

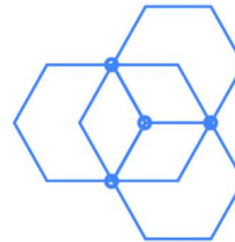
iconCFD® 3.3.X / 4.0.X

New & UPCOMING FEATURES

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



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



Your True Partner for
CAE × CFD
ICSC2016



iconCFD 3.3.X / 4.0.X

AGENDA

www.iconCFD.com

Overview

App & Platform Integration

- Process / Platform Applications / Geometry Tool

Module Development

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

iconCFD 3.3.X / 4.0.X

AGENDA

www.iconCFD.com

Overview

App & Platform Integration

- Process / Platform Applications / Geometry Tool

Module Development

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

iconCFD[®]

SUPPORTED CFD WORKFLOW

www.iconCFD.com



iconCFD Process iconCFD Wrap iconCFD Mesh

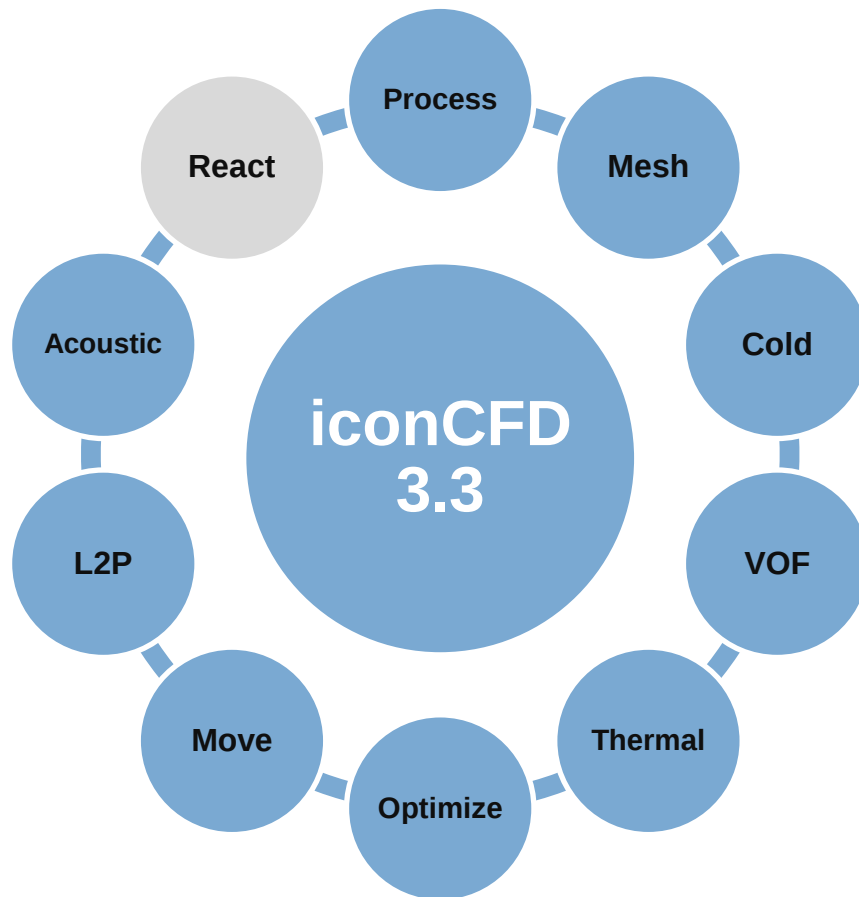
- GUI
- MultiCase

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

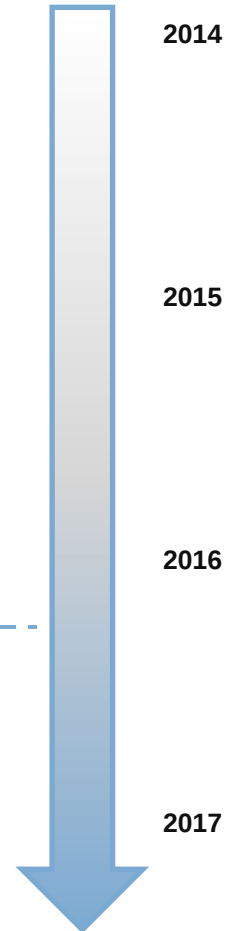
iconCFD Support & Documentation

iconCFD EVOLUTION

www.iconCFD.com

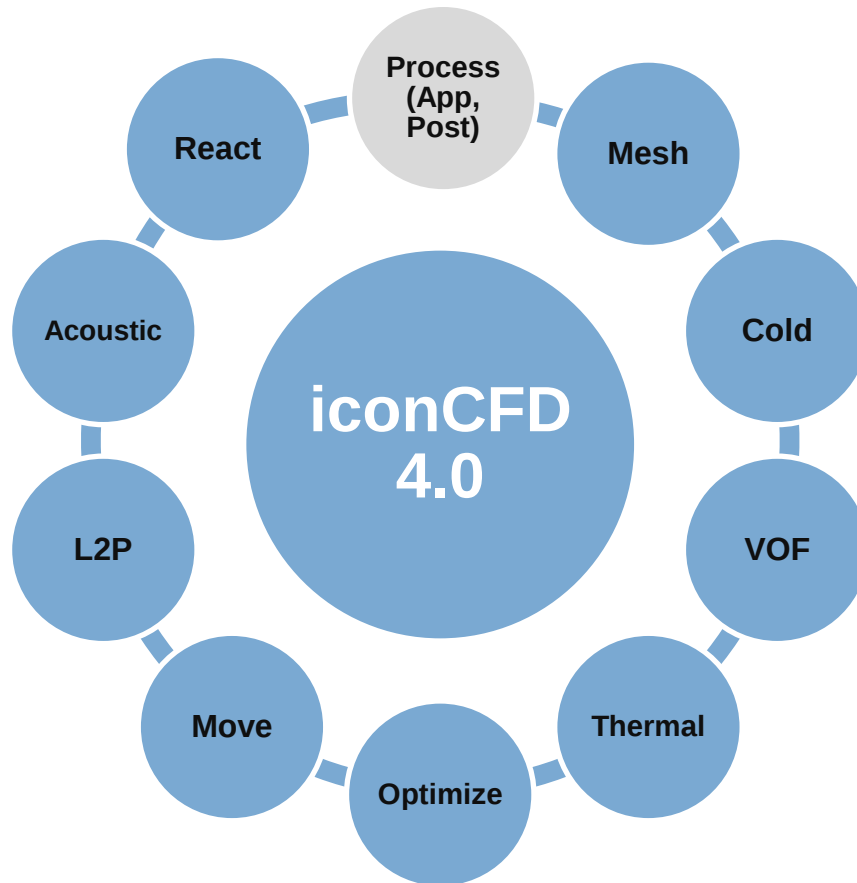


3.3 (Mar 16)
1 new module : React

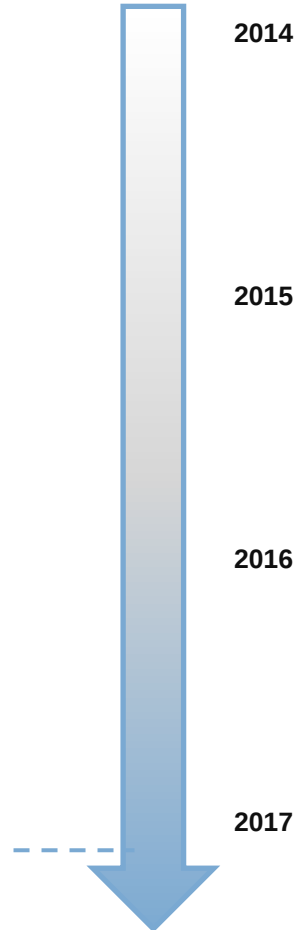


iconCFD EVOLUTION

www.iconCFD.com



4.0 (2017)
Process-App View
Process-Post View



iconCFD 3.3.X / 4.0.X

AGENDA

www.iconCFD.com

Overview

App & Platform Integration

- Process / Platform Applications / Geometry Tool

Module Development

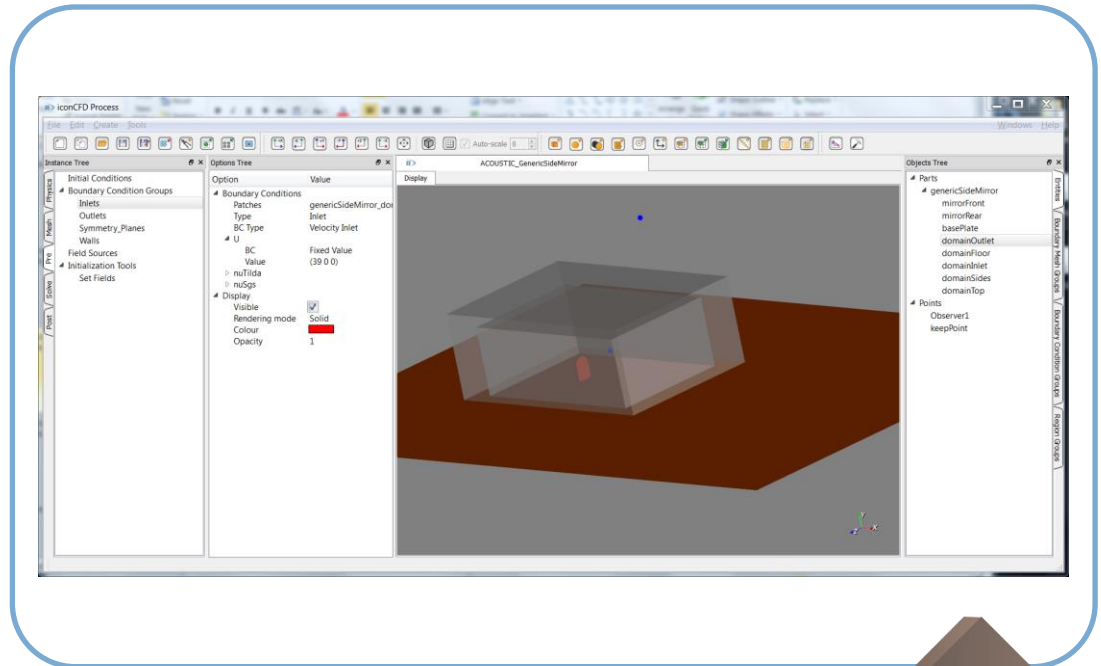
- New Features & Future Capability
- Case Studies & Validation Efforts
- Testing Framework

iconCFD PROCESS

NEW/UPCOMING FEATURES

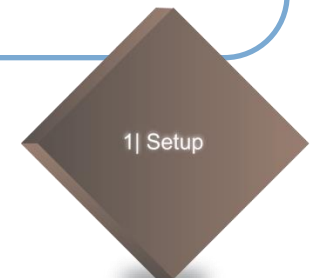
New Features:

- 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



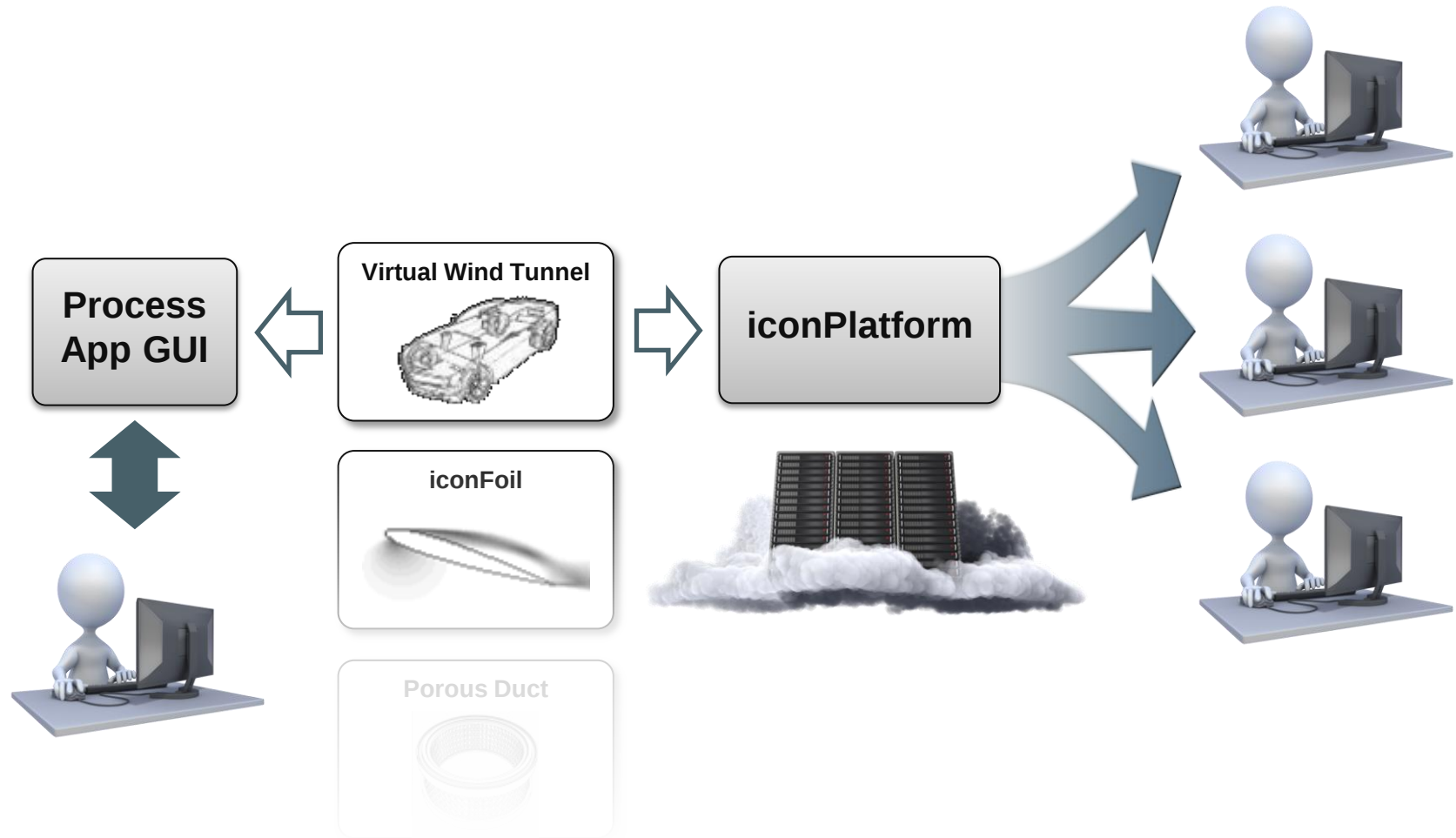
Upcoming Features:

- Resource manager
- Run/job manager
- Workflow manager
- Morphing capability



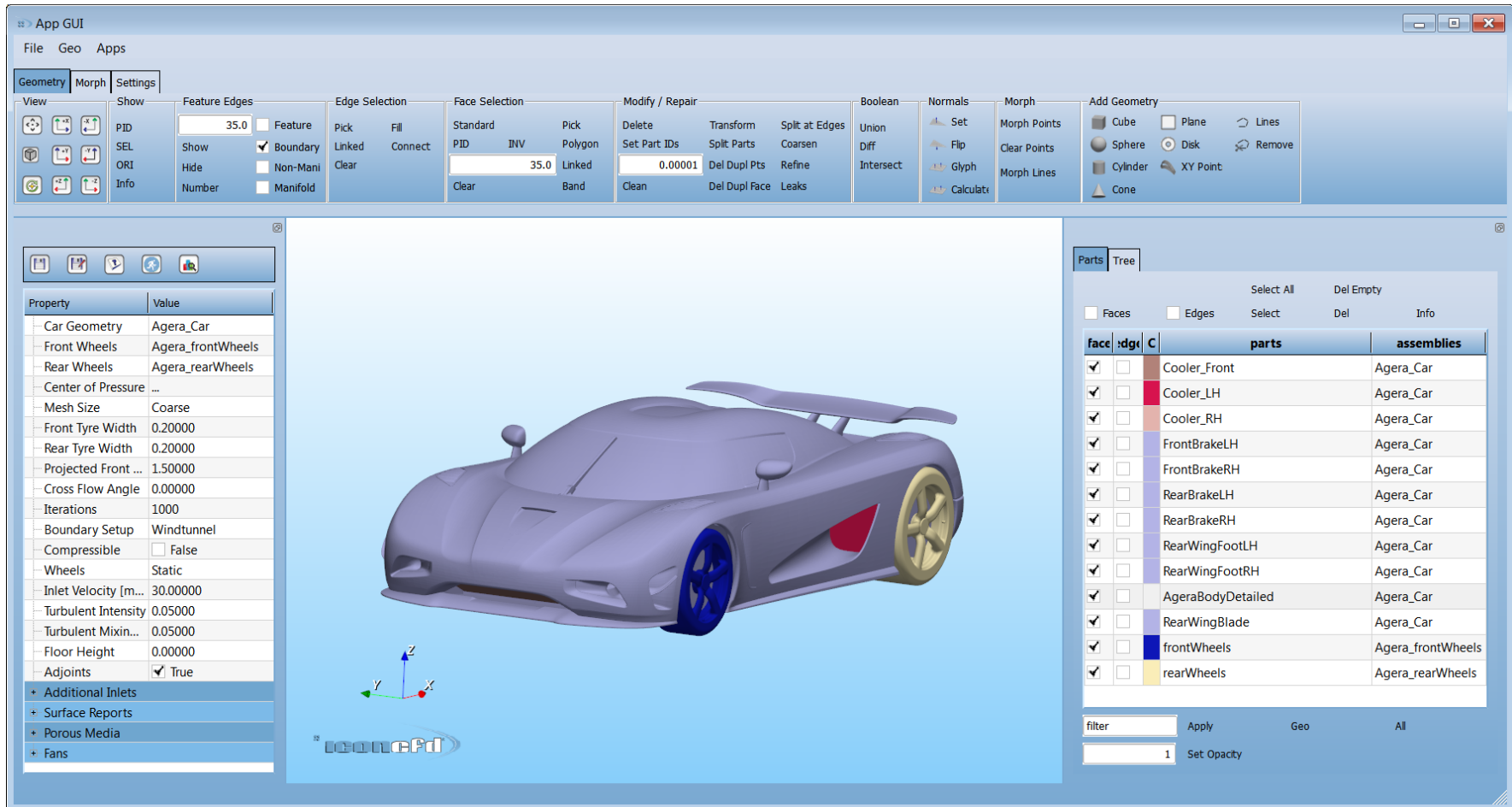
iconCFD Process/iconPlatform App Deployment

www.iconCFD.com



iconCFD PROCESS APP & GEOM INTEGRATION

www.iconCFD.com



iconCFD PROCESS APP SETTINGS

www.iconCFD.com

The screenshot displays the iconCFD App GUI with the 'Settings' tab selected. The interface includes a top menu bar (File, Geo, Apps), a toolbar with various modeling tools, and a central 3D view of a car model. A blue box highlights the 'Property' panel on the left, which lists simulation parameters. The 'Parts' panel on the right shows a list of components and their assemblies.

Property Panel (Left):

Property	Value
Car Geometry	Agera_Car
Front Wheels	Agera_frontWheels
Rear Wheels	Agera_rearWheels
Center of Pressure	...
Mesh Size	Coarse
Front Tyre Width	0.20000
Rear Tyre Width	0.20000
Projected Front ...	1.50000
Cross Flow Angle	0.00000
Iterations	1000
Boundary Setup	Windtunnel
Compressible	☐ False
Wheels	Static
Inlet Velocity [m...]	30.00000
Turbulent Intensity	0.05000
Turbulent Mixin...	0.05000
Floor Height	0.00000
Adjoints	☒ True
+ Additional Inlets	
+ Surface Reports	
+ Porous Media	
+ Fans	

Parts Panel (Right):

face	idg	C	parts	assemblies
☒	☐		Cooler_Front	Agera_Car
☒	☐		Cooler_LH	Agera_Car
☒	☐		Cooler_RH	Agera_Car
☒	☐		FrontBrakeLH	Agera_Car
☒	☐		FrontBrakeRH	Agera_Car
☒	☐		RearBrakeLH	Agera_Car
☒	☐		RearBrakeRH	Agera_Car
☒	☐		RearWingFootLH	Agera_Car
☒	☐		RearWingFootRH	Agera_Car
☒	☐		AgeraBodyDetailed	Agera_Car
☒	☐		RearWingBlade	Agera_Car
☒	☐		frontWheels	Agera_frontWheels
☒	☐		rearWheels	Agera_rearWheels

iconCFD PROCESS ASSEMBLY TREES

www.iconCFD.com

The screenshot displays the iconCFD software interface. The main window shows a 3D model of a purple sports car with blue wheels and a red rear wing. The interface includes a top menu bar (File, Geo, Apps), a toolbar with various modeling tools, and a central workspace. On the left, a 'Property' panel lists various simulation parameters like 'Car Geometry', 'Front Tyre Width', and 'Turbulent Intensity'. On the right, a 'Parts Tree' panel is highlighted with a blue border, showing a hierarchical list of components and their assemblies.

Parts Tree

face	idg	C	parts	assemblies
☒	☐		Cooler_Front	Agera_Car
☒	☐		Cooler_LH	Agera_Car
☒	☐		Cooler_RH	Agera_Car
☒	☐		FrontBrakeLH	Agera_Car
☒	☐		FrontBrakeRH	Agera_Car
☒	☐		RearBrakeLH	Agera_Car
☒	☐		RearBrakeRH	Agera_Car
☒	☐		RearWingFootLH	Agera_Car
☒	☐		RearWingFootRH	Agera_Car
☒	☐		AgeraBodyDetailed	Agera_Car
☒	☐		RearWingBlade	Agera_Car
☒	☐		frontWheels	Agera_frontWheels
☒	☐		rearWheels	Agera_rearWheels

filter: Apply Geo All
1 Set Opacity

iconCFD PROCESS

www.iconCFD.com

EDGE & FACE SELECTION METHODS

The screenshot displays the iconCFD App GUI. The top menu bar includes 'File', 'Geo', and 'Apps'. Below it, the 'Geometry' tab is active, showing a toolbar with icons for 'Show', 'SEL', 'ORI', and 'Info'. The 'Feature Edges' section has a 'Show' button and a 'PID' field set to '35.0'. The 'Edge Selection' section has a 'Pick' button and a 'Fill' button. The 'Face Selection' section has a 'Standard' button, a 'PID' field set to '35.0', and a 'Pick' button. The 'Modify / Repair' section includes buttons for 'Delete', 'Transform', 'Split at Edges', 'Set Part IDs', 'Split Parts', 'Coarsen', 'Clean', 'Del Dupl Pts', 'Refine', and 'Leaks'. The 'Boolean' section has buttons for 'Union', 'Diff', and 'Intersect'. The 'Normals' section has buttons for 'Set', 'Flip', 'Glyph', and 'Calculate'. The 'Morph' section has buttons for 'Morph Points', 'Clear Points', and 'Morph Lines'. The 'Add Geometry' section has buttons for 'Cube', 'Plane', 'Lines', 'Sphere', 'Disk', 'Remove', 'Cylinder', 'XY Point', and 'Cone'. The 'Parts' tree on the right shows a list of parts and assemblies. The 'Properties' panel on the left shows various simulation parameters.

Feature Edges

Show PID 35.0

Edge Selection

Pick Fill

Linked Connect

Clear

Face Selection

Standard PID INV Polygon

PID 35.0 Linked Band

Modify / Repair

Delete Transform Split at Edges

Set Part IDs Split Parts Coarsen

Clean Del Dupl Pts Refine Leaks

Boolean

Union Diff Intersect

Normals

Set Flip Glyph Calculate

Morph

Morph Points Clear Points Morph Lines

Add Geometry

Cube Plane Lines

Sphere Disk Remove

Cylinder XY Point

Cone

Properties

Property	Value
Car Geometry	Agera_Car
Front Wheels	Agera_frontWheels
Rear Wheels	Agera_rearWheels
Center of Pressure	...
Mesh Size	Coarse
Front Tyre Width	0.20000
Rear Tyre Width	0.20000
Projected Front ...	1.50000
Cross Flow Angle	0.00000
Iterations	1000
Boundary Setup	Windtunnel
Compressible	☐ False
Wheels	Static
Inlet Velocity [m...	30.00000
Turbulent Intensity	0.05000
Turbulent Mixin...	0.05000
Floor Height	0.00000
Adjoints	☒ True
+ Additional Inlets	
+ Surface Reports	
+ Porous Media	
+ Fans	

Parts Tree

Select All Del Empty

☐ Faces ☐ Edges Select Del Info

face	idg	C	parts	assemblies
☒	☐		Cooler_Front	Agera_Car
☒	☐		Cooler_LH	Agera_Car
☒	☐		Cooler_RH	Agera_Car
☒	☐		FrontBrakeLH	Agera_Car
☒	☐		FrontBrakeRH	Agera_Car
☒	☐		RearBrakeLH	Agera_Car
☒	☐		RearBrakeRH	Agera_Car
☒	☐		RearWingFootLH	Agera_Car
☒	☐		RearWingFootRH	Agera_Car
☒	☐		AgeraBodyDetailed	Agera_Car
☒	☐		RearWingBlade	Agera_Car
☒	☐		frontWheels	Agera_frontWheels
☒	☐		rearWheels	Agera_rearWheels

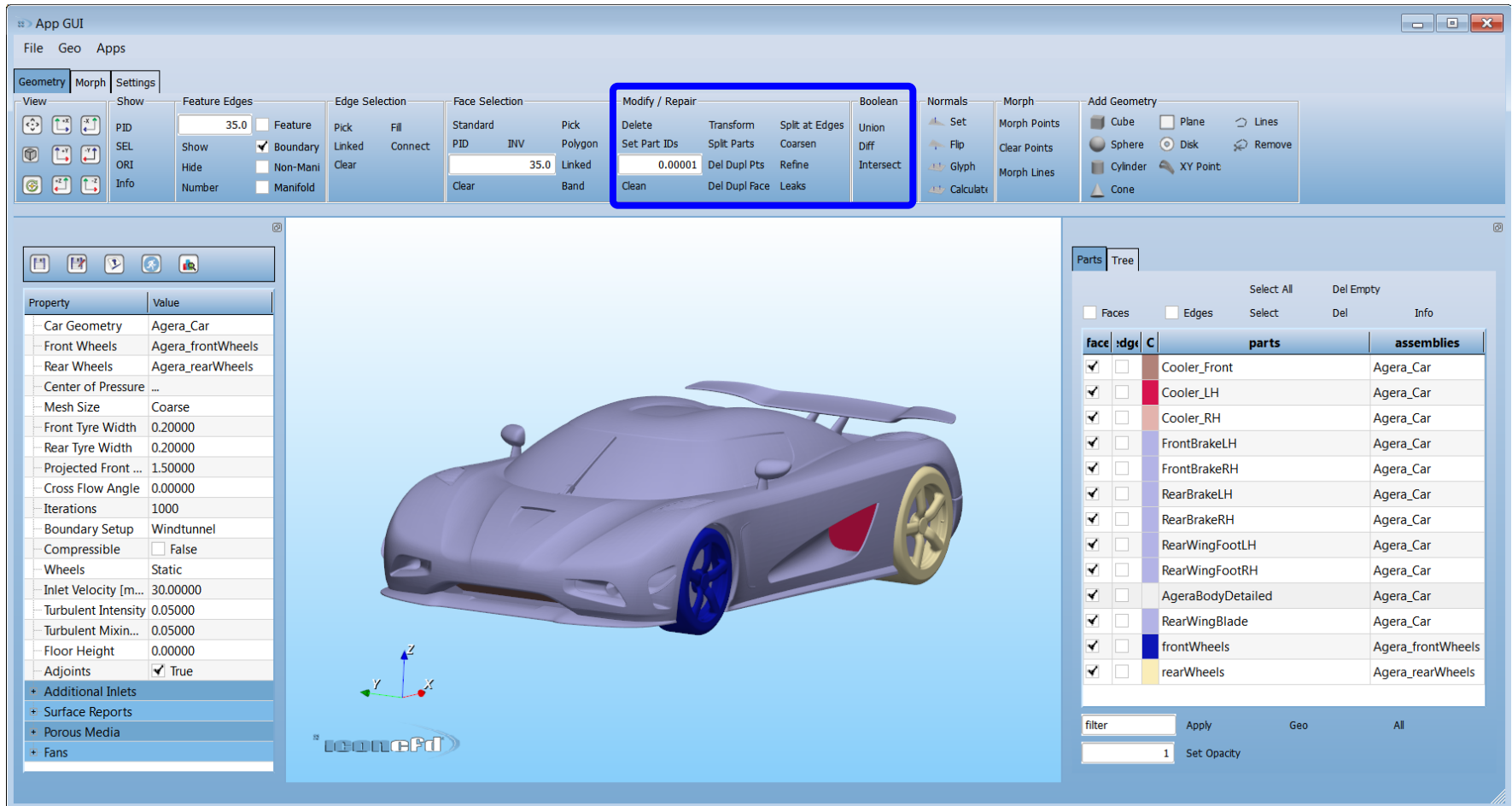
filter Apply Geo All

1 Set Opacity

iconCFD PROCESS

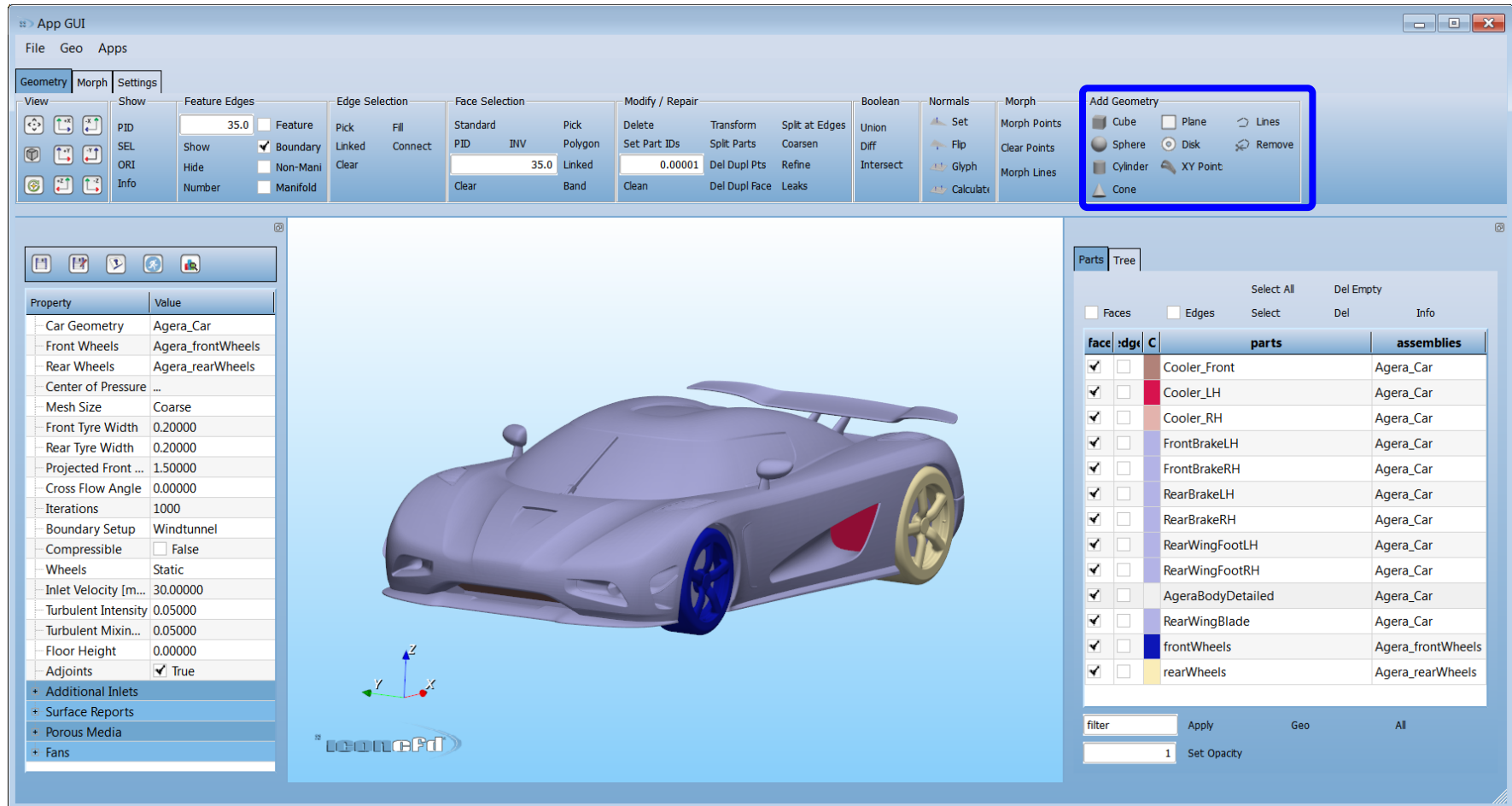
GEOMETRY MODIFICATION / REPAIR

www.iconCFD.com



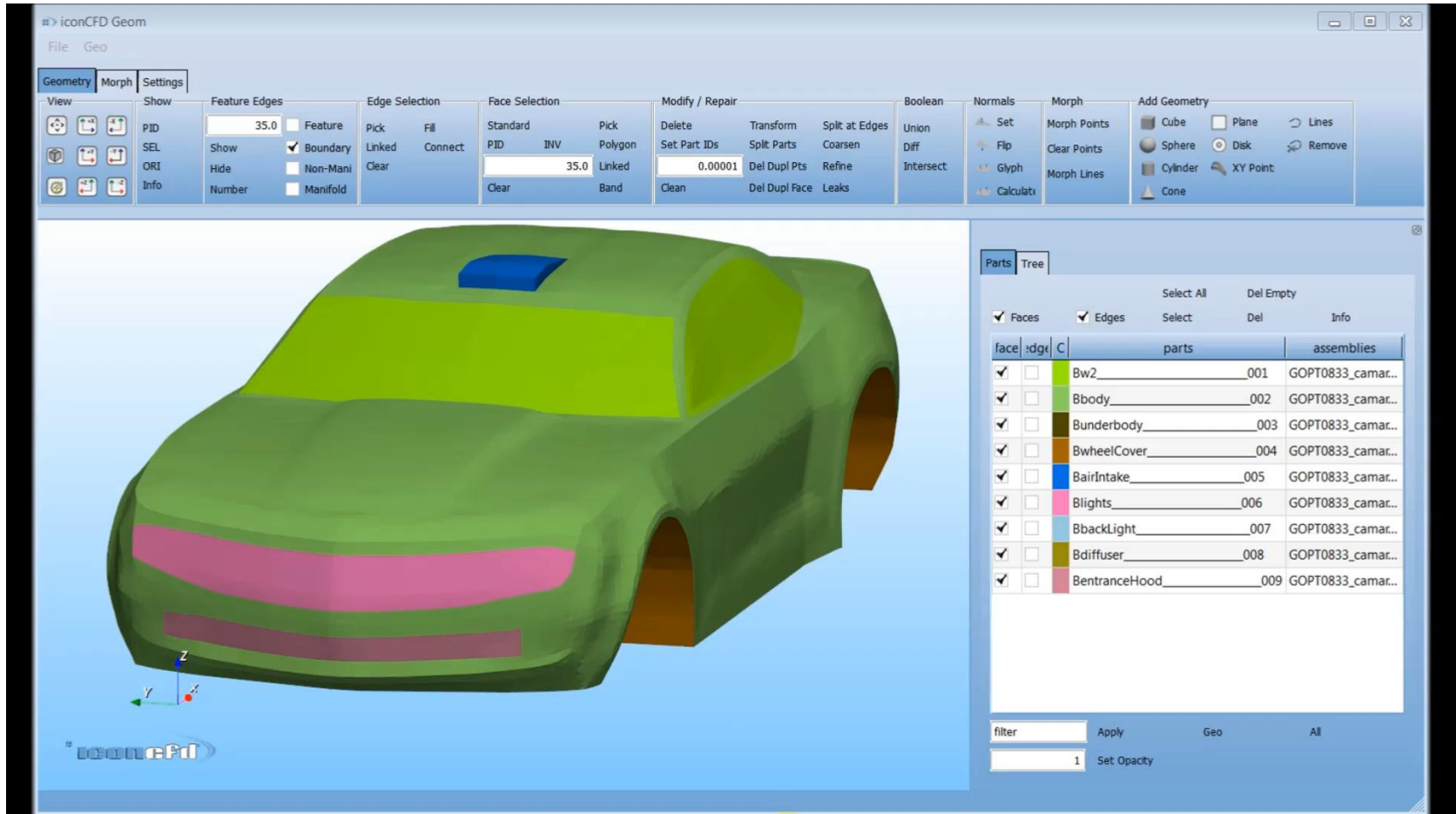
iconCFD PROCESS GEOMETRY CREATION

www.iconCFD.com



iconCFD PROCESS MORPHING

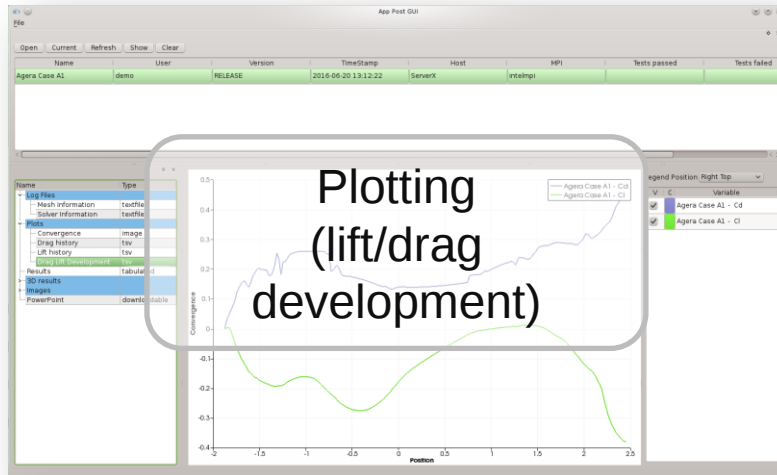
www.iconCFD.com



iconCFD PROCESS

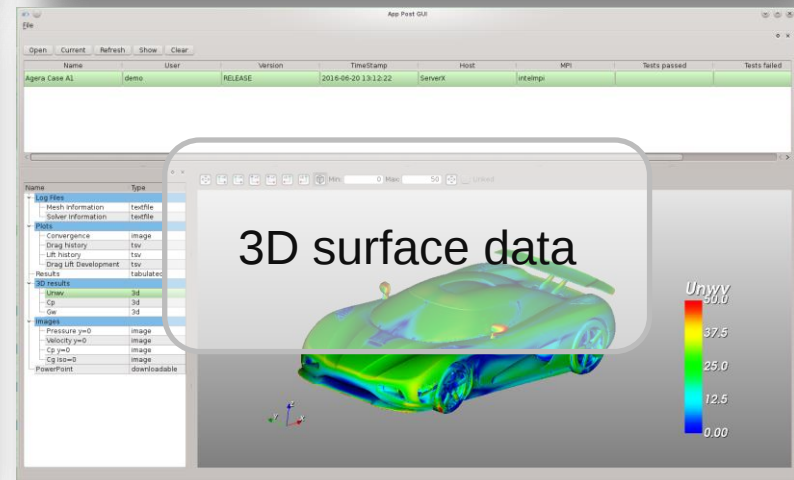
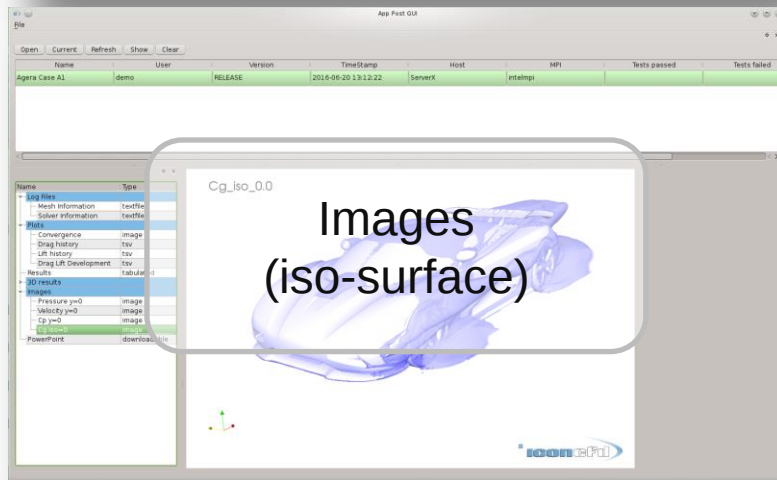
POST VIEW

www.iconCFD.com



Tabulated results

Variable	Value
1 Drag	0.45972583086
2 Lift	0.37980700897
3 Convergence	0.37980700897
4 Drag history	0.37980700897
5 Lift history	0.37980700897
6 Drag Lift Development	0.37980700897
7 wheelbase	2.691759595959596
8 front track	1.77716
9 rear track	1.81198
10 Projected Frontal Area	1.9023800477
11 drag coefficient	0.3
12 Turbulent intensity	0.05
13 Turbulent Mixing Length	0.05
14 Compressible	false
15 Adjoint	true
16 Rotating wheels	static
17 Mesh Size	Fine
18 Number of iterations	600



iconCFD 3.3.X / 4.0.X

AGENDA

www.iconCFD.com

Overview

App & Platform Integration

- Process / Platform Applications / Geometry Tool

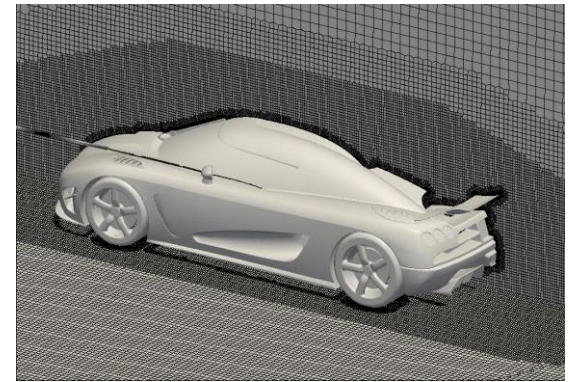
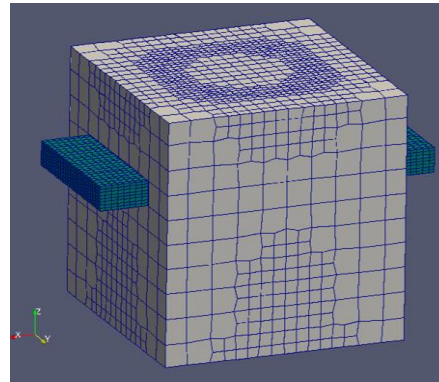
Module Development

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

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

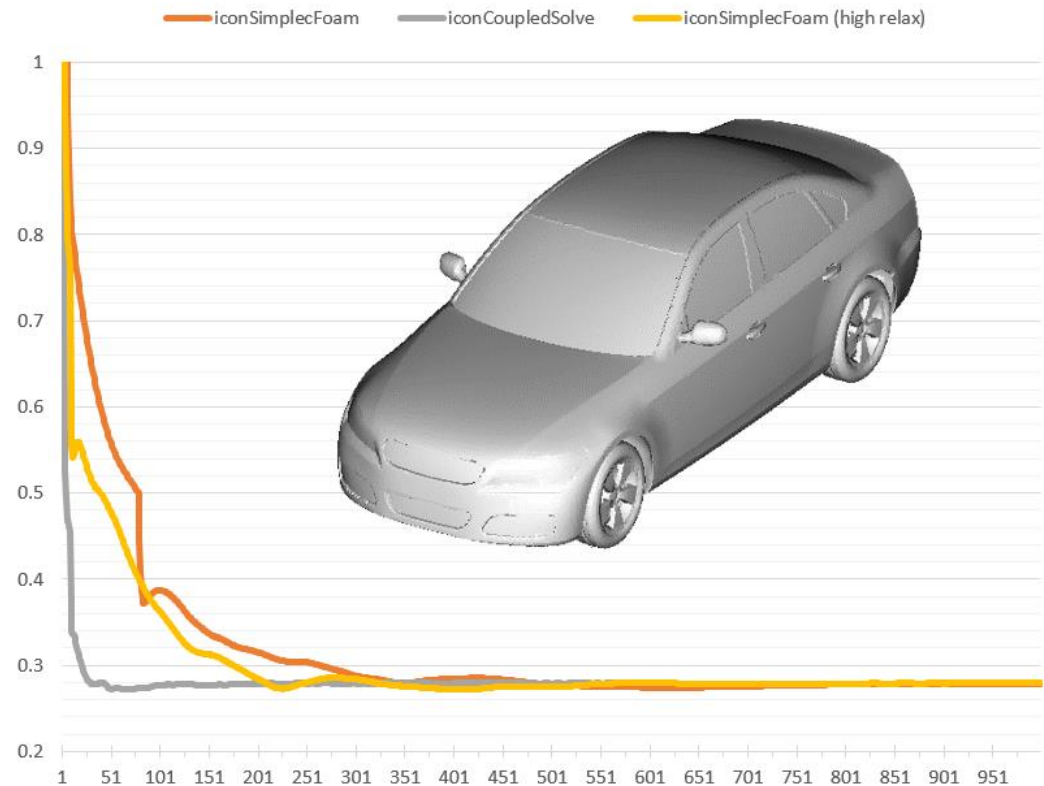
iconCFD COLD

P-U BLOCK COUPLED SOLVER

www.iconCFD.com

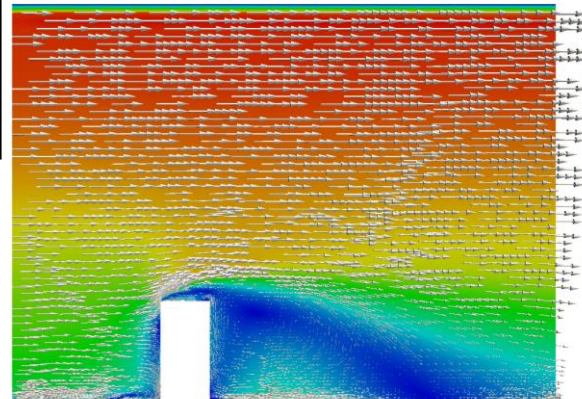
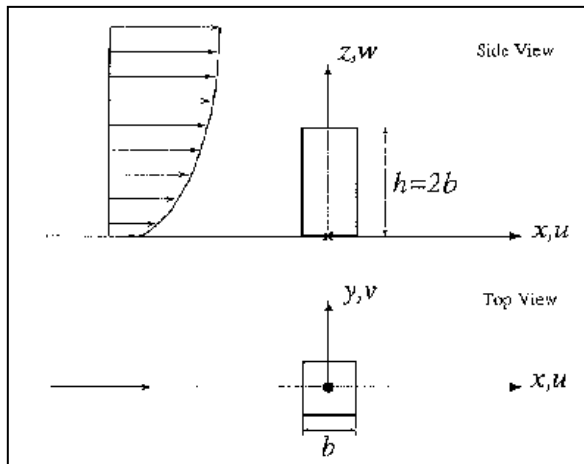
- New incompressible solver with block coupled support
- Significantly reduce number of iterations required for convergence for steady cases.
- **77%** reduction in turn around time in initial benchmarks

Block Coupled vs Segregated - Drag Convergence

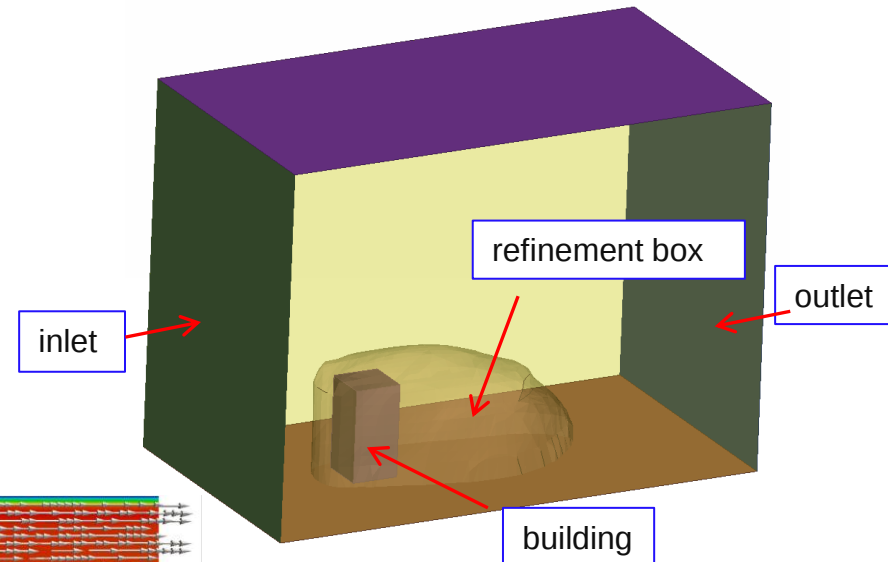


CASE STUDY: FLOW OVER BUILDING

- Large spatial scale case study
- Compare to experimental measurements



CFD model

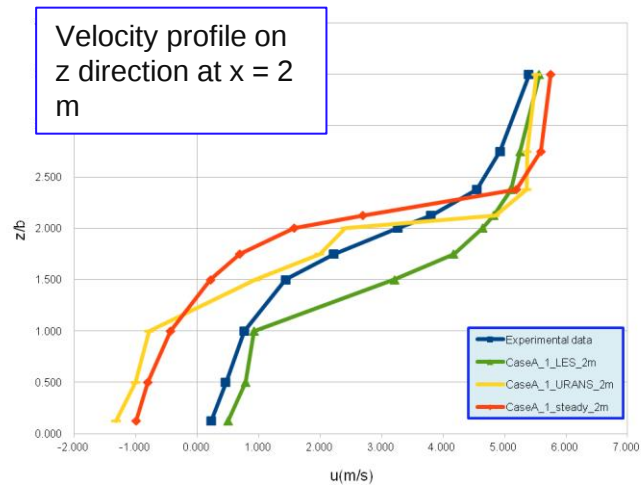


ΦTEC
INGEGNERIA

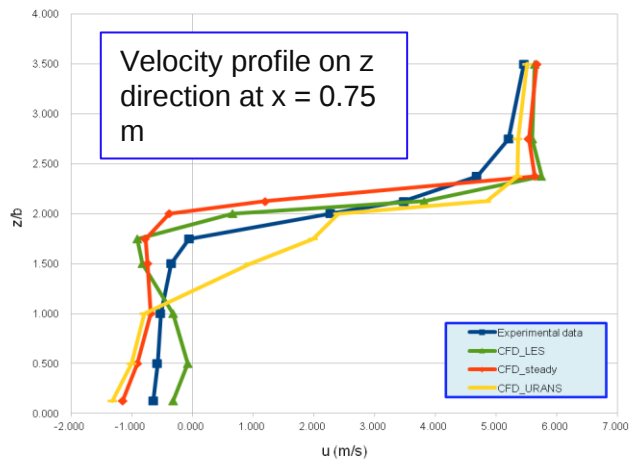
CASE STUDY: FLOW OVER BUILDING



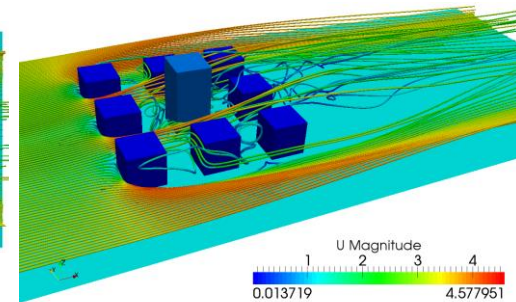
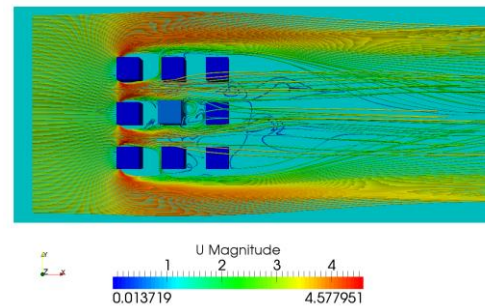
LES simulation: transient U field



ΦTEC
INGEGNERIA

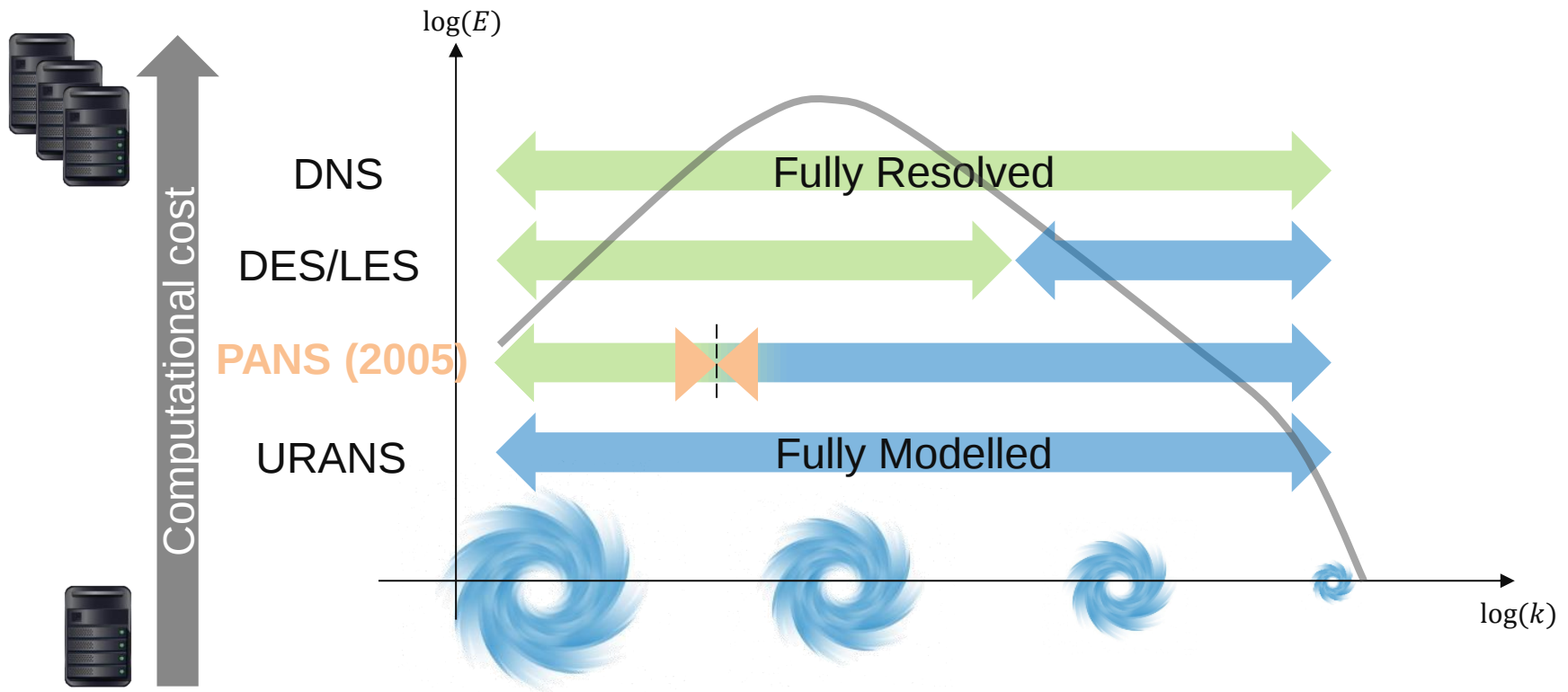


Next steps, larger scale:



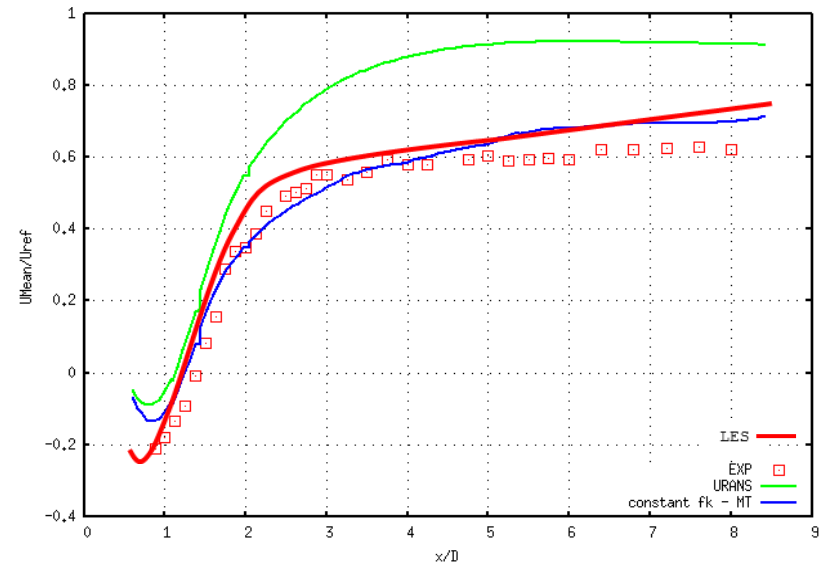
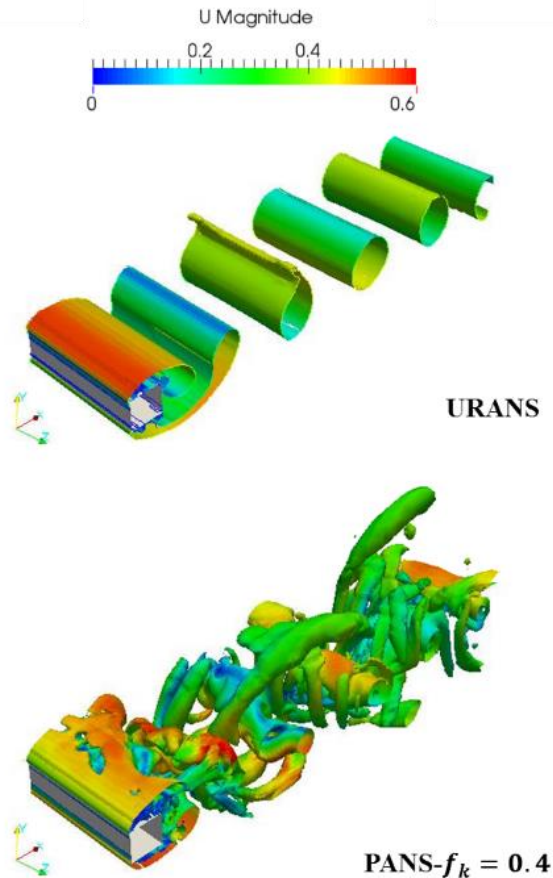
CASE STUDY: PANS VALIDATION

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



iconCFD COLD

CASE STUDY: PANS VALIDATION

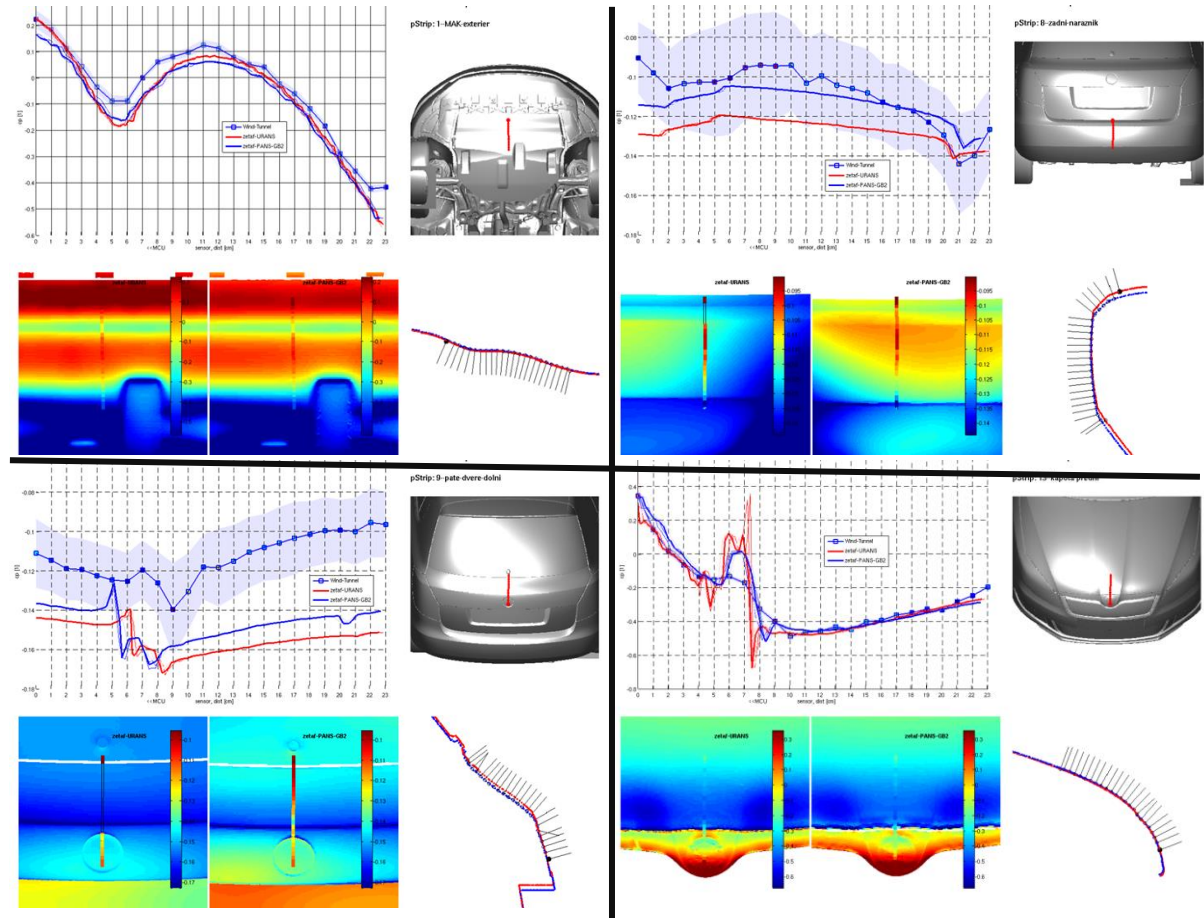


- Only spanwise vortices are captured in URANS
- Development of both spanwise and streamwise coherent vortical structures in PANS simulation
- Close to experiment (Lyn et al.) & LES solution (Ochoa et al.)

iconCFD COLD

CASE STUDY: PANS VALIDATION

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

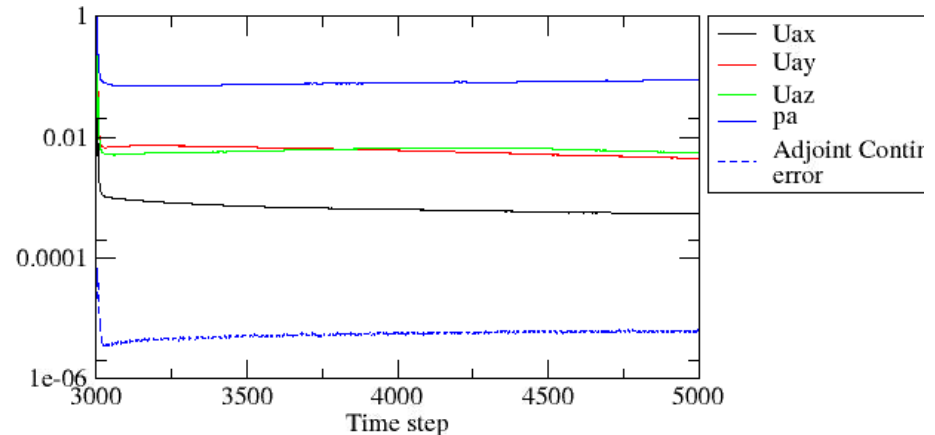


Courtesy of Škoda Auto

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

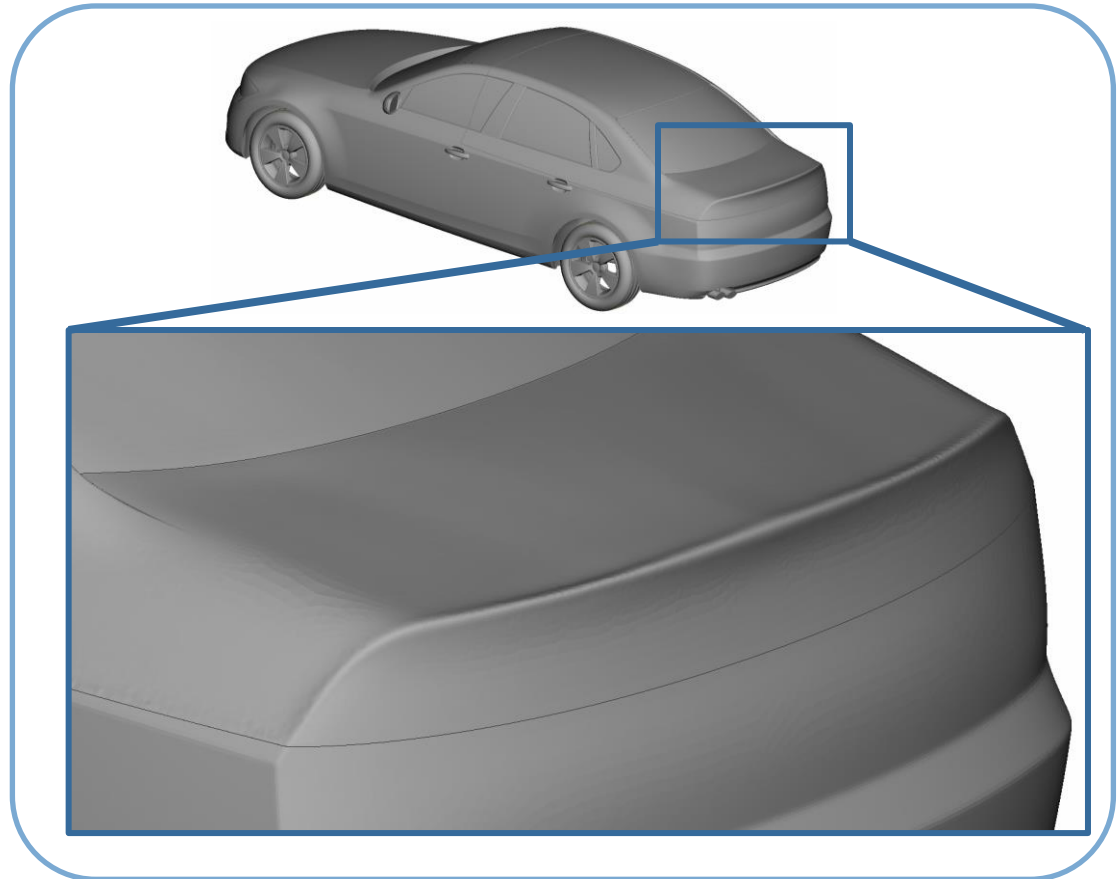


4| Solving

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

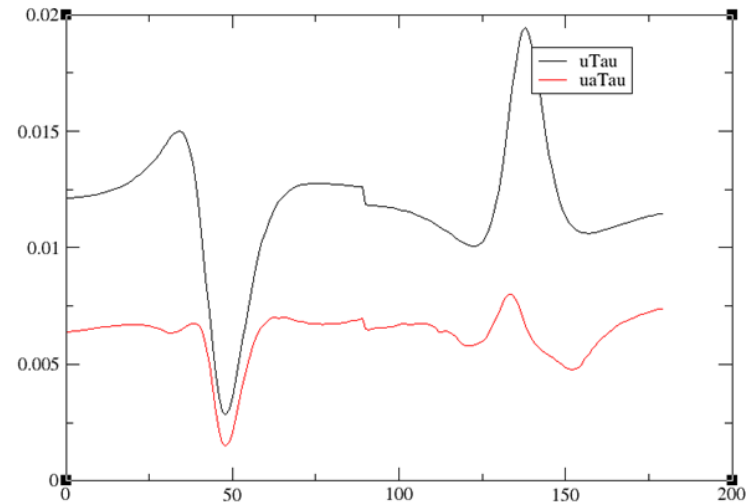


iconCFD OPTIMIZE

UPCOMING FEATURES

www.iconCFD.com

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

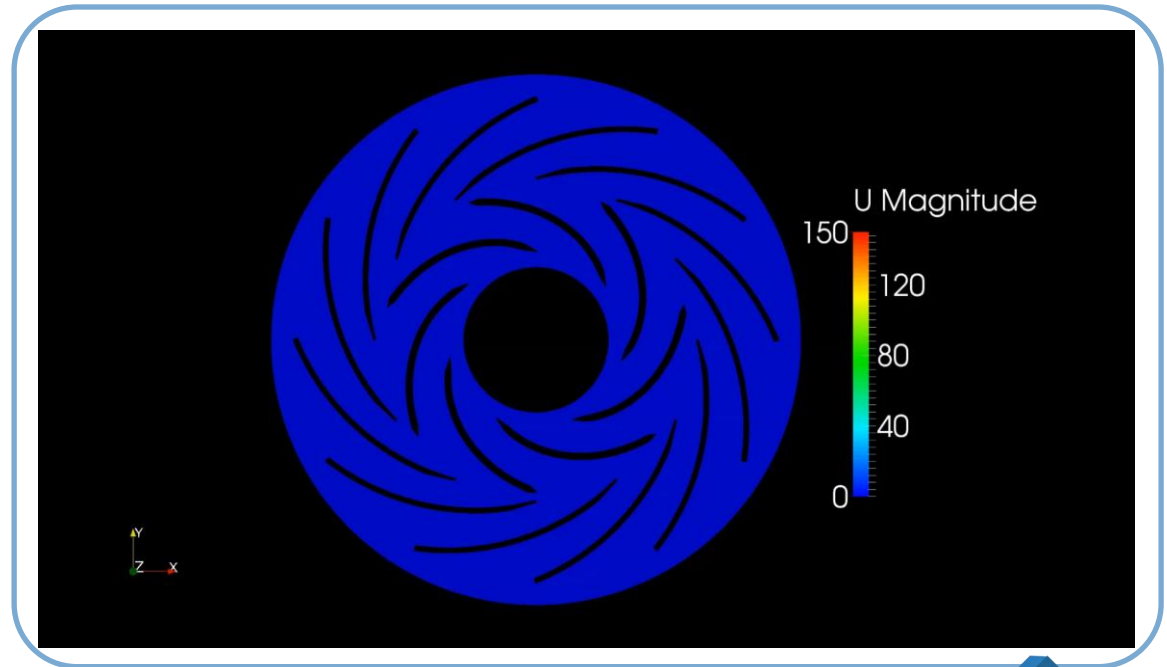


4| Solving

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.

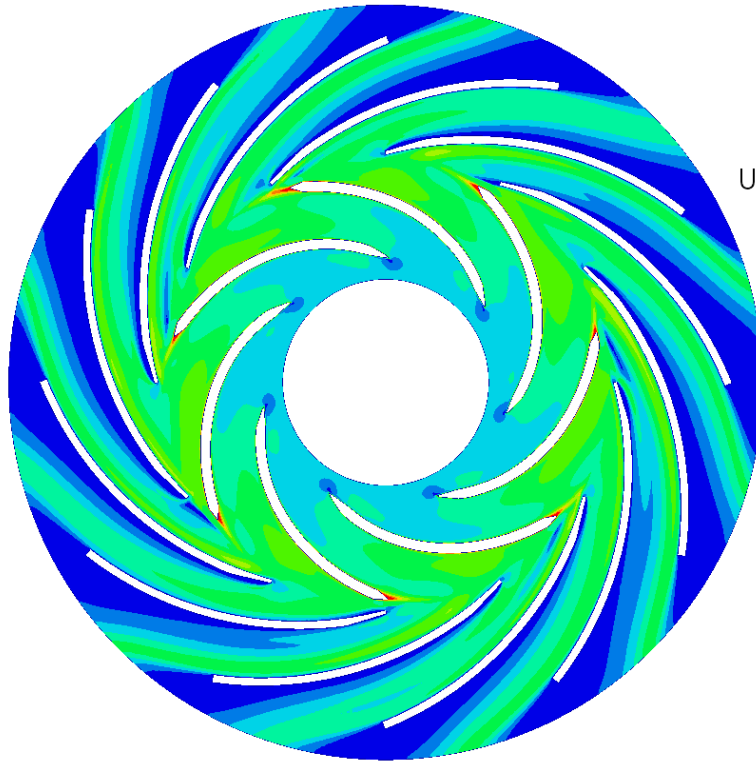
[2] Adapting OpenFOAM for Turbomachinery Applications. Maryse Page and Martin Beaudoin IREQ, Hydro-Québec's Research Institute. Second OpenFOAM Workshop, Zagreb, 7-9 June 2007

iconCFD MOVE

Case Study: Impeller Pump

www.iconCFD.com

iconCFD



U Magnitude

4.500e+01

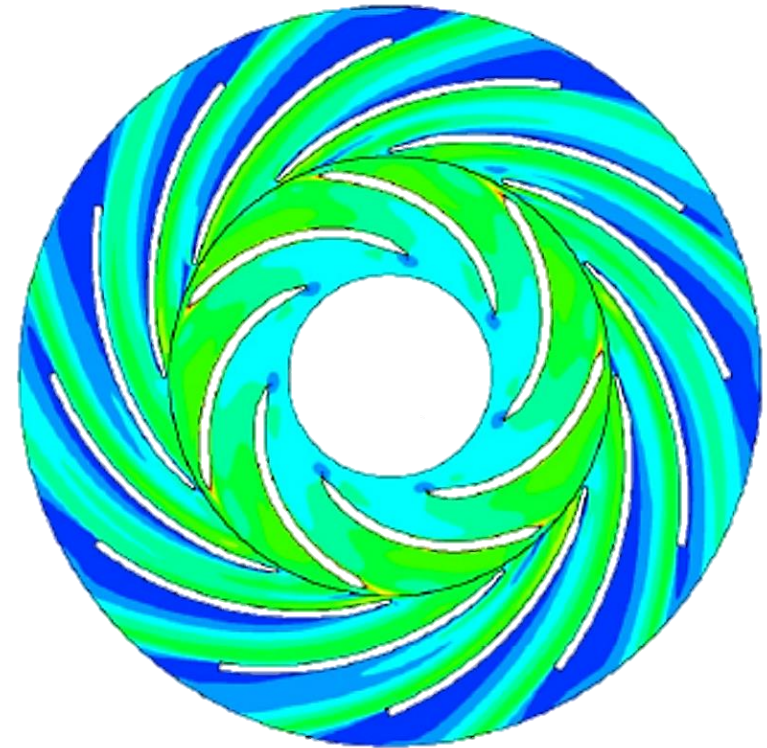
33.75

22.5

11.25

0.000e+00

Other Commercial Solver^[2]

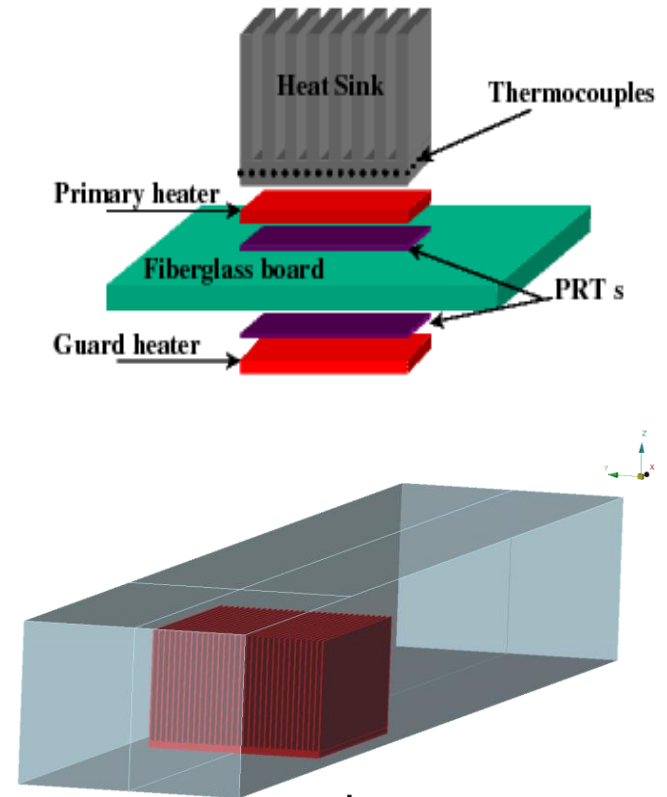


iconCFD THERMAL

CASE STUDY: HEAT DISSIPATOR

www.iconCFD.com

- 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

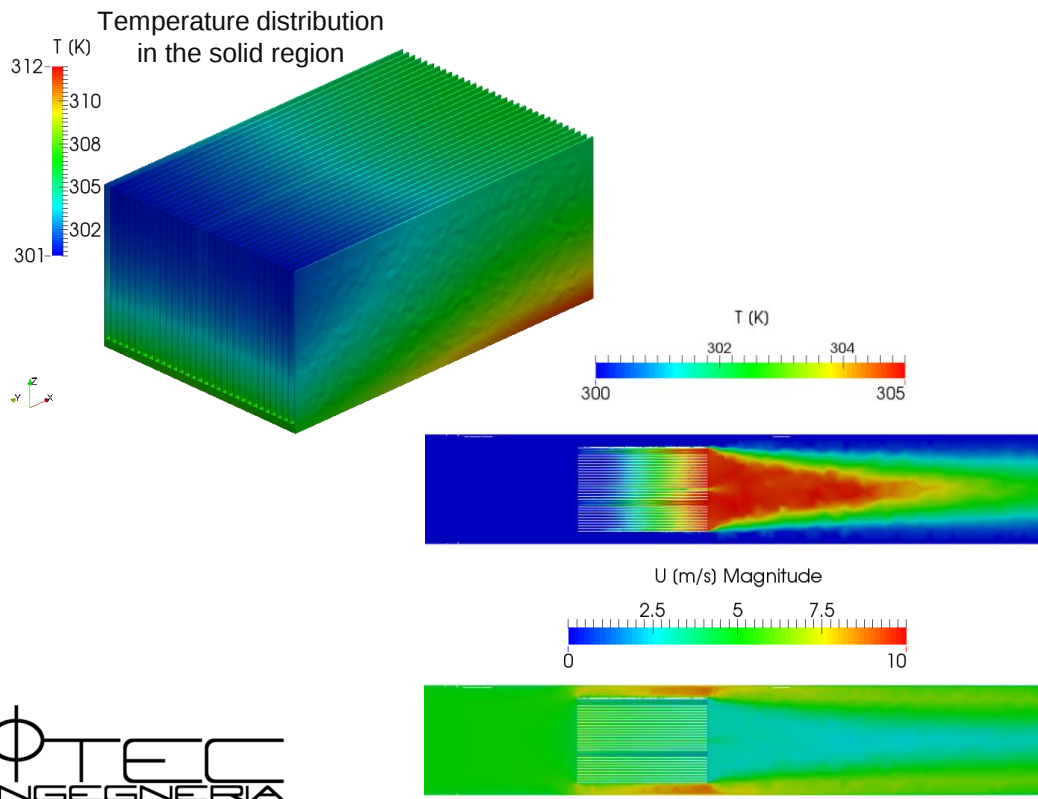


ΦTEC
INGEGNERIA

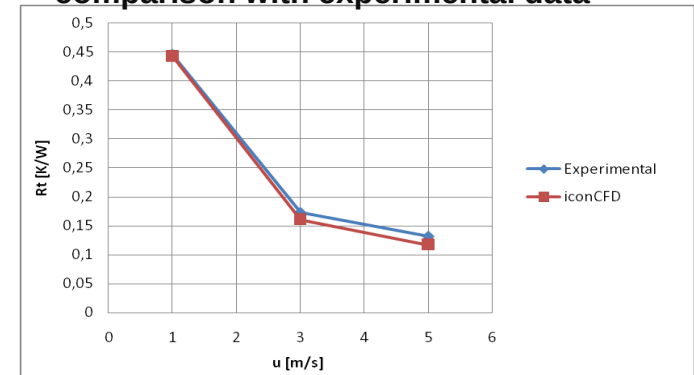
iconCFD THERMAL

CASE STUDY: HEAT DISSIPATOR

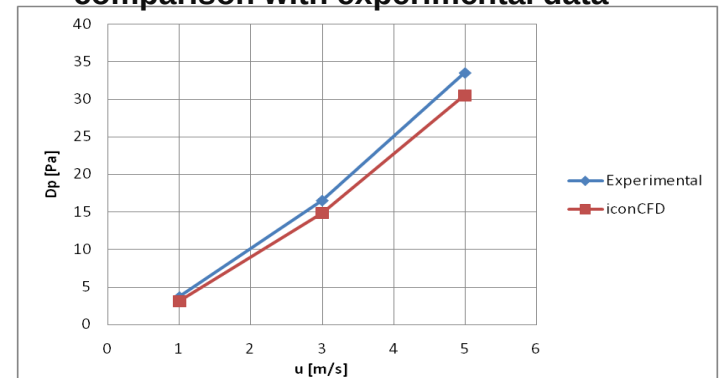
- Good experimental agreement



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



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



iconCFD THERMAL

DEMO: RADIATOR HEAT DISSIPATION

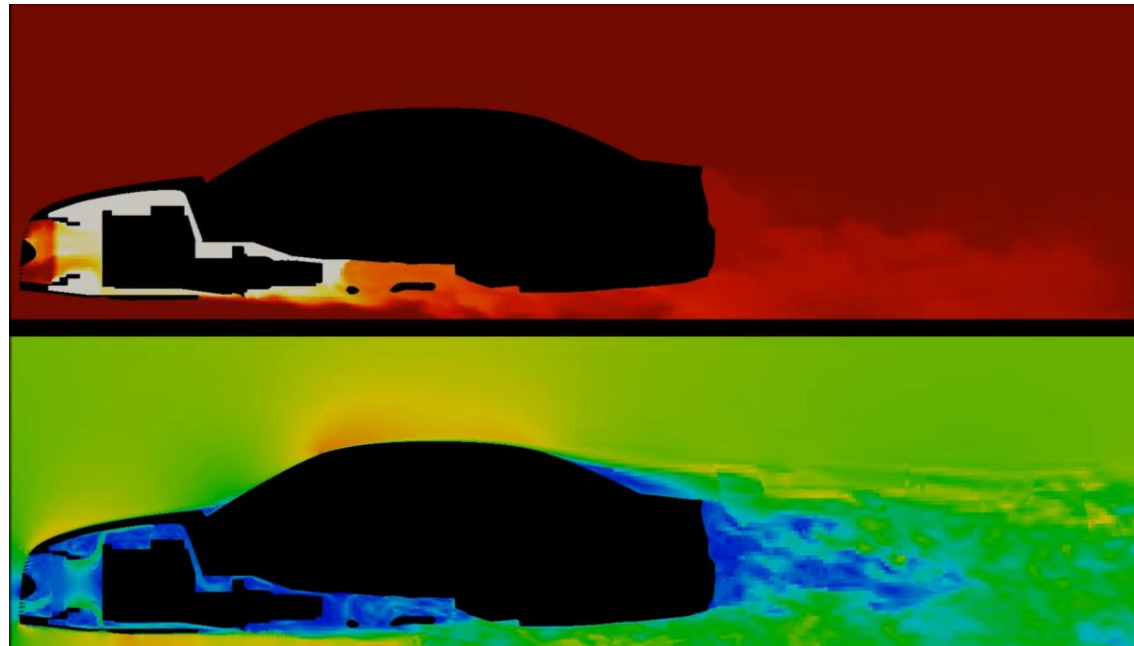
www.iconCFD.com



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

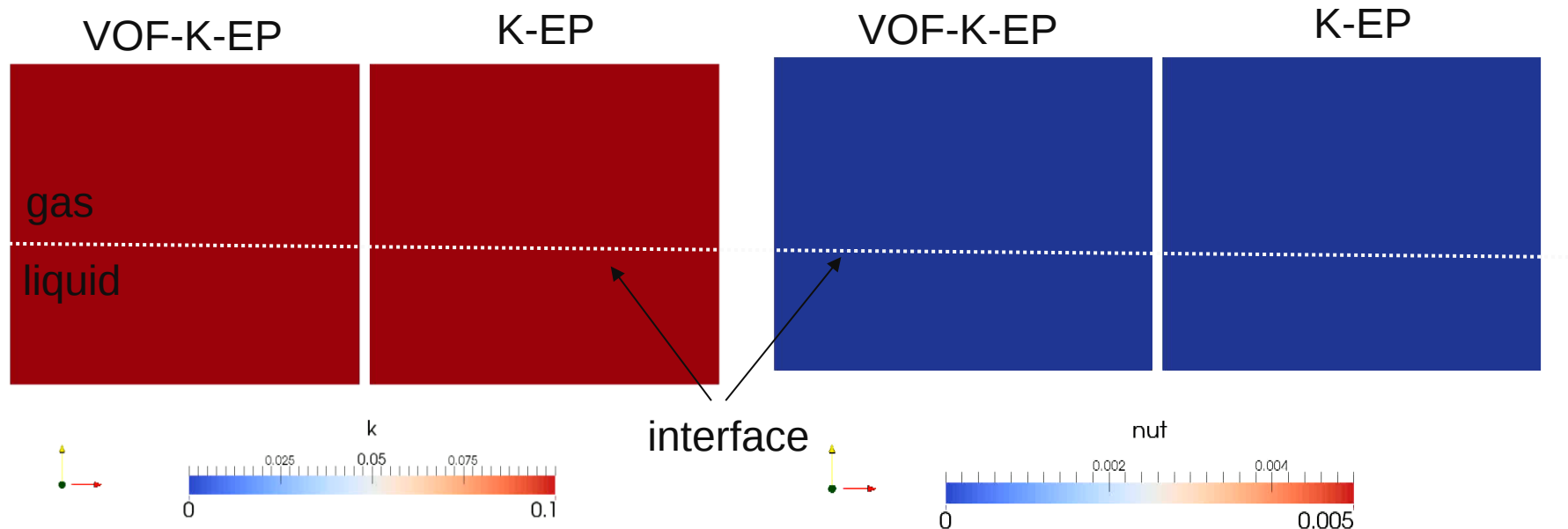
Transient heat transport from
radiator through engine
compartment

Centre-line engine bay flow
and wake structures.



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



iconCFD ACOUSTIC

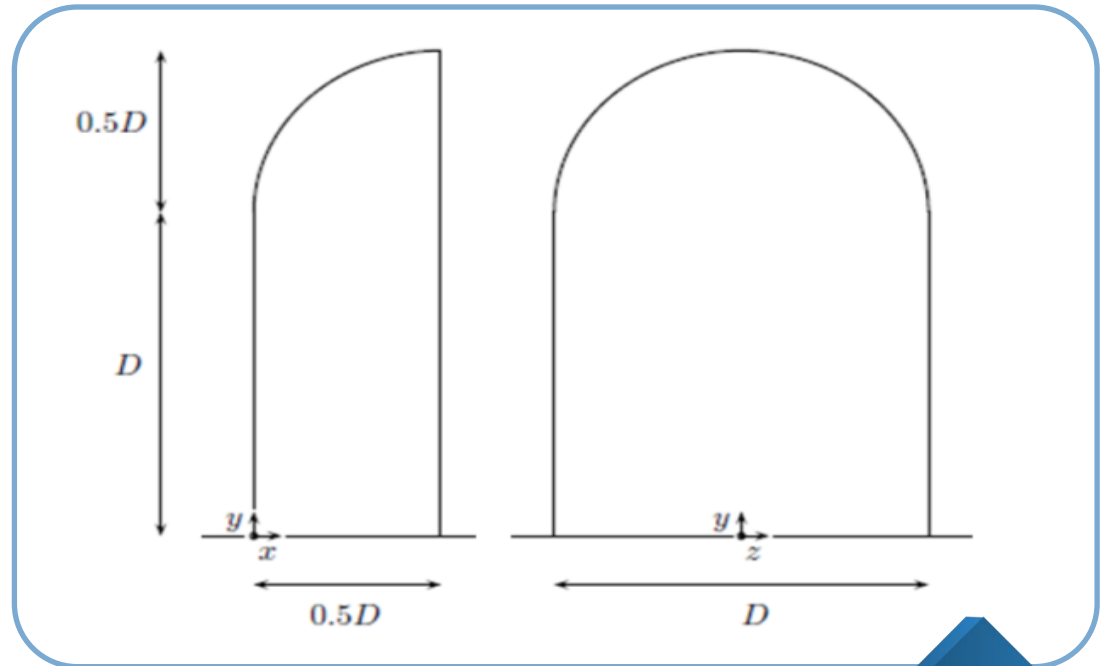
CASE STUDY: WING MIRROR

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
 - $D = 0.2\text{m}$
 - Initial Conditions
 - $U_0 = 39\text{m/s}$, $Re = 5.2e5$, $M = 0.11$
 - CFD Setup
 - $\Delta t = 0.0001\text{s}$, $\Delta x = 4\text{mm}$
- Mesh cut-off frequency = 1kHz
 - Initialized with URANS; local time-stepping for 1000 steps.
 - DES-SA, Initial transient $\sim 0.25\text{s}$
 - $T \sim 1\text{s}$



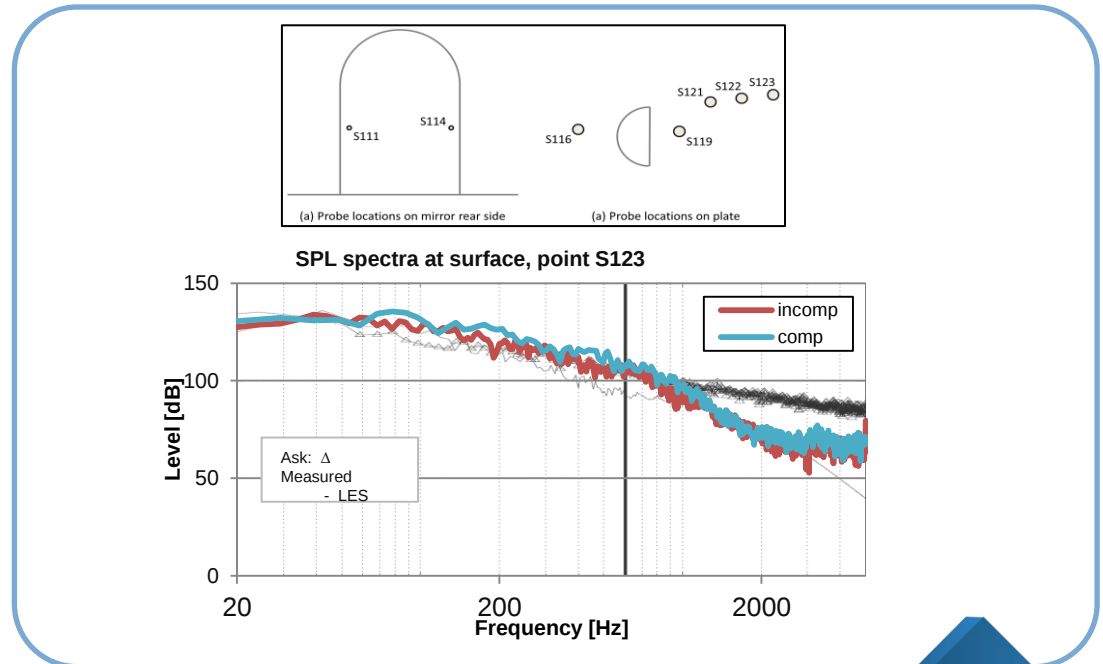
4| Solving

iconCFD ACOUSTIC

CASE STUDY: WING MIRROR

www.iconCFD.com

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



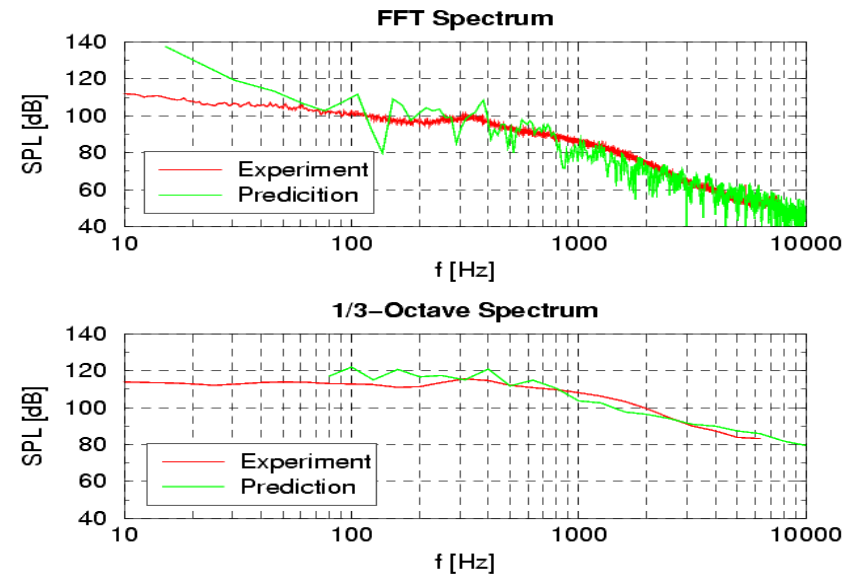
Jonas Ask and Lars Davidson. *The Sub-critical Flow past a Generic Side Mirror and its Impact on Sound Generation and Propagation*. 12th AIAA/CEAS Aeroacoustics Conference. Cambridge, Massachusetts, 8-10 May 2006 AIAA 2006-2558

4| Solving

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



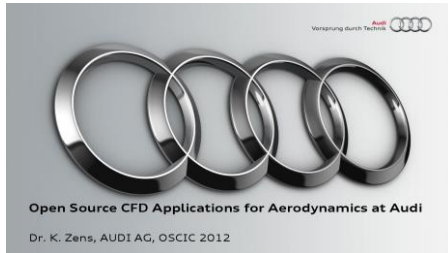
Courtesy of AUDI

4| Solving

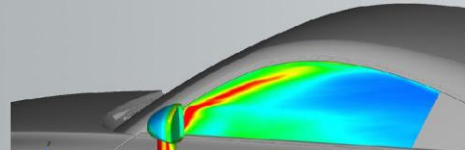
iconCFD ACOUSTIC

www.iconCFD.com

CASE STUDY: AUDI INDUSTRIAL VALIDATION

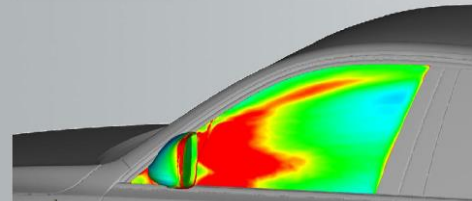


Case 1: Audi TT Coupé



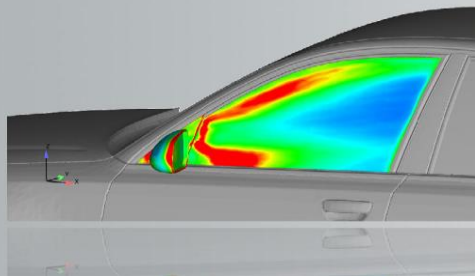
Variant	Intensity index	Ranking CFD	Ranking measurement
No mirror	0.029	1	1
Variant 1	0.041	2	2
Variant 2	0.041	3	3

Case 2: Audi Q5

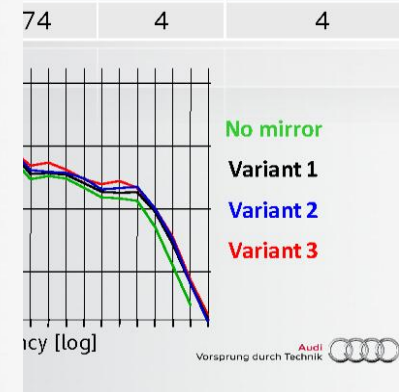


Variant	Intensity index	Ranking CFD	Ranking measurement
No mirror	0.049	1	1
Variant 1	0.059	2	2
Variant 2	0.061	3	3

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



iconCFD REACT

NEW FEATURES

www.iconCFD.com

- 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.

QUESTIONS? MORE INFORMATION?

www.iconCFD.com



www.iconCFD.com

contact@iconCFD.com

THANK YOU

LEGAL NOTICES AND DISCLAIMER

www.iconCFD.com

This presentation is supplied in confidence, and commercial security on its contents must be maintained. It must not be used for any purpose other than for which it is supplied, nor may any information be disclosed to unauthorised persons. It must not be redistributed, be reproduced in whole or in part without permission in writing from ICON.

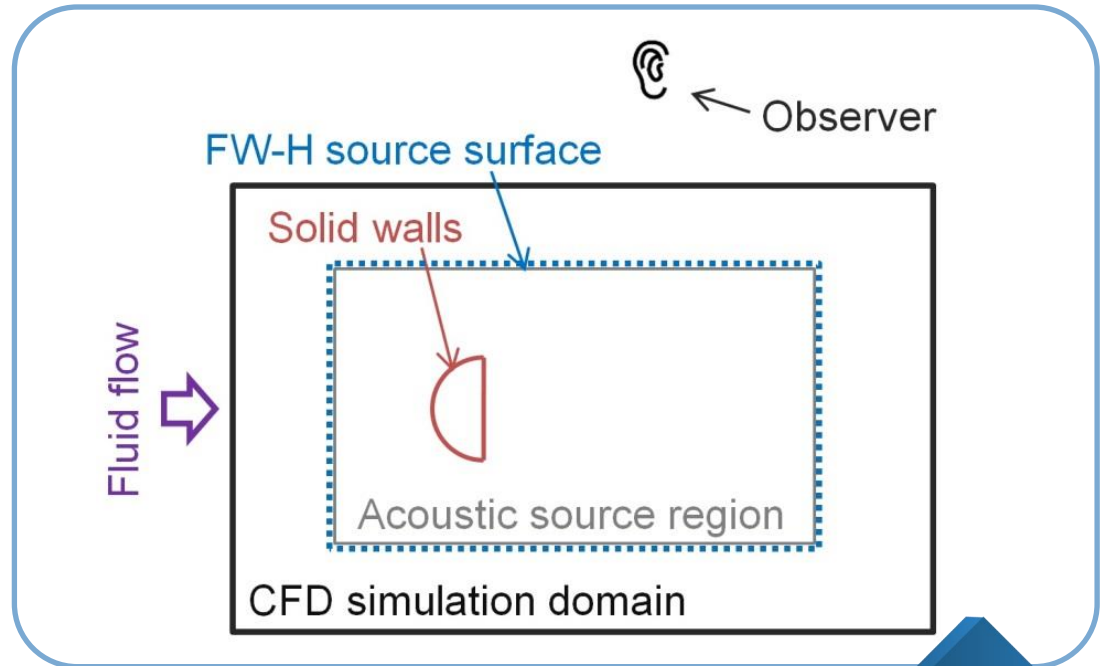
To explore the specific capabilities of iconCFD, interested parties are invited to contact ICON for a non-obligation quotation.



Please consider the environment before printing this presentation. We recommend 'Greyscale' as printing color settings.

iconCFD ACOUSTIC OVERVIEW

- Sound propagation modelling
 - Ffowcs-Williams Hawkins
 - 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



4| Solving

iconCFD ACOUSTIC

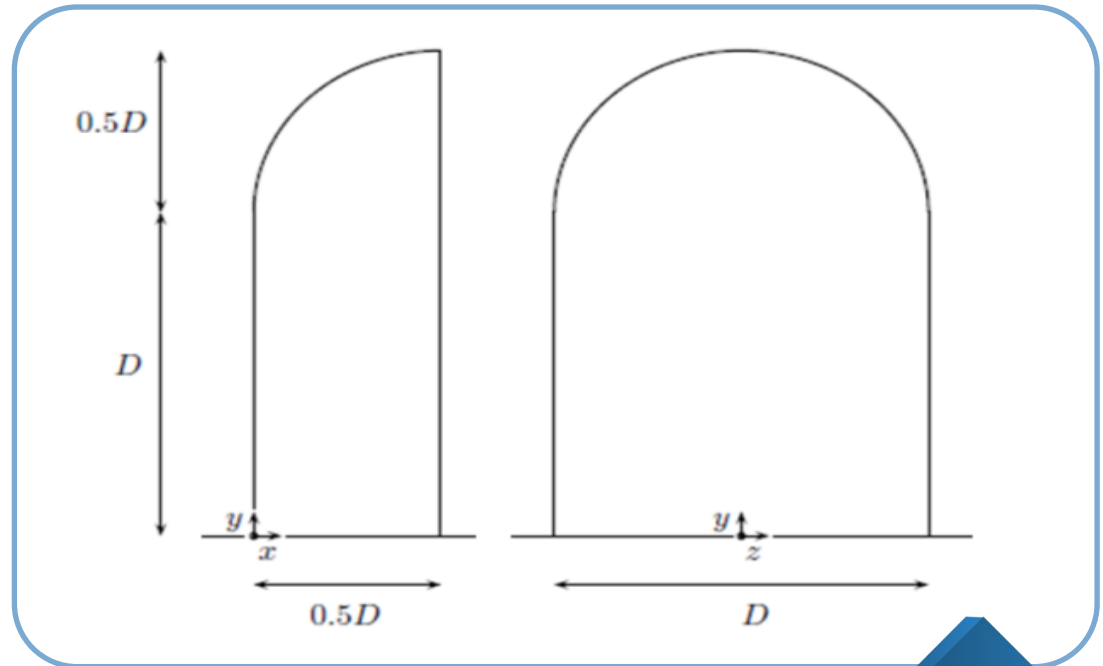
CASE STUDY: WING MIRROR

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
 - $D = 0.2\text{m}$
 - Initial Conditions
 - $U_0 = 39\text{m/s}$, $Re = 5.2e5$, $M = 0.11$
 - CFD Setup
 - $\Delta t = 0.0001\text{s}$, $\Delta x = 4\text{mm}$
- Mesh cut-off frequency = 1kHz
 - Initialized with URANS; local time-stepping for 1000 steps.
 - DES-SA, Initial transient $\sim 0.25\text{s}$
 - $T \sim 1\text{s}$

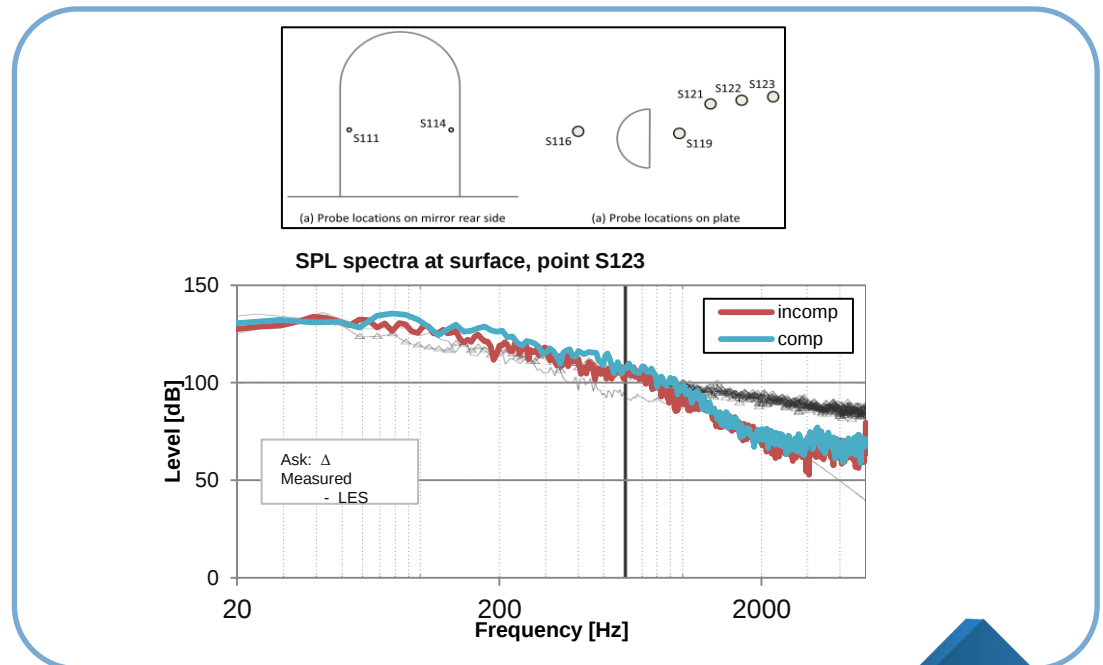


4| Solving

iconCFD ACOUSTIC

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



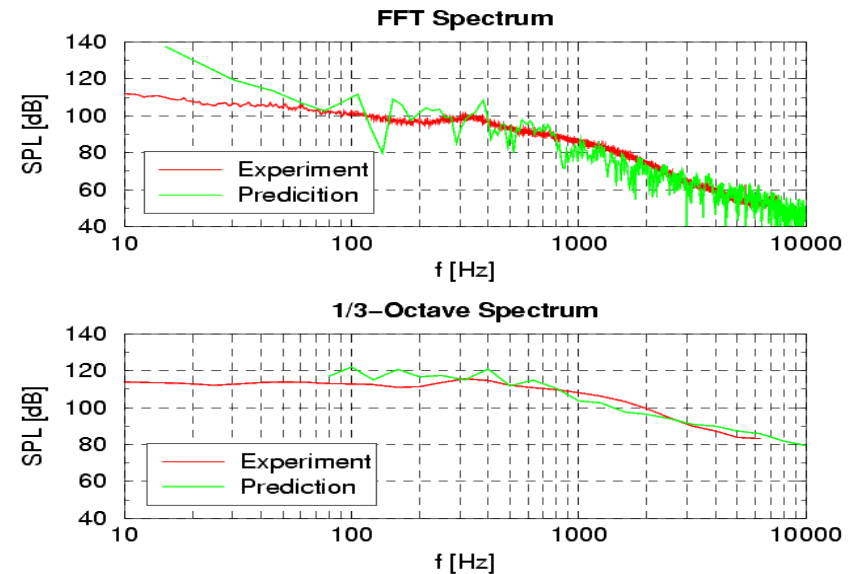
Jonas Ask and Lars Davidson. *The Sub-critical Flow past a Generic Side Mirror and its Impact on Sound Generation and Propagation*. 12th AIAA/CEAS Aeroacoustics Conference. Cambridge, Massachusetts, 8-10 May 2006 AIAA 2006-2558

4| Solving

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



Courtesy of AUDI

4| Solving