

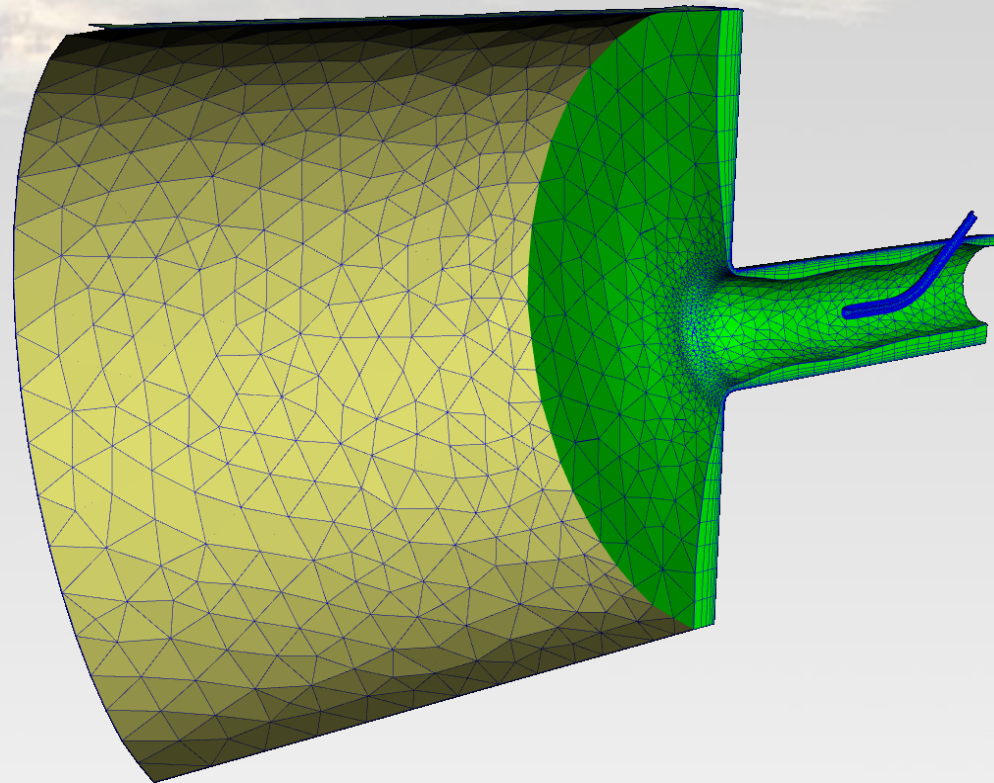
ENGRID: Open-Source Mesh Generation

OpenFOAM “Stammtisch”

Thursday, November 5, 2009

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Overview

- Where are we now
 - Brief introduction
 - Demonstration
 - Examples
- Future
 - What is planned?
 - What is envisaged?

Motivation for Open-Source Meshing

- *enGits* started in October 2006
 - Main activity: software development for very specific CFD problems
 - To extend business a reliable CFD solution was desired
 - Commercial codes too expensive
(no guaranteed business coming in)
 - Open-source, as well as in-house, solver and post-processing available
 - Meshing situation not sufficient for commercial CFD work
- Expertise and a few ideas on how to improve unstructured mesh generation
 - Write own meshing software ...

Motivation for Open-Source Meshing

- Open-source or proprietary software?
- Decision was made rather quickly in favour of OSS
- As a small company it would be extremely difficult to compete with the commercial codes
- Funding available for an open-source development
(funded by the European Space Agency)
- *Possibility to generate business with support and customisation of the software*

open-source „process chain“

- **geometry modelling**
 - Blender
 - Salome
- **geometry import and surface meshing**
 - Gmsh
 - NETGEN
- **isotropic volume meshing (tetras)**
 - NETGEN
 - Tetgen → ATTENTION: not allowed for commercial applications, NOT OPEN-SOURCE
- **an-isotropic boundary layer grids**
 - ... → Engrid
- **solver**
 - OpenFOAM
 - Code Saturne
 - Elmer
- **visualisation**
 - ParaView
 - Open Data Explorer

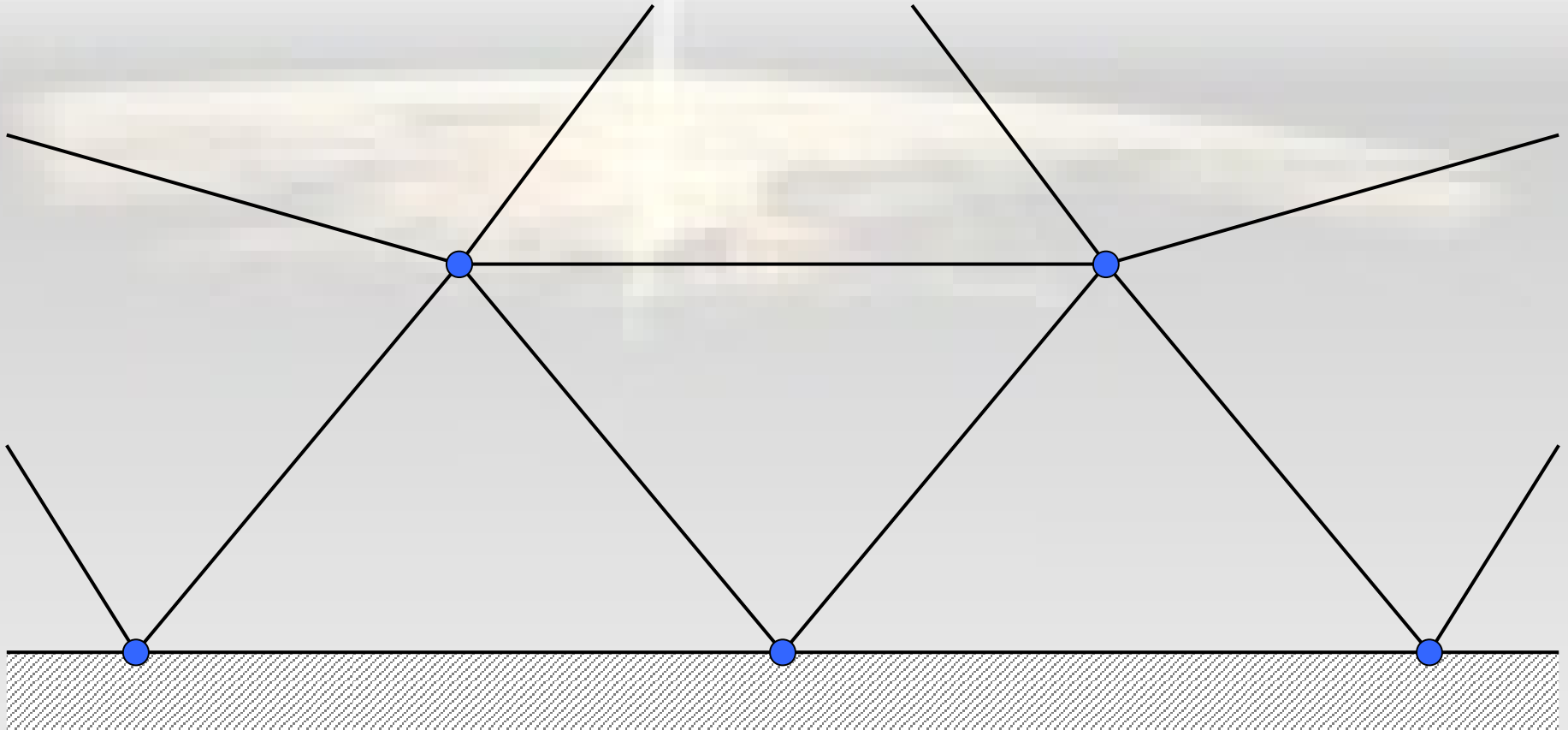
Current Status of ENGRID

- Capable to create unstructured hybrid grids for CFD (prisms & tetras)
- Reliable support for prismatic boundary layers
- Requires a triangulated surface as input
 - STL files like for snappyHexMesh
 - NETGEN could be used as IGES/STEP → STL converter
- Exports OpenFOAM cases (native format)
- Experimental support for polyhedral grids
 - direct export to OpenFOAM
- Basic modification tools (e.g. extrusion, rotation)

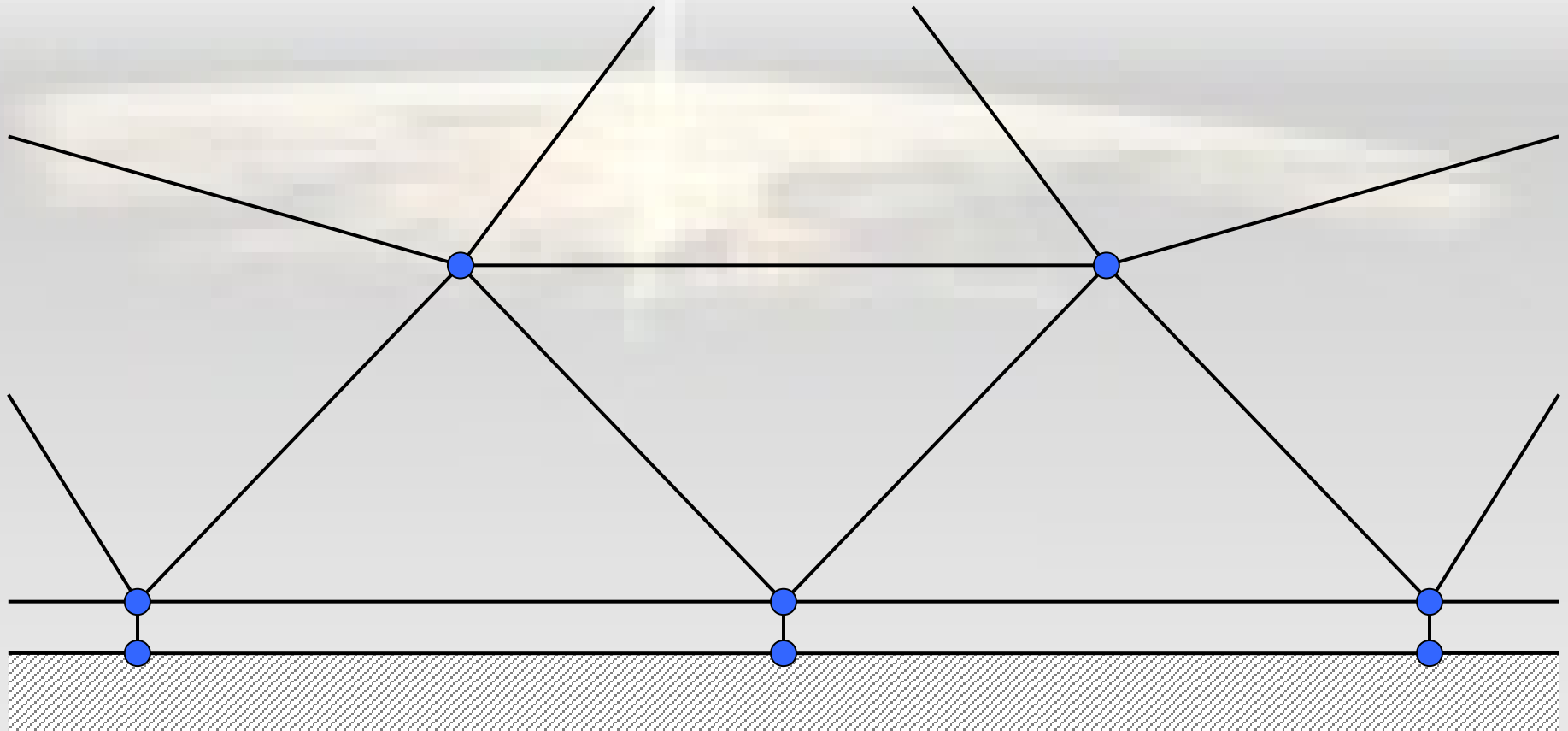
Brief Technical Background

- ENGRID uses NETGEN to create tetrahedral grids from surface triangulations
- Prismatic layers are “seeded” and “grown” into an existing and healthy grid
- No overlapping in sharp corners
- Polyhedral support keeps the boundary layer as it is and “dualises” the tetrahedral part of the mesh

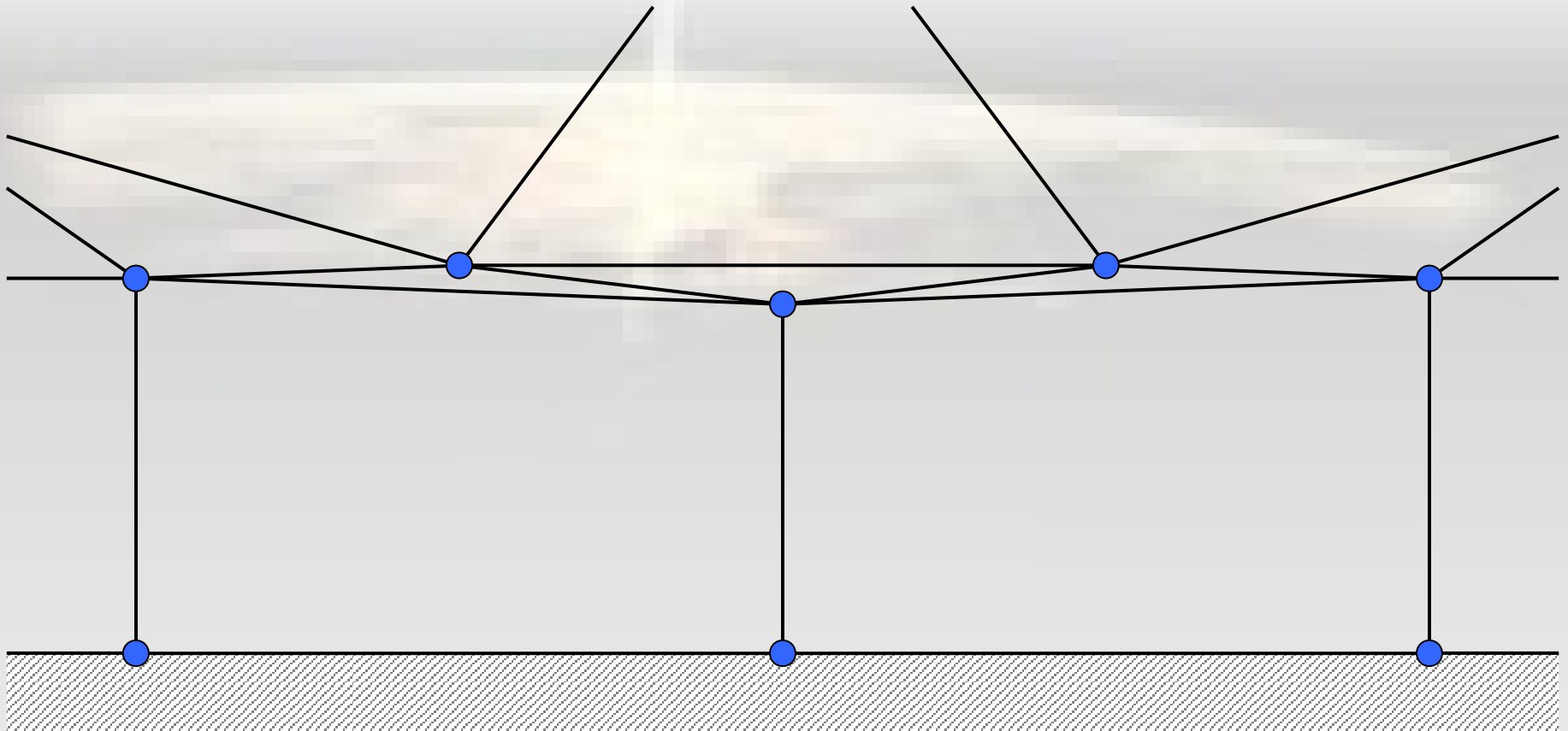
Creating Prismatic Layers



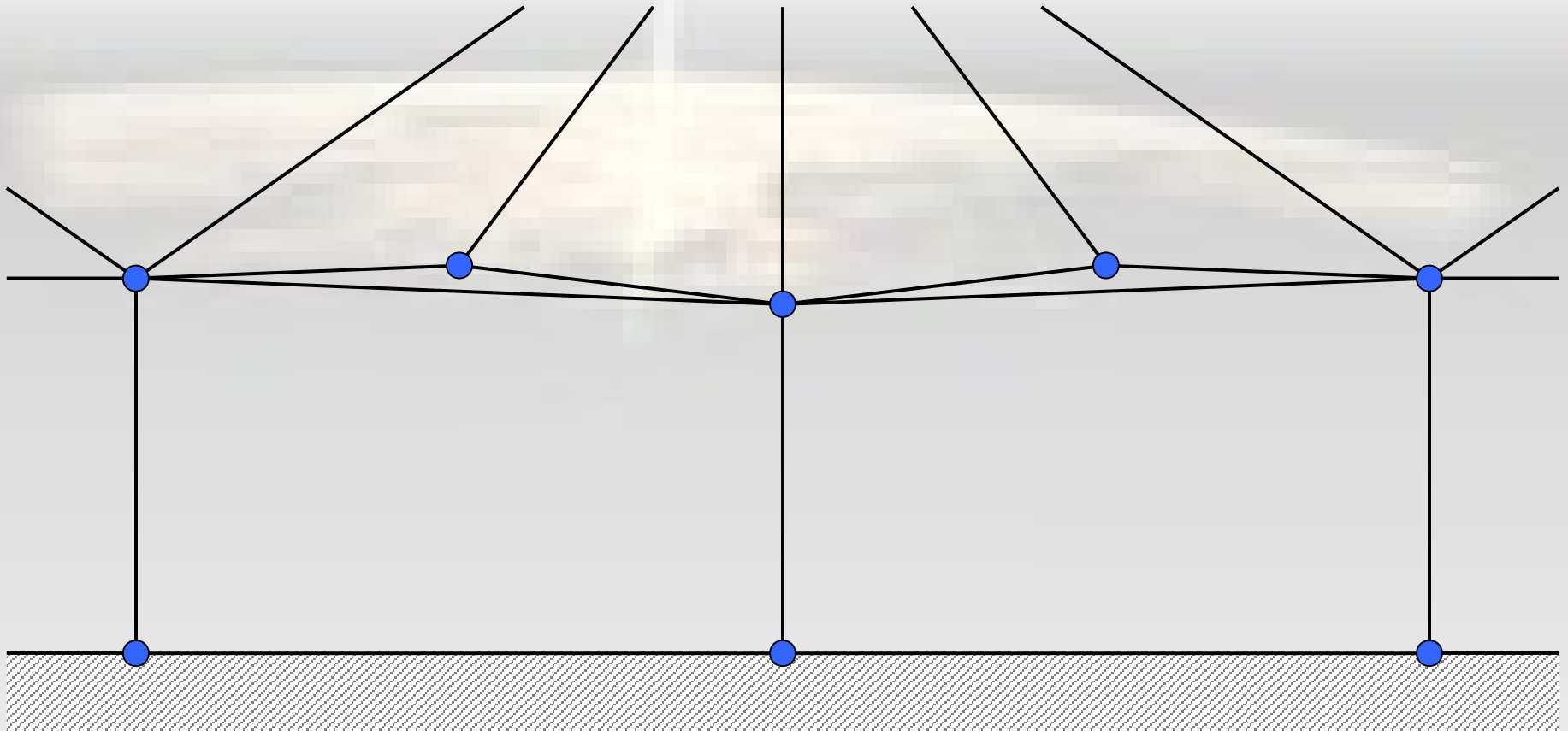
Creating Prismatic Layers



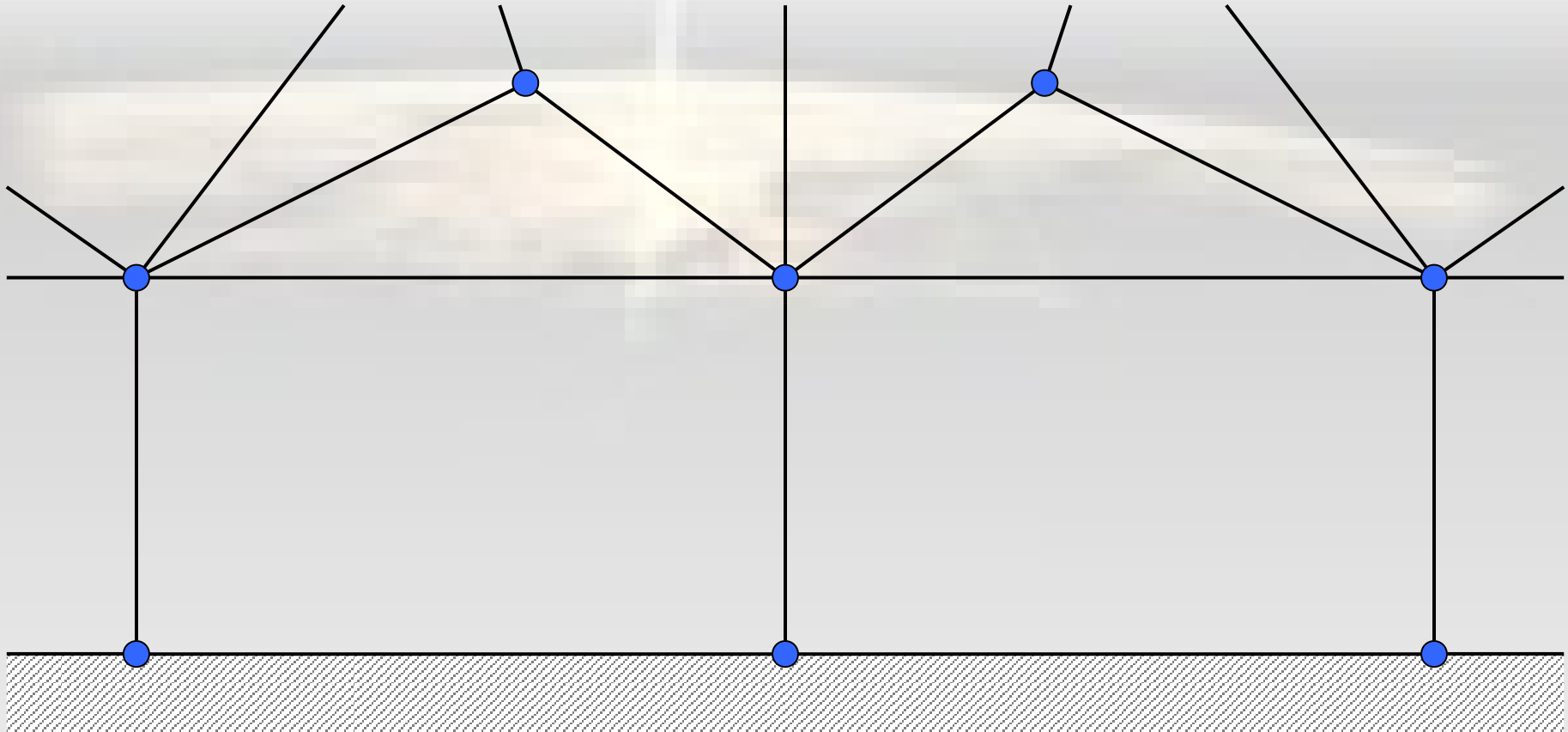
Creating Prismatic Layers



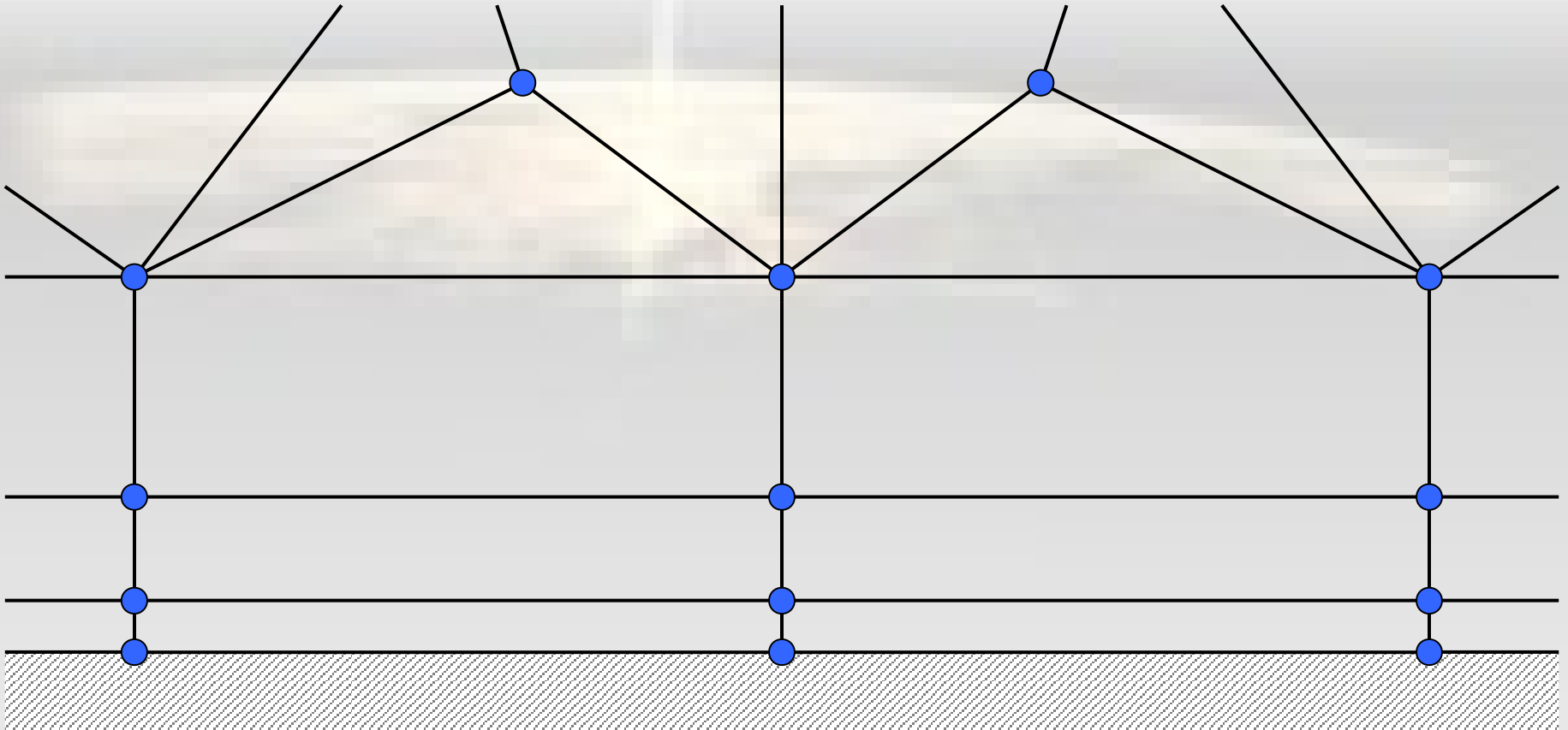
Creating Prismatic Layers



Creating Prismatic Layers



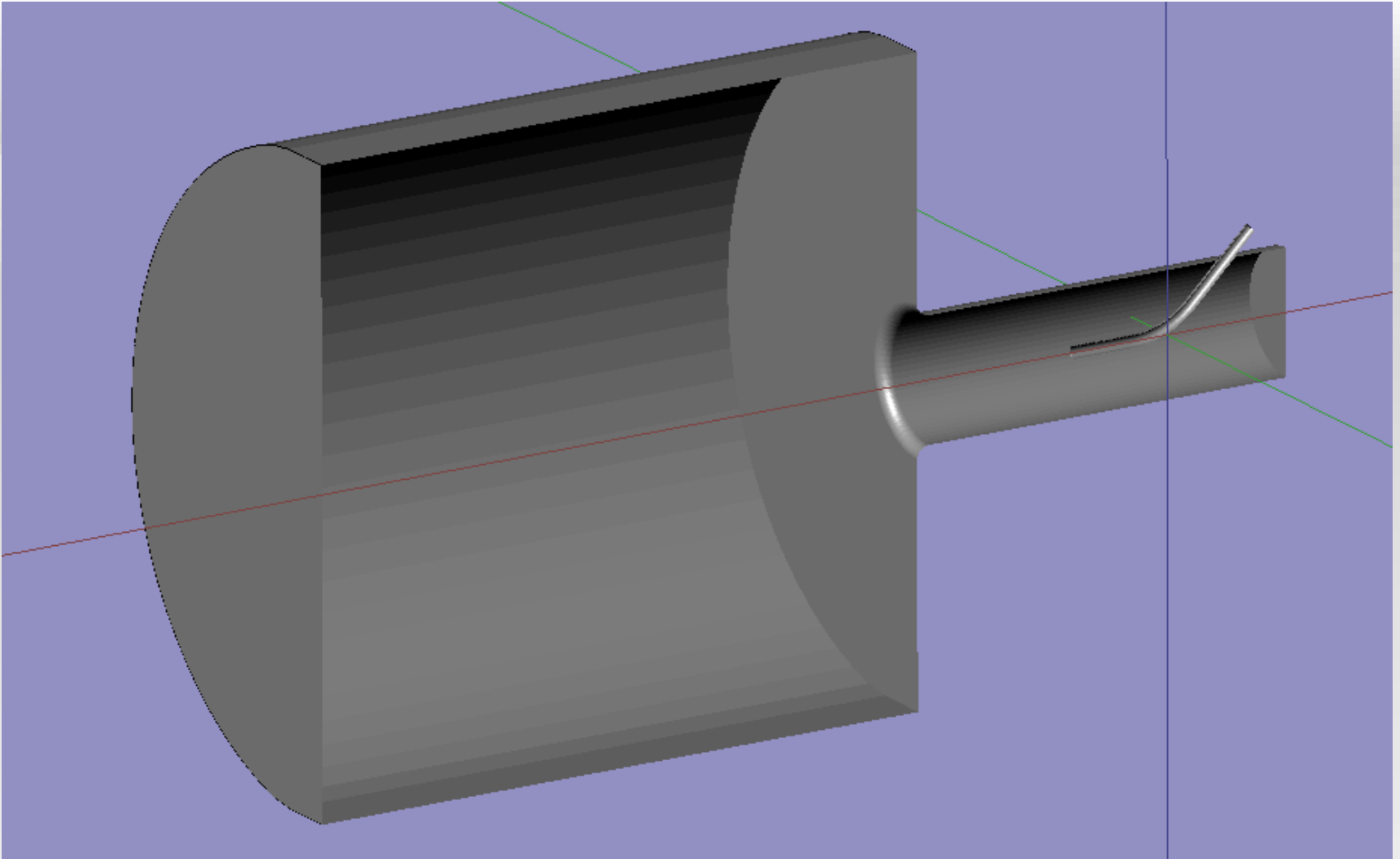
Creating Prismatic Layers

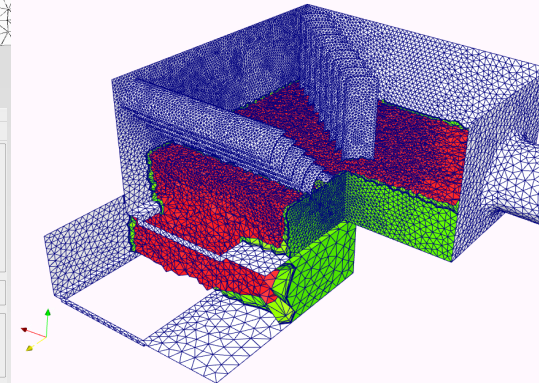
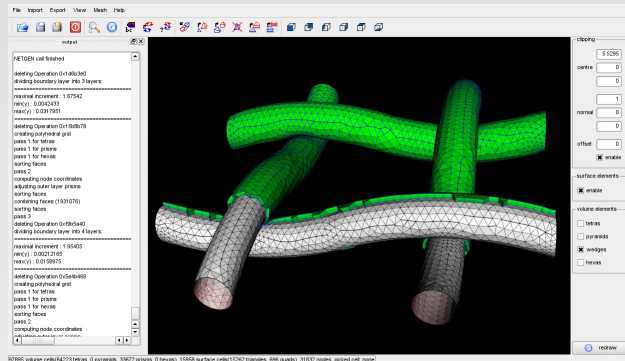
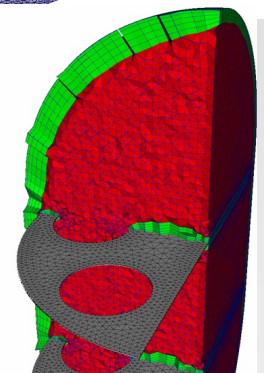
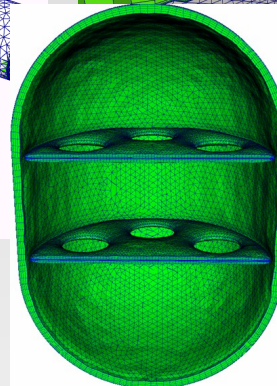
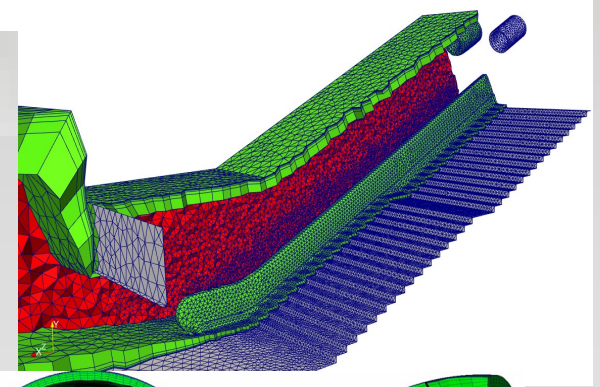
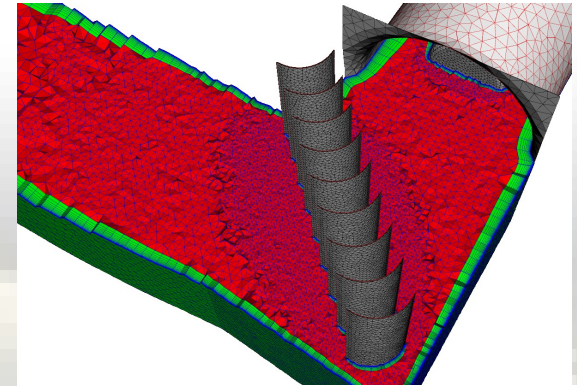
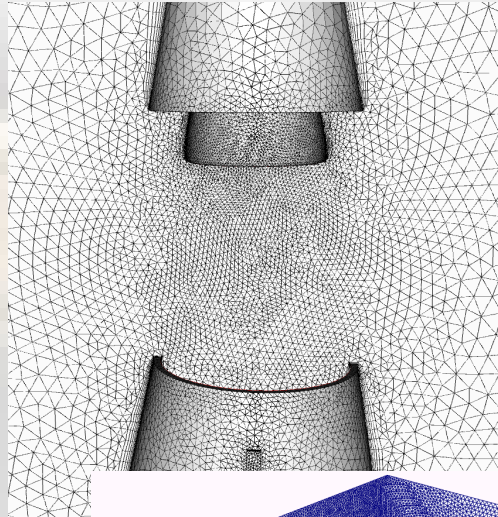


Demonstration

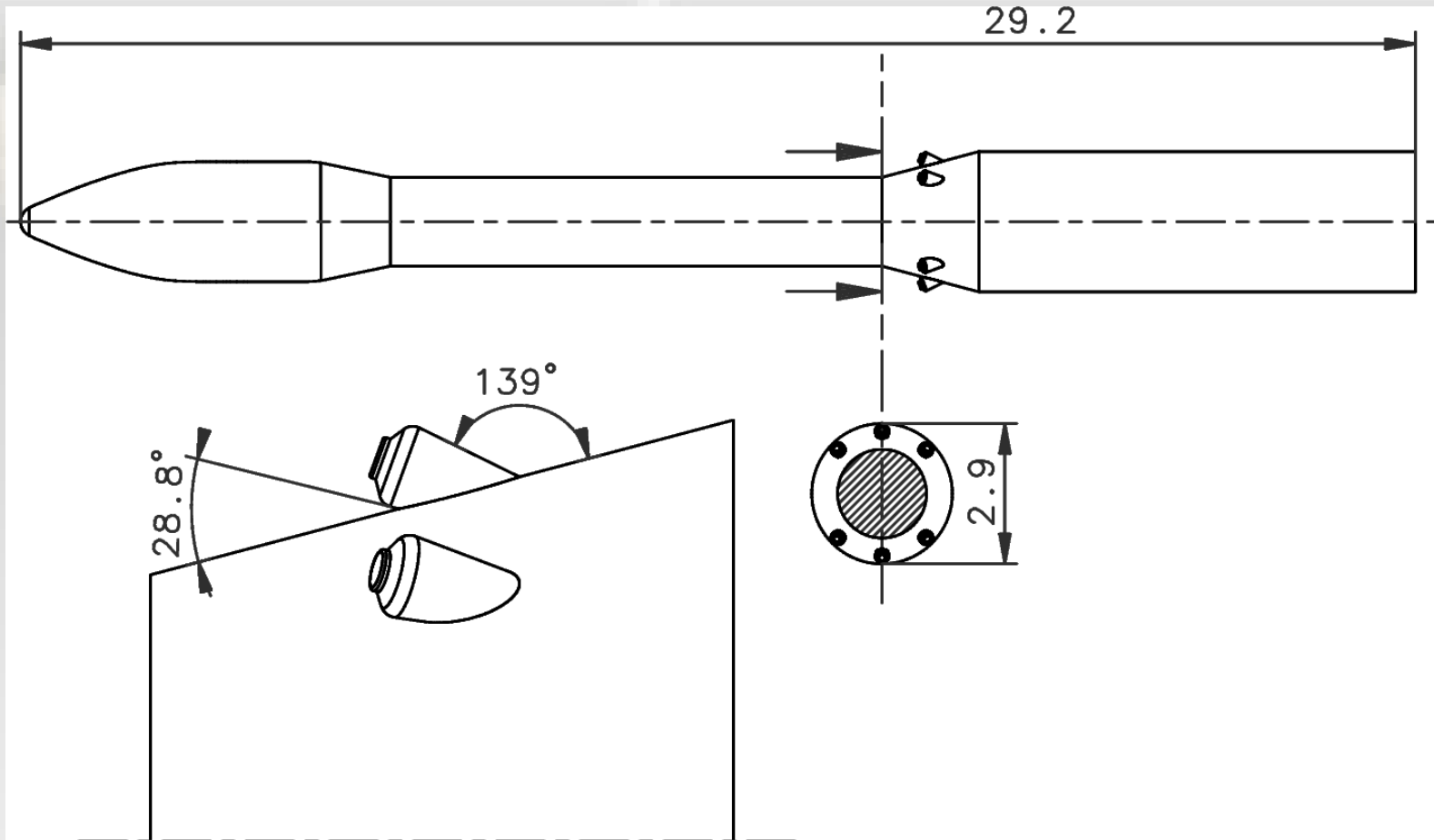
- Engrid is not perfect
 - between 1.5 and 2 'man years' development
- We are happy about feedback
- We are happy about suggestions
- We would be even more happy about help ;-)

Demonstration

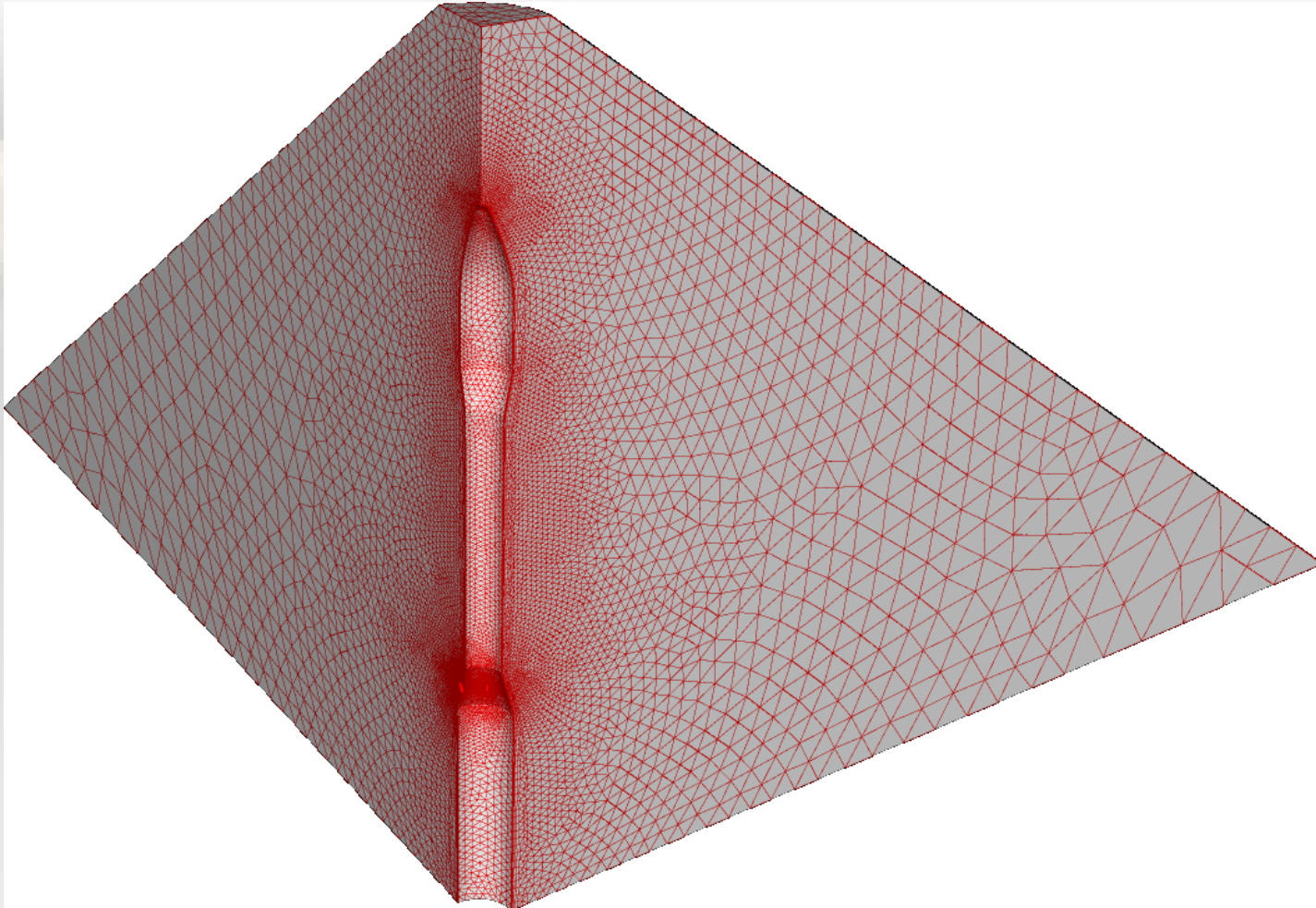




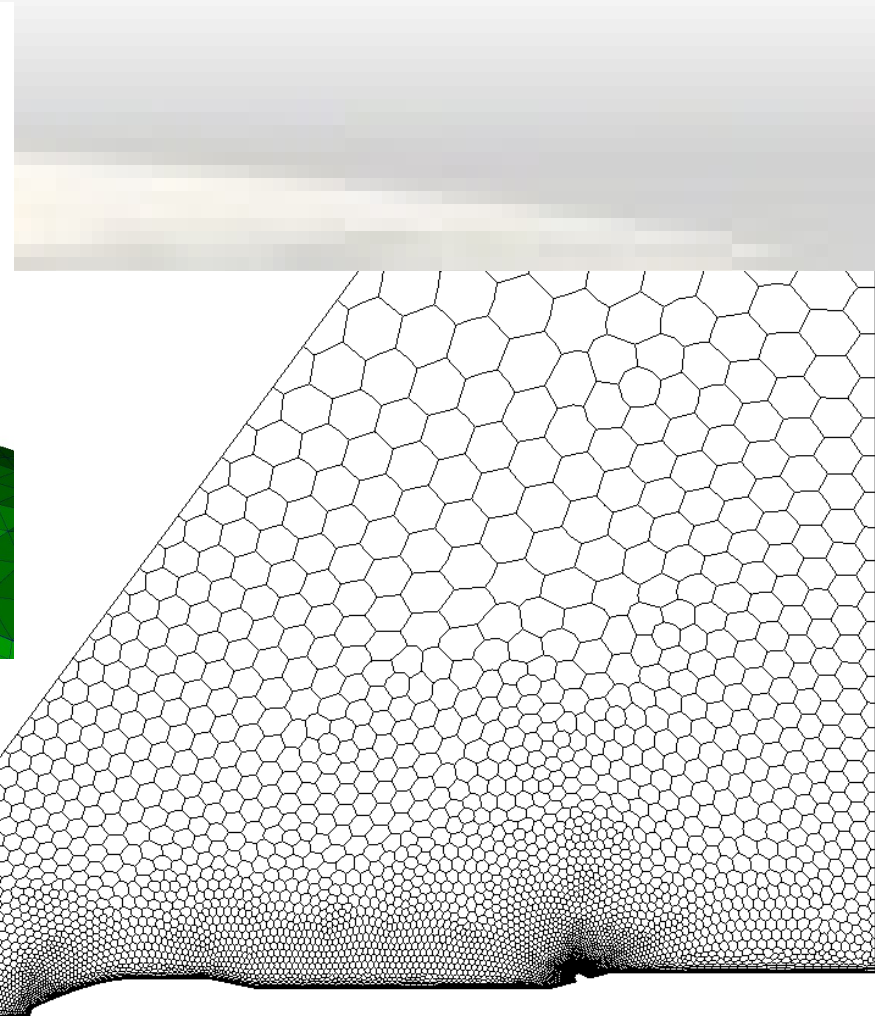
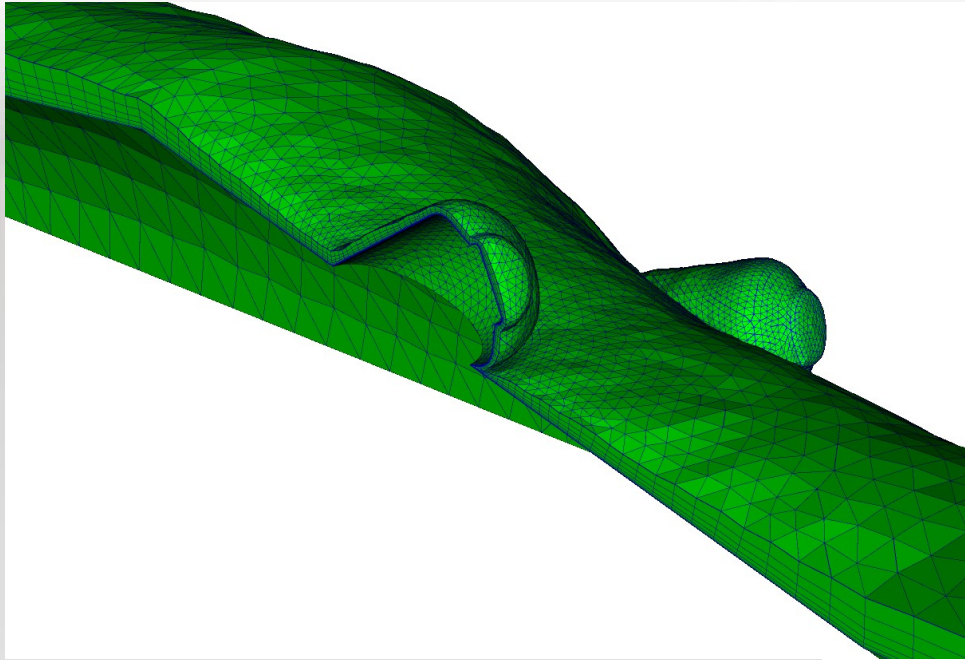
Vega at $Ma=2.7$



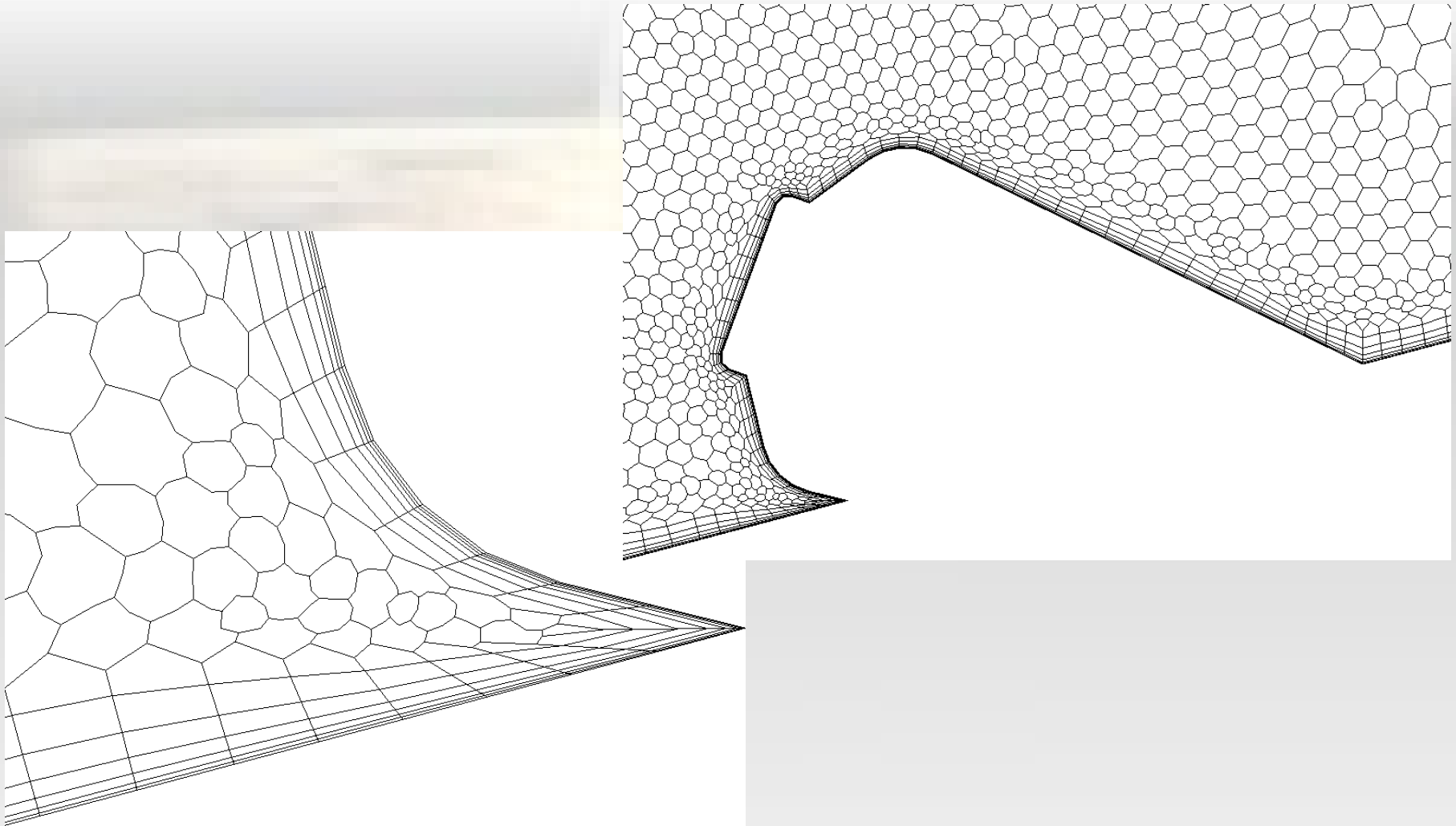
Vega at $Ma=2.7$



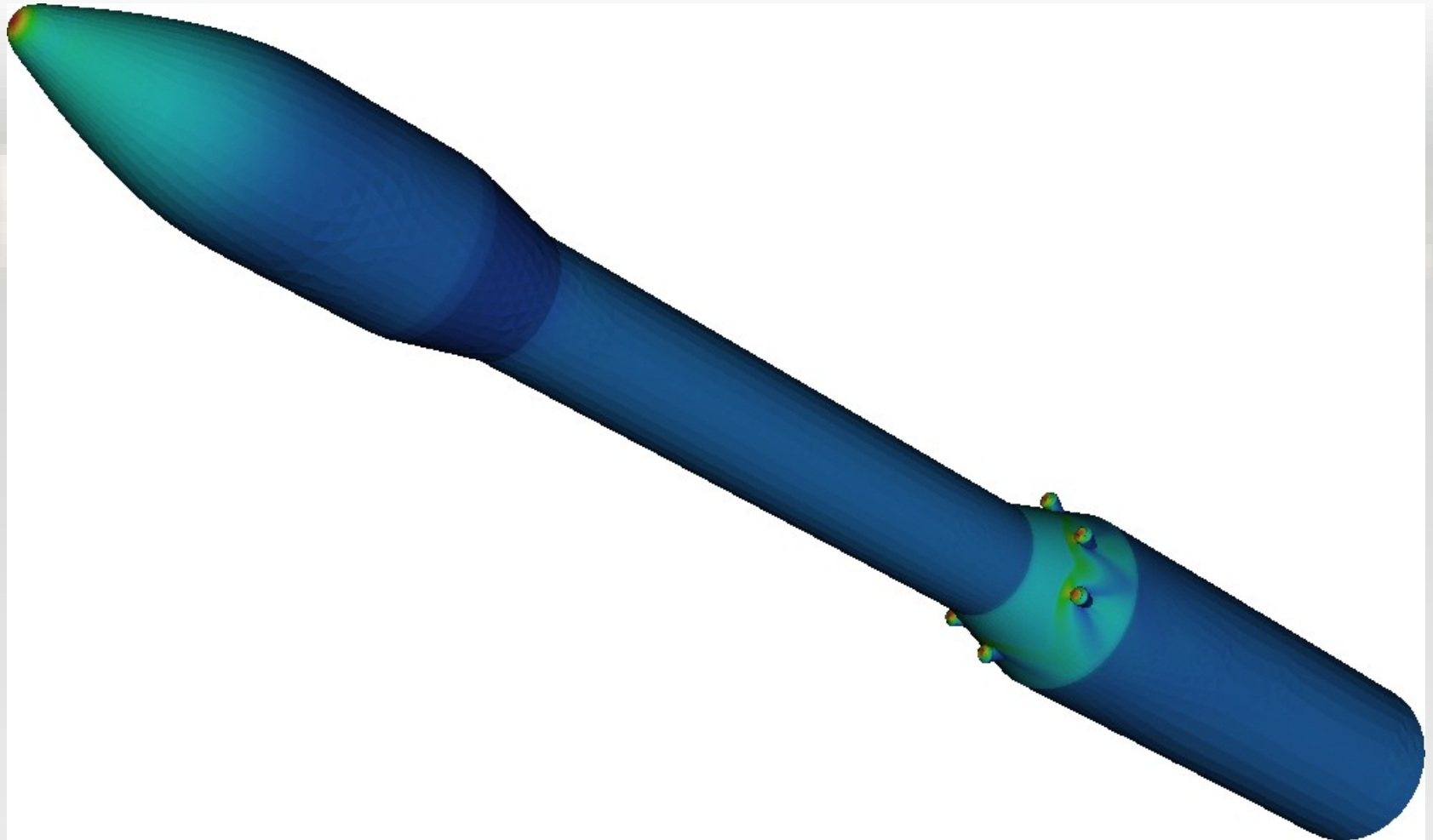
Vega at $Ma=2.7$



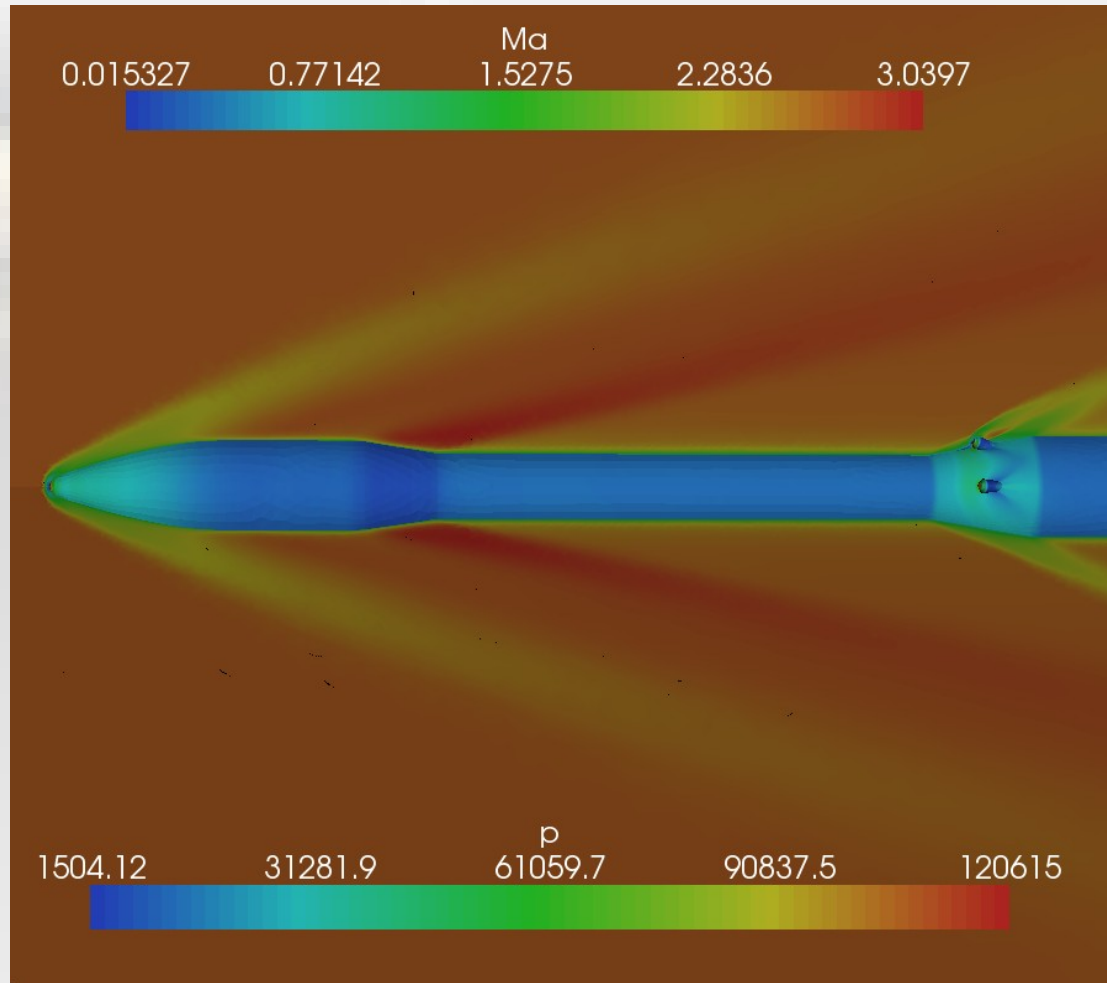
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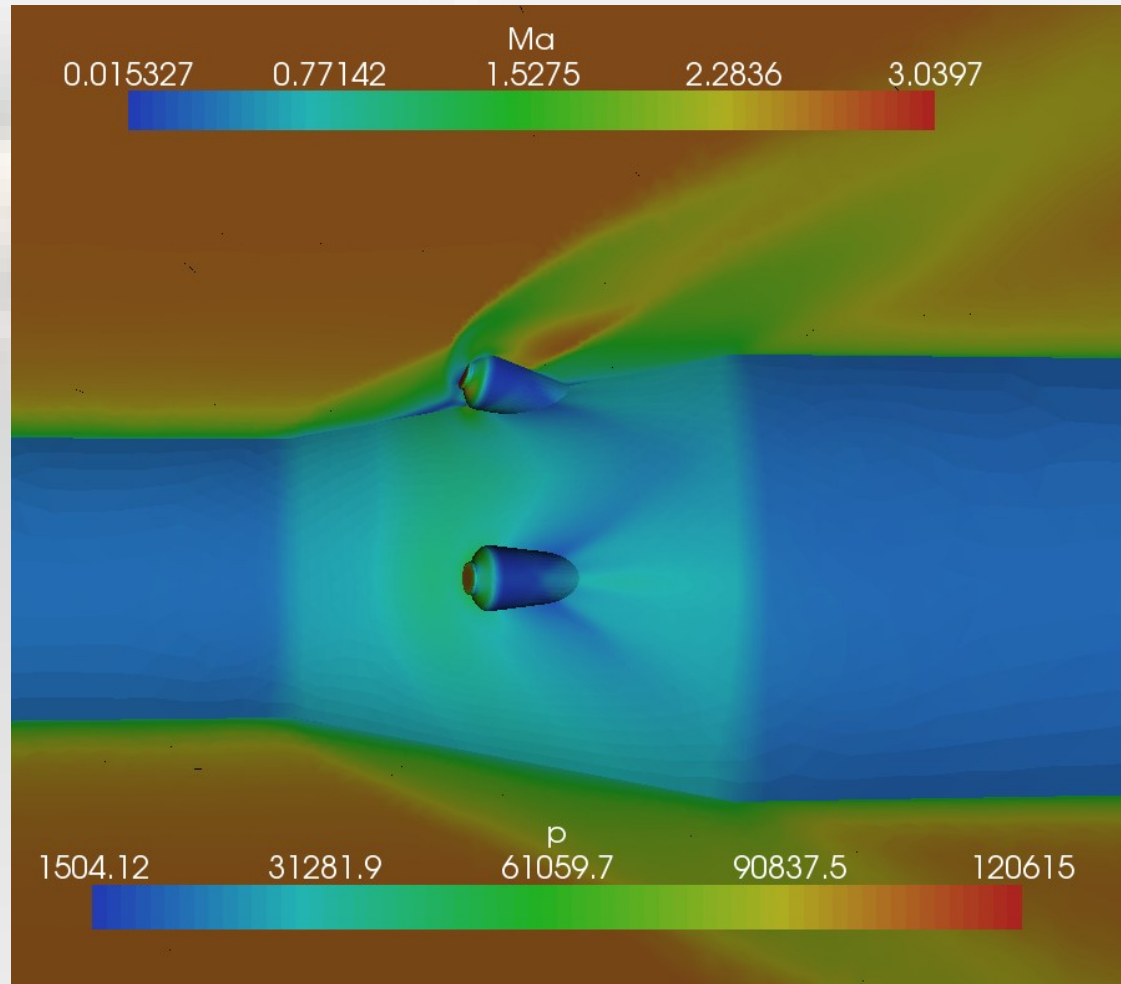
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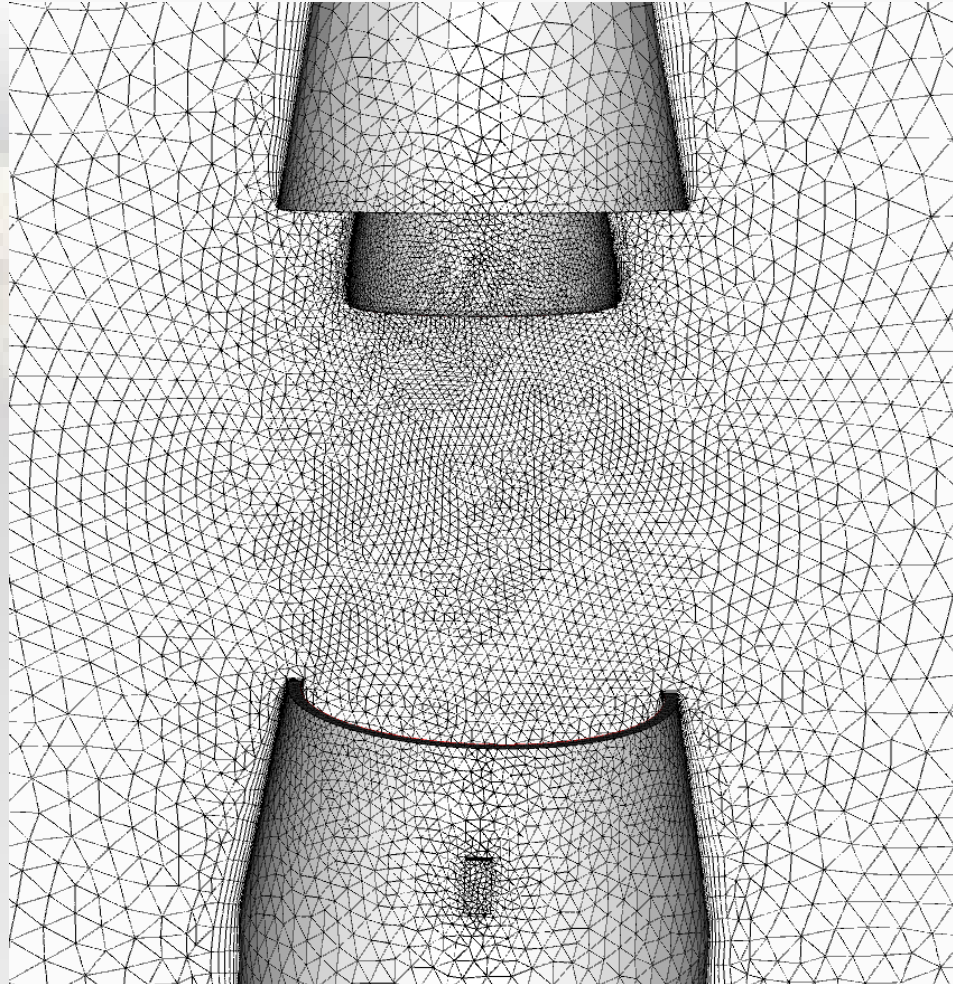
Vega at $Ma=2.7$



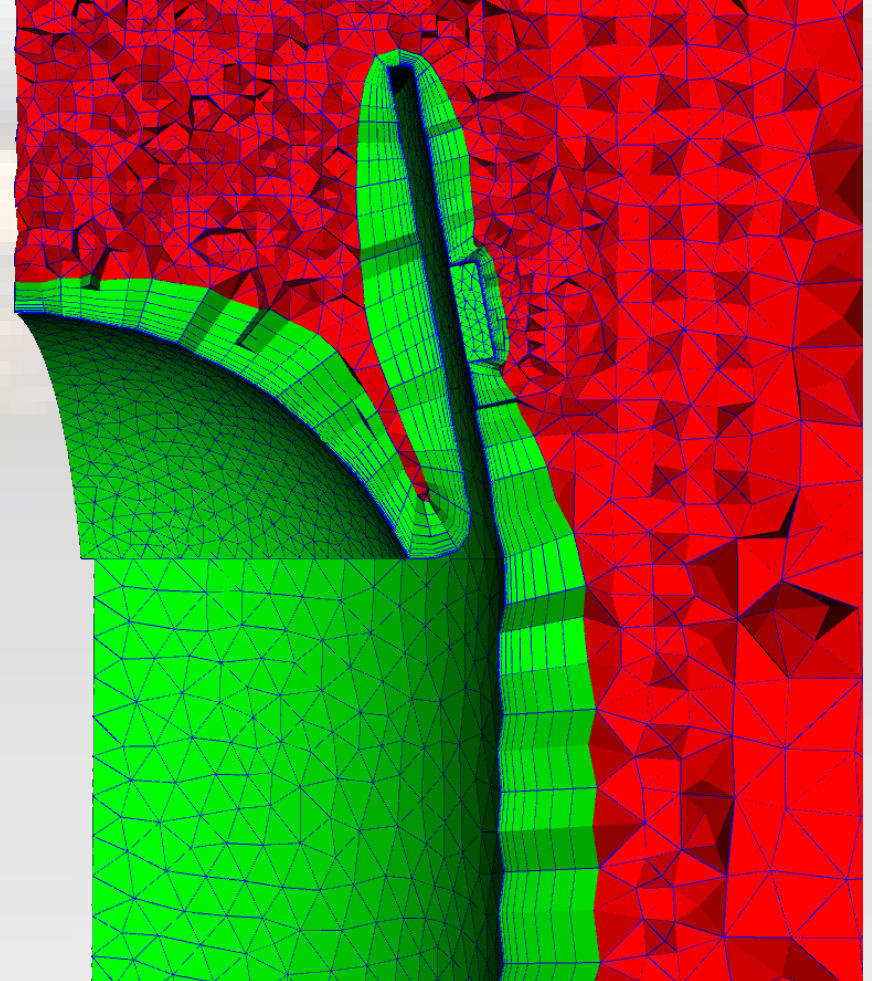
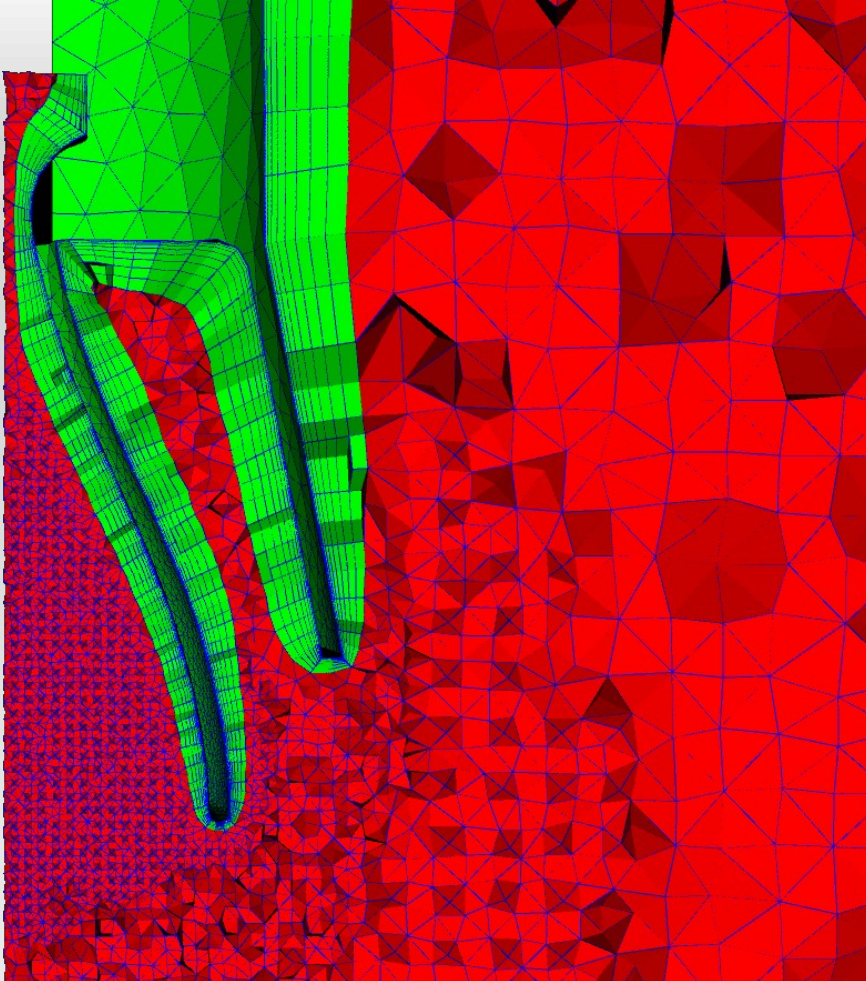
Vega at Ma=2.7



Stage-Separation



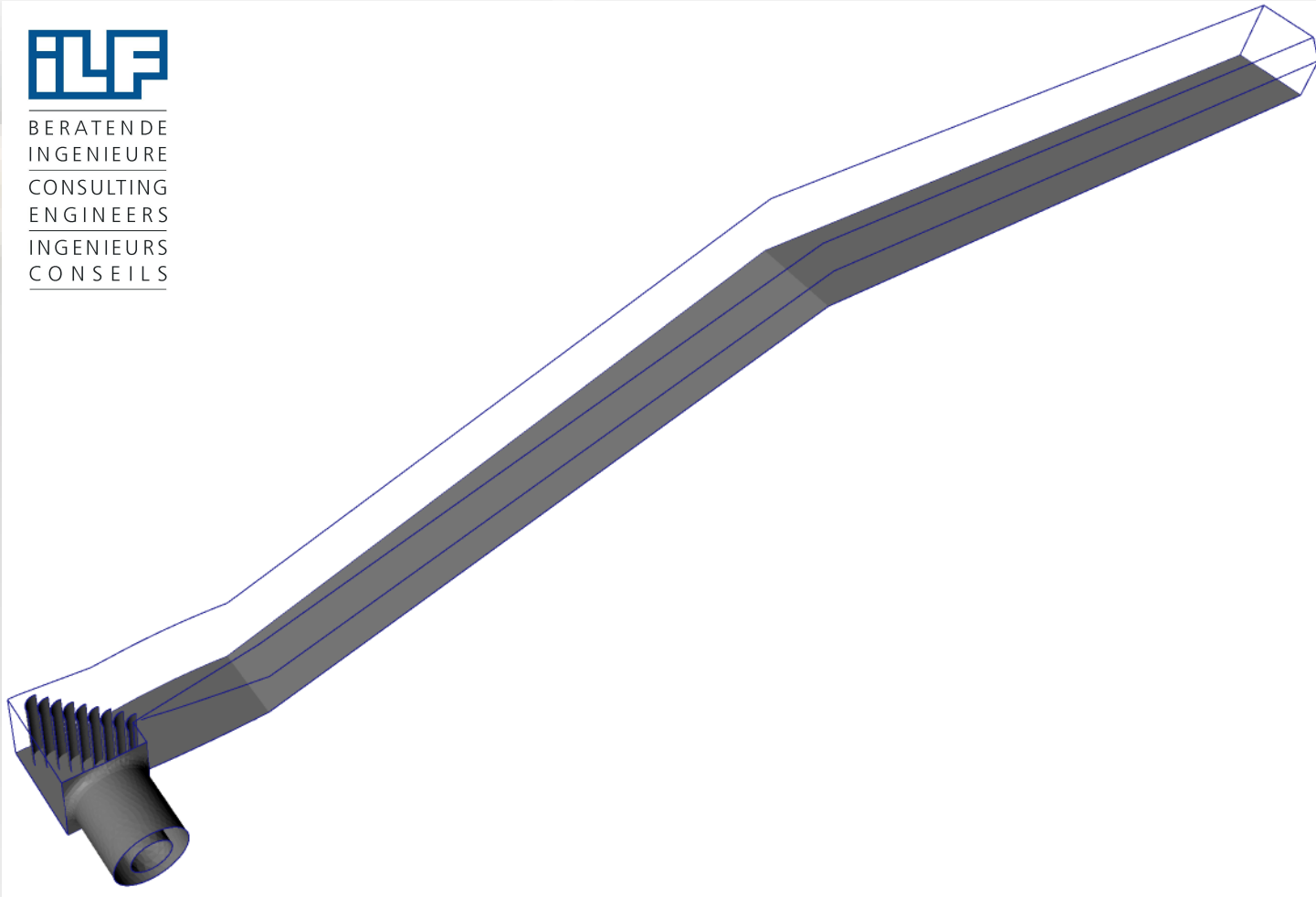
Stage-Separation



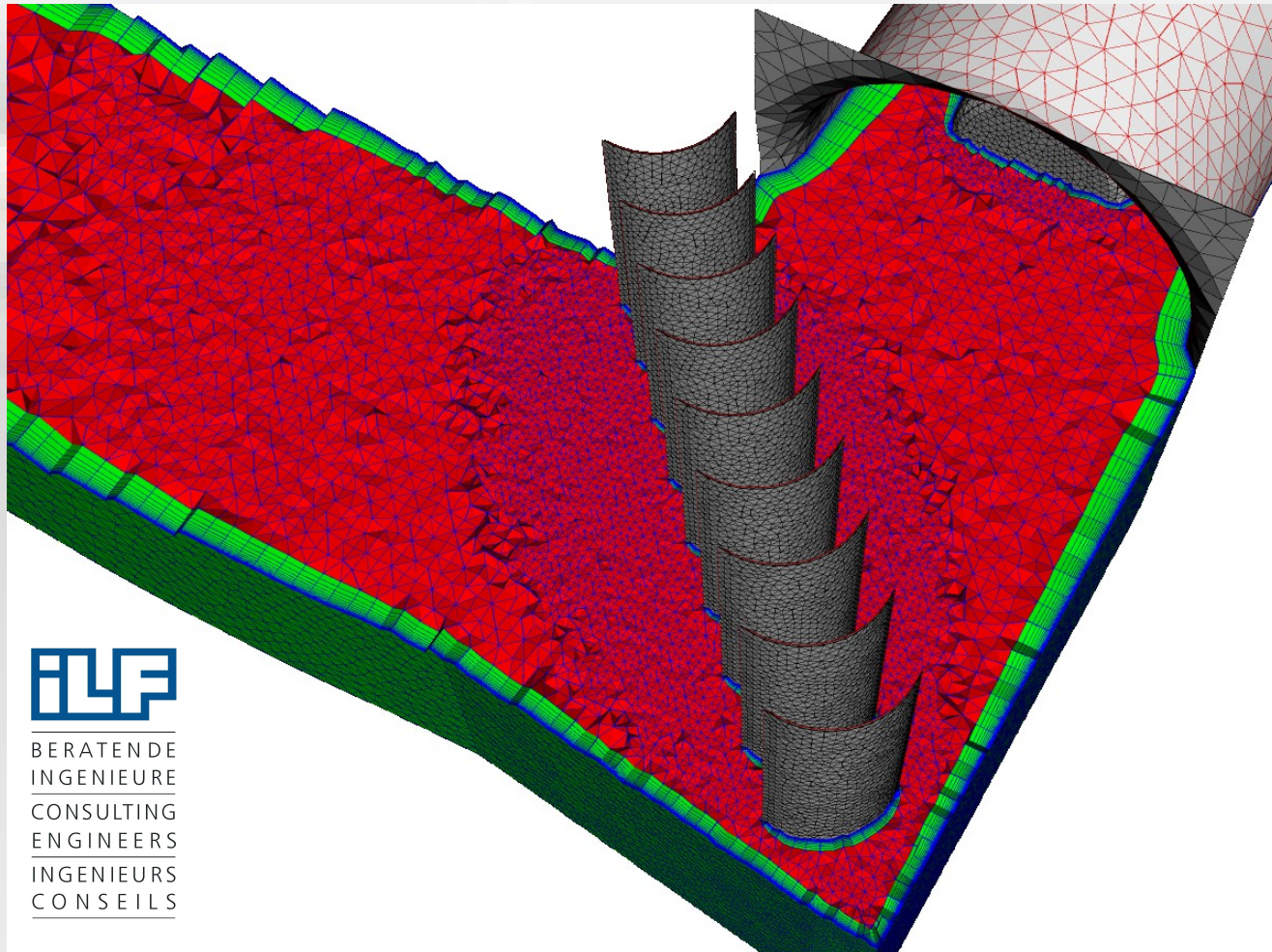
90° Bend (Ventilation system Tauerntunnel)



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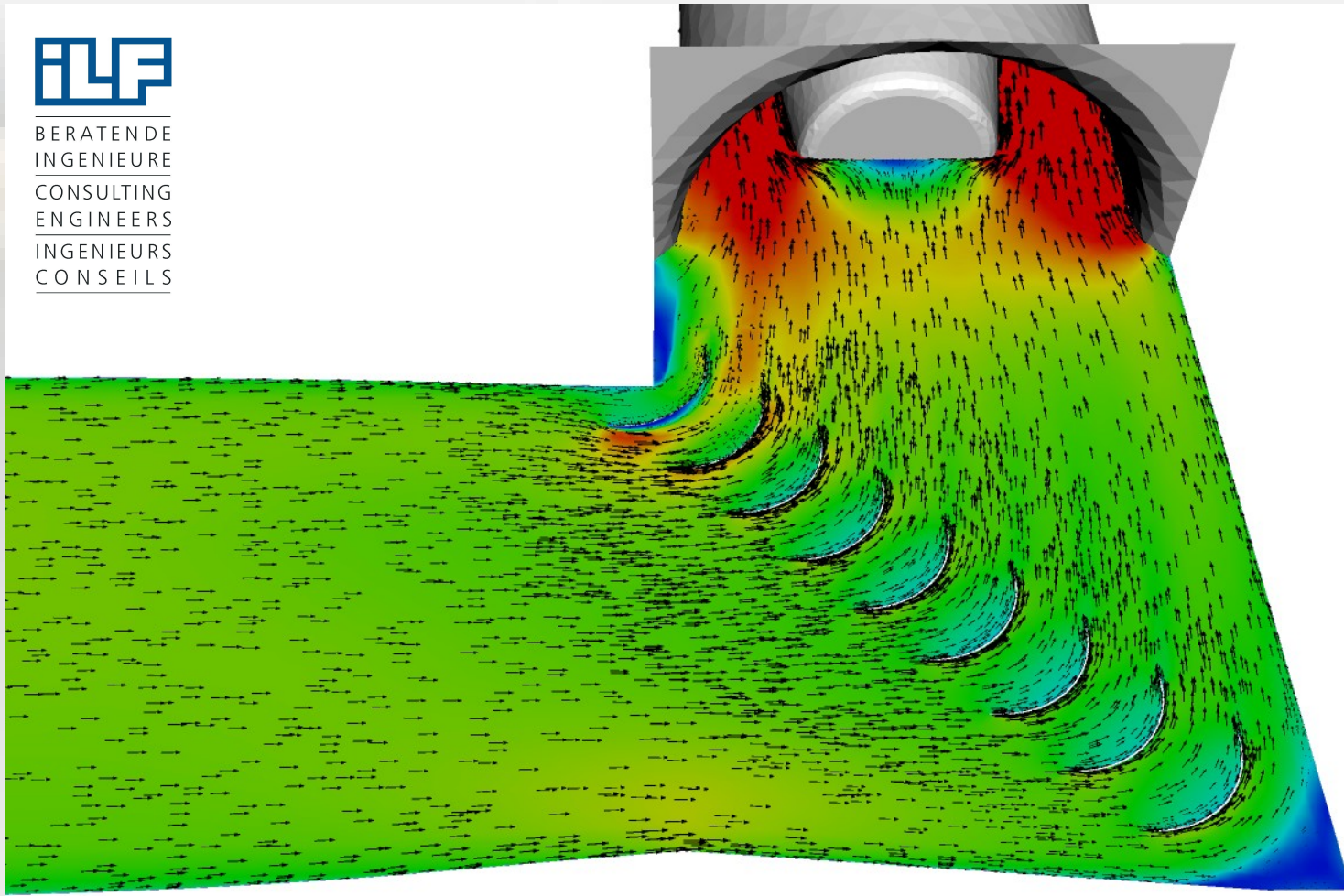
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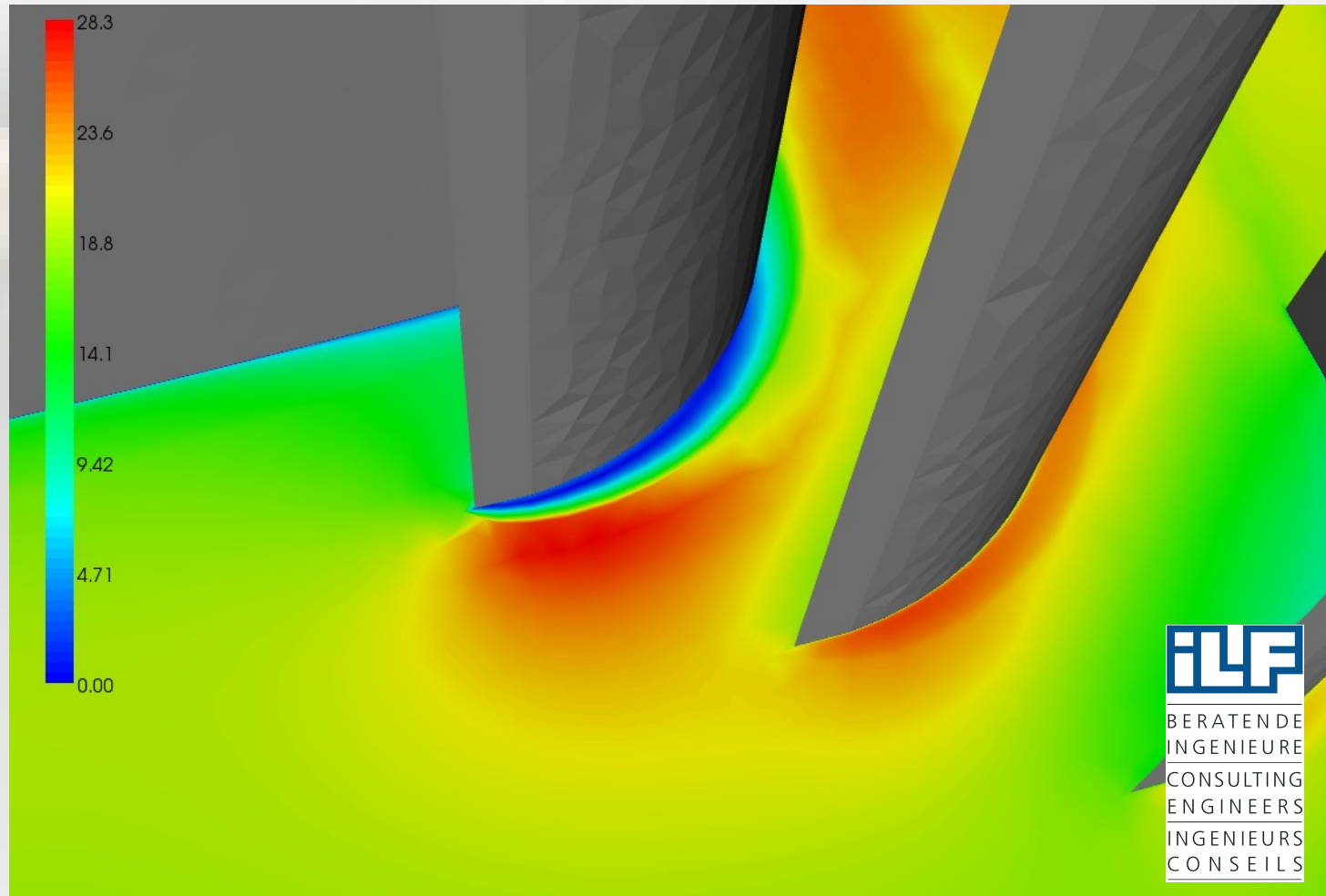
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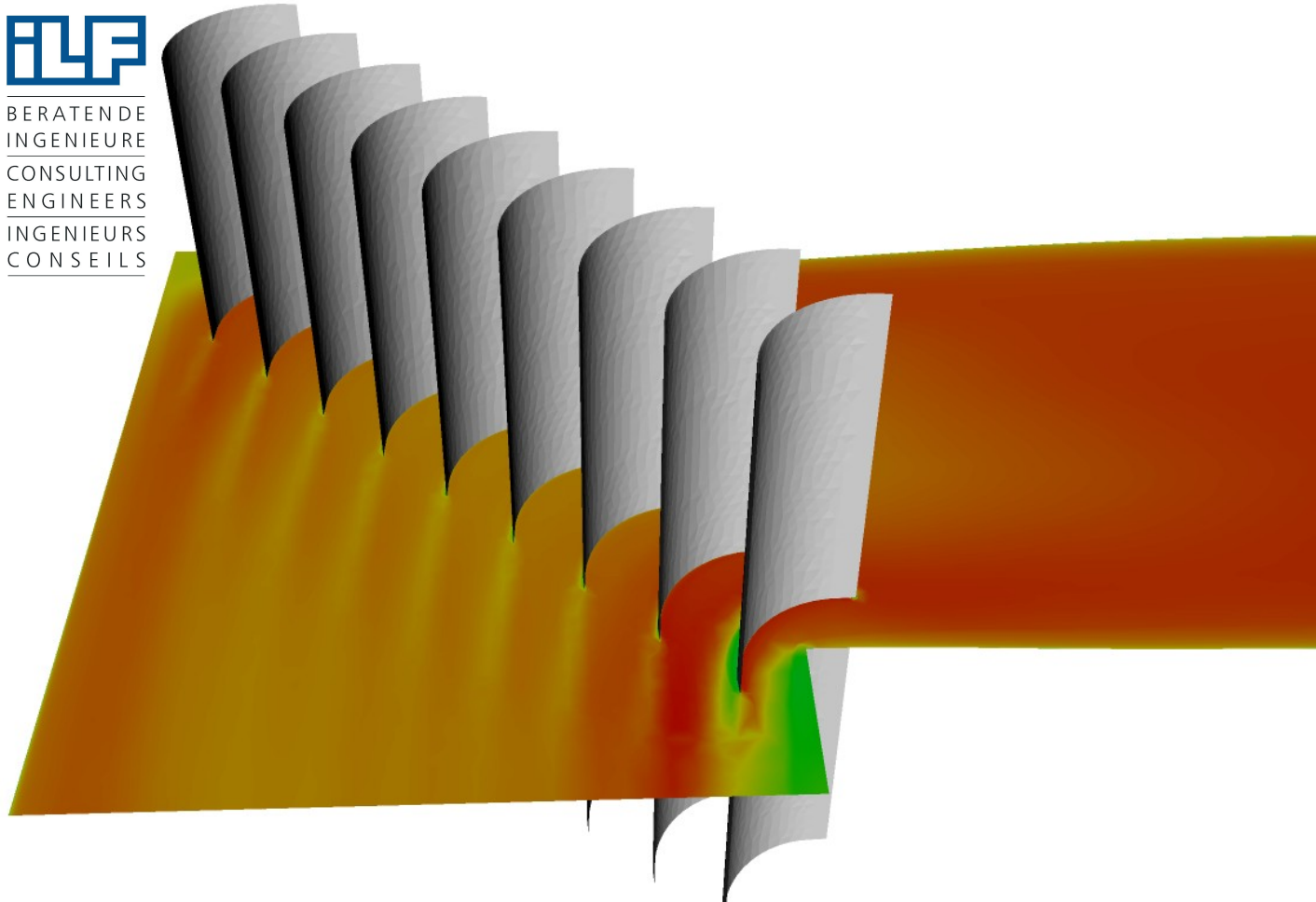
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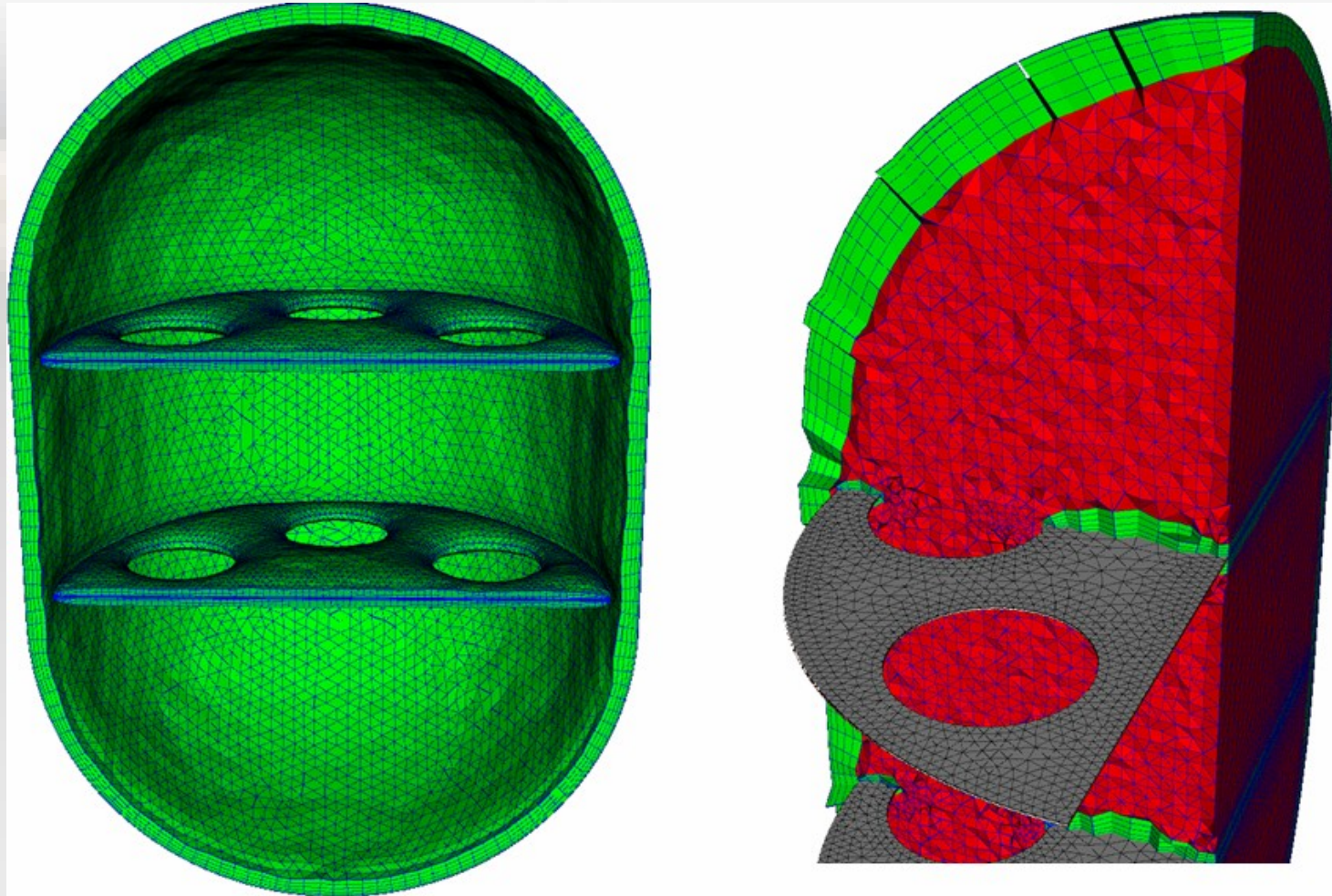
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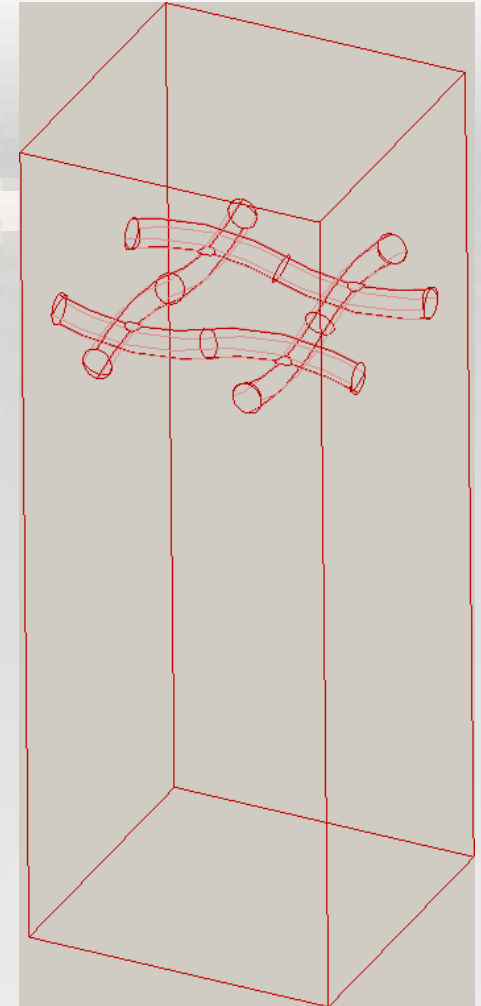
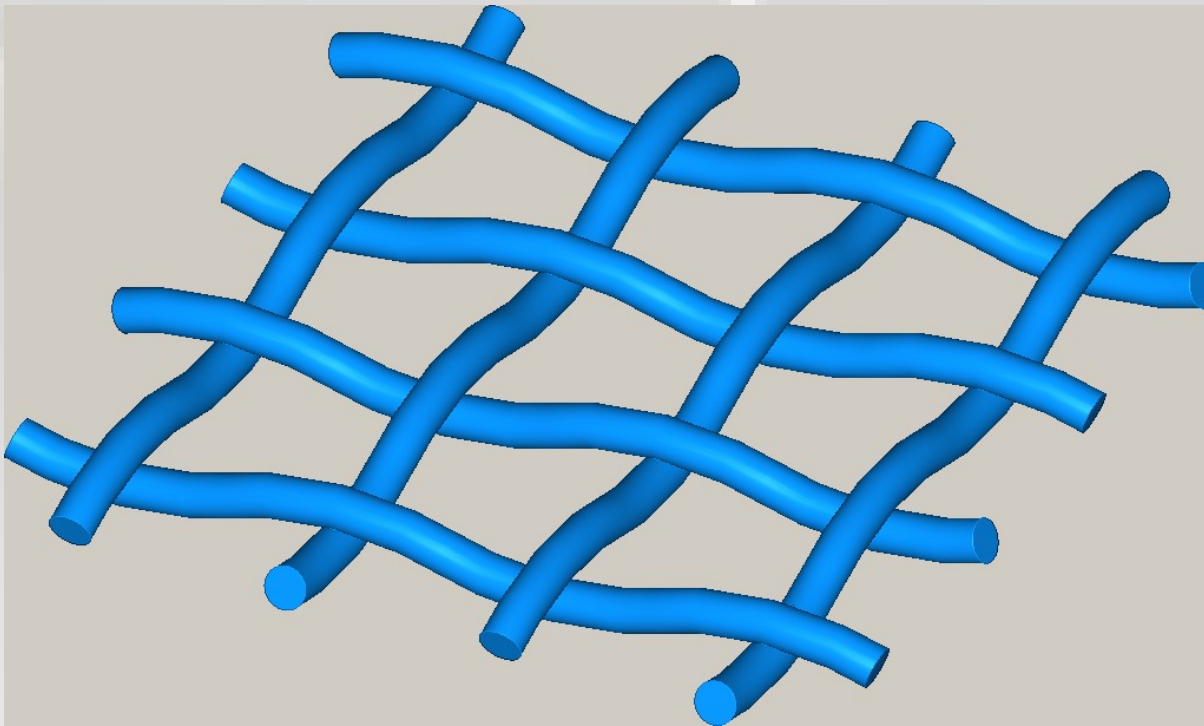
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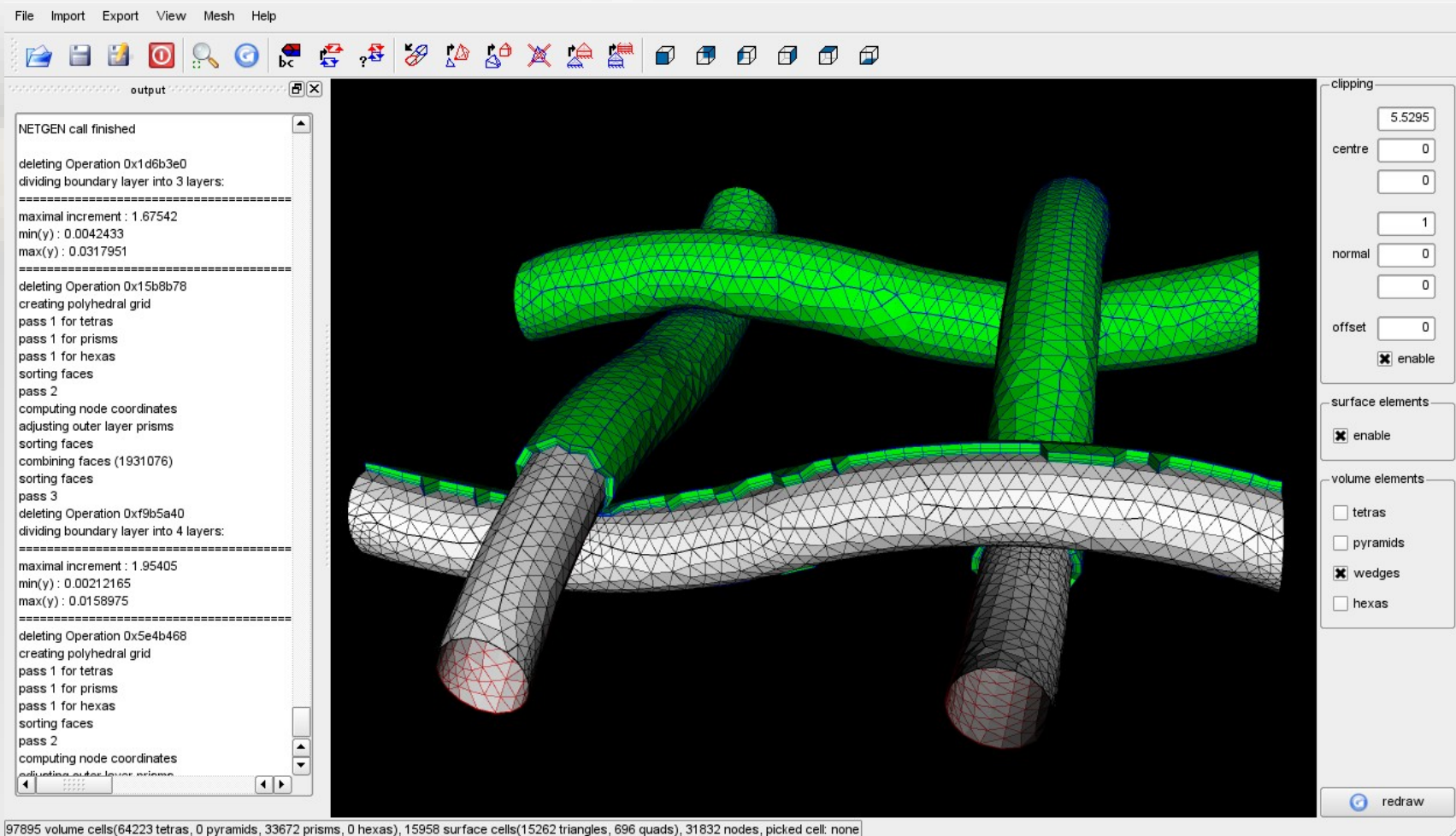
Satellite Tank



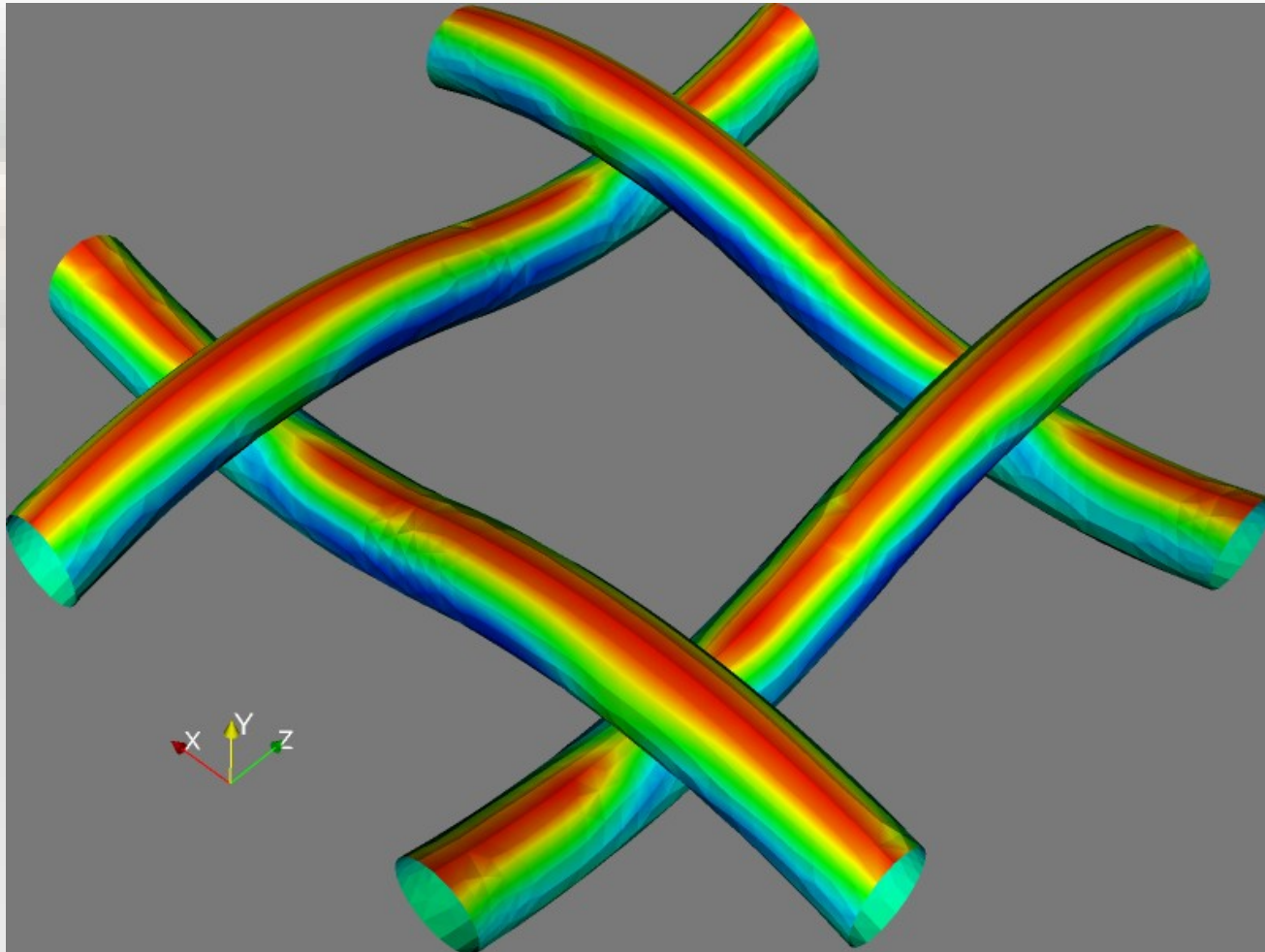
Fabric of a Filter



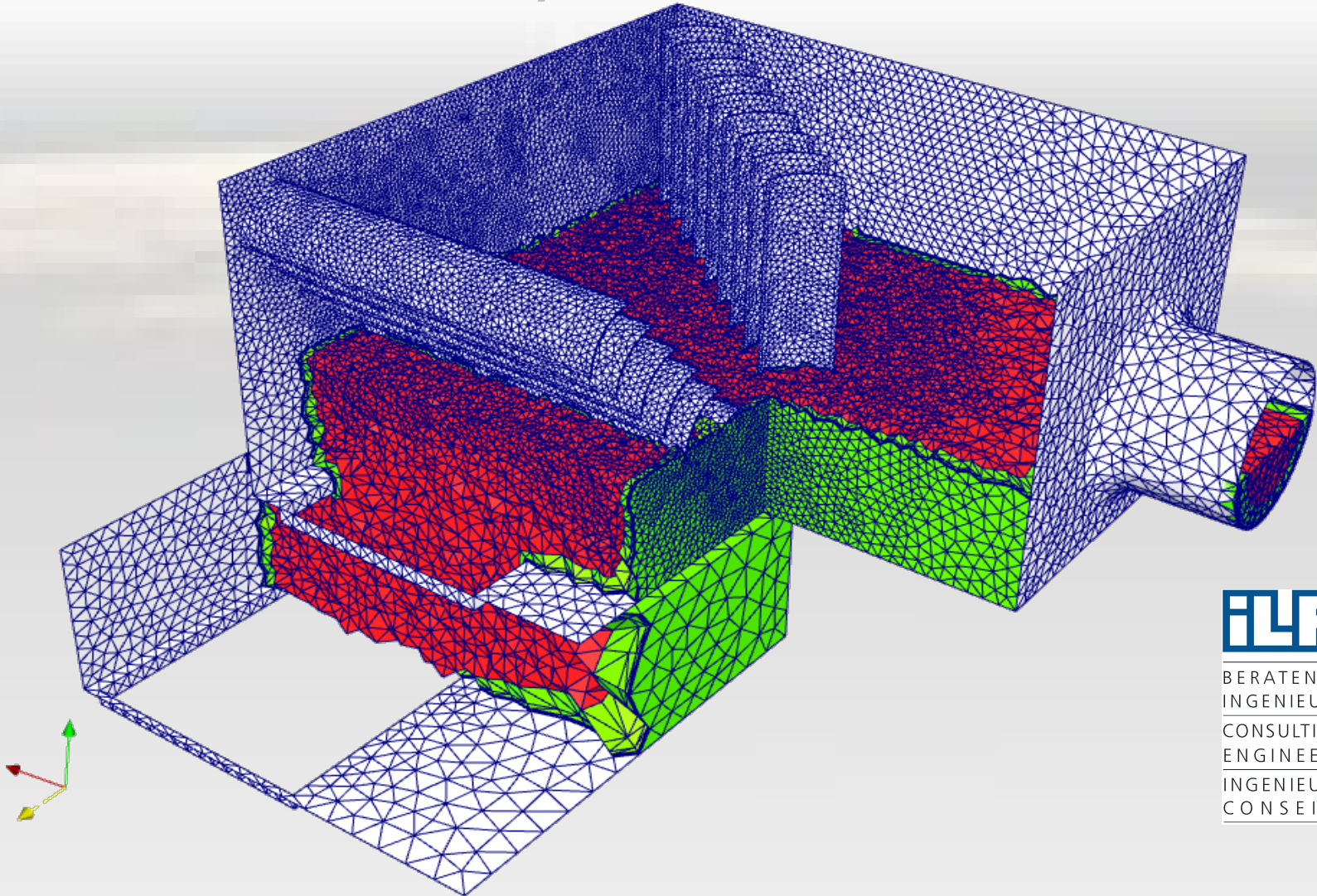
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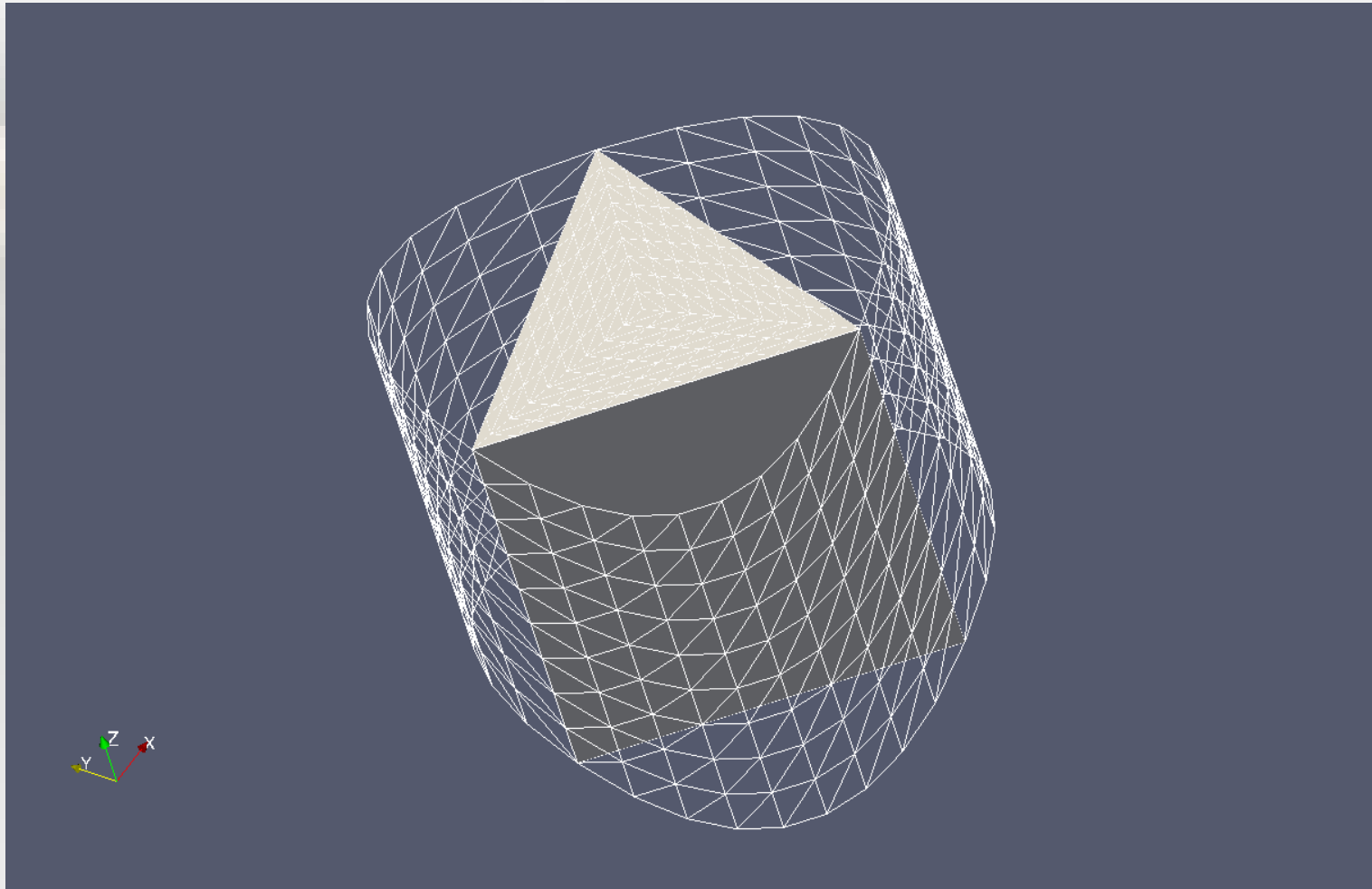
Complex Air-Duct



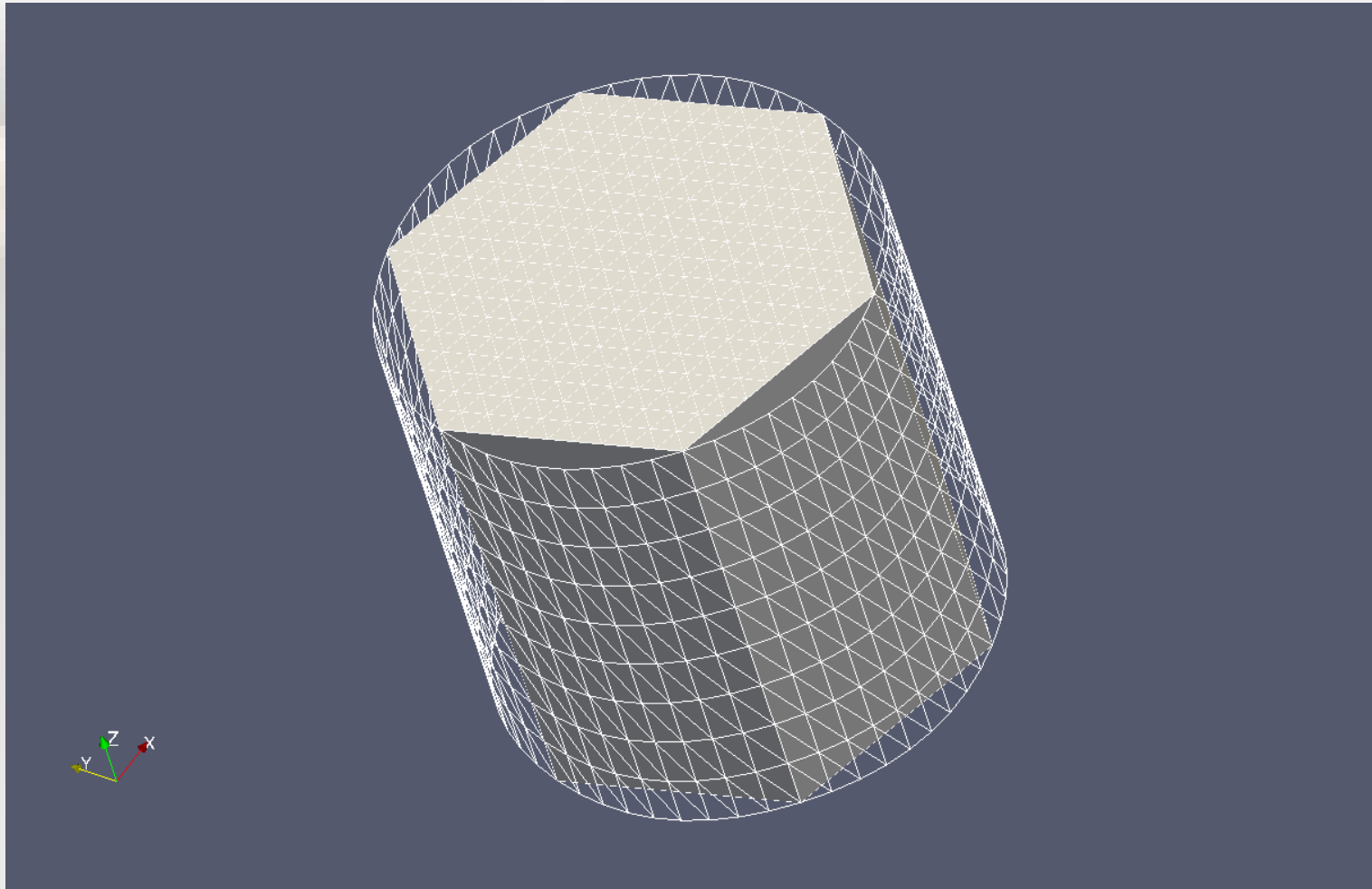
Planned Developments

- Interpolated surfaces
- Anisotropic (prisms) refinement of free shear layers
 - feasibility/demonstration for customer
 - first step towards adaptive meshing
- Better control of mesh density
 - better user interface
 - point, line, ..., sources
- Interface to more OpenFOAM solvers

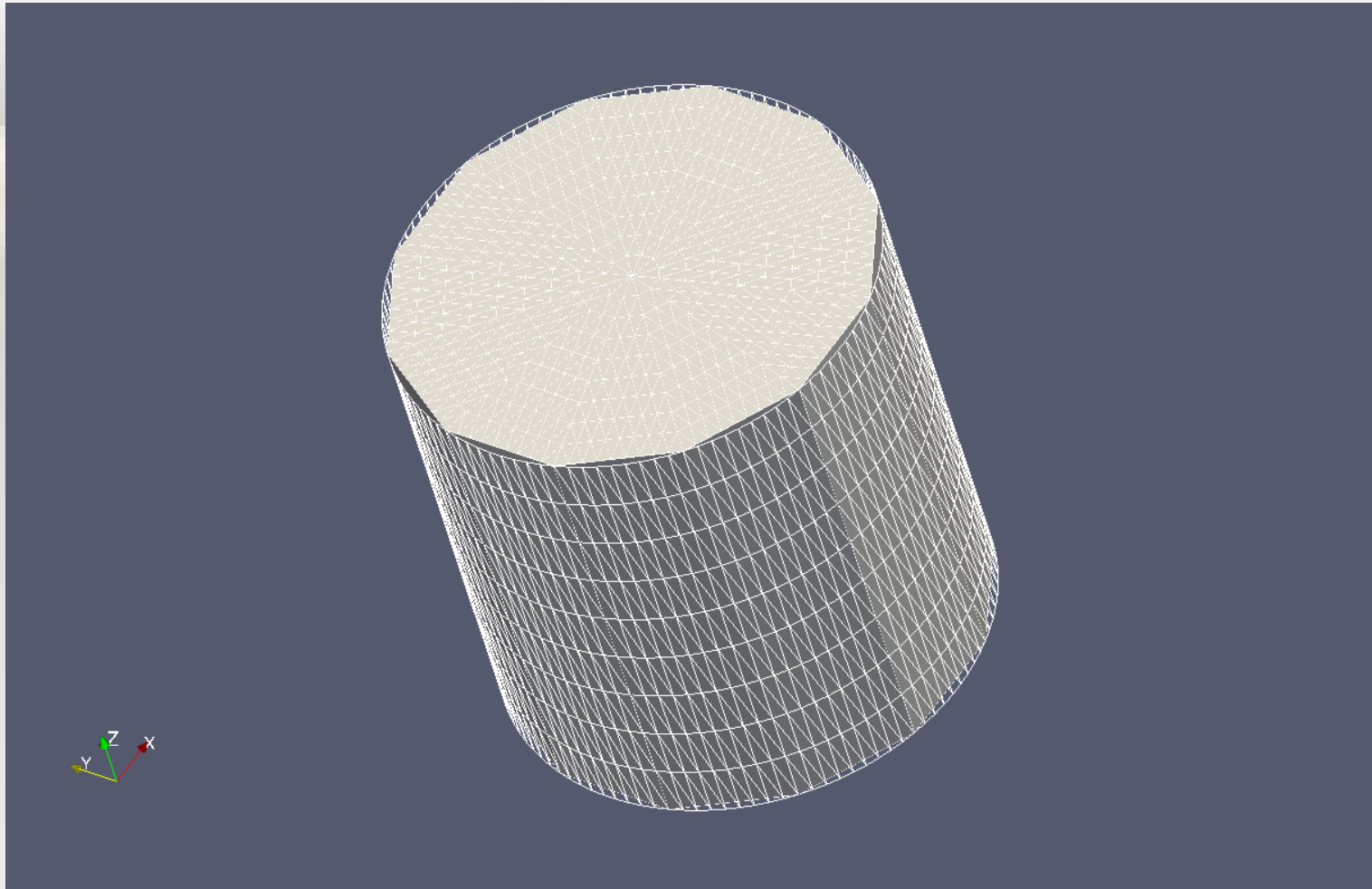
Interpolated Surfaces



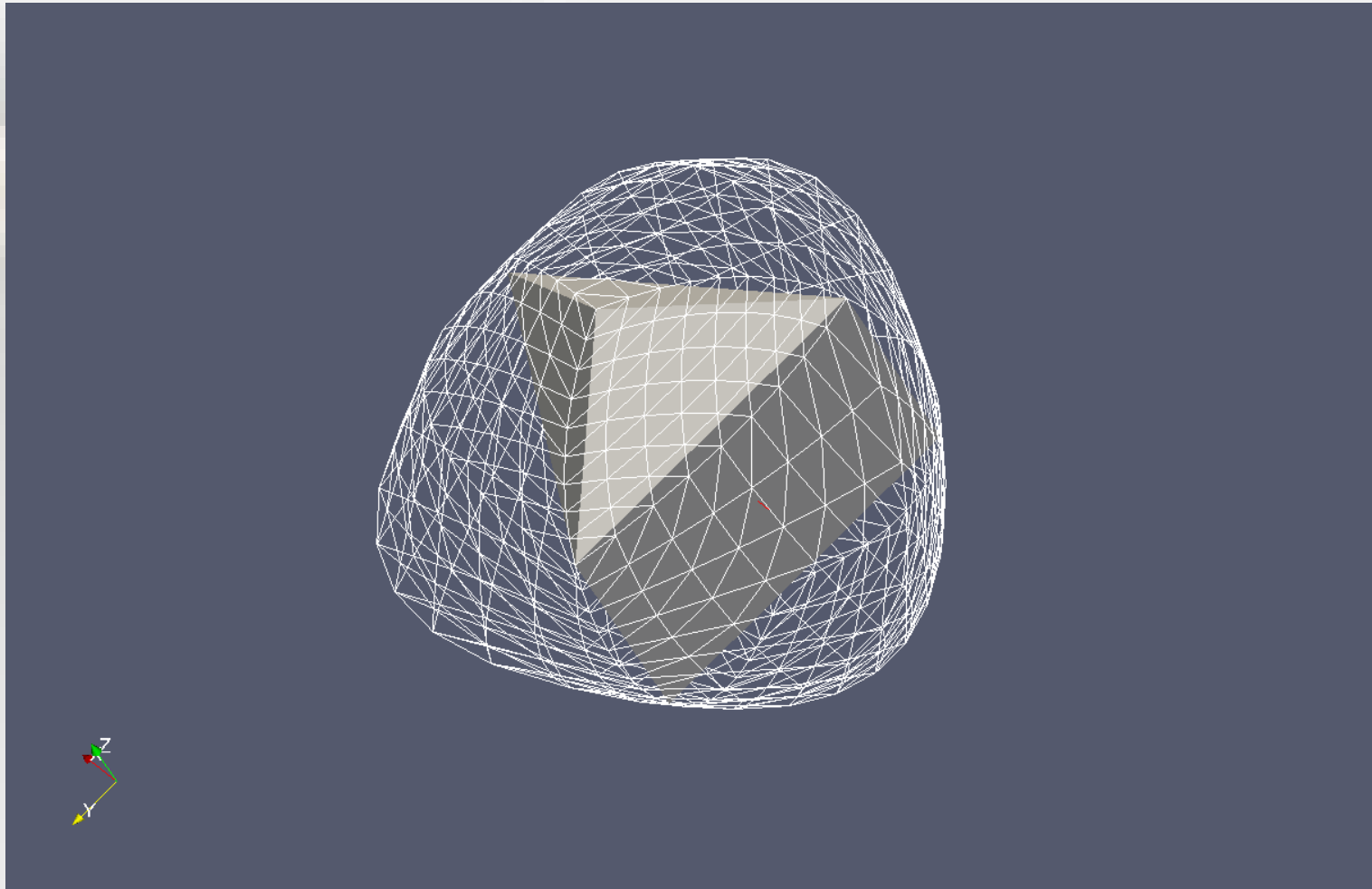
Interpolated Surfaces



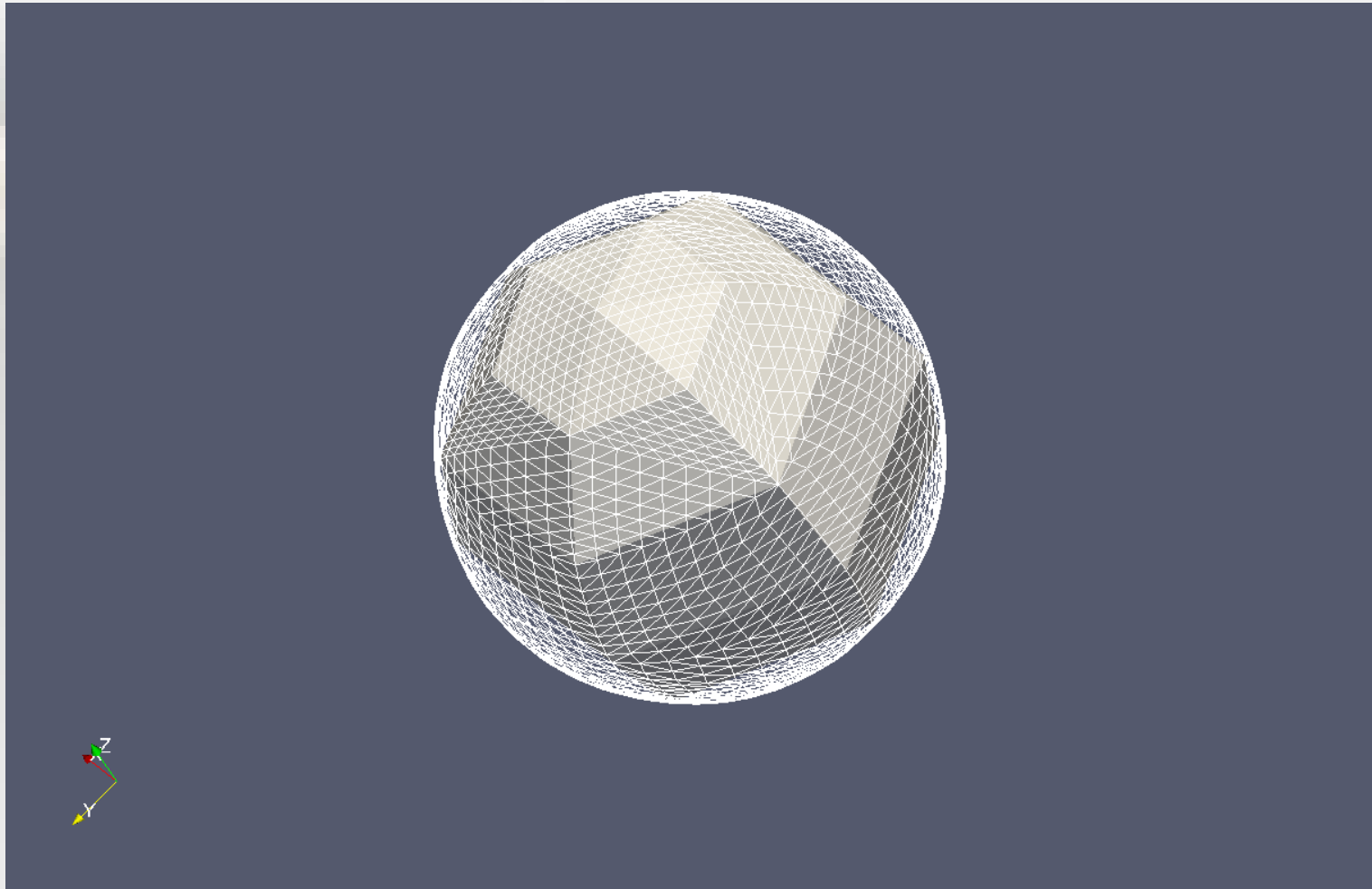
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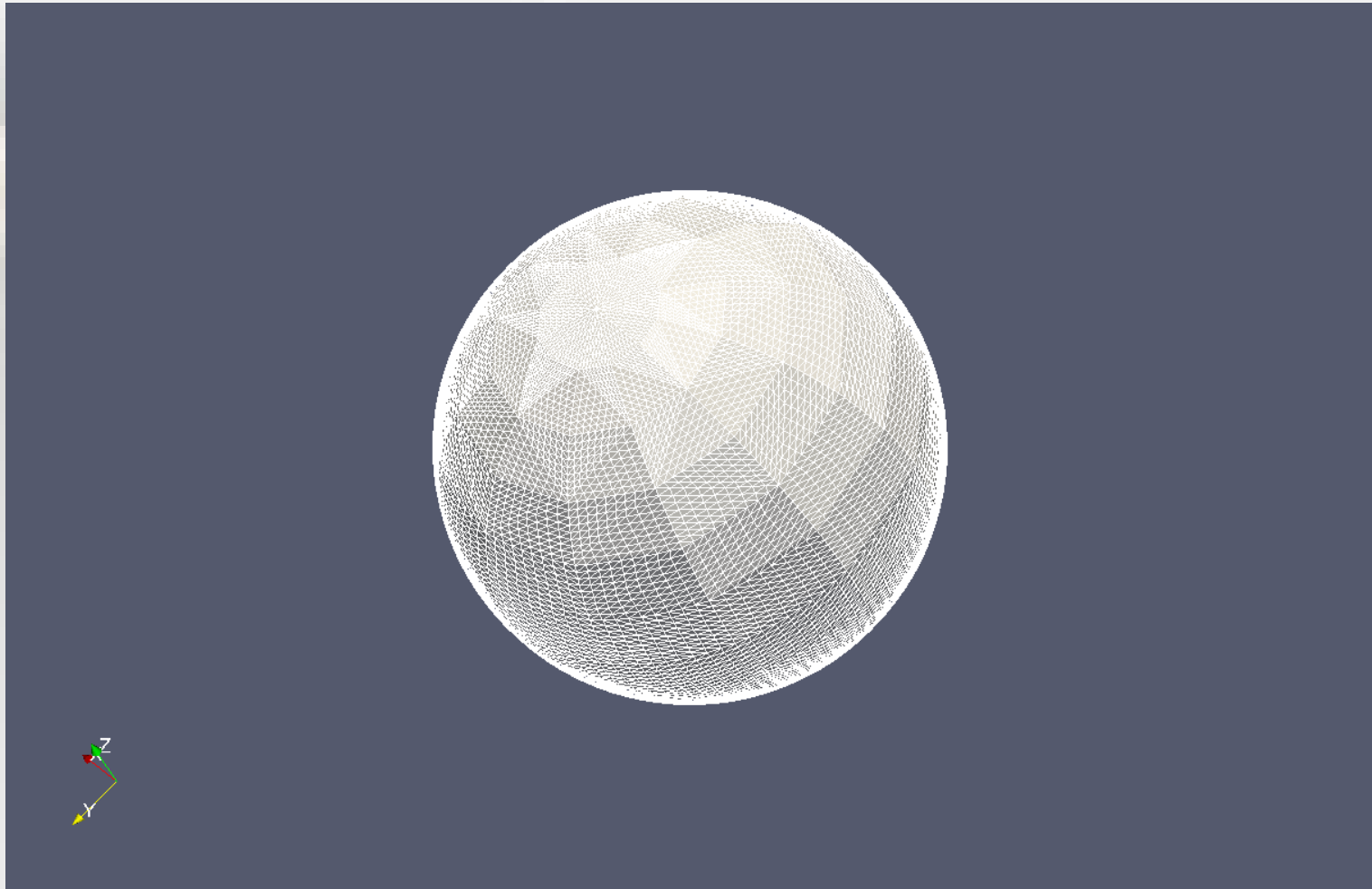
Interpolated Surfaces



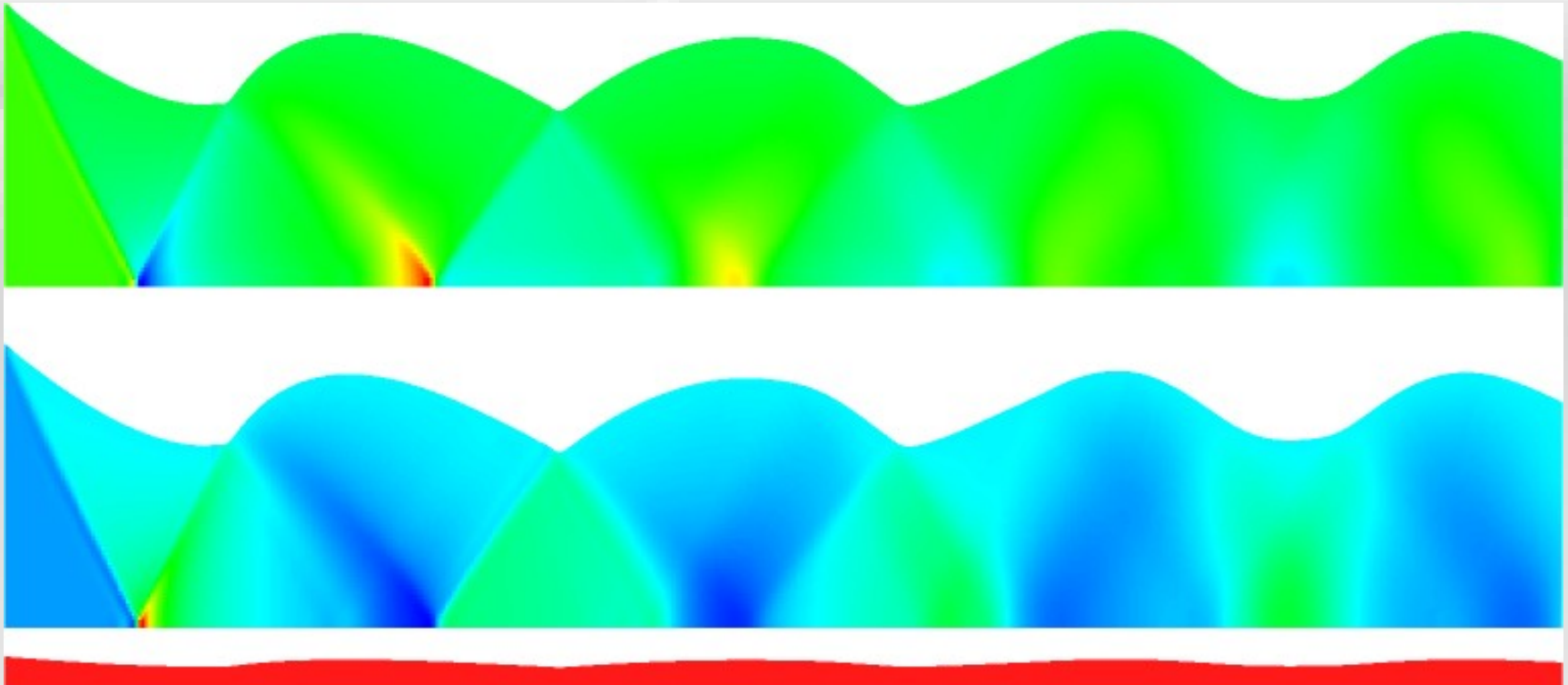
Interpolated Surfaces



Interpolated Surfaces

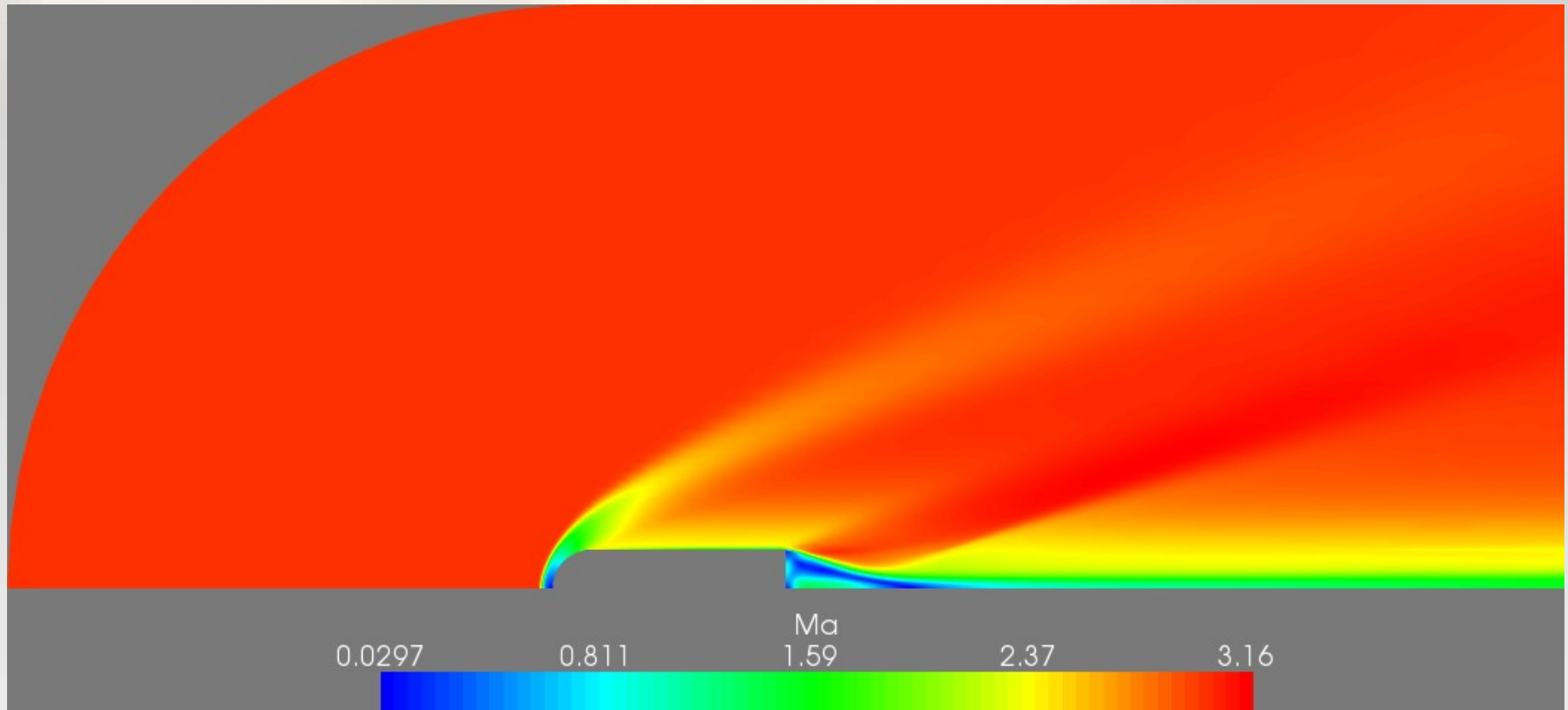


Refinement of Free Shear Layers



Size in y-direction exaggerated

Refinement of Free Shear Layers (*supersonic base-flow*)



Envisaged Developments

- Adaptive meshing
 - y^+
 - shear layers
 - shocks
 - ...
- Better support for polyhedral grids
- Hex far fields
 - maybe coupled with `snappyHexMesh`

Thank you for your attention

[**engits.com/engrid**](http://engits.com/engrid)