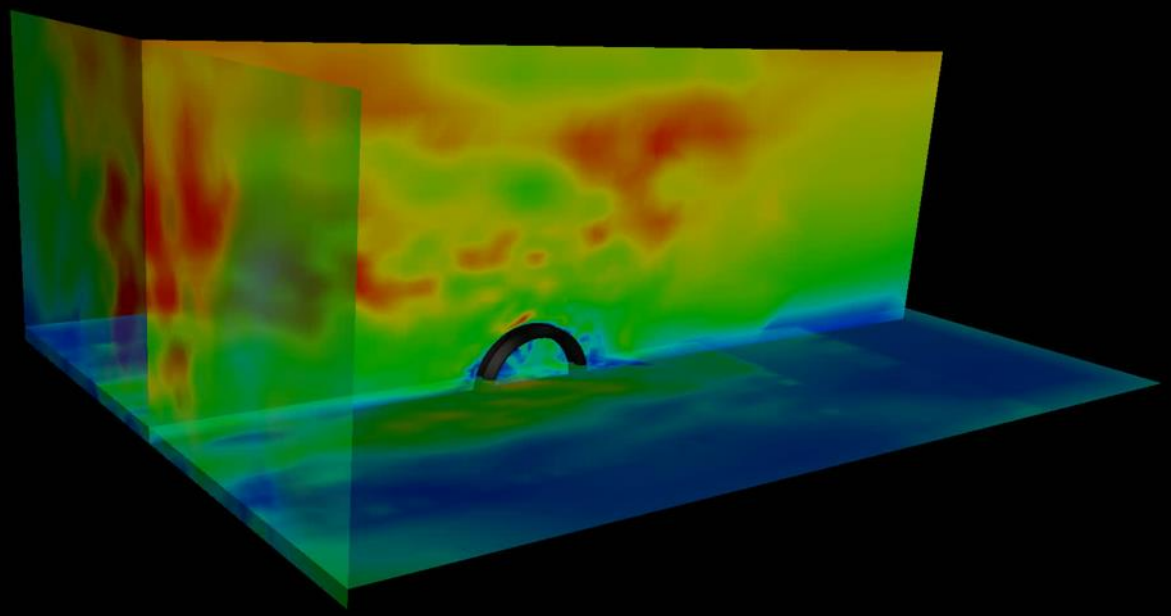
Chair of Structural Analysis
TUM Department of Civil, Geo and Environmental Engineering
Technical University of Munich



STRUCTURAL WIND ENGINEERING

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Kratos 3D CFD Tutorial

The aim of this tutorial is to do the postprocessing of an already existing result file and import a given geometry.

Covered topics:

- Post processing of results
- Using a 3D Geometry from a CAD software

Disclaimer: This example serves the sole educational purpose of demonstrating how to postprocess a 3D CFD case. It also includes note how an example case could be set up from CAD data.

Technical note: Tested on 04.12.2019, works with GiD 14.1.7d and the pre-release of the Kratos problemtype (7.1) on Windows 10 and Ubuntu 18 64 bit.

Solution Postprocessing

Load the results

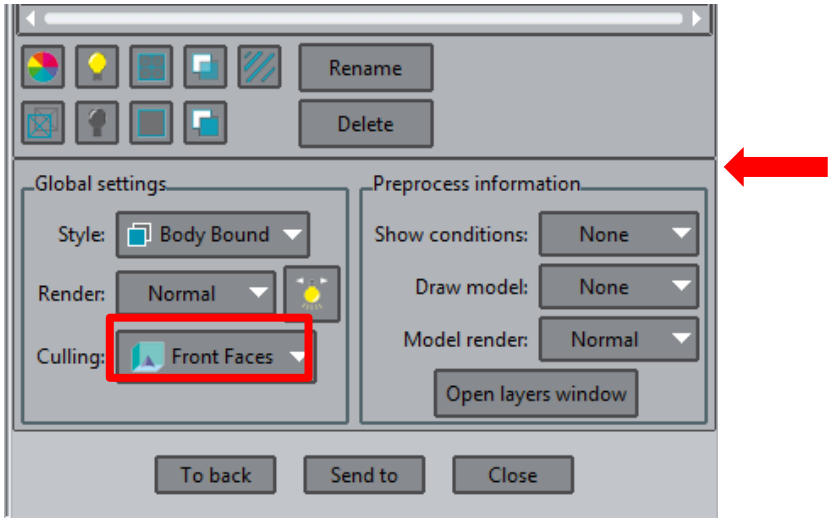
- Previous Task 2 (3D CFD-analysis) takes too long to compute during the tutorials
- To see the results, download the pre-calculated result file
- To load the provided results, go to *postprocessing*
- Load the provided … *.post.bin* – file

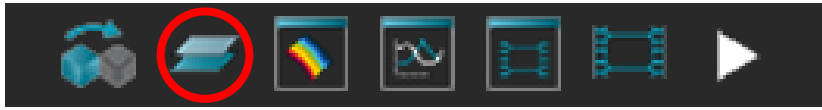
Alternative:

- Although you can solve the previous problem with the created mesh, it is by far too coarse to get reasonable results. But it can be done for the purpose to practice
- The following slides deal with results from a different structure (different values to your 3D calculation)
- The result files of a computation with a reasonable fine are provided to do the postprocessing in *CFD_HighRiseExampleFine/cfd.gid* (via a download link)
- Additional information and useful files saved from postprocessing in *CFD_HighRiseExampleFine\additional_information_and_data/*
- Auxiliaryfiles in *CFD_HighRiseExampleFine\auxiliary_files/*

Post processing

- Play around with the results and the visualization
- Plot and animate the results for the velocity and the pressure and compare them
- To view the interior of the model
  Window → View style
- In the Select & Display Style window, select Culling: Front Faces

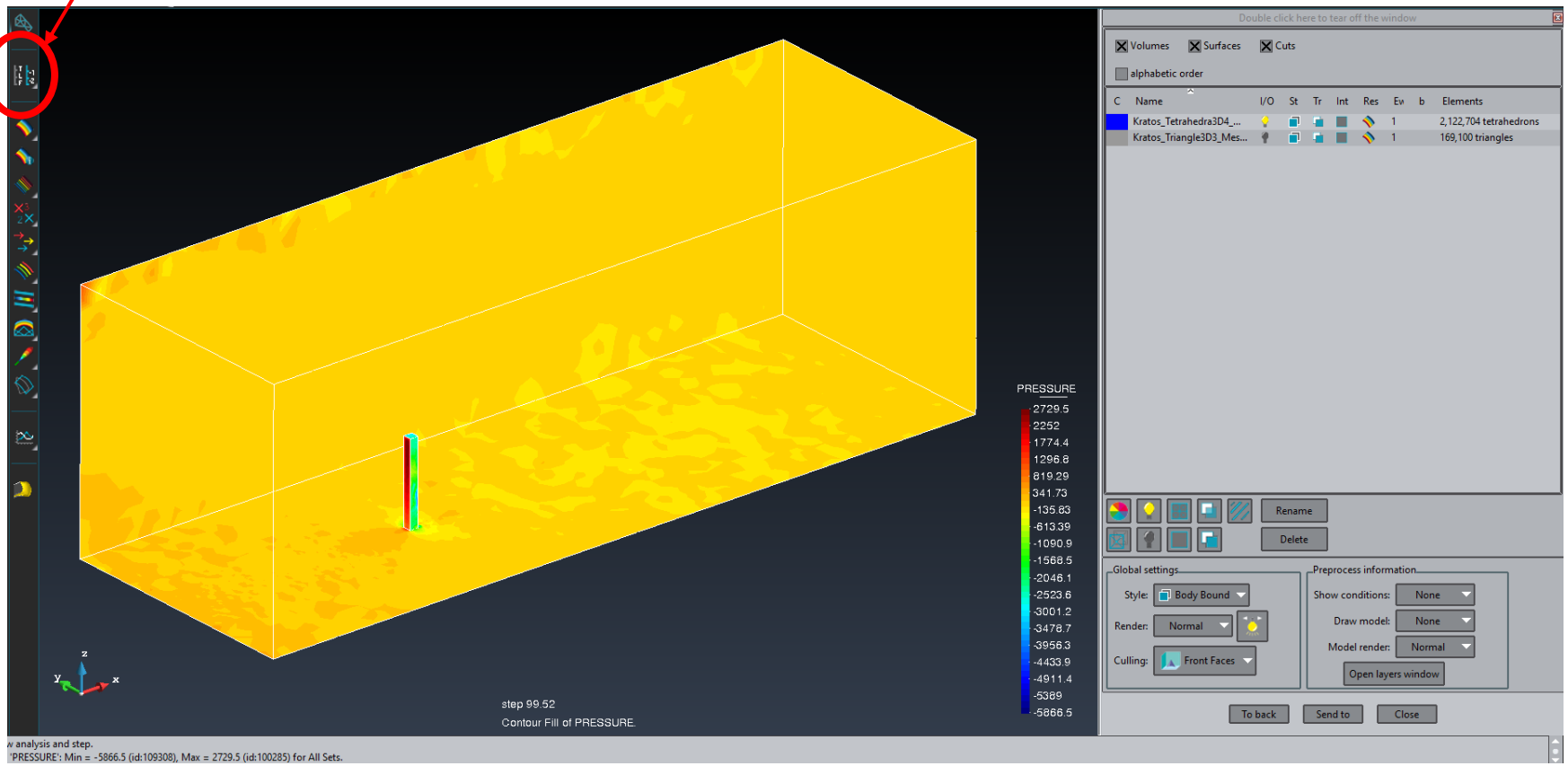




Post processing

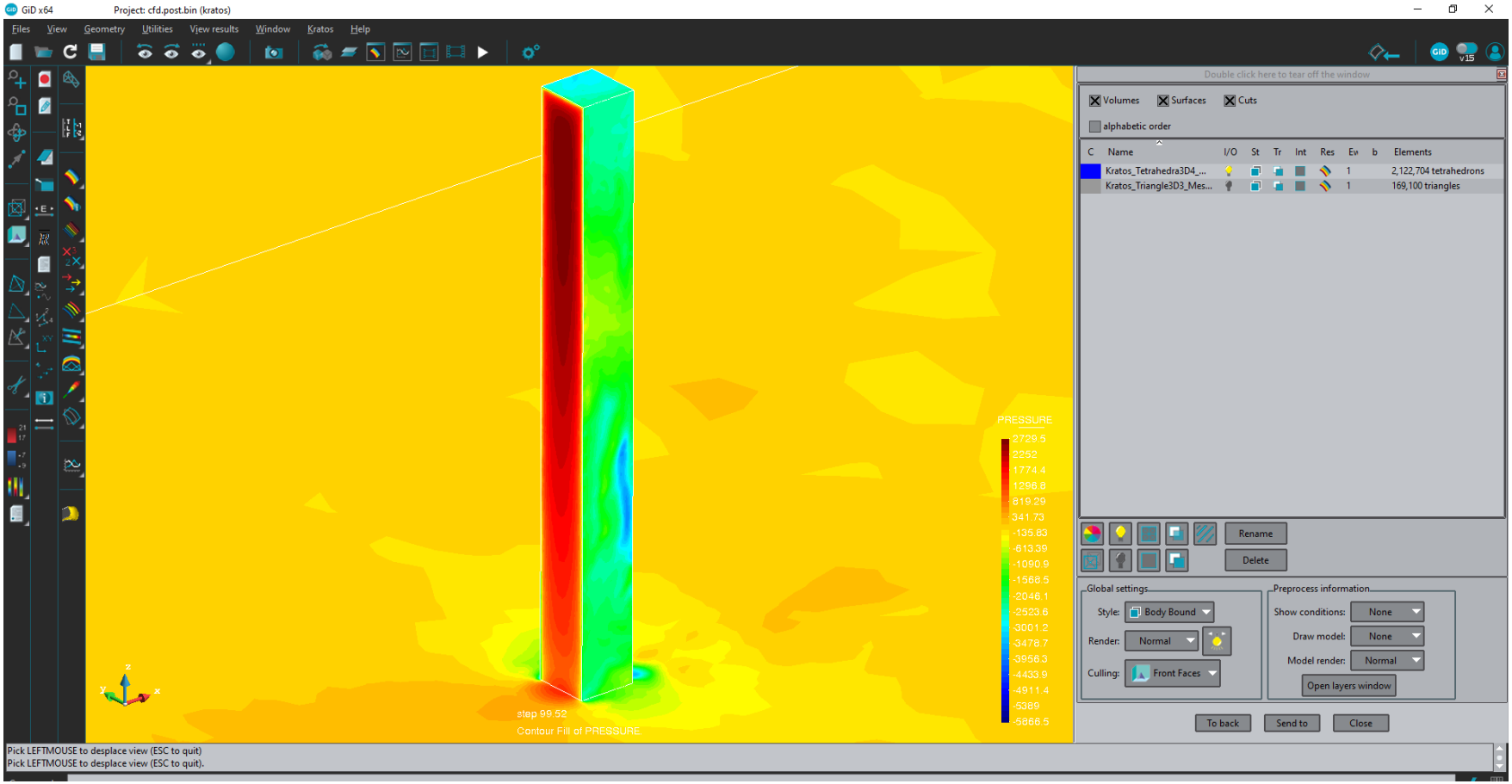
- Results for *pressure* in the last timestep:

Select the time step here



Post processing

- Close-up of the structure :

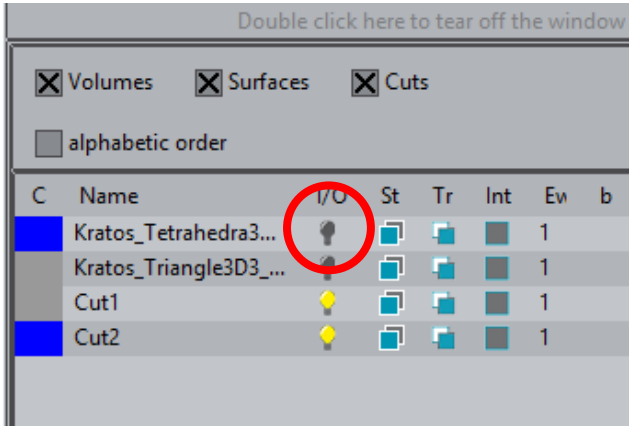


Using cuts

- View the results of an arbitrary plane using a cut
- Define a cut using
  Geometry→ Cut plane → 3 points
- Use these points (type this in command line one by one):

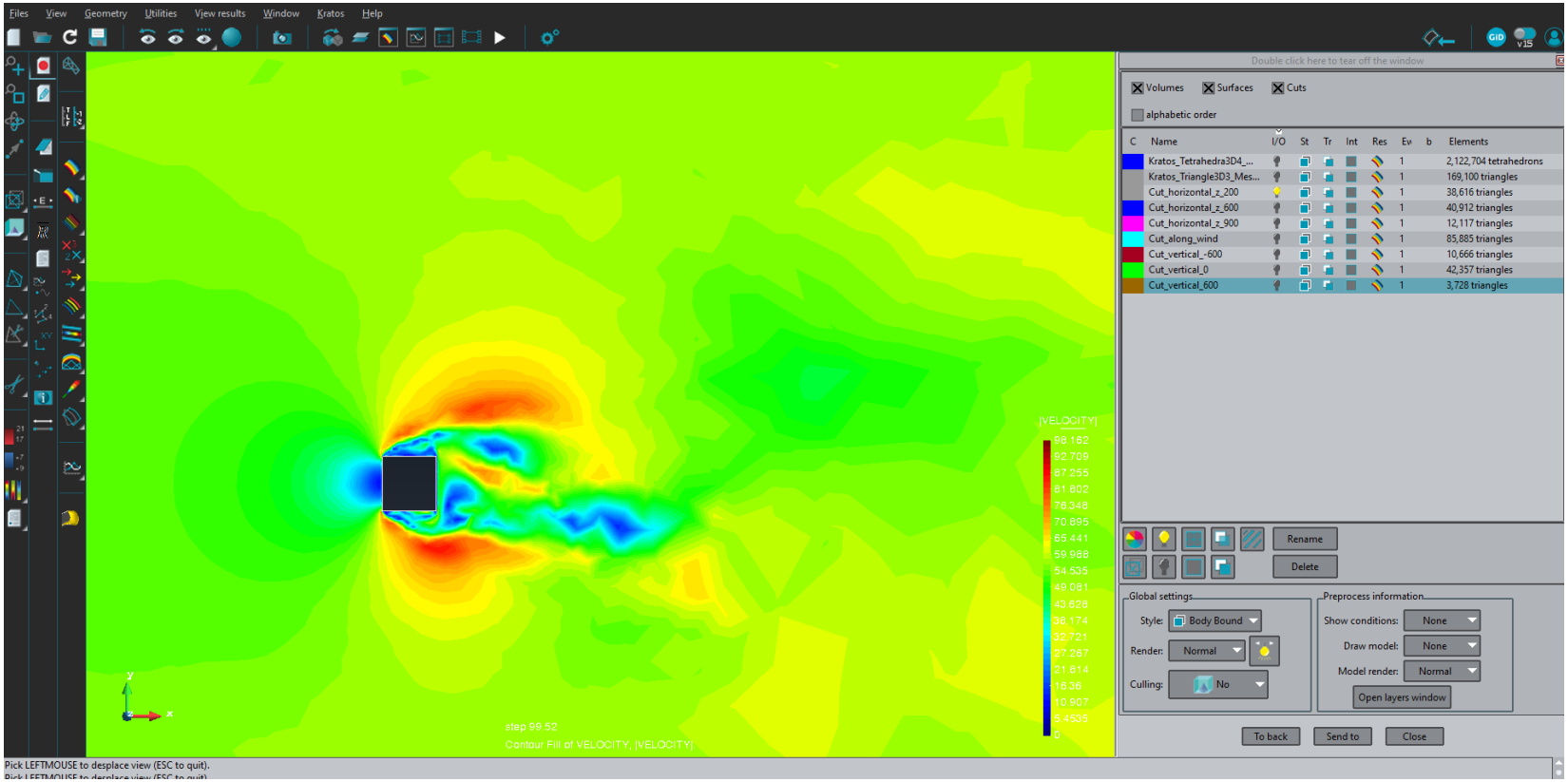
Cut plane X	2/3 H Y	2/3H Z (alt.)	2/3H (Tut. 3)
0.0	0.0	400.0	65.0
1.0	0.0	400.0	65.0
1.0	1.0	400.0	65.0

- To view just the cut:
  - Click on View Style option
  - Turn off the light bulbs next to the Kratos entries
  - Select Culling: No



Post processing - cuts

- Visualize the time evolution of the velocity using *Ctrl + m*
- The figure shows results for *magnitude of velocity* in the last timestep (using the first cut):



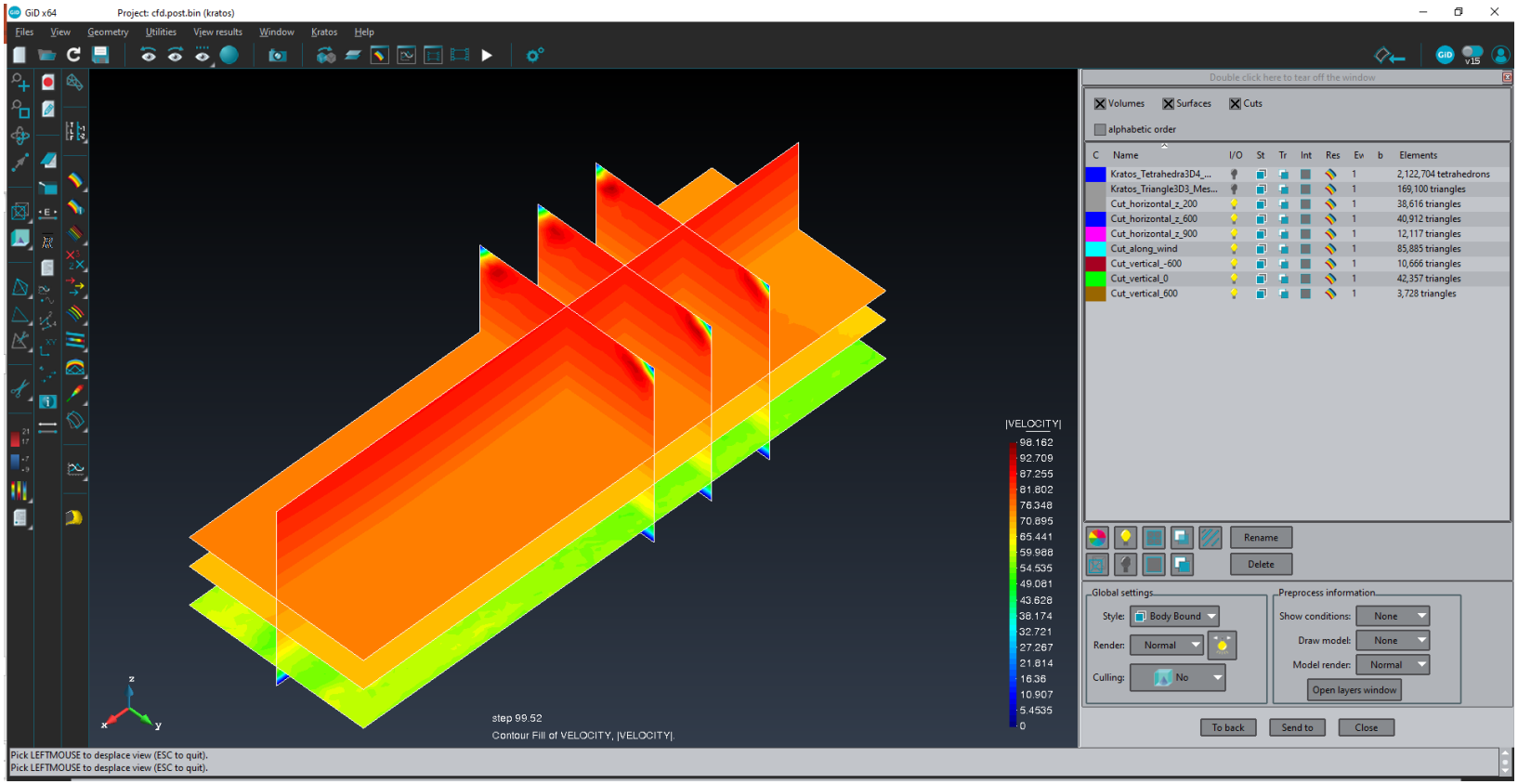
Using cuts

- Create additional horizontal and vertical cuts
- Export the cuts
  Files → Export → Cut → All cut
- Cuts can be reused
  Files → Import → Cut …
- *Play around with different plane coordinates*

Horizontal X	for example Y	Z
0	0	200
1	0	200
1	1	200
0	0	600
1	0	600
1	1	600
0	0	900
1	0	900
1	1	900

Vertical X	for example Y	Z
0	0	0
1	0	0
1	0	1
-600	0	0
-600	1	0
-600	1	1
0	0	0
0	1	0
0	1	1
600	0	0
600	1	0
600	1	1

Using cuts


GiD x64
Project: cfd.post.bin (kratos)
Files View Geometry Utilities View results Window Kratos Help
Volumes Surfaces Cuts
alphabetic order
C Name I/O St Tr Int Res Ew b Elements
Kratos_Tetrahedra3D4_... 1 2,122,704 tetrahedrons
Kratos_Triangle3D3_Mes... 1 169,100 triangles
Cut_horizontal_z_200 1 38,616 triangles
Cut_horizontal_z_600 1 40,912 triangles
Cut_horizontal_z_900 1 12,117 triangles
Cut_along_wind 1 85,885 triangles
Cut_vertical_-600 1 10,666 triangles
Cut_vertical_0 1 42,357 triangles
Cut_vertical_600 1 3,728 triangles
Rename
Delete
Global settings
Style: Body Bound
Render: Normal
Culling: No
Preprocess information
Show conditions: None
Draw model: None
Model render: Normal
Open layers window
To back
Send to
Close
|VELOCITY|
98.162
92.709
87.255
81.802
76.348
70.895
65.441
59.988
54.535
49.081
43.628
38.174
32.721
27.267
21.814
16.36
10.907
5.4535
0
step 99.52
Contour Fill of VELOCITY, |VELOCITY|.
Pick LEFTMOUSE to desplace view (ESC to quit).
Pick LEFTMOUSE to desplace view (ESC to quit).

Using graphs

- Create a graph with several points at the inlet and the building

  View Results → Graphs → Line graphs → VELOCITY → X_VELOCITY
- Exports the graph

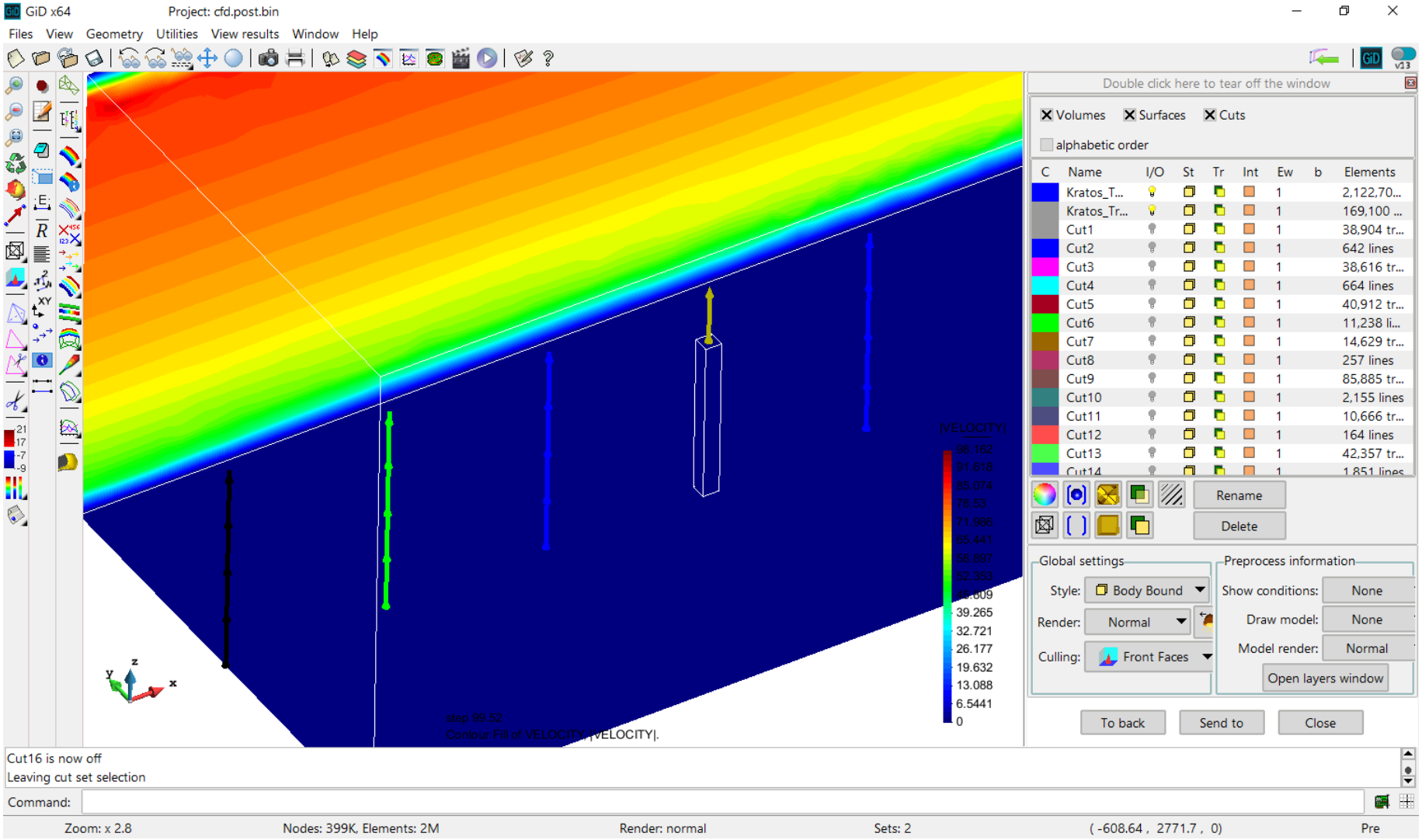
  Files → Export → Graph → All graphsets
- Graph can be reused

  Files → Import → Graph …

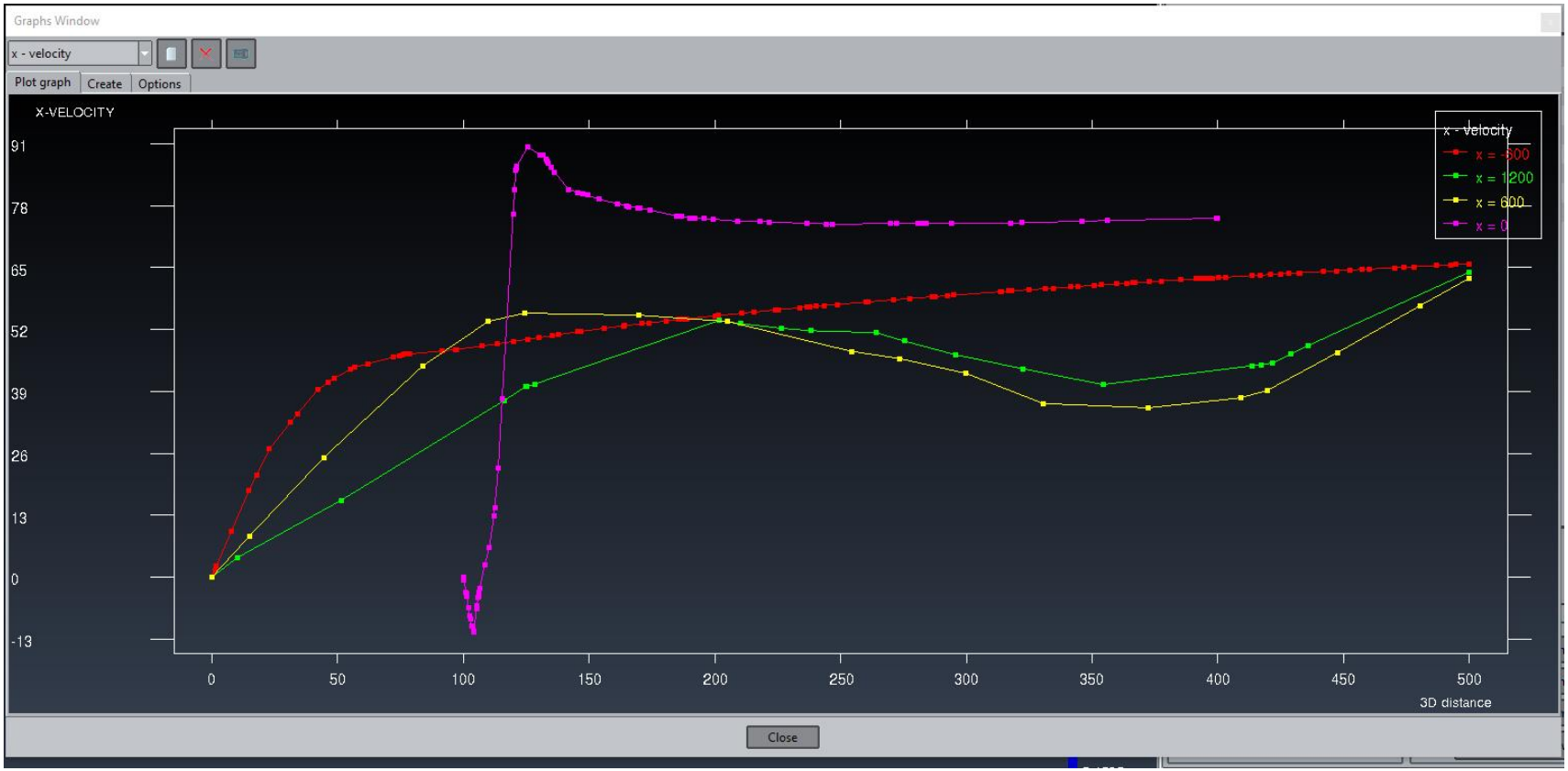
In the *.grf file you have all the numerical data to create plots in Excel, Python etc. for your project report and presentation.

Graphs X	for example Y	Z	
-600	0	0	at the inlet
-600	0	500	
1200	0	0	
1200	0	500	
-300	0	0	
-300	0	500	
0	0	600	at the building
0	0	900	
600	0	0	
600	0	500	

Using graphs



Using graphs



Using streamlines

- Create streamlines, for e.g. along lines (defined by X, Y, Z of the start and end points), like shown in the table (they are for a certain time step)
  View Results → Streamlines → Along line → Velocity

- Change the color property of the streamlines
  Utilities → Preferences → Postprocess → Streamlines → Color mode → Stream contour filled

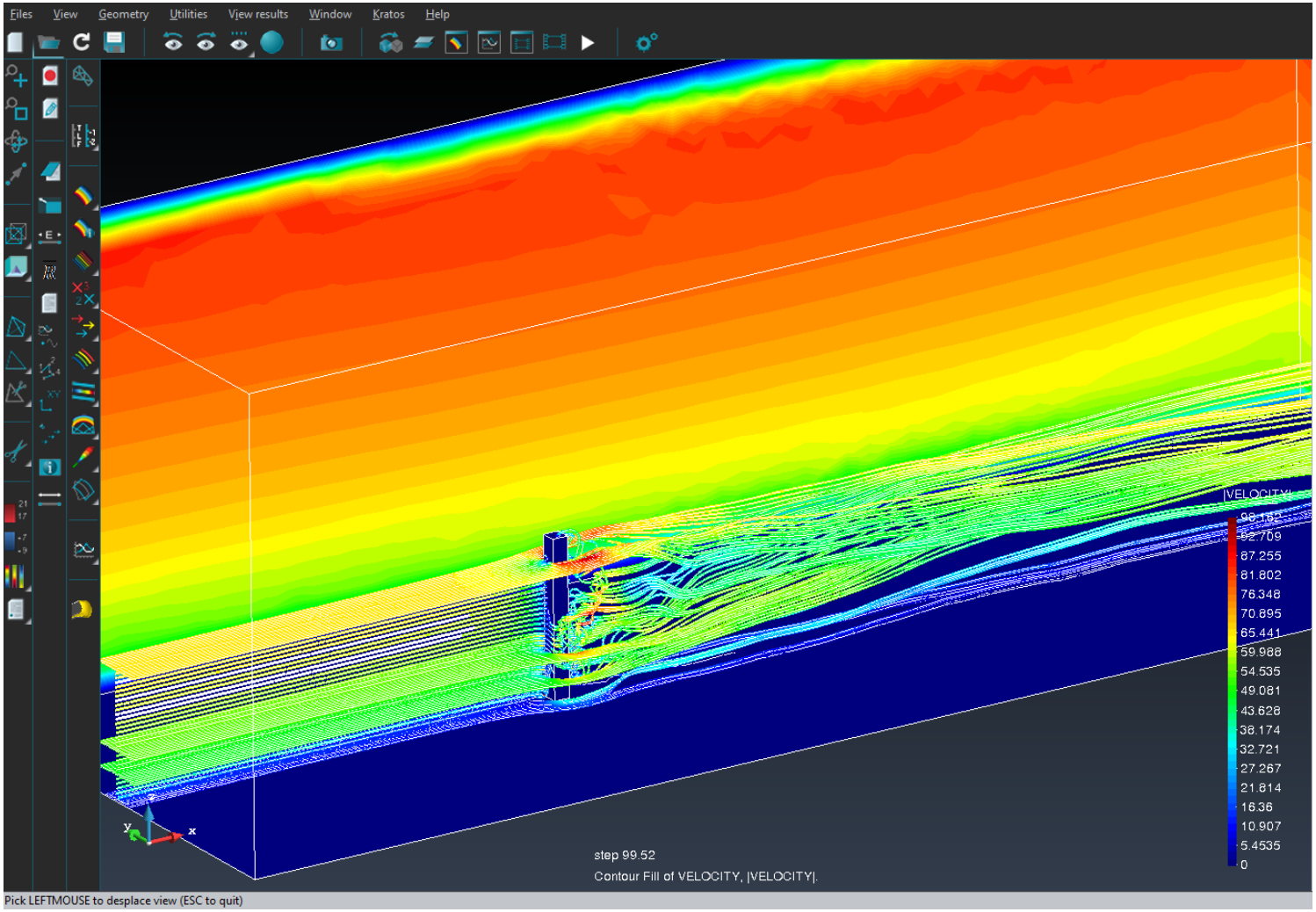
- Exports streamlines
  Files → Export → Post information → Streamlines

- Streamlines can be reused
  Files → Import → Streamlines …

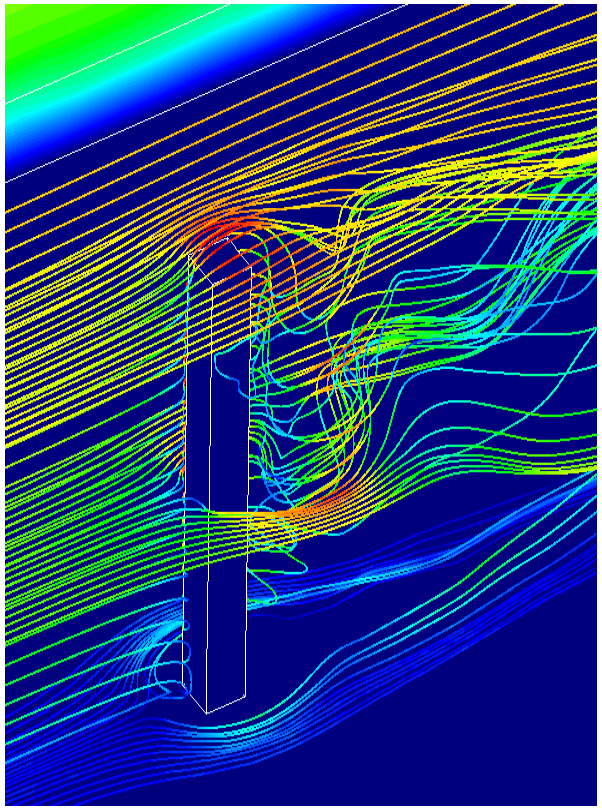
Streamline

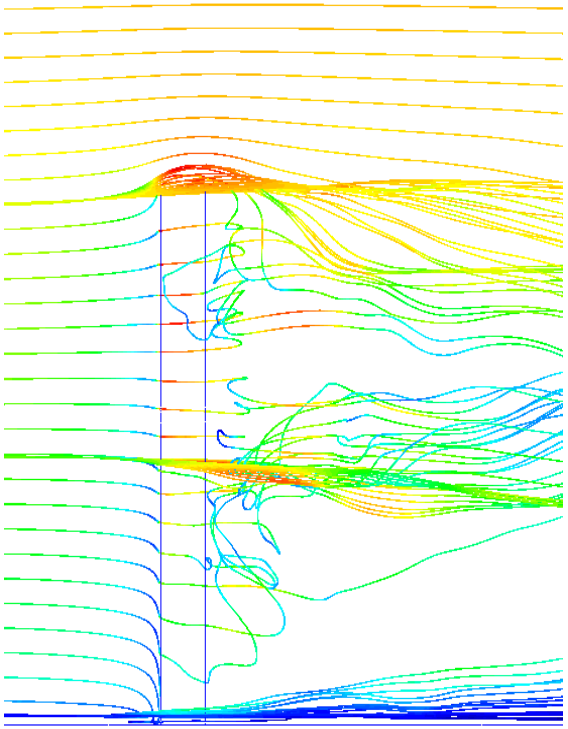
X	Y	Z	
-200	0	0	
-200	0	500	→ *30 points*
-120	-120	10	
-120	120	10	→ *20 points*
-120	-120	100	
-120	120	100	→ *20 points*
-120	-120	190	
-120	120	190	→ *20 points*

Using streamlines

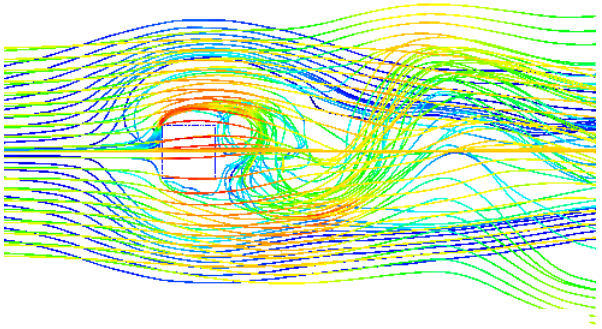


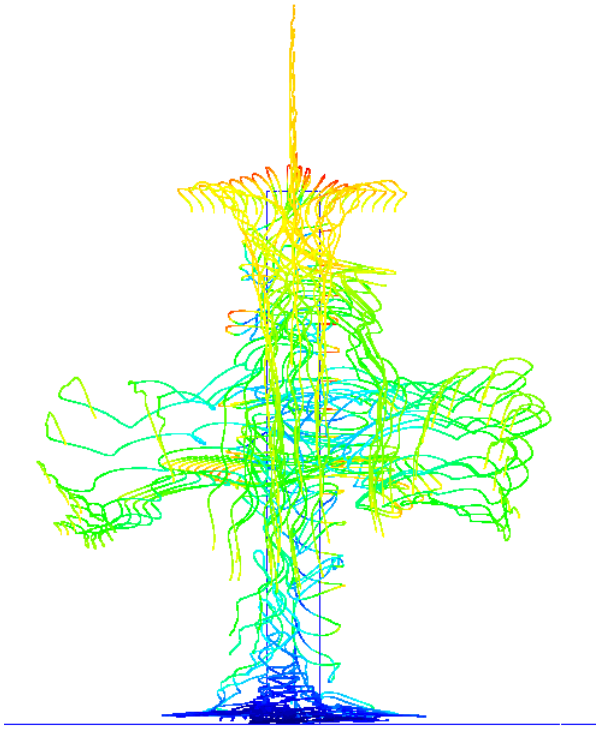
Using streamlines





step 82.5
Contour Fill of VELOCITY, |VELOCITY|.

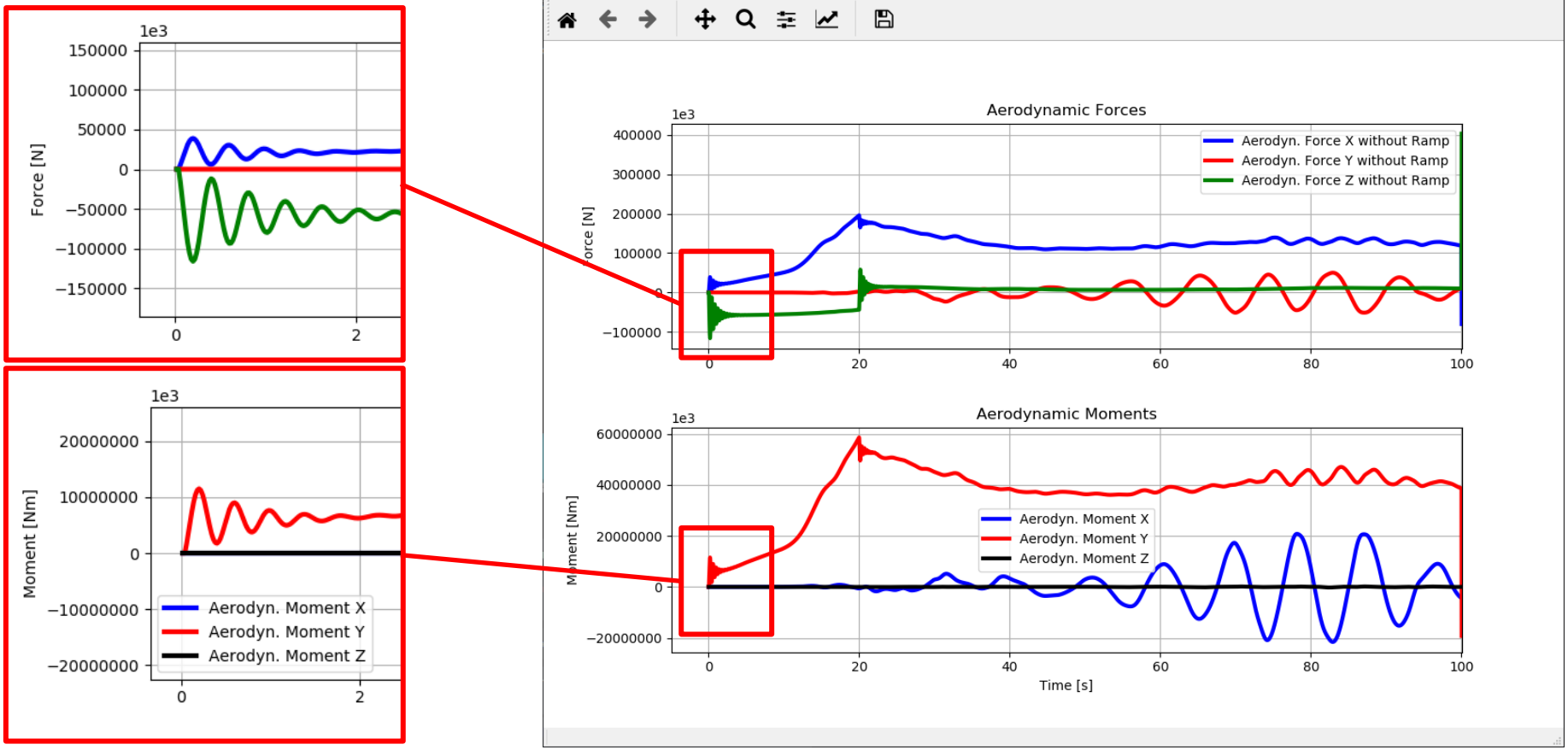




step 82.5
Contour Fill of VELOCITY, |VELOCITY|.

Aerodynamic results

- Copy “plot_custom_aerodynamic_force_results.py“ into your GID project folder and run the python file
- The results should look like this:



Using a 3D geometry from a CAD software

→ suggested task for individual work, useful for projects

Kratos 3D Fluid Tutorial – real geometry

In this tutorial it is shown how to edit geometries in GiD 15. Useful commands are presented at the example of the Dubai Peark.

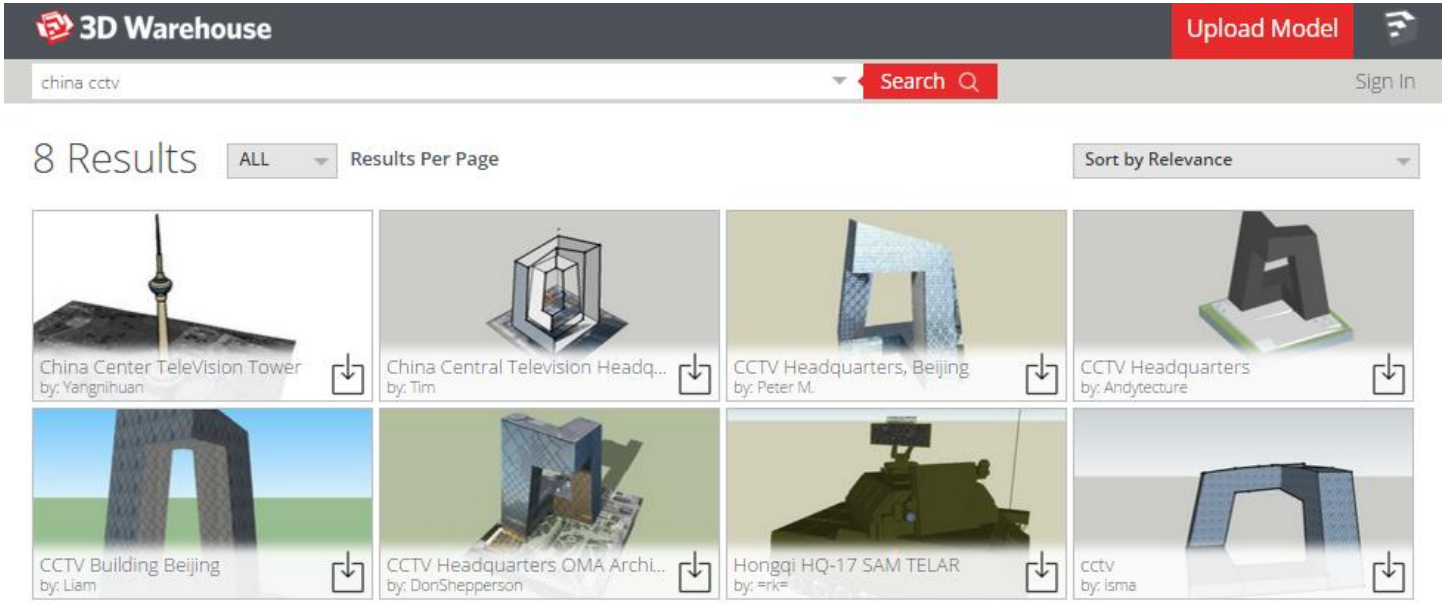
Covered topics:

- Cleanup of CAD-geometries
- Creating and meshing fluid domains

[http://blog.blockbrief.com/wp-content/uploads/2014/10/Dubai-Pearl.jpg]

Kratos 3D Fluid Tutorial – real geometry

You can create 3D models on your own or import some available (for e.g. from 3D Warehouse)



Necessary steps:

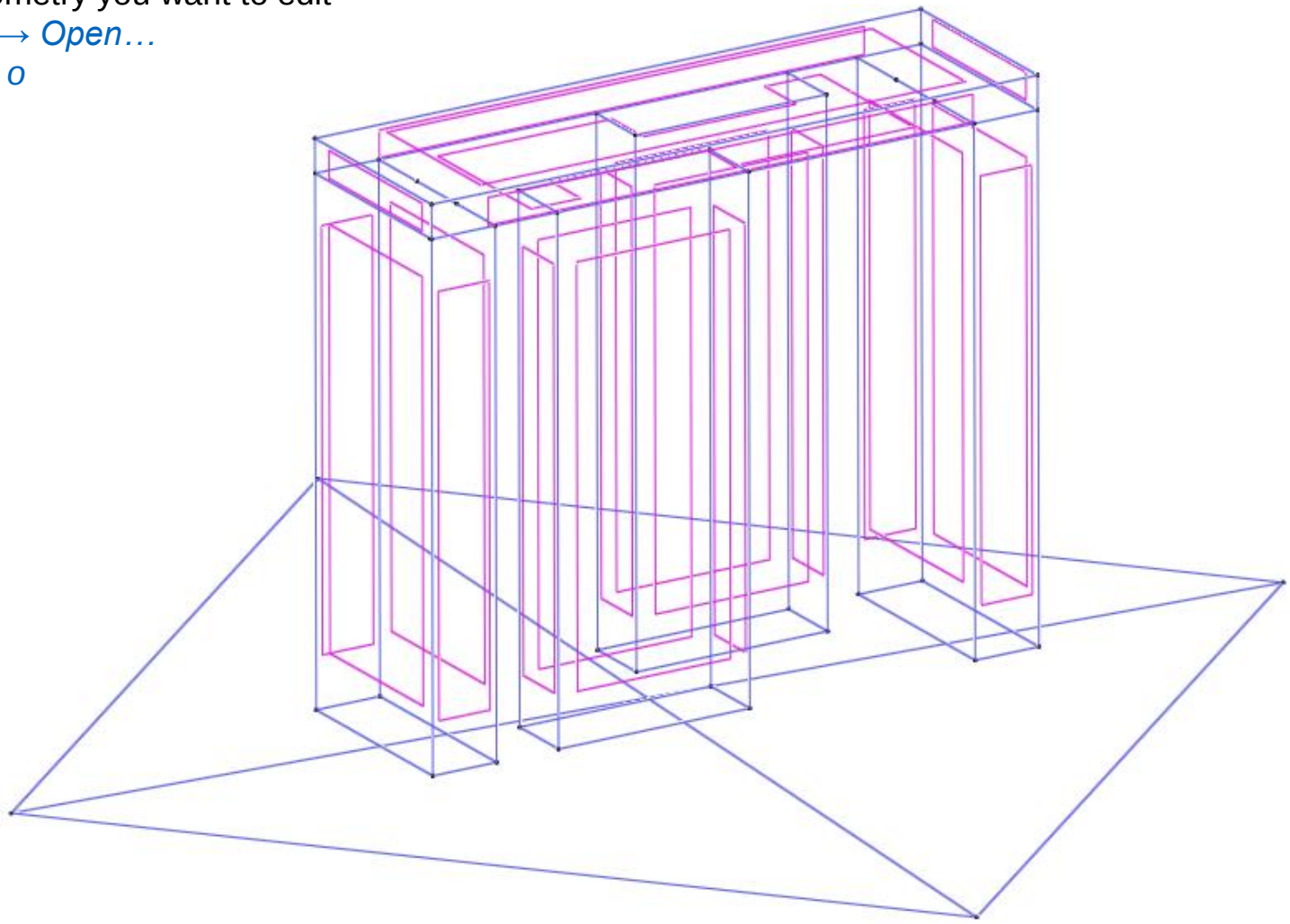
1. Import the SketchUp file format *.skp to AutoCAD using this plugin
2. Export a common CAD format such as *.dxf, *.stl, etc.
3. Import the more common format into GiD
4. Clean and prepare the geometry for a CFD simulation → see steps on the following slides

Cleaning and preparing the geometry is necessary because for CFD you need to avoid overlapping geometric entities as in the end you will need a so-called „watertight“ geometry for meshing and simulation.

Cleaning the Geometry

Geometry

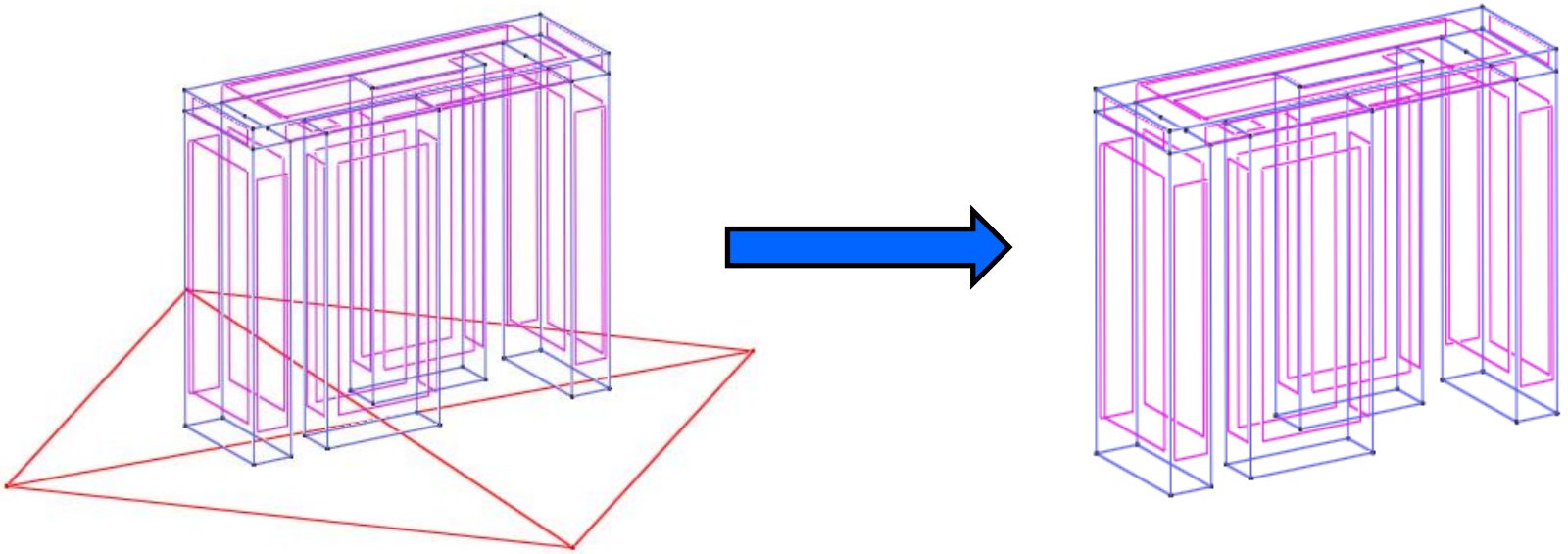
- Load the geometry you want to edit
  Files → Open…
  or *Ctrl + o*



Geometry

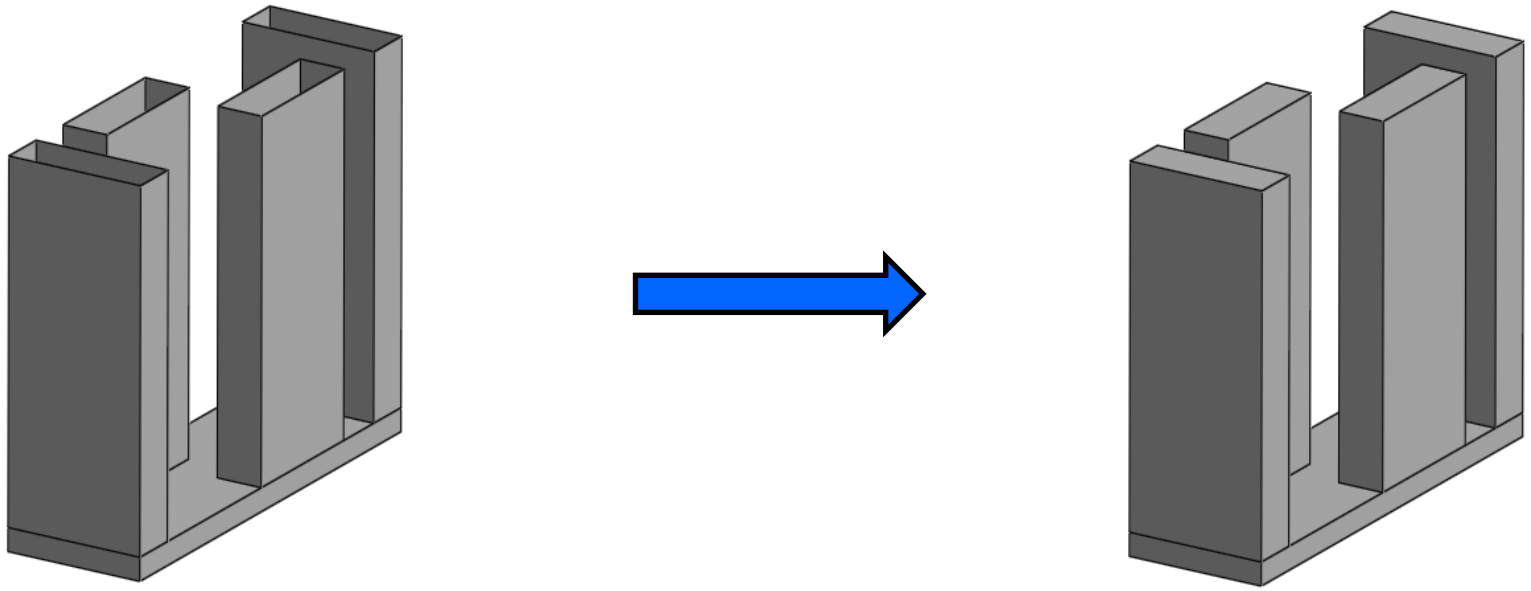
- To create a mesh, one first needs to create a **volume**
  => This is not possible if the body is not fully closed by surfaces

- Delete „artificial“ lines unnecessary points by:
  Geometry → Delete → All types



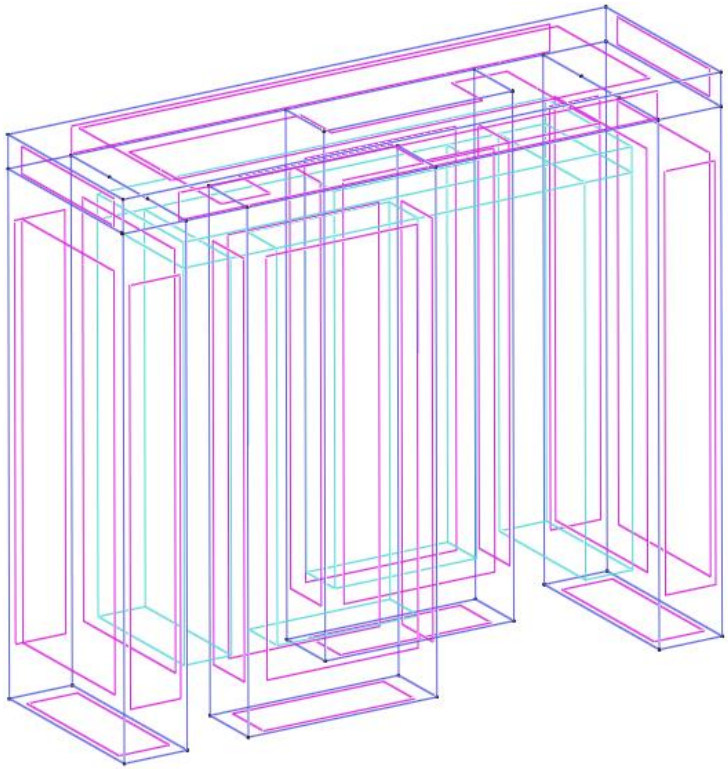
Geometry

- Find missing surfaces by changing the Render (switch from Normal to Flat)
  View→ Render → Normal / Flat
- Rotate the model to find the missing surfaces
- Create missing surfaces



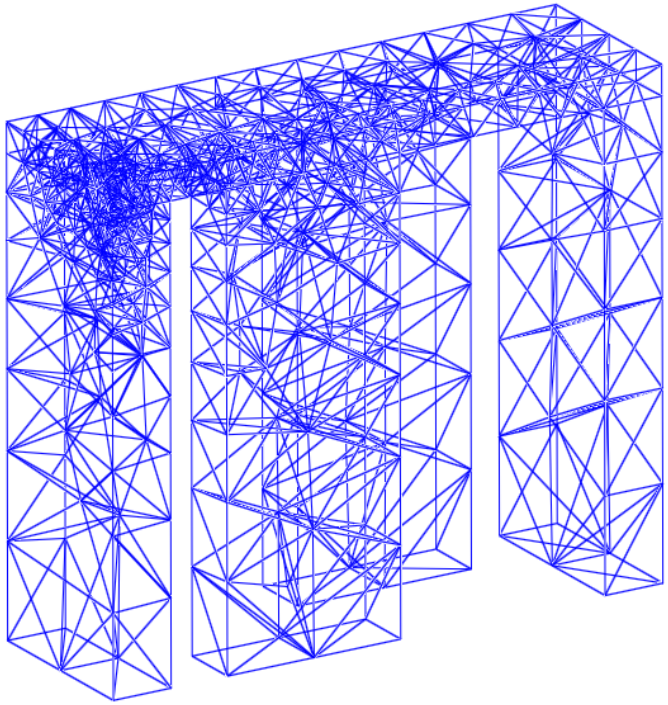
Geometry

- Create a volume by selecting all surfaces
- If no volume can be created, it is an indicator, that there is something wrong with the geometry!



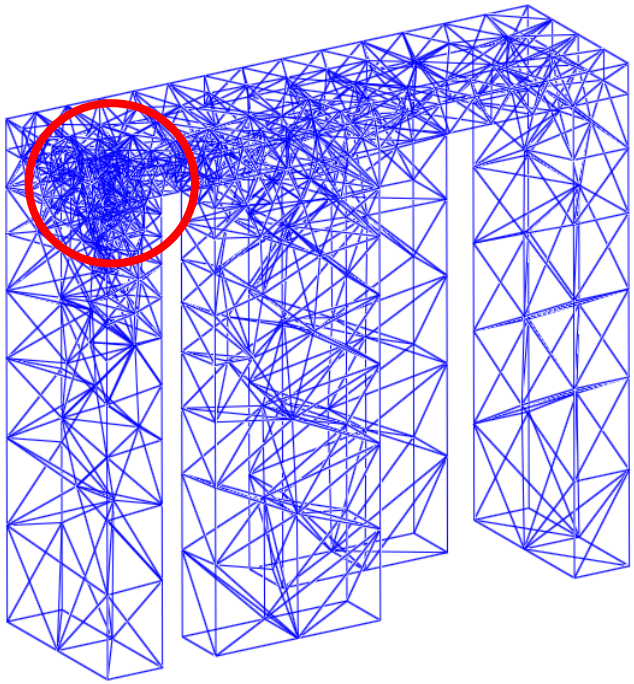
Geometry

- To check the quality of the geometry, mesh the structure:
  - First reset all mesh data
    Mesh → Reset mesh data
  - Create the mesh using „10000“ as element size



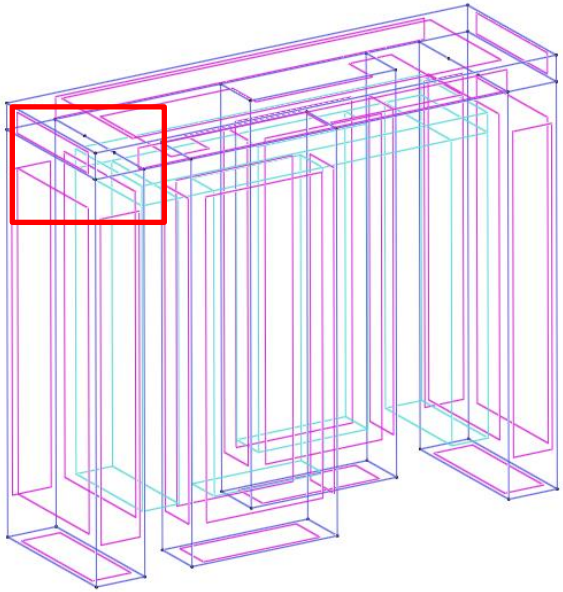
Geometry

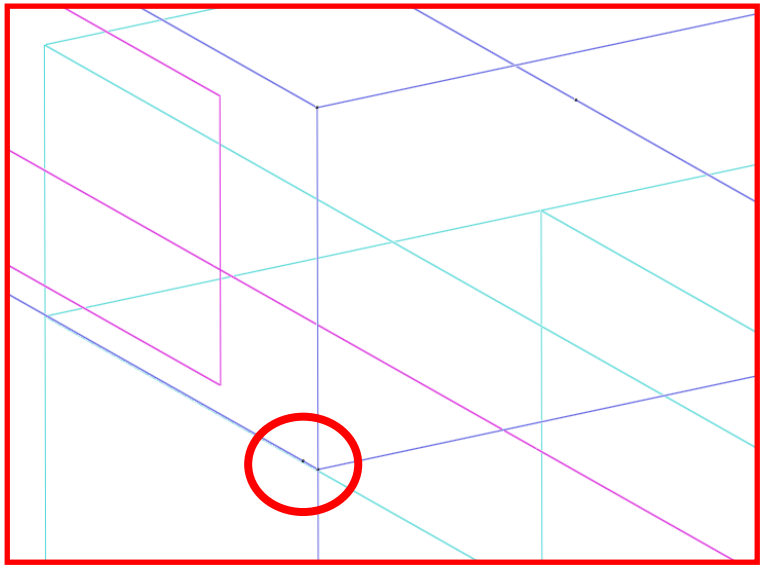
- Check the quality of the mesh
- In this example there is an unfortunate concentration of small elements in one corner
- This is an effect of an uncleaned geometry



Geometry

- Switch back to geometry view and investigate the geometry in this area closely





- Some tiny line segments exist, that causes the fine mesh in this area.
- Check the model for further very small primitives
- **This is a typical result form importing CAD-geometries!**

Geometry – cleaning up

- One way to (automatically) clean the model is to collapse it
  Geometry → Edit → Collapse → Model
- This option joins small entities to larger one
- Using the automatic model collapsing is not always a good idea, especially if small features want to be resolved.
- Therefore, cleaning up the geometry can also be done manually. GiD provides many functionalities to so.
  Geometry → Edit

Geometry

- Re-mesh the model
- The mesh is a lot more homogeneous than before