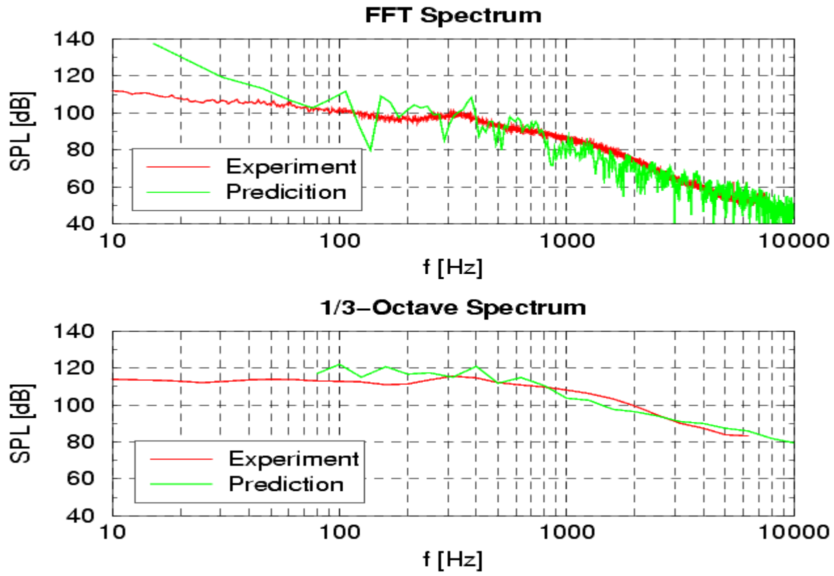
AERO-ACOUSTICS
CASE STUDY: AUDI A2

- Study for flow around Audi A2 wing mirror with aeroacoustic analysis
- Wing mirror mesh domain
- Comparison of predicted & measured surface-pressure fluctuations (noise sources)
- Results
  - Velocity streamlines (LES)
  - Surface Pressure Fluctuations (SPL) for microphone #4



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