# iconCFD® v4.0 New Features

A summary of the new features which will be available in iconCFD 4.0



David Winkler d.winkler@iconcfd.com November 2017



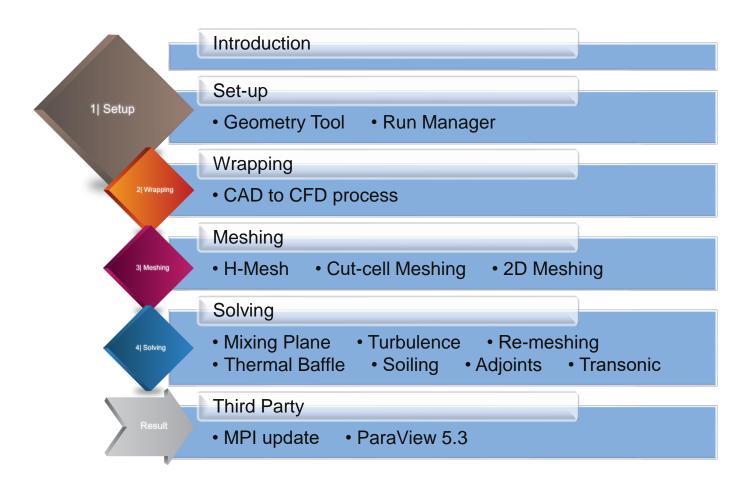




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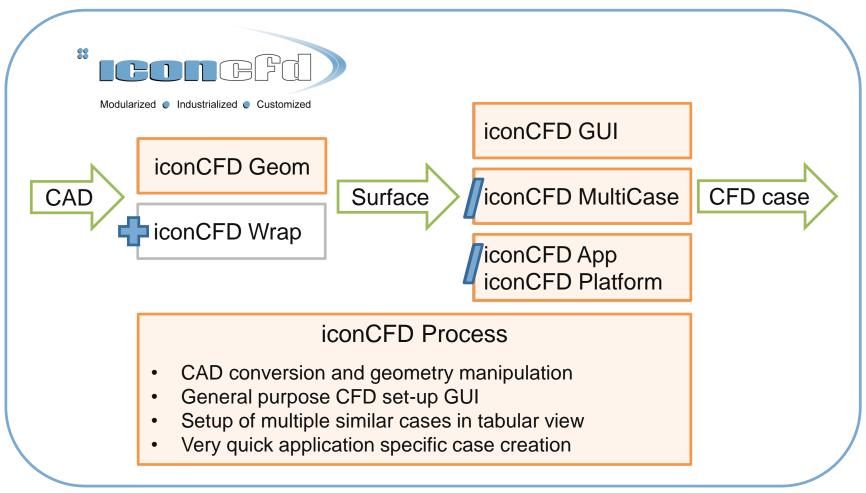
### iconCFD v4.0 Agenda





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### iconCFD PROCESS CASE SETUP WORKFLOW





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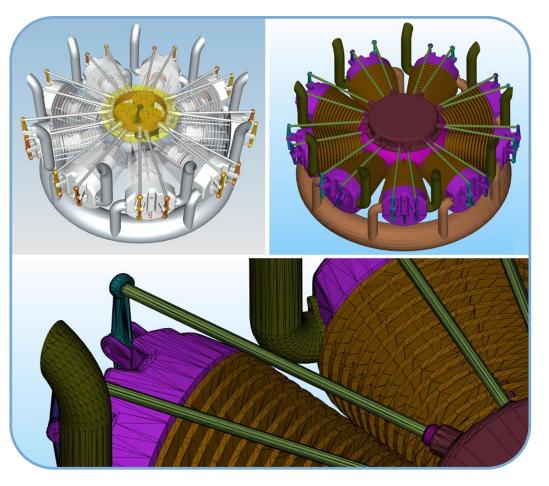
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# iconCFD PROCESS GEOM TOOL

#### Geometry pre-processing

1| Setup

- Import and triangulate CAD data
  - IGES, STEP, JT
- Modify triangulated surface data
  - STL, VTK, NASTRAN, OBJ
  - Assign patch IDs
  - Transform and copy parts
  - Detect and stitch leaks
  - Fill holes, connect edges
  - Manipulate surfaces
  - Adjust surface normals





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**GEOM TOOL** 

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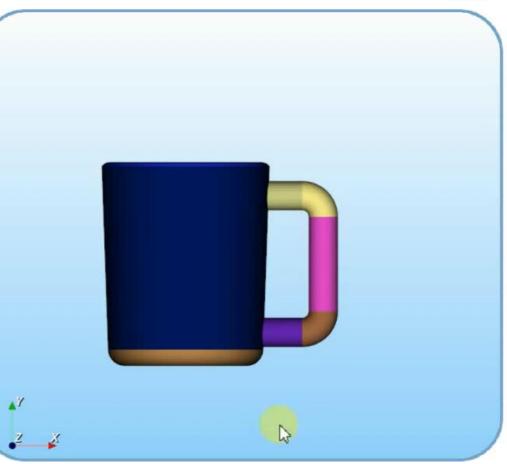
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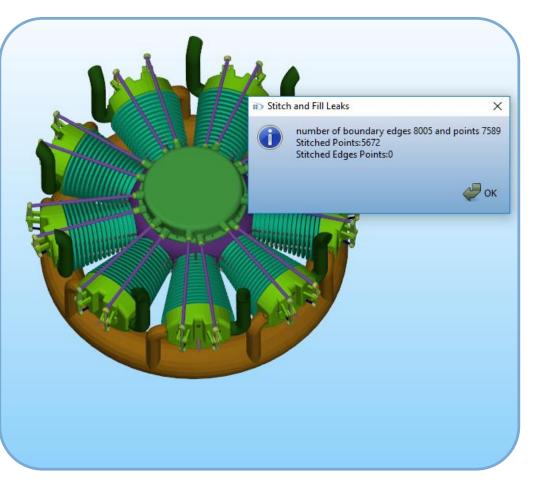
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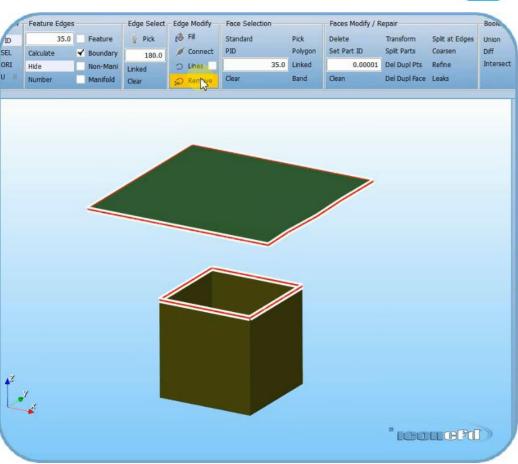
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1| Setup

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# **ICONCED PROCESS** GEOM TOOL



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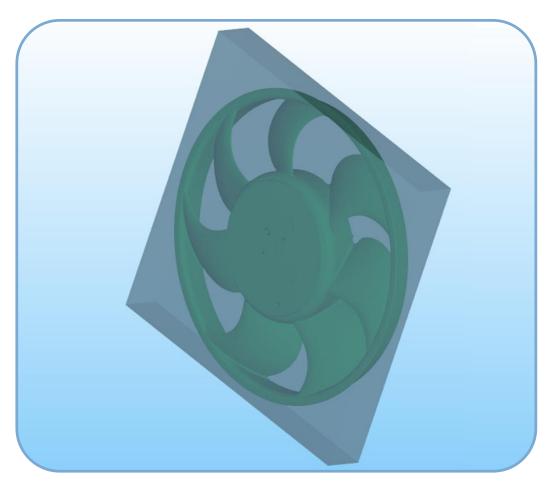


# **ICONCERS PROCESS** GEOM TOOL

Geometry pre-processing

1| Setup

- Create surfaces for computational domain, cell or face zones
  - (Rotated) Bounding box
  - Convex object around part
  - Surface offset
  - Rotational volumes
- Support Aero-CFD case setup with calculations of
  - Distance
  - Projected frontal area
  - Surface area and normal
- Surface morphing
  - Based on adjoint sensitivities





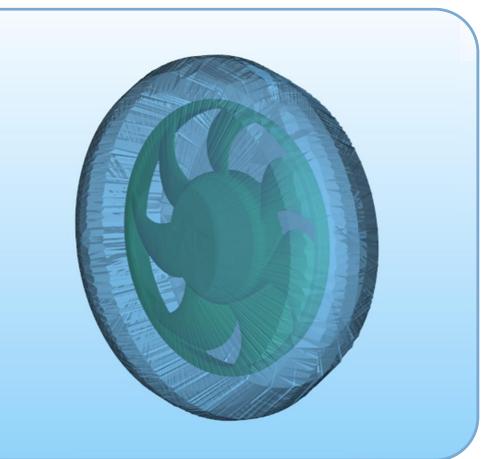
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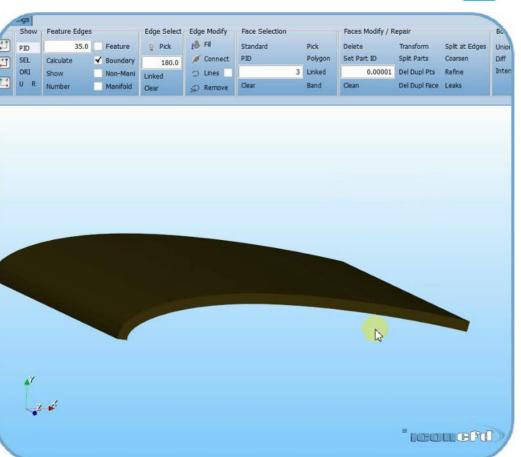
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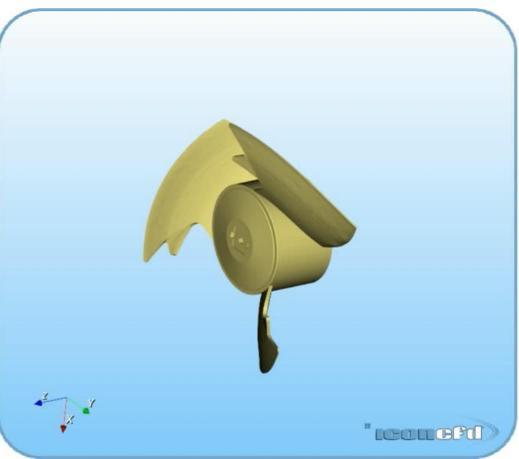
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	Front Right	0.0069925	0.760271	7.49528e-06				
(Str)	Rear Left	2.79319	-0.763432	-5.00679e-06				
	Rear Right	2.79317	0.763432	-9.98378e-07				
	Front Track	1.52054						
	Rear Track	1.52686						
<b>v</b>	Wheel Base	2.78618						
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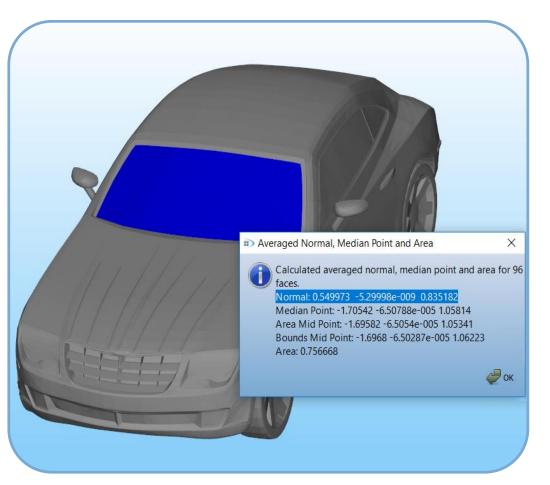


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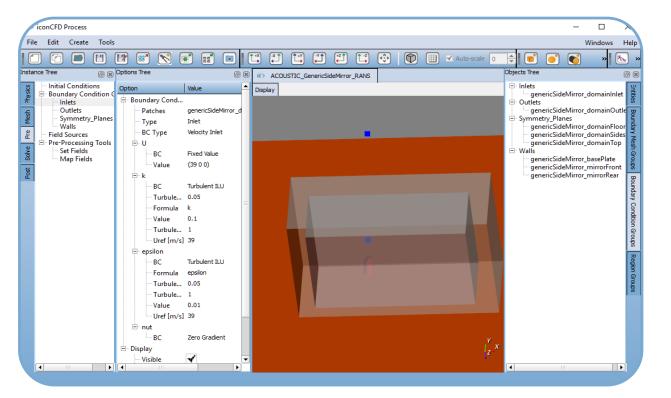


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### iconCFD PROCESS ICONCFD GUI

#### Purpose:

- Set up (mesh and solver) and run iconCFD cases



#### New Key Feature: Run Manager

- Resource Library
- Job and Workflow Libraries
- Python API



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### **iconCFD PROCESS** GUI – RUN MANAGER

#### Resource Library:

1| Setup

- Definition of resources, i.e. specifications of machines to submit to, how to run, etc.

Resource Library	- 🗆 X	<ul> <li>Host settings</li> </ul>
abc Image: Comparison   Remote Host Information   Host Name :   192.168.254.10   User Name :   punit	ð ð	<ul><li>Job settings</li><li>Submit script</li></ul>
Password :       •••••••       ••       (?)         Connection Command :       C:\\Programs\\Applications\\PuTTY\\plink.exe       ••       (?)         Scp Command :       C:\\Programs\\Applications\\PuTTY\\psc.exe       ••       (?)         Zip Command :       C:\\Programs\\Utilities\\7-Zip\\72.exe a       (•)       (?)		<ul> <li>Set-up by IT or expert user</li> </ul>
Max MPI Ranks Per Node : 8 Num Nodes : 16 File Management Settings		<ul> <li>Script editor</li> <li>Detailed help menu</li> </ul>
Scratch Path : /users/terra02/punit Path Equivalence : (→) (⑦) Job Script Settings		<ul> <li>Examples</li> </ul>
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### **iconCFD PROCESS** GUI – RUN MANAGER

#### • Job Library:

1| Setup

- Generic interface to allow specification of job types

Job Library		- 🗆 X
Default	<u> </u>	🗐 🚺 🗅 🍘 🗒
Command	Options	Туре
1 blockMesh		serial 💌
2 decomposePar		serial 👻
3 iconHexMesh	-parallel	parallel 👻
4 checkMesh	-parallel	parallel 👻
5 changeDictionary	-parallel	parallel 👻
6 distributeFields	-from 0.org	serial 👻
7 iconCellLimiter	-parallel	parallel 👻
8 iconSimpleFoam	-parallel	parallel 👻
9 foamToVTK	-latestTime -parallel	parallel 👻

 List of commands to run a single job

Add Delete Last Delete Selected



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### **iconCFD PROCESS** GUI – RUN MANAGER

#### Workflow Library:

1| Setup

Generic interface to allow specification of workflow types

Workflow Library					- 0		Х
DistributedWorkflow	• e •	e 🖊 🗅 🛙	•	Path	C:\Users\Punit Nayyar\.iconCFD-GUI\workflows\DistributedWorkflow.ict		
Exposed User Parameters					Workflow Script		
Name	Default				echo Running workflow	-	Ø
					{{resource.preCommands}}		đ
					# Number of Nodes export NNODEs=\$(cat hostfile   wc -I) echo NNODEs=\$(NNODEs)		0
					<pre># Copy case(s) to each node homePath=\$PWD dos2unix hostfile for i in \$(findtype f -name "{{resource.jobScriptFileName}}"); do</pre>		
					caseDir=\$(dirname \$i) echo \$caseDir		
					cp hostfile \$caseDir cd \$caseDir chmod u+x *Case		
					for i in \$({{resource.hostfileCommand}}); do echo Copying case to node \$i scp -r{\$caseDir {{resource.userName}}@\${i}:{{resource.scratchPath}}. >/dev/null done		
					cd {{resource.scratchPath}}/\$caseDir/ dos2unix {{resource.jobScriptFileName}} echo Running case \${caseDir} ./{{resource.jobScriptFileName}} >/dev/null	-	

- Multiple simulation jobs in one run
  - Sequential jobs
  - Steady transient
  - Primal adjoint
- Set-up by expert user
- Important parameters exposed to user



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### **iconCFD PROCESS** GUI – RUN MANAGER

#### Run Manager:

1| Setup

Main interface

n Manager	-	
Logs Status Monitor		
		6
source 🗾		
Type Single Job 🗾		
/Workflow 🗾		
bmiDobScript deanJobScript fetchJob Script runCase Script cleanCase Script		
Edit		
@echo off SET CaseDire SET CaseName= SET CaseName= SET ScratchPath= SET NorkName= SET NorkName= SET RunScript= SET WorkNowScriptFilePath= SET ConnectionCommand= SET ScpCommand= SET ZipCommand= SET ZipCommand= SET ZipCommand* "%ConnectionCommand%" %HostName% -1 %UserName% -pw exit f exist "%WorkNowScriptFilePath%" copy "%WorkNowScriptFilePath%" "%CaseDir%\" %ZipCommand%" 4%UserName% -pw "%CaseDir%\" %ZspCommand%" 4%UserName% -pw "%CaseDir%\" %ZspCommand%" 4%UserName% -pw "%CaseDir%\" %ScpCommand%" 4%UserName% -pw "%CaseDir%\" %KipCommand%" 4%UserName% -pw "%CaseDir%\" %KipCommand% -pw "%CaseDir%\" %Ki		
f not exist "%WorkflowScriptFilePath%" echo In Single Job Mode f not exist "%WorkflowScriptFilePath%" "%ConnectionCommand%" %HostName% -I %UserName%		

- Select case path
- Pick resource
- Pick job/workflow type
- Submit job
- Scripts can be edited
- Python API: main components of Run Manager can be invoked by user in Python script



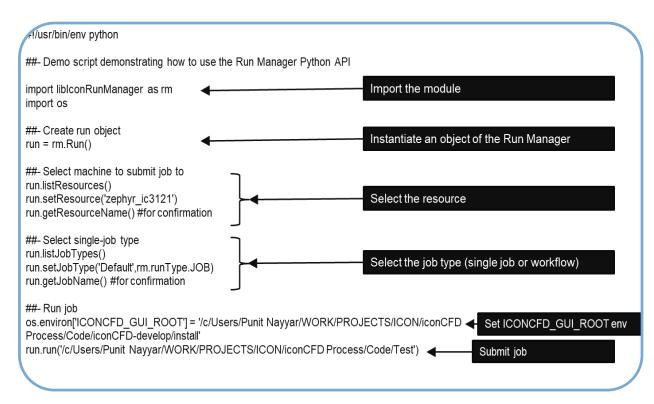
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### **iconCFD PROCESS GUI – RUN MANAGER**

#### Run Manager:

1| Setup

Main interface

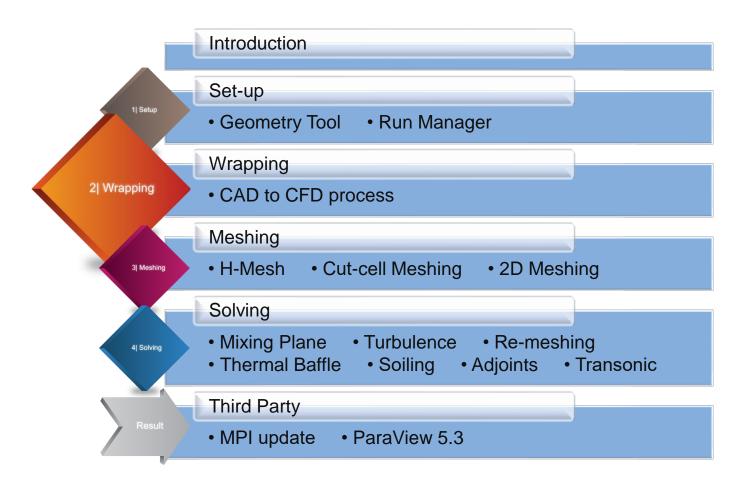


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### iconCFD v4.0 Agenda





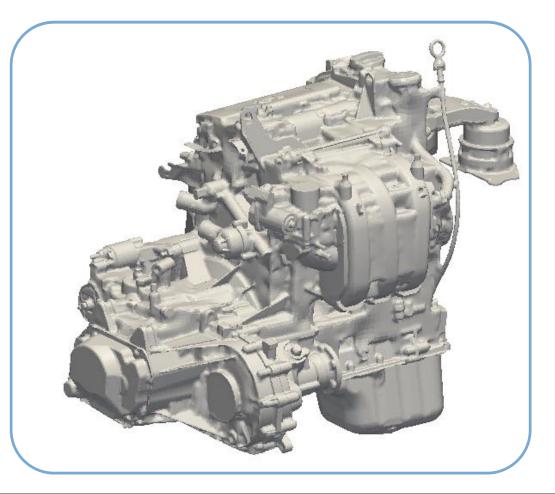
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# iconCFD WRAP CAD TO CFD PROCESS

#### CAD to CFD

2| Wrapping

- CAD triangulation and minimal surface mesh preparation with iconCFD Geom
- Automatic surface wrapping with iconHexMesh-based approach in iconCFD Wrap
- Case creation with iconCFD Gui or iconCFD MultiCase
- Hexa-dominant meshing with iconCFD Mesh





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### iconCFD WRAP CAD TO CFD PROCESS



#### SUMMARY from CAD to CFD:

CAD Preparation = 15min Wrapping = 2h16min Case creation = 5min Meshing= 1h37min

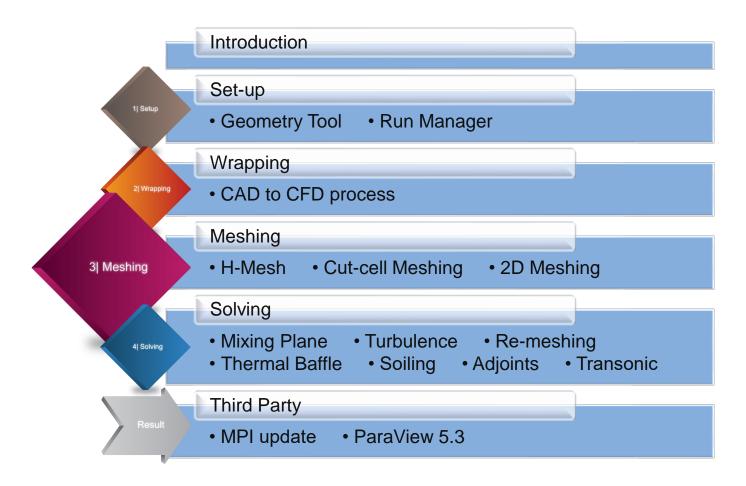
TOTAL = 4h14min



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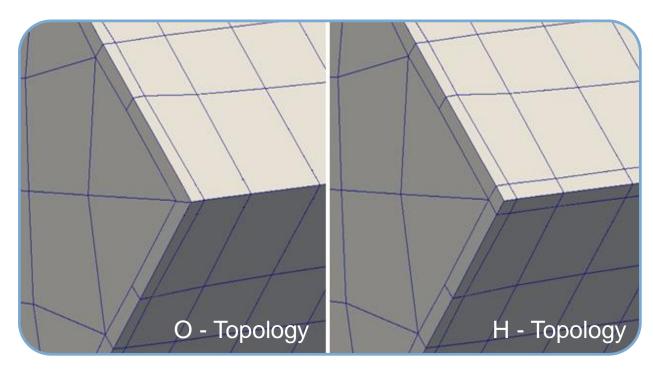


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- H-topology layer mesh in concave corners
  - Improve quality and accuracy of boundary layer flow simulation
  - Structured-style layer mesh automatically generated in concave corners



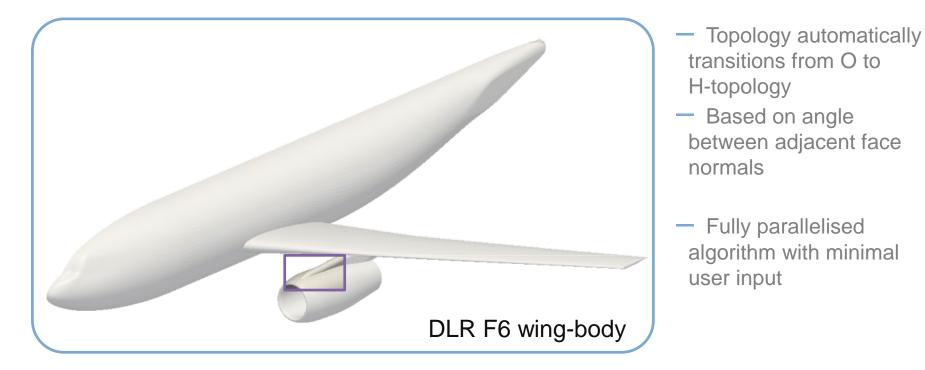
- Topology automatically transitions from O to H-topology
- Based on angle between adjacent face normals
- Fully parallelised algorithm with minimal user input



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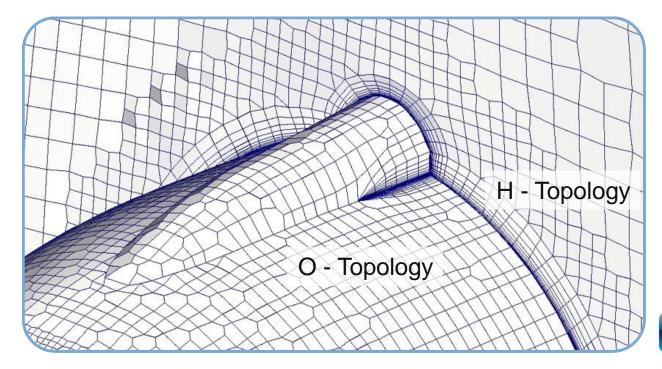
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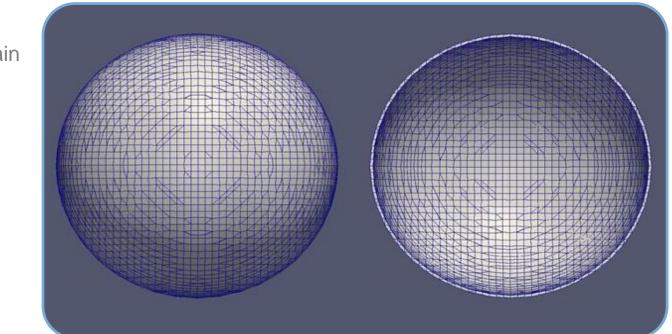
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# iconCFD MESH CUT-CELL MESHING

- Cut cells at surfaces instead of snapping
  - Improved mesh quality due to less distortion
  - Advantageous for face zones, narrow gaps, high fidelity meshes with good quality
  - Cells are cut

3| Meshing

- Cells outside domain are removed
- Surface layers are added





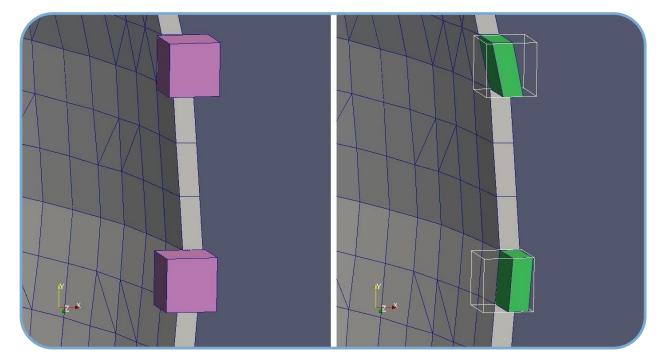
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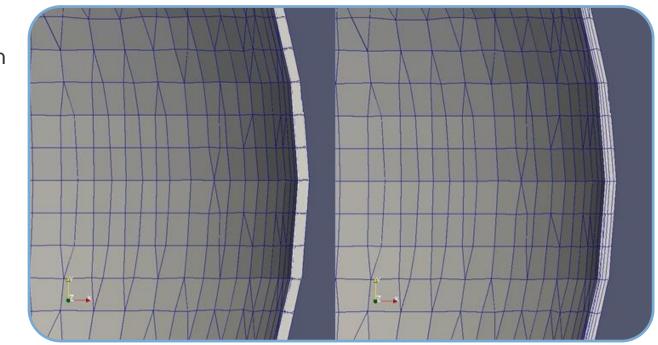
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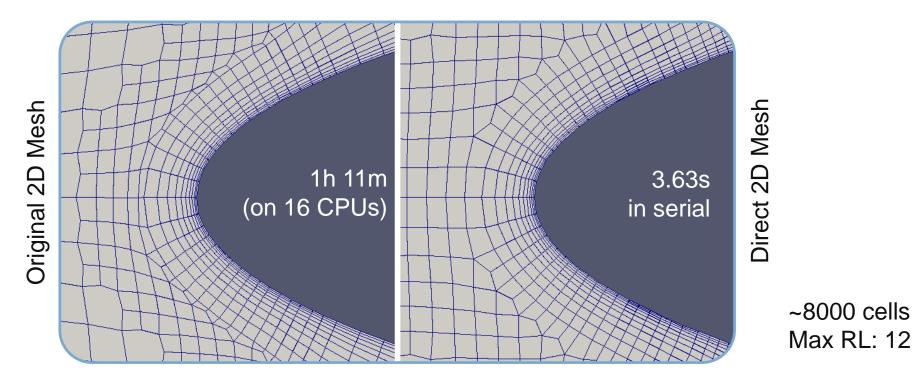




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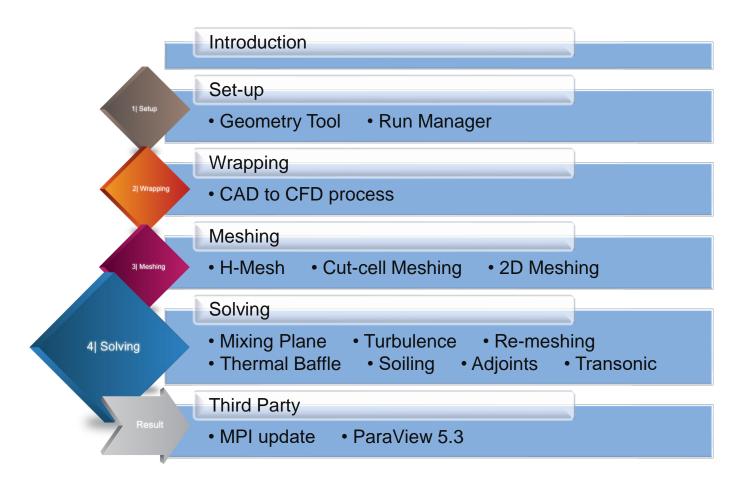
# Interview in the second second

- Mesh directly in 2D, instead of generating 3D mesh and then extruding 2D mesh from a patch
  - Refinement, snapping and layering now performed in 2D





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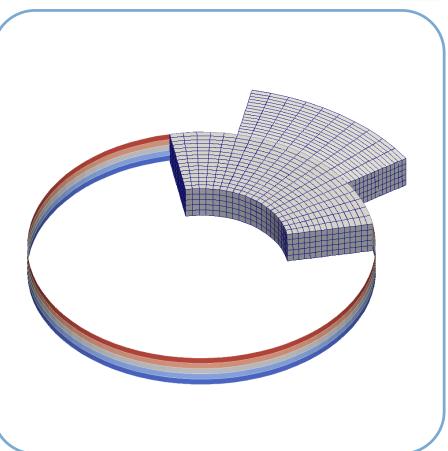
## **iconCFD CORE MIXING PLANE**



Mixing Plane Interface

4| Solving

- Turbo-machinery simulations in steady-state
- Couples rotor and stator mesh regions at rotationally symmetric interface
- Circumferential averaging of fields (area or flux weighted)
- Matrix-coupled mesh interface
- Used in combination with
  - Multiple Reference Frame (MRF) in rotating domain
  - Periodic cyclicAMI boundaries





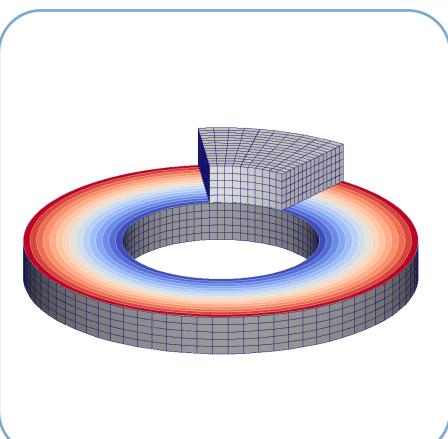
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### iconCFD CORE www.iconCFD.com TURBULENCE ENHANCEMENTS

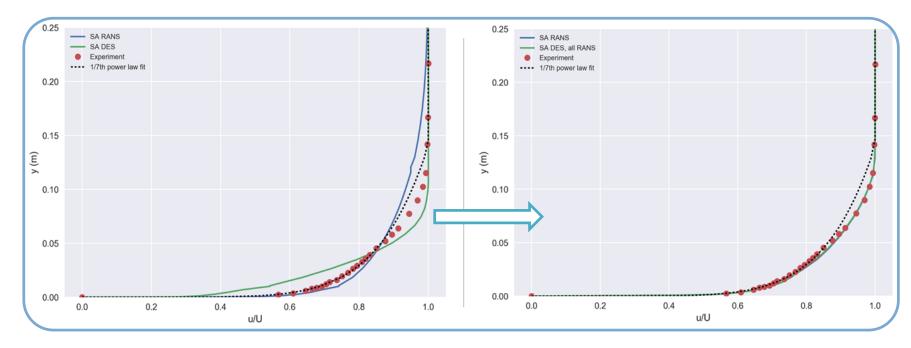
Spalart Allmaras DES:

4| Solving

- Enhancements:
  - Explicit specification of RANS zones
  - Corrections to S-term

Results:

- Corrected boundary layer profiles
- Avoided grid-induced separation





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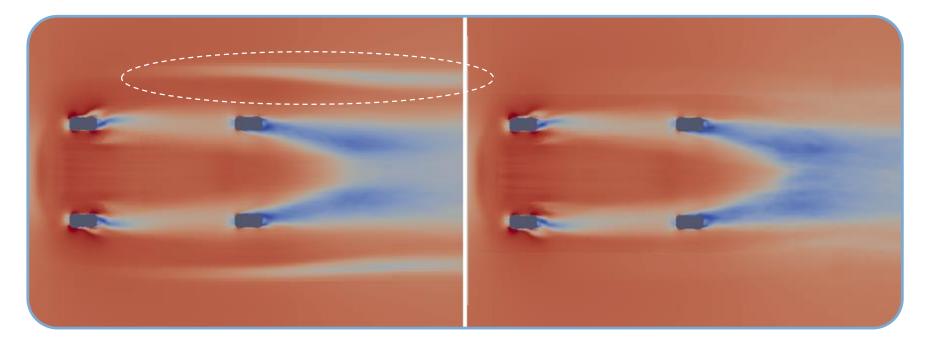
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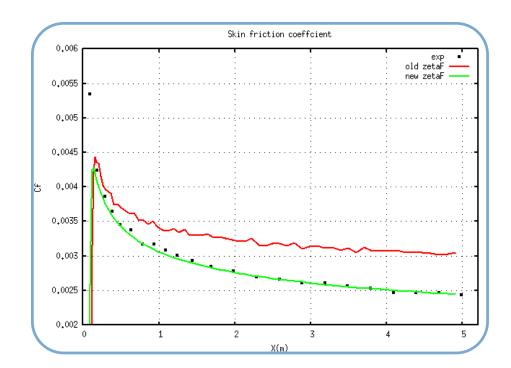
URANS Zeta-F improvements:

- Proving beneficial to external vehicle aerodynamics simulations

**TURBULENCE ENHANCEMENTS** 

iconCFD CORE

- New kOmegaSST models:
  - kOmegaSST DES, DDES, IDDES
- DES hybrid convection scheme
  - For hybrid RANS/LES calculations
  - Blends between two convection schemes based on wall distance, velocity gradient and eddy viscosity





4| Solving

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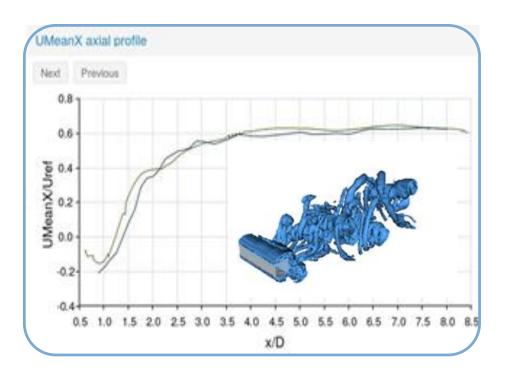
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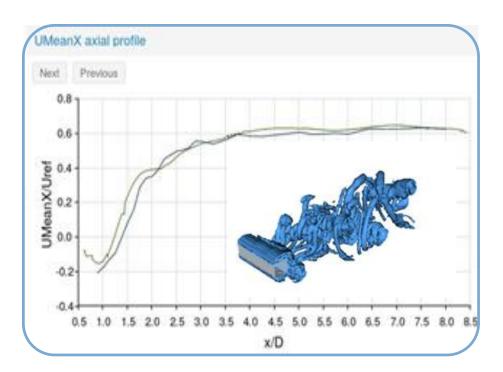
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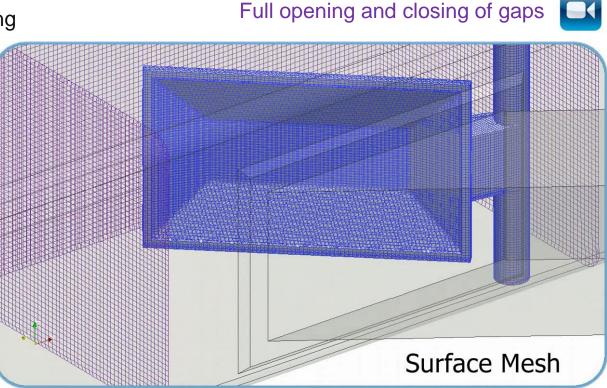
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## iconCFD MOVE www.iconCFD.com DYNAMIC LOCAL RE-MESHING

- Dynamic local re-meshing algorithm
  - Seamless re-meshing in solver run
  - Global or local re-meshing
  - Conservative field mapping
  - Fully automated and parallelized
  - Surface geometry updated based on
    - Patch faces
    - Surfaces moved with patches
  - Cell zones for
    - Frozen points
    - Prescribed movements





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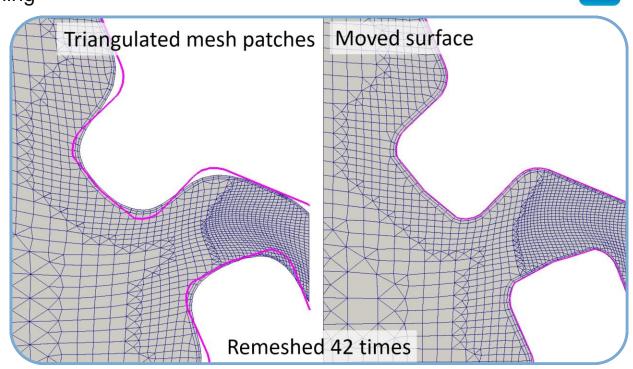
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Intersecting paths

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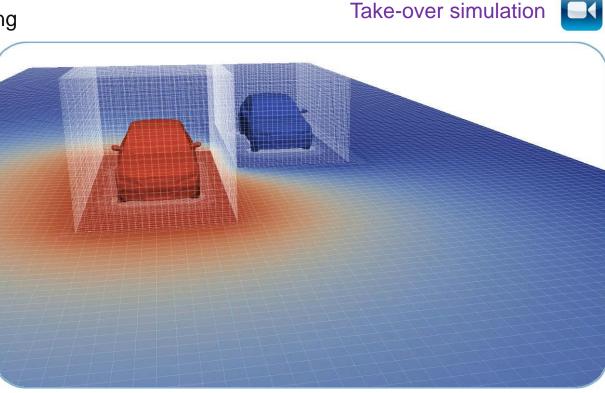
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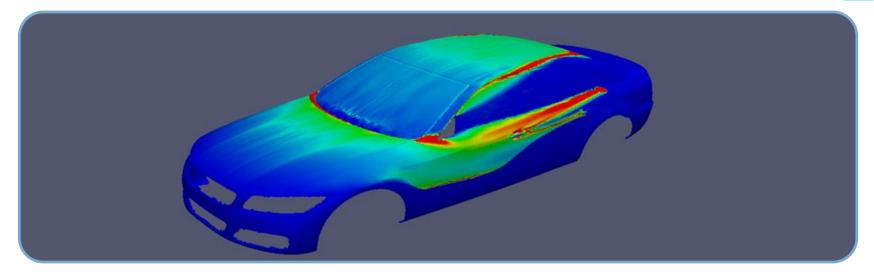


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- Soiling simulations
  - Eulerian carrier flow: steady-state or transient, turbulent, incompressible
  - Lagrangian cloud transport: in frozen Eulerian solution or fully coupled
  - Surface film model
    - 1-cell extrusion of surface patches
    - Velocity coupling between Eulerian and surface film regions





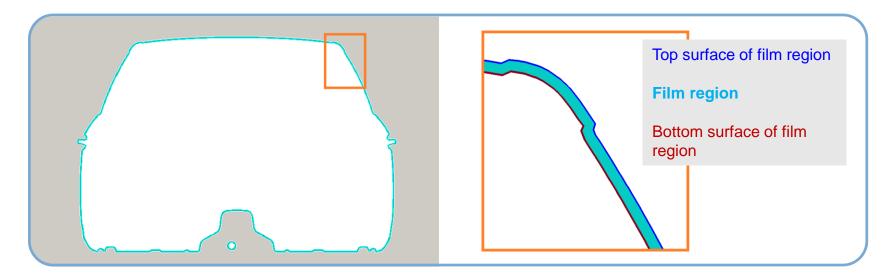


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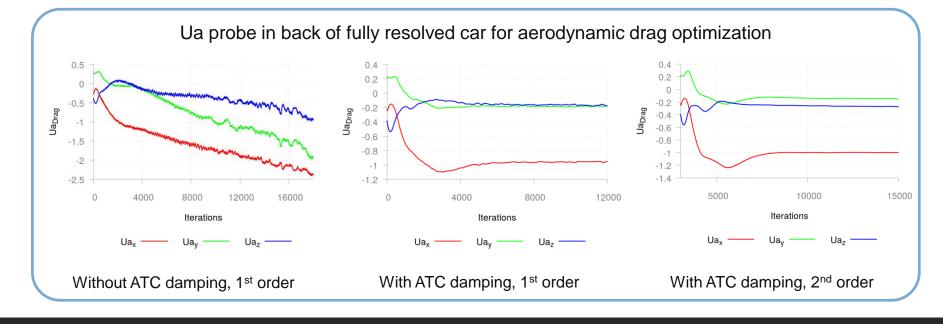


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## **iconCFD OPTIMIZE** EXTERNAL AERO

- Local damping of ATC term
  - Much better convergence of adjoint equations
  - Symmetrical sensitivity field
  - Better optimization reached

- 2<sup>nd</sup> order adjoint discretization
  - Same schemes for primal and adjoint





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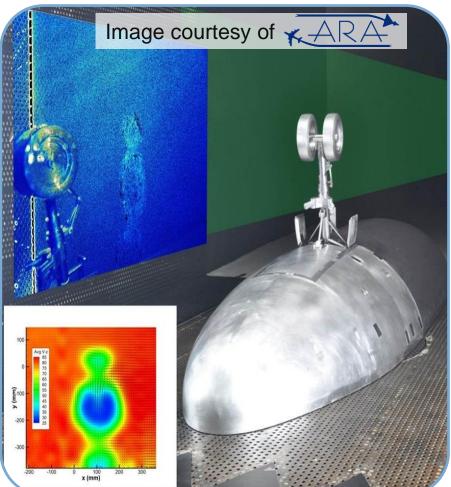
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### iconCFD TRANSONIC www.iconCFD.com www.ara.co.uk NEW MODULE

- Collaboration between ICON and Aircraft Research Association (ARA).
- Transonic solver

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- Implicit, block-coupled, density based
- Semi-implicit RANS turbulence modelling
- Validation case: Onera M6
  - Swept, semi-span wing
  - Mach: 0.8395
  - Reynolds Number: 11.72 E+6
  - Angle of Attack: 3.06 deg
  - Structured C-H grid: 884736 cells
  - Important phenomenon: λ-shock
    - Two shocks meet close to 85% of wing span
    - Well captured with iconCFD



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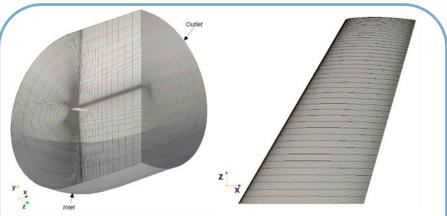
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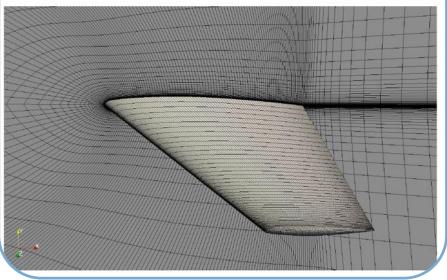
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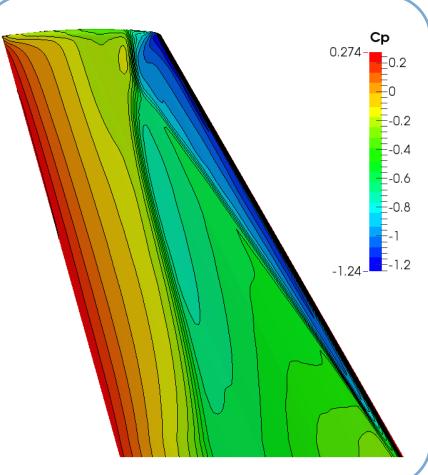
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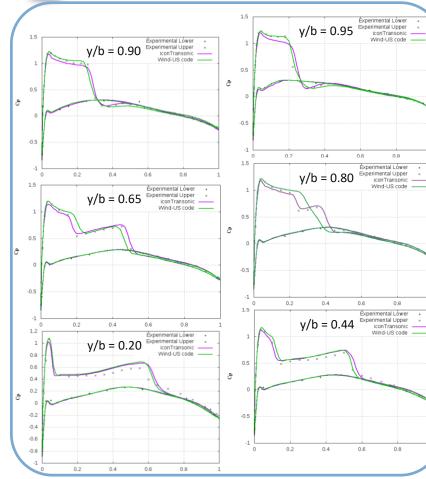
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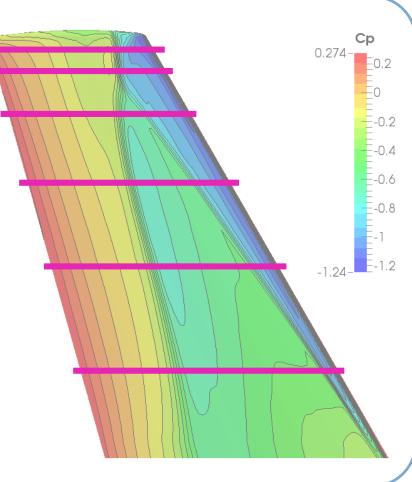
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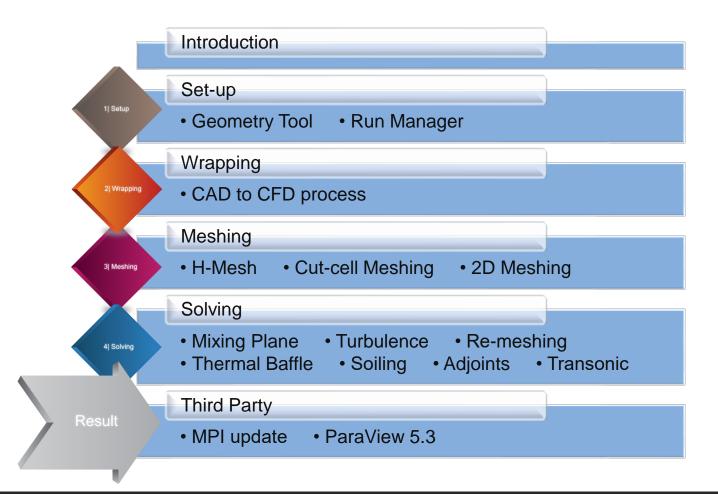
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## iconCFD v4.0 Agenda

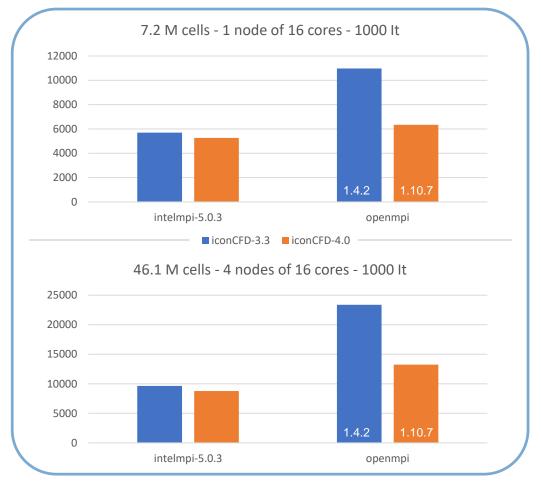




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## Result iconCFD THIRD-PARTY UPGRADES

- Code performance upgrades
- Openmpi upgrade
  - From openmpi-1.4.2
  - To openmpi-1.10.7



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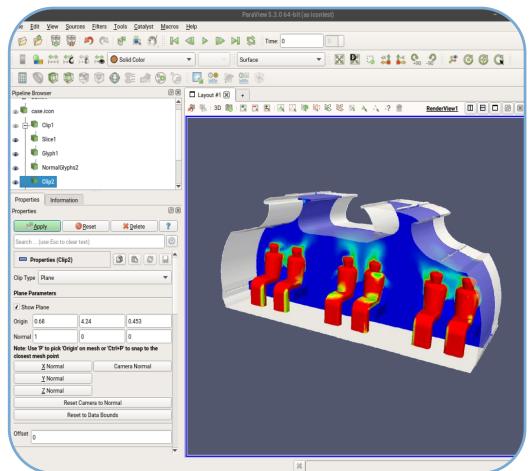
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iconCFD THIRD-PARTY UPGRADES

- Upgrade to ParaView 5.3
  - Previously 4.1, only server
  - One build with OpenGL 2 and Mesa:
    - Uses GPUs and CPU
    - Considerably faster
    - Server, Python API and client
  - Second build with OSMesa:
    - For off-screen rendering on clusters without GPUs
    - Server and Python API
    - Use python scripts or remote-connect with client





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