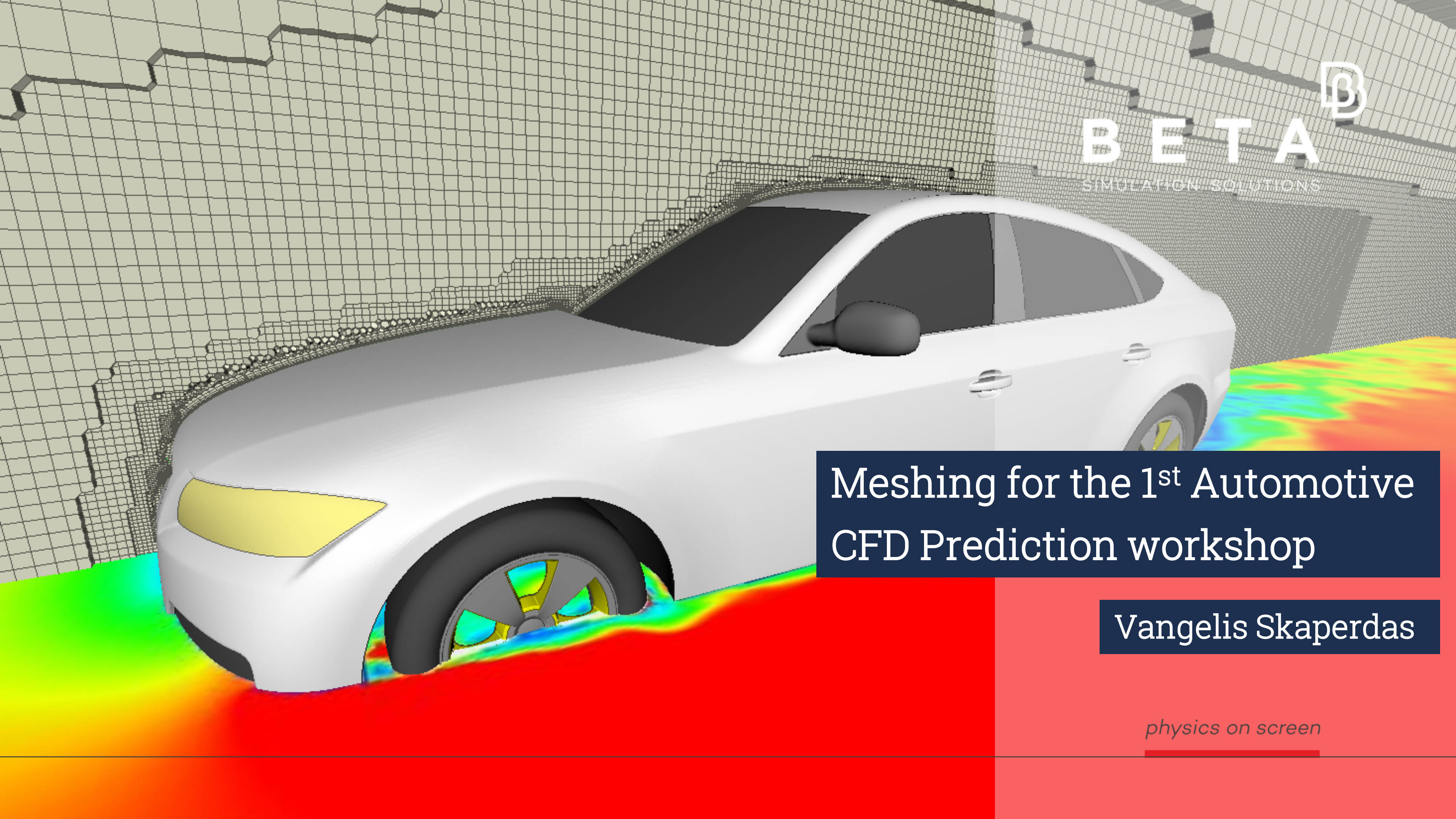


BETA SIMULATION SOLUTIONS

Meshing for the 1st Automotive CFD Prediction workshop

Vangelis Skaperdas

physics on screen

Overview

- Generate the committee meshes for Case 2 DrivAer (FastBack and Estate variants)

Objectives:

- High quality meshes that should run in any CFD solver
- y+1 layers all around the model
- Smooth transition from layers to volume mesh
- Provide a consistent set of refined meshes for a mesh independence study
- Provide alternative Hexa dominant volume mesh approaches to examine their effect on the solution
- Output meshes in several formats

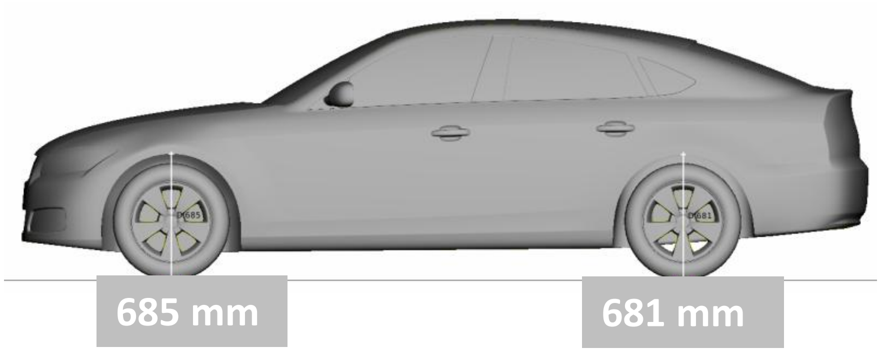
Software and Hardware used

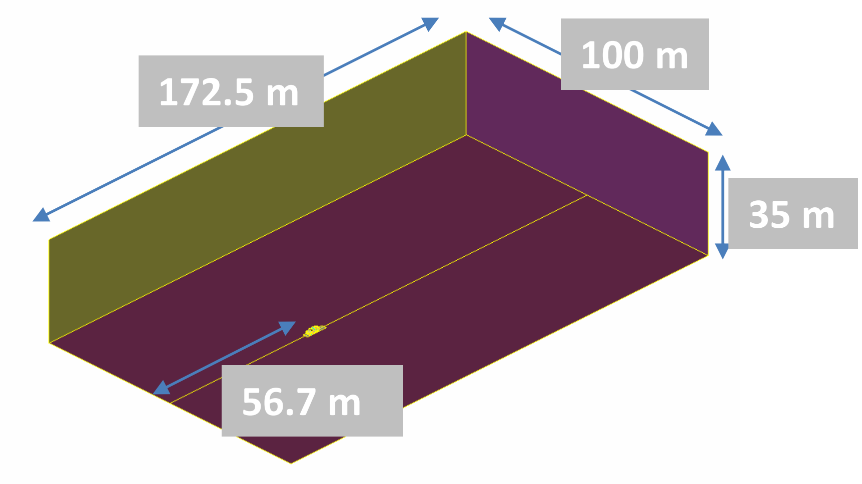
- ANSA v19.1.2

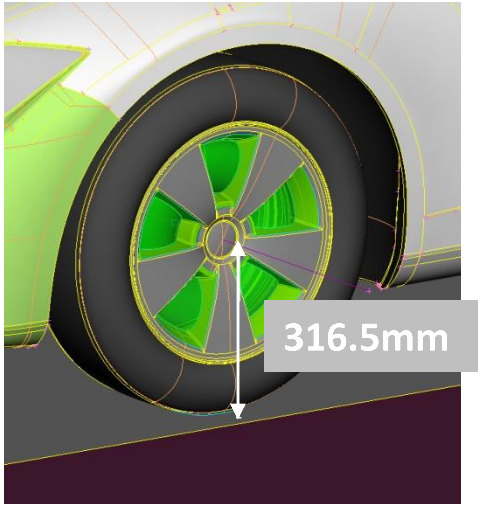
- Linux Centos 6.8
- Intel® Xeon® CPU ES-2643 v4 @ 3.4GHz (6 physical cores, 12 threads)
- 128 Gb RAM

Domain dimensions and DrivAer setup

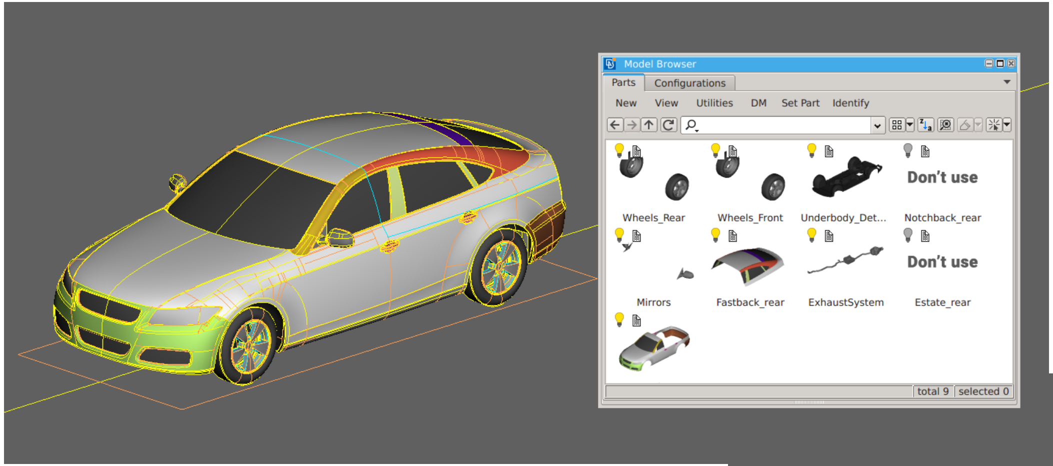
- Full scale model
- Domain inlet 56.7m upstream of car
- Front wheel axis at x=z=0mm
- Road located at z=-316.5mm

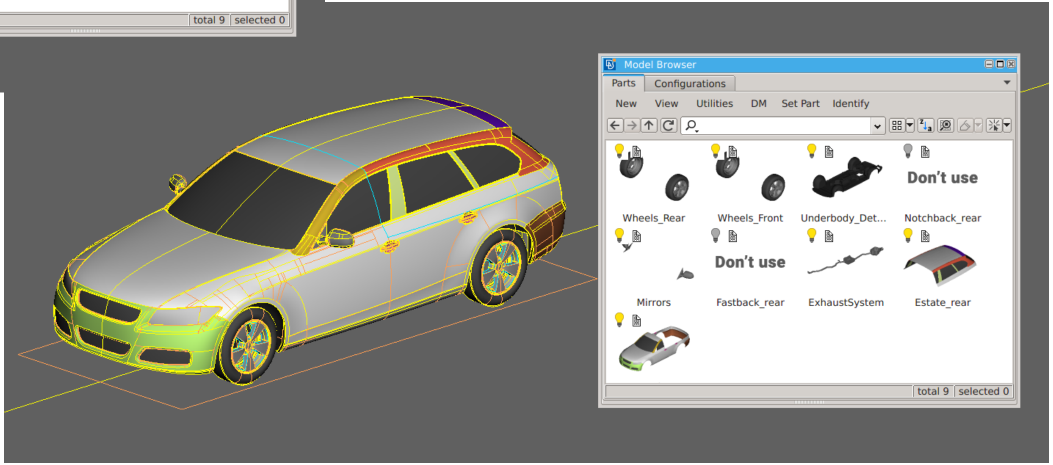




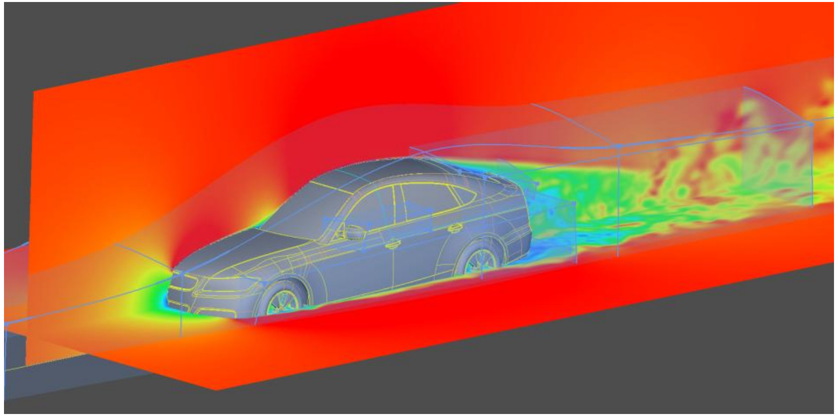


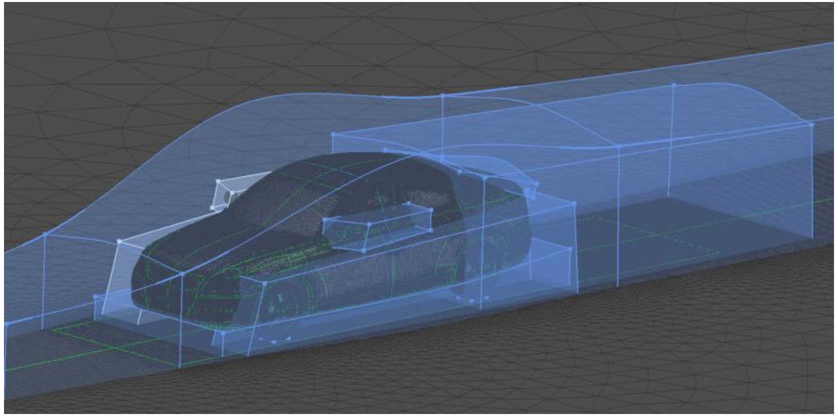
Managing DrivAer variants

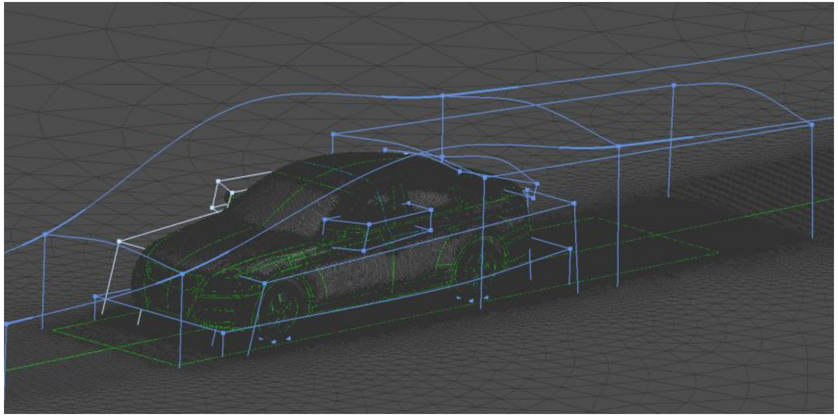


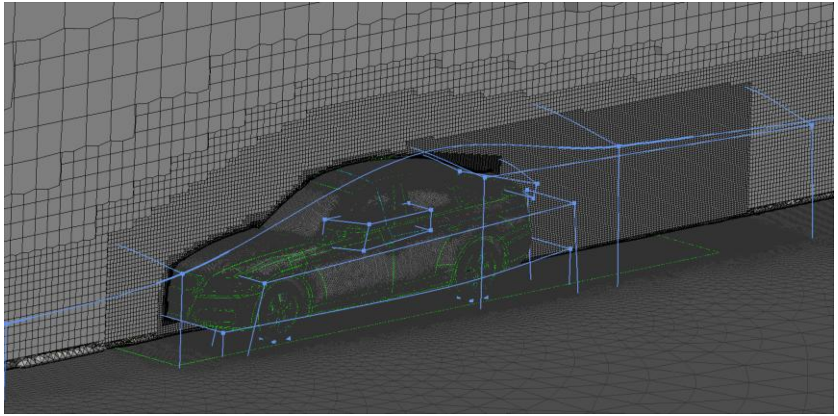


Setting up the meshing process in Batch Mesh

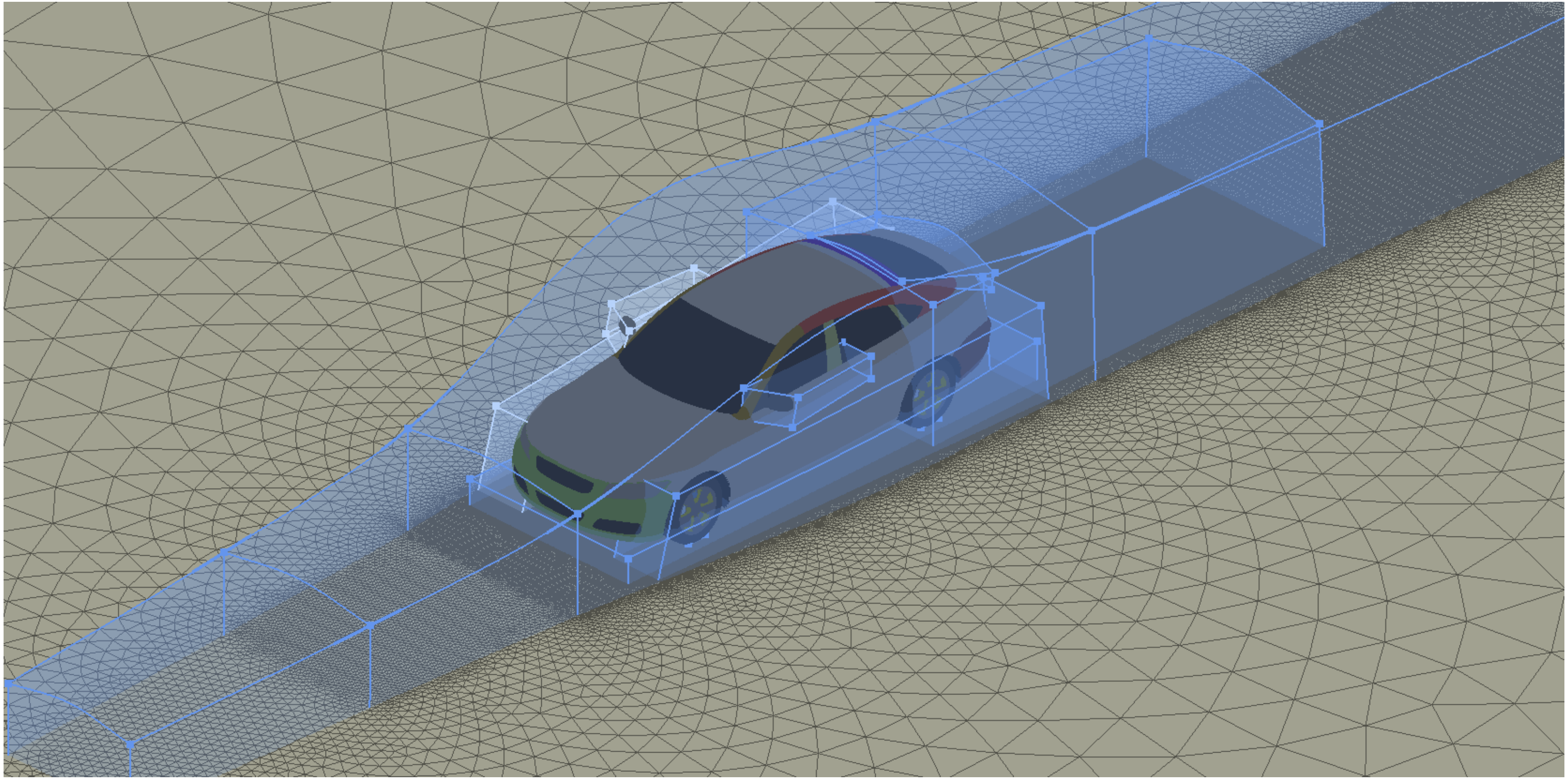








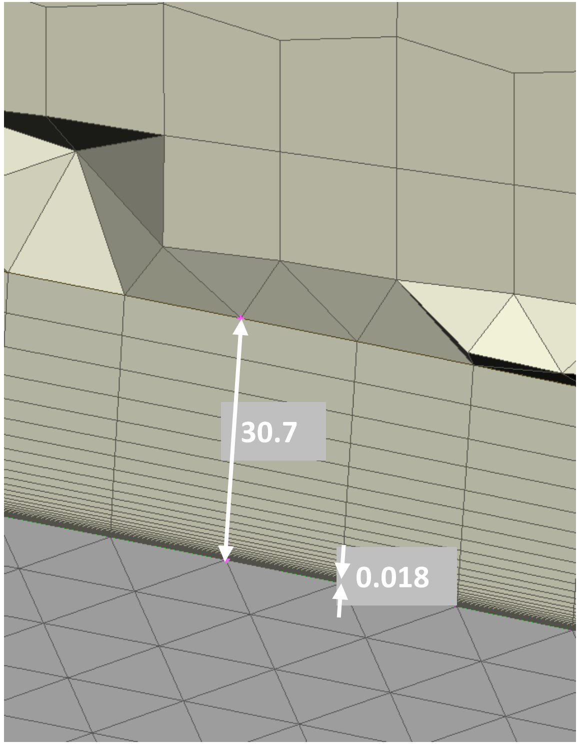
Overview of surface mesh

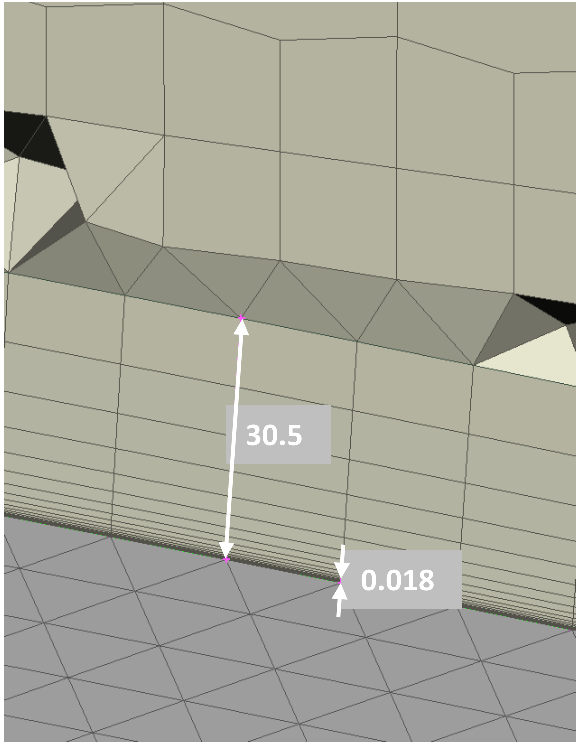


Layer Growth rate specification

32 layers with
Constant growth rate of 1.2

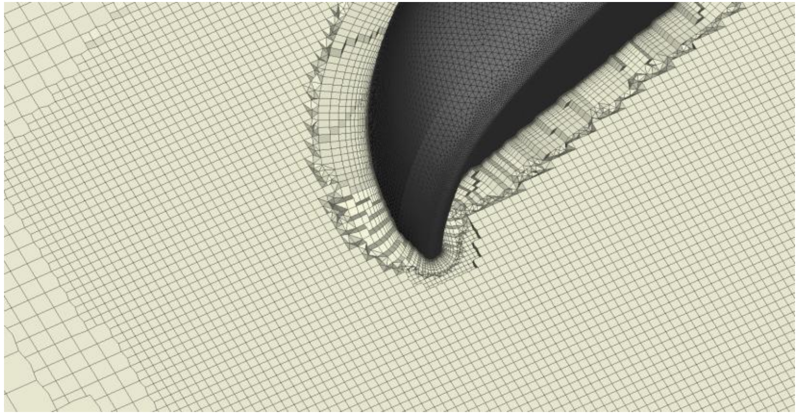
22 layers with
Variable growth rate, from 1.05 to 1.4

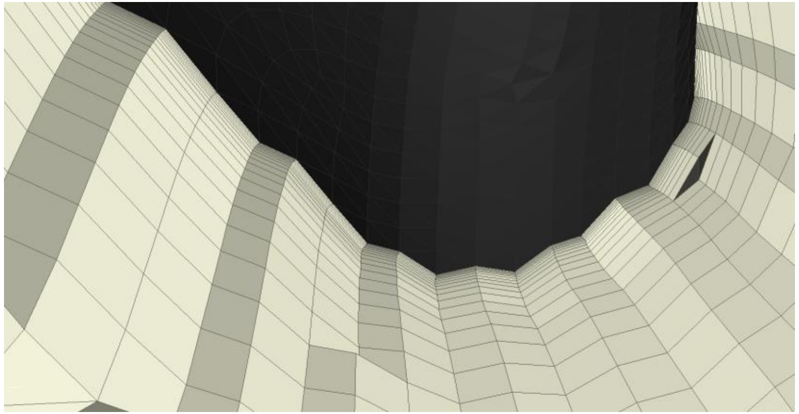


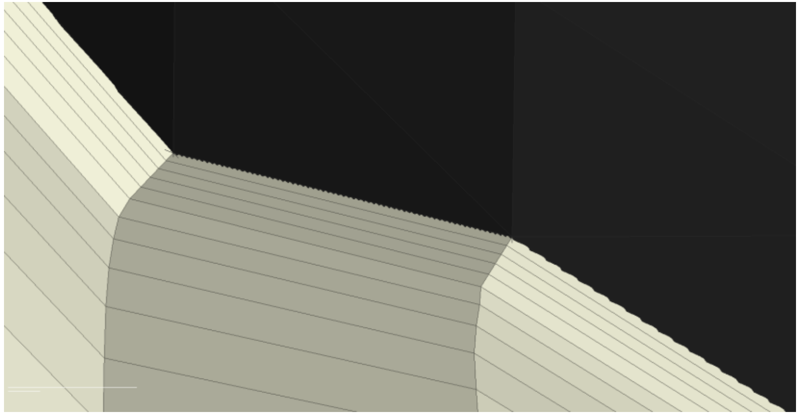


	Specs
Coarse	17 layers, 1st height =0.018mm Variable growth rate from 1.3 to 1.5
Medium	22 layers, 1st height =0.018mm Variable growth rate from 1.05 to 1.4
Fine	26 layers, 1st height =0.018mm Variable growth rate from 1.05 to 1.3

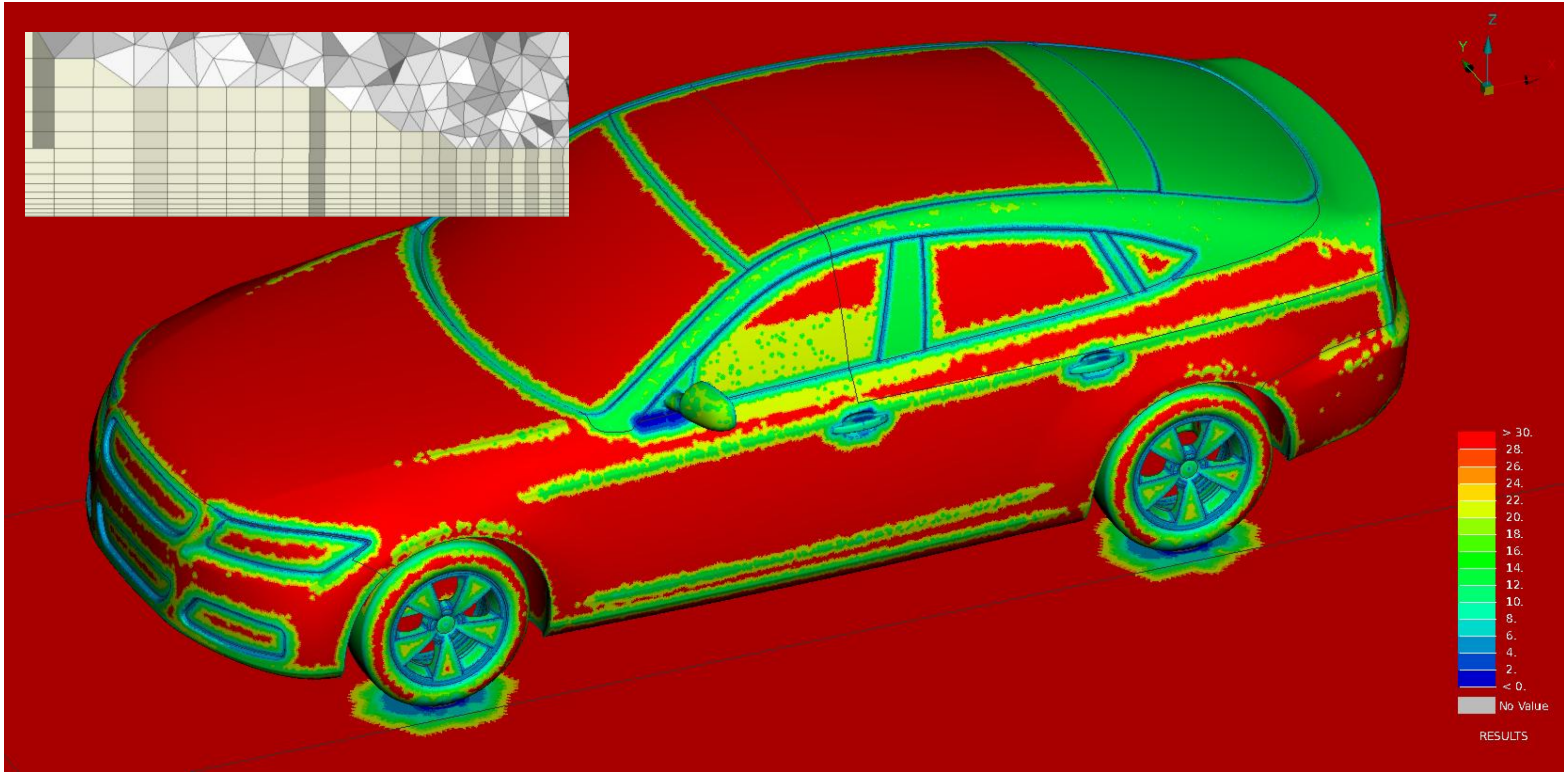
Near wall imposed orthogonality





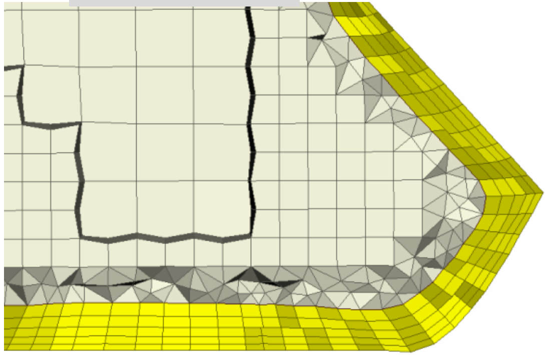


Visualization of total layer height



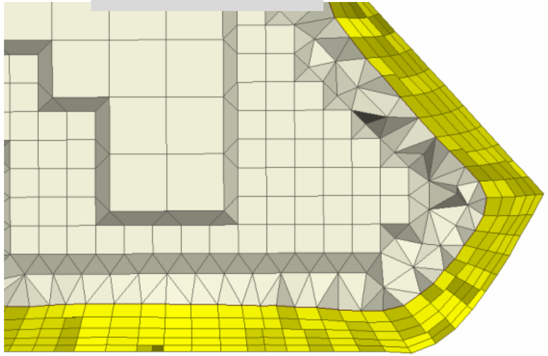
Volume meshing alternatives

HexaPoly



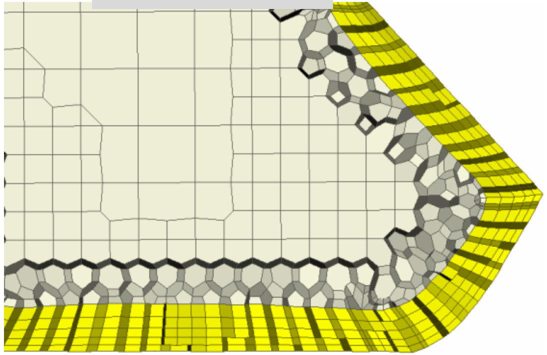
Polyhedral

HexaInterior



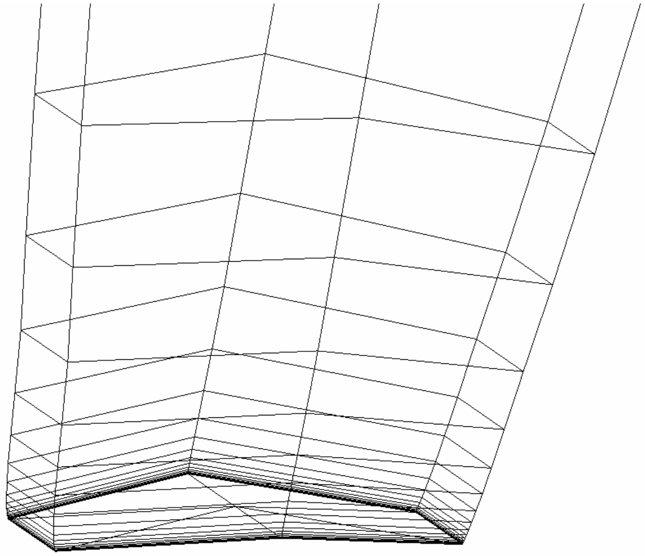
Standard

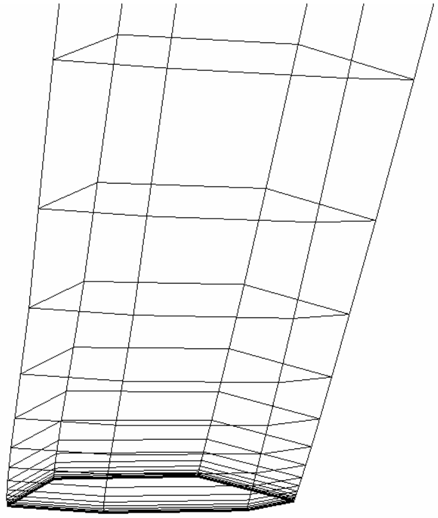
HexaIntConv



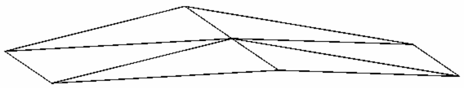
Polyhedral

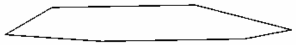
Issues with high aspect y+1 layer polyhedral meshes

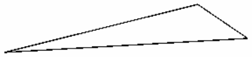


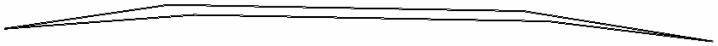


Issues with high aspect y+1 layer polyhedral meshes

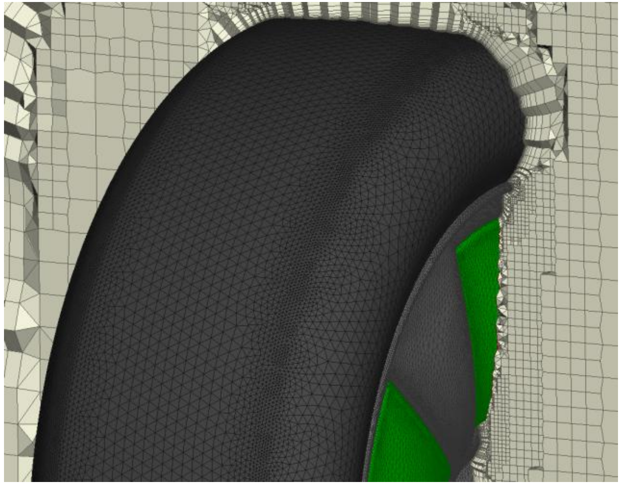


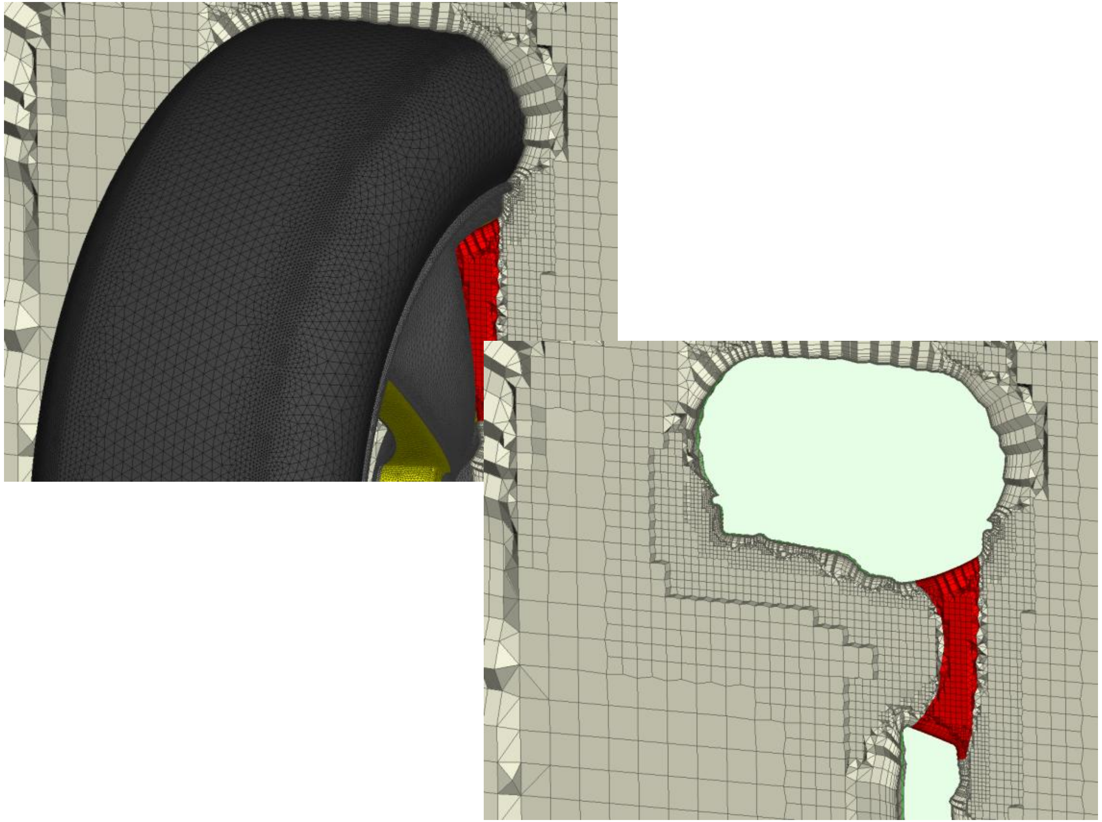




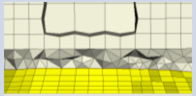
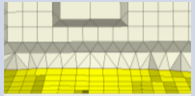
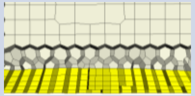
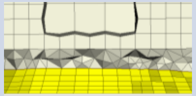
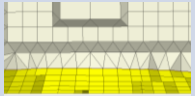
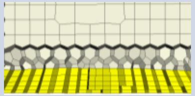


MRF zones

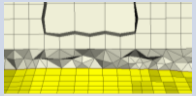
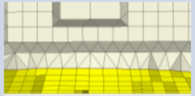
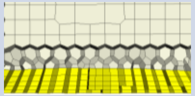
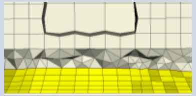
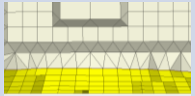
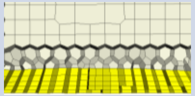




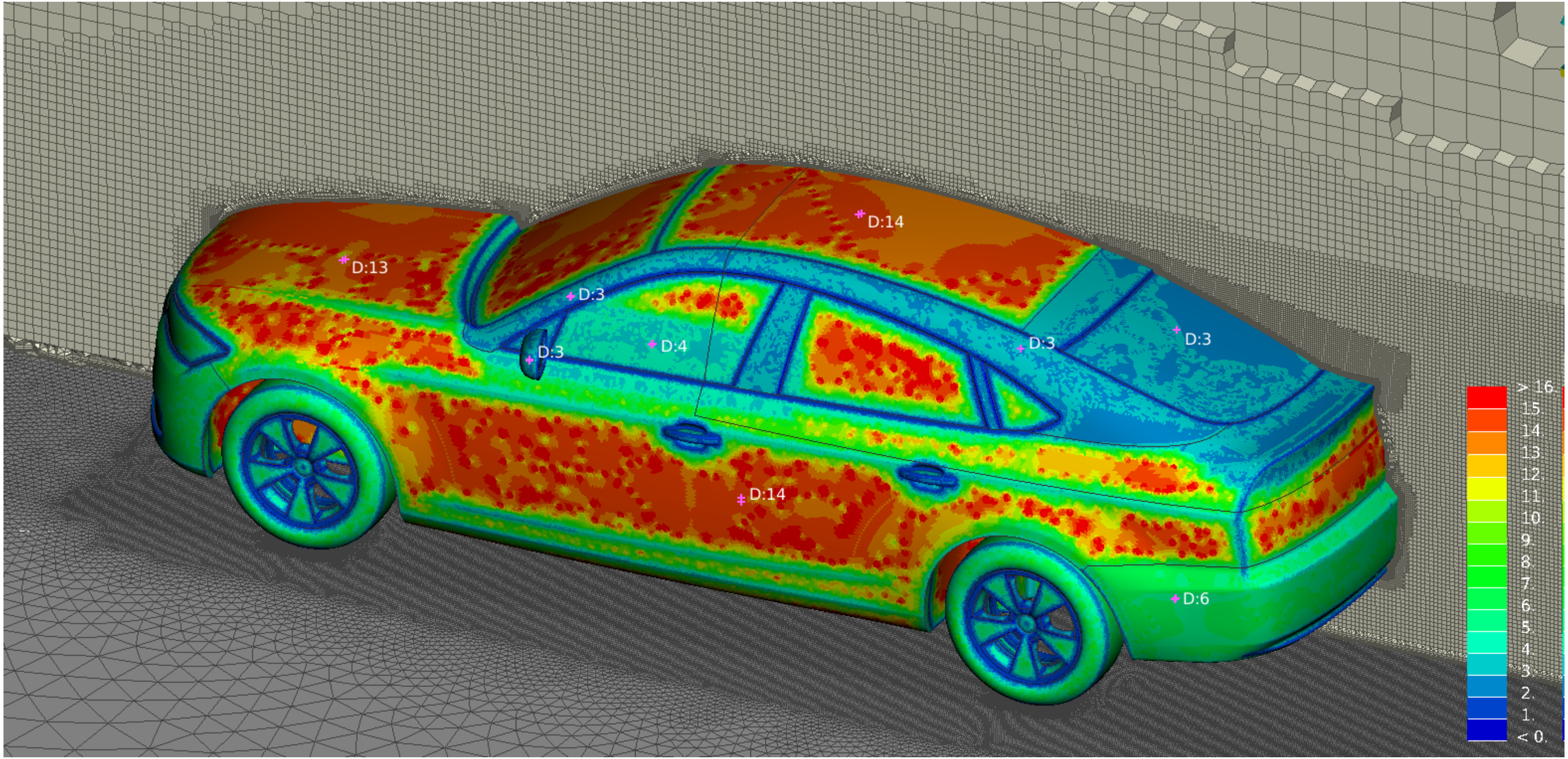
Mesh sizes (in millions)

	FastBack			Estate		
	HexaPoly 	HexaInt 	HexaIntConv 	HexaPoly 	HexaInt 	HexaIntConv 
Coarse Scale up lengths by 1.35						
Medium 6.2 mil trias on surface 22 layers	165	164	140	162	161	138
Fine Scale down lengths by 0.8						

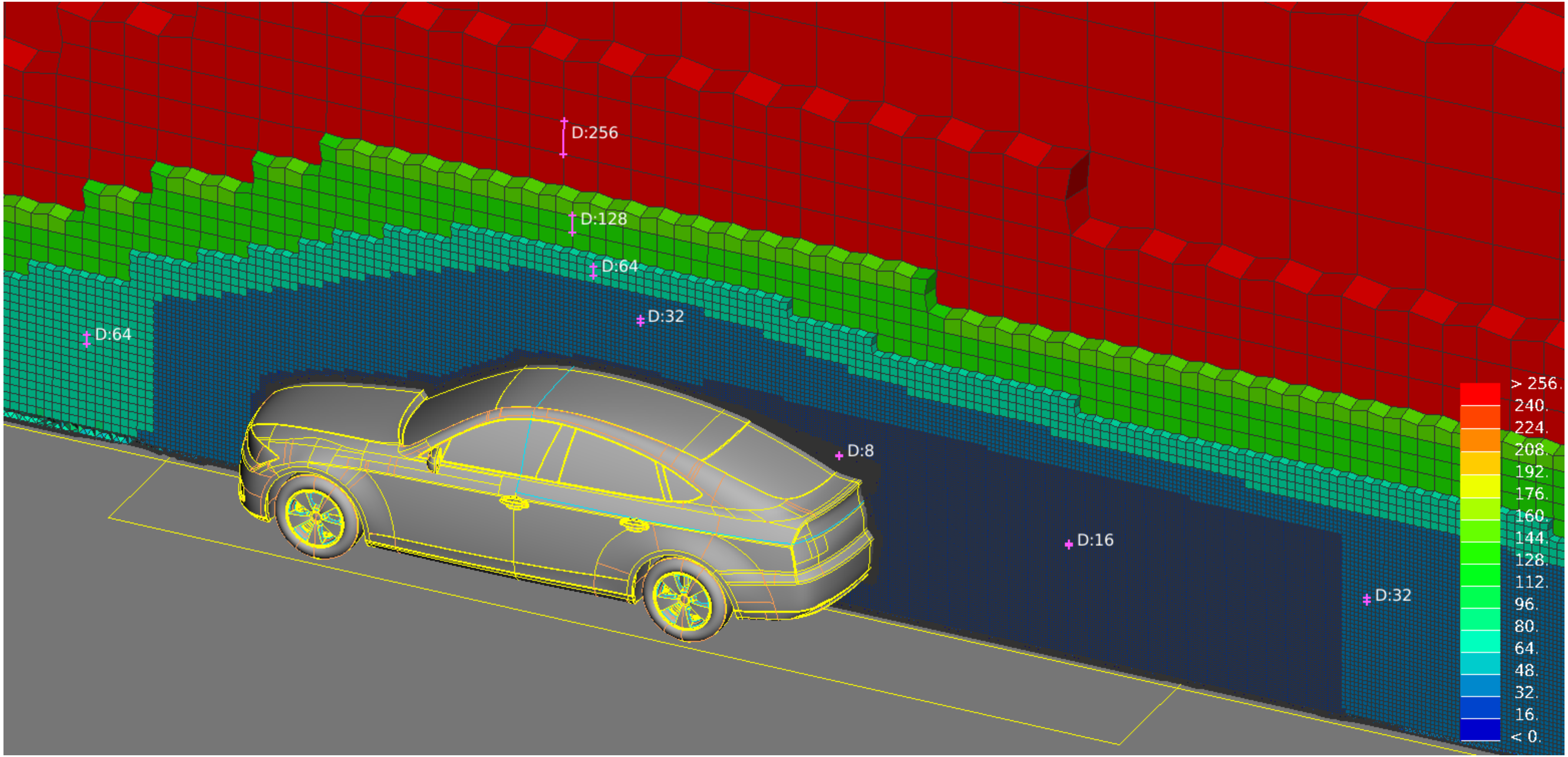
Mesh sizes (in millions)

	FastBack			Estate		
	HexaPoly 	HexaInt 	HexaIntConv 	HexaPoly 	HexaInt 	HexaIntConv 
Coarse 4 mil trias on surface 17 layers	93	91	76	92	92	75
Medium 6.2 mil trias on surface 22 layers	165	164	140	162	161	138
Fine 8.5 mil trias on surface 26 layers	258	253	224	250	245	217

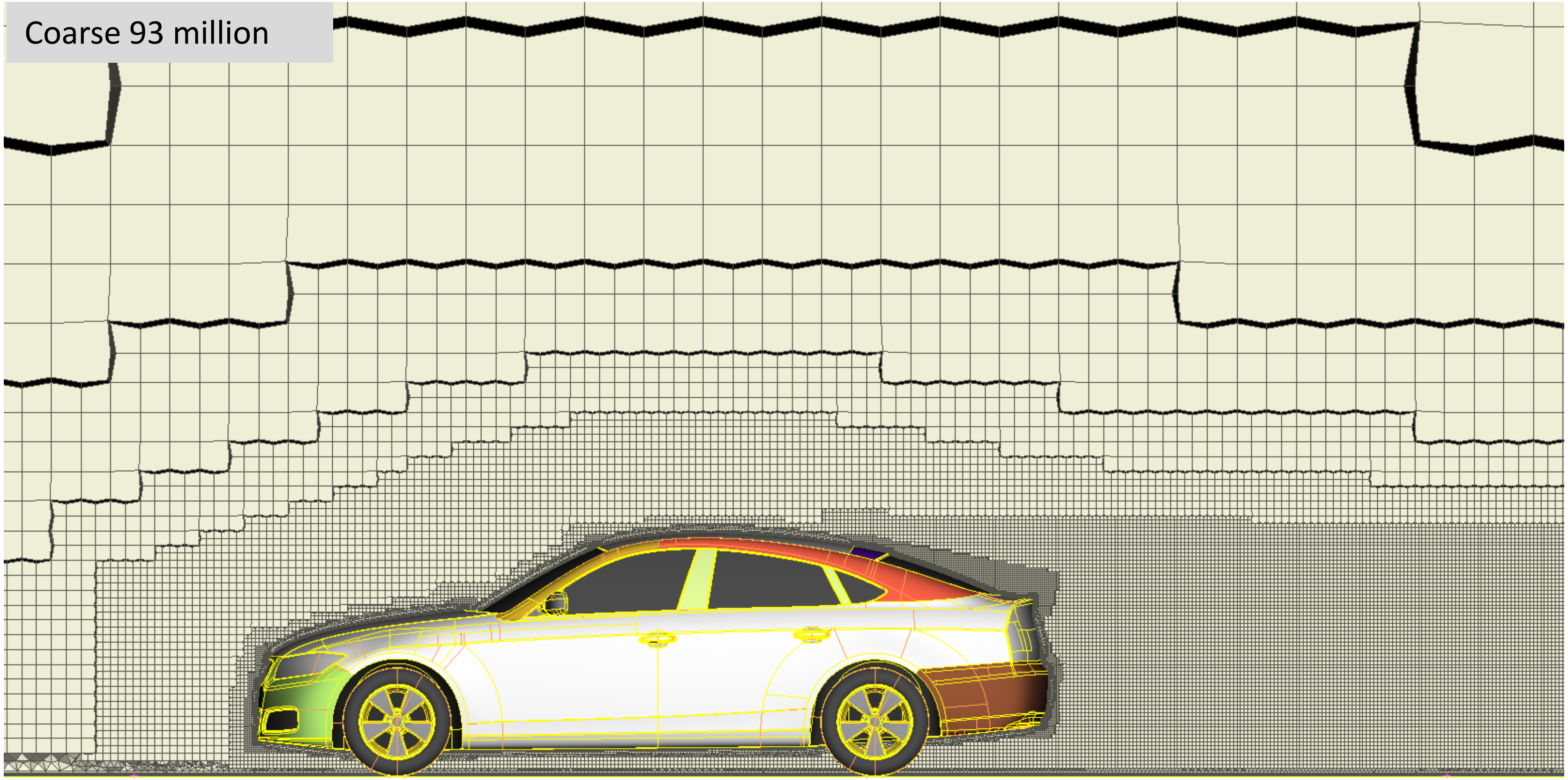
Surface mesh size distribution for medium mesh



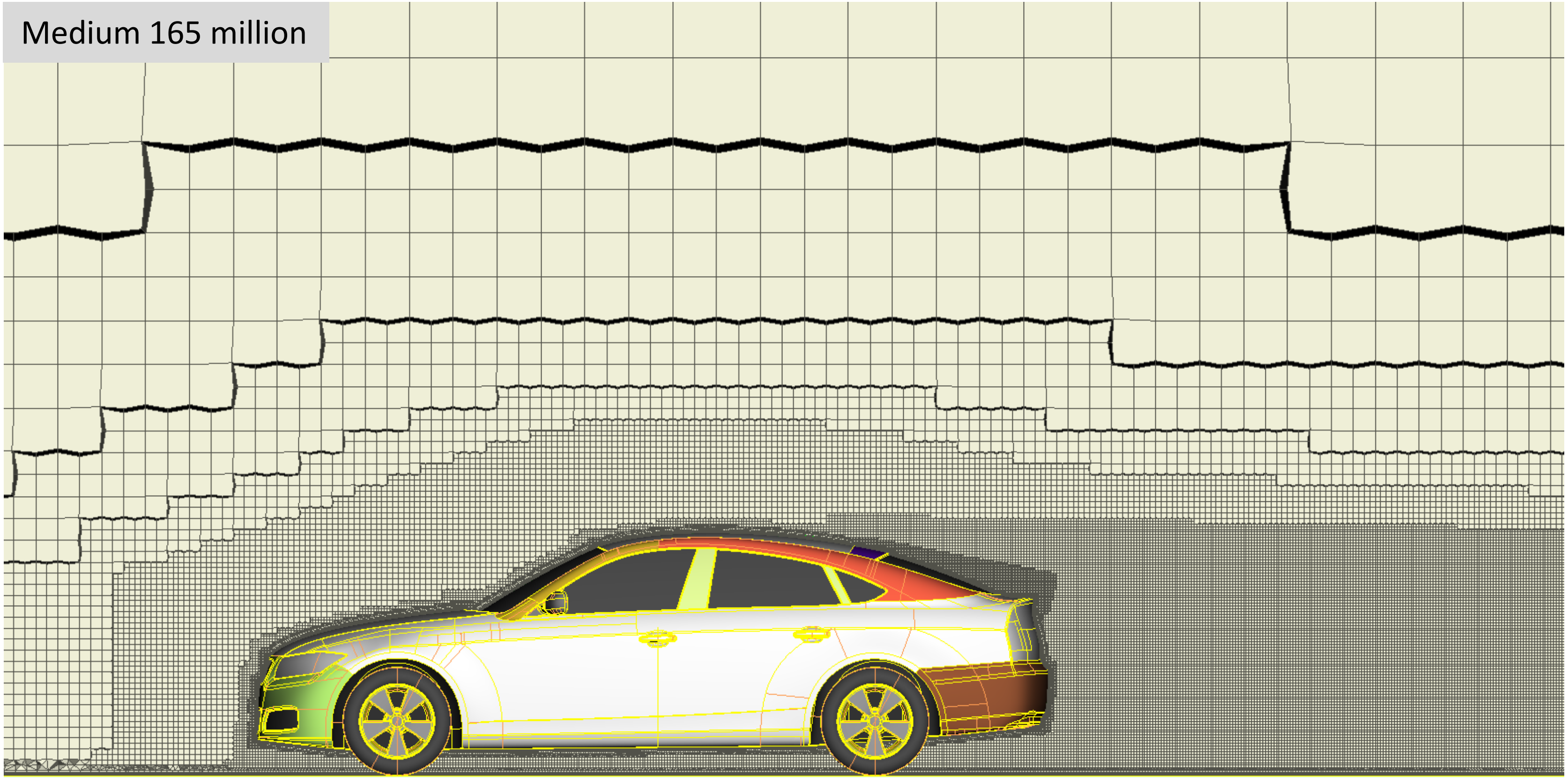
Volume mesh size distribution for medium mesh



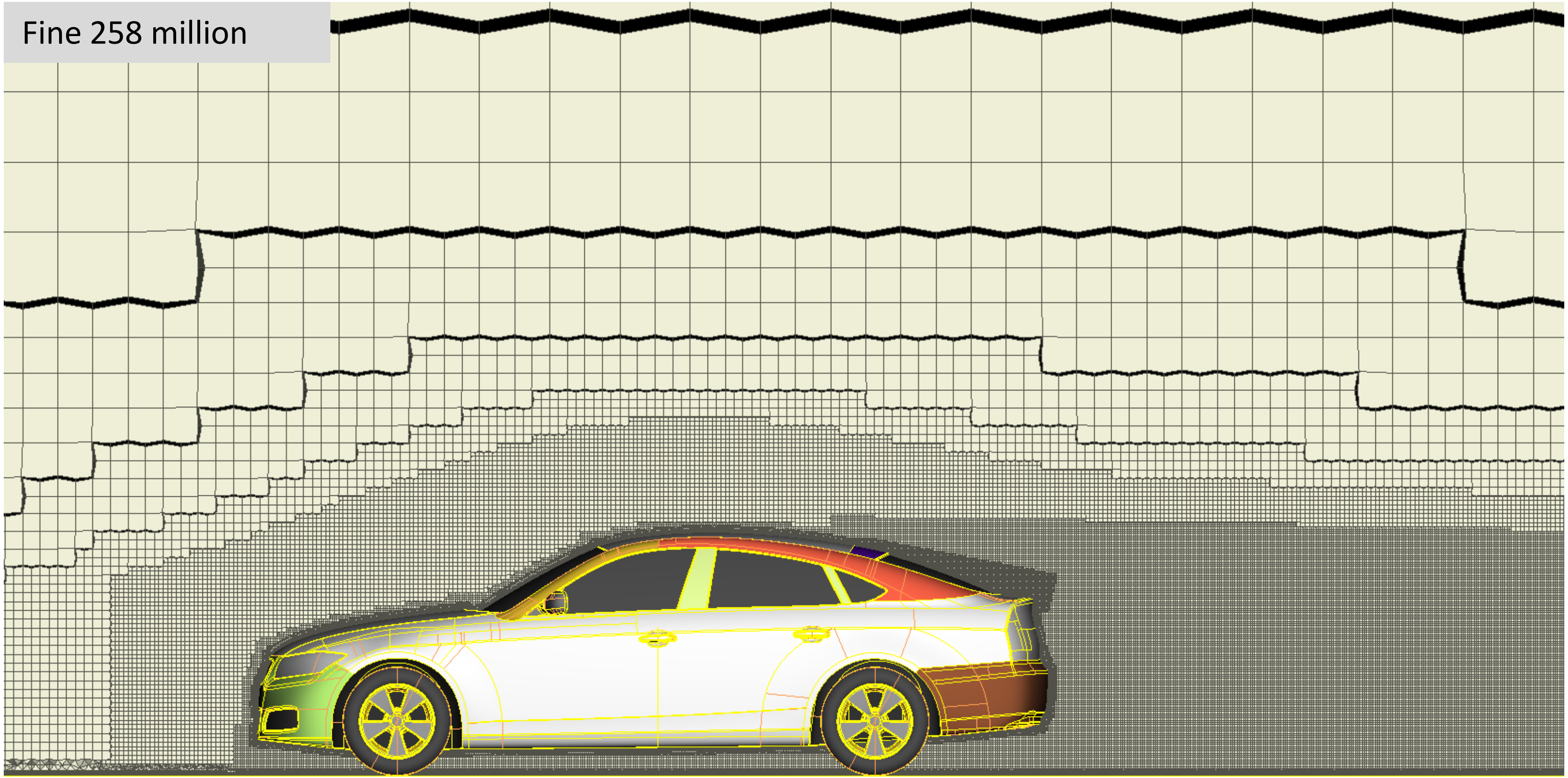
Batch mesh refinement study – HexaPoly meshes



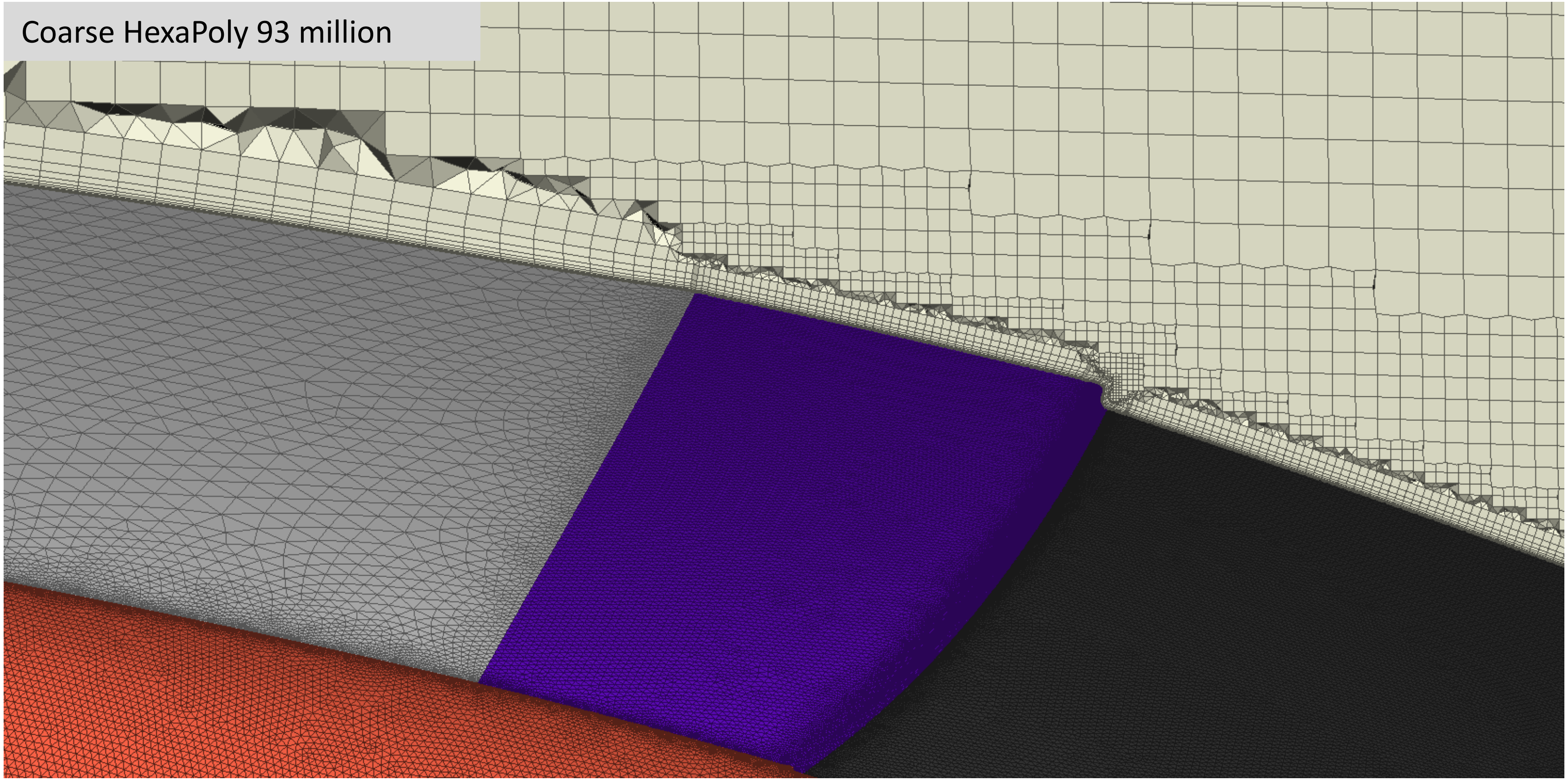
Batch mesh refinement study – HexaPoly meshes



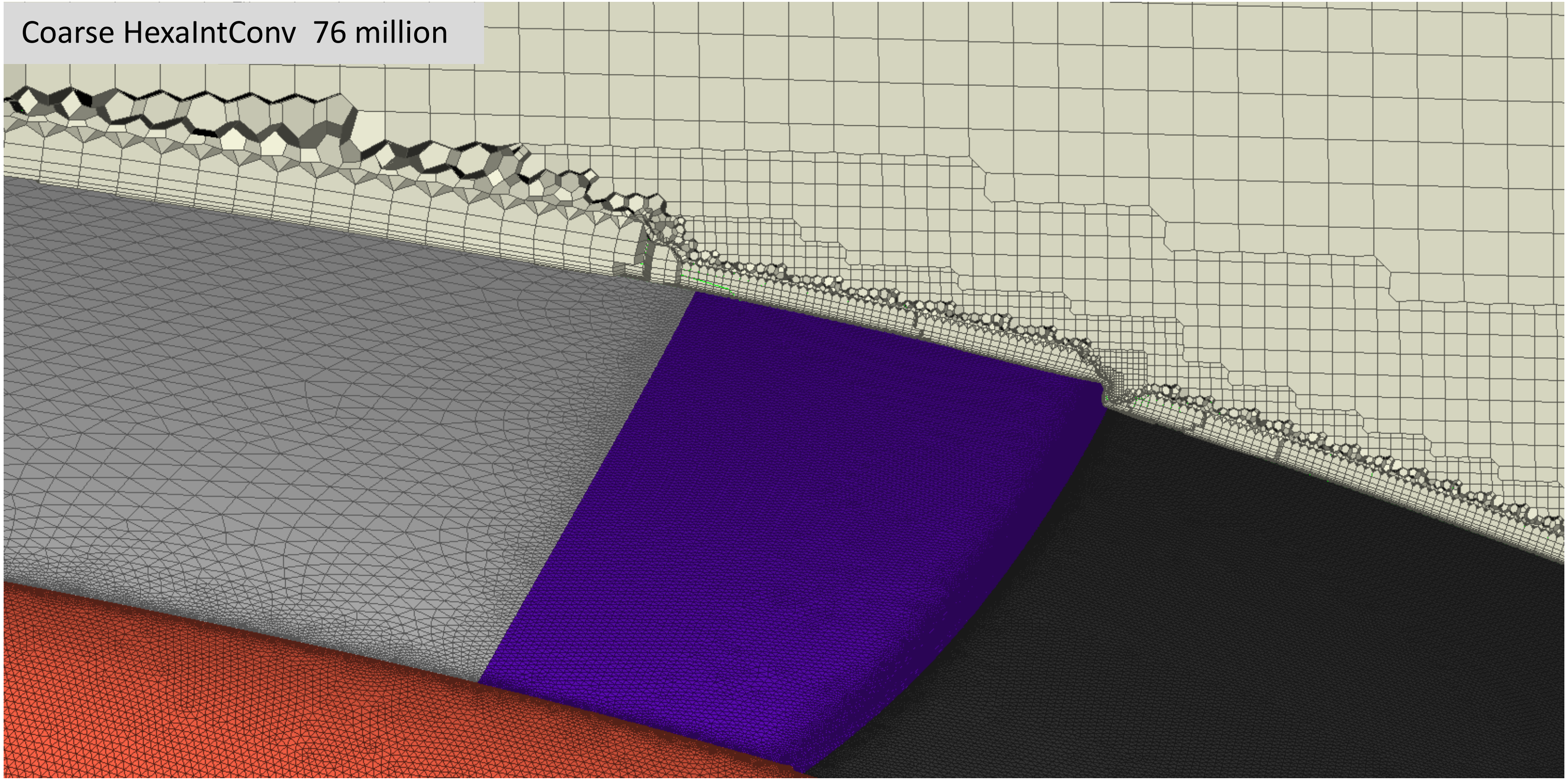
Batch mesh refinement study – HexaPoly meshes



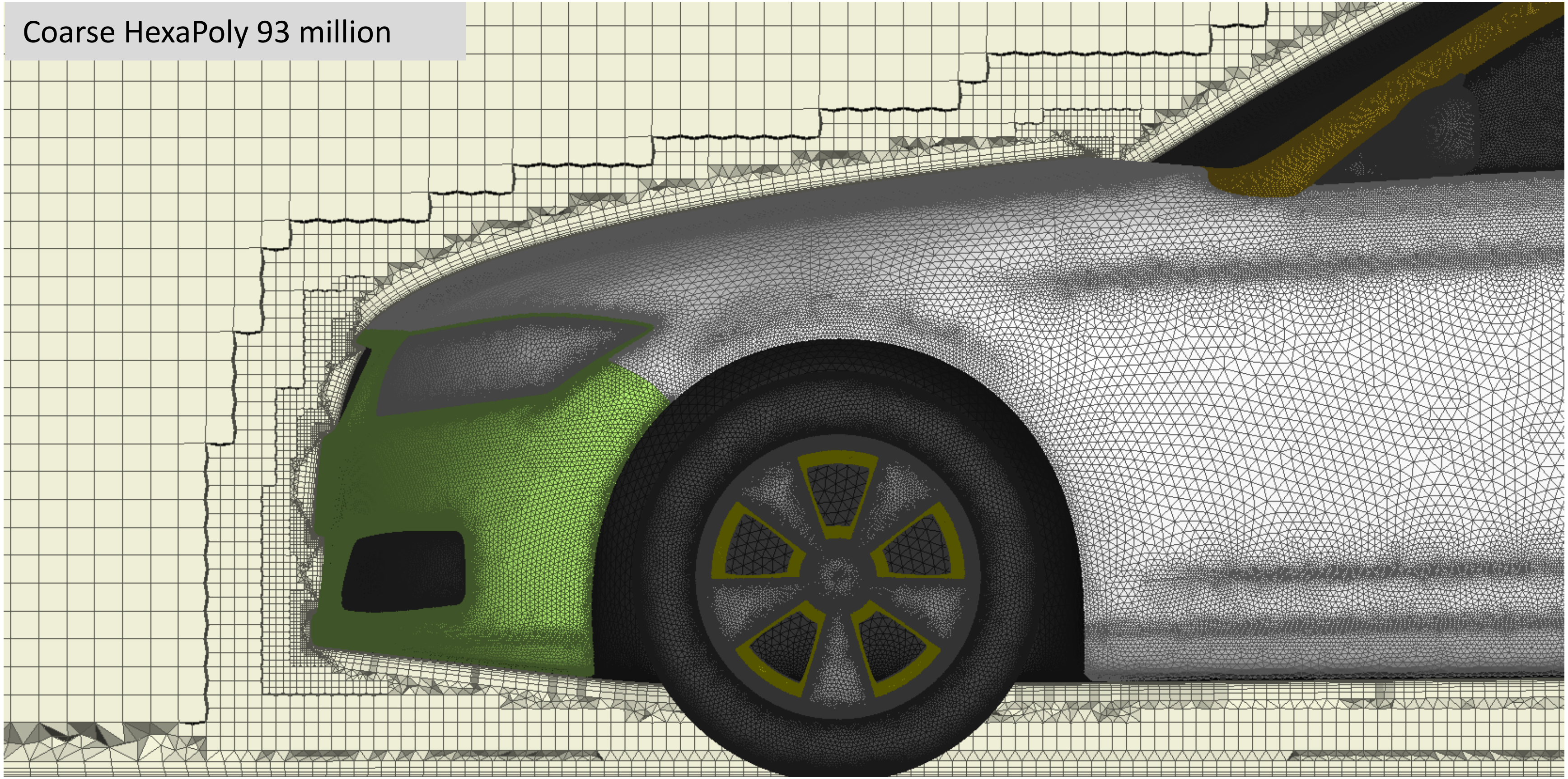
HexaPoly and HexaInteriorConverted mesh comparison



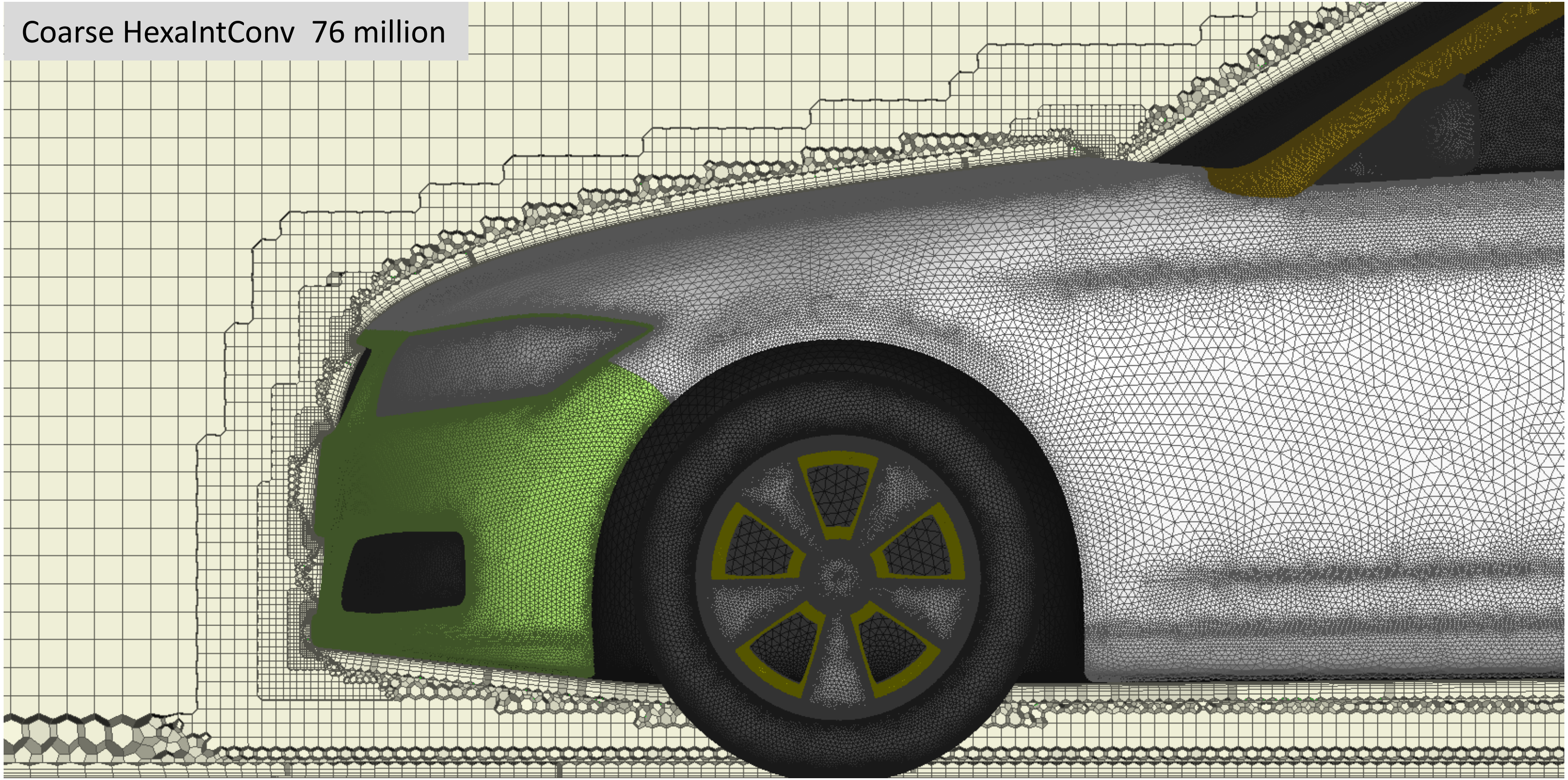
HexaPoly and HexaInteriorConverted mesh comparison



HexaPoly and HexaInteriorConverted mesh comparison

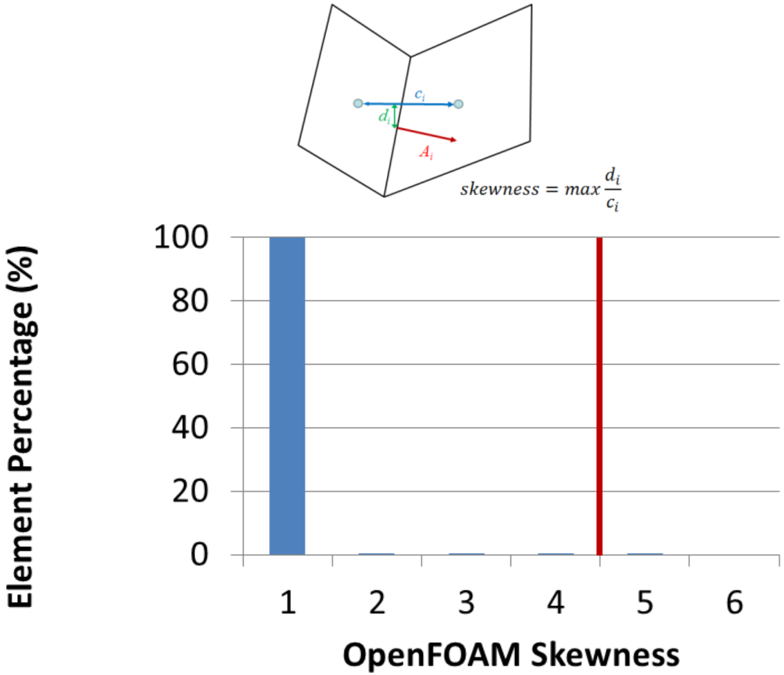


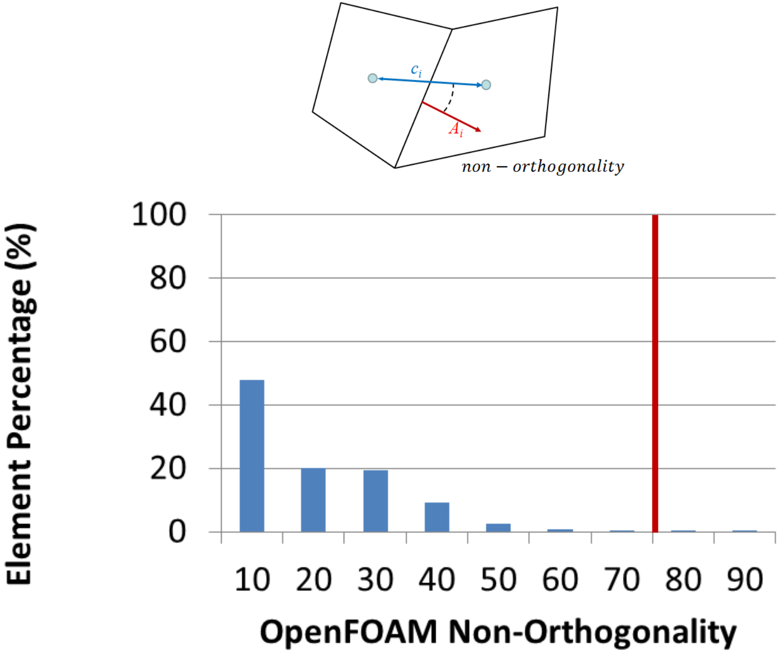
HexaPoly and HexaInteriorConverted mesh comparison



Mesh quality metrics

Statistics for Fine HexaPoly mesh
253 million cells (168 million prisms, 90 million core)

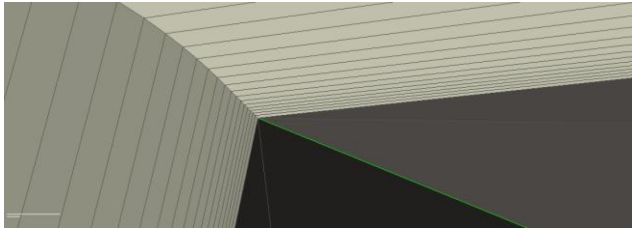


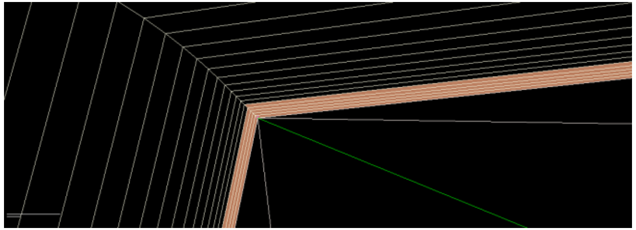


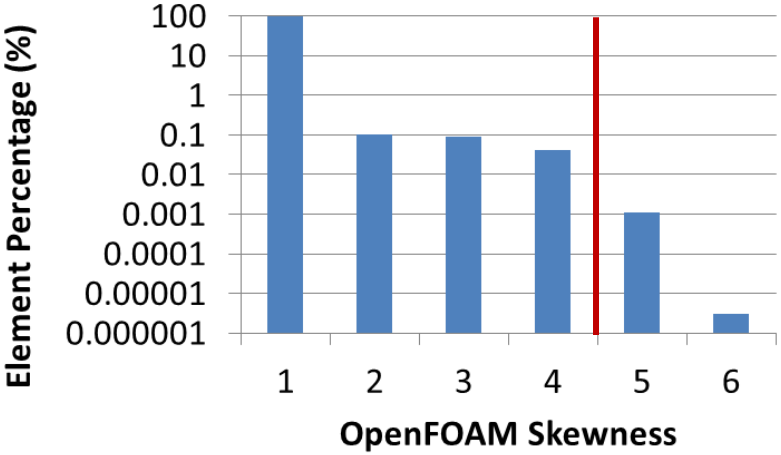
Mesh quality metrics

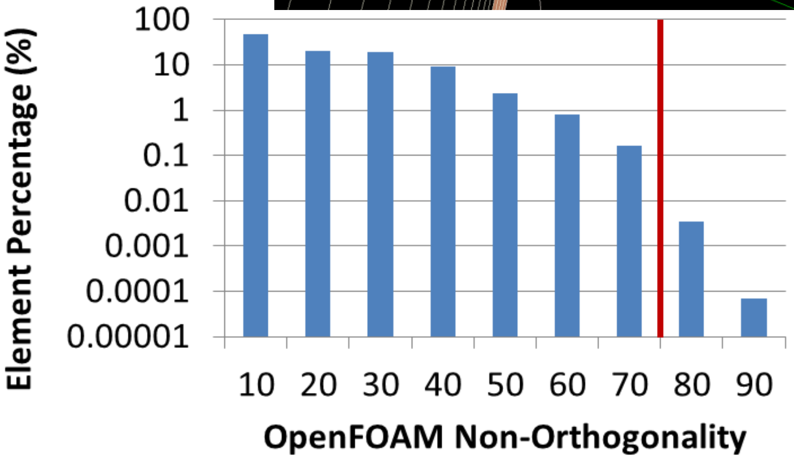
Statistics for Fine HexaPoly mesh
258 million cells (168 million prisms, 90 million core)

Quality violations limited in areas with sharp corners and very thin layers









Files available for download

Available mesh formats are:

- Fluent
- StarCCM+
- OpenFOAM
- CGNS ADF mixed

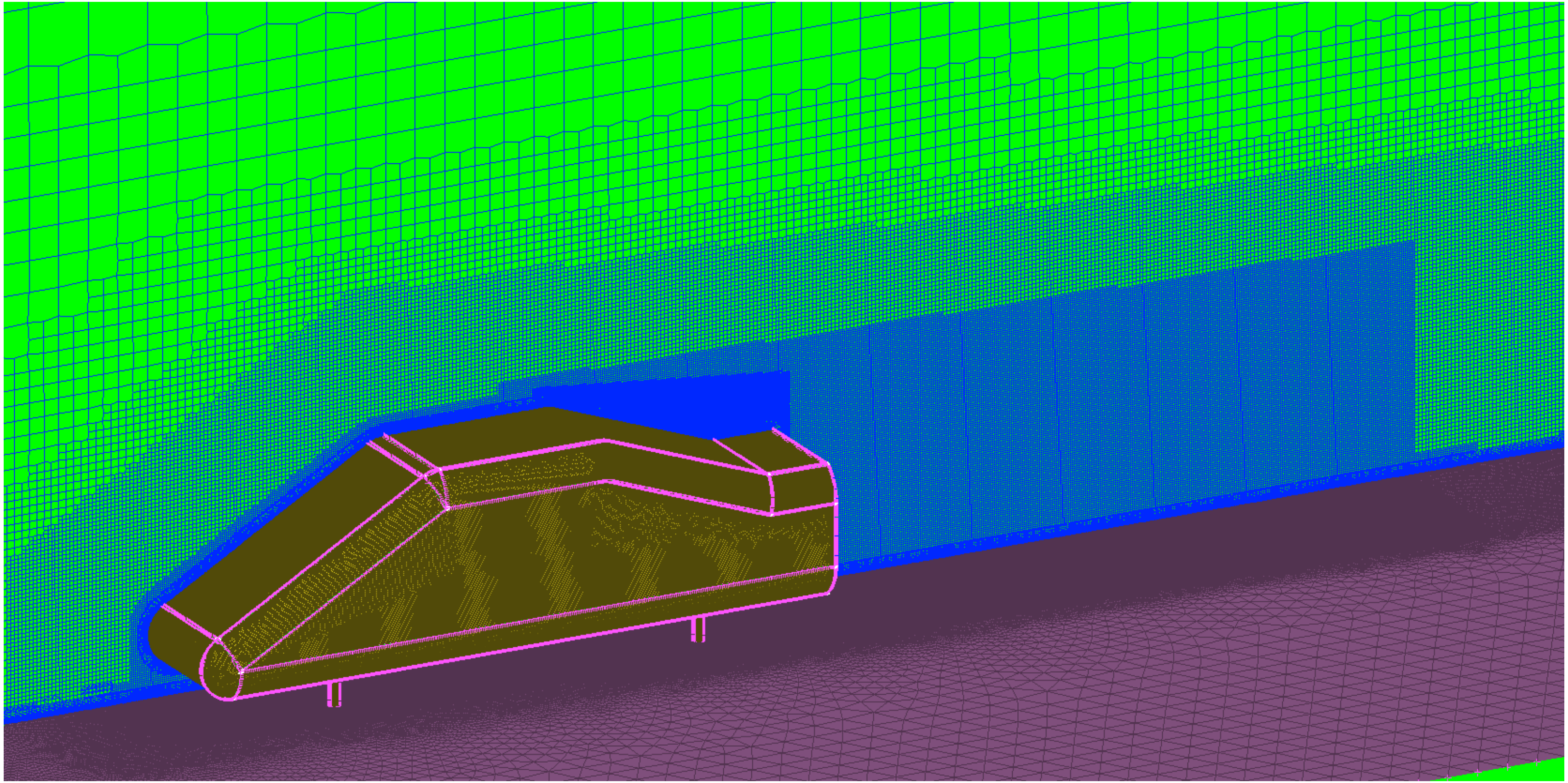
Units are metres

Also available for download:

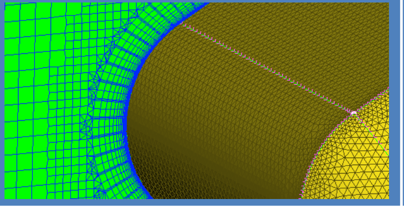
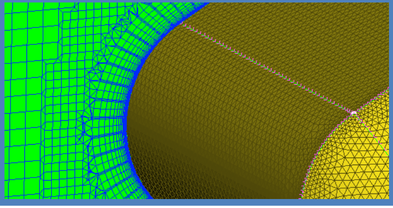
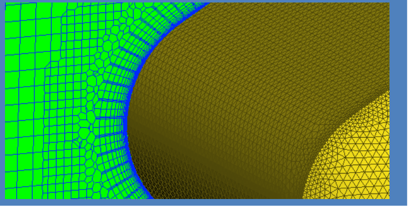
- STEP files of geometries
- STL meshes

Units are mm

Case 1 meshes



Volume mesh sizes (in millions)

	HexaPoly 	HexaInt 	HexaIntConv 
Coarse 692k trias on surface 25 layers	32	32	28
Medium 990k trias on surface 31 layers	53	53	48
Fine 1.5 mil trias on surface 37 layers	94	95	88

Looking for answers…

- Was the boundary layer properly resolved
- Were the three mesh refinement levels adequate to cover needs of RANS, hybrid RANS/LES and WMLES
- Was mesh independence achieved for any model?
- Which volume mesh approach gave best results? (RANS, LES, accuracy, convergence…?)

BETA
SIMULATION SOLUTIONS

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