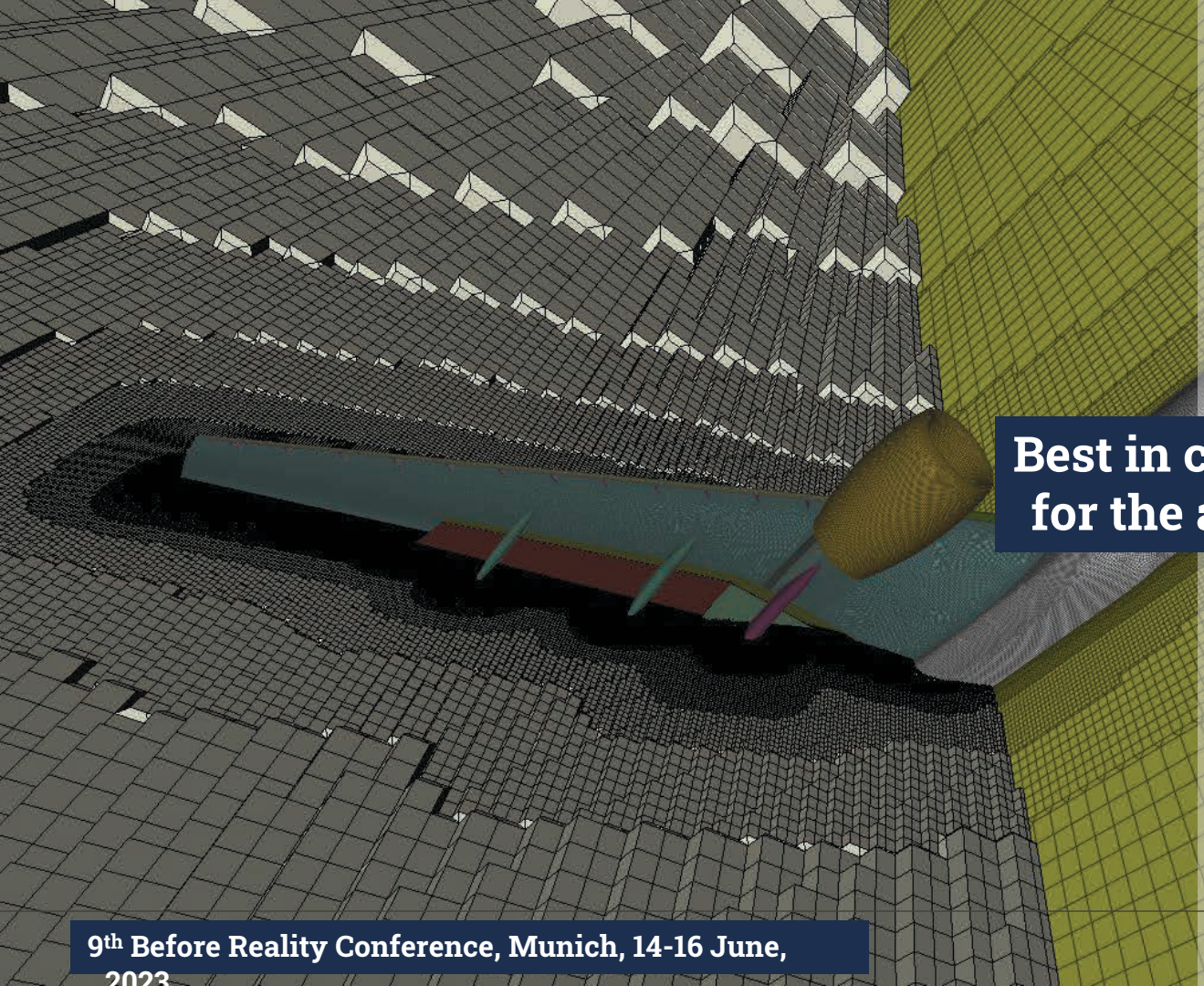


BETA

SIMULATION SOLUTIONS

Best in class CFD meshing for the aerospace sector

Vangelis Skaperdas

physics on screen

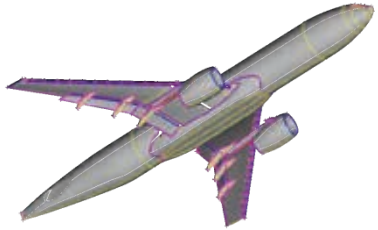
9th Before Reality Conference, Munich, 14-16 June, 2023

ANSA evolution

Born in the automotive industry back in the early 90s, for FEA meshing

In the late 90s it becomes widespread for CFD meshing in motorsports teams and OEMs

In the late 2000s it enters the CFD aerospace sector and is growing ever since



What is the recipe of success of a pre-processing software?

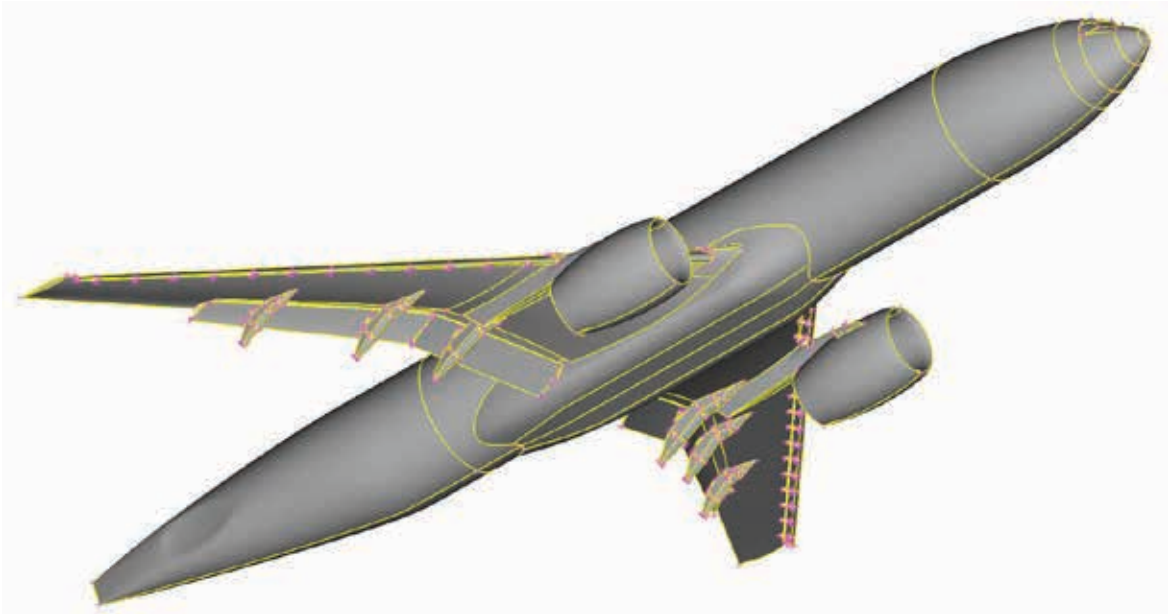
Recipe:

INGREDIENTS:	DIRECTIONS:
Quality	Geometry and flow features - Mesh quality - Consistency
Speed	
Automation	Minimum to no user involvement
User Control	No black box approach
Feedback	GUI guidance, preview, reporting…
Efficiency	Most accurate result with least cell count
Wide range of functionality	Geometry, Mesh, Morph, Model update …
Discipline and solver independent	A common yet adaptable approach to all CAE problems
Support!!!	

Case study description

- Demonstrate ANSA pre-processing capabilities on the geometry of the CRM model from the 4th High Lift Prediction Workshop

- ANSA v23.1.2



- Linux workstation with AMD Ryzen Threadripper 3970X with 32 cores (64 threads) and 256Gb RAM

ANSA steps to high fidelity mesh generation

1- Start ANSA in CFD layout and select your meshing profile

2- Read the CAD and check its topology

4- Assign correct orientation

3- Create the domain

5- Assign PIDs and BC types

6- Detect and manage Features

7- Setup Batch Mesh

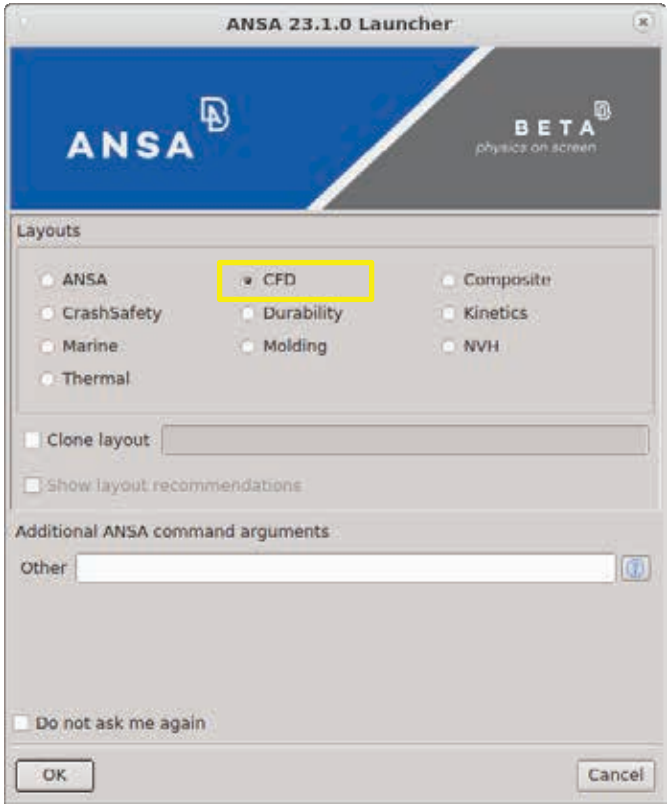
8- Setup Size Field

9- Execute Batch Mesh

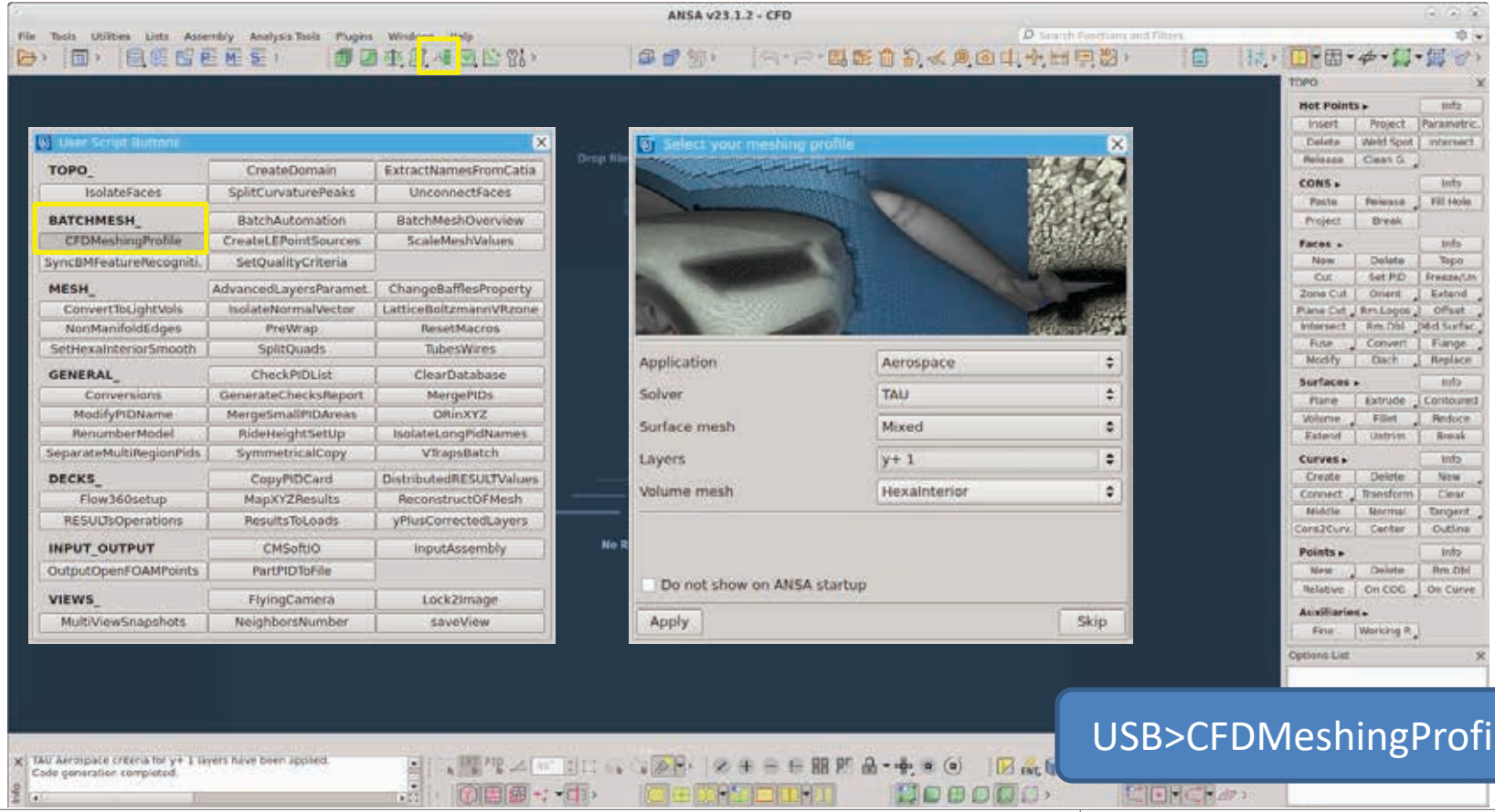
10- Check Mesh quality

11 – Output mesh

Launching ANSA for CFD



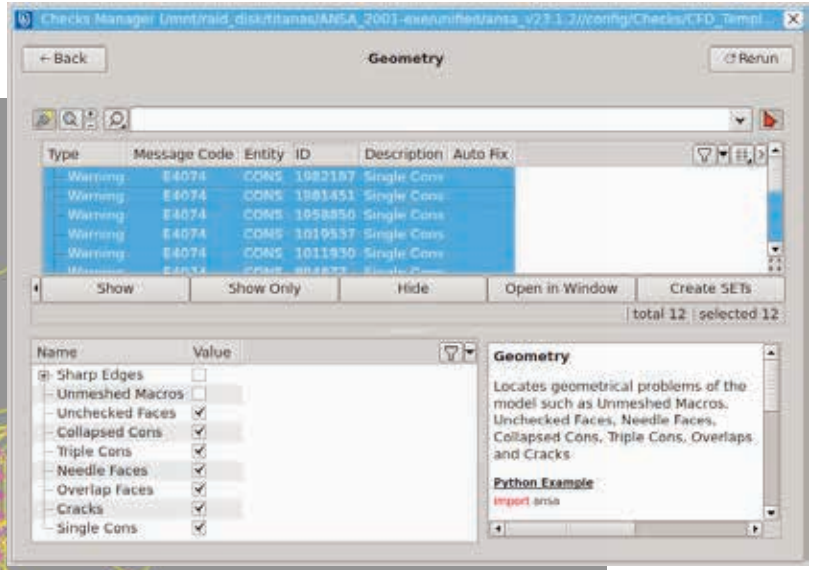
Selecting a Meshing Profile



USB>CFDMeshingProfile

Geometry import and check

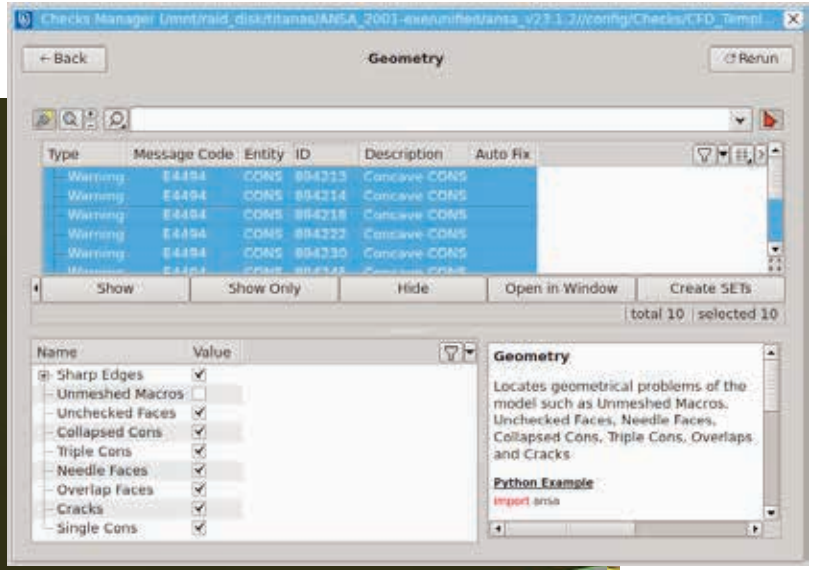
Topological errors



Check>Geometry

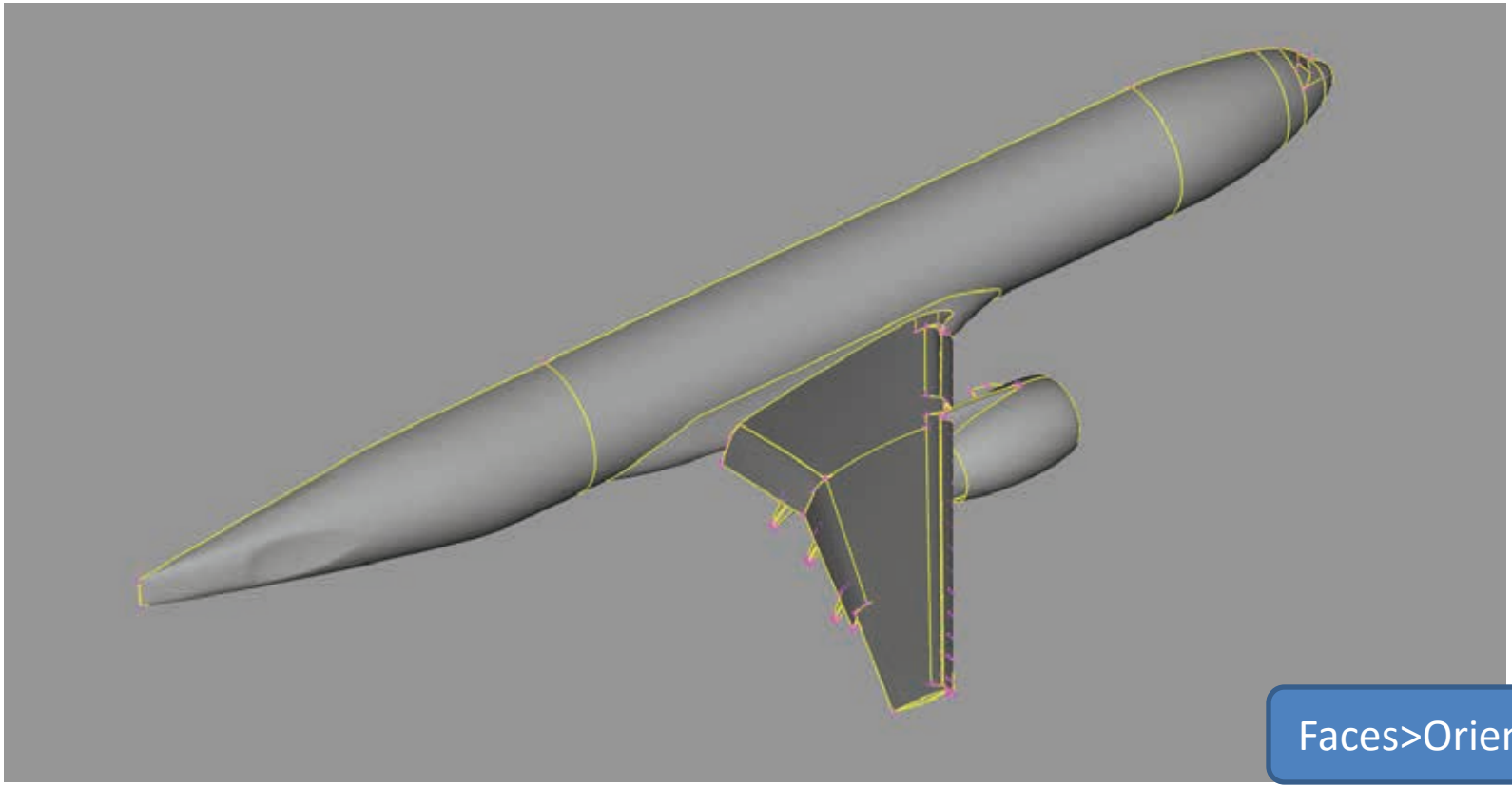
Geometry import and check

Very concave areas



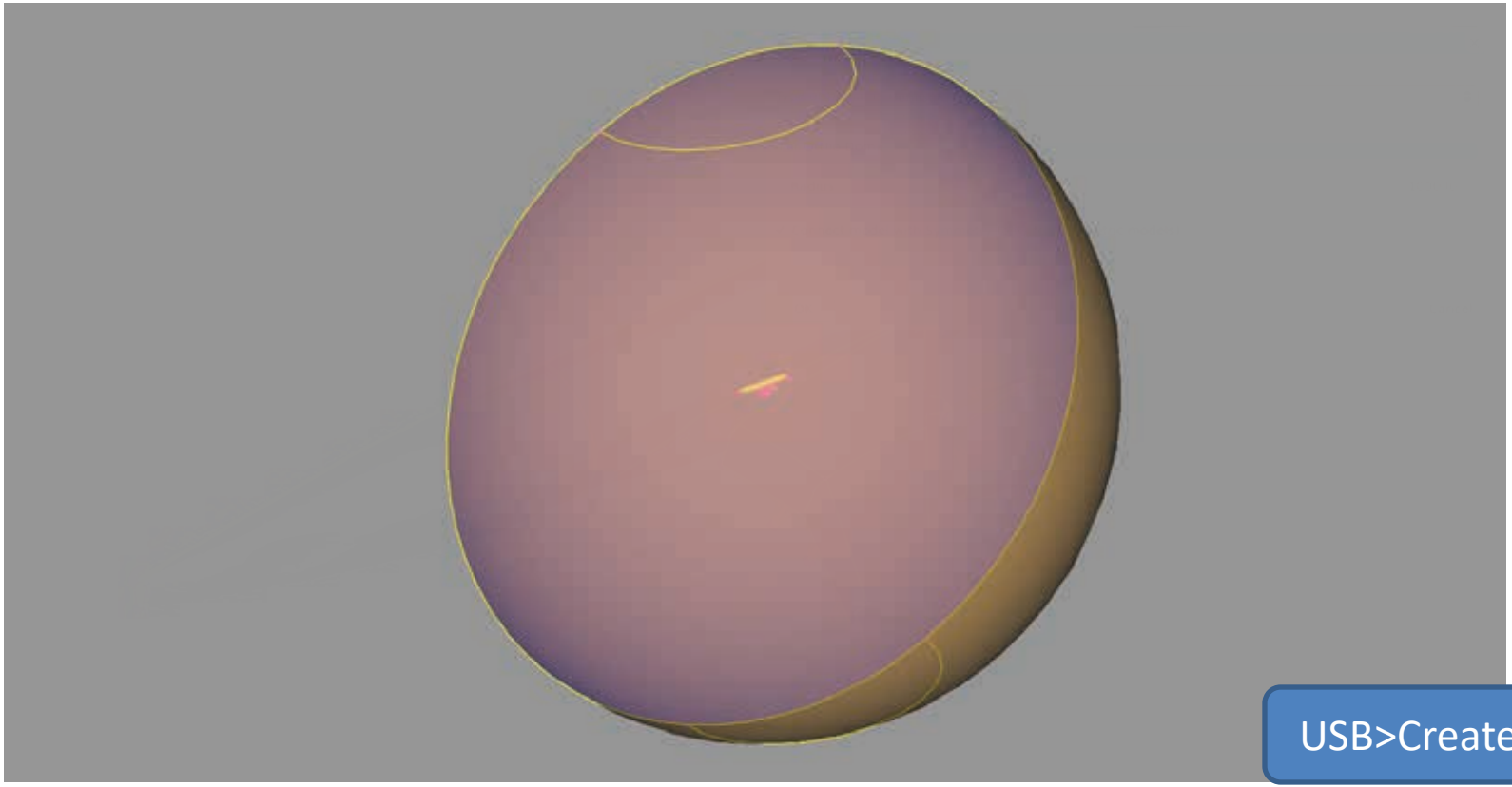
Check>Geometry

Correct orientation



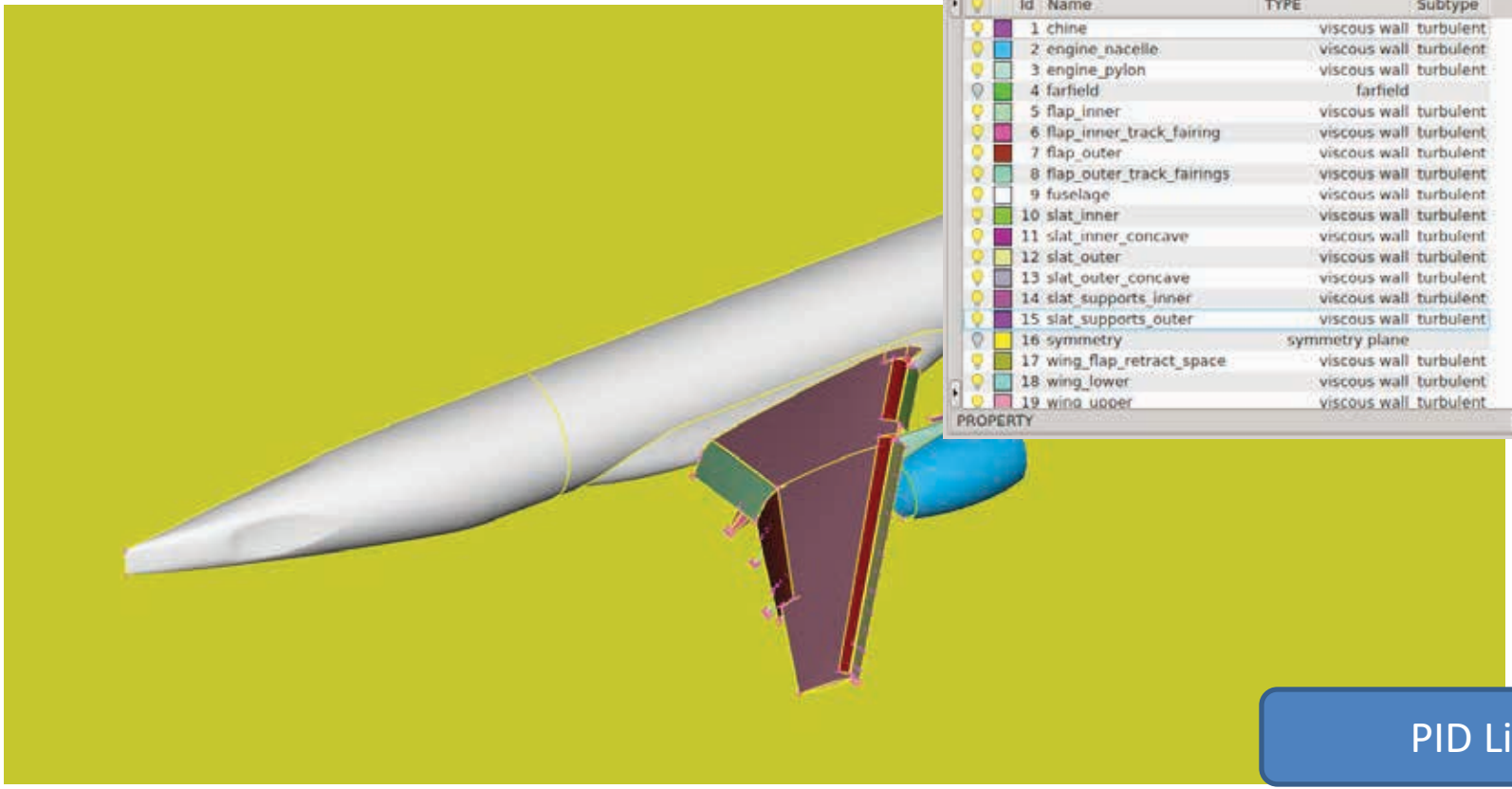
Faces>Orient [Auto]

Domain creation



USB>CreateDomain

Assigning PIDs and BC type



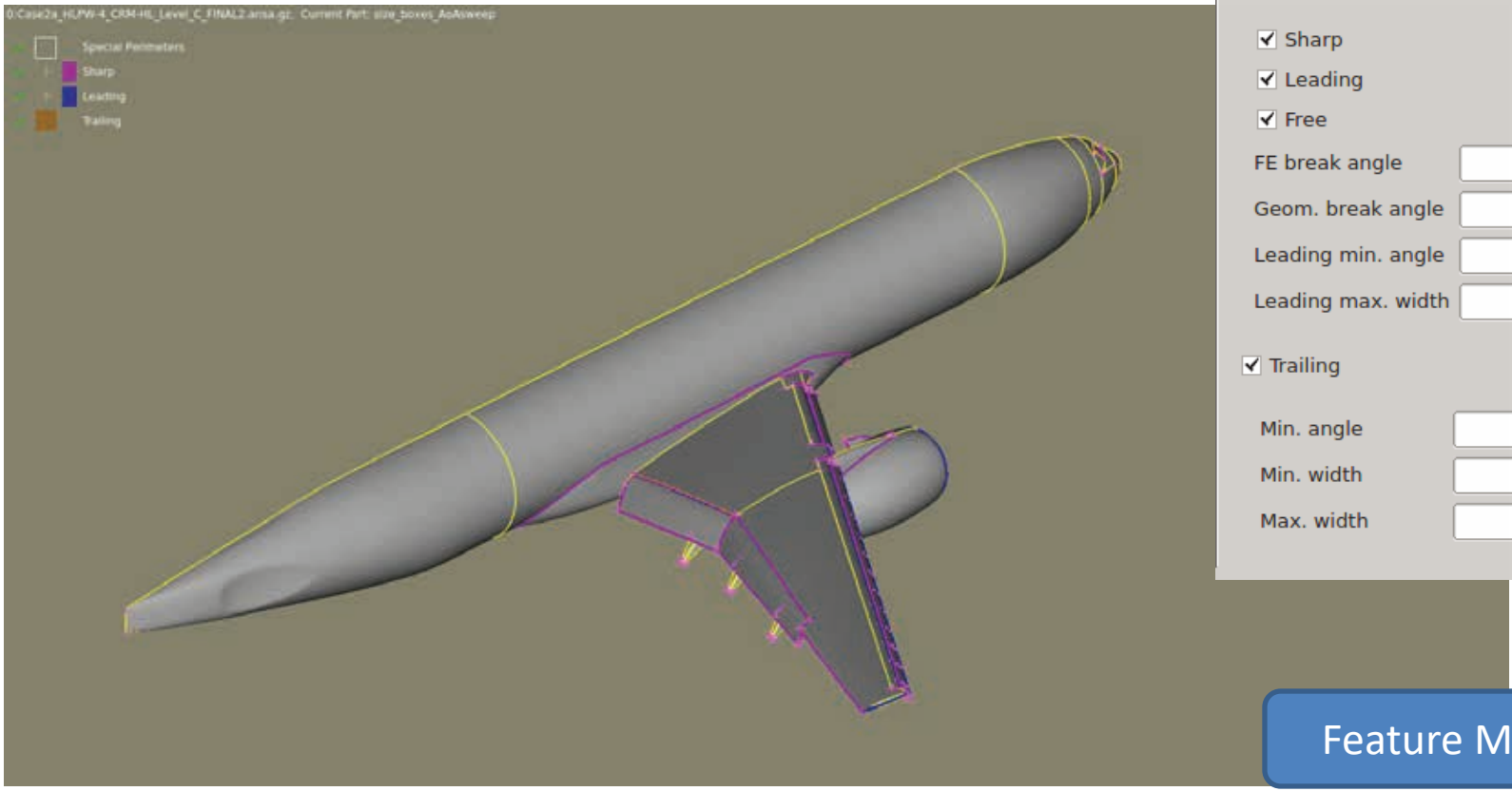
Properties

Id	Name	TYPE	Subtype
1	chine	viscous wall	turbulent
2	engine_nacelle	viscous wall	turbulent
3	engine_pylon	viscous wall	turbulent
4	farfield	farfield	
5	flap_inner	viscous wall	turbulent
6	flap_inner_track_fairing	viscous wall	turbulent
7	flap_outer	viscous wall	turbulent
8	flap_outer_track_fairings	viscous wall	turbulent
9	fuselage	viscous wall	turbulent
10	slat_inner	viscous wall	turbulent
11	slat_inner_concave	viscous wall	turbulent
12	slat_outer	viscous wall	turbulent
13	slat_outer_concave	viscous wall	turbulent
14	slat_supports_inner	viscous wall	turbulent
15	slat_supports_outer	viscous wall	turbulent
16	symmetry	symmetry plane	
17	wing_flap_retract_space	viscous wall	turbulent
18	wing_lower	viscous wall	turbulent
19	wing_upper	viscous wall	turbulent

PROPERTY | total 22 | selected 0

PID List

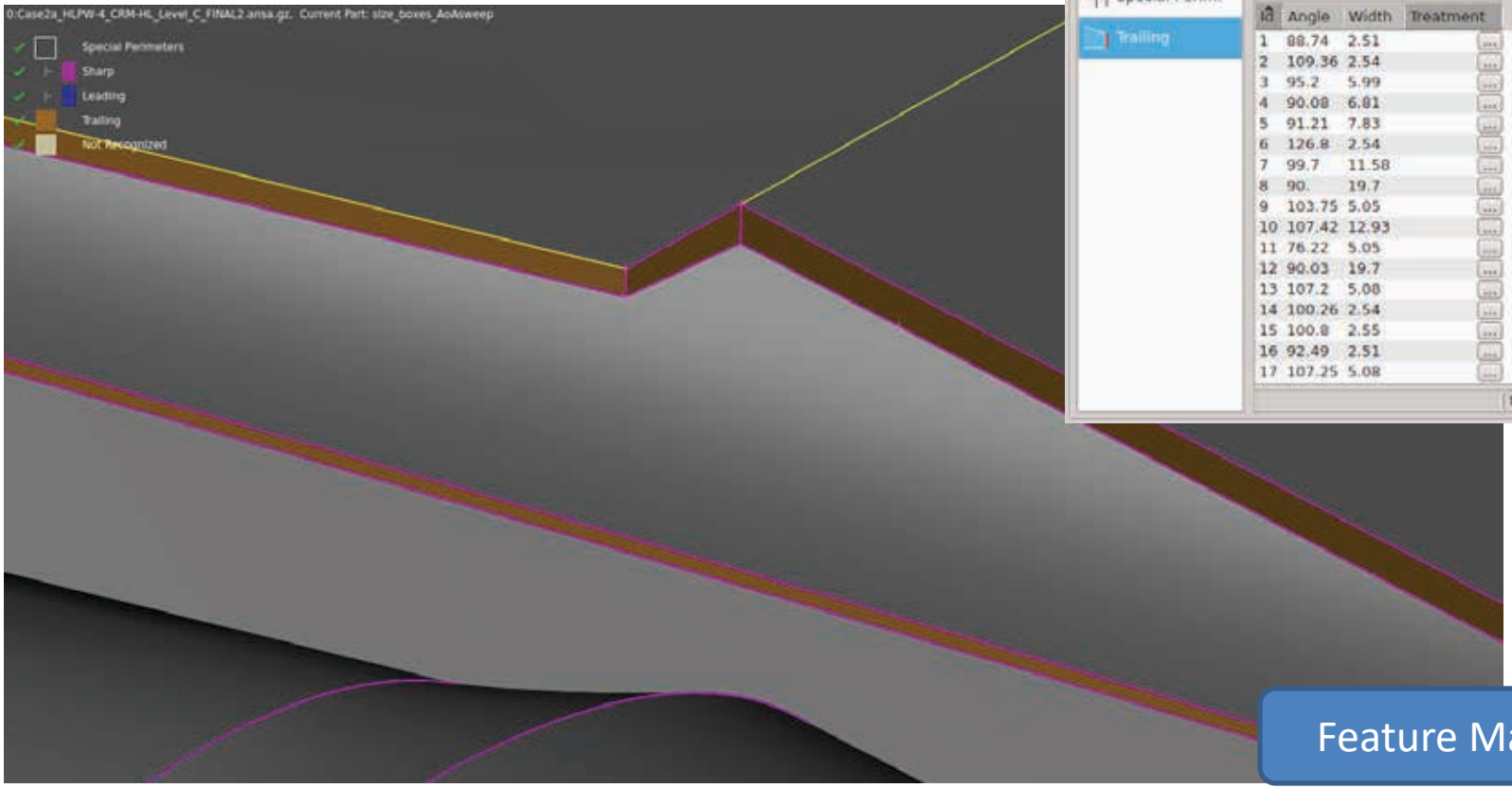
Detection and Management of geometrical Features



Special Perimeters
Sharp
Leading
Free
FE break angle 30.
Geom. break angle 20.
Leading min. angle 120.
Leading max. width 200.
Trailing
Min. angle 30.
Min. width 0.5
Max. width 50.

Feature Manager

Detection and Management of Features

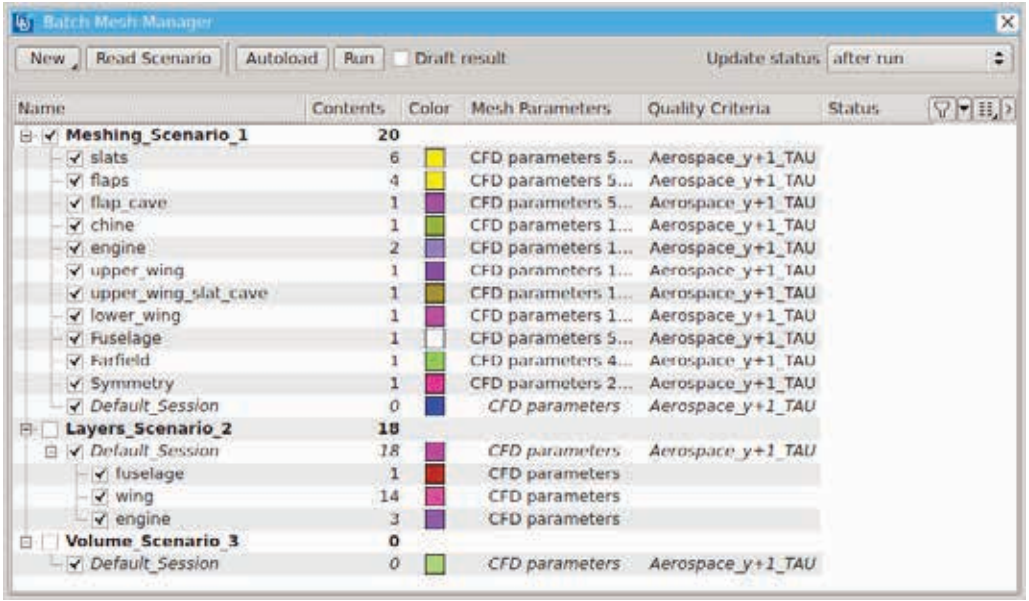


Feature Manager

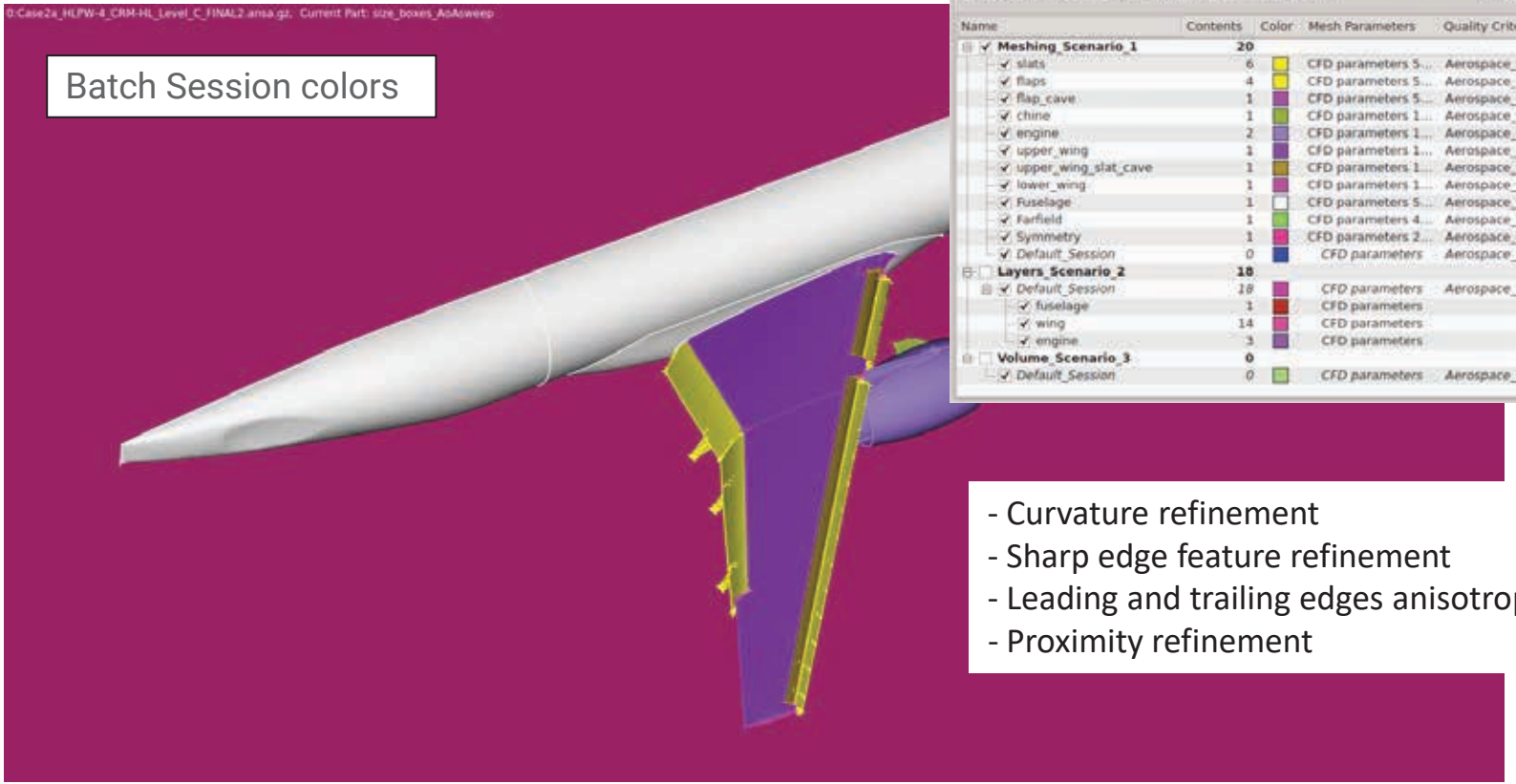
Batch Mesh tool

Batch Mesh tool in ANSA performs fully automatic surface and volume meshing, ensuring:

- Automation
- Reusability of scenario templates for new geometries
- No user interaction and hence consistency in meshing
- Facilitates mesh refinement studies
- Mesh specs traceability as template is saved in ANSA file



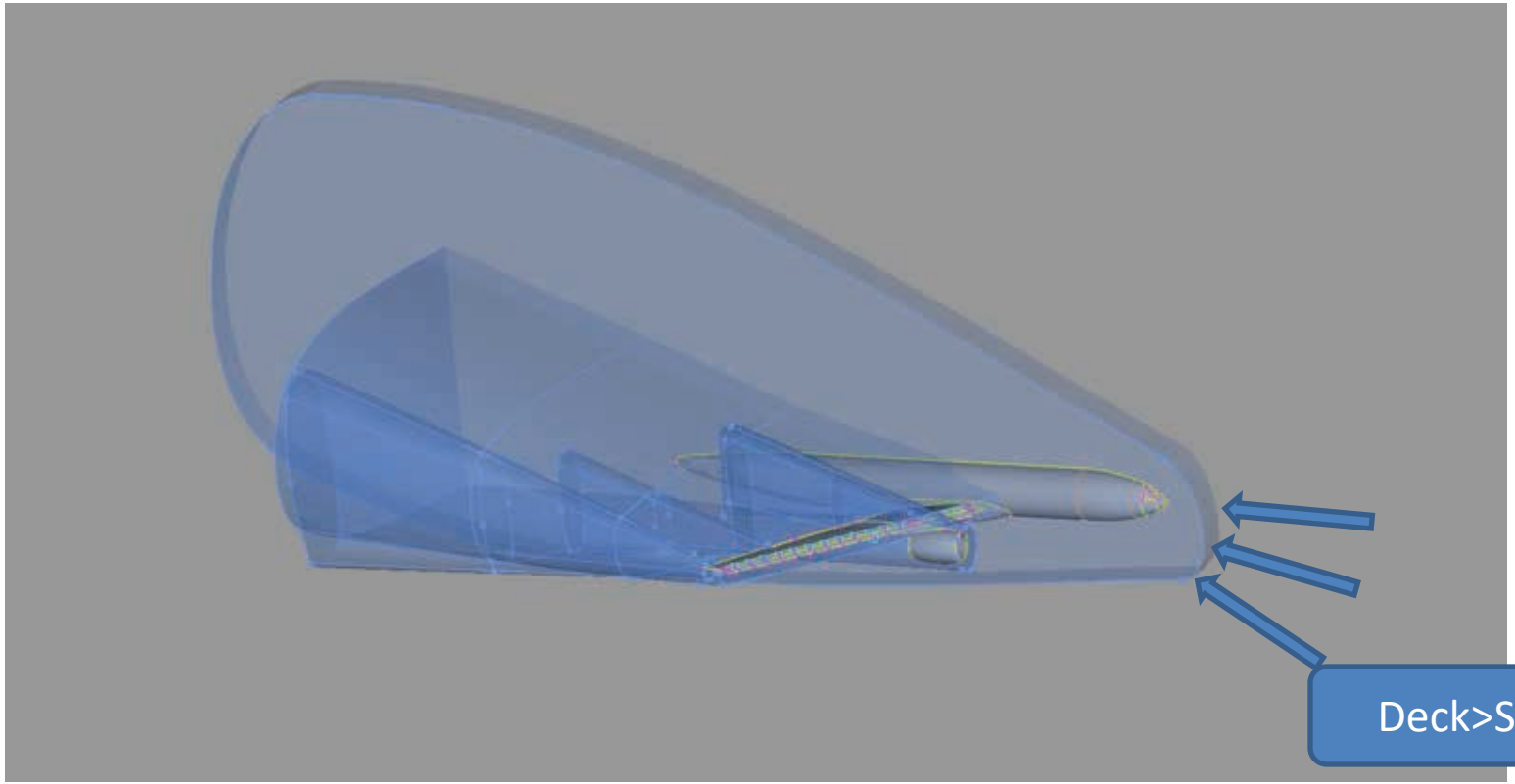
Setup of Batch Mesh tool



- Curvature refinement
- Sharp edge feature refinement
- Leading and trailing edges anisotropic meshing
- Proximity refinement

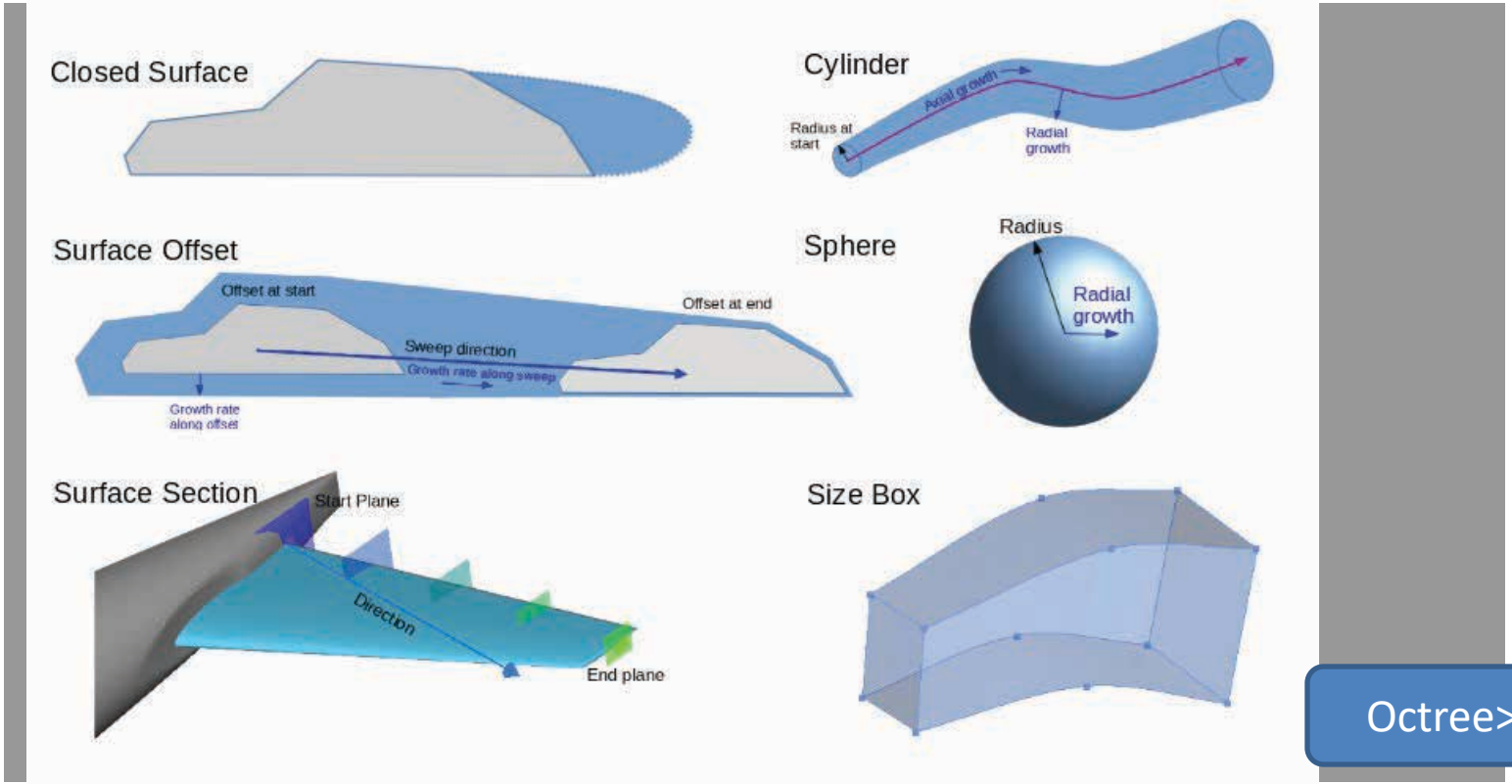
Setup of additional size refinement zones

Creation of flexible Size Boxes to control the wake refinement



Setup of additional size refinement zones

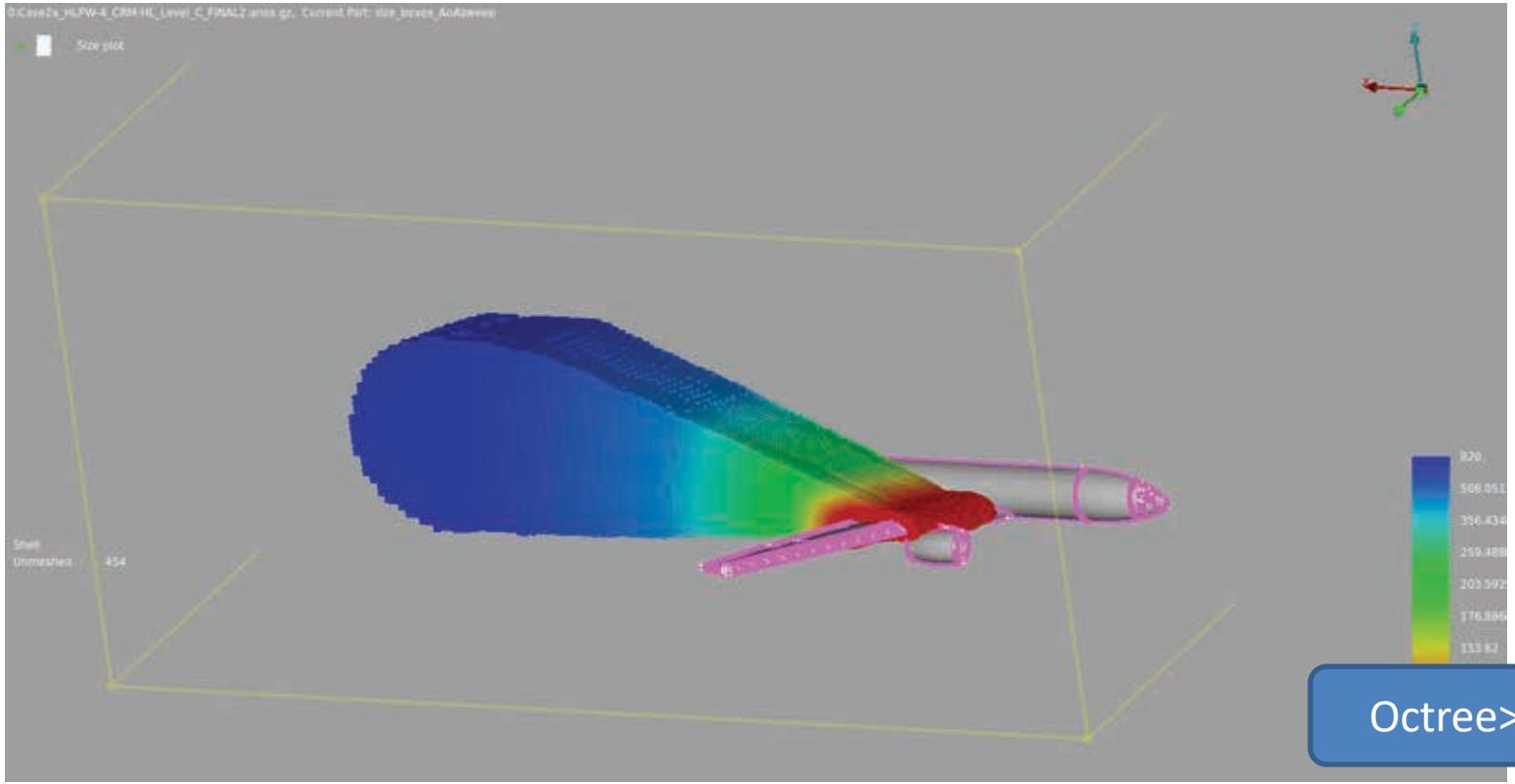
Specification of advanced Size Field functions



Octree>Size Field

Setup of Size Field

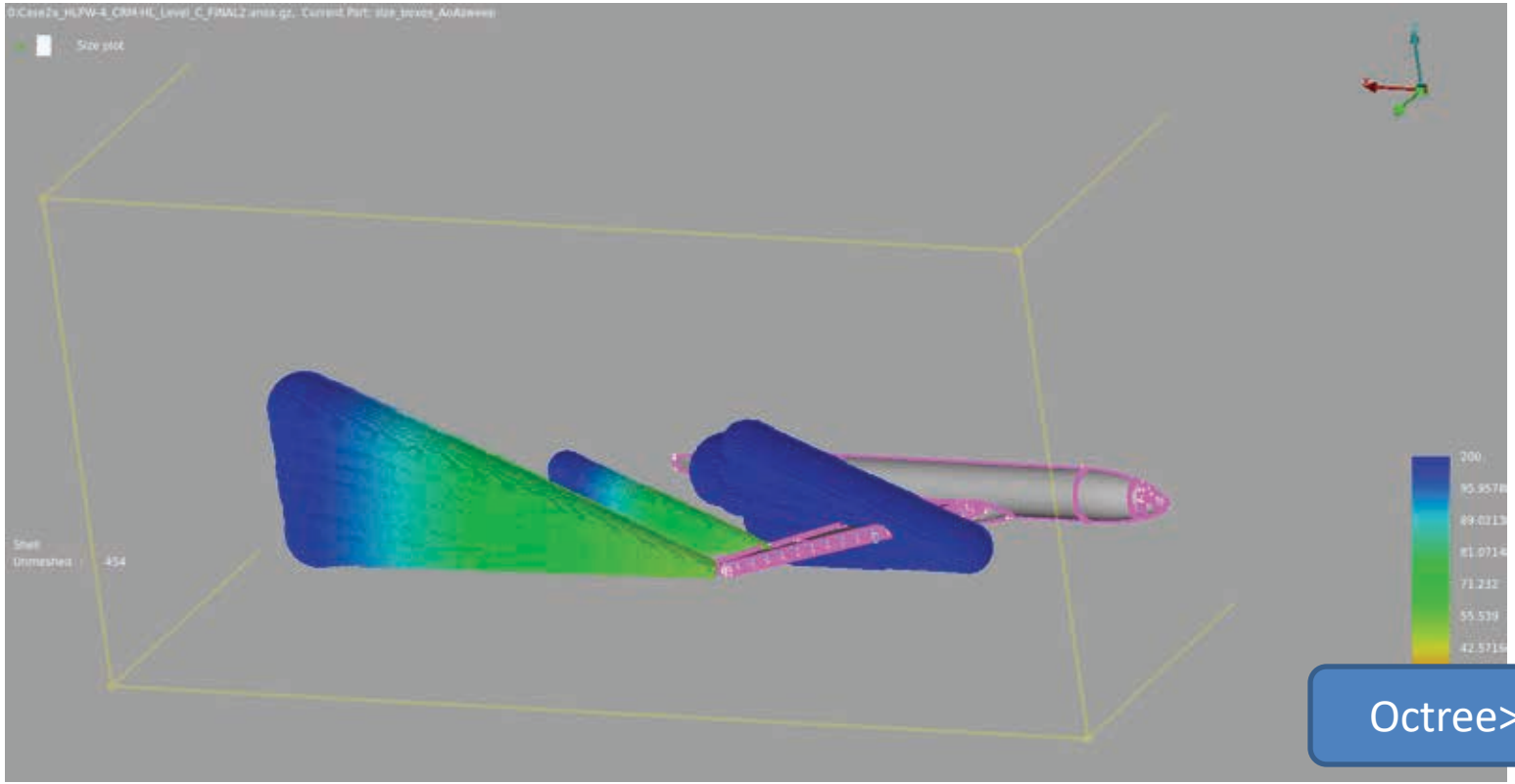
Surface Offset Rule from selected PIDs along a user specified direction



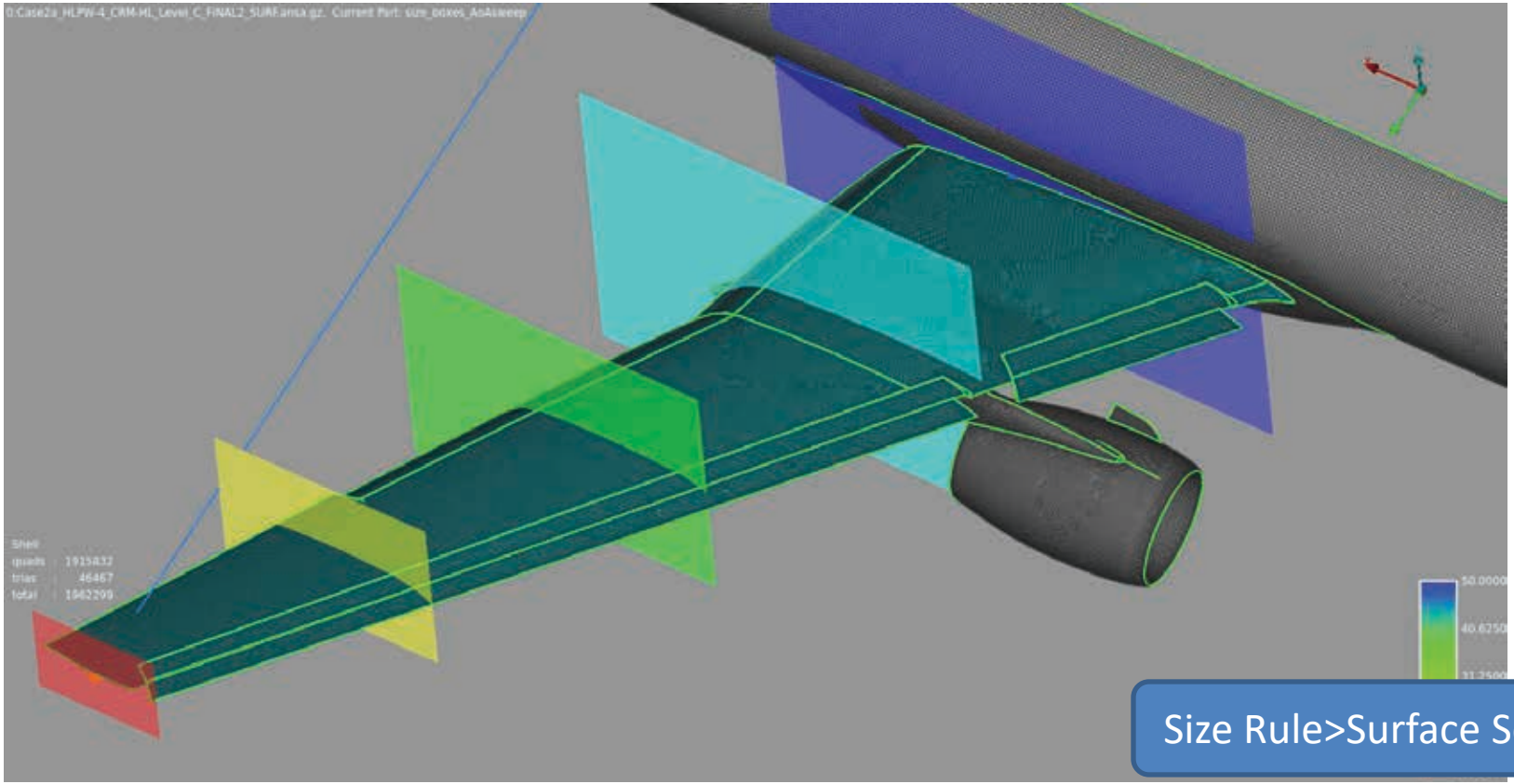
Octree>Size Field

Setup of Size Field

Cylinder Rule along selected 3D Curves



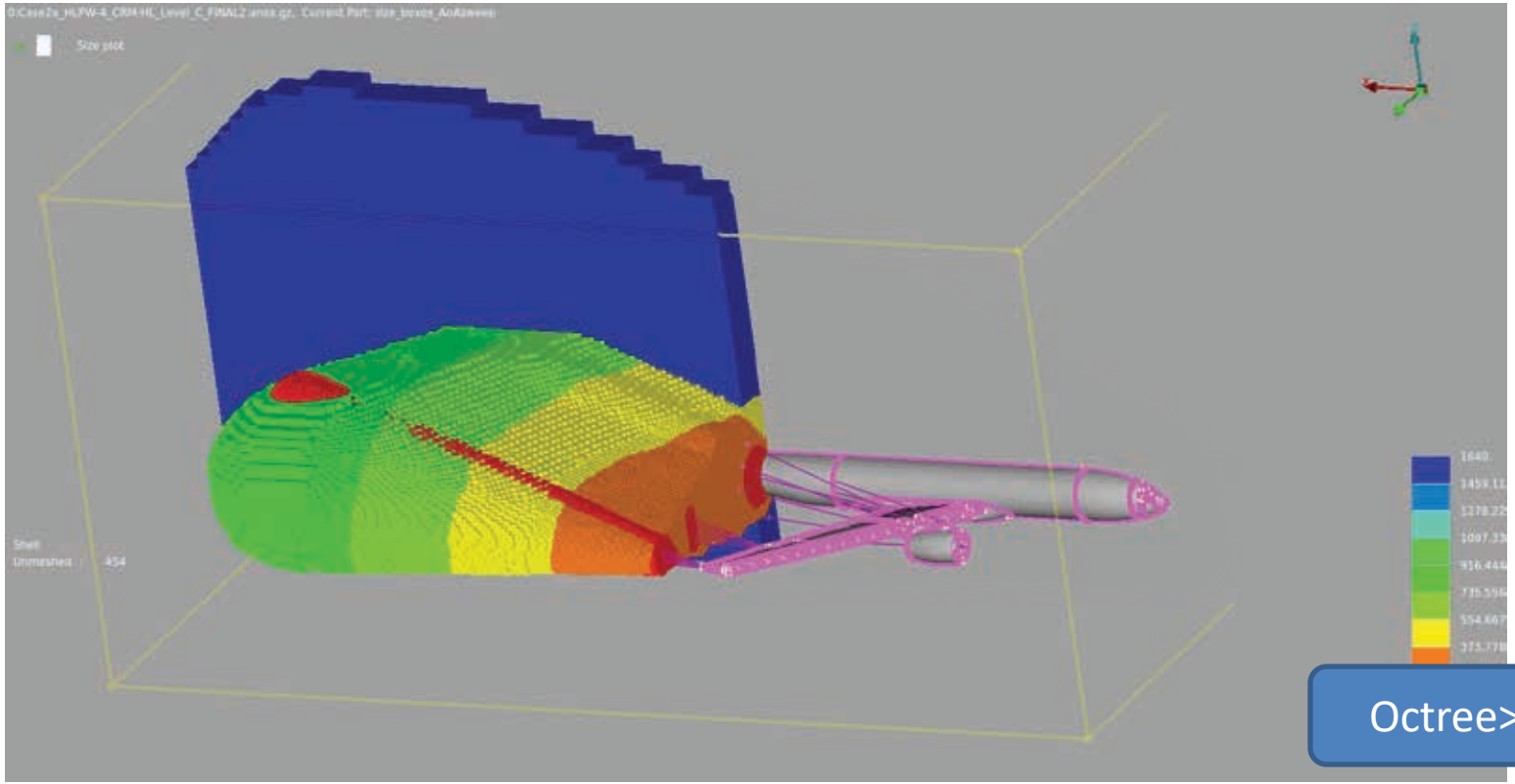
Main wing – Linear Variation of maximum length



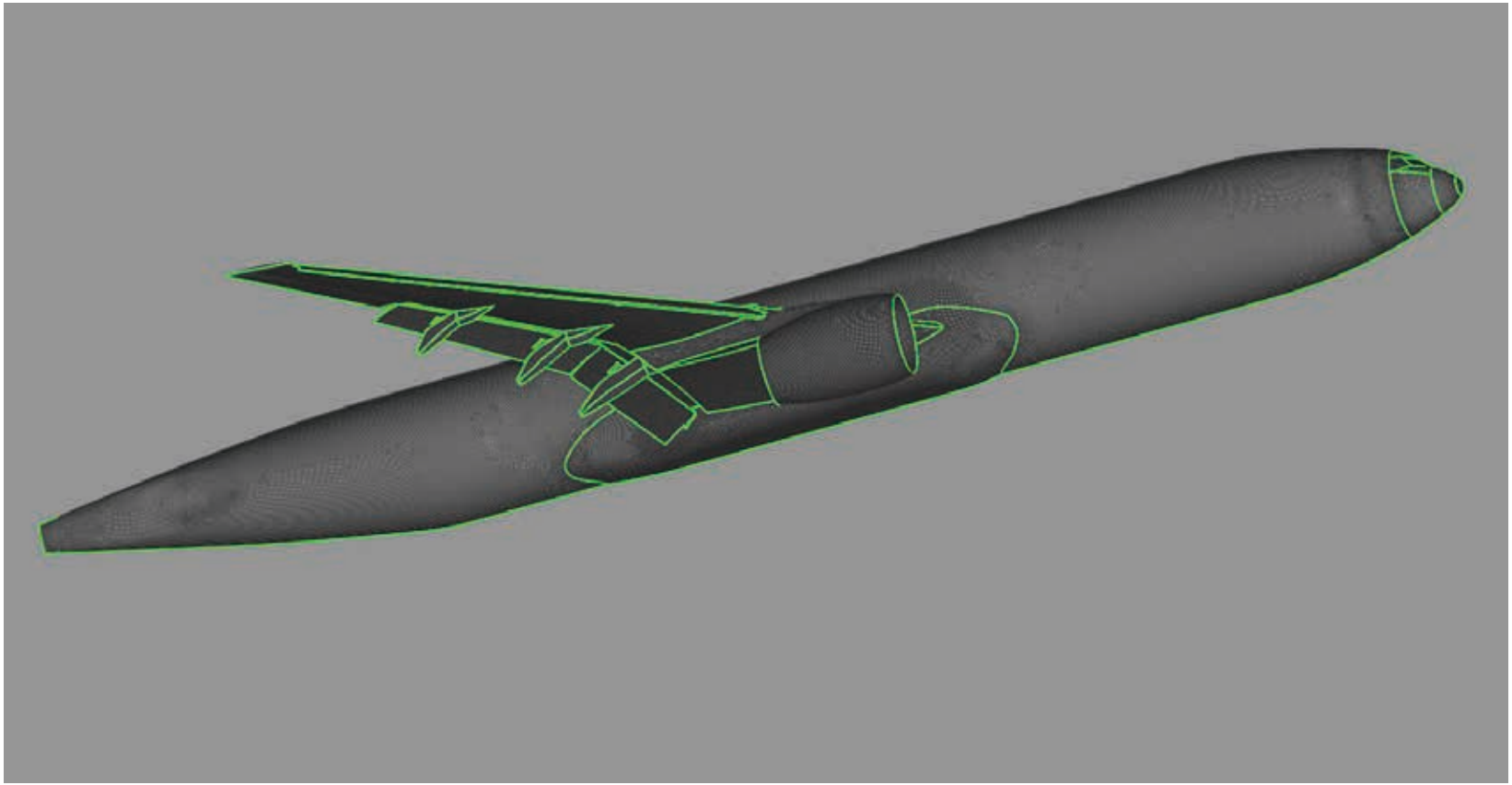
Size Rule>Surface Section

Setup of Size Field

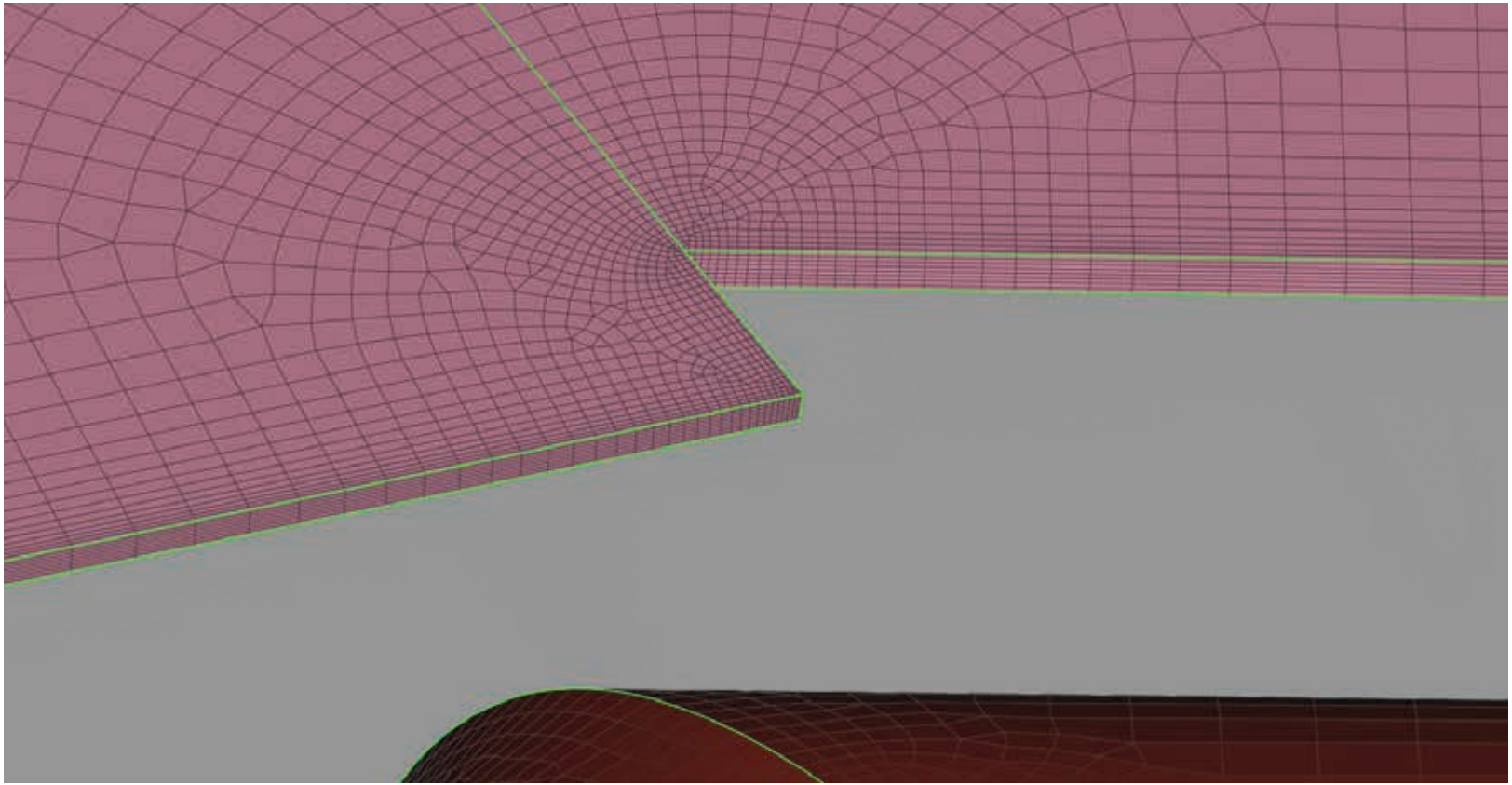
Final combined Size Field



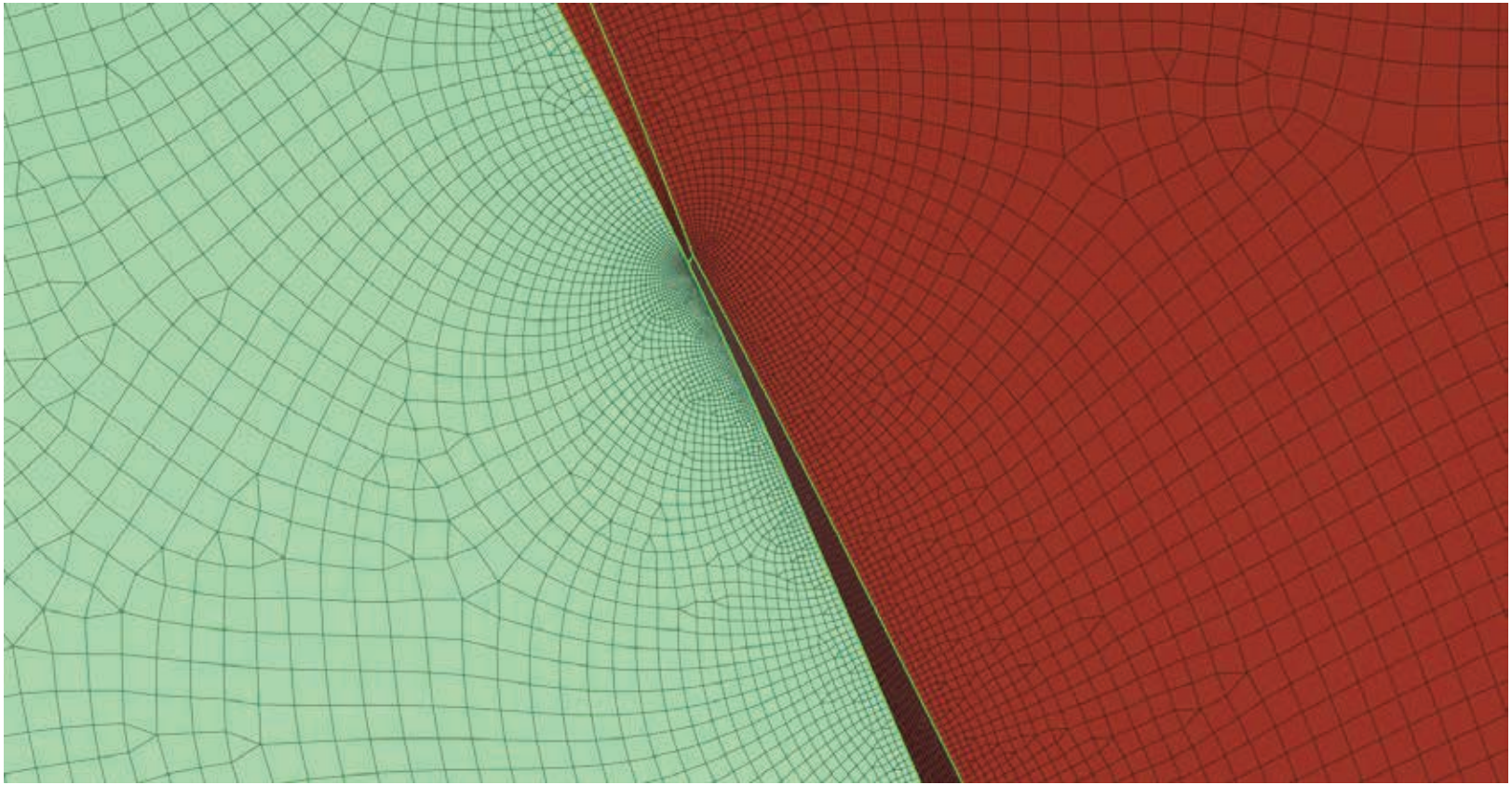
Surface mesh Level C refinement - 2 million shells



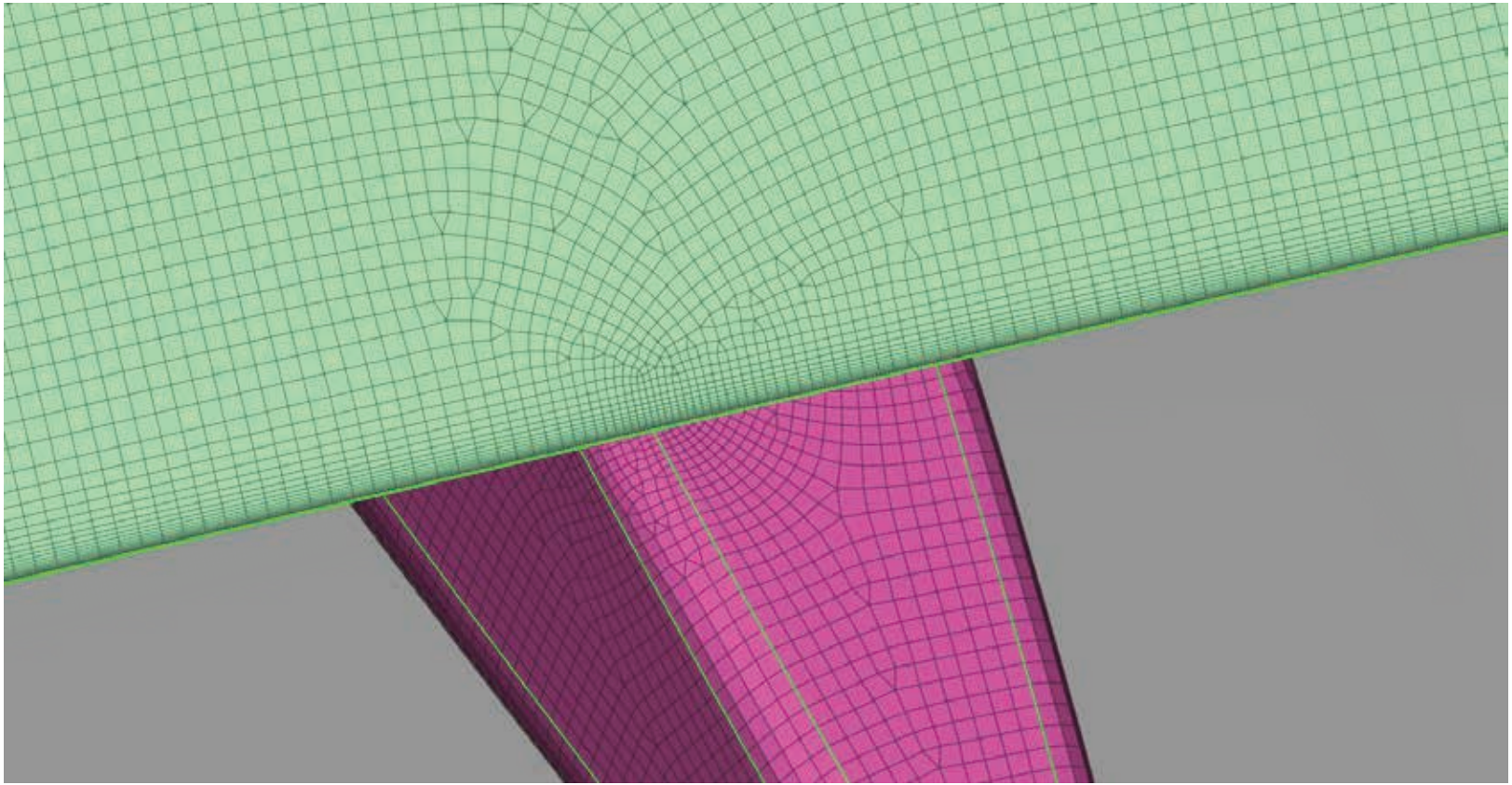
Flaps area



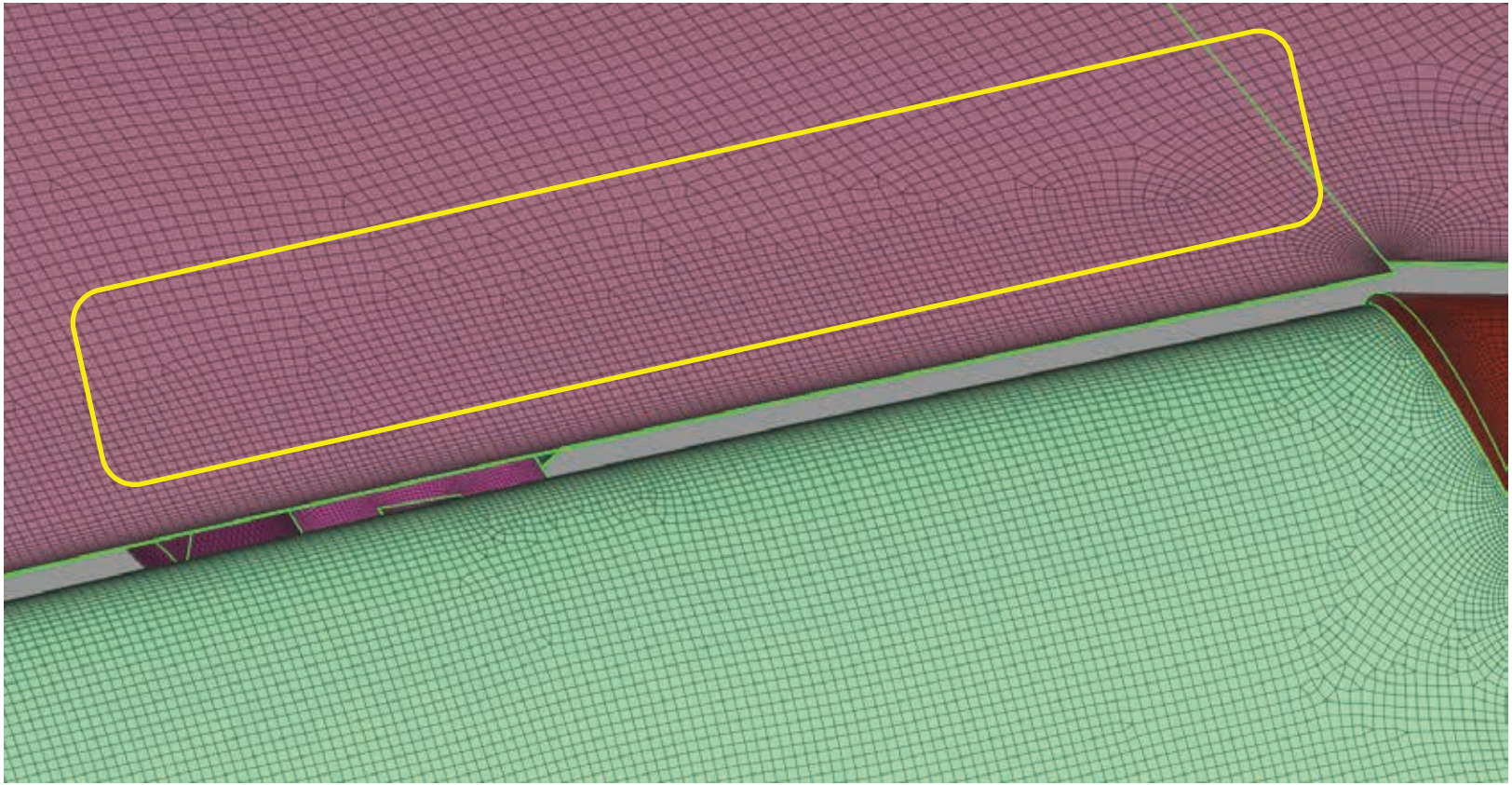
Flaps area



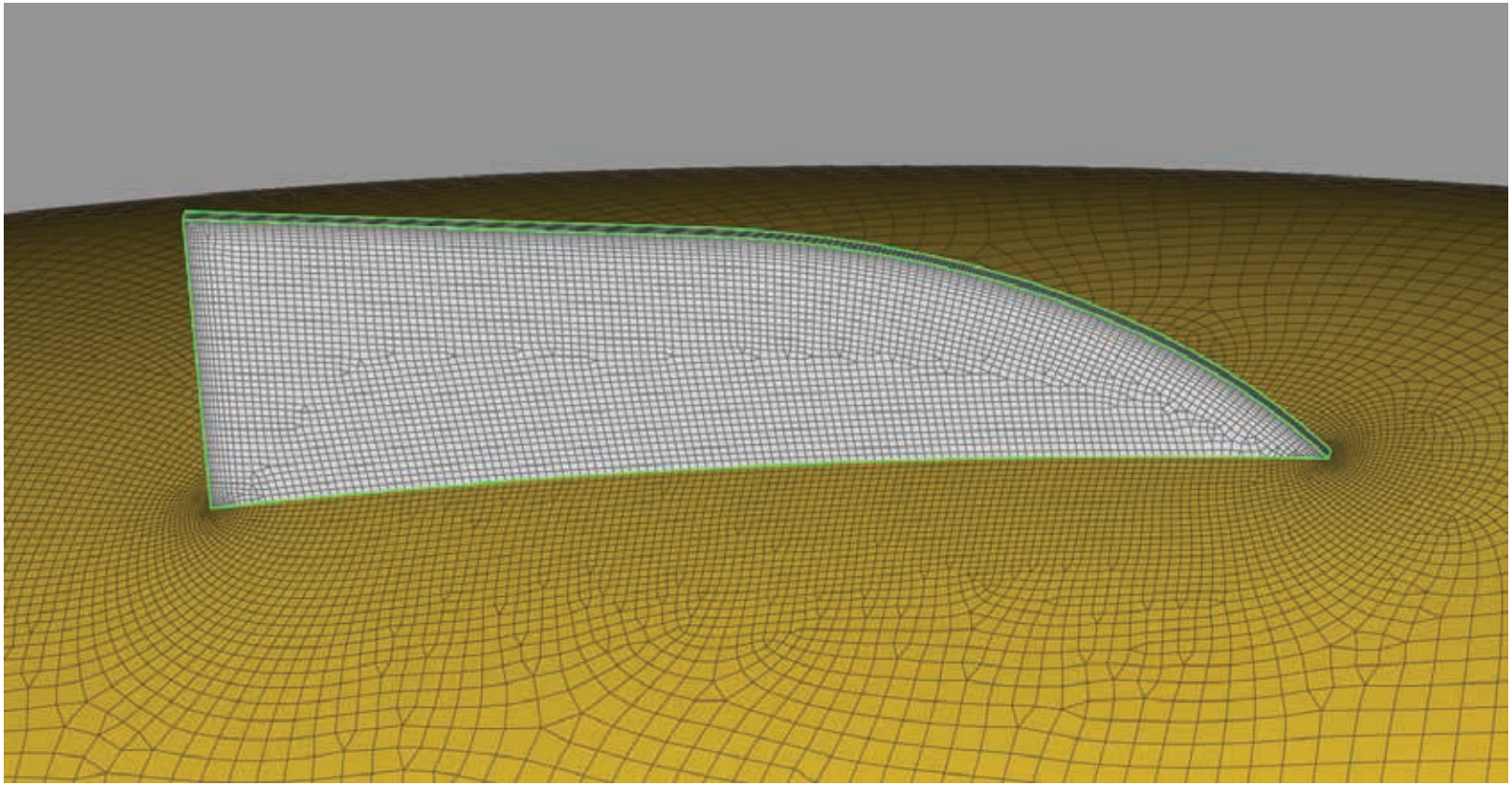
Flaps area



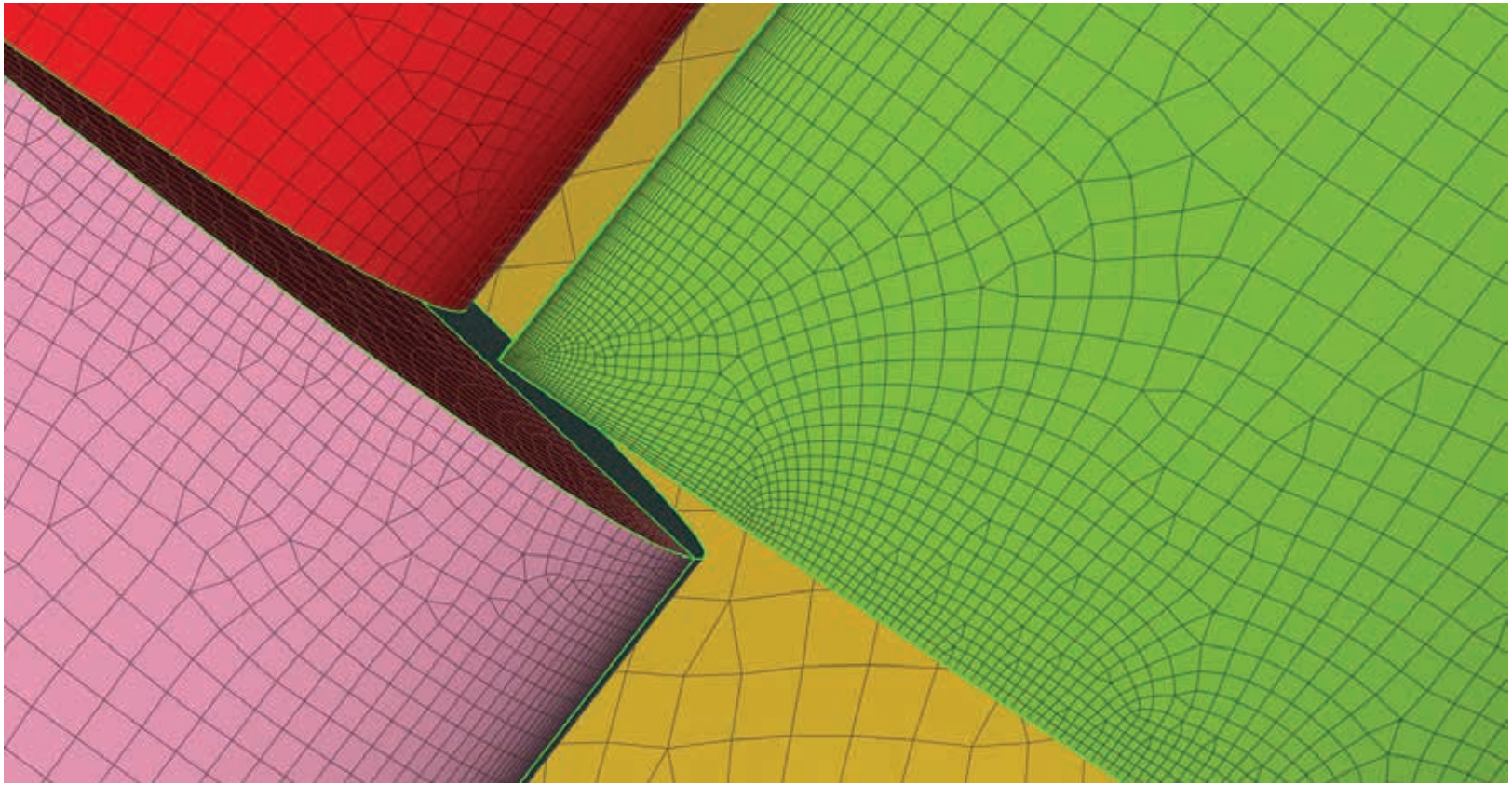
Flaps area



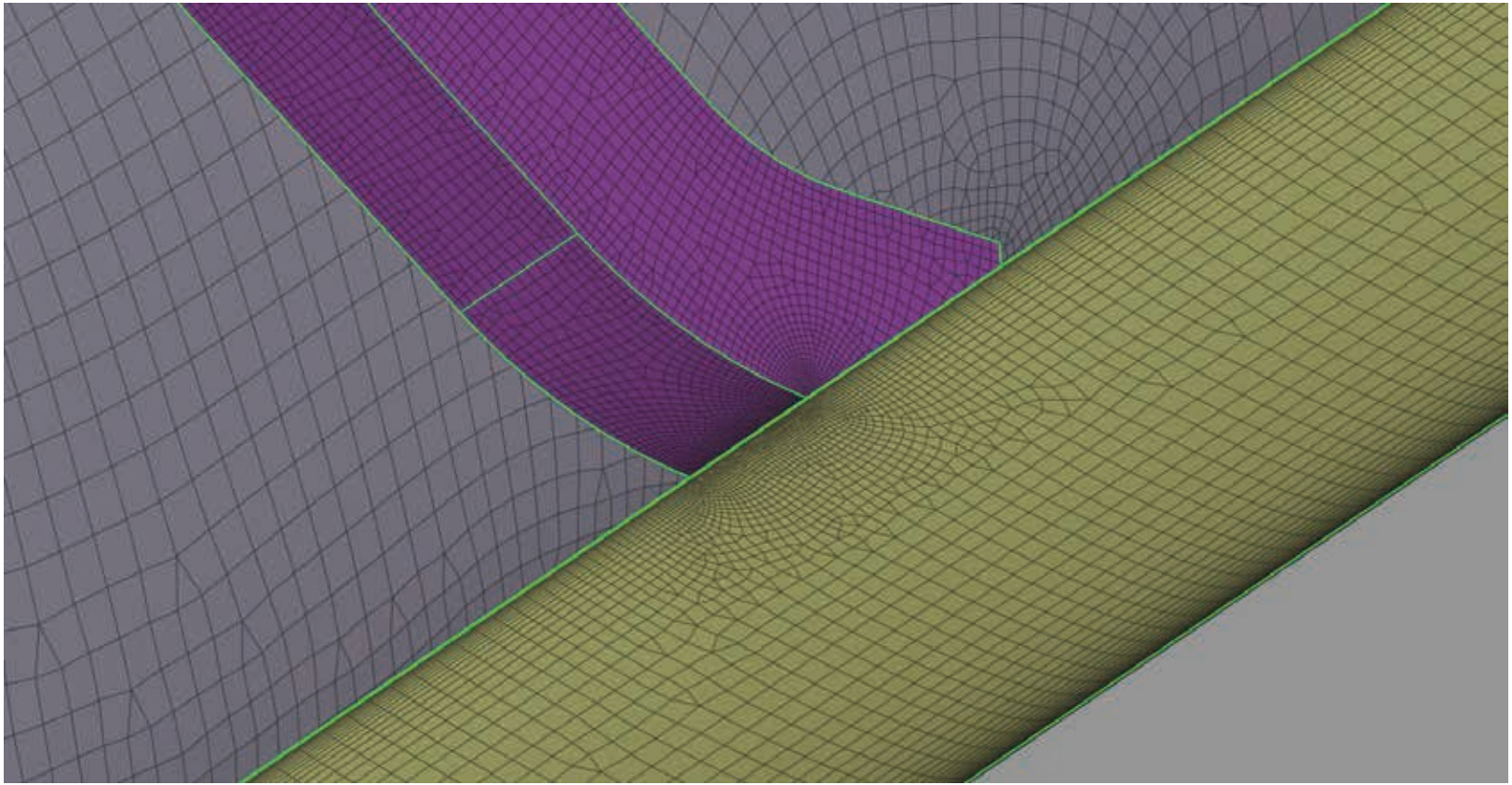
Engine nacelle area



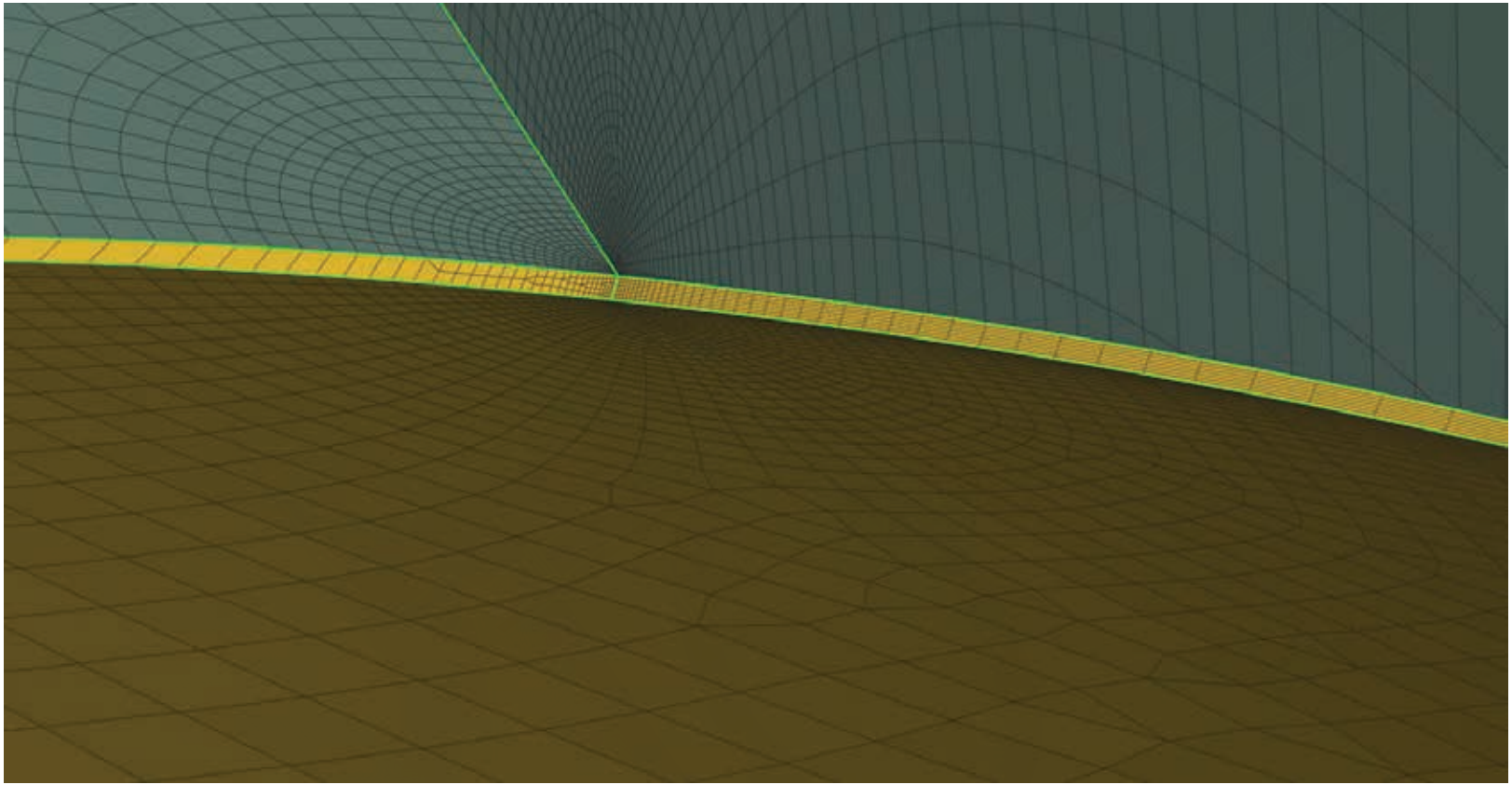
Engine nacelle area



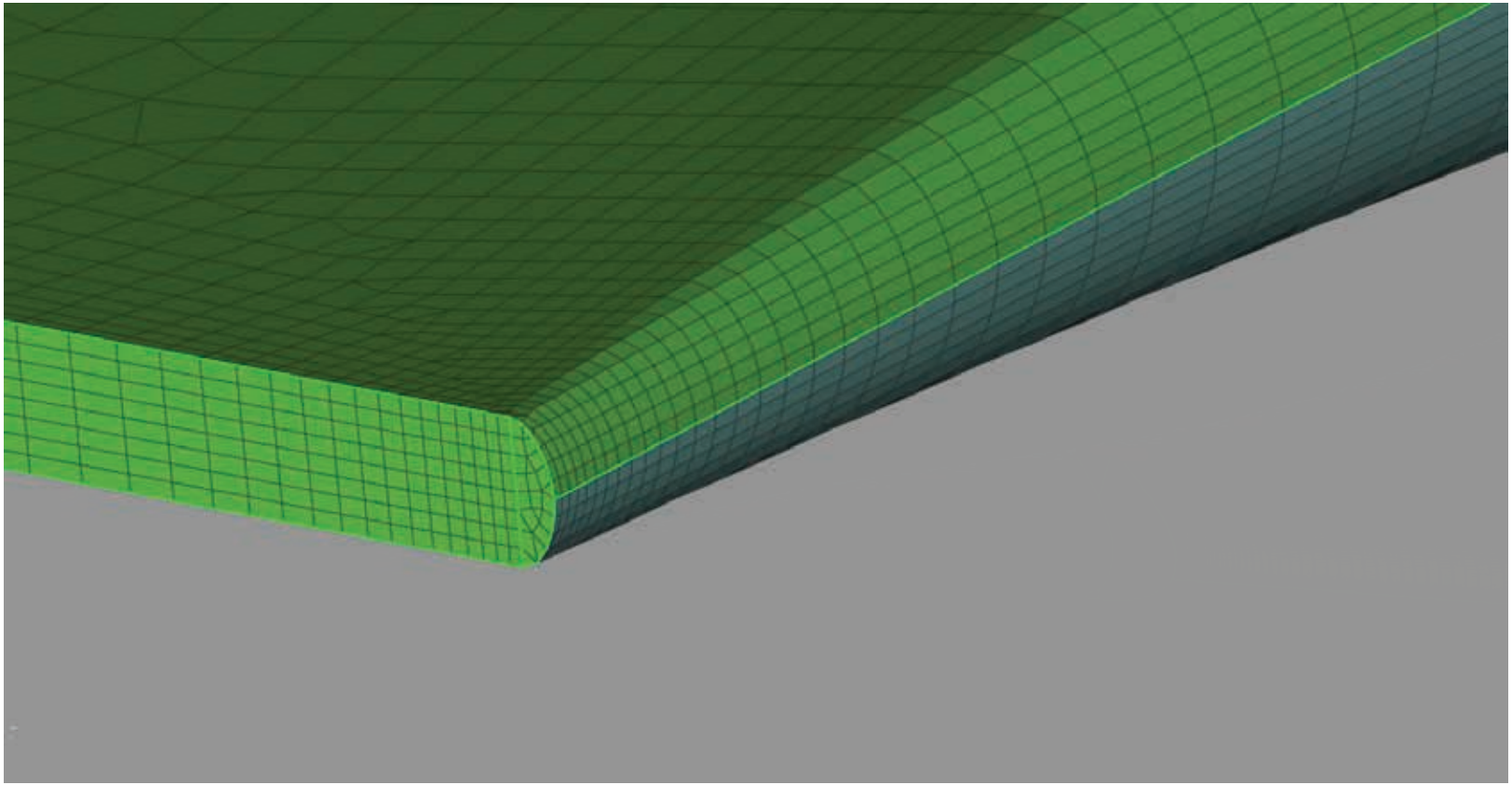
Underside area



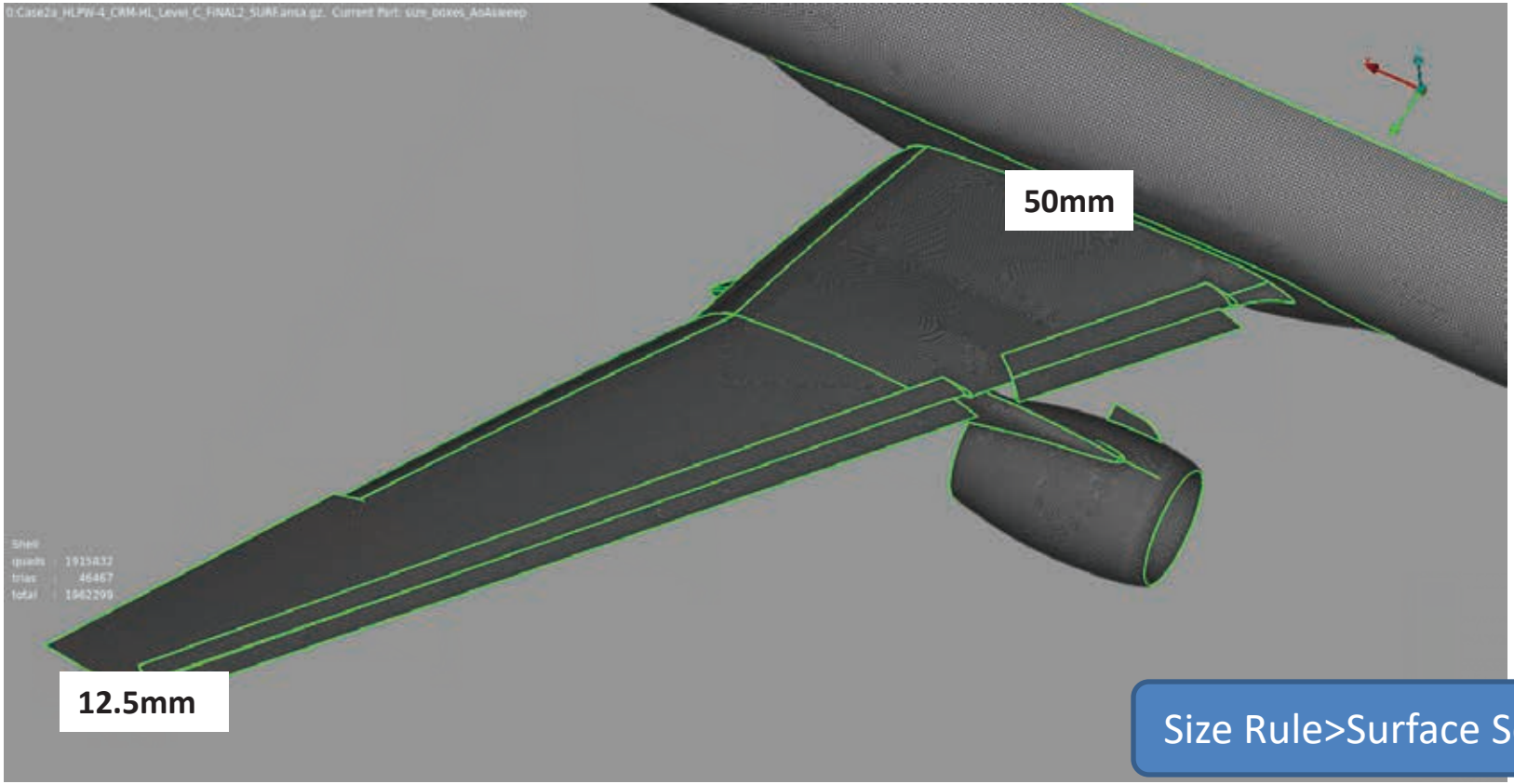
Underside area



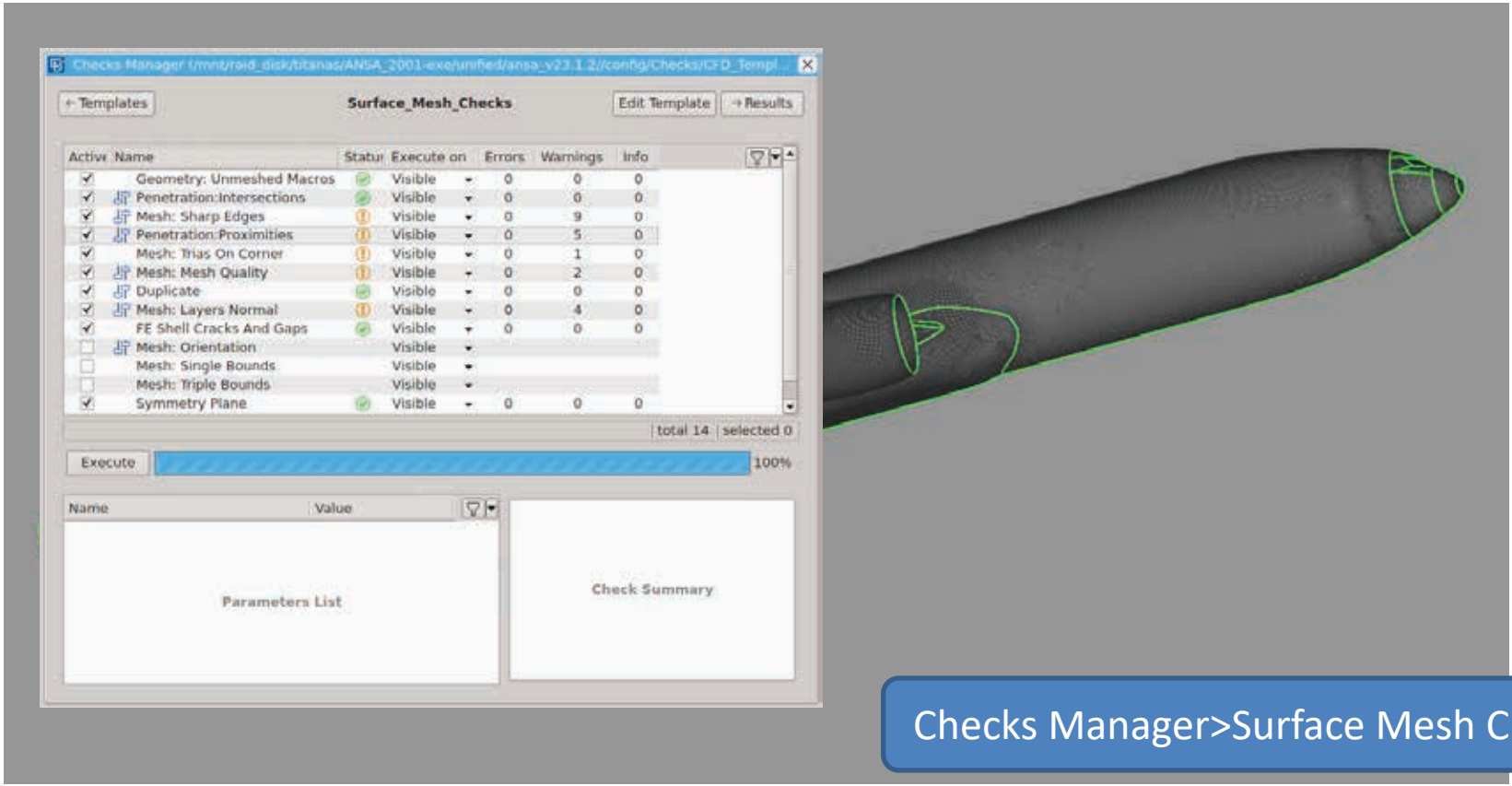
Wingtip area



Main wing – Linear Variation of maximum length

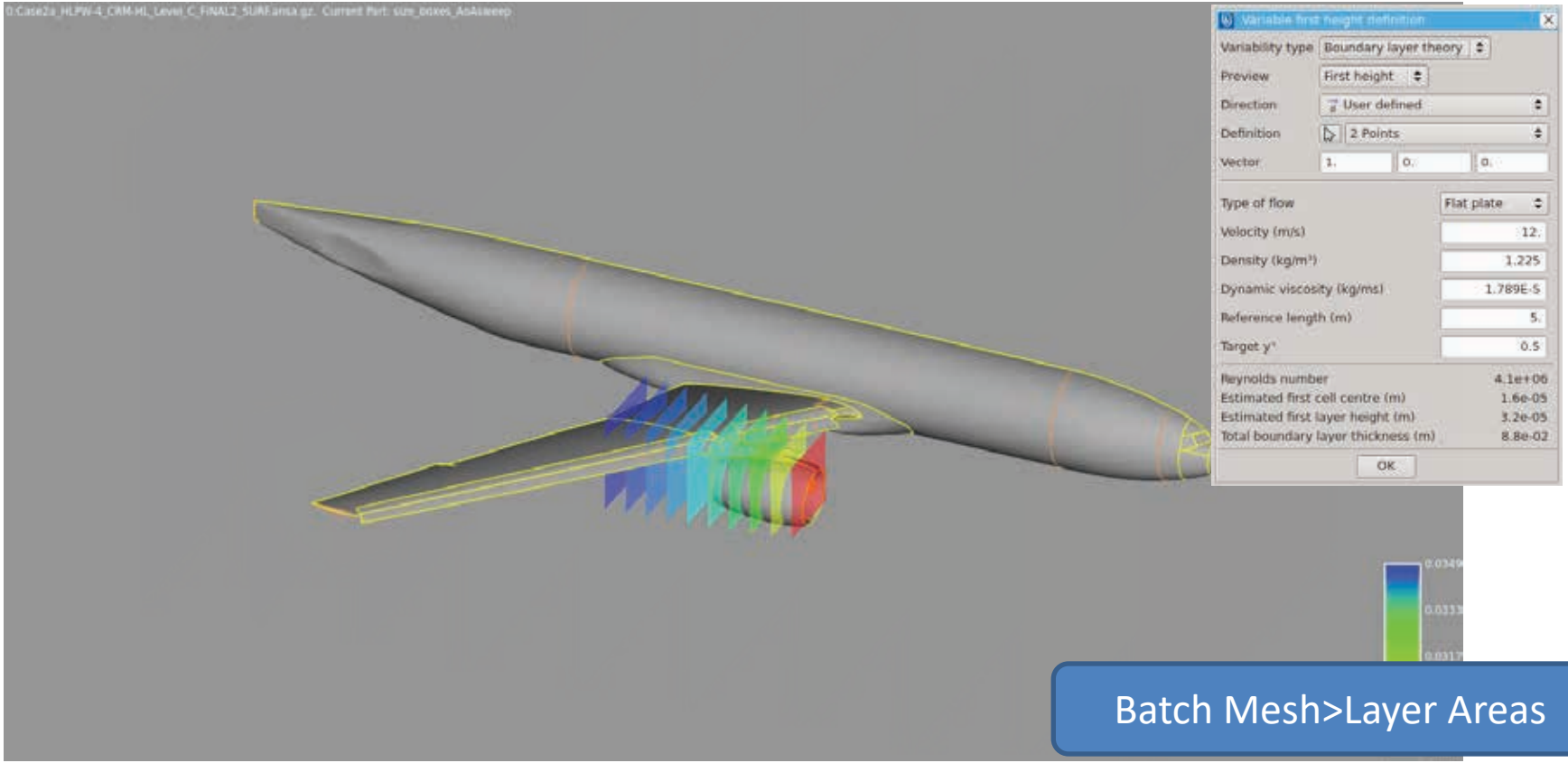


Surface Mesh Checks



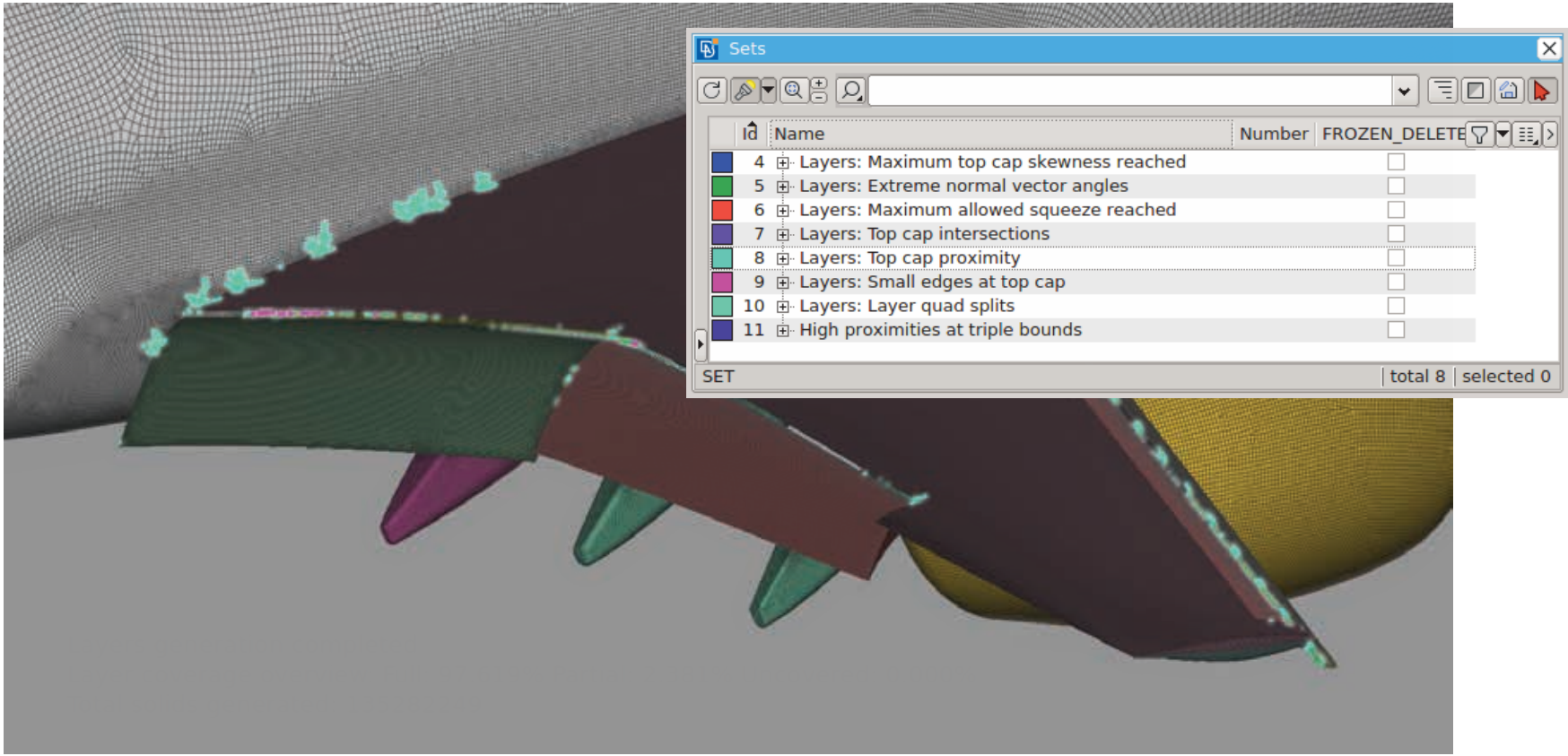
Checks Manager>Surface Mesh Checks

Variable First Layer height specification

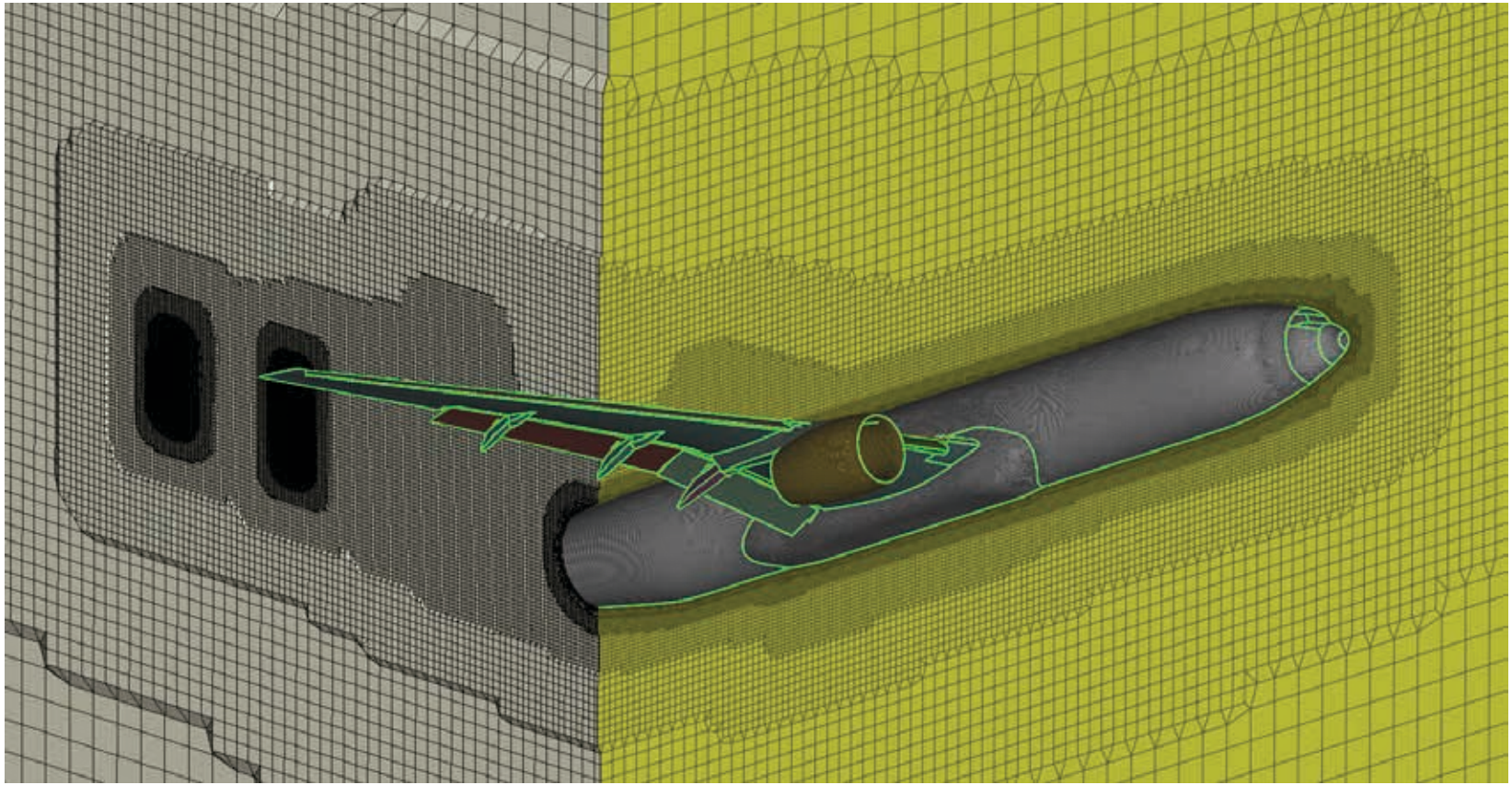


Batch Mesh>Layer Areas

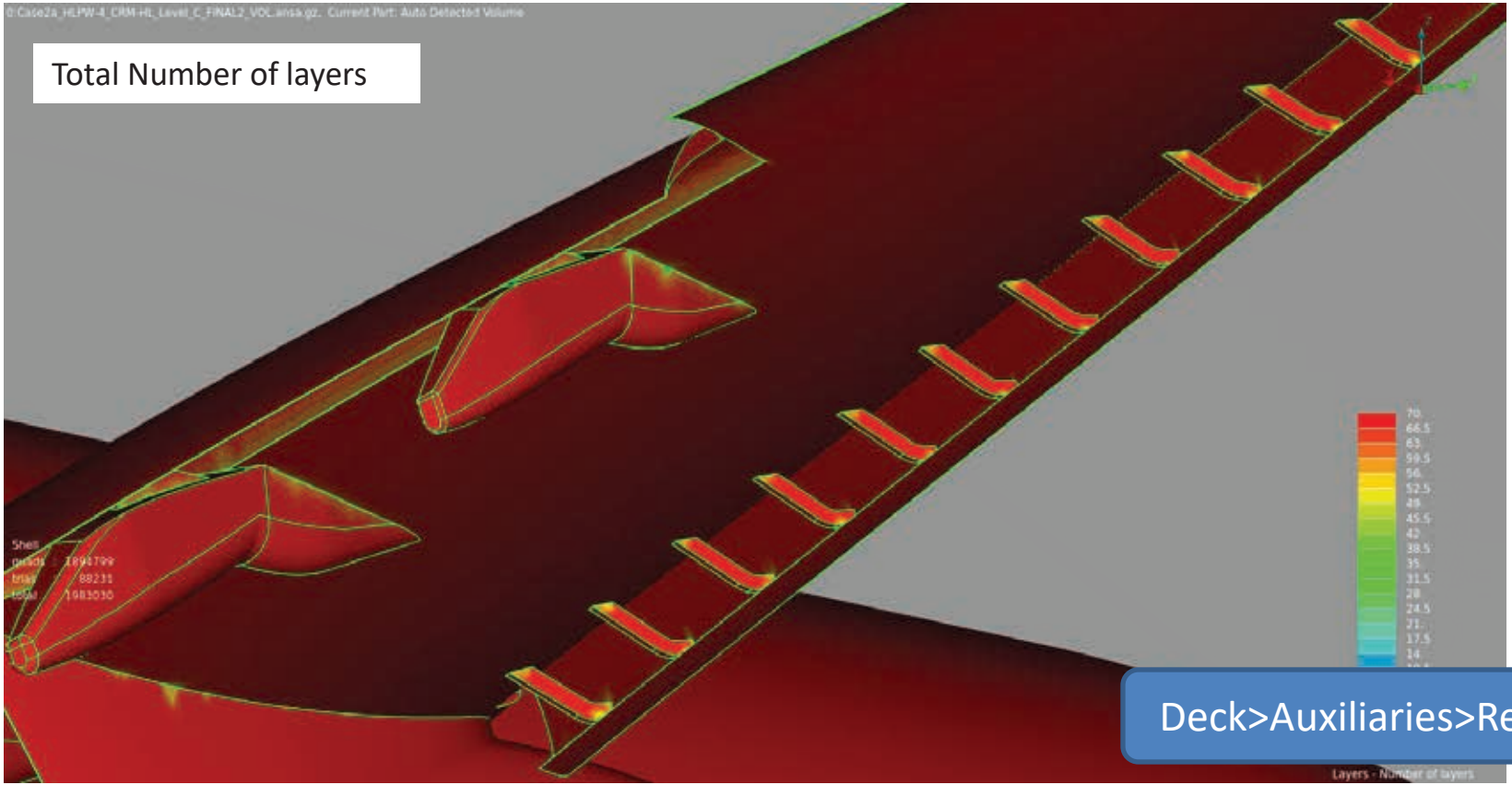
Layers generation – 70 layers variable first height and growth rate



Volume mesh Level C refinement - 211 million cells (188 million nodes)

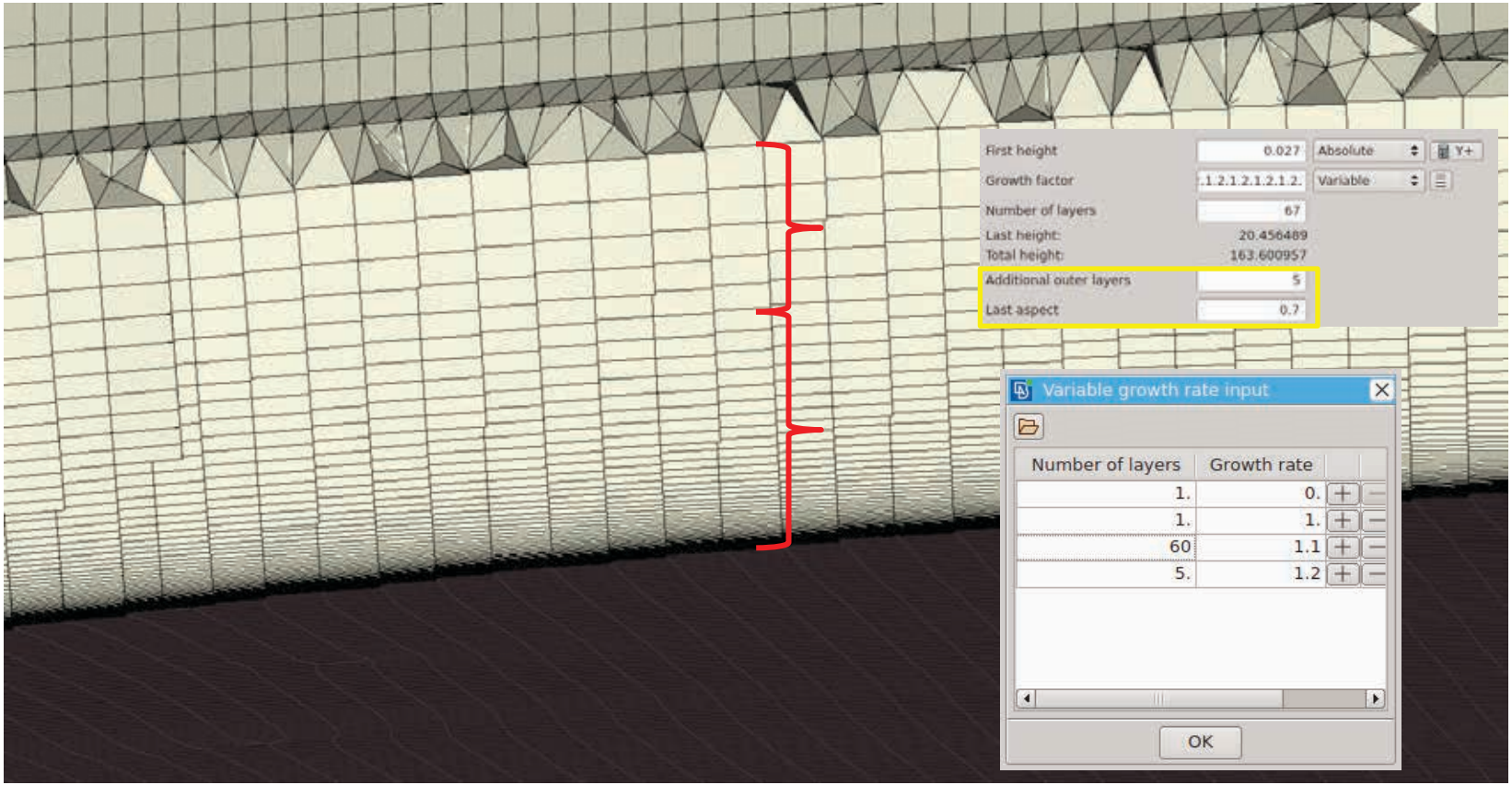


Boundary Layer coverage display

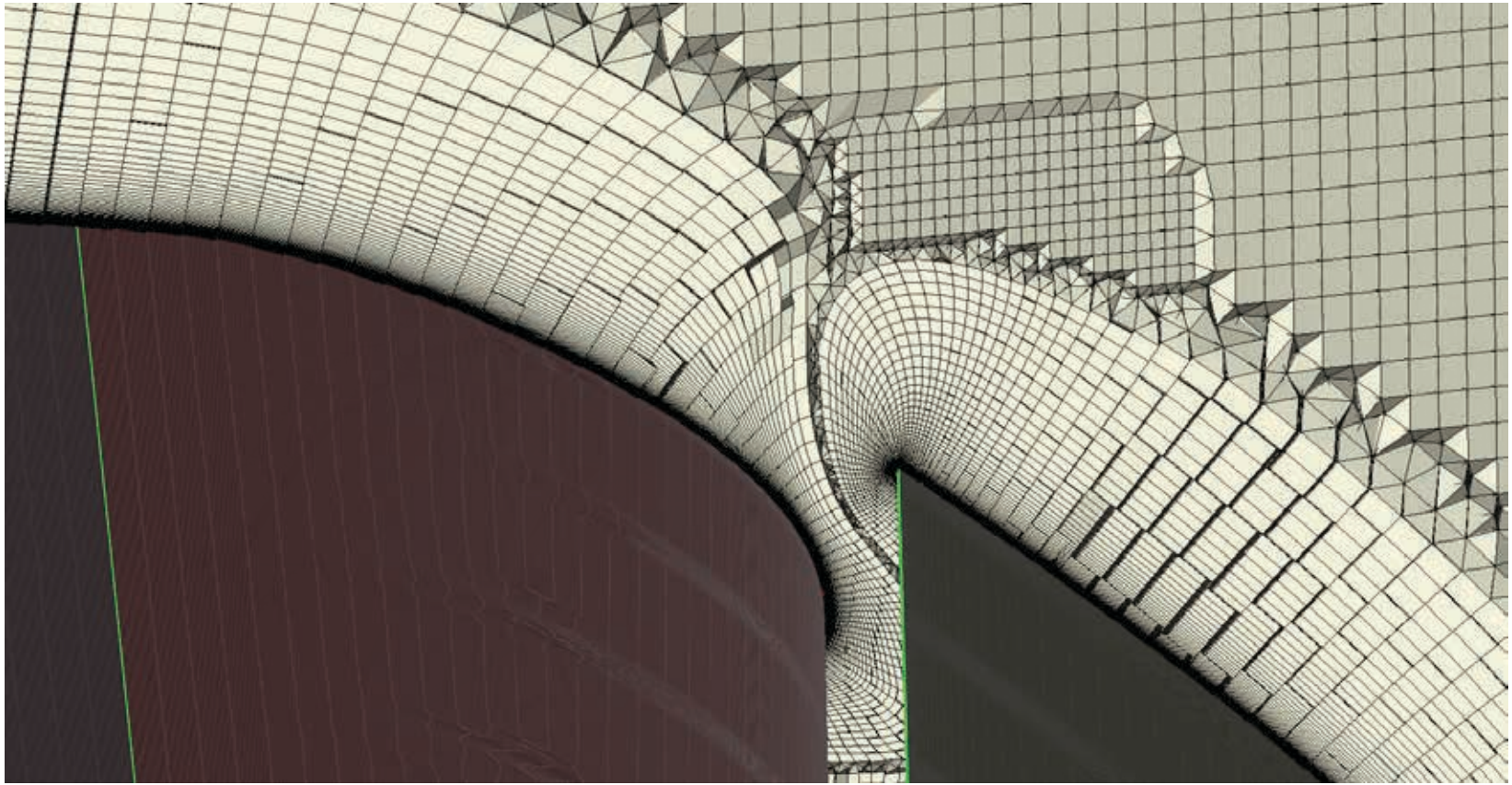


Deck>Auxiliaries>Results

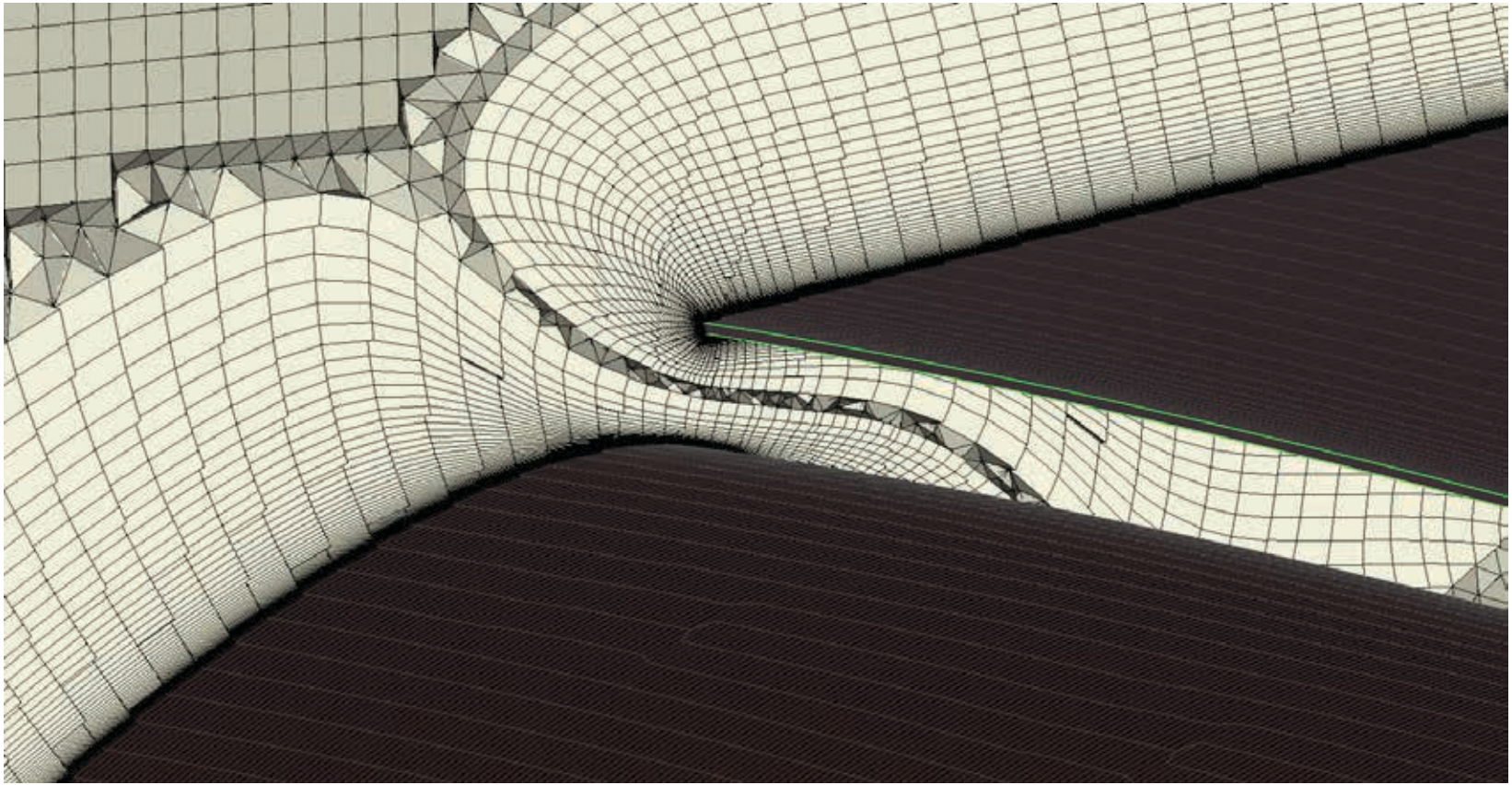
Layers on wing section



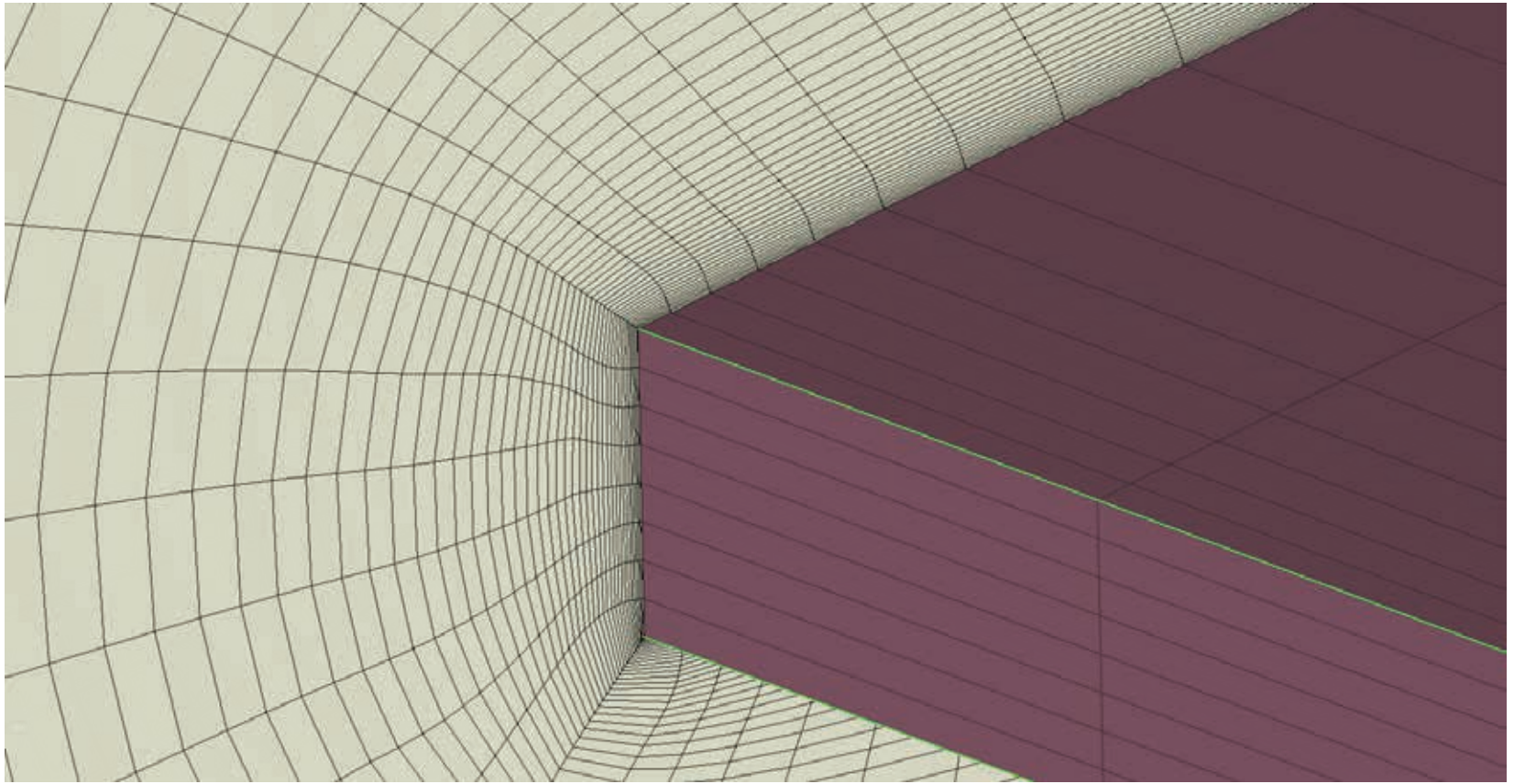
Layers on wing section



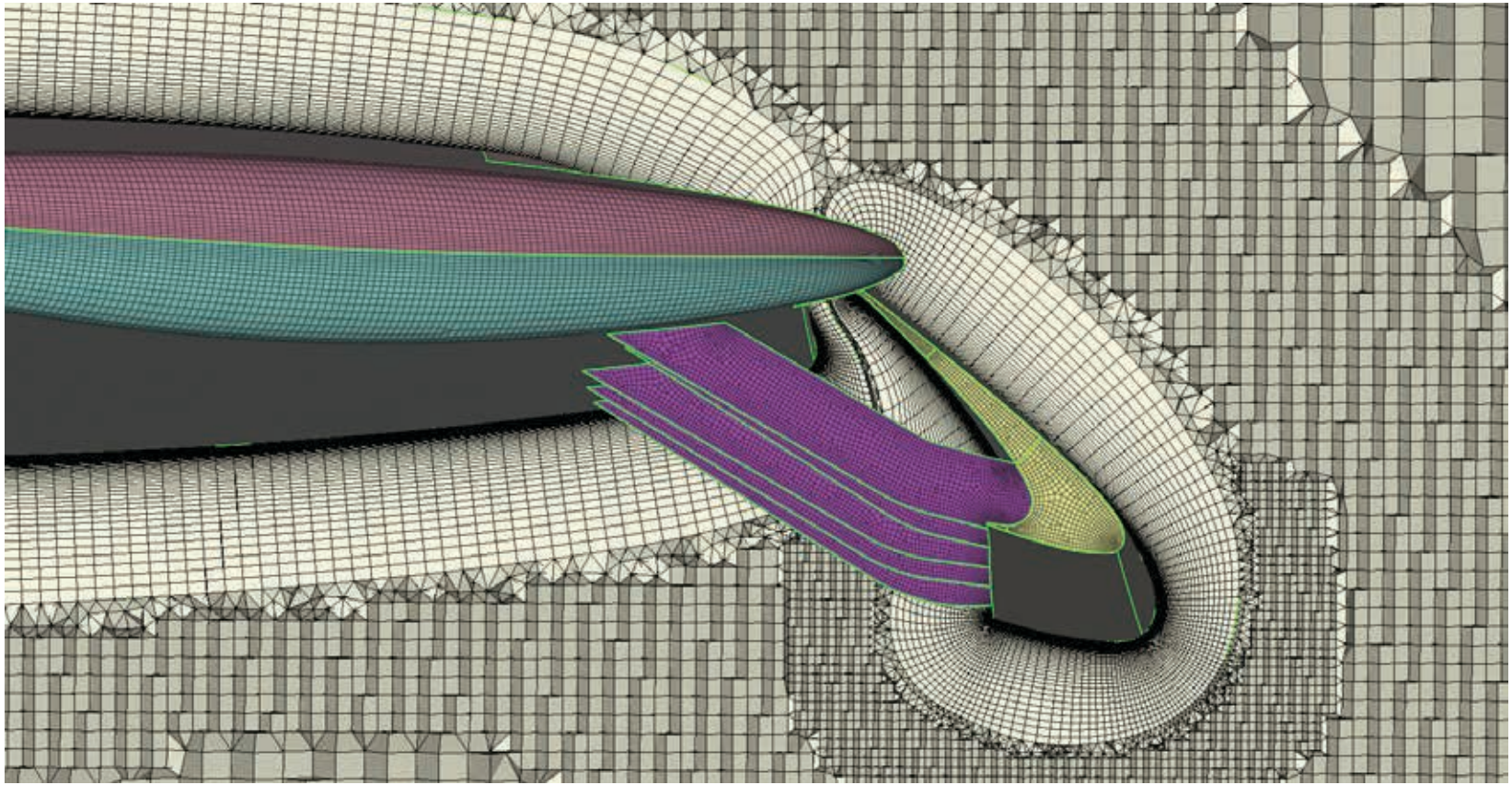
Layers on wing section



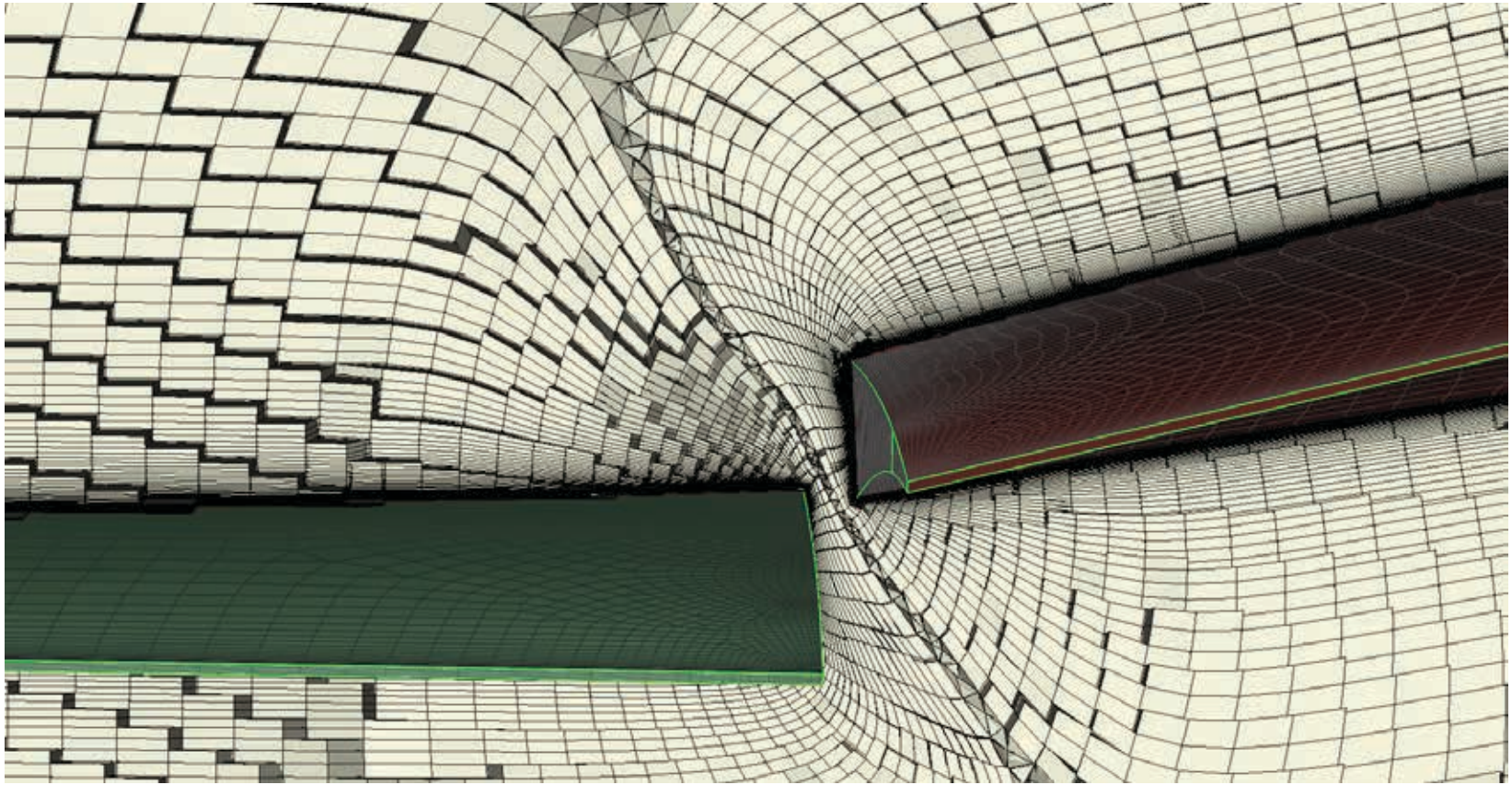
Orthogonality near the wall



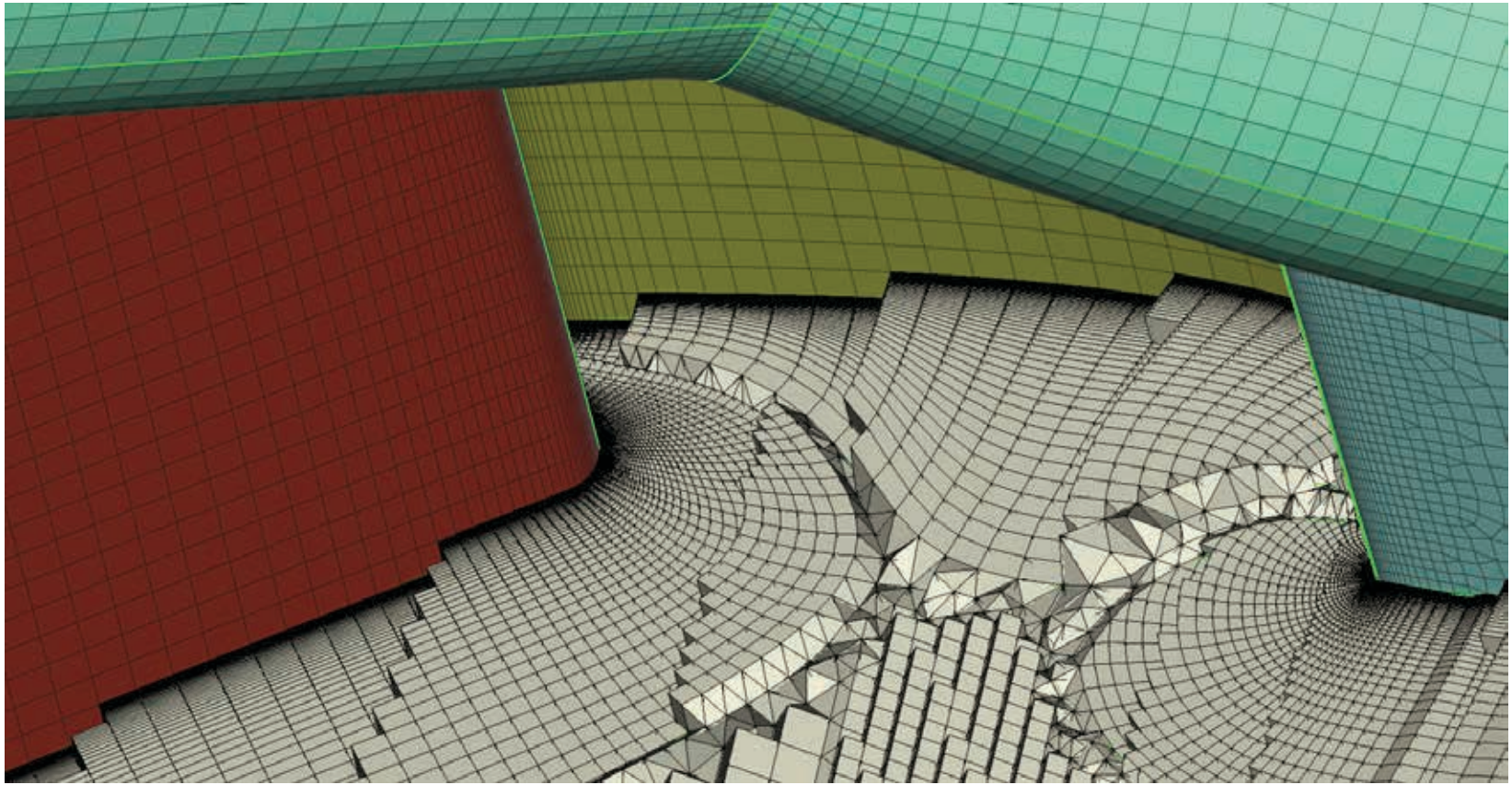
Slat area



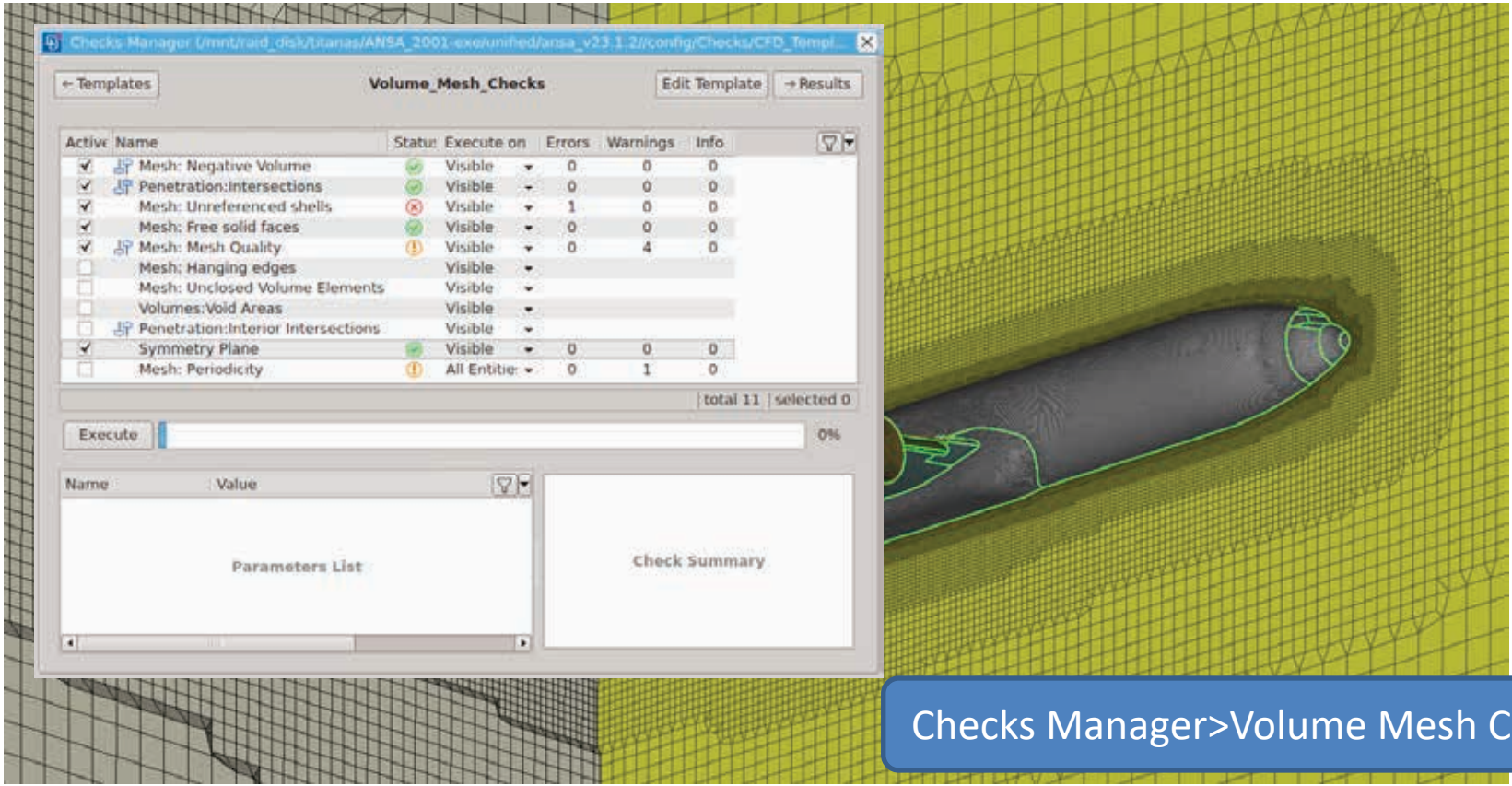
Gap between the two flaps



Flap underside area

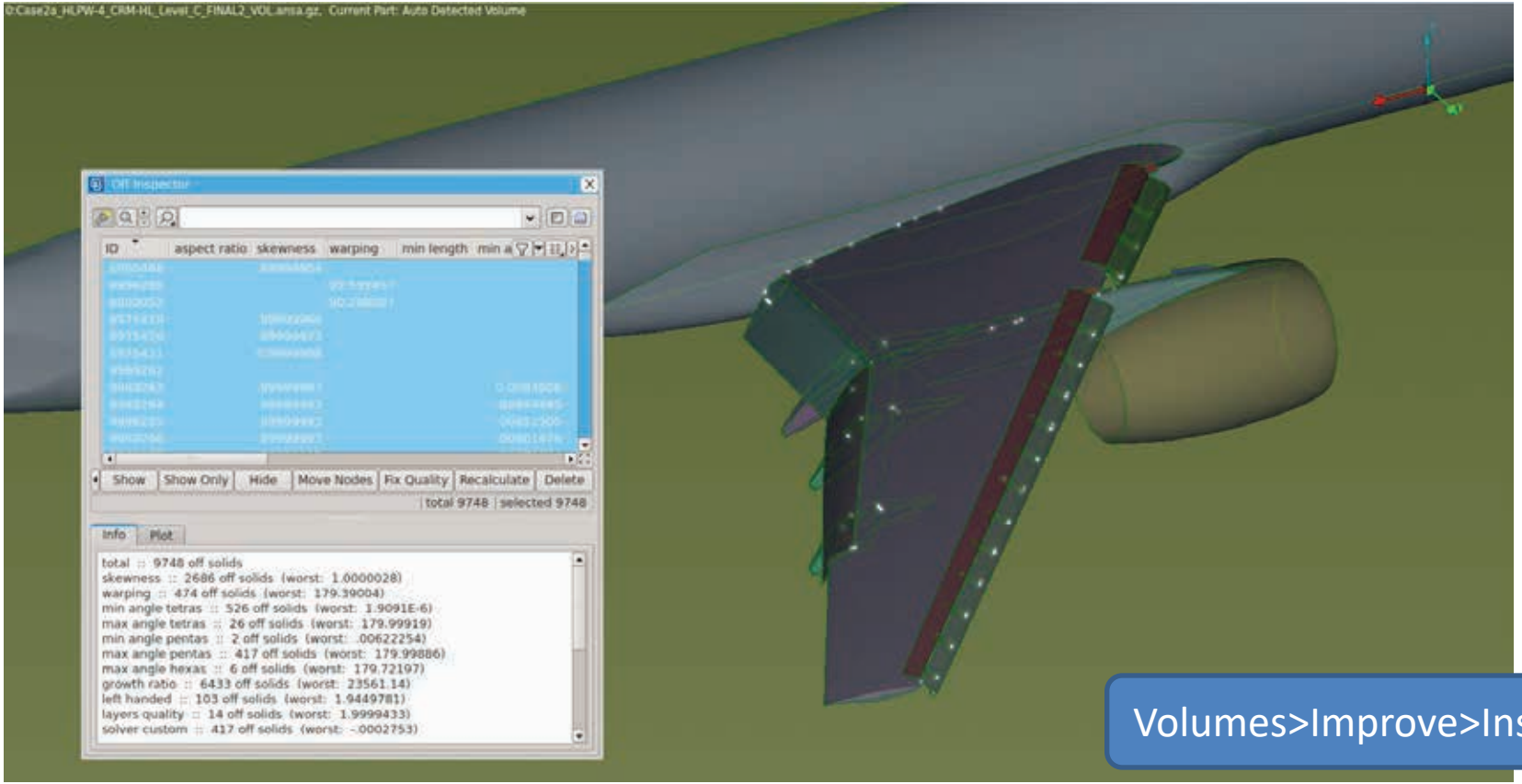


Volume mesh Checks



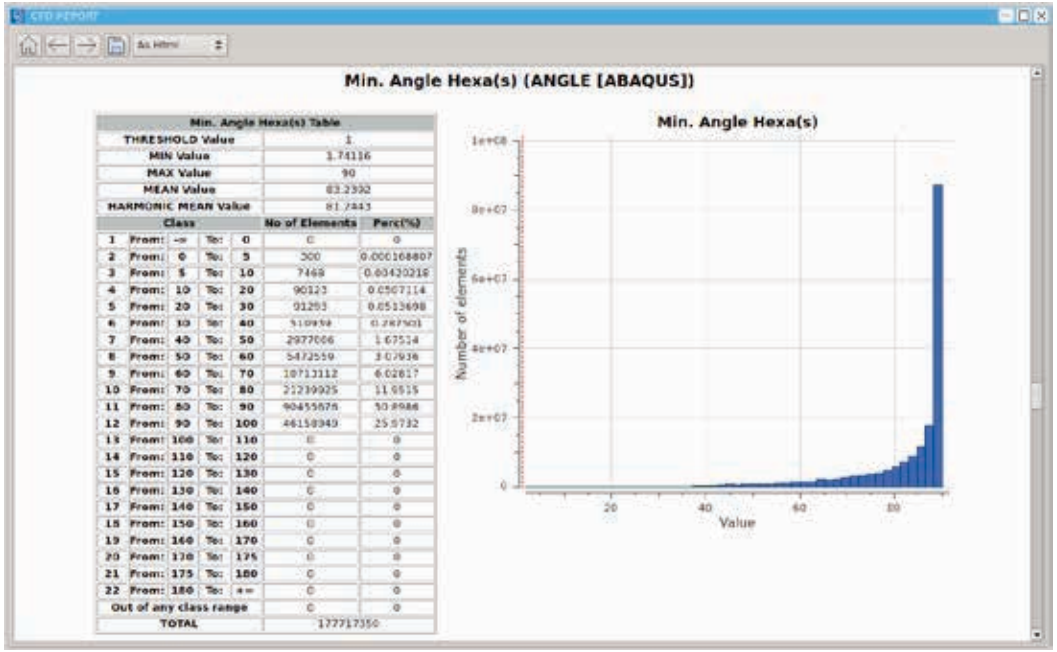
Checks Manager>Volume Mesh Checks

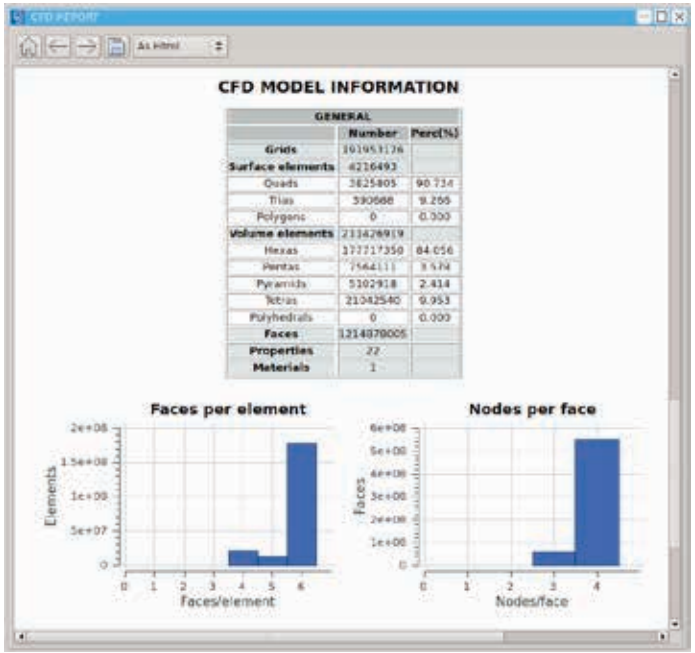
Inspecting mesh quality violations



Quality Metrics Reporting

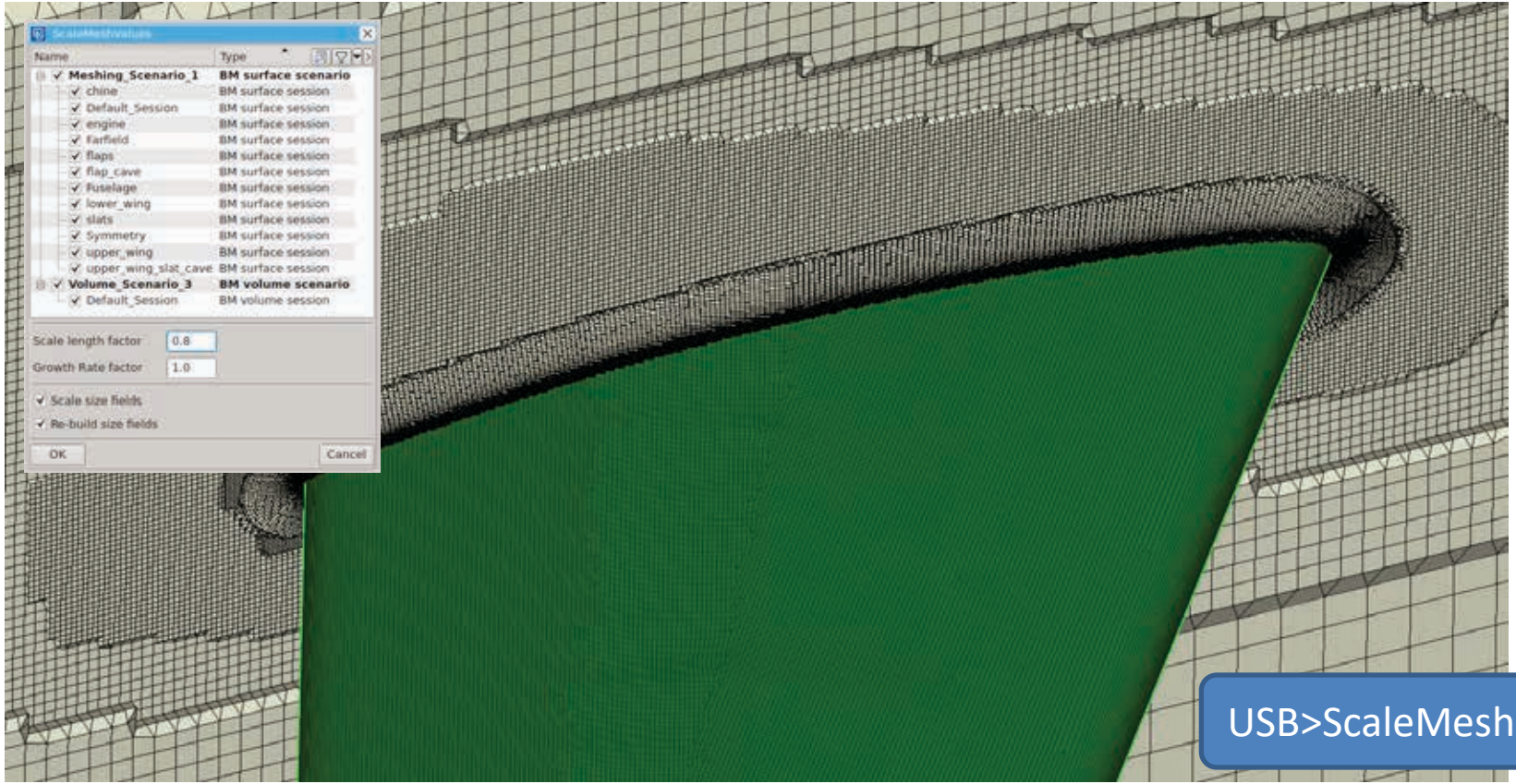
Html creation of mesh statistics
- Mesh quality criteria histograms
- Nodes, Elements, Facets number
- Element type percentages





Report Tool

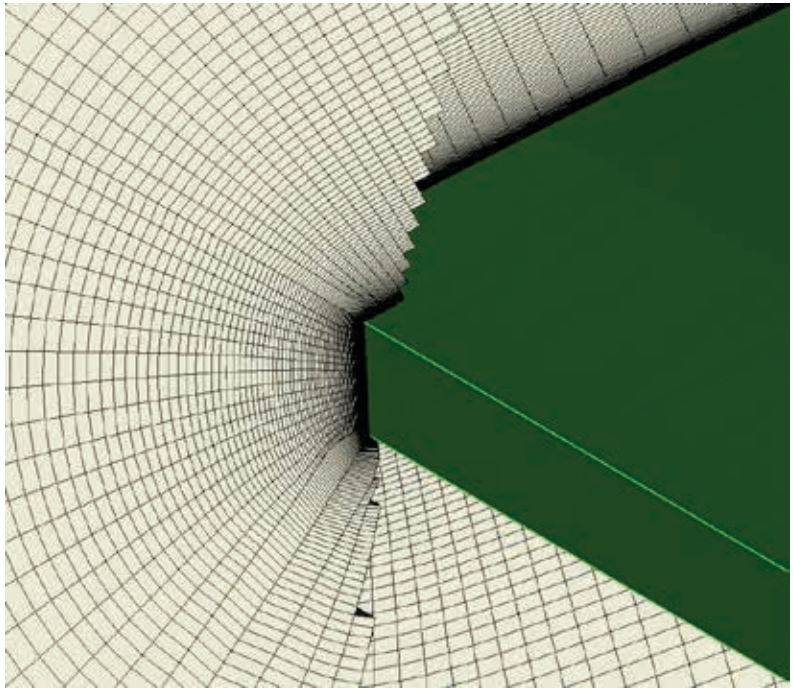
Mesh Refinement Studies on Case 1 of HLPW-5 - five mesh levels

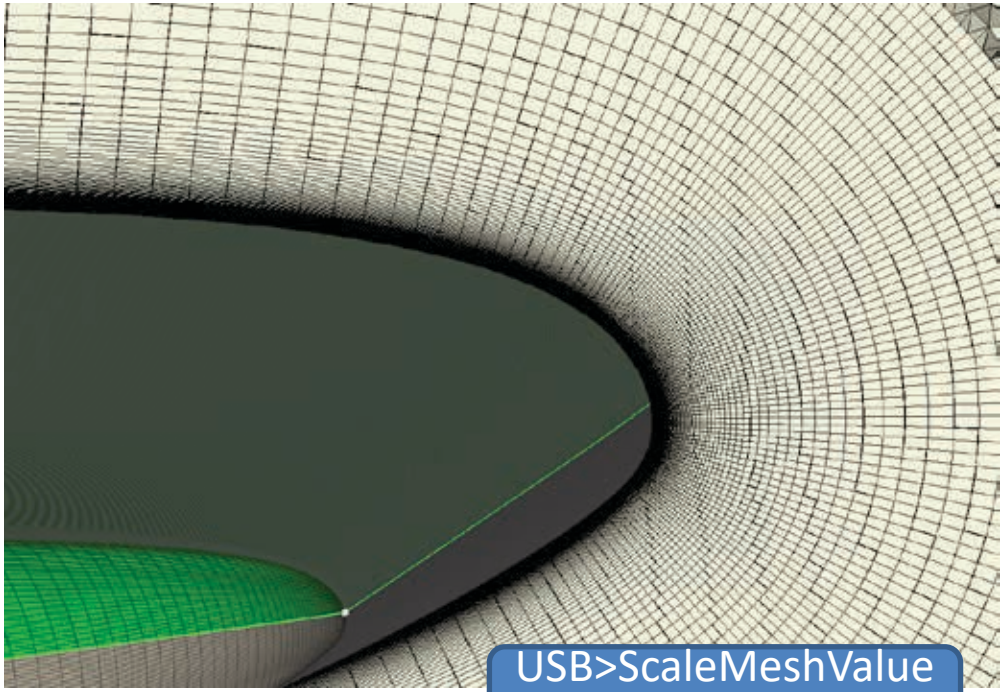


USB>ScaleMeshValues

Mesh Refinement Studies on Case 1 of HLPW-5 - five mesh levels

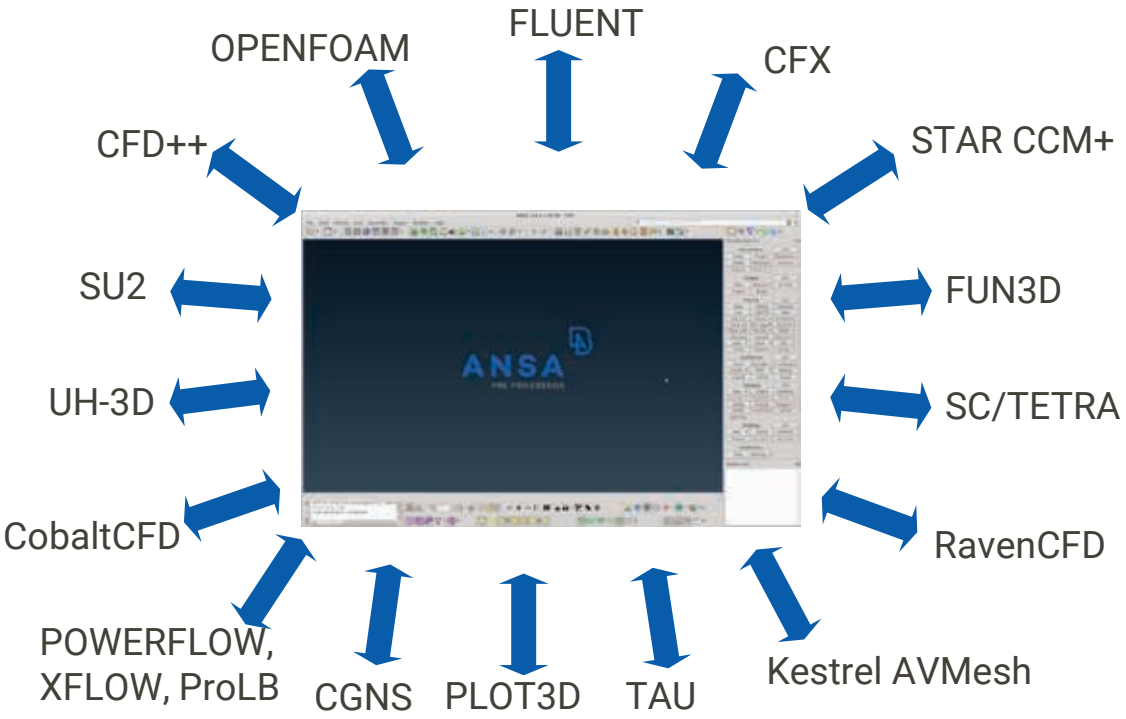
Functionality to automatically scale all length values of Batch Mesh





USB>ScaleMeshValues

Mesh output in multiple CFD mesh formats



Performance - Memory

211 million cells
Peak memory usage 92 Gb RAM

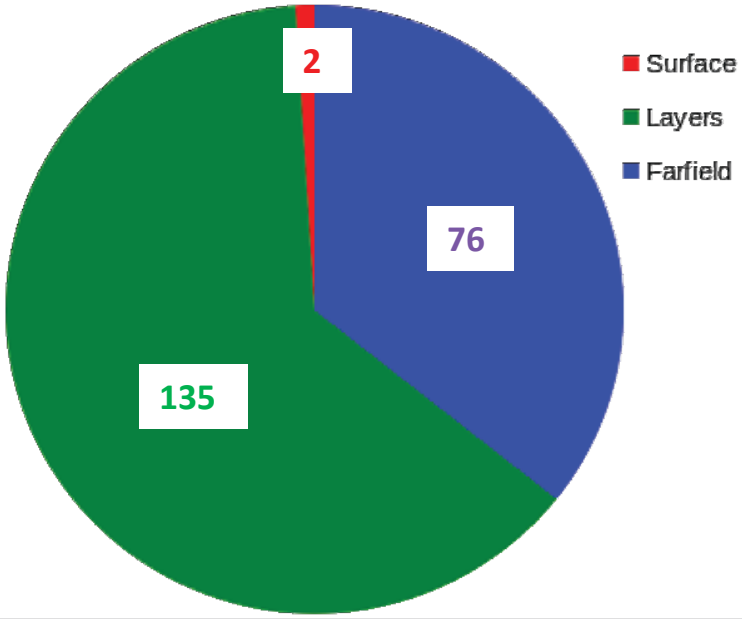
0.44 Gb/million cells

GENERAL		
	Number	**Perc(%)**
Grids	190019251	
Surface elements	2137201	
Quads	2034023	95.172
Trias	103178	4.828
Polygons	0	0.000
Volume elements	211426919	
Hexas	177717350	84.056
Pentas	7564111	3.578
Pyramids	5102918	2.414
Tetras	21042540	9.953
Polyhedrals	0	0.000
Faces	1214878005	
Properties	21	
Materials	1	

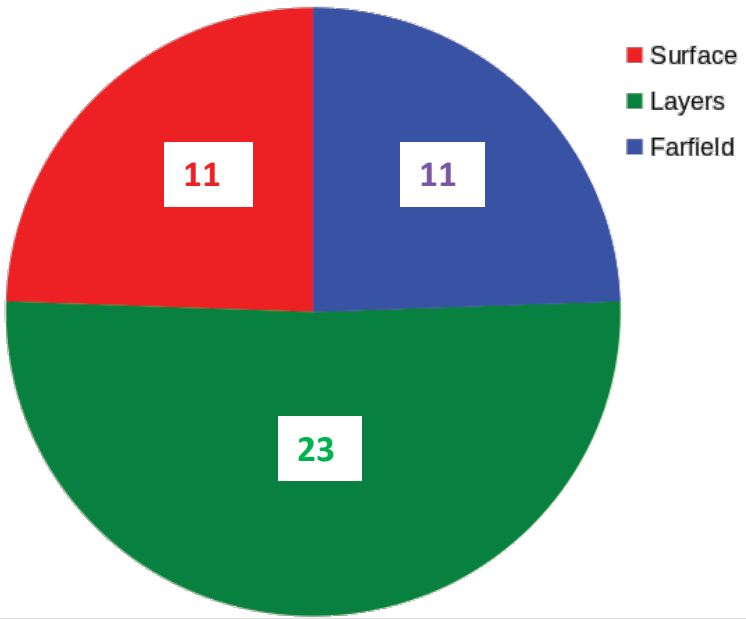
Performance – Speed

2 million shell elements in 11 min
211 million volume elements in 34 min
Surface mesh = 11 million shells/hour
Volume mesh = 372 million cells/hour

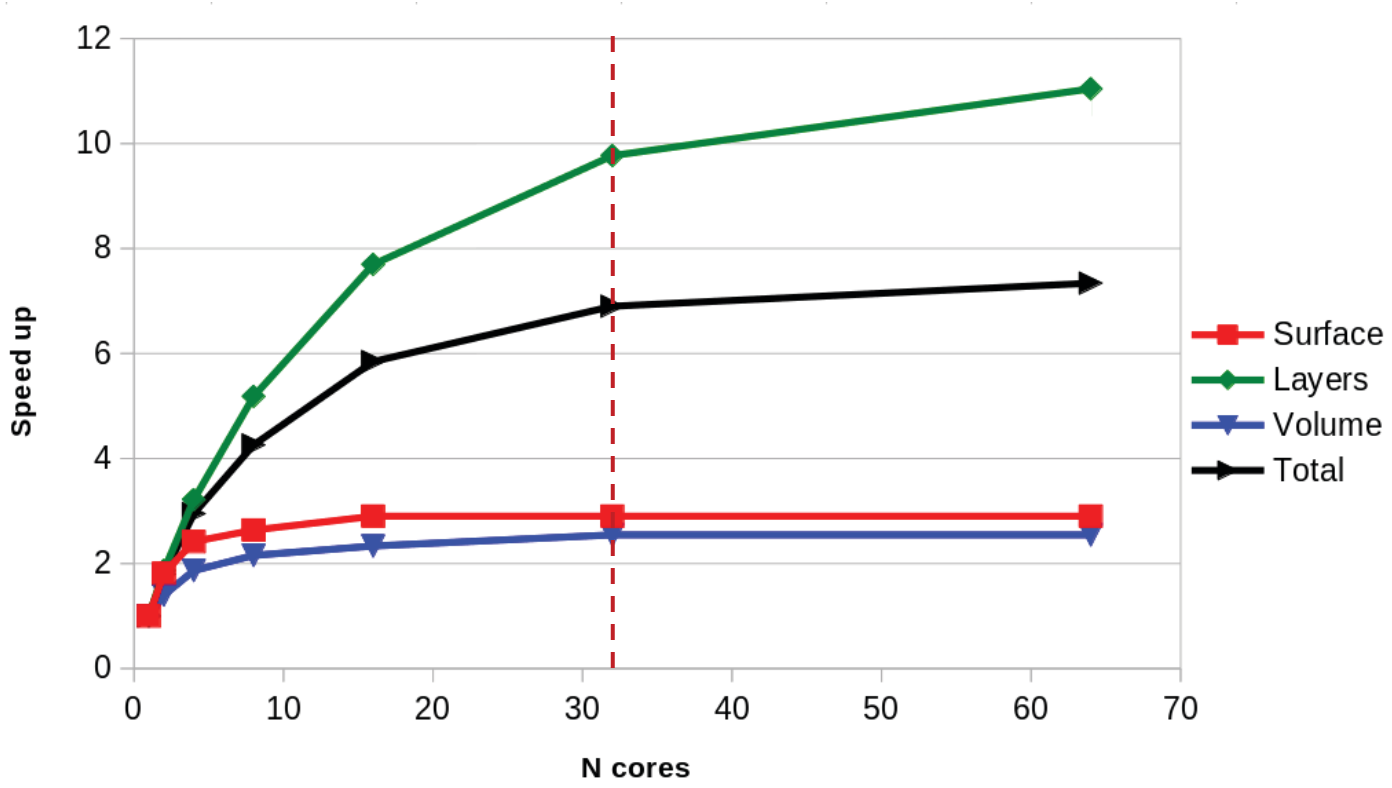
Number of elements (millions)



Meshing time (min)

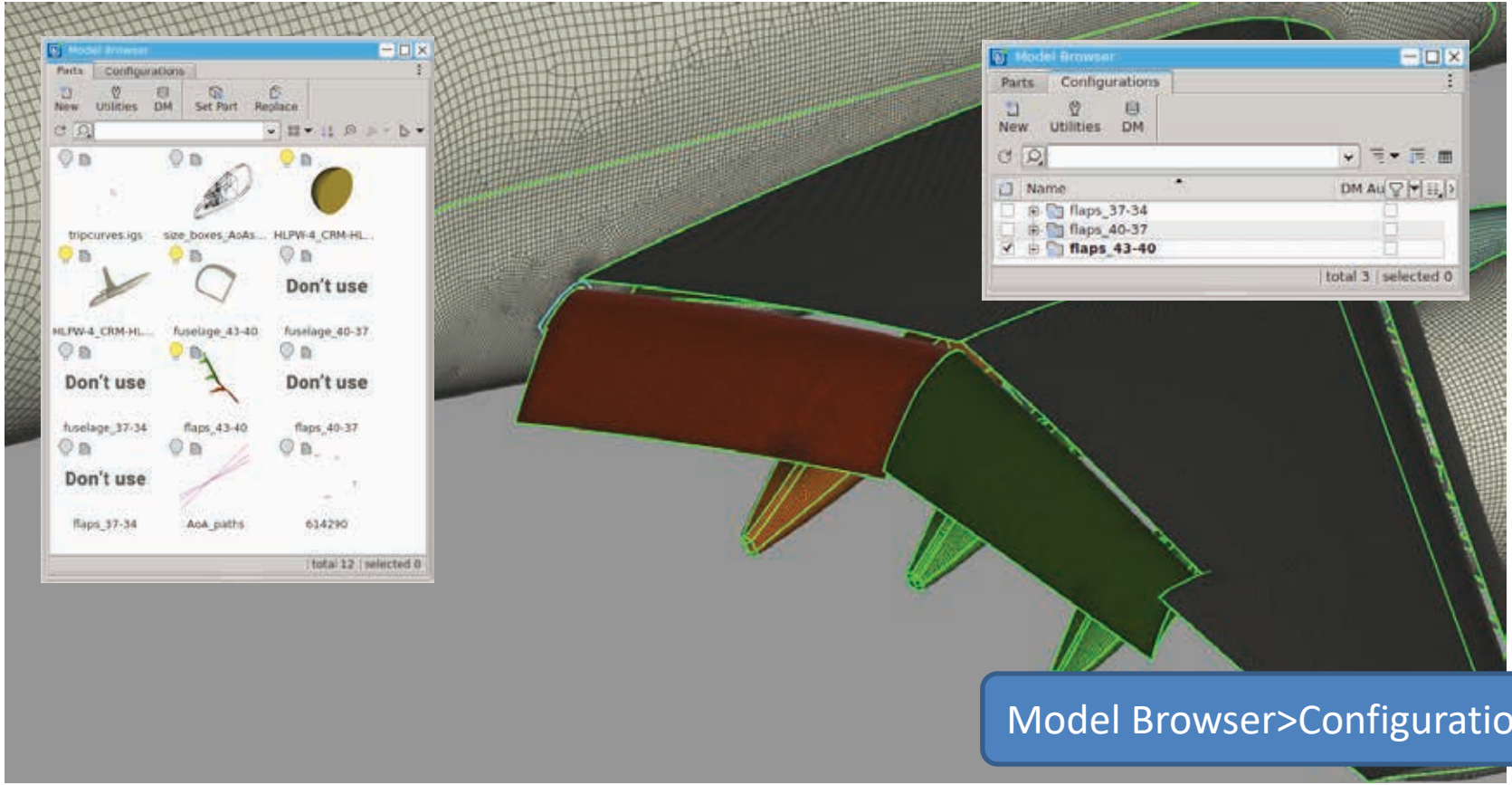


Speed performance scalability

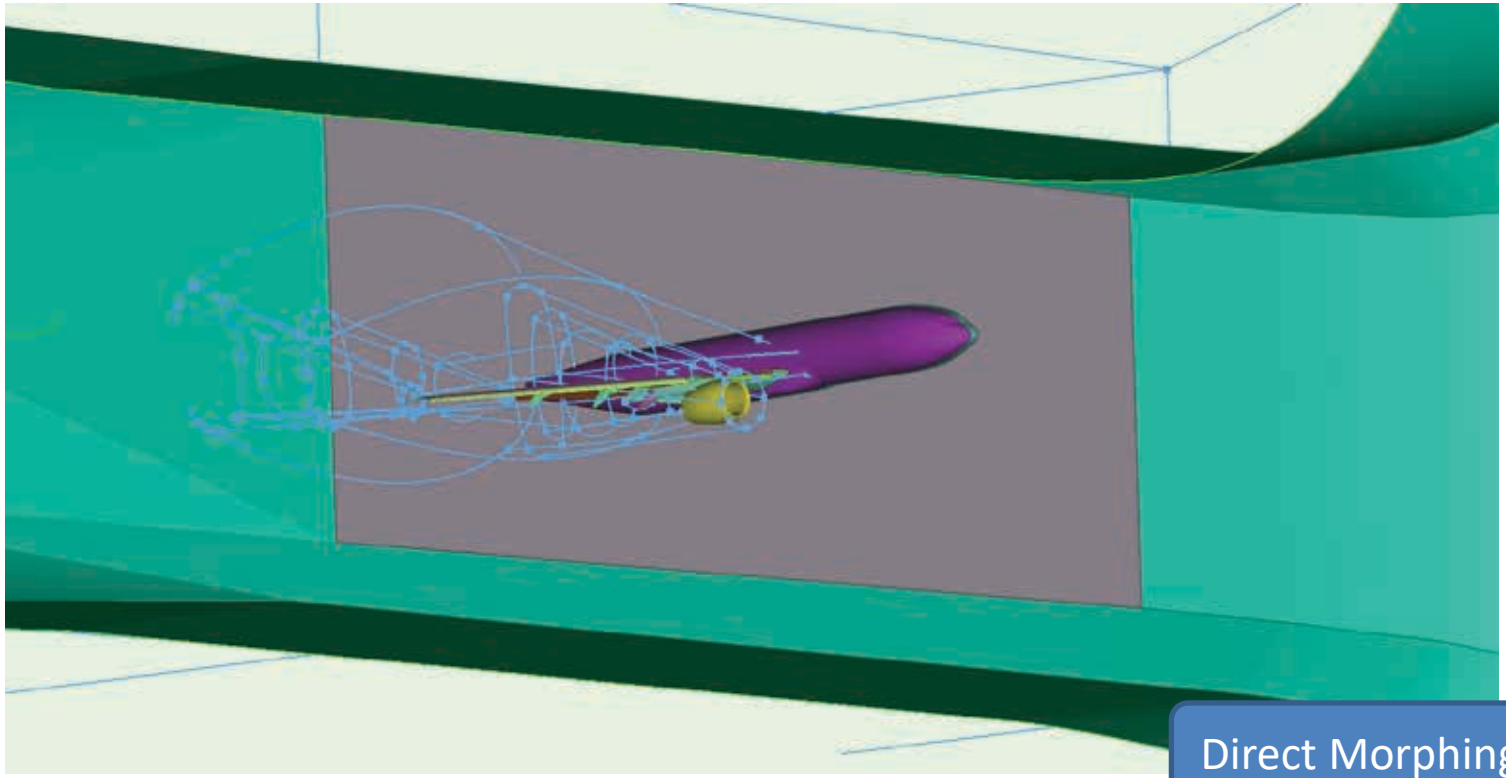


Hardware used has 32 cores (64 threads)

Use of Configurations for modifying flap angles – HLPW-4

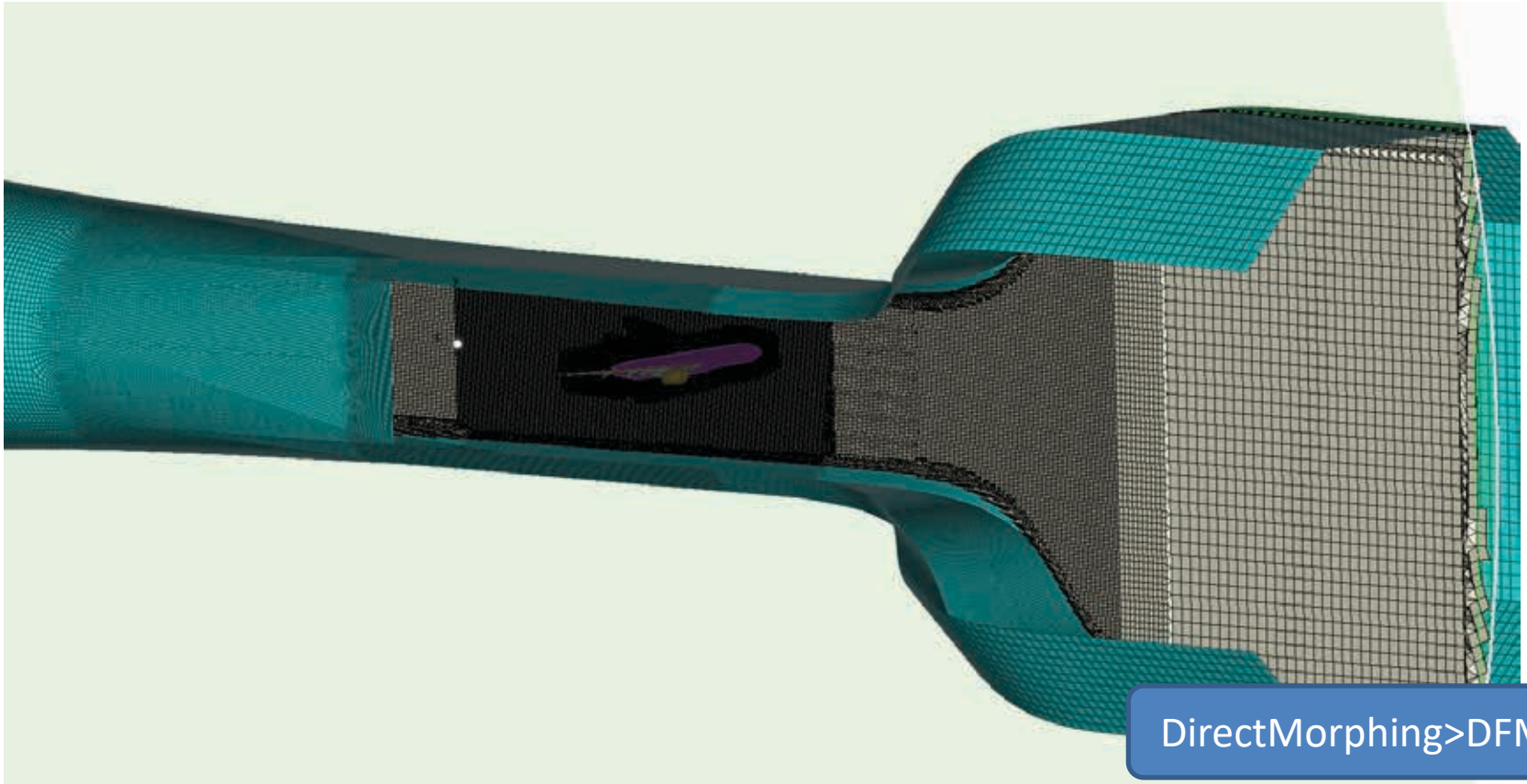


Morphing to change the AoA of the model in a wind tunnel – HLPW-4

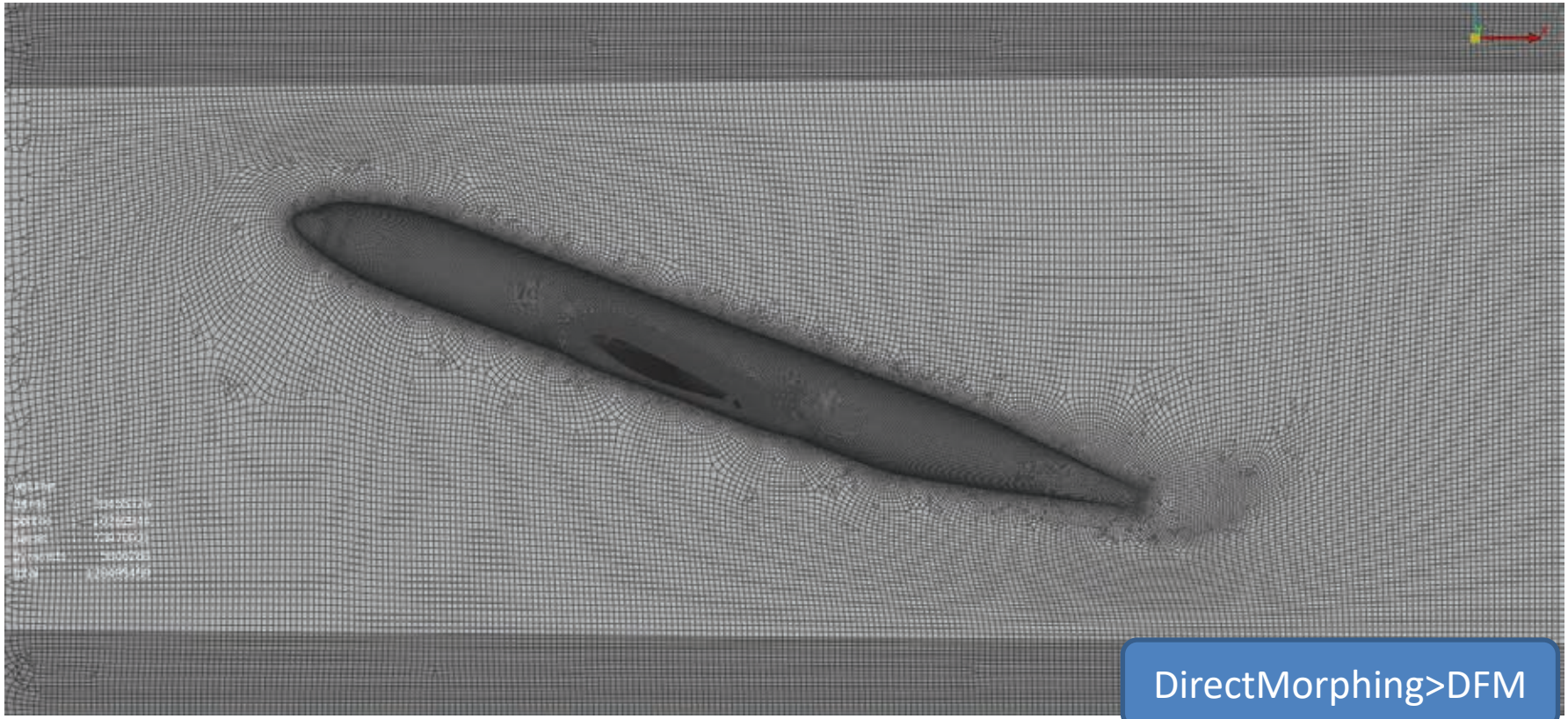


Direct Morphing>DFM

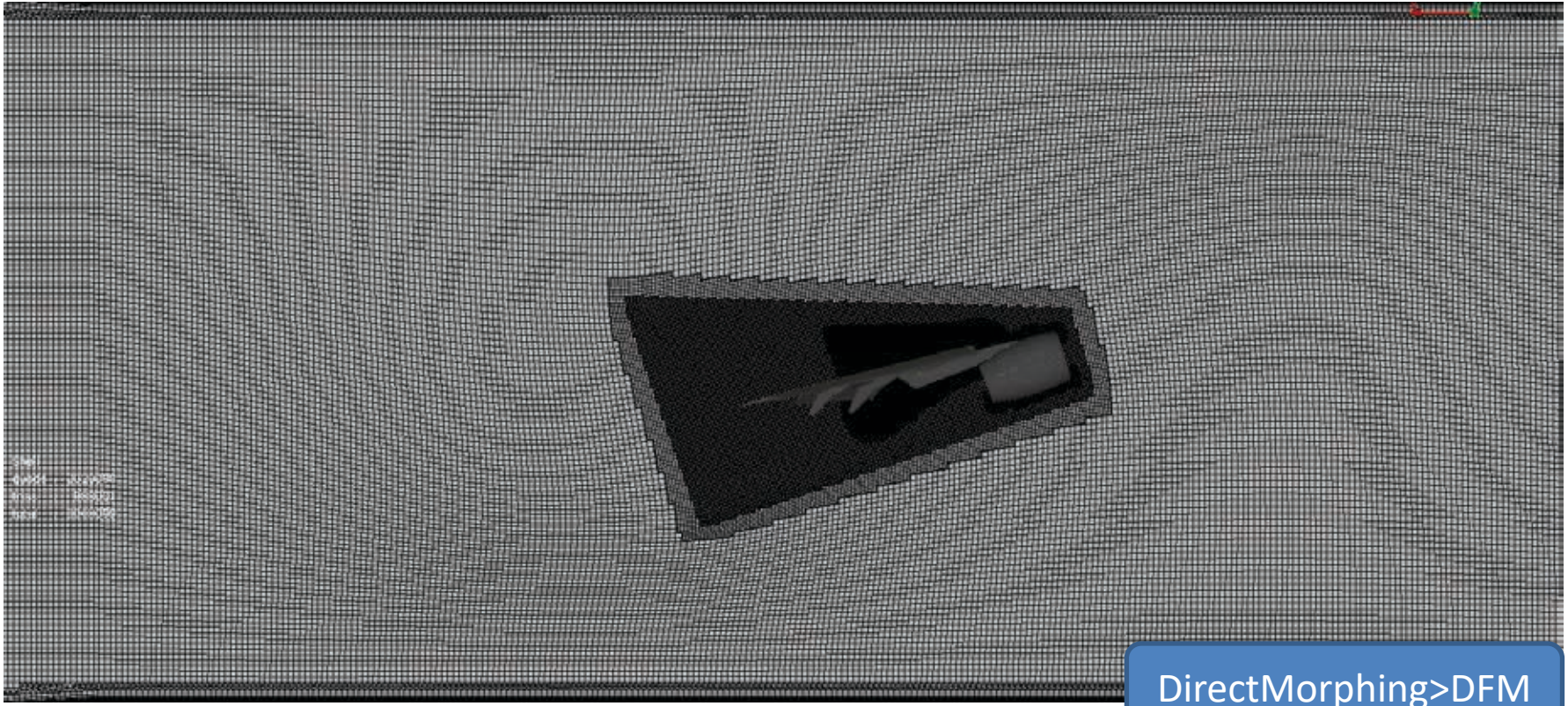
Morphing to change the AoA of the model in a wind tunnel – HLPW-4



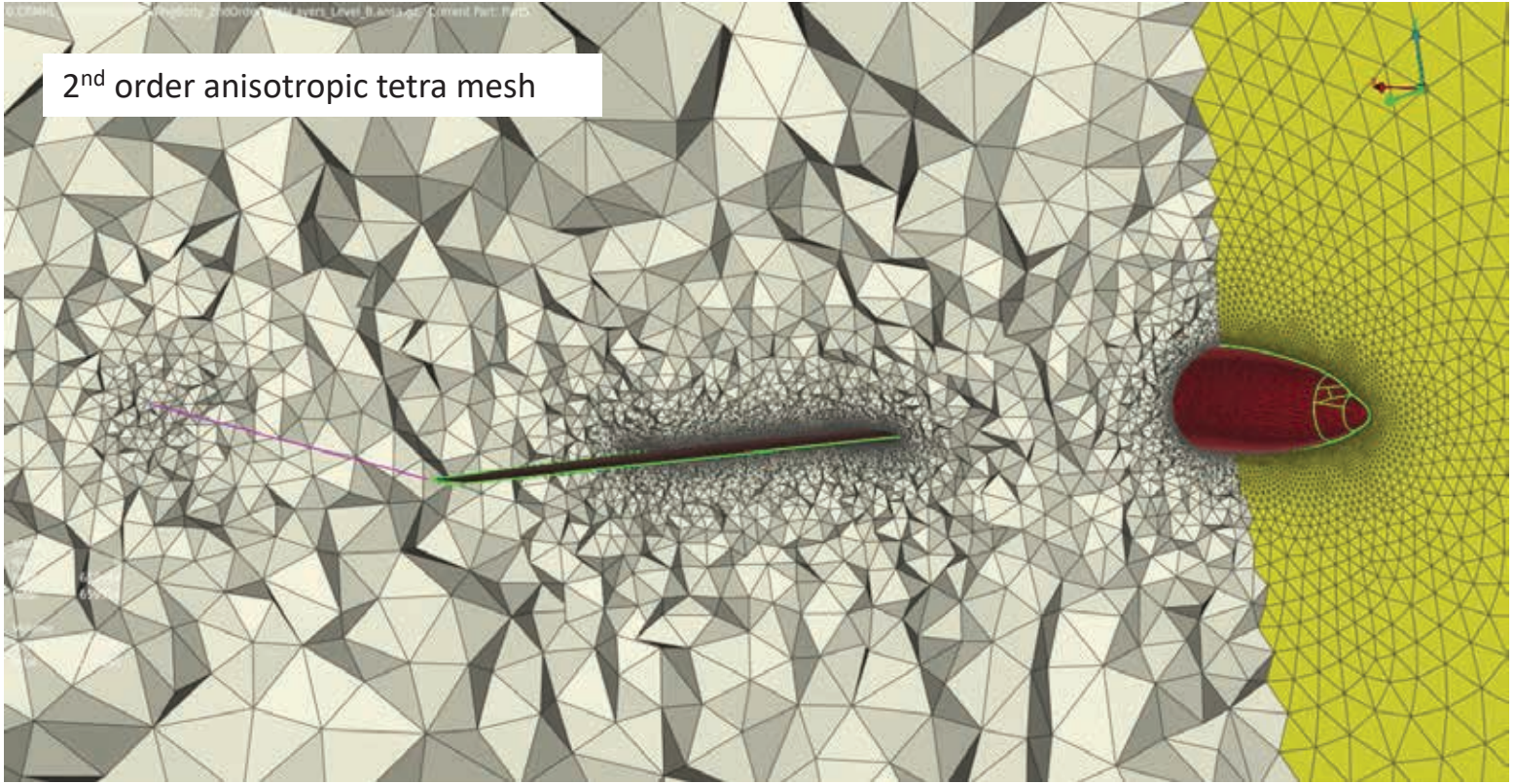
Morphing to change the AoA of the model in a wind tunnel – HLPW-4



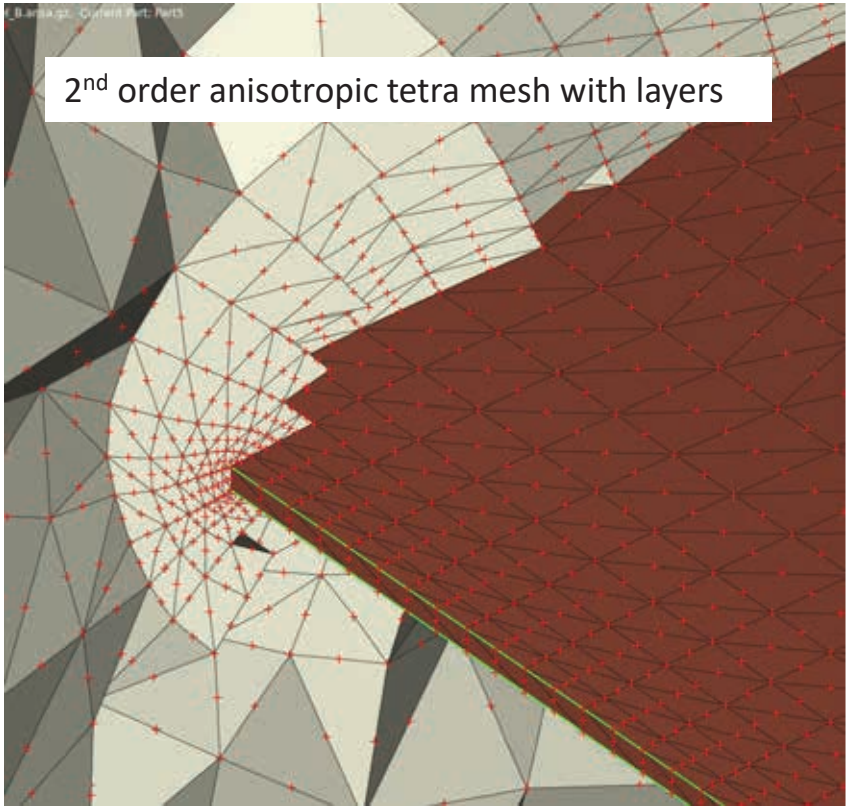
Morphing to change the AoA of the model in a wind tunnel – HLPW-4

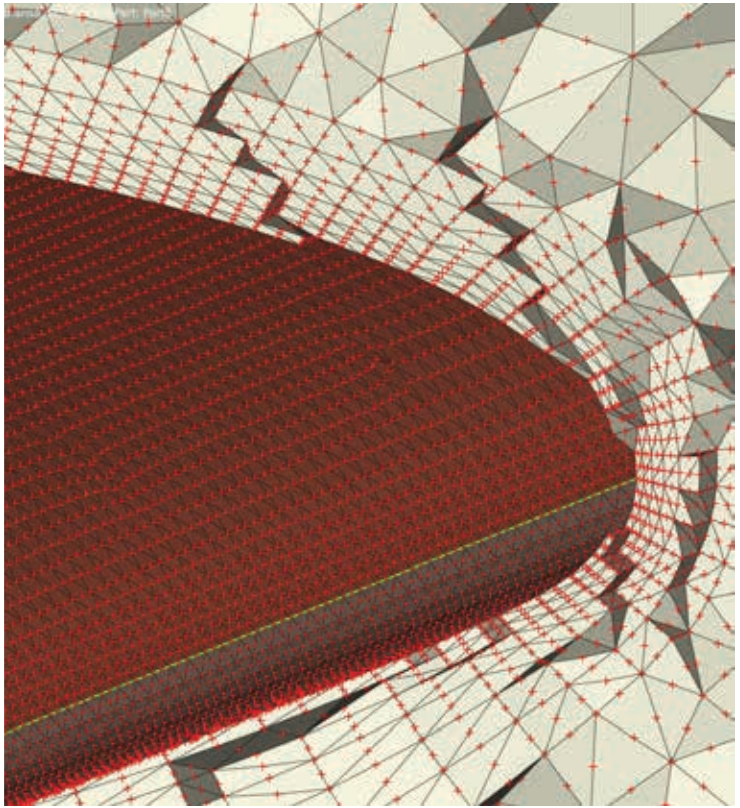


Meshing for CFD High Order methods – HLPW-5 Case 1 - WMLES methods

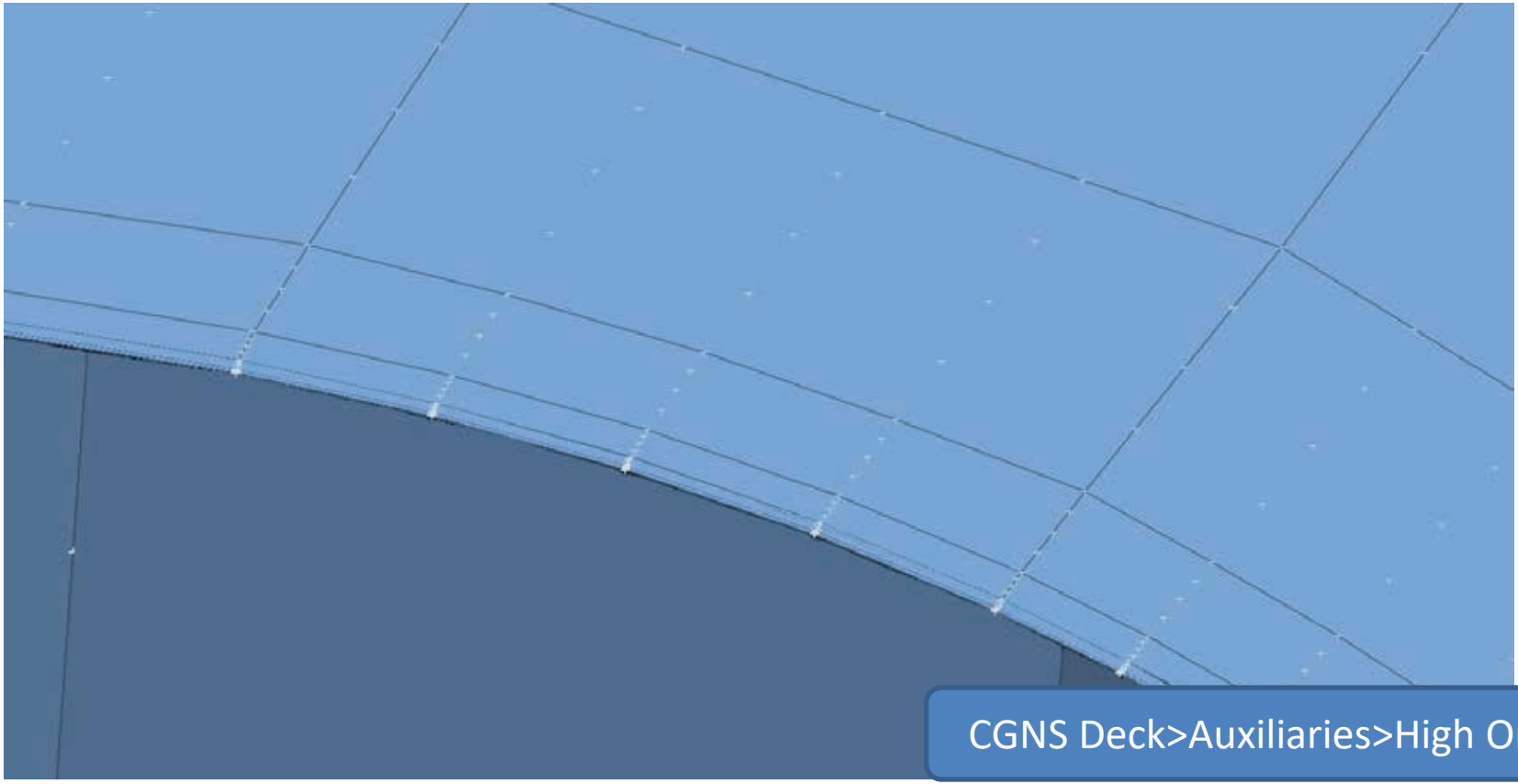


Meshing for CFD High Order methods – HLPW-5 Case 1 - WMLES methods





Mesh elevation to 3rd and 4th order



Recap

Recipe:

INGREDIENTS:

- Quality
- Speed
- Automation
- User Control
- Feedback
- Efficiency
- Wide range of functionality
- Discipline and solver independent

DIRECTIONS:

Support!!

Closing remarks

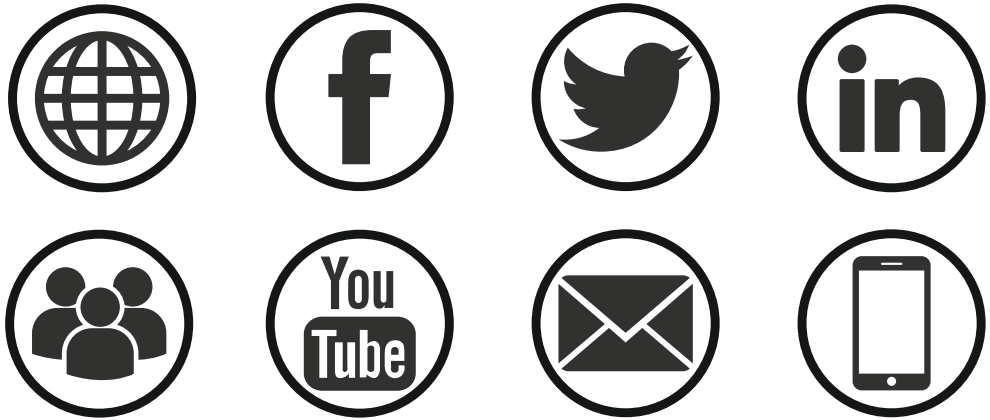
- ANSA can generate fully automatically high quality meshes for aerospace models, following precise user controls and specifications.

- ANSA presence is now widespread in the aerospace field (Industry, Academia, AIAA workshops..)

- We have achieved this by listening to our customers, working together and learning from them, in order to provide them with the optimum solutions for their work.

- We have done this since the beginning of BETA CAE and we have enjoyed every single moment of this journey.

BETA
SIMULATION SOLUTIONS



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