Your True Partner for CAE CFD ICSC2016

IDAJ CAE Solution Conference

CADfix - CAE Geometry for Advanced Simulation

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ITI
International TechneGroup

CADfix - CAE Geometry for Advanced Simulation

- Introduction to ITI and CADfix
- The need for CAE Geometry
- Technology for deriving CAE Geometry
- CAE Geometry CEM
- CAE Geometry for CFD
- CAE Geometry for FEA

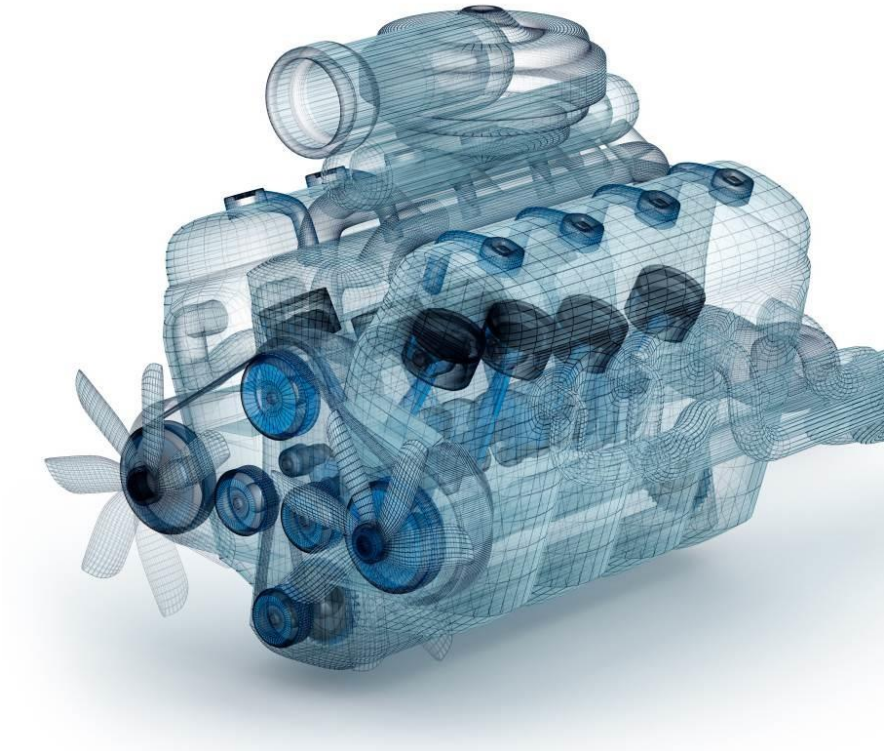
ITI and CADfix

- ITI provides interoperability solutions for product data and related systems

ITI

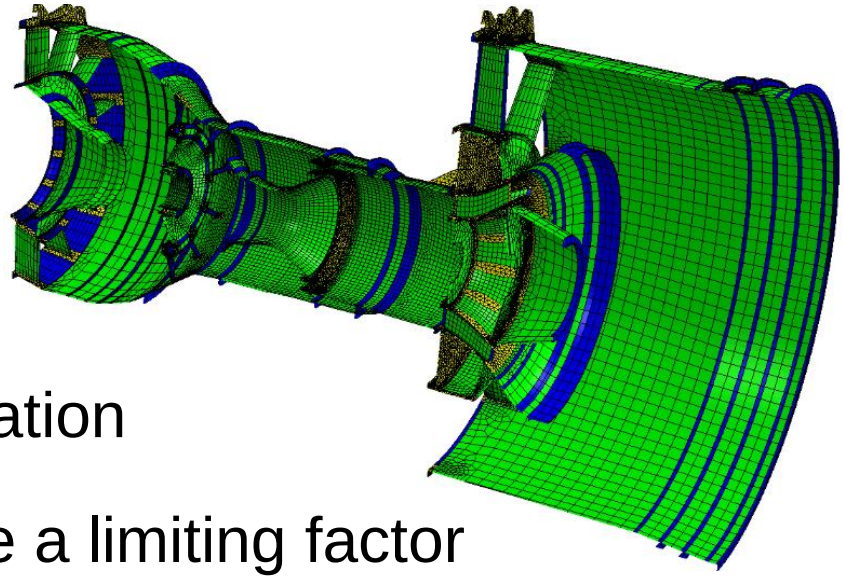
CADfix

- Translate, repair and simplify
- Connect CAD and CAE
- Eliminate model rework
- Reduce CAE lead times



CAE Geometry

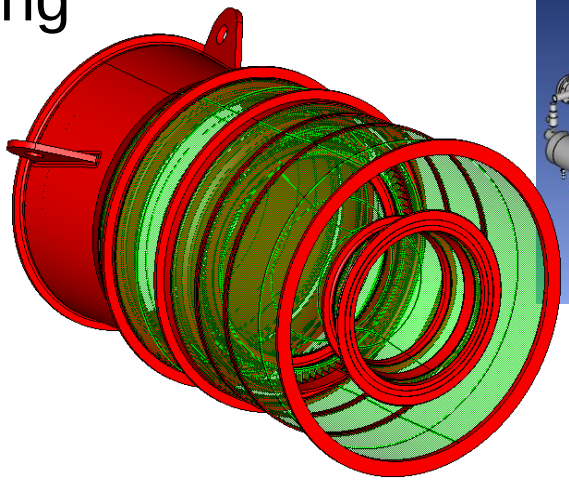
- Customers are demanding more from their engineering analysis processes
  - Bigger and more complex models
  - Iterative optimisation

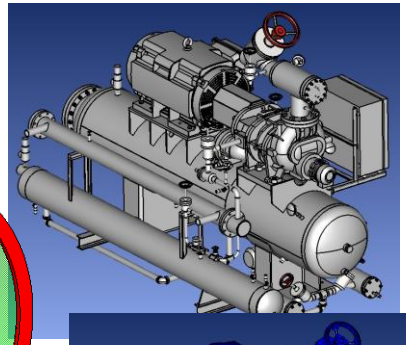


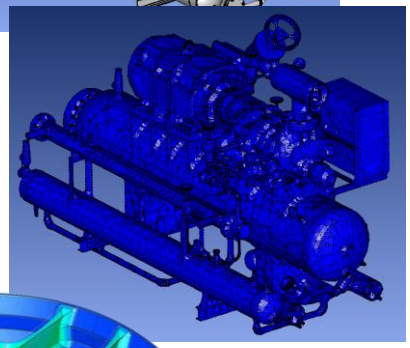
- Need for greater automation and improved CAD-CAE integration
- Deficiencies in CAD models are a limiting factor
- Requires an alternative idealised **CAE GEOMETRY**
  - Idealised and adapted for the specific CAE process
  - Often very different to the original CAD model

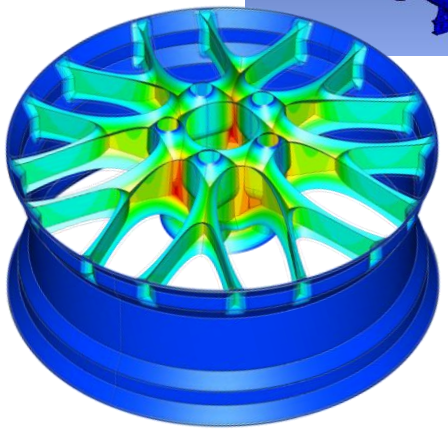
Technology for Deriving CAE Geometry

- Advanced model defeaturing
- Dimensional reduction
- Shrinkwrapping
- Welding
- CAE back to CAD and geometry morphing
- Facetted models
- Hybrid BREP & facetted models
- Medial Object (MO)



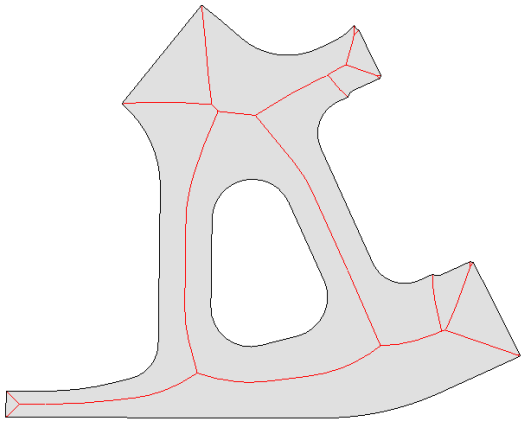


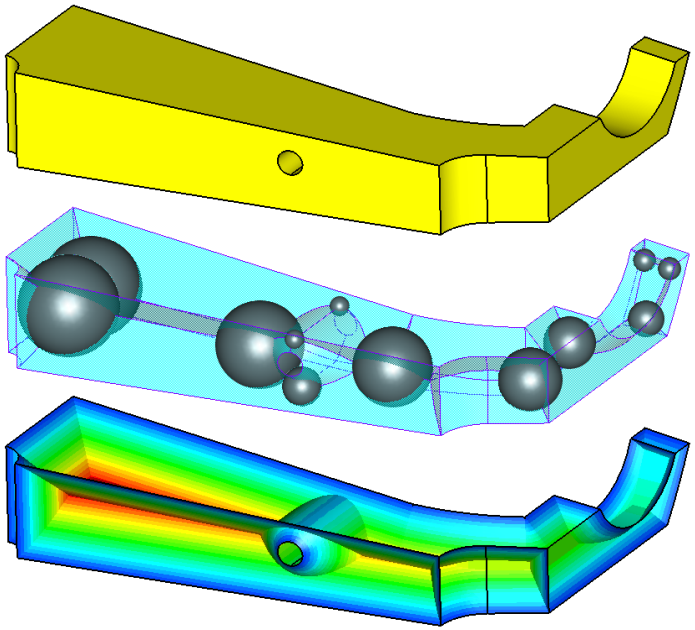


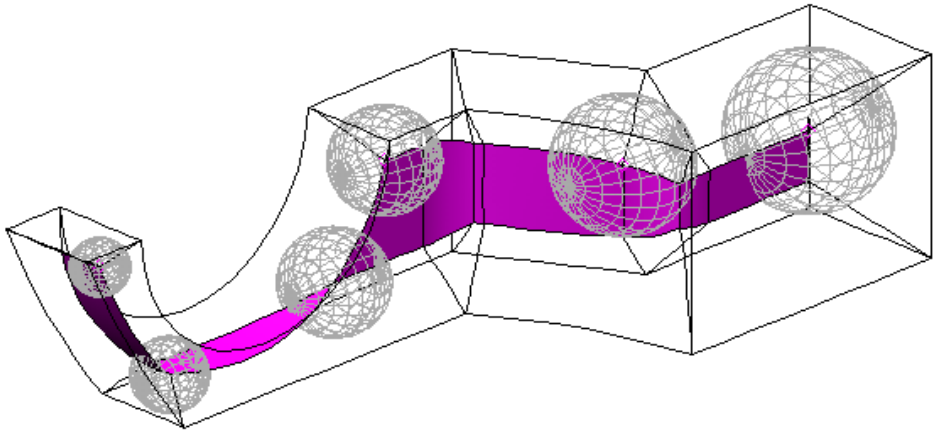


Unique CADfix Medial Object Technology

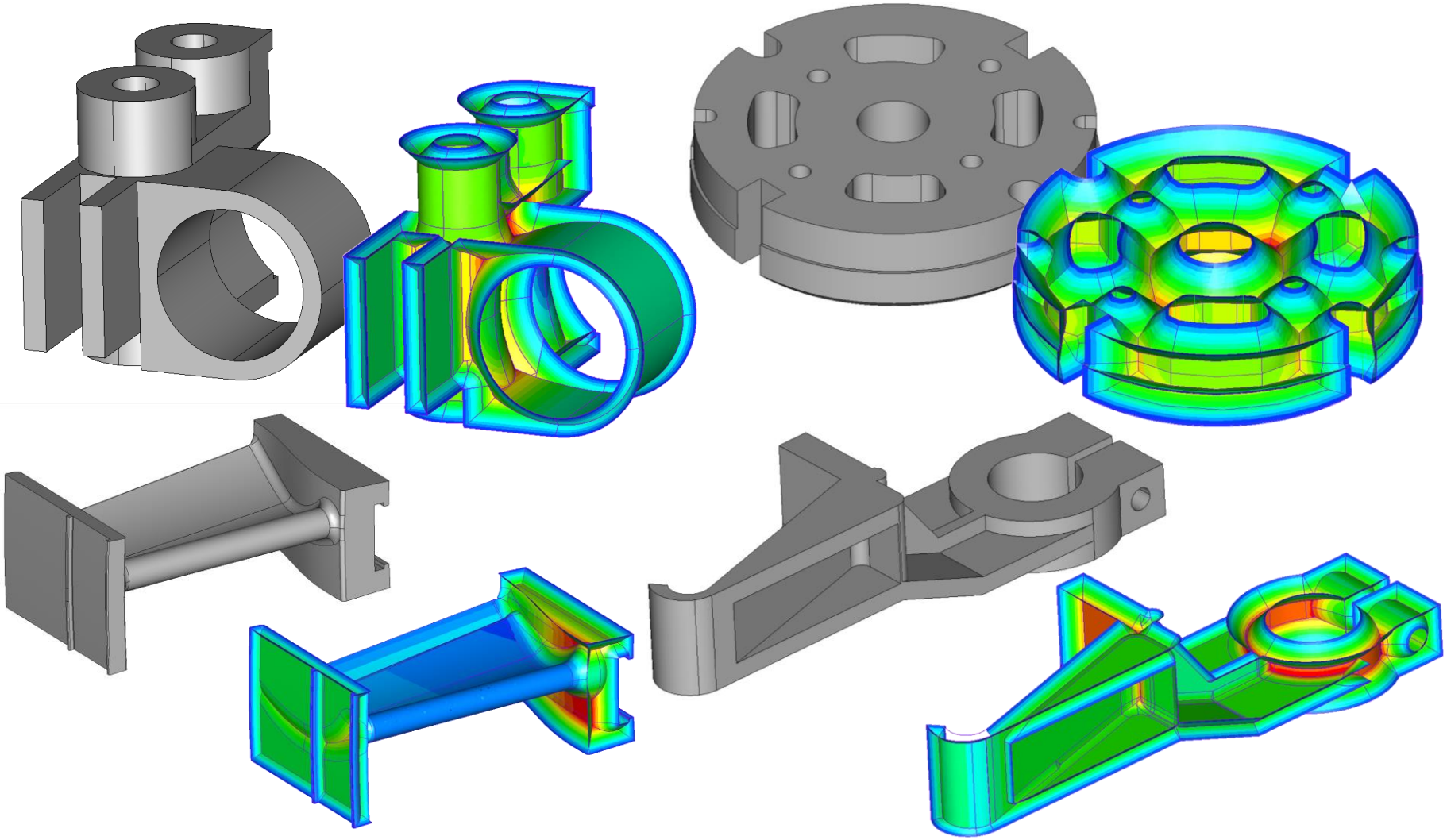
- CADfix Medial Object (MO)
  - Centre of maximal diameter disc in a 2D face
  - Centre of maximal diameter sphere in a 3D solid
- Provides information about the thickness, proximity and parent geometry



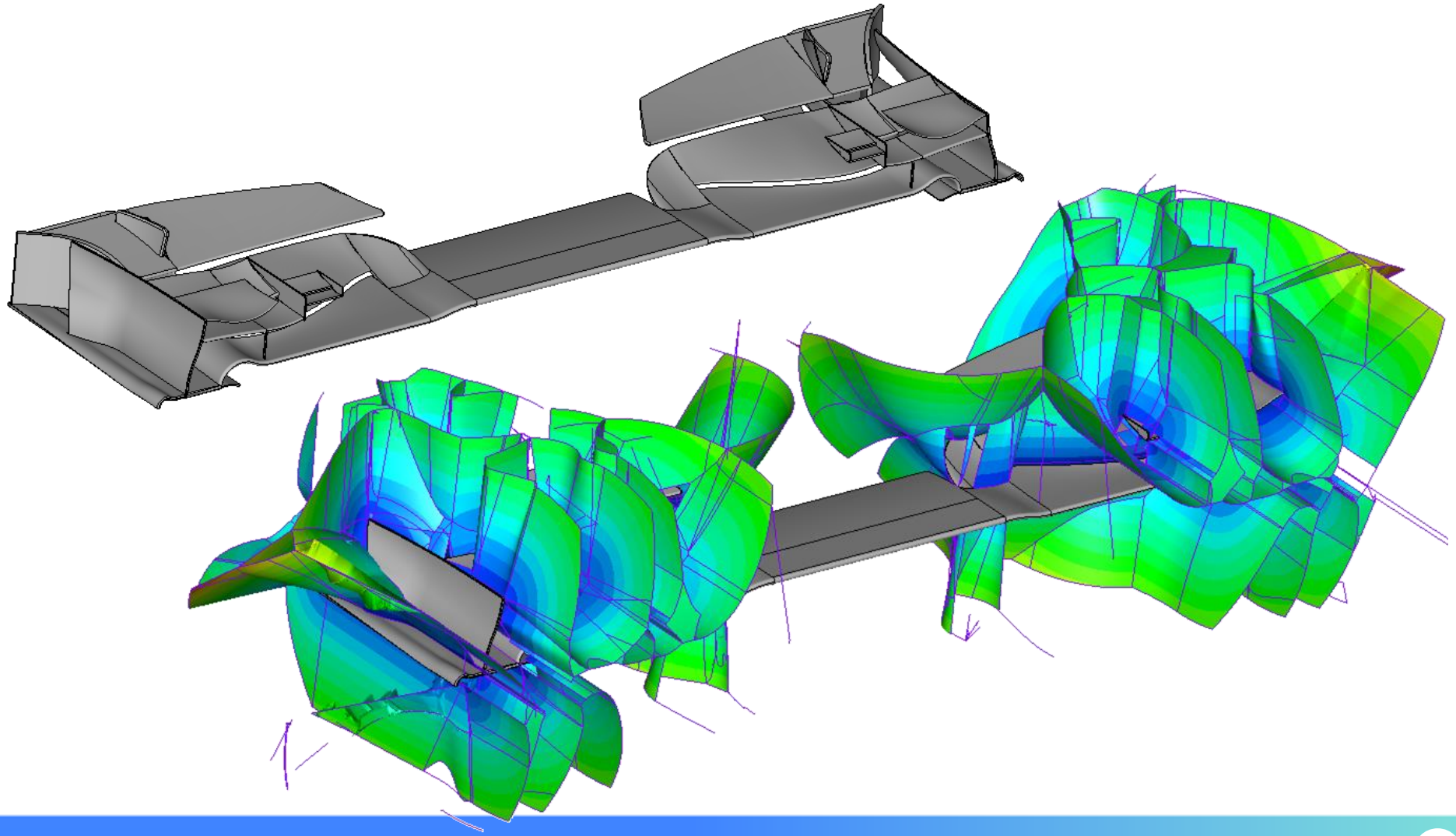




CADfix MO Maturing for Complex Models

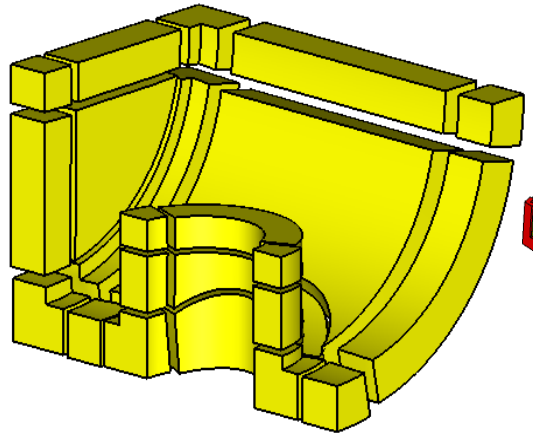
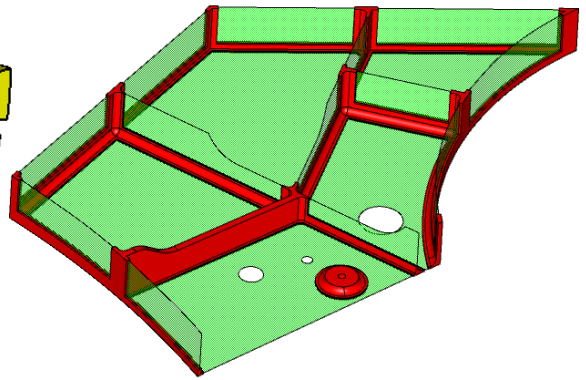
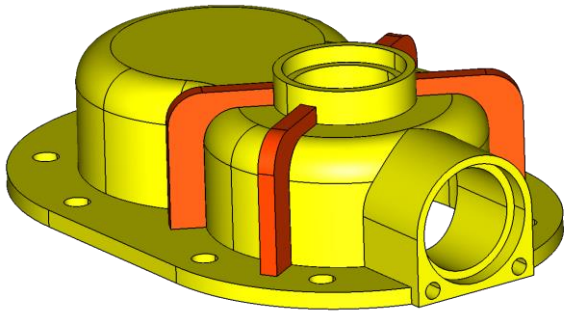
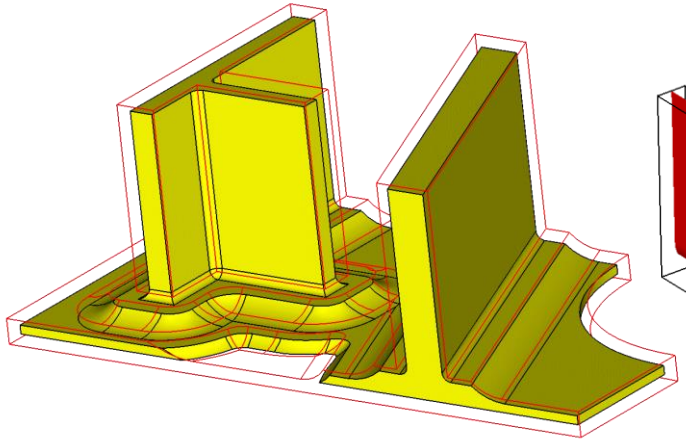
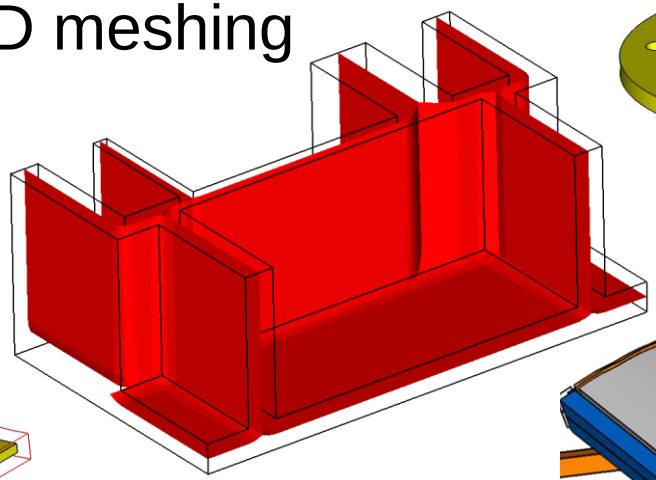
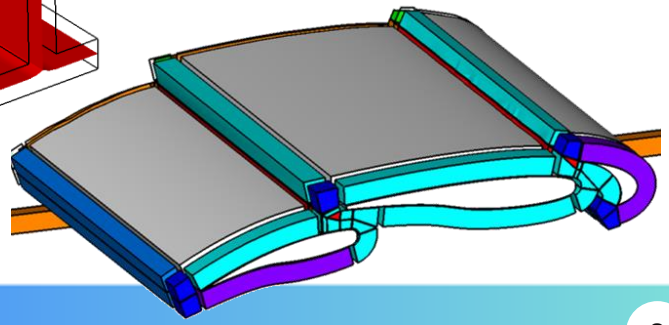


Complex Example: F1 Front Wing (external truncated MO)



Uses of the 3D Medial Object

- Hexahedral meshing
- Thin/Thick subdivision
- Feature recognition
- Shelling
- Mid-surfacing
- Partitioning for CFD meshing

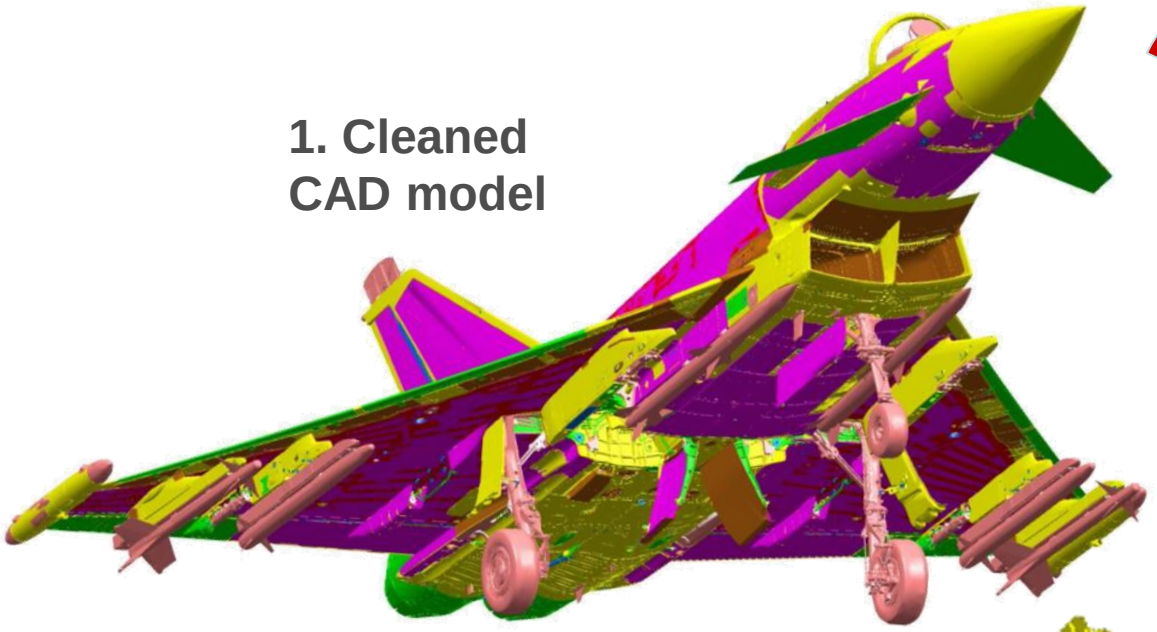







CAE Geometry for CEM

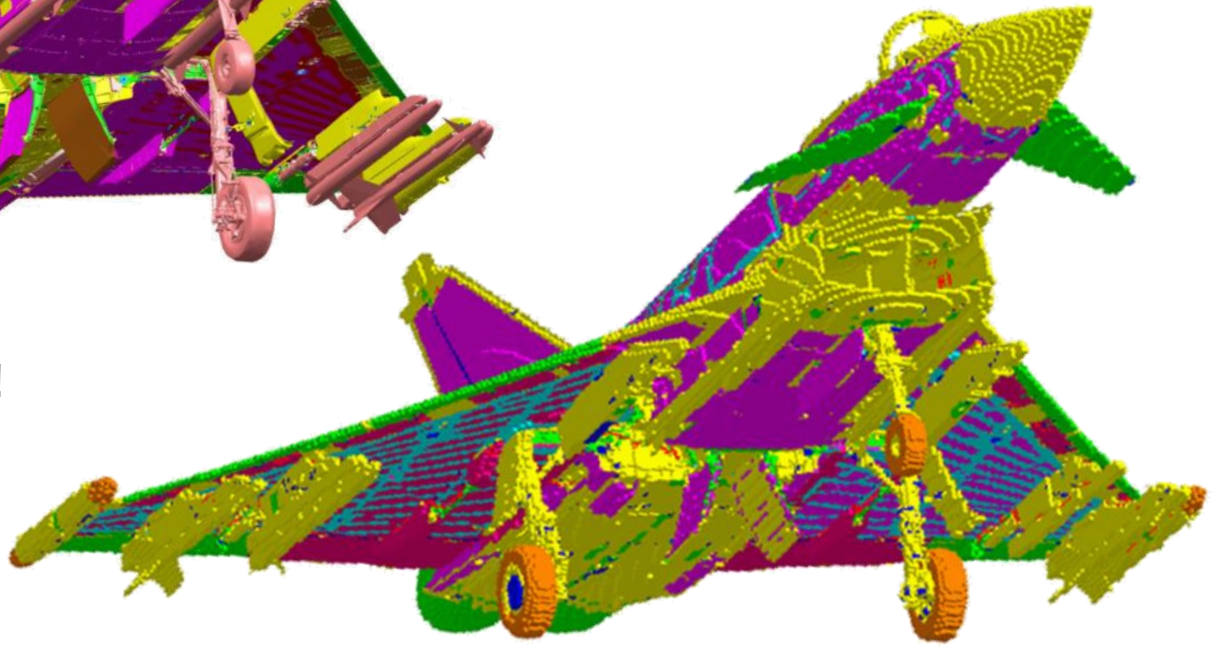
- ICE NITe project - Geometry processing for CEM

Different Requirements for Solver Technologies

1. Cleaned CAD model



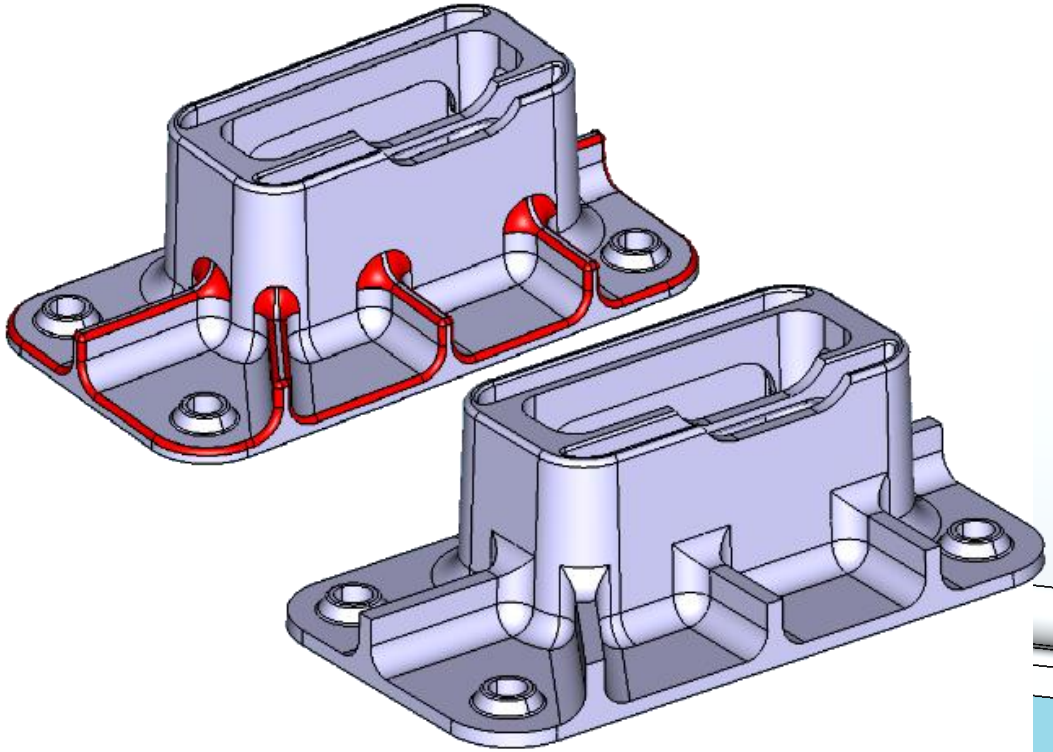
2. Cartesian IJK mesh for PTLM

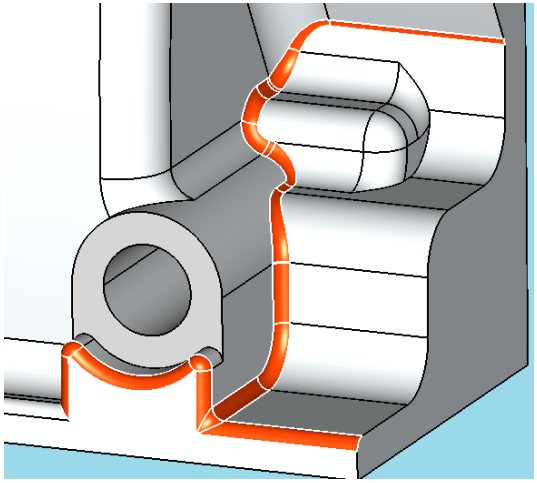


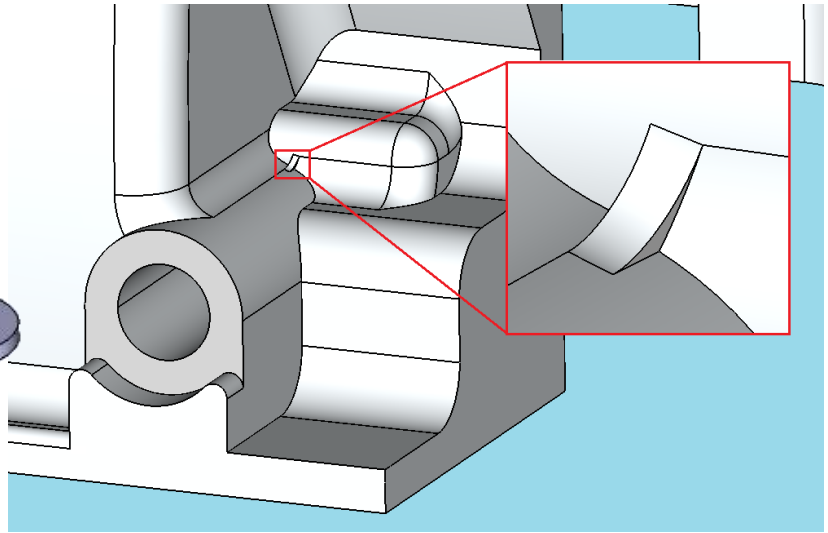
3. This is what we now want to analyse for UTLM!

Defeature

- Updated fillet removal tool
  - Improved performance
  - Partial removal when full removal is impossible

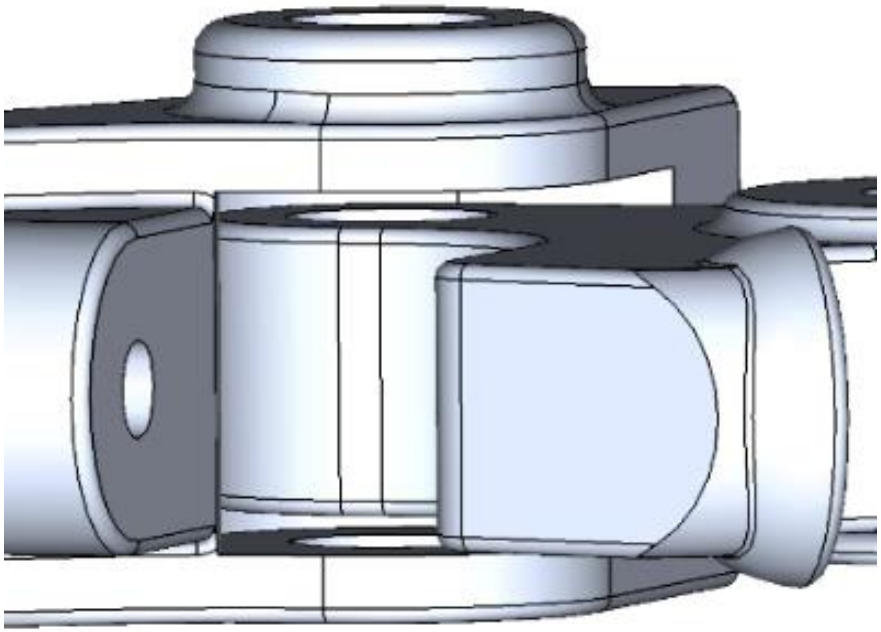


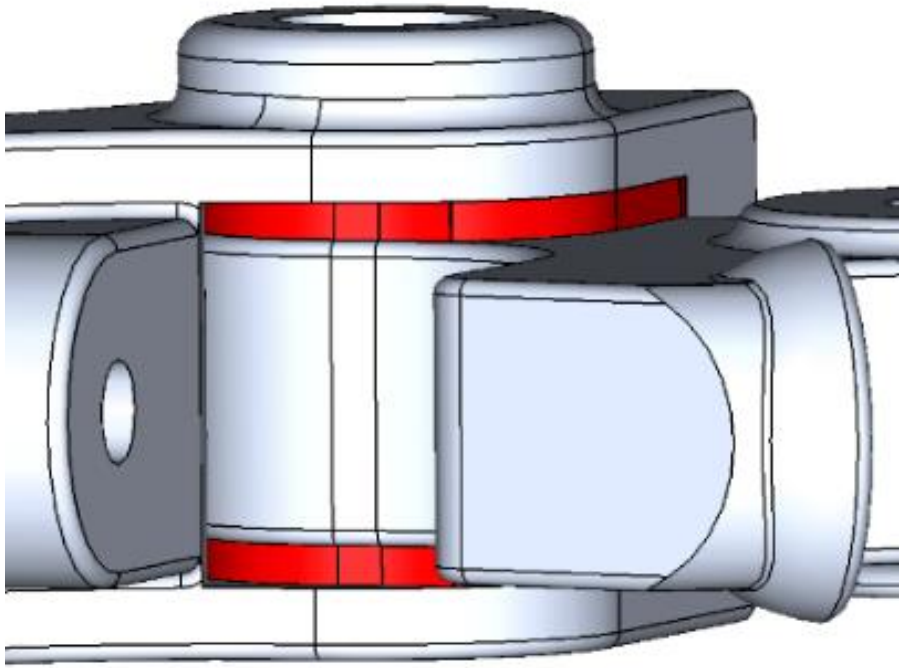




Welding

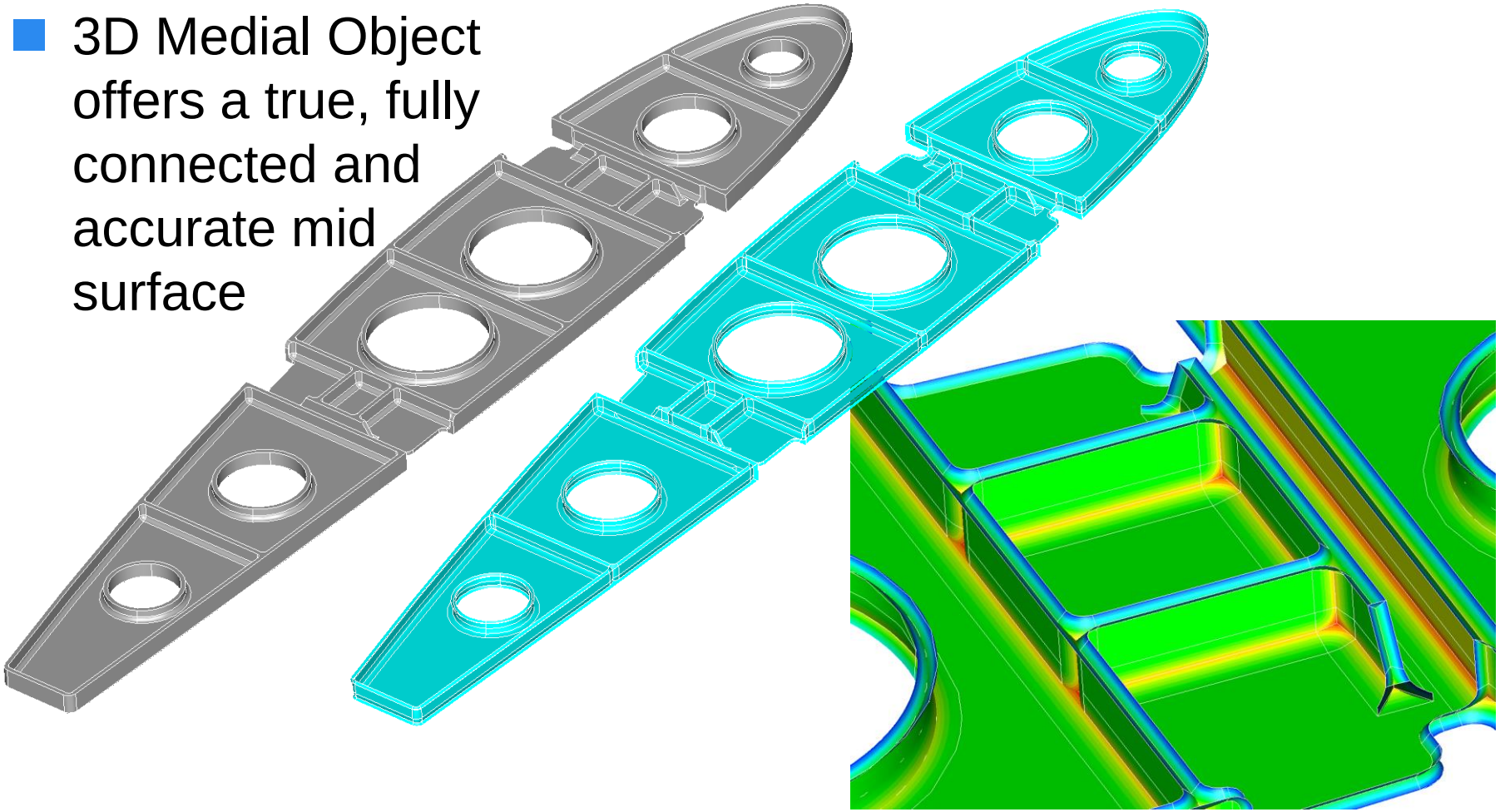
- Gap discovered and “weld” body constructed automatically
  - Useful when shims and fillers are not modelled explicitly in CAD





Idealisation – Mid-Surface of an Aircraft Rib

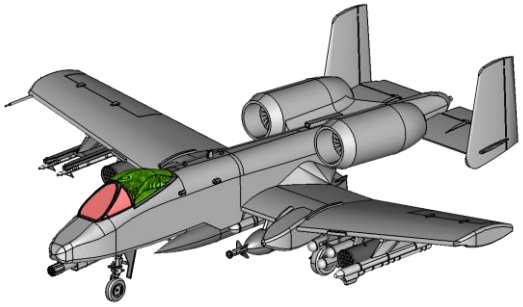
- 3D Medial Object offers a true, fully connected and accurate mid surface

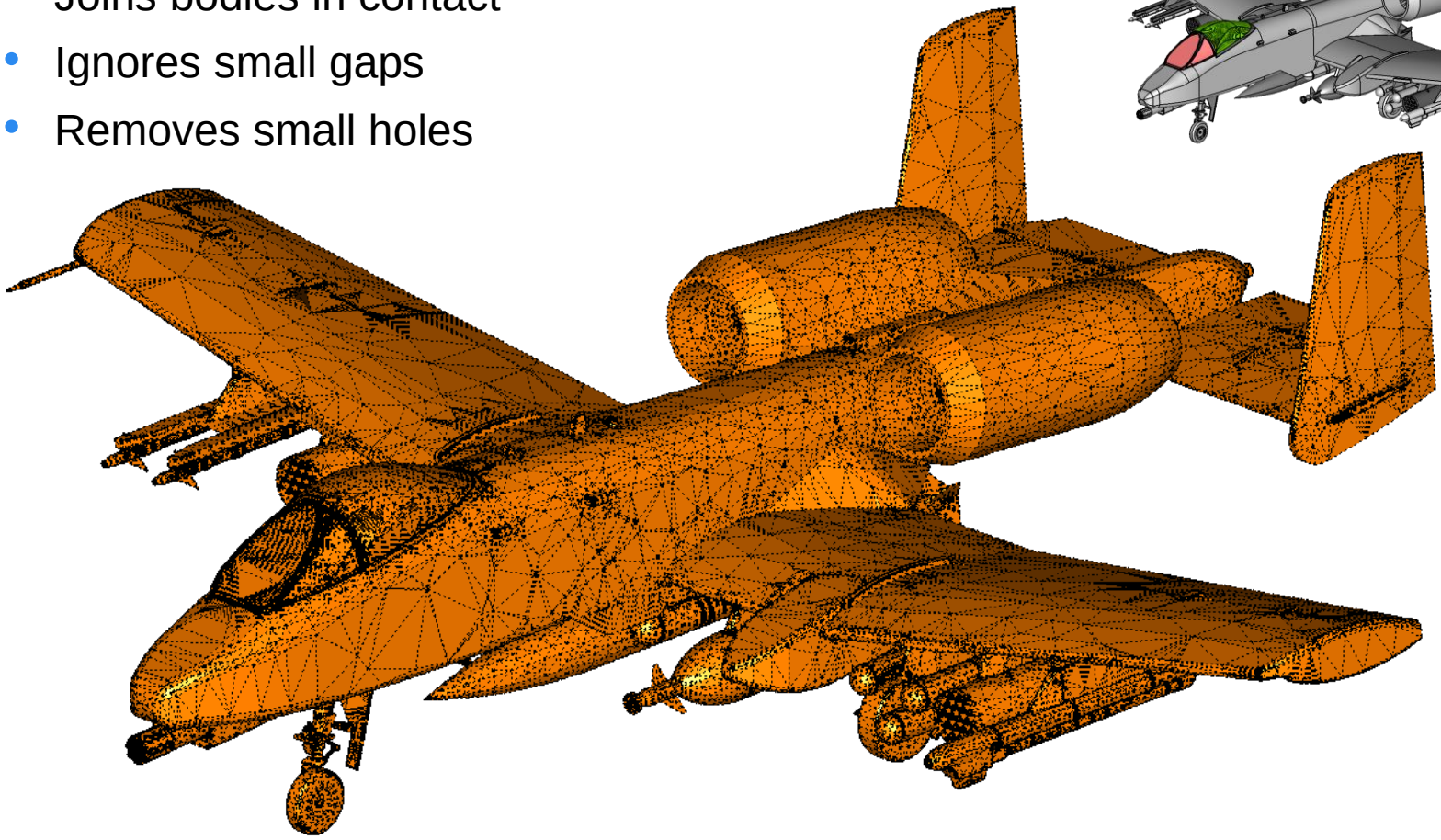


Colour contours on 3D MO indicate thickness

Shrinkwrapping

- One-click model preparation
  - Joins bodies in contact
  - Ignores small gaps
  - Removes small holes





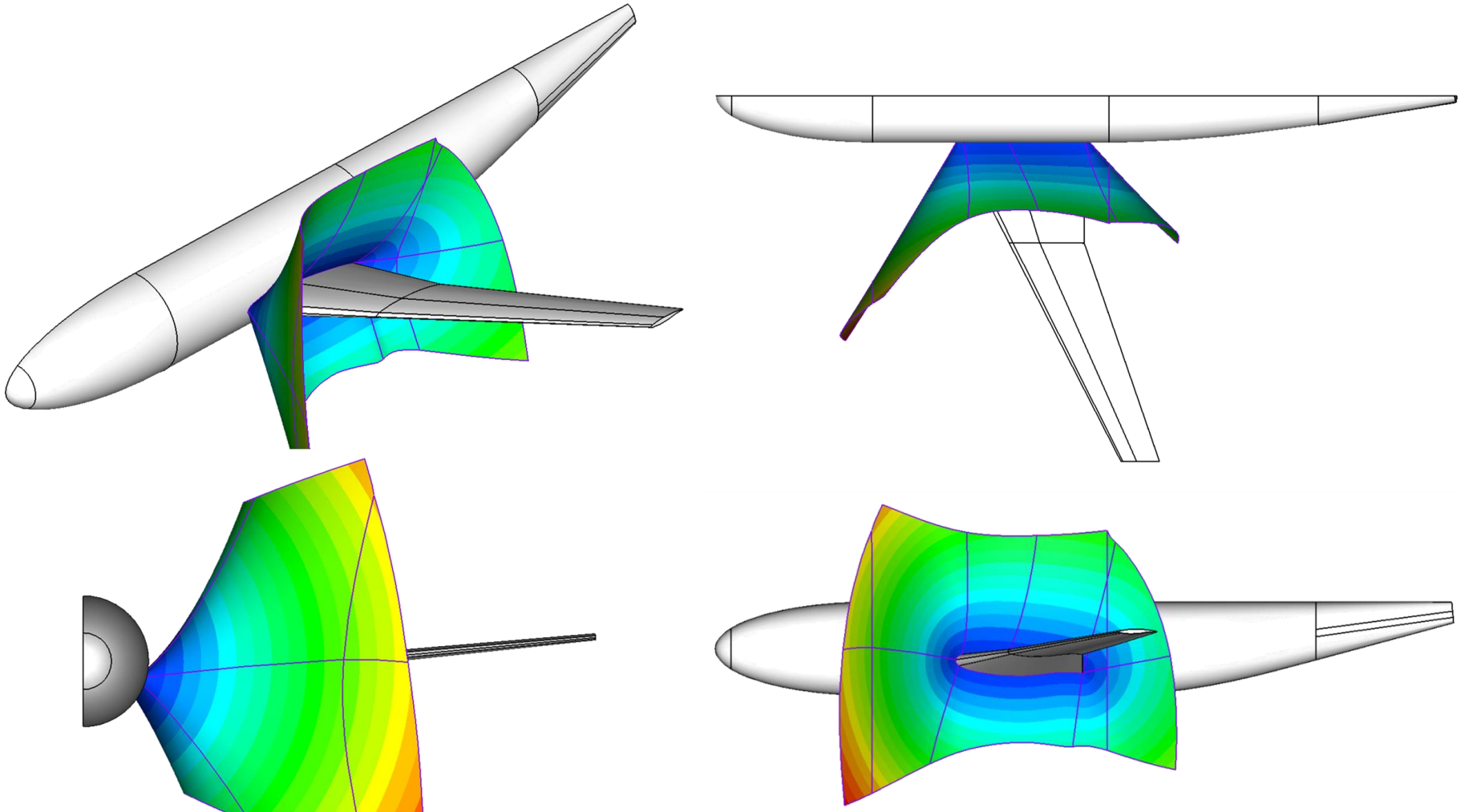
CAE Geometry for CFD

- Enabling high quality hybrid meshing for advanced CFD
- UK funded projects - ANSD, SimOD and GHandl

CAE Geometry for CFD

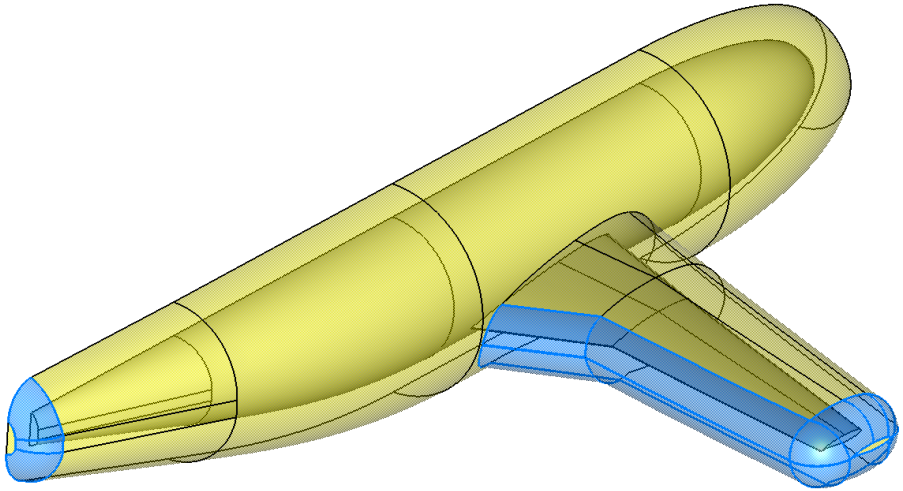
- Retain the benefits of **structured multi-block** meshing
  - Control over global mesh topology and local mesh behaviour
- Retain the benefits of **unstructured** meshing
  - Automation and speed
- Project objectives for new meshing
  - Similar or less manual effort as unstructured/hybrid methods
  - Accuracy close to structured multiblock methods
  - Better control over mesh density and topology
- Achieved by partitioning the model to create CAE Geometry
  - Control over mesh topology and alignment
  - Different mesh styles for different parts of the flow domain

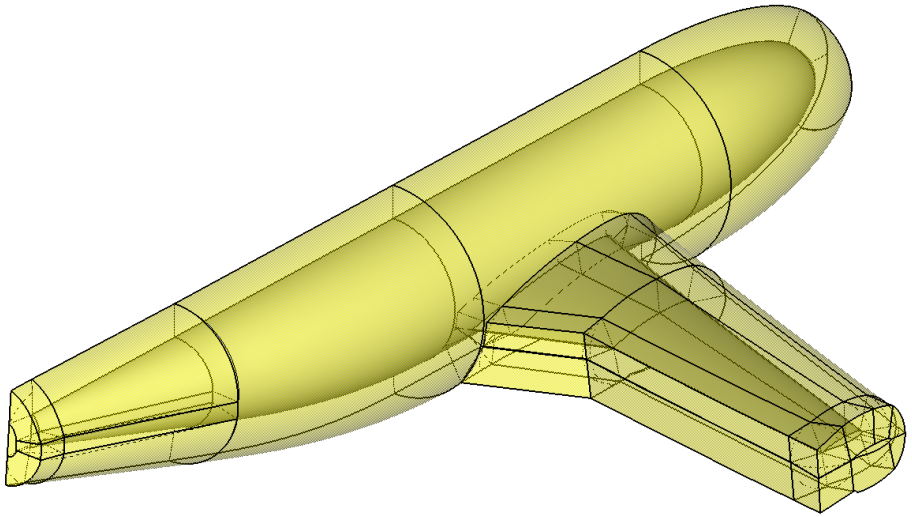
Generate Medial Object of Flow Domain



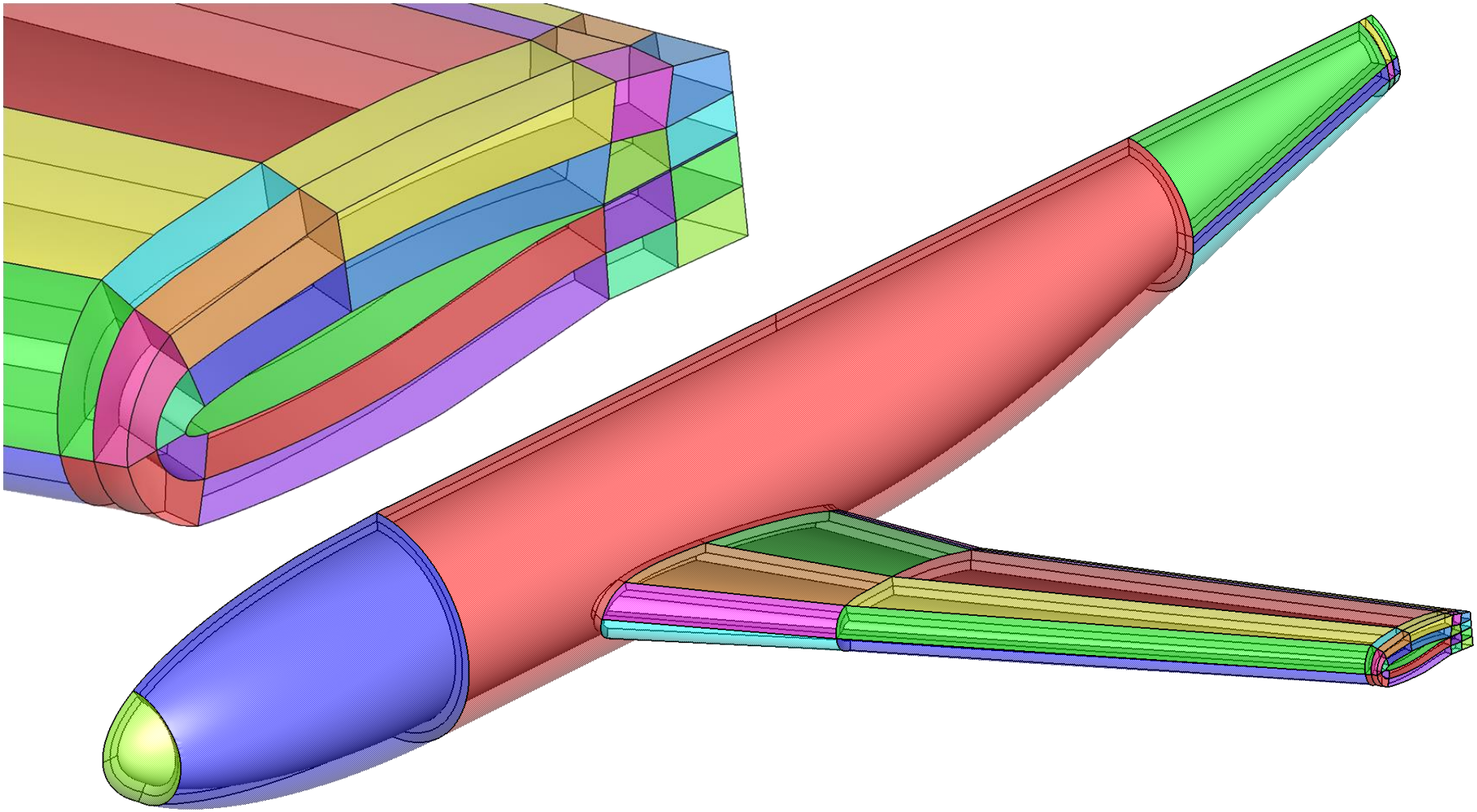
Generate Offset Shell, Subdivide and Square Off

- Medial object guarantees the offset surfaces meet cleanly
- Offset region is subdivided into partitions
- Rounded sections at sharp corners are squared off for better alignment with the flow

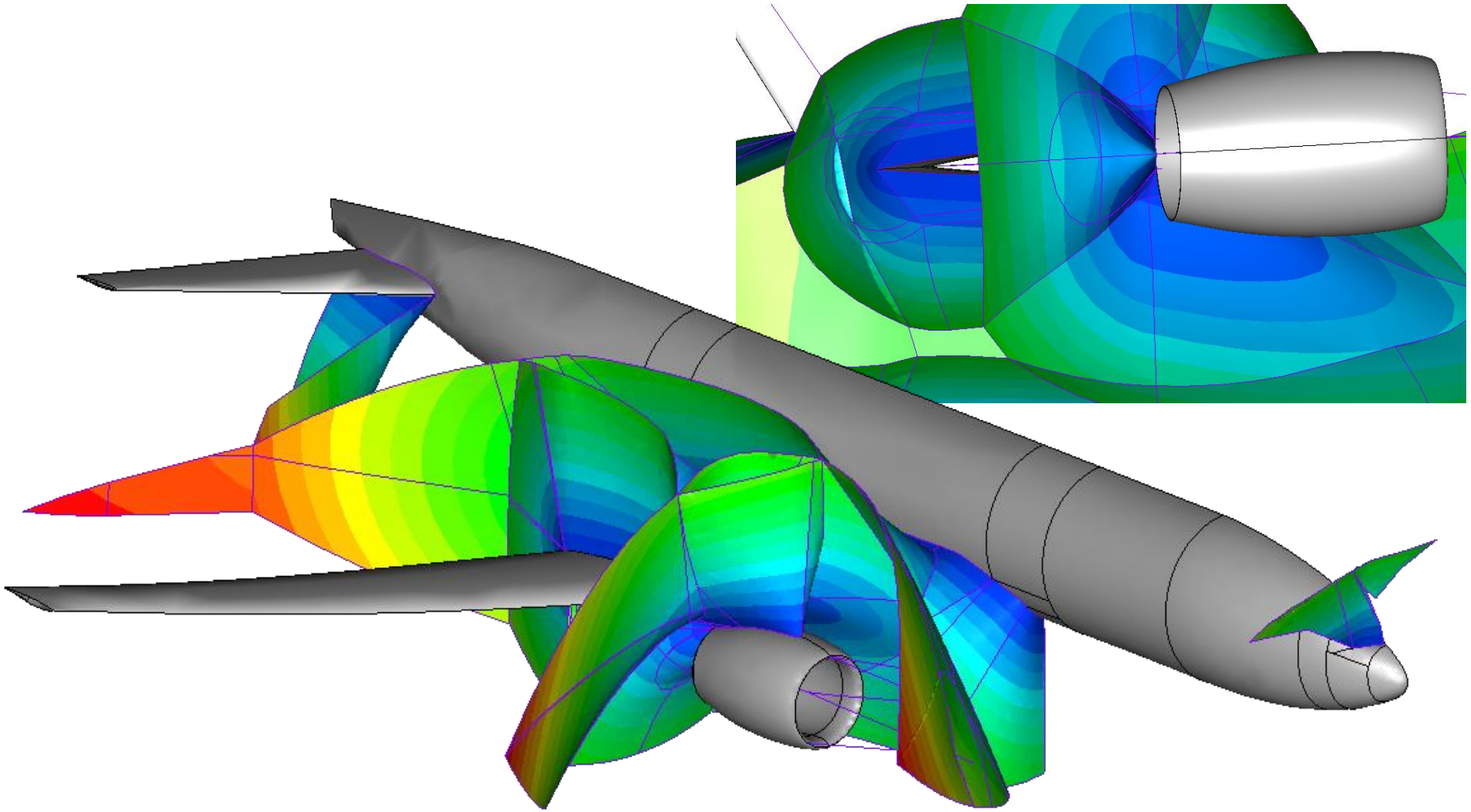




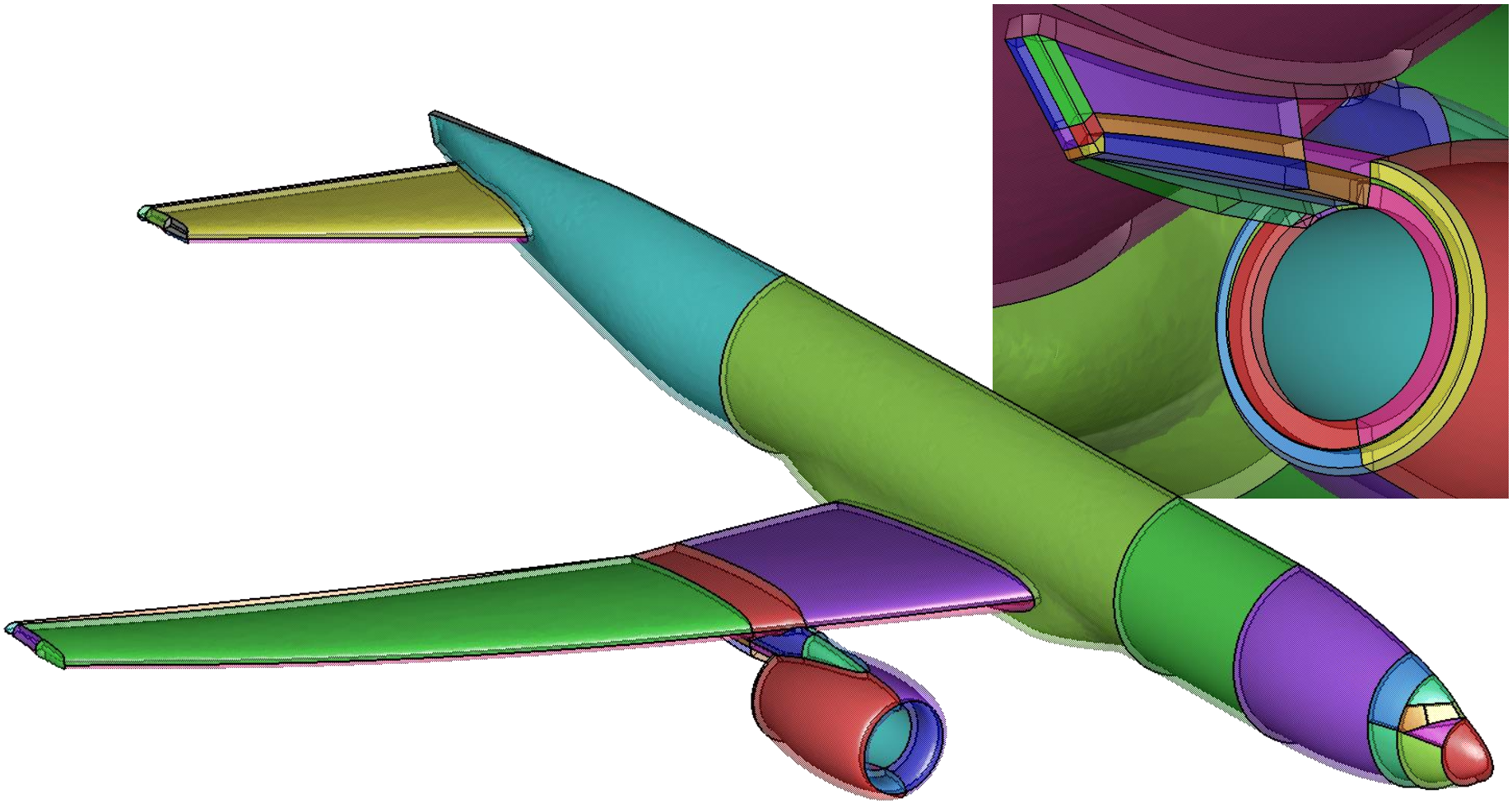
Automatic Partitioning with Multiple Layers



Results: Medial Object Generated in 20 minutes



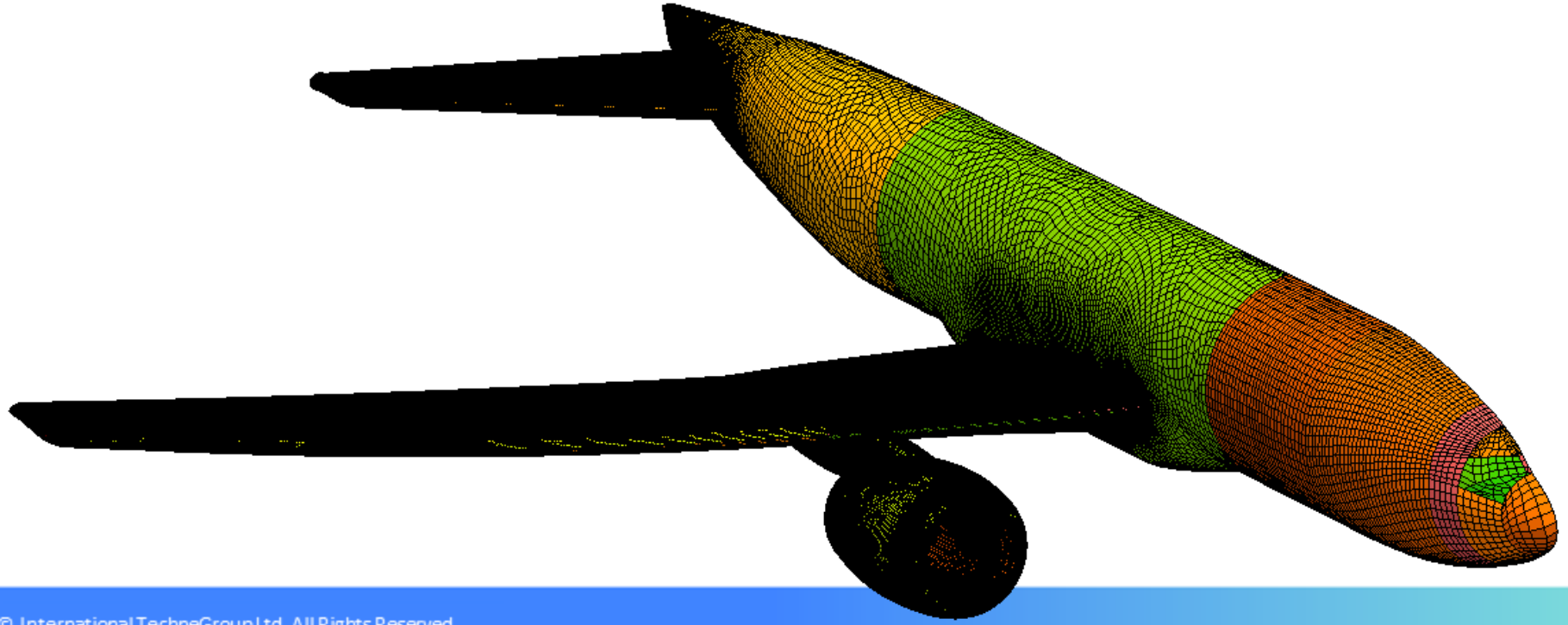
Results: Auto Near-Field Partitioning in 2 minutes



Colours randomly chosen for each partition

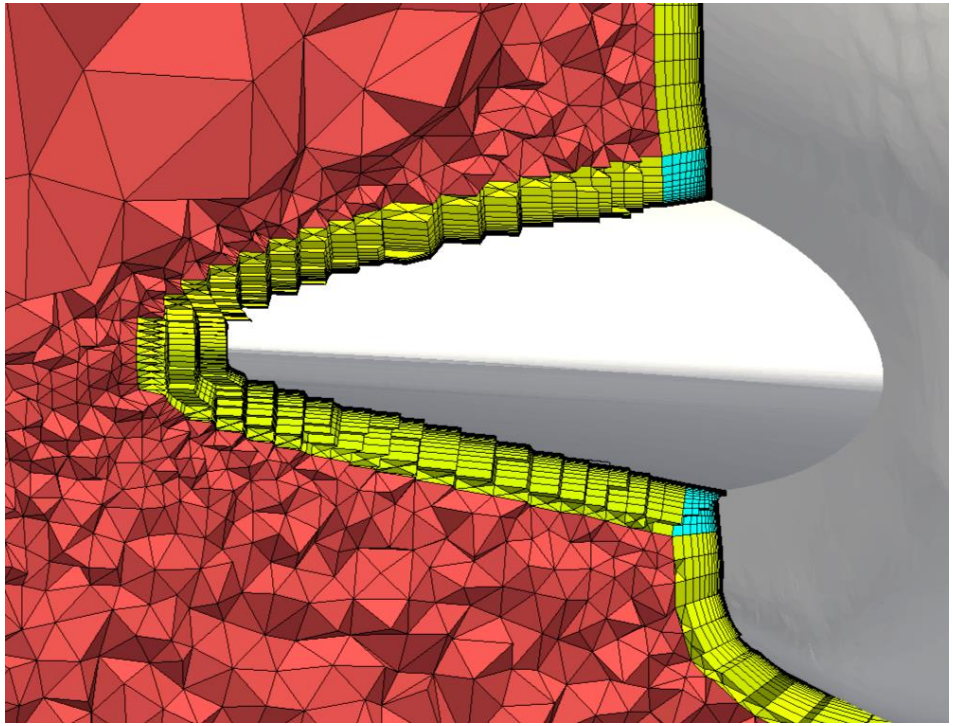
Results: Mesh Generated in 25 minutes

- Surface mesh - AIRBUS Mercury anisotropic quad mesher
- Structured solid mesh of near-field partitions - CADfix hexahedral and swept mesher
- Unstructured far-field mesh - Distene mg-tetra (not shown)

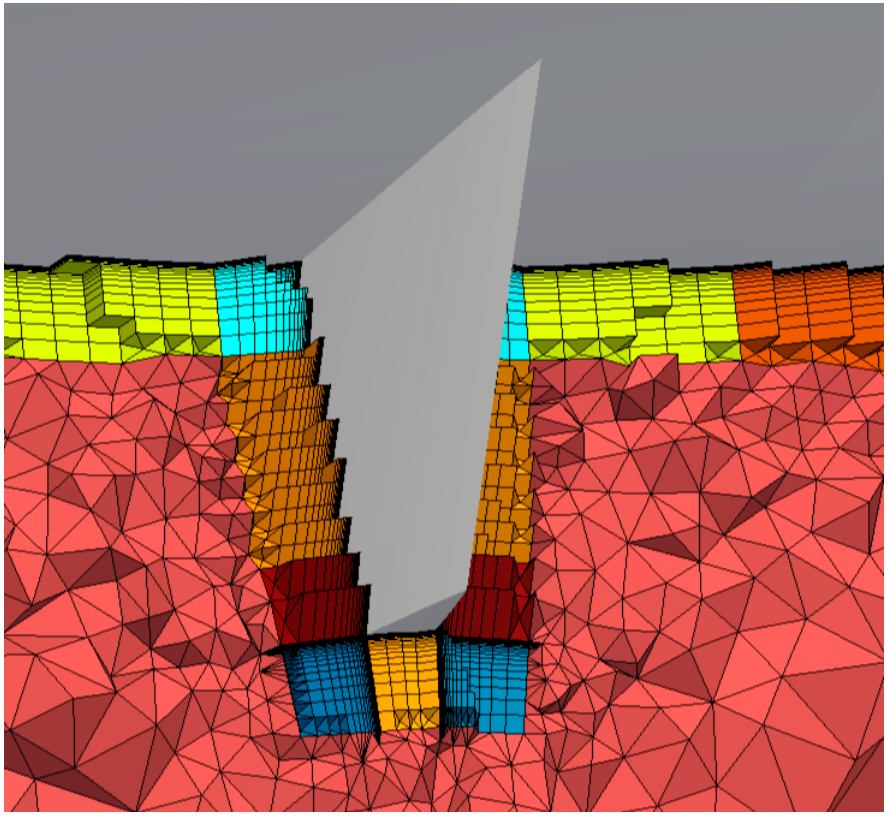


Results: Wing/Fuselage Junction & Pylon

Wing/fuselage junction with structured mesh in concave region

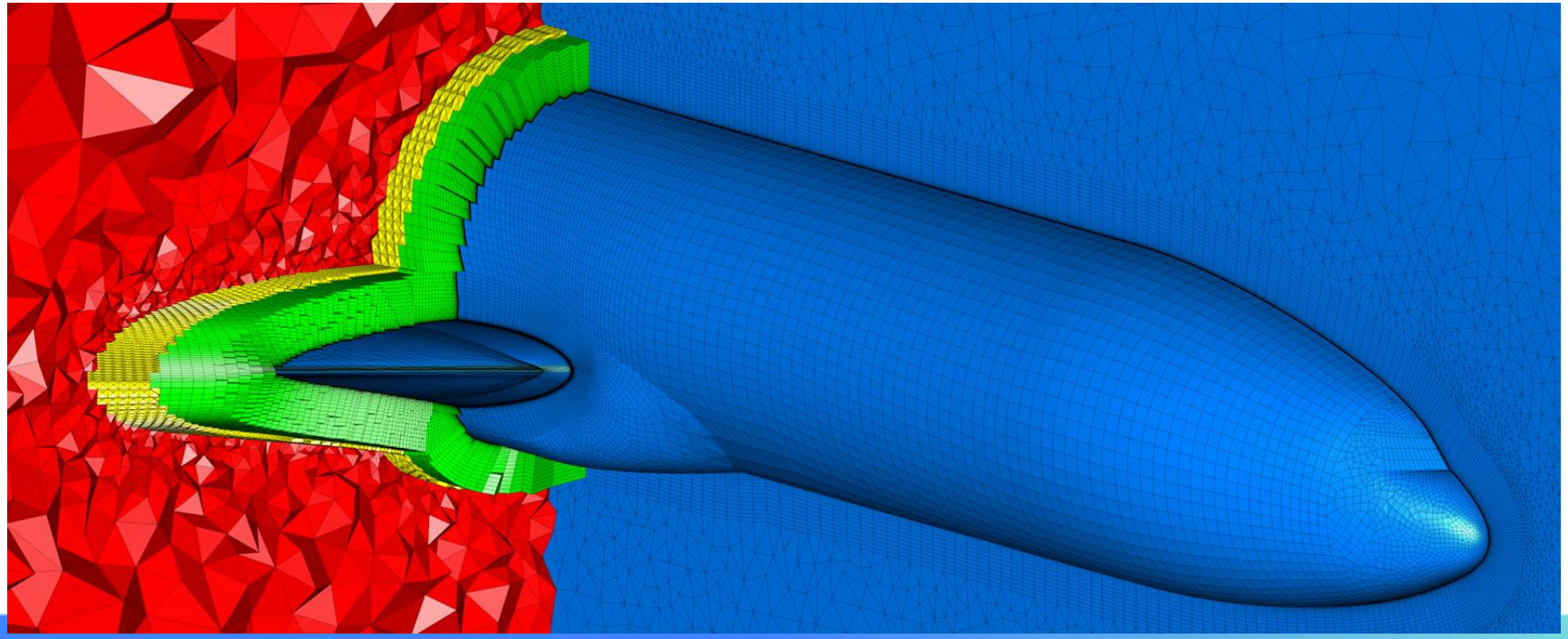


Pylon trailing edge



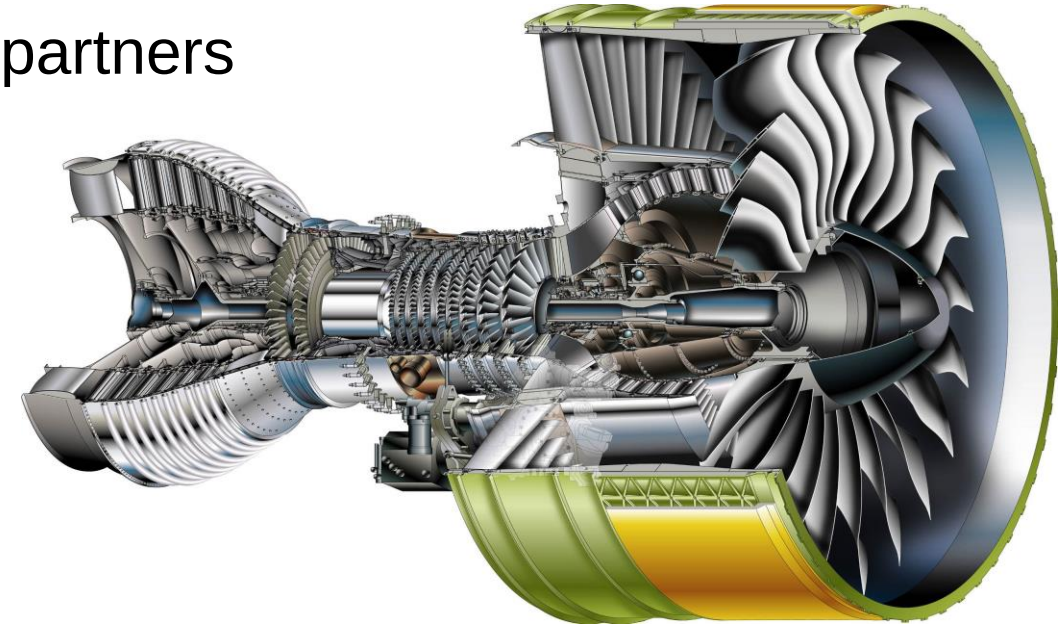
Results: Hybrid Mesh on NASA CRM

- Auto partitioning with no prior knowledge of the geometry
- Good mesh alignment in concave areas e.g. wing/body
- Good mesh alignment in convex areas e.g. trailing edges
- Unstructured far field mesh allows density to dissipate



CAE Geometry for FEA

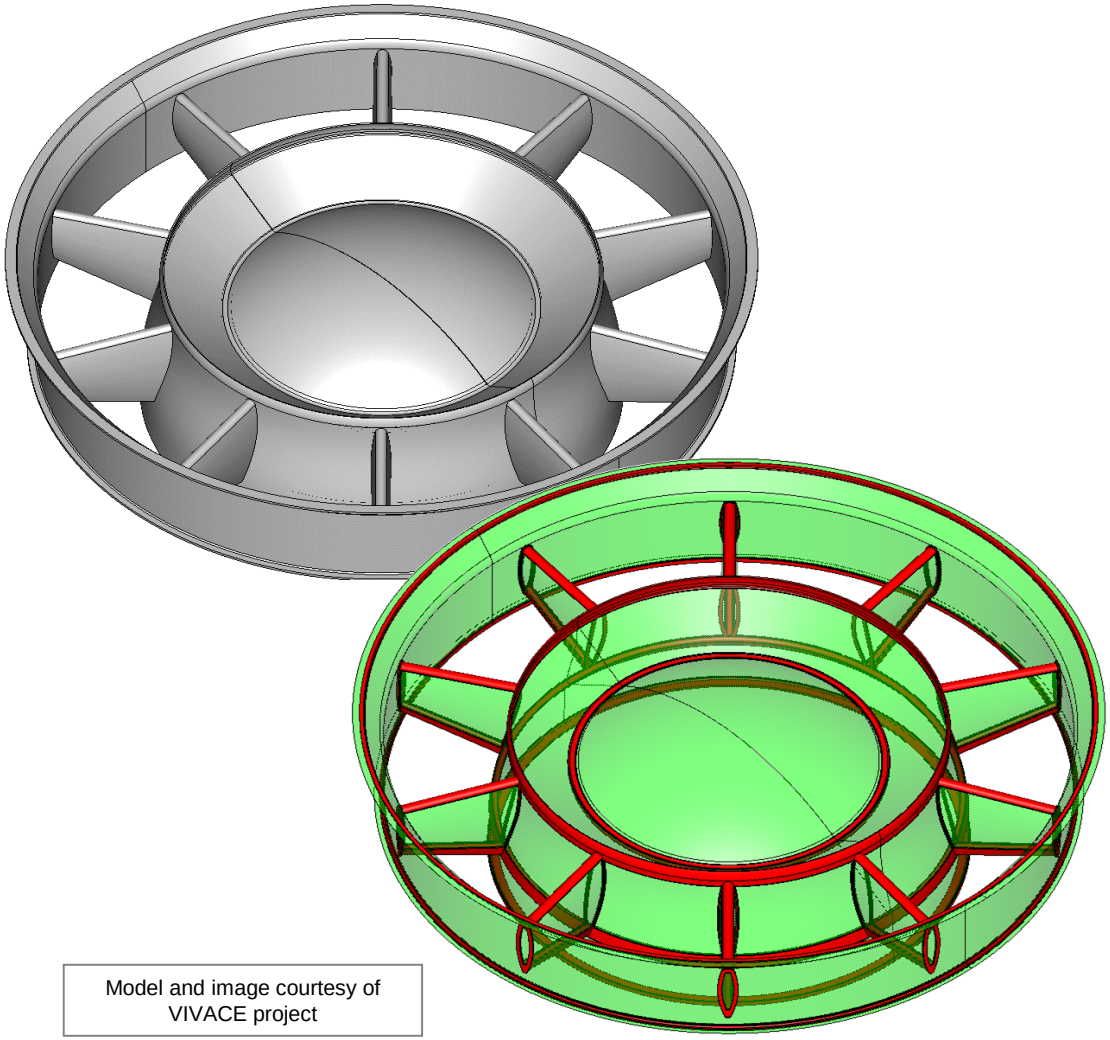
- Analysis of a full virtual engine is a massive task
- Dimensional reduction of complex CAD models to enable efficient structural and dynamic simulation and optimisation processes for very large models
- Supported by industrial partners and UK and European collaborative projects



Thin-Thick Reduction using the 3D MO

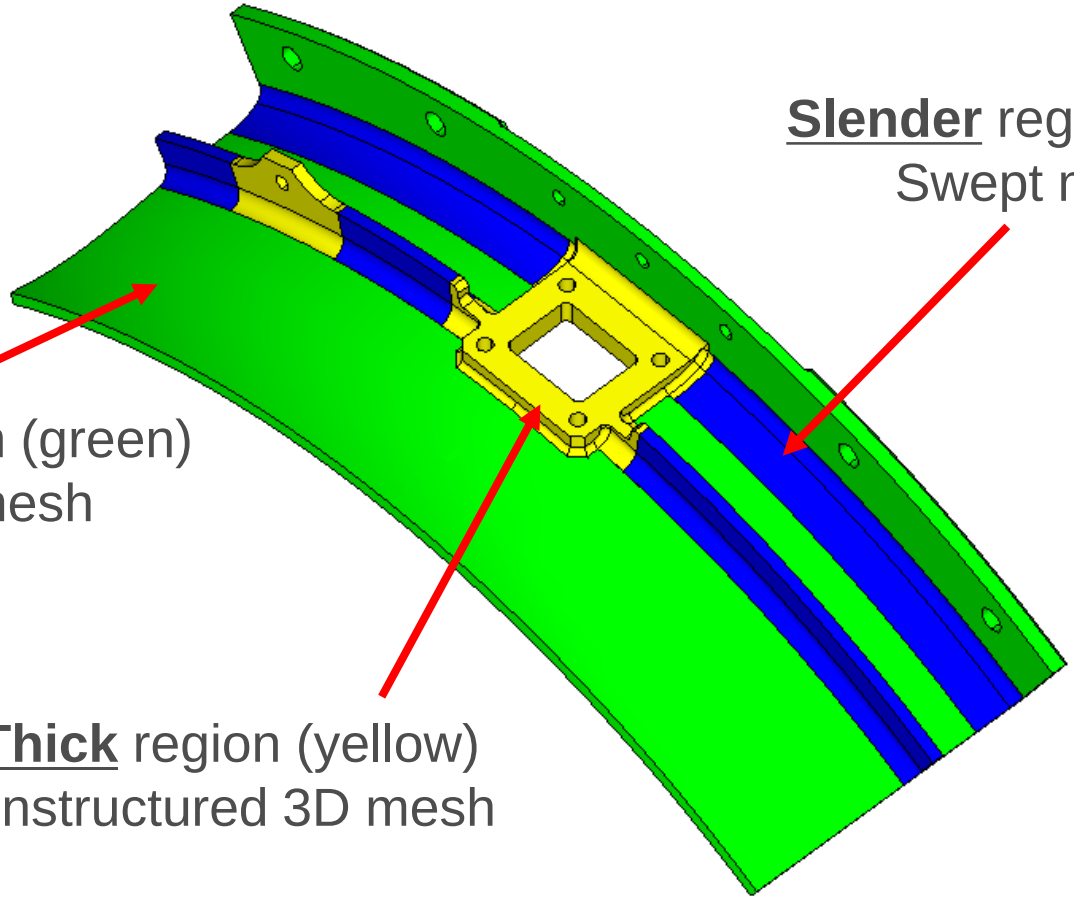
Another VIVACE Project test case:

- Degrees of Freedom reduced from 9.4M down to 700K
- Analysis time reduced from 48 hours to 40 minutes
- Acceptable Maximum error <11%



Model and image courtesy of VIVACE project

Automatic Thin-Thick-Slender Subdivision



Slender region (blue)
Swept mesh

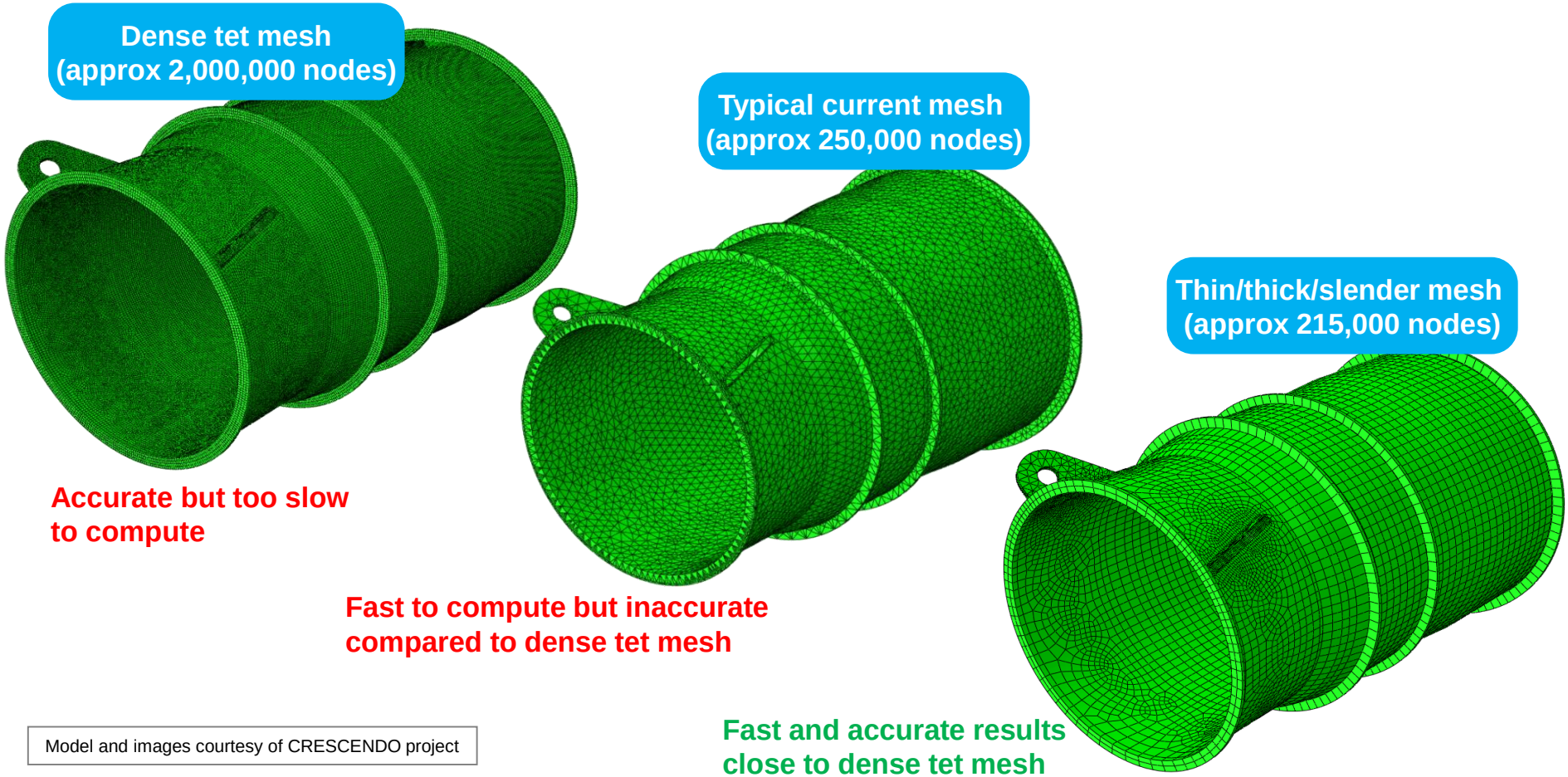
Thin region (green)
Shell mesh

Thick region (yellow)
Unstructured 3D mesh

Model and image courtesy of CRESCENDO project

Validation of a Thin-Thick-Slender Mesh

- Results of a modal analysis comparing different meshes



Model and images courtesy of CRESCENDO project

Conclusions

- As CAE becomes more ambitious the deficiencies in CAD models will limit what can be done in CAE
- There is a continuing requirement for tools that automate the flow of data between and integrate CAD and CAE
- This drives requirements for the fast and automatic creation of appropriate CAE Geometry
- CADfix is tackling the derivation of CAE Geometry for advanced simulation in close cooperation with major industrial partners

CADfix

聞いてくれてありがとう！

感谢聆听！

Thank you for listening !