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Advanced Automation and Customisation

iconCFD MultiCase

Pedro Rubio
Software & Methods Developer
p.rubio@iconCFD.com
November 2015

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E. contact@iconCFD.com

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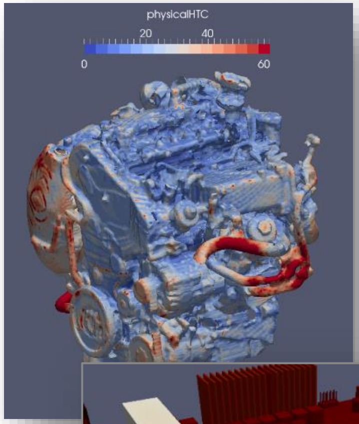
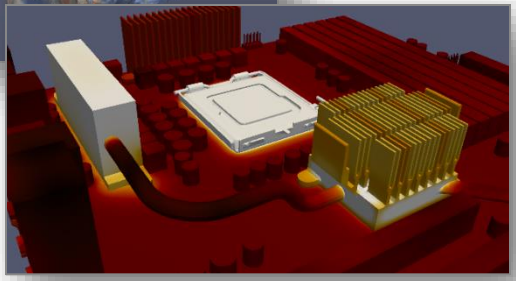
AGENDA

- Overview
- Latest Features
- Advanced Examples
- Conclusions





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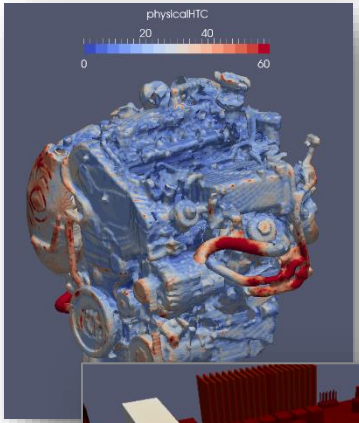

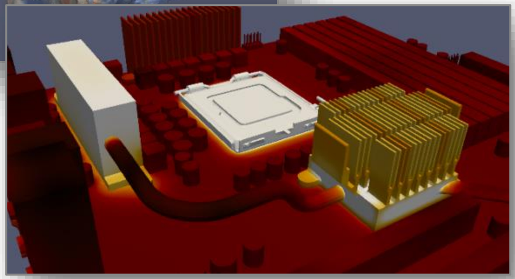

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SUPPORTED CFD PROCESS

Modularized • Industrialized • Customized

iconCFD Process
- GUI
- **MultiCase**

iconCFD Wrap

iconCFD Mesh

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

iconCFD Support & Documentation

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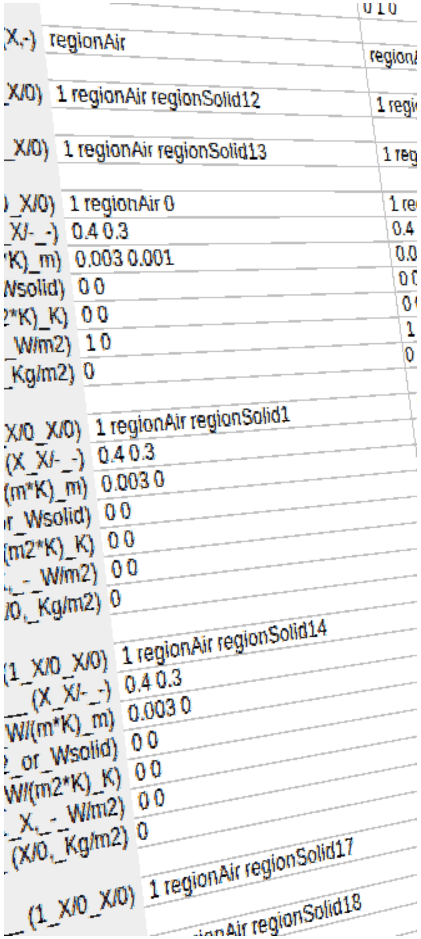
OVERVIEW

- A general purpose CFD pre-processing tool designed for industrial environments
  - In use in several large OEMs for > 7 years
- **Inputs**
  - Multiple cases are specified by populating a table using a spreadsheet or txt file
  - Each column in the table represents a case
  - Every geometry file is assigned a “state” label, which defines its CFD type (e.g. wall , symmetry)
- **Interface**
  - Command line (Windows/Linux)
  - Python API



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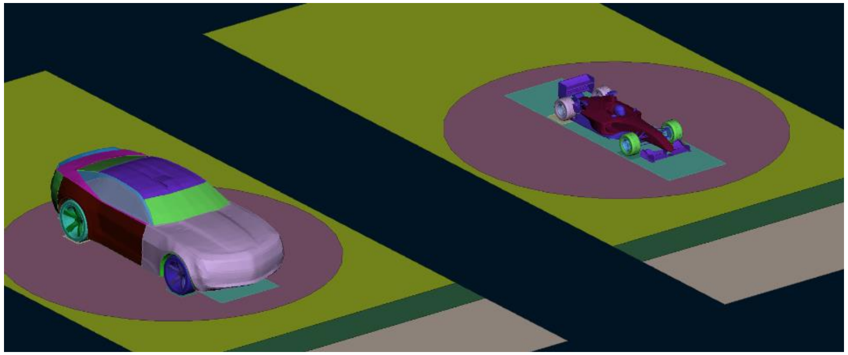
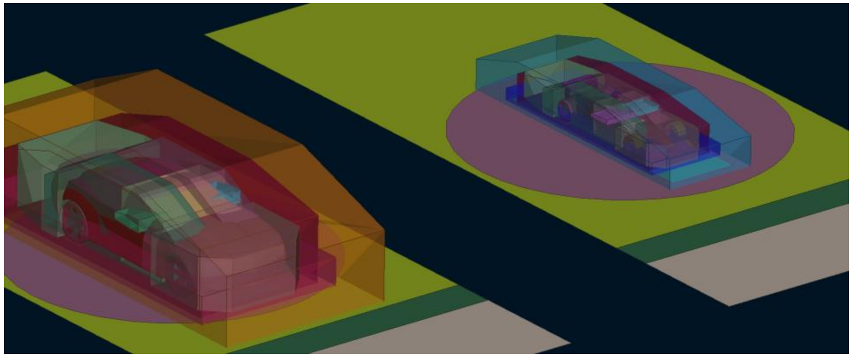
ADVANTAGES

- **Rapid setup of multiple variations of a case**
  - Parametric studies: different inlets velocities, porous media, rpms…
  - Optional geometries / CFD features / setups: ON/OFF
  - Geometric transformations: Automatic translation, rotation and scale of parts.
- **Standard domain templates (e.g. wind tunnel)**
  - User defined database of template geometries: geometry and VRs
  - Each template has different setups e.g.: placement of parts, boundary values…
  - User parametric volume of resolution (based on the geometry dimensions)

Base geometries from http://tf3dm.com

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ADVANTAGES

- **Standardization**
  - User input checks. Case coherency is double checked automatically
  - Input file/pid name “cleaning” and geometry normalization
  - Default domains / materials / best practices shared between all users
- **Efficiency**
  - Automatic creation of auxiliary CFD entities:
    - parametric volume of resolution
    - automatic PLOAD/eMesh geometries
    - automatic transformations and measurements
  - Multithreaded to speed up big assembly preparation

- **Customization**
  - The pythonAPI/configDefaults allows total user control.
- **Robustness**
  - A case prepared with iconCFD MultiCase should run without problems

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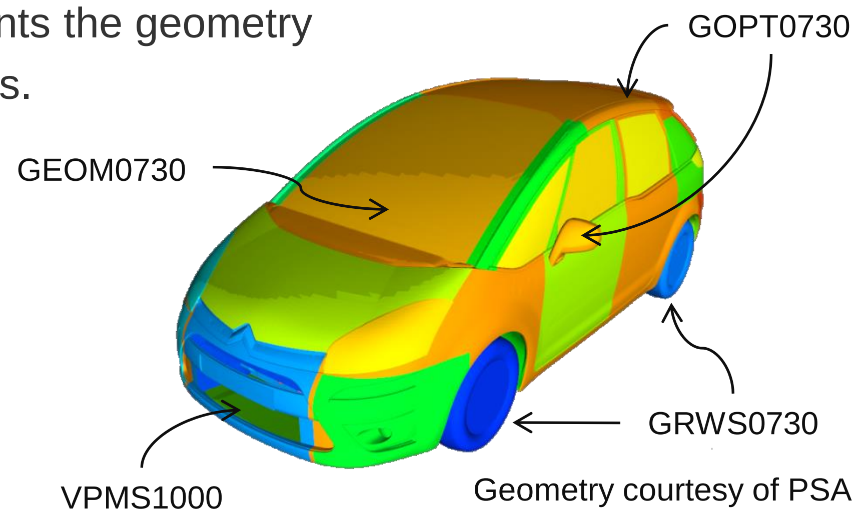
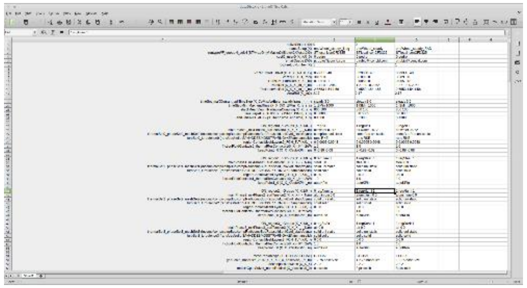
USAGE

1. Input geometry preparation:
   - Collection of stl/nas files that represents the geometry
   - Each file is a group of “close” surfaces.
2. Execute iconCFD MultiCase
   - Enter the input geometry
   - Define their CFD states labels:
     - GEOM, GOPT, GRWS, GMRF
     - VMRF, VPMS, VRES, VROP
     - BPID, SREP…
3. Fill the setup table
   - Default values can be customized
   - “Copy/paste” of columns helps reduce setup time
4. Finally, MultiCase will create a folder per setup
   - Each case is ready to run



Geometry courtesy of PSA



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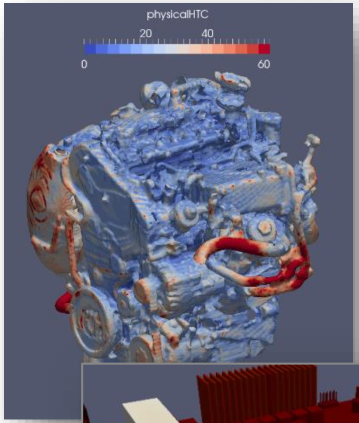

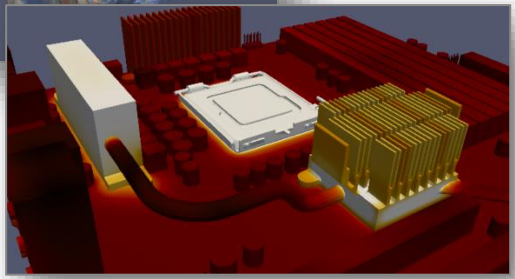

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LATEST FEATURES

- iconCFD Module integration
  - **iconCFD-Thermal:**
    - Buoyancy and Radiation(S2S).
    - CHT with automatic keepPoints and material dataBase.
    - Dual streams (Heat exchangers)
  - **iconCFD-Wrap:**
    - external and internal
  - **iconCFD-Optimize:**
    - shape (iterative loops) and topo optimization
  - **iconCFD-Mesh:**
    - Mesh/solver redistribution
    - extrudeMesh and AMI.
  - **iconCFD-VoF:**
    - Integration with templates.
  - PreCase initialization:
    - steady to transient. GroovyBc and configDict.

Base geometry from http://tf3dm.com

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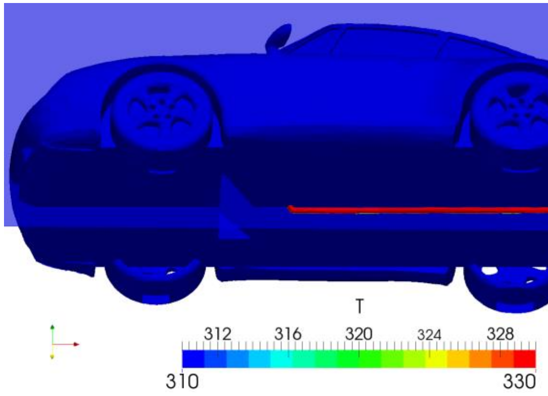
LATEST FEATURES

- Remote computing (Cloud)
  - Main queue systems supported: Torque, PBS, LSF, sunGrid
  - Queue database. User selects one in the dataDict

```
                     activeSetup (1/0) : 0
                       nameSetup (X) : Anl_mBoSi
(ST/wrapOnly/lMasterX/lSlaveX,X/local,X/0) : ST cerberus iconCFD325
                  costC_userQ (X_X/0_0) : 0 pedro
                     emailQueue (X/0) : p.rubio@iconcfd.com
                     DEFsetupNumber (X) : 1
```

- User defined workflow database
  - MapCases: coarseToFine, ransToDes
  - Master/Slave: share mesh with efficient job dependency (queue)
  - Iterative adjoints: RAS and DES+mapping optimization
  - Iterative Radtherm coupling



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

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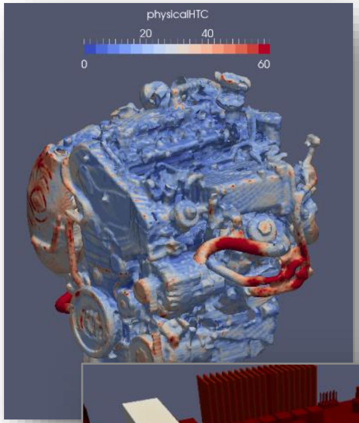

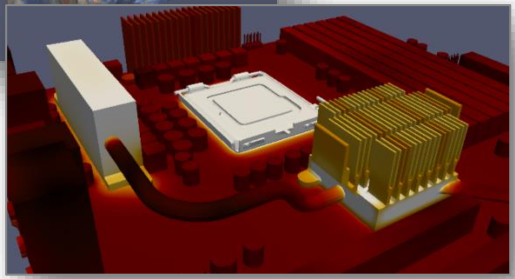

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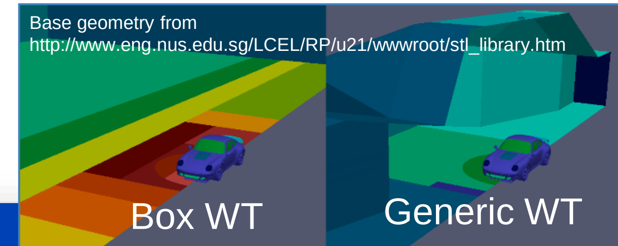
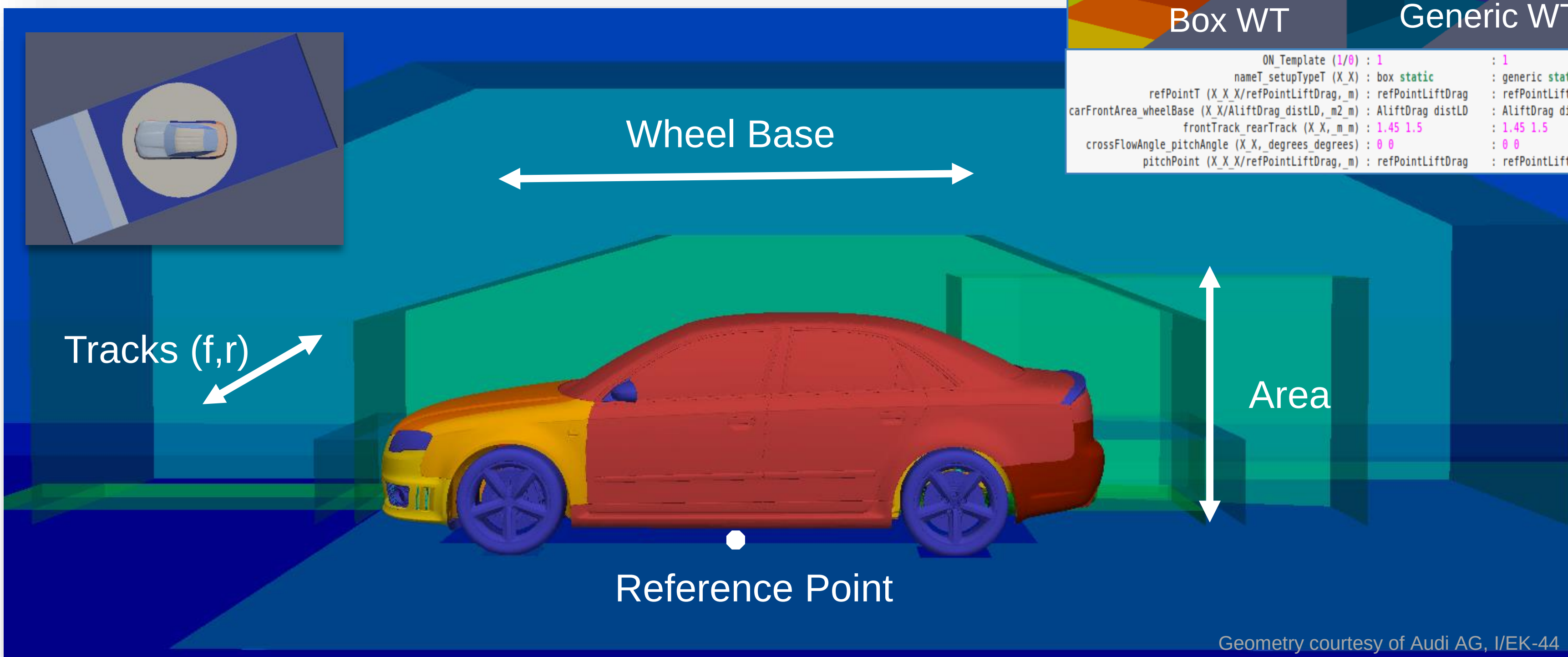
WIND TUNNEL TEMPLATE

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




```
ON_Template (1/0) : 1 : 1 :
nameT_setupTypeT (X_X) : box static : generic static :
refPointT (X_X_X/refPointLiftDrag,_m) : refPointLiftDrag : refPointLiftDrag :
carFrontArea_wheelBase (X_X/AliftDrag_distLD,_m2_m) : AliftDrag distLD : AliftDrag distLD :
frontTrack_rearTrack (X_X,_m_m) : 1.45 1.5 : 1.45 1.5 :
crossFlowAngle_pitchAngle (X_X,_degrees_degrees) : 0 0 : 0 0 :
pitchPoint (X_X_X/refPointLiftDrag,_m) : refPointLiftDrag : refPointLiftDrag :
```



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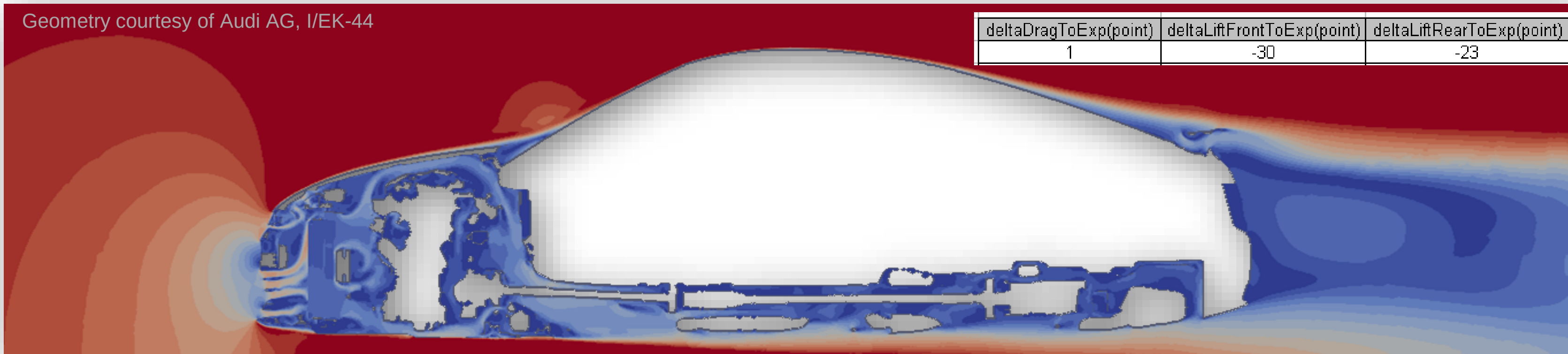
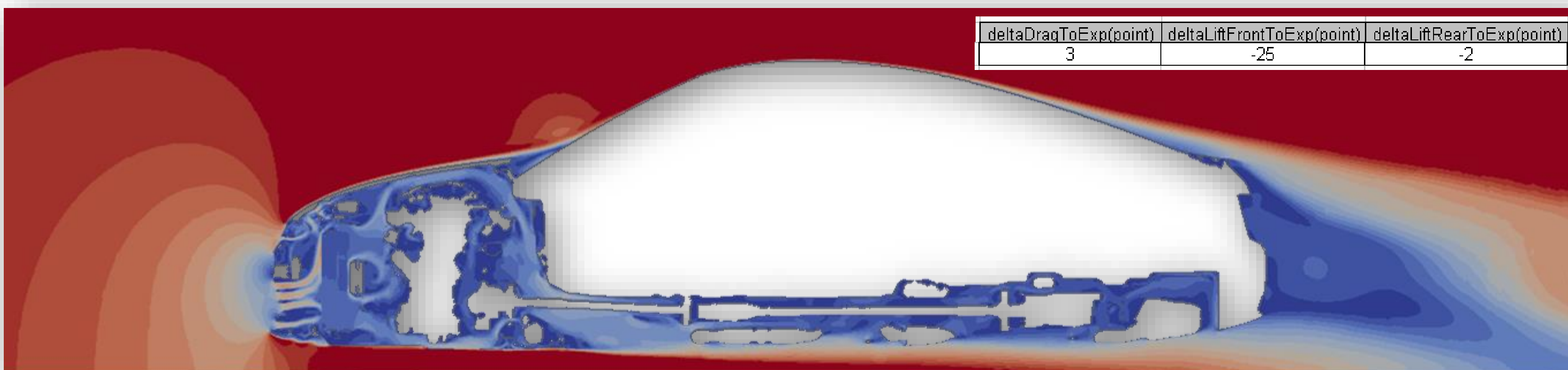
AERO SPOILER DELTA





Easy selection of optional parts between setups: 1/0

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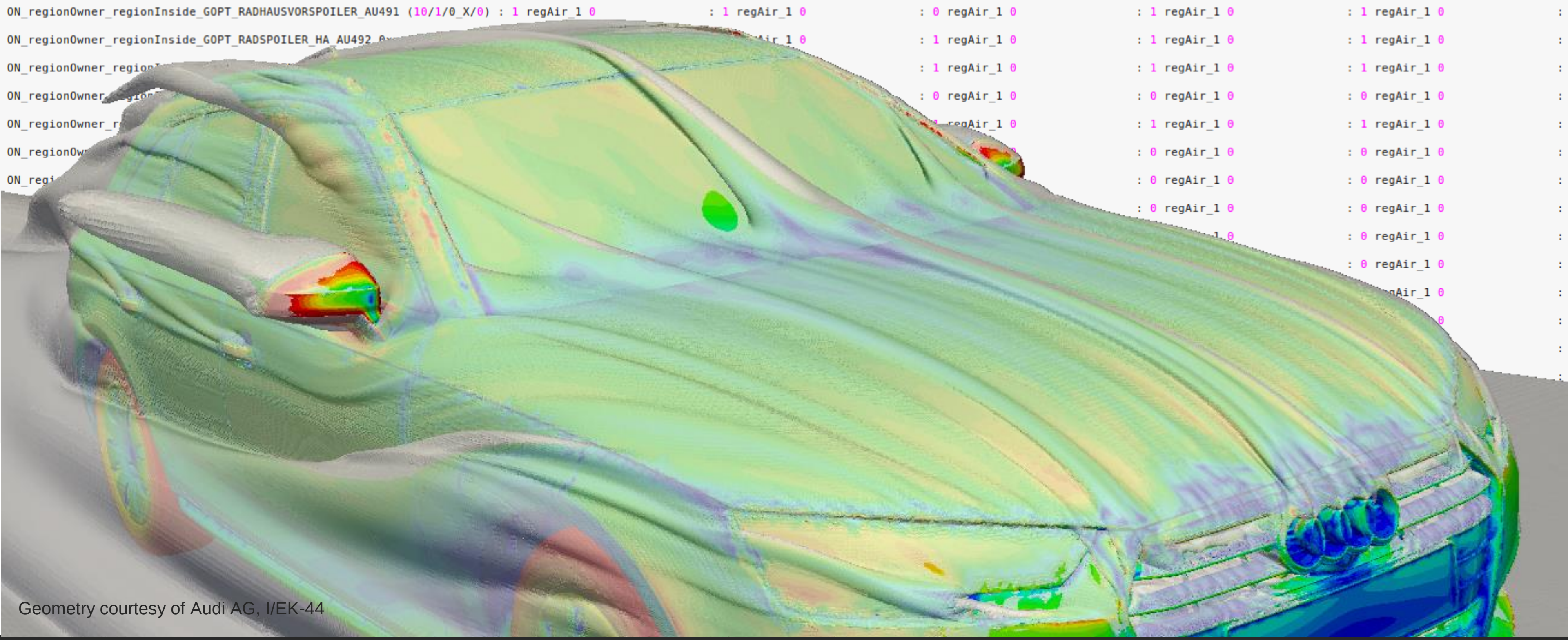
AERO DELTAS

- Different spoilers/covers tested in a single dataDict.
- Good global overview without human errors.

Setups	deltaDragToExp(point)
Case1_refCase	3
Case2_Uhflaps	1
Case3_radSpoilers	4
Case4_rearUnderBodyCovers	0



Geometry courtesy of Audi AG, I/EK-44

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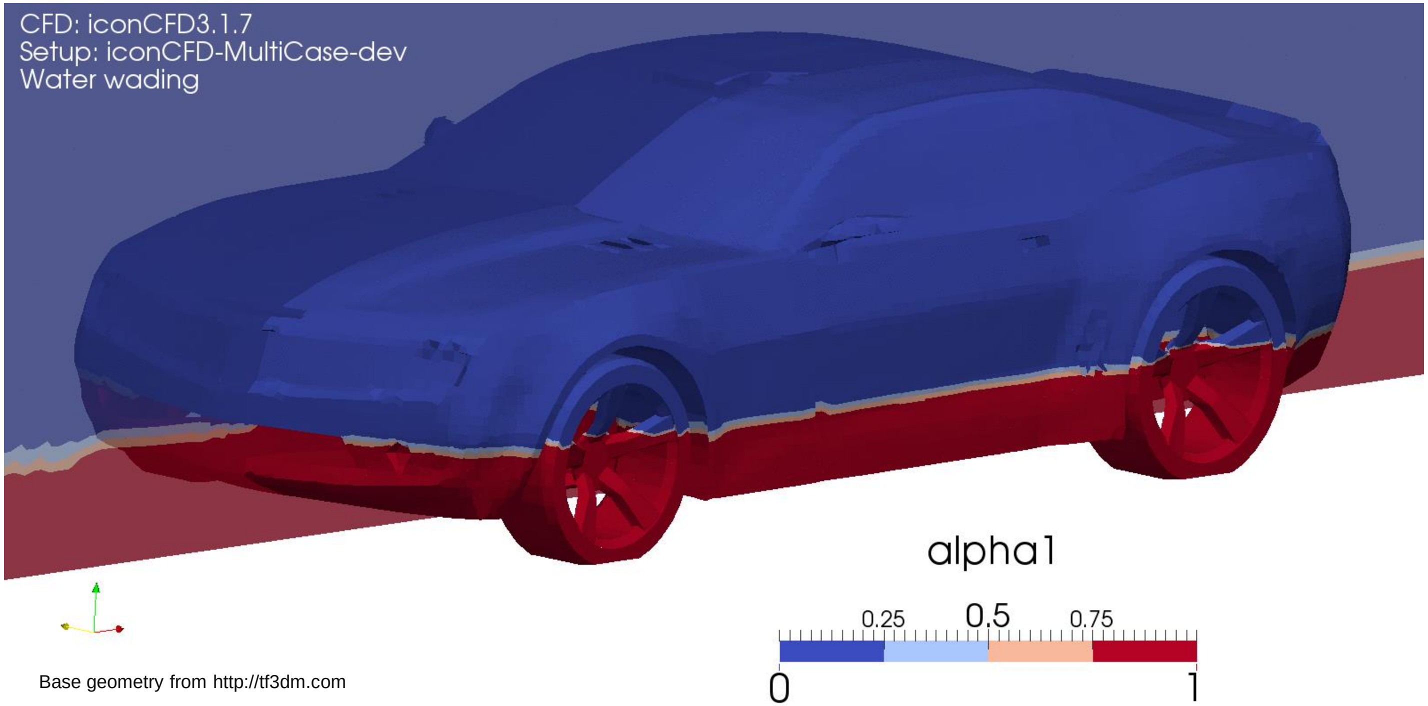
WADING WITH ROTATING WHEELS

- VoF analysis has been integrated inside MultiCase
- Complex setups like wading are easy to prepare
    - Simply select wading template and set AMI rotation for wheels.



Base geometry from http://tf3dm.com

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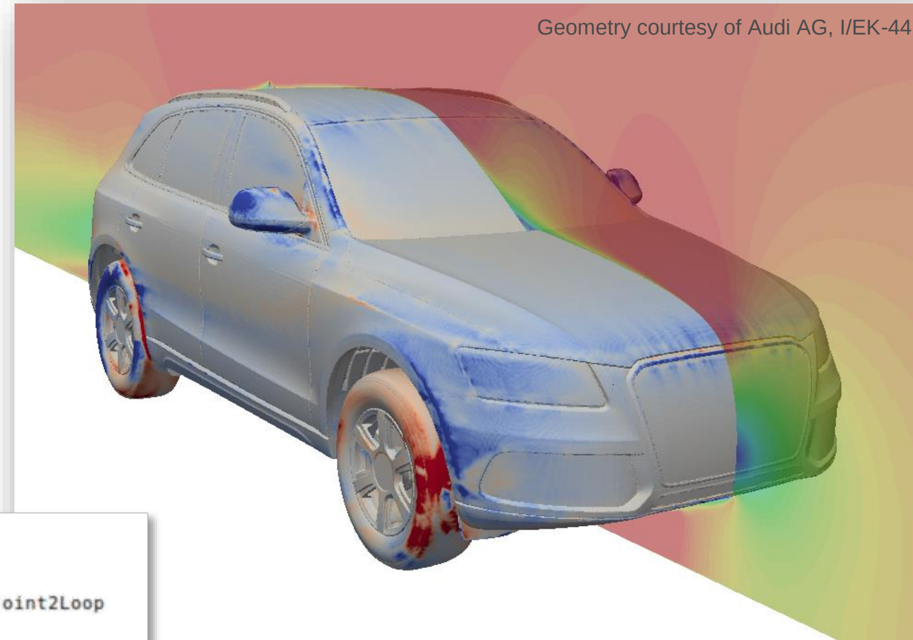
ADJOINT OPTIMIZATION

Optimize module fully supported

From a primal RANS or DES solution, the user can run the adjoint solver and morph the input surfaces in an iterative way.

- RANS or DES choice for primal
- automated morphing setup
- multiple optimization iteration loops




```
                  activeSetup (1/0) : 1
                     nameSetup (X) : camaroOpt
  runtypeWF (ST/wrapOnly/lMasterX/lSlaveX/X) : mapCaseAdjoint2Loop
          queueN_softN (X_X/local_0) : local 0
             costC_userQ (X_X/0_0) : 0 0
                 emailQueue (X/0) : 0

        ON_GOPT_camaro_spoiler_________ (1/0) : 1
 amaro_spoiler_________ (ensight/VTK/0_X/0,-_-) : 0 0
 SE_FTEN_GOPT_camaro_spoiler_________ (1_1/0_0) : 0 0
  ON_Morph_GOPT_camaro_spoiler_________ (2/1/0) : 2

          ON_adjointsType (ASSD/ATSP/0) : ASSD
intMorph/Geometry/SurfaceMesh/geometryMorpher) : 1 geometryMorpher
```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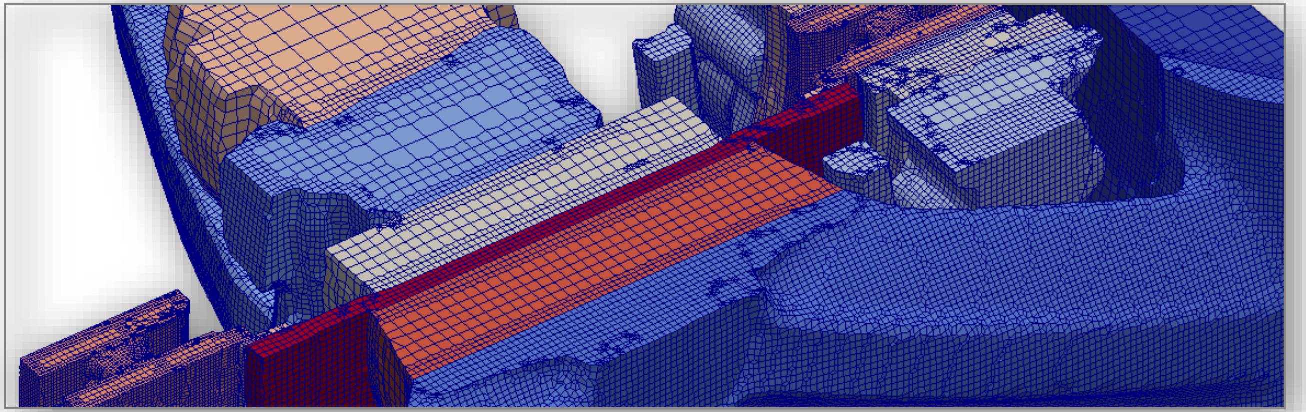
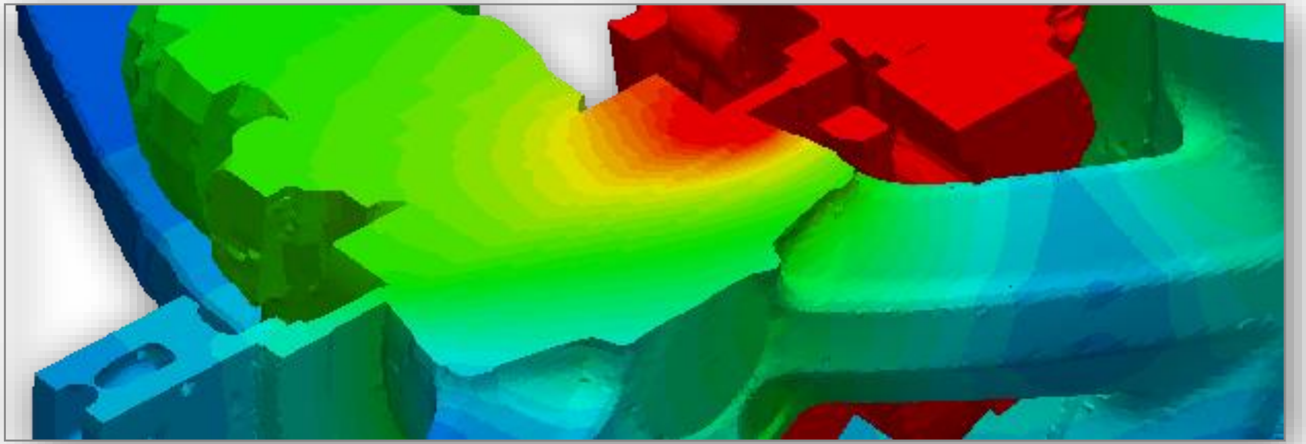
BRAKE COOLING

- CHT
- S2S radiation
- User-defined materials database



Geometry courtesy of Audi AG, I/EK44



CHT interfaces are managed automatically (no user-defined keep points required)

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UHTM KEY-OFF

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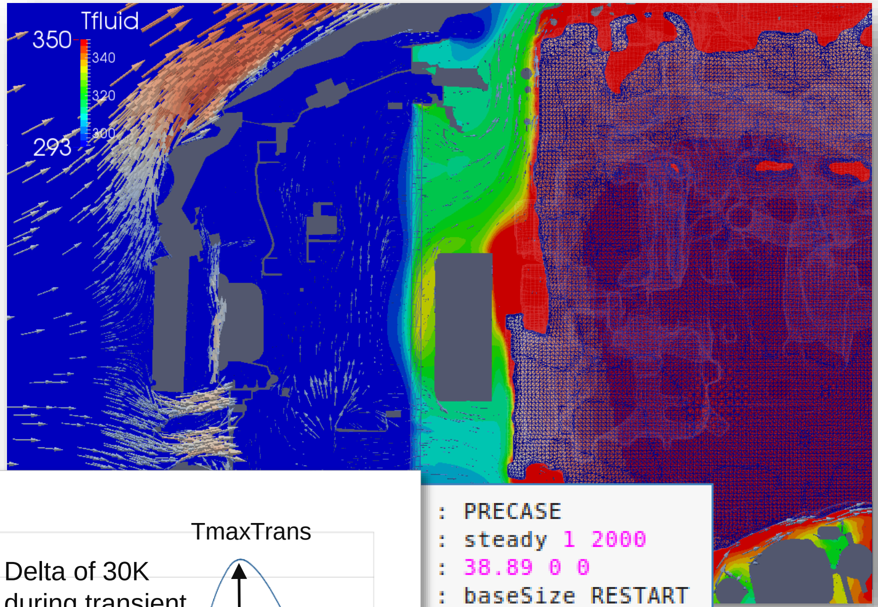
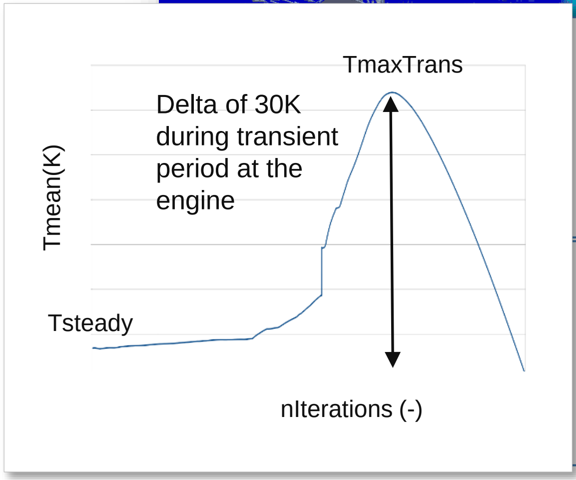
Geometry courtesy of Audi AG, I/E-44



Thermal inertia causes temperature increase when the engine is stopped

Steady state CHT followed by a transient CHT simulation is a good approach to estimate maximum transient temperature inside the UH compartment

MultiCase allows this type of study in a single setup




```
: PRECASE
: steady 1 2000
: 38.89 0 0
: baseSize RESTART
: trans 3 CoMax
: 0.0001 tSMin 2010
: 1500 100
```

```
: 10 regAir_1
: MIV3
: MIV2
: LW
: 0.1 425
: 0.15 9
: 0
```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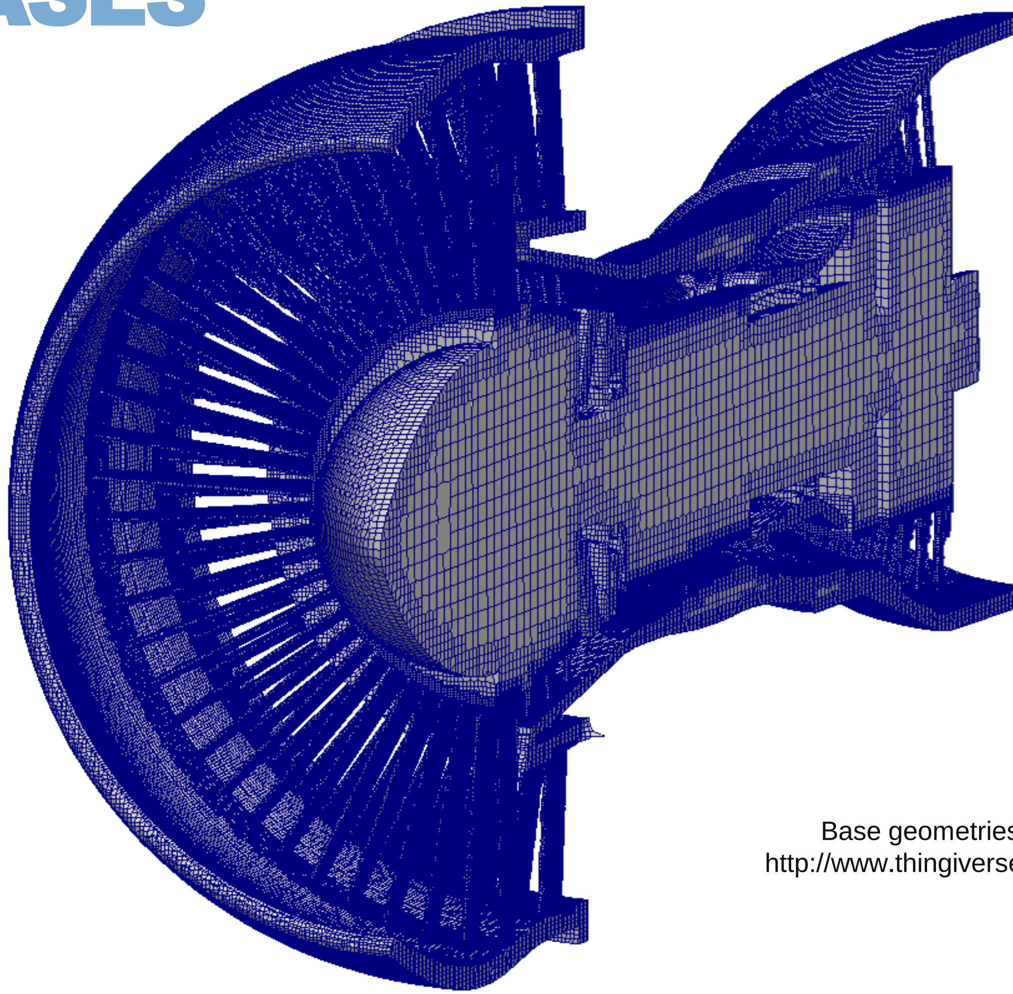
LARGE CHT CASES

It is quite complex / impossible to manually set up CHT cases with a large number of regions:

- Huge number of files
- Prone to human error



Base geometries from http://www.thingiverse.com

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ELECTRONIC MOTHERBOARD

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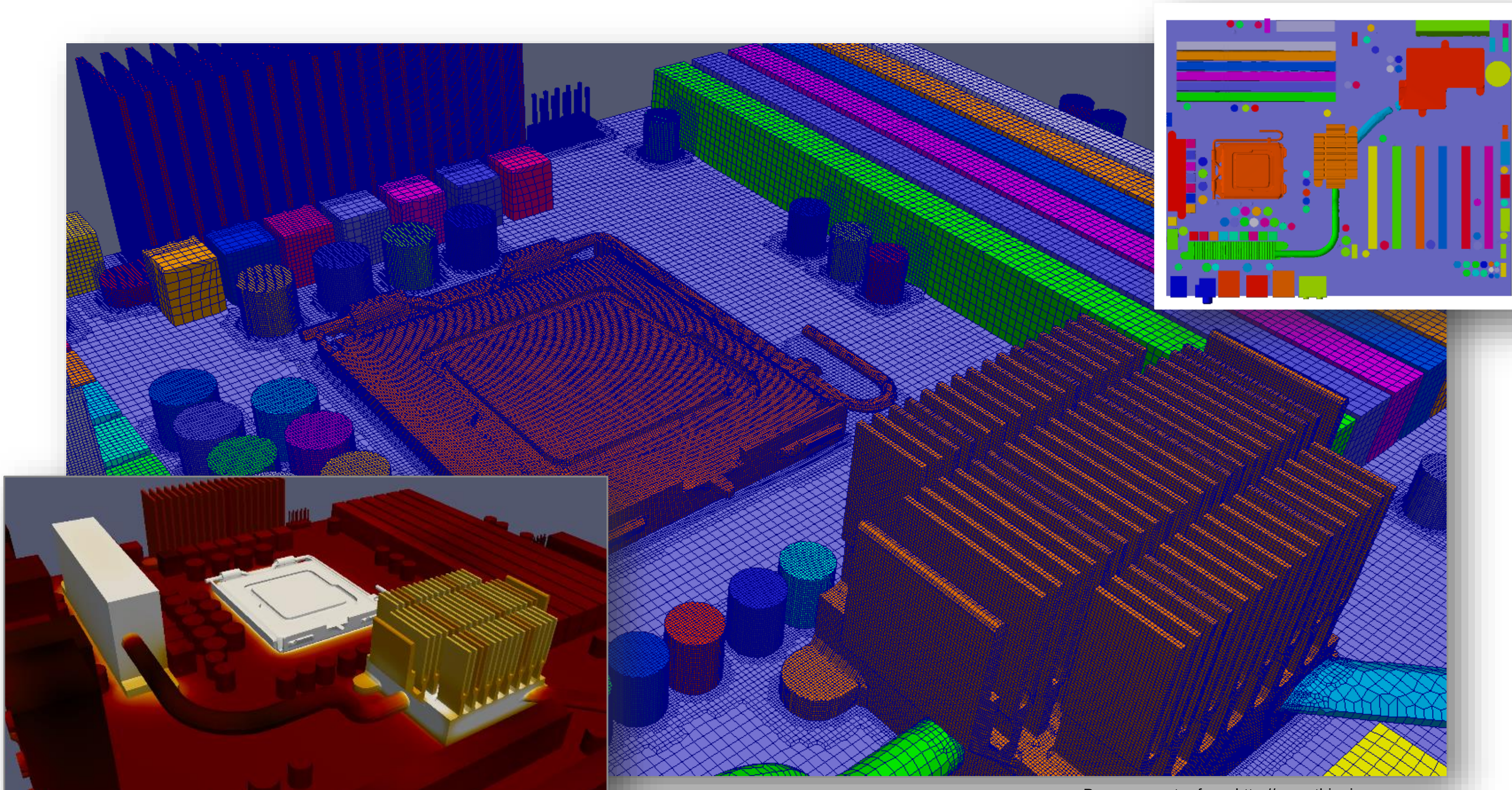
131 regions



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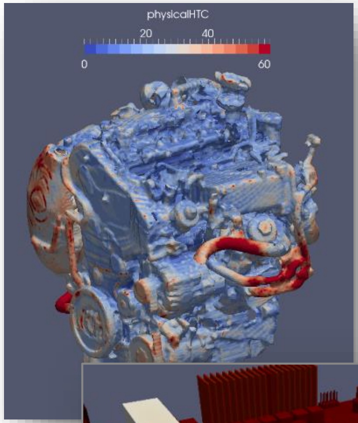

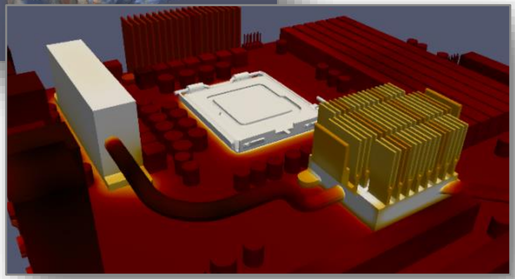

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CONCLUSIONS

- The main features of iconCFD MultiCase have been presented:
  - Reliable working system for more than 7 years
  - Suited to industrial environments

- Various industrial test cases demonstrate the efficiency of the tool:
  - Aerodynamics & UHTM
  - Wading: Volume of fluid
  - Adjoint Optimization
  - Conjugate heat transfer with radiation

- iconCFD MultiCase is included unlimited with iconCFD modules
  - Try MultiCase and send us your feedback!

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THANK YOU

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

print green

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