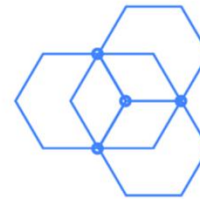


The Industry Process for Automotive Aerodynamics

iconCFD® MultiCase



Mr. Pedro Rubio
p.rubio@iconCFD.com
November 2016



Your True Partner for
CAE × CFD
ICSC2016

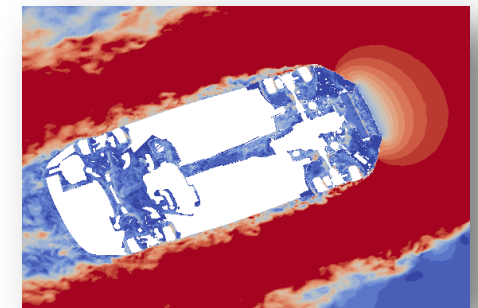
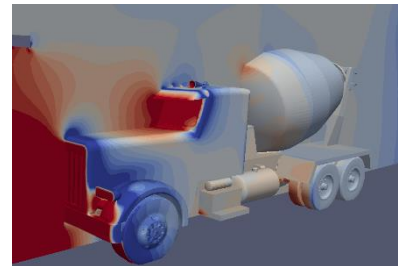
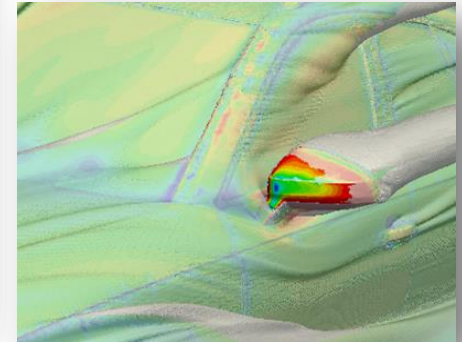
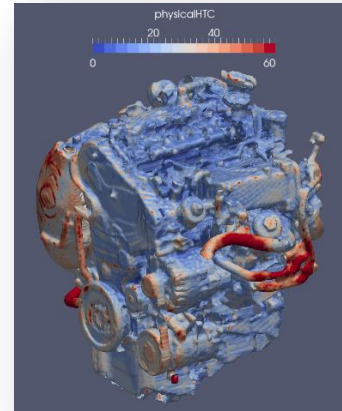


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AGENDA

www.iconCFD.com

- MultiCase GUI
- Examples
- Aero demo
- UH demo
- Conclusions



SUPPORTED CFD PROCESS



Modularized • Industrialized • Customized



iconCFD Process

•GUI

•MultiCase

iconCFD Wrap

iconCFD Mesh

iconCFD Cold

iconCFD Thermal

iconCFD Optimize

iconCFD VOF

iconCFD ... etc.

iconCFD Support & Documentation

iconCFD MultiCase

MULTICASE GUI

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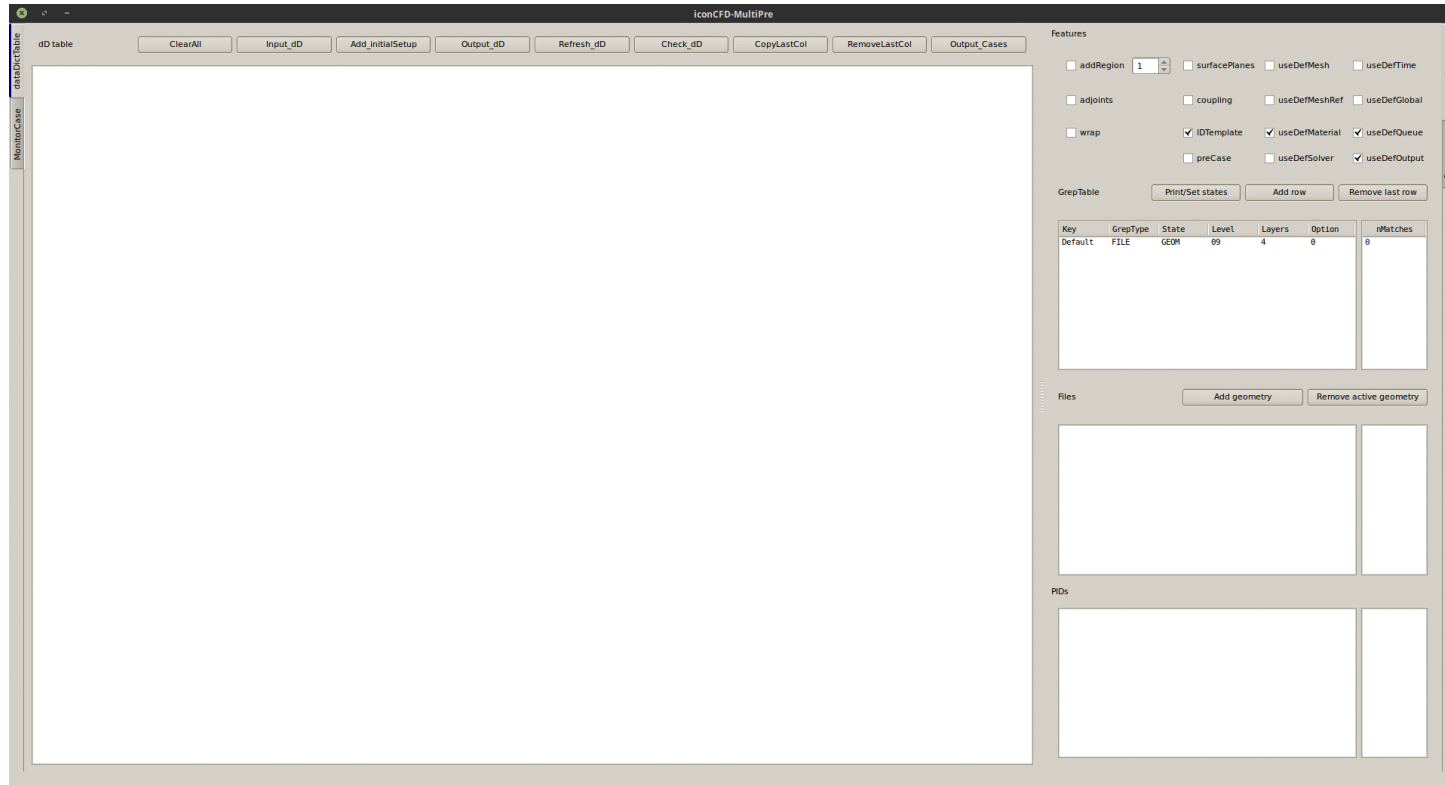
iconCFD MultiCase GUI 3.1.27

- MultiCase GUI: new graphical user interface to iconCFD MultiCase.
- Focus on usability and efficiency to fulfil the needs of modern OEMs.
- Simple but flexible interface designed around a spreadsheet table.
- Multiple cases: each column of the main table is a single case. Easy to populate and copy/paste values.
- Just a setup tool: *"Do not try to do everything. Do one thing well."* Steve Jobs.

iconCFD MultiCase

FIVE STEPS SETUP

www.iconCFD.com

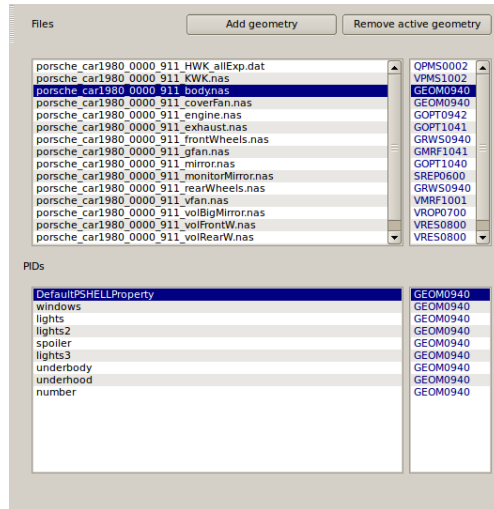


Load Geometry → Define Keys → Module Activation → Fill DataDict → Output

SETUP TIME: Few minutes

iconCFD MultiCase

MULTICASE COMPONENTS



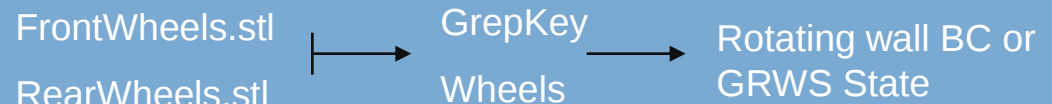
Geometry Info

Geometry Info: Display geometry filenames (top window) and pids/regions (bottom window). Clicking on a filename, pid list is updated. Only car geometry is needed to load (**no Tunnel**).

Grep Table: Define relationships between geometry filenames or pid names to boundary conditions. A keyword (*GrepKey*) is used as match. It also sets surfaceLevel and layers.

Key	GrepType	State	Level	Layers	Option	nMatches
Default	FILE	GEOM	09	4	0	0
engine	FILE	GOPT	09	4	MESH	
exhaust	FILE	GOPT	10	4	THERMO	
vfan	FILE	VMRF	10	0	LINK1	
gfan	FILE	GMRF	10	4	LINK1	
Wheels	FILE	GRWS	09	4	0	
altExp	FILE	QPMs	00	0	LINK2	
K&K	FILE	VPMS	10	0	LINK2	

Grep Table



iconCFD MultiCase

MULTICASE COMPONENTS

Modules: Group of check boxes to activate features: “Enable what you need and disable what you don’t”. Template module is recommended: Wind Tunnels.

Module Activation

DataDict Table: Spreadsheet table where each column is one setup. Initial default values can be customized with user best practices. Easy to populate and copy/paste.

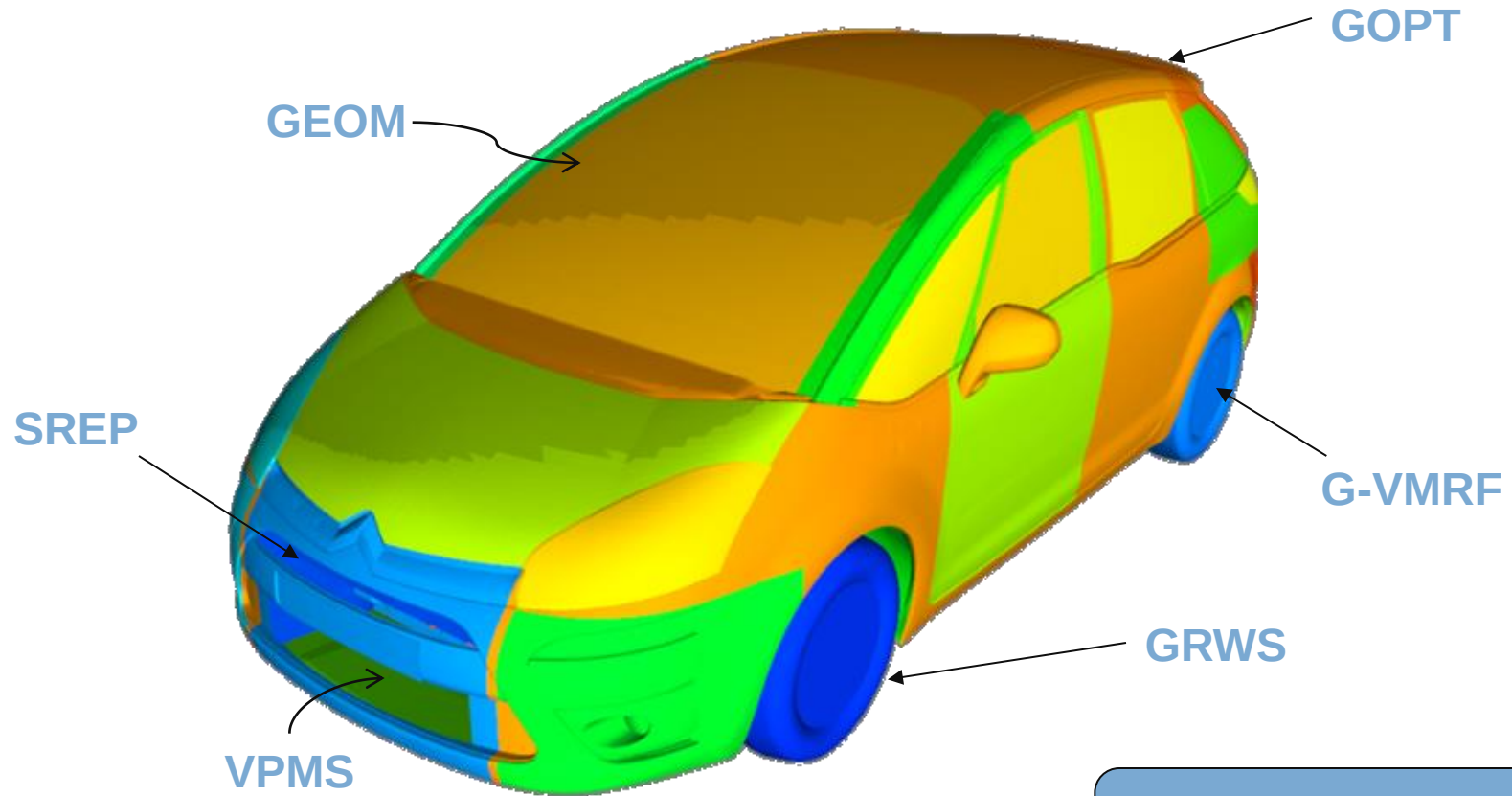
activeSetup (1/0)	1	1
nameSETUP (X)	911RANS_incomp	911IDES
eAdjoint2Loop/radTherm3Loop/mapCase(X)	1Master2	1Slave2
initSolver (POT/INIT/STEADY)	POT	POT
VInit (X X X, m/s)	38.89 0 0	38.89 0
ITurb LTurb (X X, - m)	0.05 0.05	0.05 0.0
g_force (X X X, m/s2)	0 0 -9.8	0 0 -9.8
steady/trans X CoMax/coEuler/0, - - -)	steady 3 0	trans 20
n Max AUX (X X X/X tSMin tSMin, s s s)	1 tSMin tSMin	0.00001
rtMeanVars (X X X/0 endTime 0, s s s)	50 endTime 25	0.005 0.
ompBuo/compRad/compBuoRad_static/dyna)	incomp static	comp sti
KE/laminar SIMPLE/SIMPLEC/PISO/PIMPLE)	rans SA SIMPLEC	des SA f
keepPoint0 (X X X, m)	0.33 -2.15 1.27	0.33 -2.

DataDict Table

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MULTICASE STATES

www.iconCFD.com



Geometry courtesy of PSA

13 STATES are available
to cover all setups

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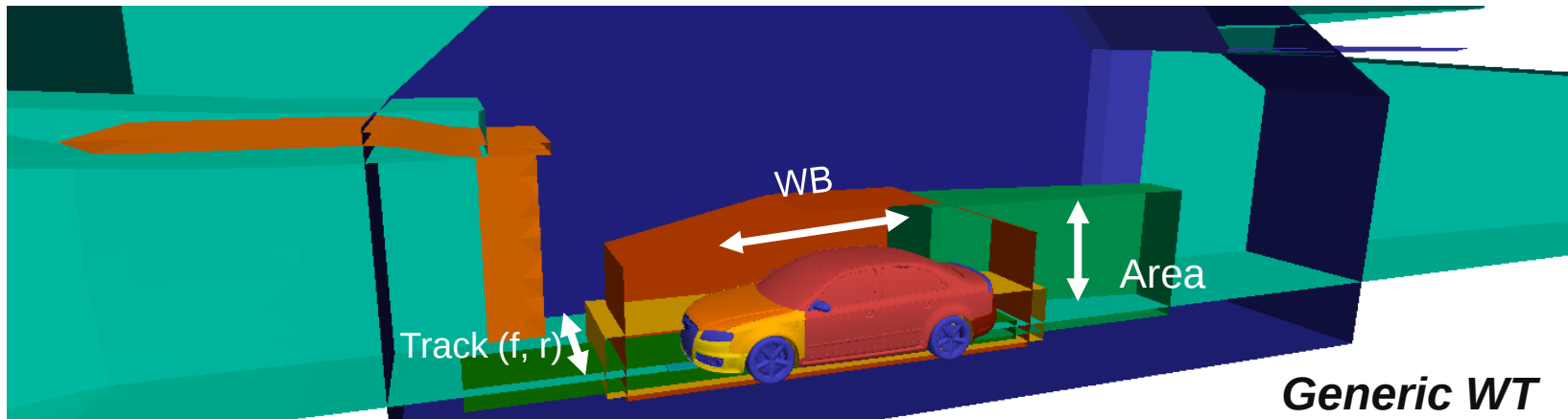
MODULES: TEMPLATES

www.iconCFD.com

Geometry courtesy of Audi AG, I/EK-44

ON LiftDrag Template (1/0 1/0)	1 1	1 1
Template_nameSetupTemplate (X X)	box staticParam	generic static39
X X X/referencePointTemplate, m)	referencePointTemplate	referencePointTemplate
TEMPLATE/INPUT, degrees degrees -)	0 0 INPUT	0 0 INPUT
X X/rhoDensity VInit, Kg/m3 m/s)	rhoDensity VInit	rhoDensity VInit
auxVARs (X X X, m)	-6.5 0 0	-6.5 0 0

Car Pitch/Yaw/Roll



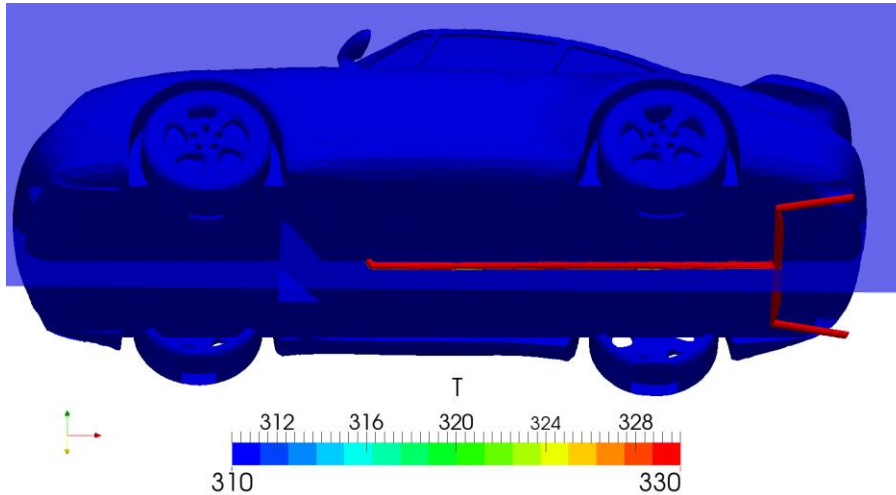
The parametric volumes of refinement automatically fit the car shape. Users can create/add their own based on the input parameters shown above.

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MODULES: WRAP & COUPLING

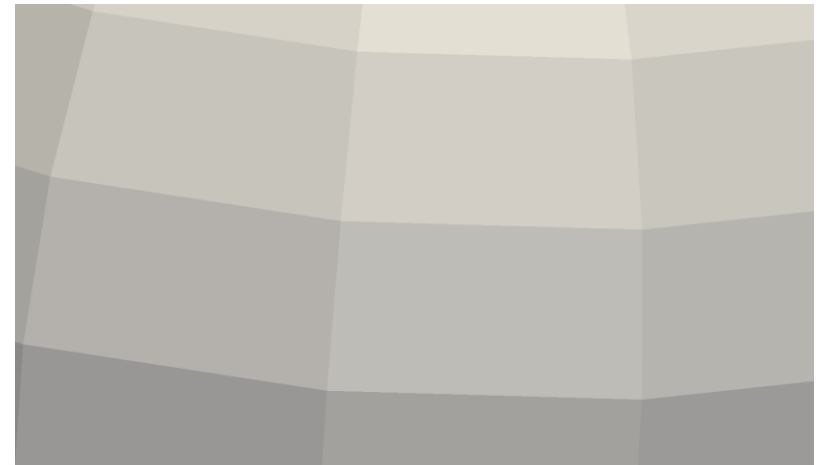
www.iconCFD.com

Base geometry from http://www.eng.nus.edu.sg/LCEL/RP/u21/wwwroot/stl_library.htm



Radtherm coupling for
steady and transient setups.

Wrap: seamless integration
to avoid problems with bad
quality inputs.

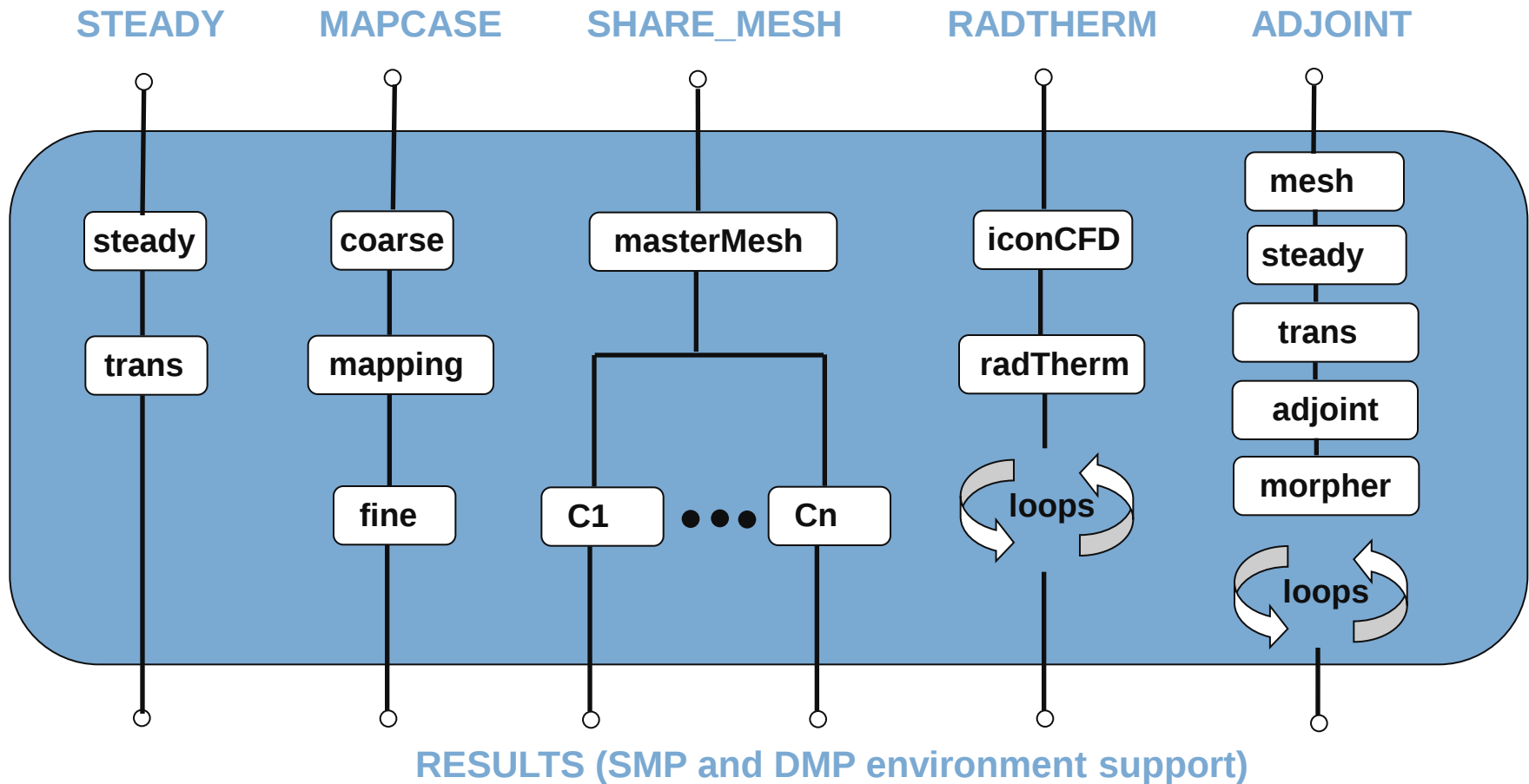


Base geometry from <http://openfoam.com/>

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WORKFLOWS WITH QUEUE SUPPORT

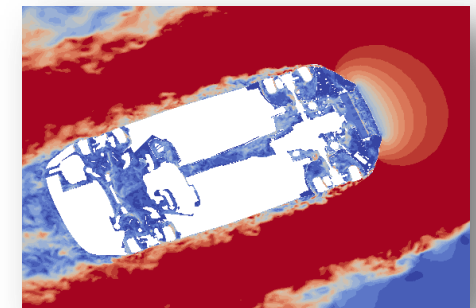
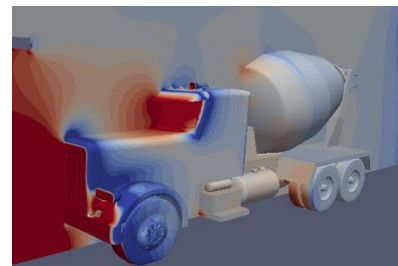
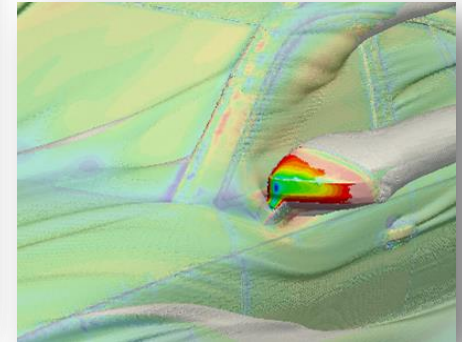
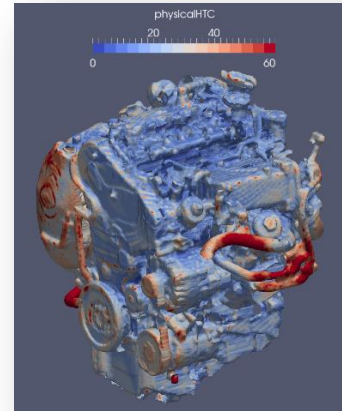


iconCFD MultiCase

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www.iconCFD.com

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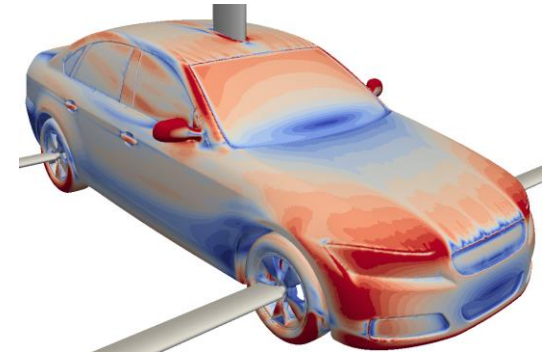
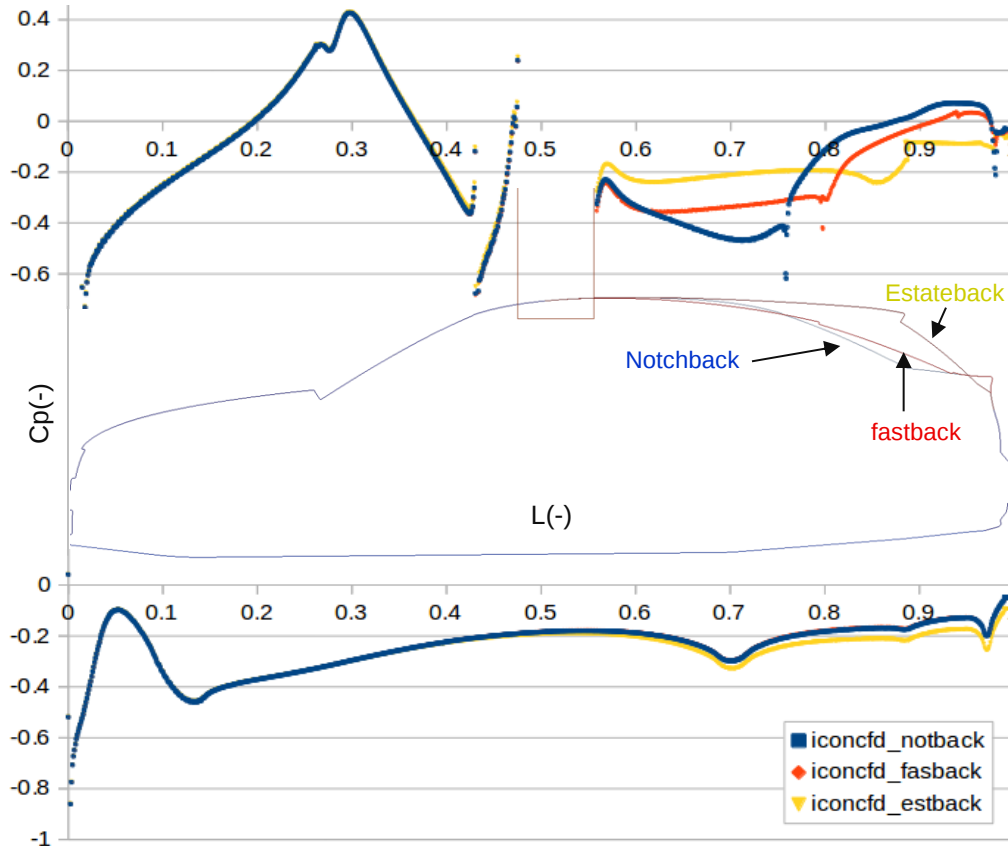


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CP DISTRIBUTION

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DrivAer geometry courtesy of TUM



Velocity distribution: Notchback

50 MCells steady(RKE) runTime (64 cores) 12h
1:1 setup with equivalent test Reynolds

All car parts included (no supports)						
	Cx(-)	Cy(-)	Cz(-)	Cmx(-)	Cmy(-)	Cmz(-)
notback	0.250	-0.008	-0.019	-0.001	-0.081	0.000
fasback	0.250	-0.007	0.000	-0.001	-0.094	0.000
estback	0.272	-0.008	-0.142	-0.002	-0.058	0.000

frontBody	rearBody	mirror	wheels	underbody	WT
mockup	notchback	standard	openSmooth	smooth	Box-roadMov
	fastback				
	estateback				

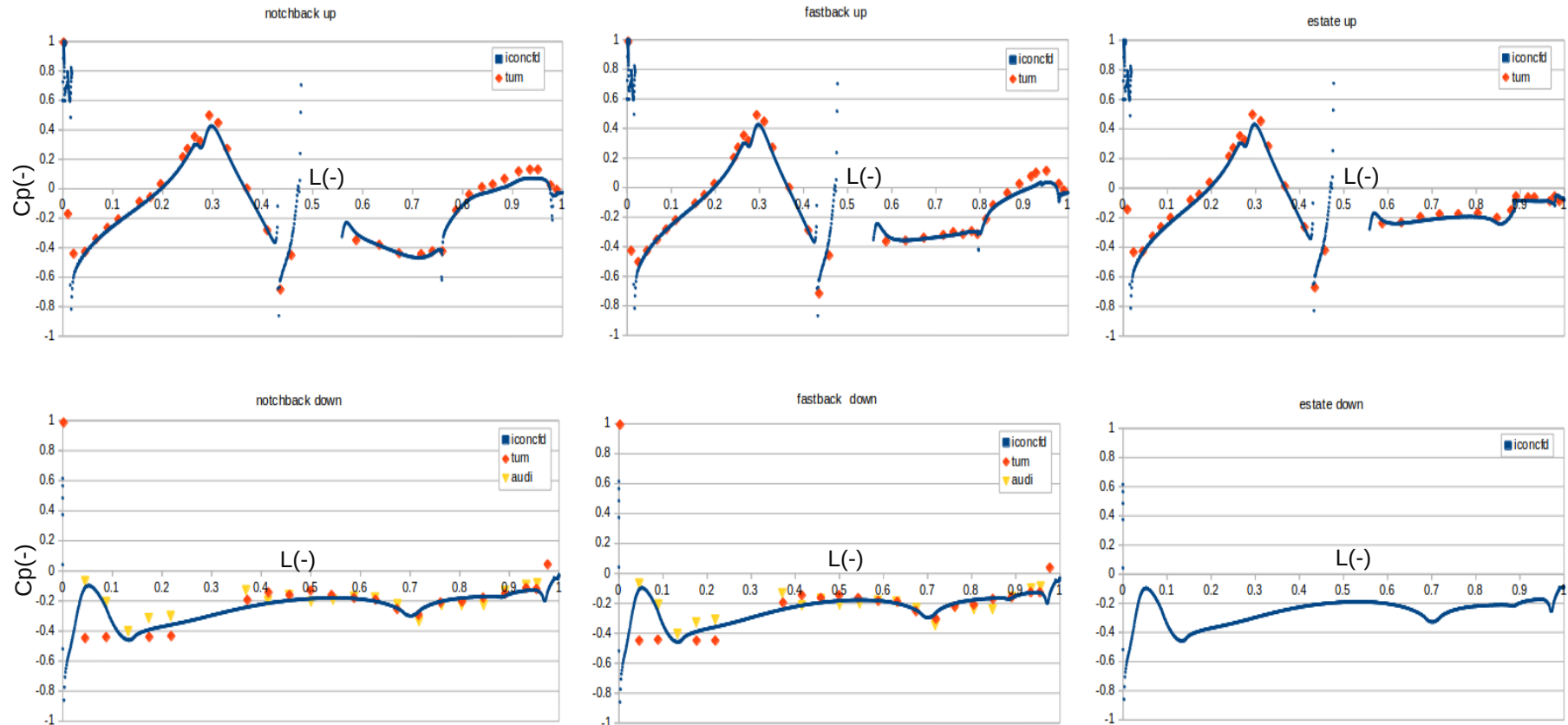
DrivAer model fits perfectly inside MultiCase methodology. **Setups** can be created in few minutes.

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CP DISTRIBUTION

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DrivAer geometry courtesy of TUM



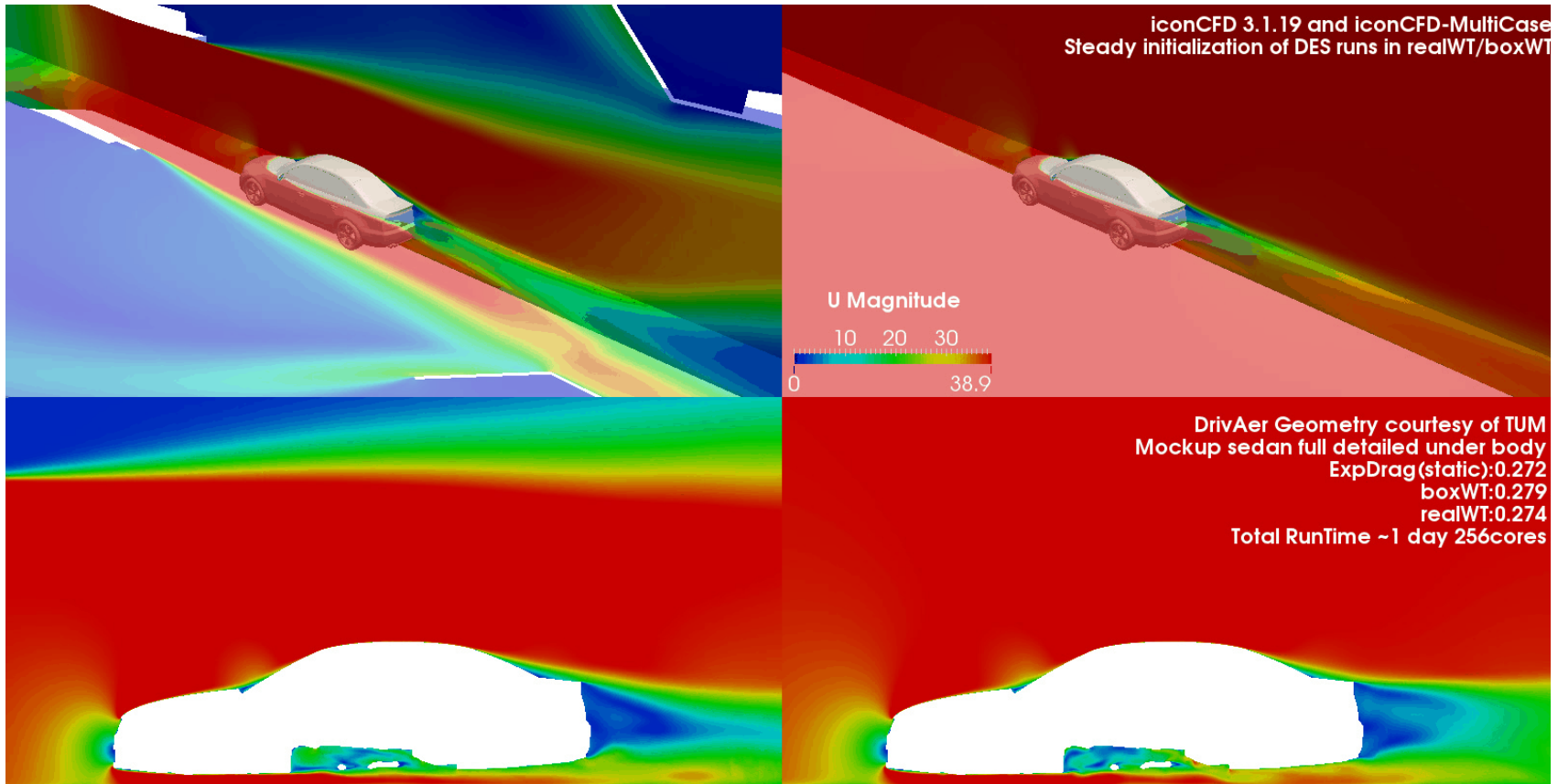
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WIND TUNNEL TEMPLATE

www.iconCFD.com



Geometry courtesy of TUM

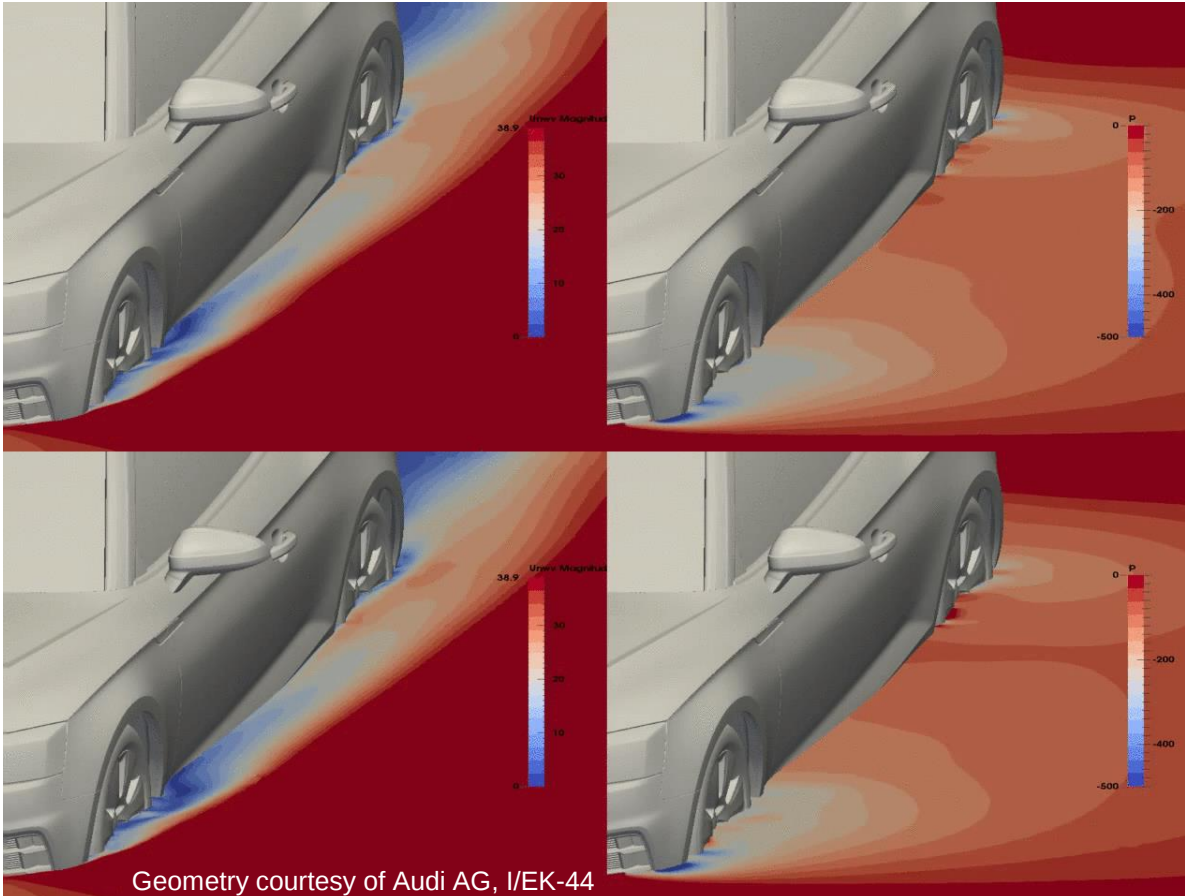


Easy WTT replacement. Above realWT geometry compared with boxWT.

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DES AND DYNAMIC MESH

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Geometry courtesy of Audi AG, I/EK-44

Correct rim pressure distribution can only be capture with dynamic movement: MRF or other velocity BCs are not enough.

Delta wheel replacement
zero as WT test

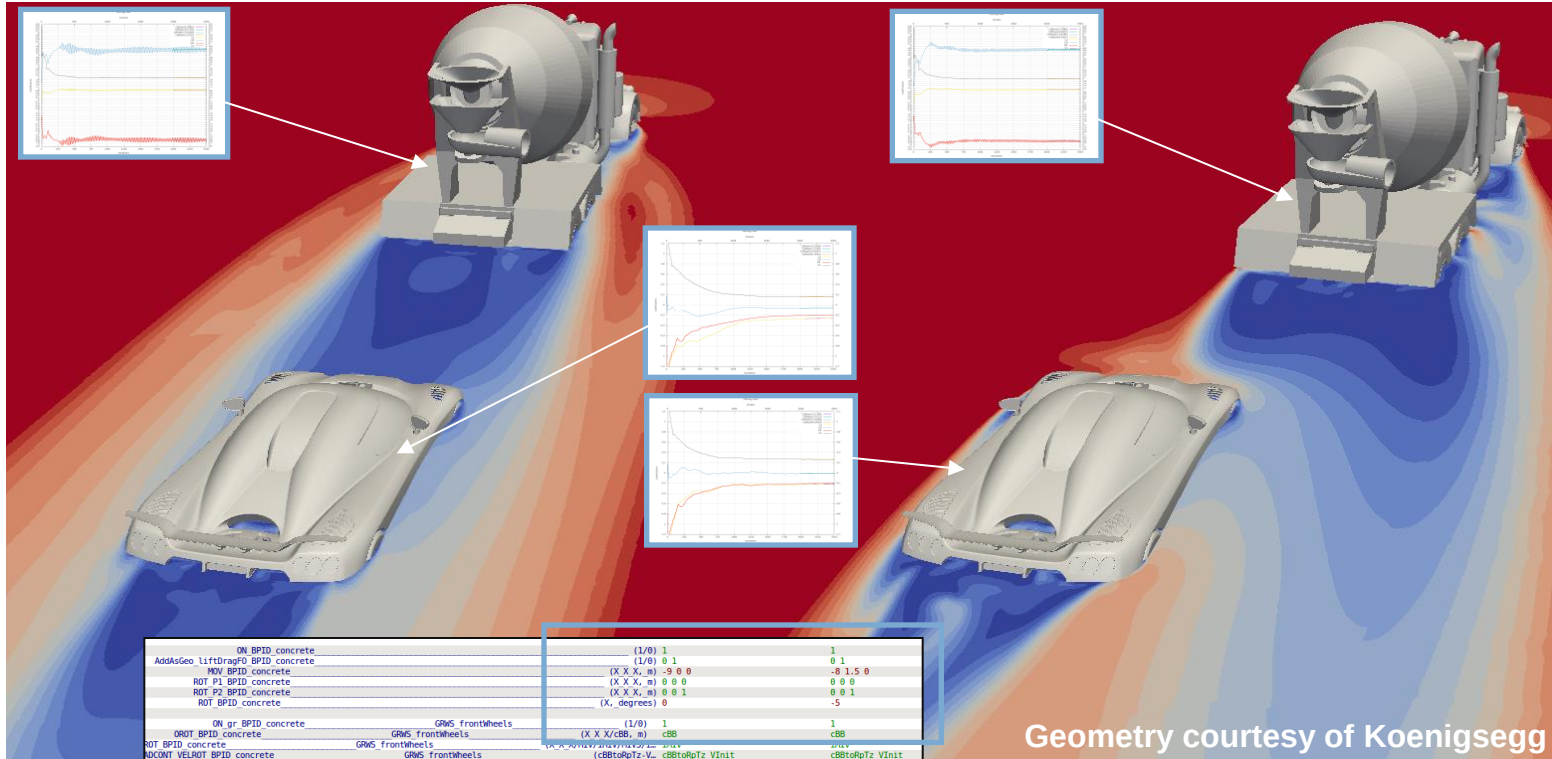
	iconCFD RANS	iconCFD DES	iconCFD Move DES
CD	-7	-2	-1
CLf	-10	-9	0
CLr	11	16	0
CL	1	7	0

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DoE: OVERTAKE OPTIMIZATION

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Base geometry from <http://tf3dm.com>



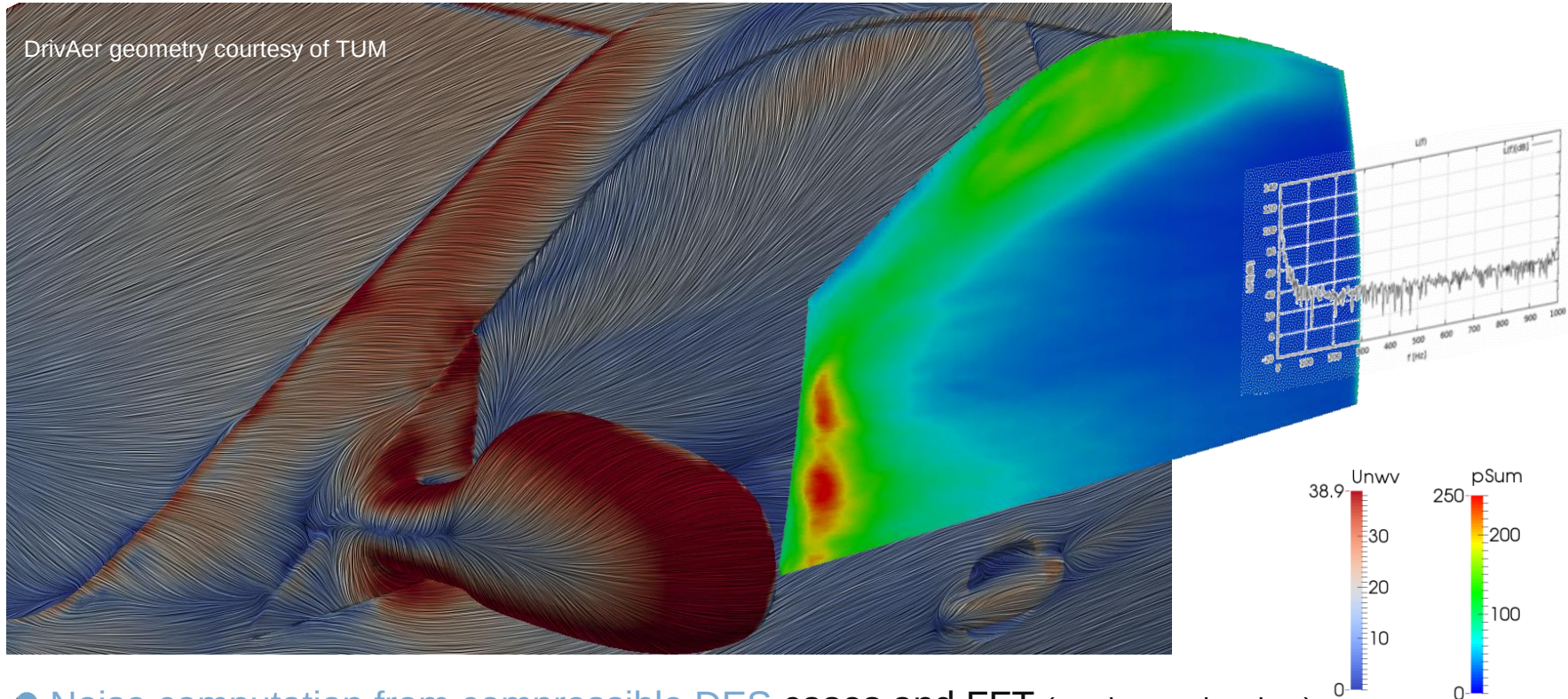
ON BPID concrete	(1/0)	1	1
AddsGeo L11d1r4f0 BPID concrete	(1/0)	0 1	0 1
M0V BPID concrete	(X X X, m)	-9 0 0	-8 1.5 0
ROT P1 BPID concrete	(X X X, m)	0 0 0	0 0 0
ROT P2 BPID concrete	(X X X, m)	0 0 1	0 0 1
ROT BPID concrete	(X, degrees)	0	-5
ON gr BPID concrete	GRWS frontwheels	(1/0)	1
OROT BPID concrete	GRWS frontwheels	(X X X/cBB, m)	cBB
ROT BPID concrete	GRWS frontwheels	(X X X/cBB, m)	cBB
ROCONT VELROT BPID concrete	GRWS frontwheels	(cBBtoRpTz-V, cBBtoRpTz VInit	shv-
WALL ONALL gr BPID concrete	GRWS frontwheels	(X X/0, K, -	0 0
RF PASS Morph gr BPID concrete	GRWS frontwheels	(1.0/X, 0, 0 0 1	0 0 1
ON gr BPID concrete	GRWS middlewheels	(1/0)	1
OROT BPID concrete	GRWS middlewheels	(X X X/cBB, m)	cBB
ROT BPID concrete	GRWS middlewheels	(X X X/MIV/IMV/MIV3/L, IMIV	shv-
ROCONT VELROT BPID concrete	GRWS middlewheels	(cBBtoRpTz-V, cBBtoRpTz VInit	shv-
WALL ONALL gr BPID concrete	GRWS middlewheels	(X X/0, K, -	0 0
RF PASS Morph gr BPID concrete	GRWS middlewheels	(1.0/X, 0, 0 0 1	0 0 1
ON gr BPID concrete	GRWS rearwheels	(1/0)	1
OROT BPID concrete	GRWS rearwheels	(X X X/cBB, m)	cBB
ROT BPID concrete	GRWS rearwheels	(X X X/MIV/IMV/MIV3/L, IMIV	shv-
ROCONT VELROT BPID concrete	GRWS rearwheels	(cBBtoRpTz-V, cBBtoRpTz VInit	shv-
WALL ONALL gr BPID concrete	GRWS rearwheels	(X X/0, K, -	0 0
RF PASS Morph gr BPID concrete	GRWS rearwheels	(1.0/X, 0, 0 0 1	0 0 1

Cars positioning controlled by parameters inside dataDict.
Independent monitoring of forces.

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ACOUSTICS AND FFT

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- Noise computation from compressible DES cases and FFT (patches and probes).
- Extended variables: pPrimeToMean, meshCutOff, SPL (dB) etc.
- Acoustic propagation: Lighthill-Curle, Ffowcs Williams-Hawkings (FWH).

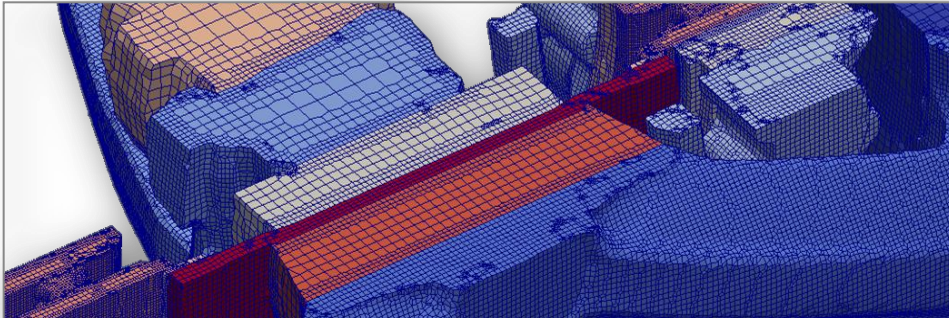
iconCFD MultiCase

ADJOINT, CHT AND VoF

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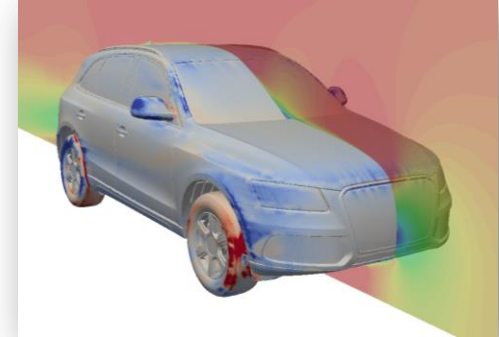
- RANS or DES choice for primal
- Automated morphing setup
- Multiple optimization iteration loops

Geometry courtesy of Audi AG, I/EK-44



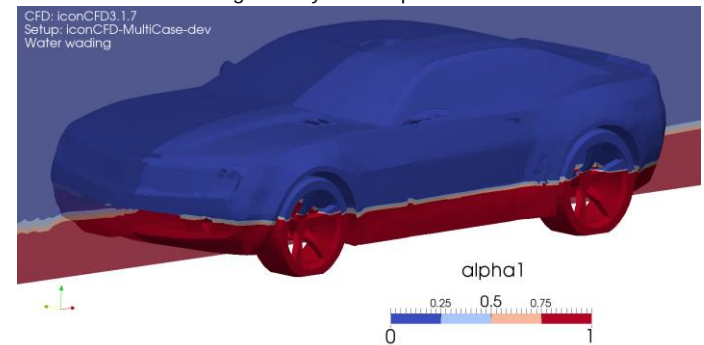
- VoF and dynamic mesh integration
- Template extended to support VoF

Geometry courtesy of Audi AG, I/EK-44



- CHT
- S2S radiation
- User-defined materials database

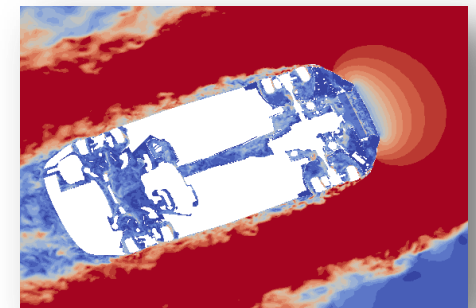
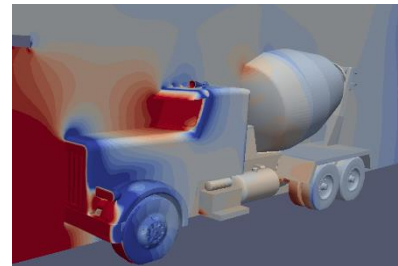
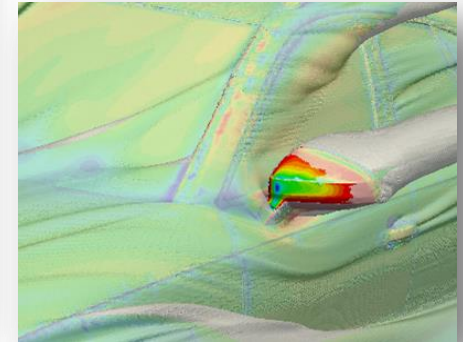
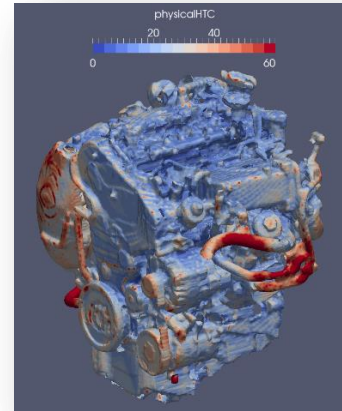
Base geometry from <http://tf3dm.com>



iconCFD MultiCase

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iconCFD MultiCase

AERO DEMO

List of **basic** inputs:

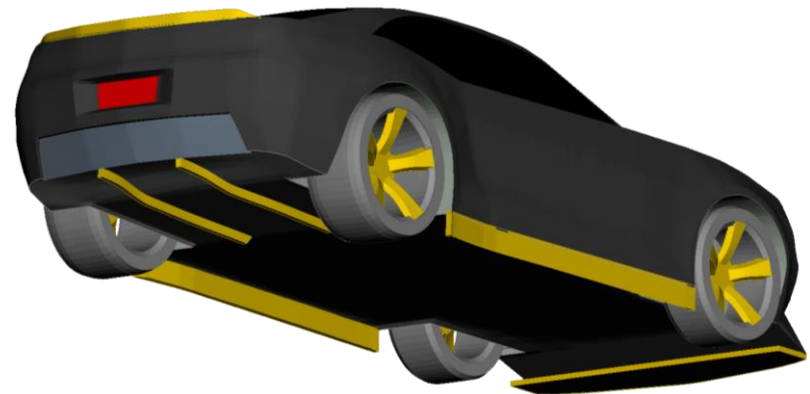
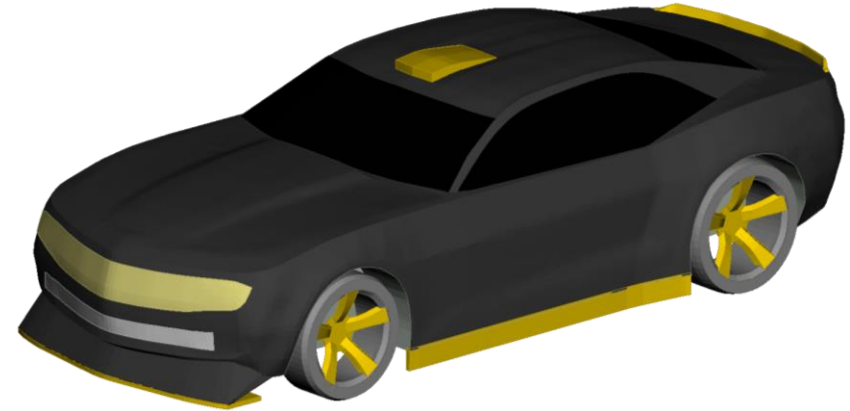
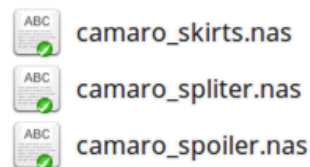
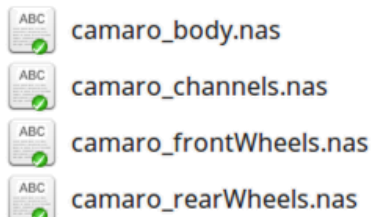
- **Car properties:** refArea, wheelBase, frontTrack, rearTrack and refPoint
- **CFD model:** RANS/DES, SA/RKE/KOSST and timeStep/endTime
- **Material properties:** mainly rho and mu
- **Test conditions:** Inlet velocity and turbulent level (I, L). Friction distance to be used in static case (distance from the center of the WT to the starting friction point)
- **Porosity to be used in heatExchangers:** powerFlow/Fluent/Star formats can be used. If needed, heat map should be defined too
- Number of **cores** and decomposition
- If possible, **group the geometry** in a logical way: e.g. not mix heatExchanger with body parts

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AERO DEMO

CAMARO geometry info:

scaleFactor 1;
referencePoint (0 0 0.03);
frontArea 1.45;
wheelBase 2.32;
frontTrack 1.37;
rearTrack 1.37;
pitchAngle 0;
pitchPoint (0 0 0);
WT box in road condition (40)



Base geometry from <http://tf3dm.com>

iconCFD MultiCase

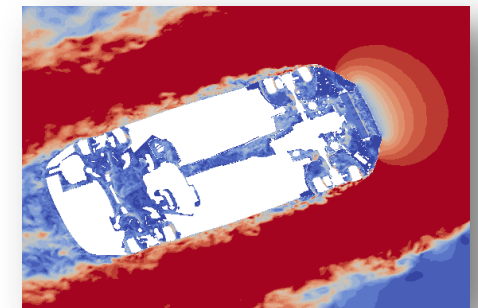
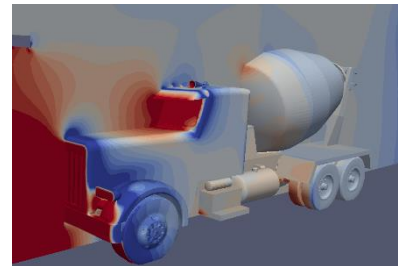
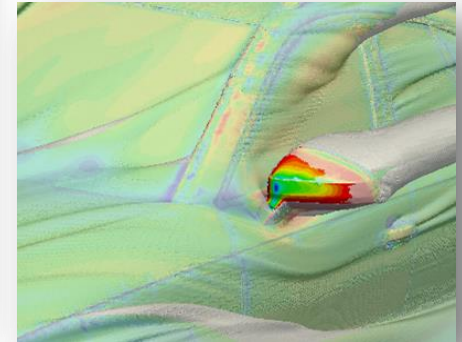
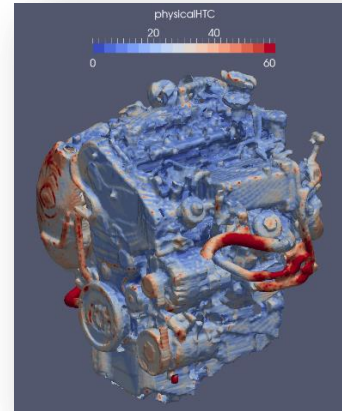
AERO DEMO

- Load geo and setup case using all defaults
- Expand modules: template, turbulence, time and general
 - RANS RKE
 - Pitch car keeping WT flat
 - Set wheels rotation (off) and body (features)/spoiler (mesh) as optional parts
- Upgrade setup to adjoints: activate module and set morph over body
- Clone setup and replace box with realWT with ground movement.
 - Set DES with steady initialization: *steady+trans+adj+morph*
 - Move wheels (on)
 - Add mesh refinement module: apply curvature and proximity
- Add remote queue to setup 2 and keep local for case 1

iconCFD MultiCase

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UH DEMO

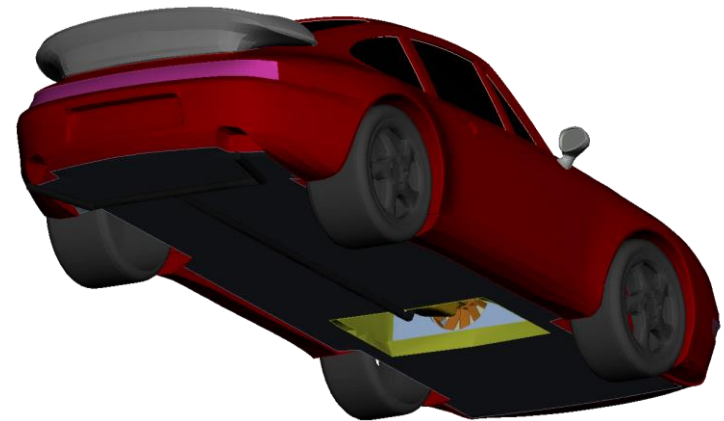
www.iconCFD.com

911 geometry info:

scaleFactor 0.001; PM (table p, Q);
referencePoint (0 0 0); Fan,w 200;
frontArea 2.07; EngineHeat 50000
wheelBase 2.4; WT generic mov (40)
frontTrack 1.45;
rearTrack 1.55;
pitchAngle 0;
pitchPoint (0 0 0);

ABC porsche_car1980_0000_911_body.nas
ABC porsche_car1980_0000_911_coverFan.nas
ABC porsche_car1980_0000_911_engine.nas
ABC porsche_car1980_0000_911_exhaust.nas
ABC porsche_car1980_0000_911_frontWheels.nas
ABC porsche_car1980_0000_911_gfan.nas
ABC porsche_car1980_0000_911_HWK_allExp.dat
ABC porsche_car1980_0000_911_KWK.nas

ABC porsche_car1980_0000_911_mirror.nas
ABC porsche_car1980_0000_911_monitorMirror.nas
ABC porsche_car1980_0000_911_rearWheels.nas
ABC porsche_car1980_0000_911_vfan.nas
ABC porsche_car1980_0000_911_volBigMirror.nas
ABC porsche_car1980_0000_911_volFrontW.nas
ABC porsche_car1980_0000_911_volRearW.nas
ABC porsche_car1980_0000_911_volSmallMirror.nas



Base geometry from http://www.eng.nus.edu.sg/LCEL/RP/u21/wwwroot/stl_library.htm

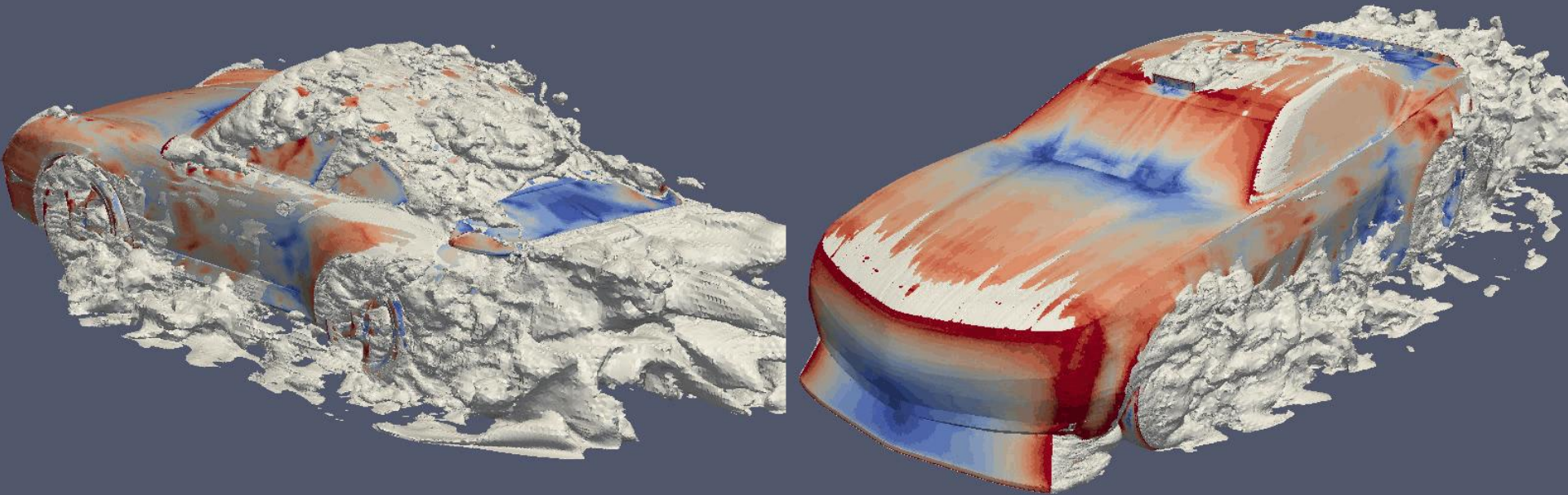
iconCFD MultiCase

UH DEMO

- Load geo and set all states. Comp steady.
 - Set normal PM to later upgrade to heat map with passive scalar
 - Set MRF for the fan
 - Set Wheels for rotation (on)
 - Set engine as BPID and set T and Q over pids
 - Set all vol* parts as VROP(0)
 - Set monitor close to left mirror
- Clone setup and update solver settings
 - Transient. Compressible DES model and inlet velocity. Radiation
 - Share mesh with setup 1
- Add third case as 2D mesh

iconCFD MultiCase DEMOS

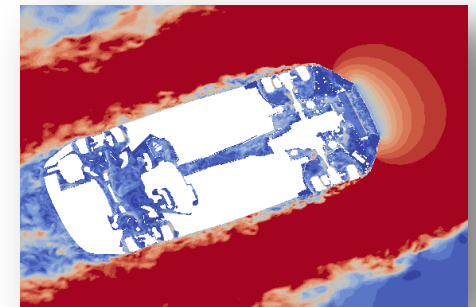
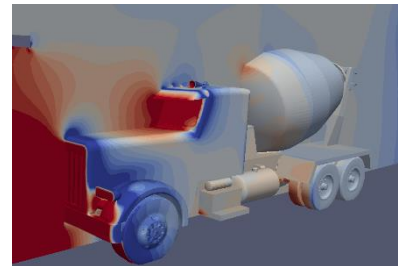
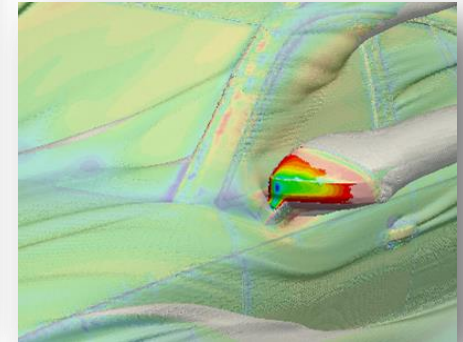
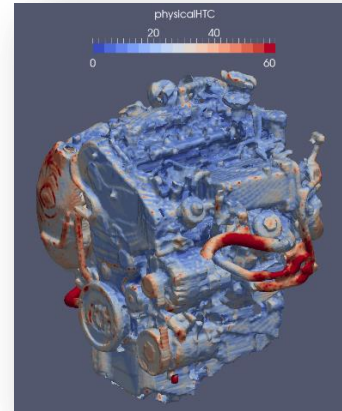
www.iconCFD.com



iconCFD MultiCase

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iconCFD MultiCase

CONCLUSIONS

- An overview of iconCFD MultiCase GUI has been presented:
 - New front-end for iconCFD MultiCase
 - Suited for industrial environments
- Various industrial examples have been shown:
 - Aerodynamics, UHTM & CAA
 - Wading: Volume of fluid with dynamic mesh
 - Adjoint Optimization with iterative loops
 - Conjugate heat transfer with radiation
- AERO and UH demos have been conducted
- iconCFD MultiCase is included unlimited within iconCFD modules.
[Try MultiCase and send us your feedback!](#)

THANK YOU



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