

STRUCTURAL WIND ENGINEERING

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The aim of this tutorial is to do another exercise on solving a fluid problem with GiD and Kratos. This time we will work with a 3D-problem.

Covered topics:

- Preprocessing
 - Geometry
 - Input data and conditions
- Postprocessing

You should be able to run this 3D example on your own computer in 15-45 minutes.

Disclaimer: This example serves the sole educational purpose of demonstrating how to setup a basic 3D CFD problem, run the simulation and do some postprocessing. A mesh and time step refinement should be carried out for a qualitative check of the results.

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.

Defining the Geometry

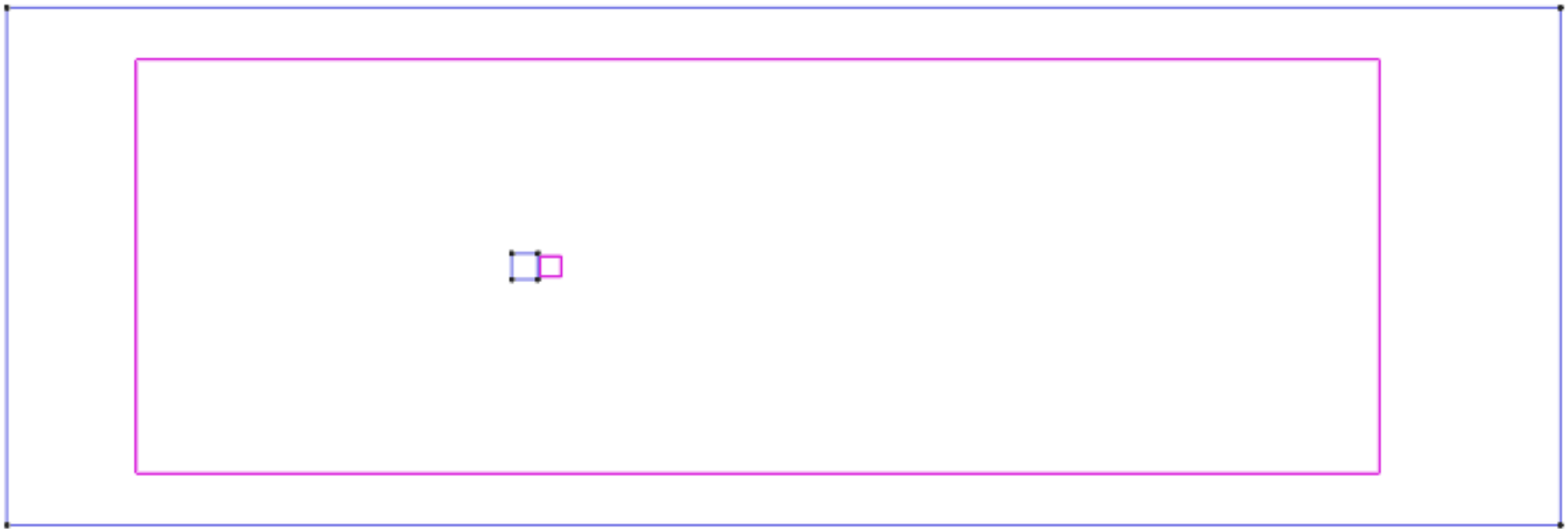
- Create the geometry in the XY-plane using the following points to describe it:

Structure X	Y	Z
15.0	15.0	0.0
15.0	-15.0	0.0
-15.0	-15.0	0.0
-15.0	15.0	0.0

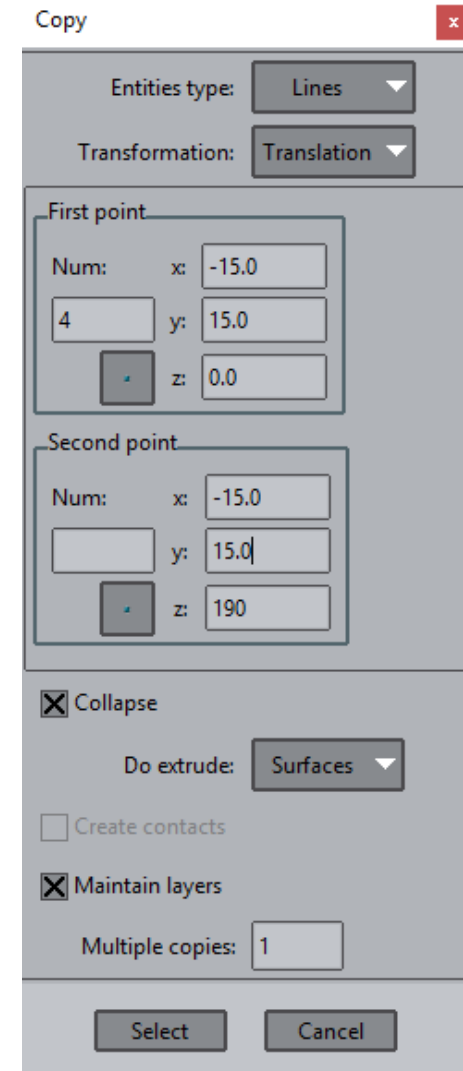
Boundary X	Y	Z
-600.0	-300.0	0.0
-600.0	300.0	0.0
1200.0	-300.0	0.0
1200.0	300.0	0.0

- Create the points first, followed by the lines and the surface

- The final geometry should look like this:



- Now we add the third dimension
or *Utilities* → *Copy*
Ctrl + c
- Select the following options in the Copy window:
 - *Entities type:* Lines
 - *Transformation:* Translation
 - *First Point:* One of the structure corners
 - *Second point:* Enter the same point but set the *z-coordinate to 190.0*
 - *Do extrude:* Surfaces
- Don't change any other options
- Click *Select* and mark the structure base (4 lines)
- Press *Esc* after marking the base



The image shows a 'Copy' dialog box with a red close button in the top right corner. The dialog is divided into several sections. At the top, 'Entities type:' is set to 'Lines' and 'Transformation:' is set to 'Translation'. Below this, there are two sections for point selection. The 'First point' section has 'Num:' set to 4, and the coordinates are x: -15.0, y: 15.0, and z: 0.0. The 'Second point' section has 'Num:' set to an empty box, and the coordinates are x: -15.0, y: 15.0, and z: 190. Below these sections, there are checkboxes for 'Collapse' (checked), 'Create contacts' (unchecked), and 'Maintain layers' (checked). The 'Do extrude:' dropdown is set to 'Surfaces'. At the bottom, 'Multiple copies:' is set to 1. There are 'Select' and 'Cancel' buttons at the very bottom.

Copy

Entities type: Lines

Transformation: Translation

First point

Num: 4 x: -15.0 y: 15.0 z: 0.0

Second point

Num: x: -15.0 y: 15.0 z: 190

☒ Collapse

Do extrude: Surfaces

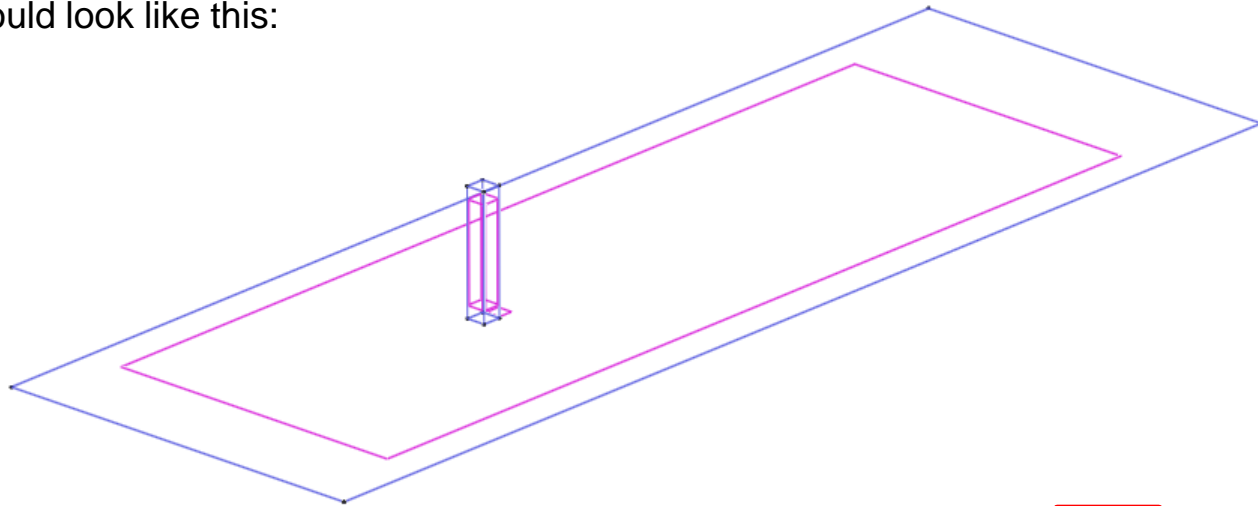
☐ Create contacts

☒ Maintain layers

Multiple copies: 1

Select Cancel

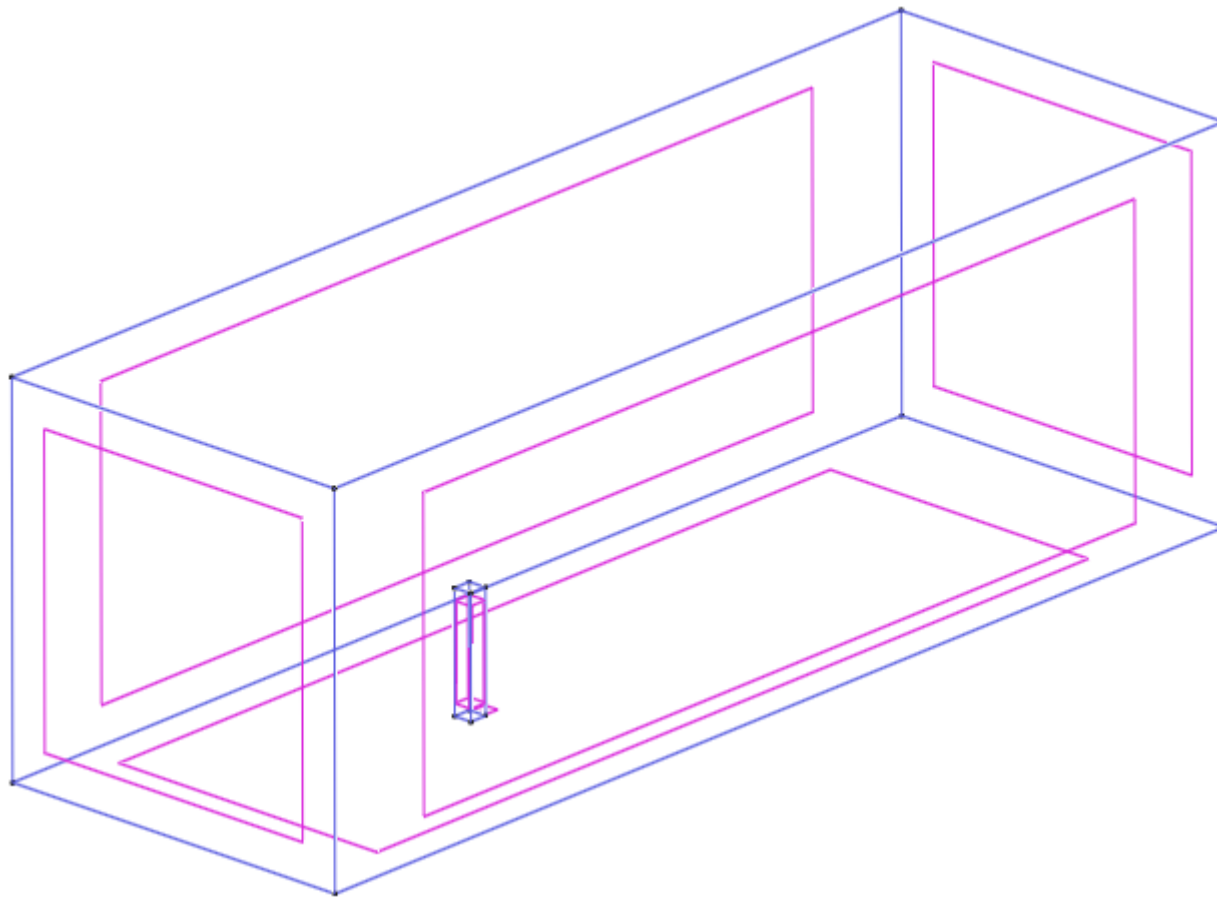
- The result should look like this:



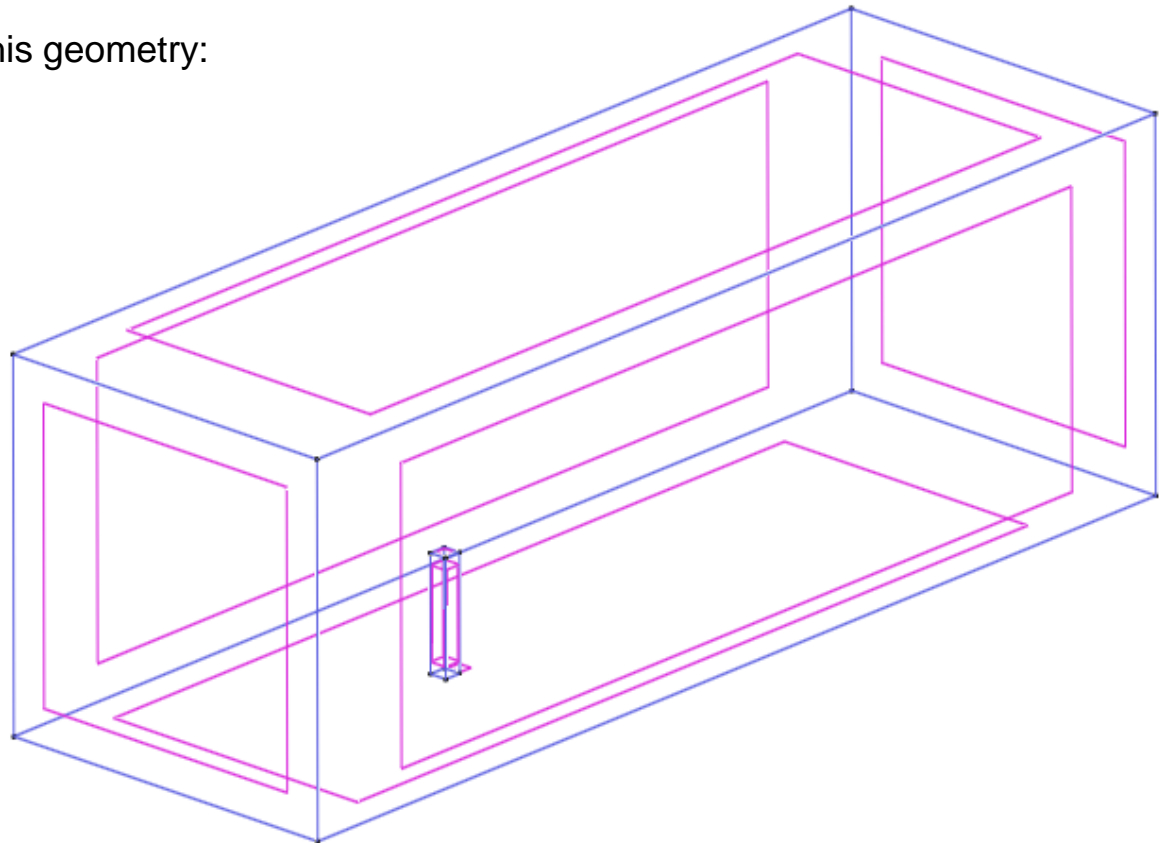
- Adjust/rotate the view to check if the transformation worked



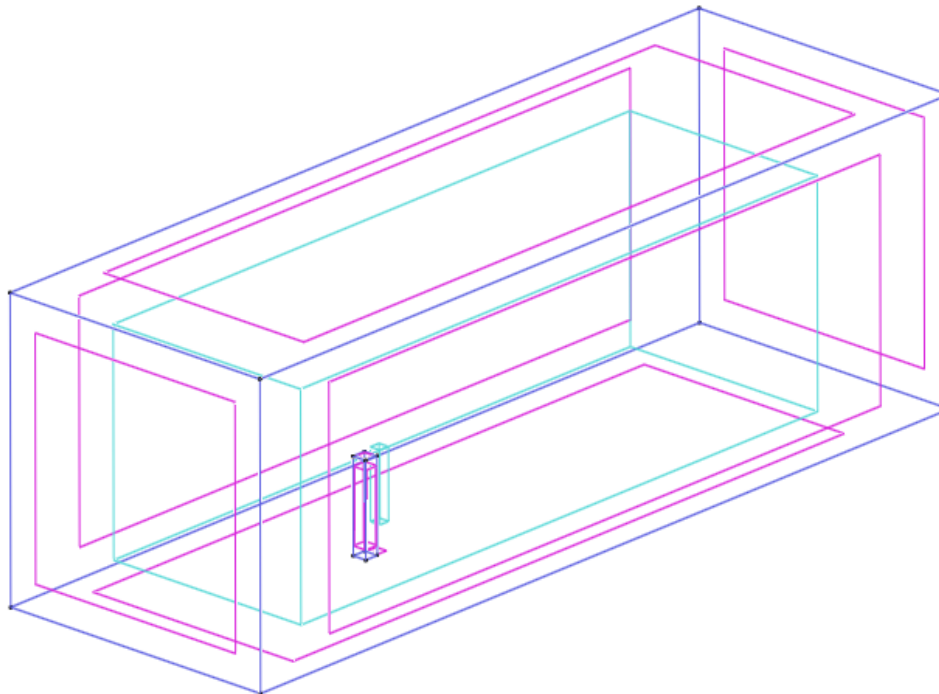
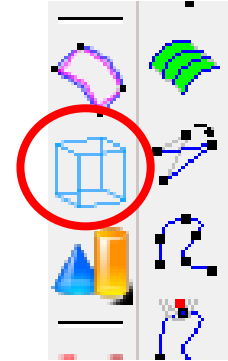
- Repeat the same steps for the outer boundary. Set the *z-coordinate to 600*
- *The result looks like this:*



- Clearly there are still two surfaces missing
- One *on top of the structure* and one *on top of the boundary*
- Creating them you will get this geometry:



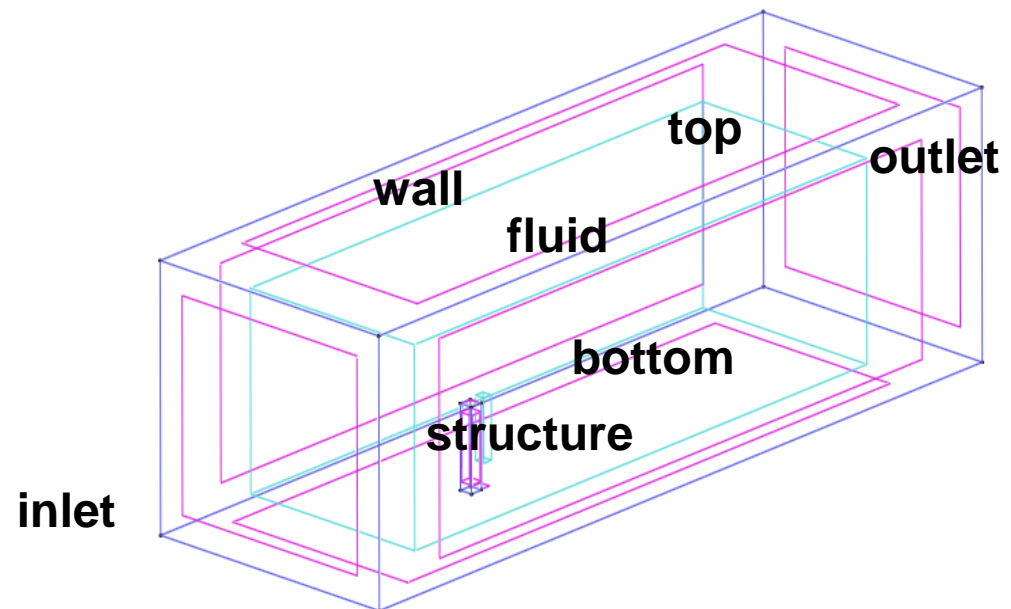
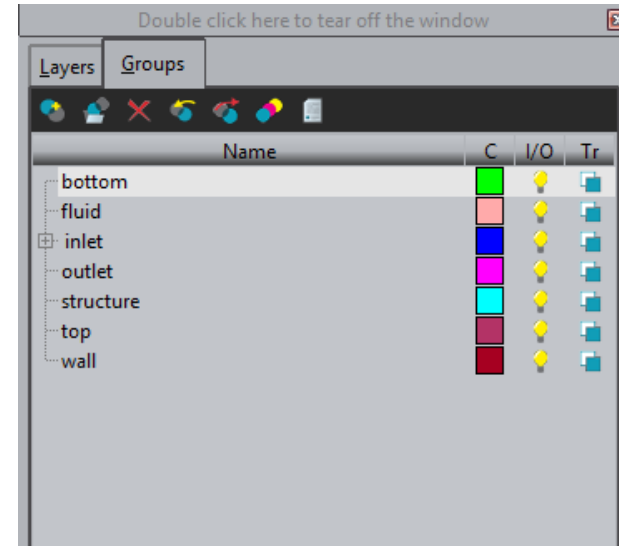
- The final step is to define the volume
Geometry → Create → Volume → By contour
- Select all surfaces and press *Esc*
 - You can select all surfaces by drawing a box around the entire model



Problem Input

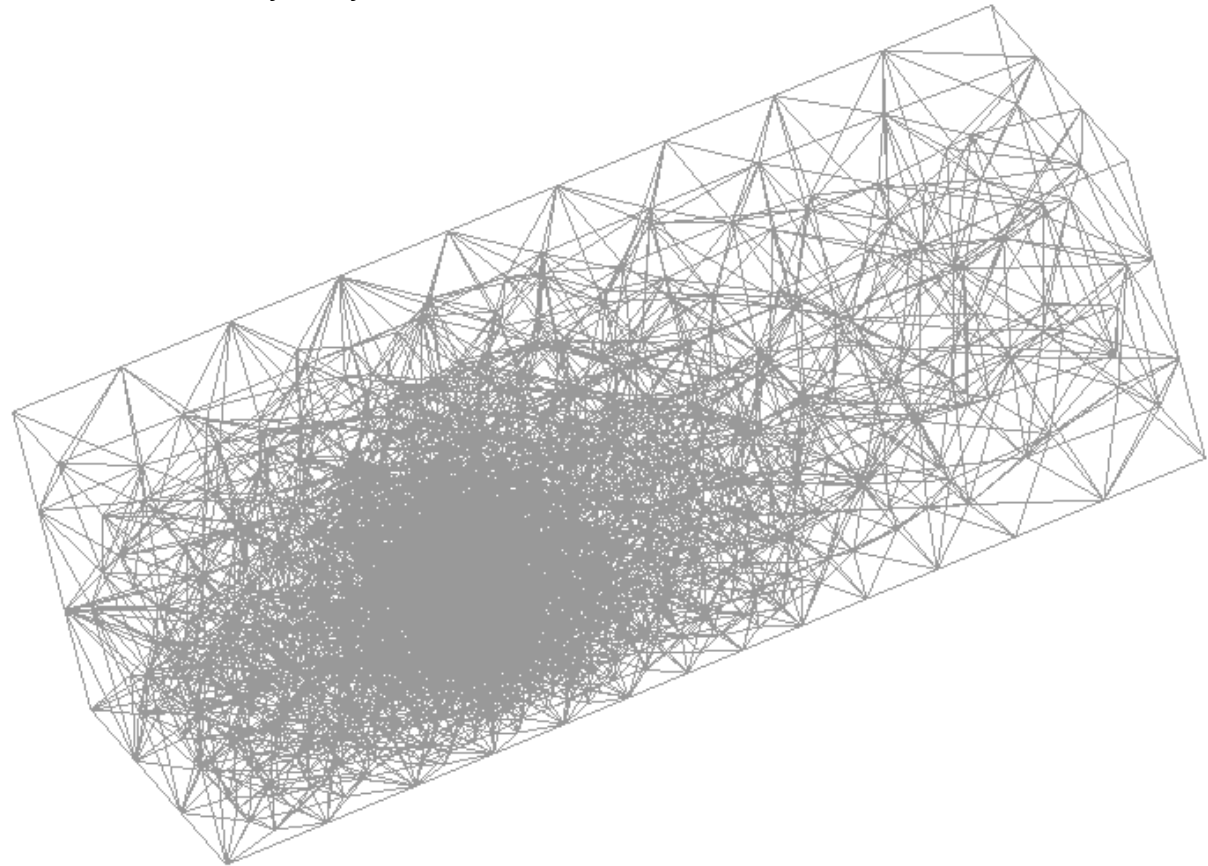
Define the entity groups

- *bottom* group
 - Select surface
- *fluid* group
 - Select volume
- *inlet* group
 - Select surface
- *outlet* group
 - Select surface
- *structure* group
 - Select surfaces of the structure
- *wall* group
 - Select surface on the sides
- *top* group
 - Select surface on the top



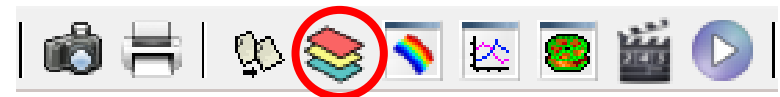
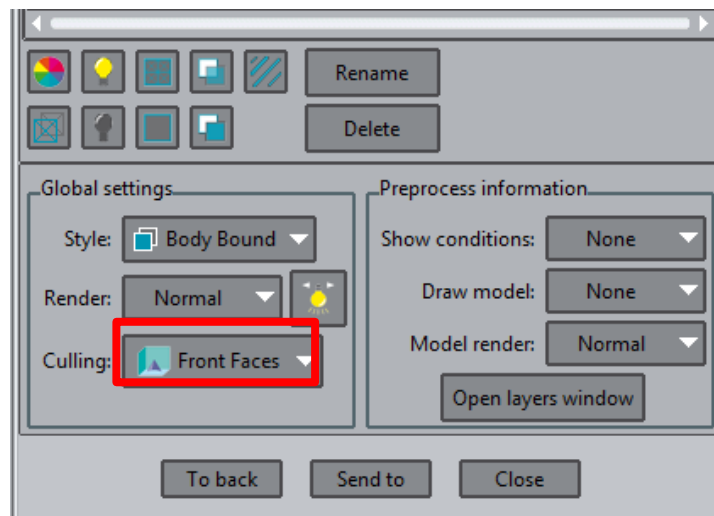
- Set *End time of the analysis to 100* and *Delta time to 0.1*
- Set the same *fluid properties* and *elements* as in the first tutorial
- Assign the following *boundary conditions*:
 - inlet: Inlet velocity ($X = 25.0$)
 - outlet: Outlet pressure
 - wall: Is-slip
 - top: Is-slip
 - structure: No-slip
 - bottom: No-slip

- Assign *size = 10 to the five surfaces of the structure* and set the *element size to 200*
- The generated mesh should have ~ *3440 nodes* and ~ *19500 elements*
- Please keep in mind that this mesh is very very coarse!

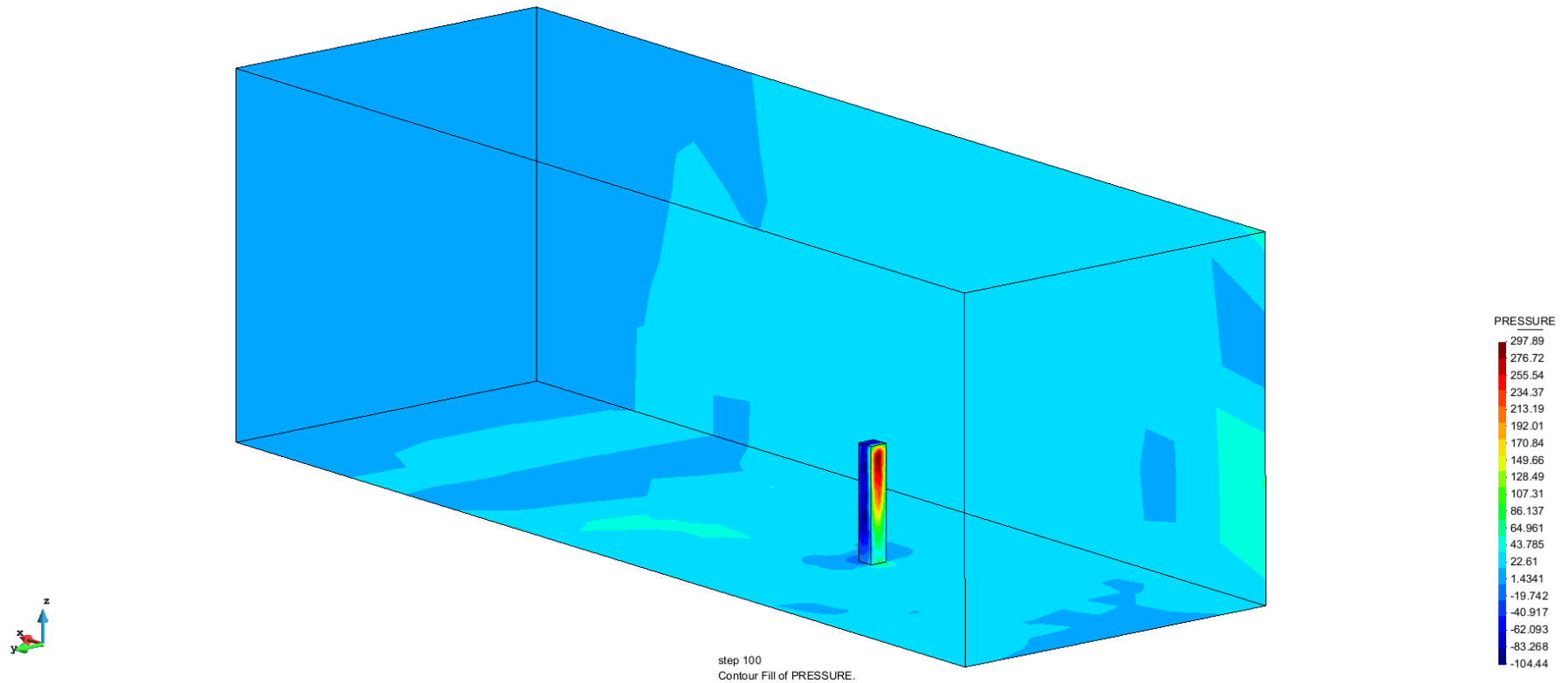


Postprocessing

- 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**

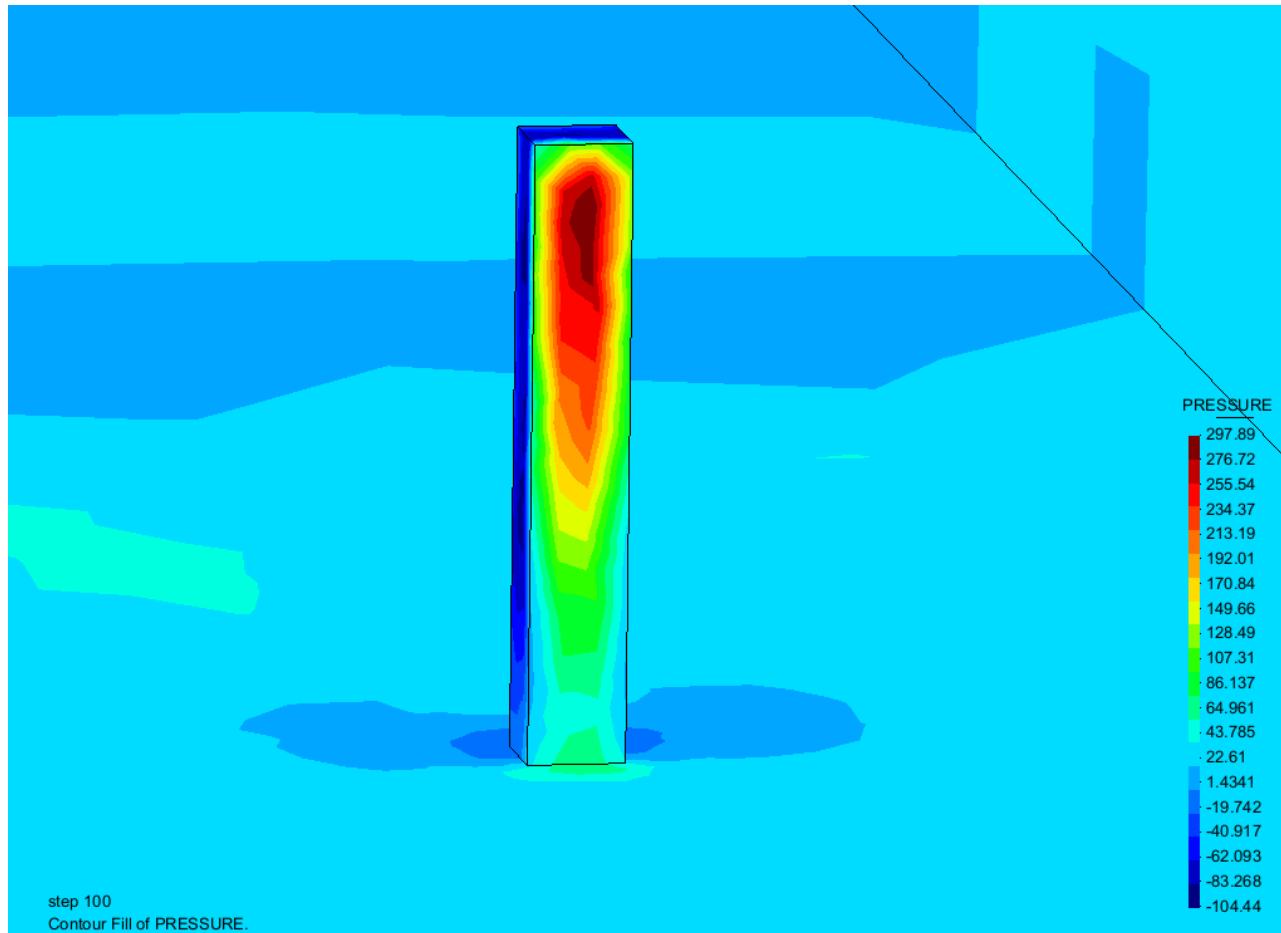


- Results for *pressure* in the last timestep:



Post processing

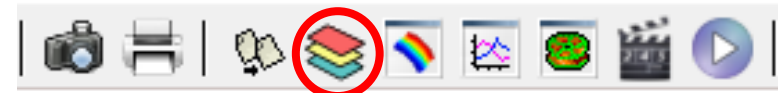
- Close-Up of the structure:



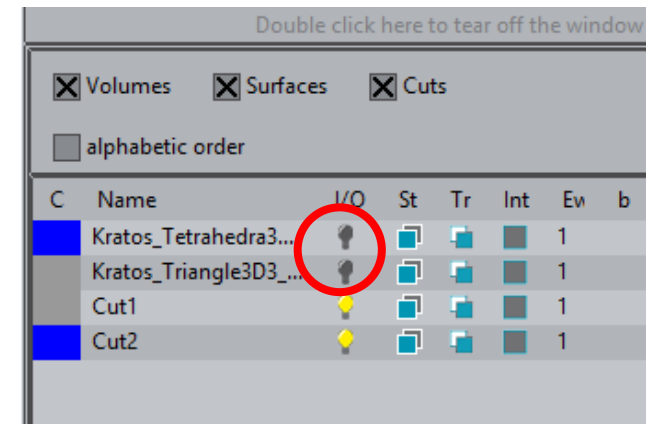
Using cuts

- **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):

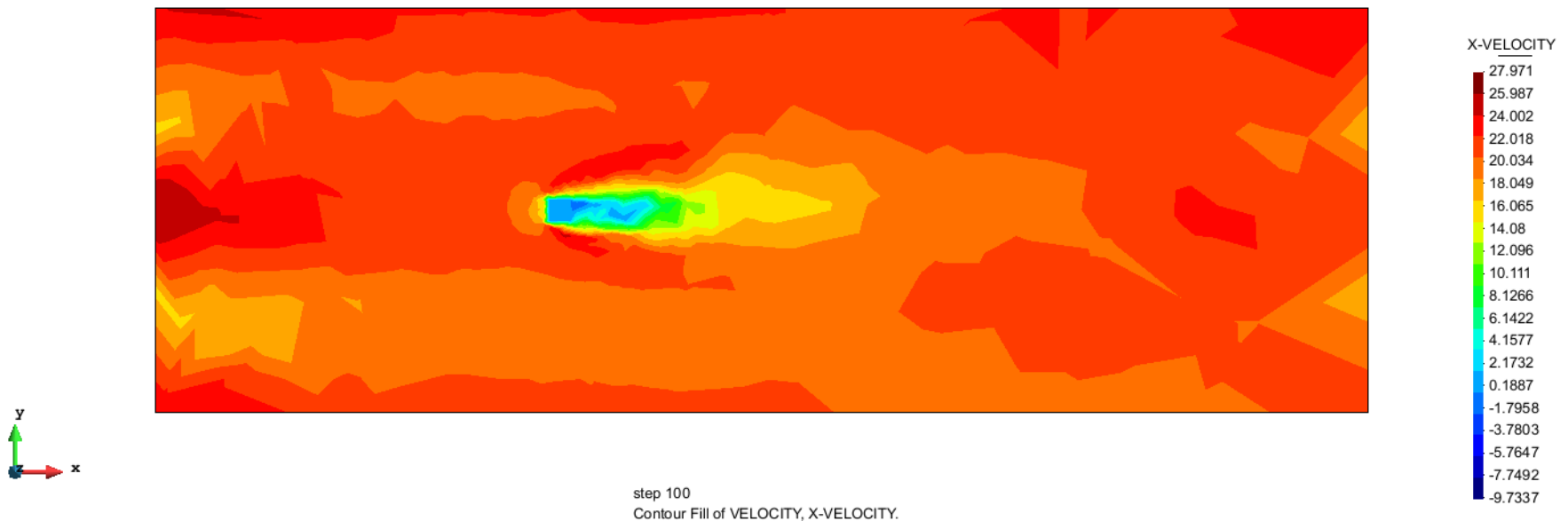
Cut plane		
X	Y	Z
0.0	0.0	190.0
1.0	0.0	190.0
1.0	1.0	190.0



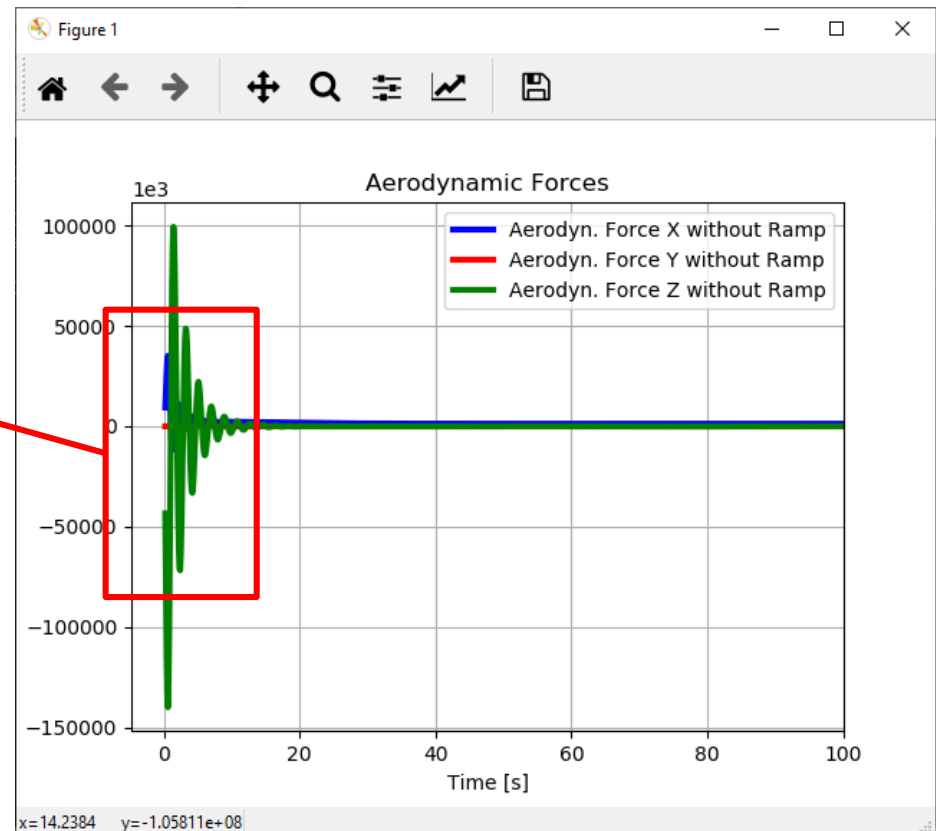
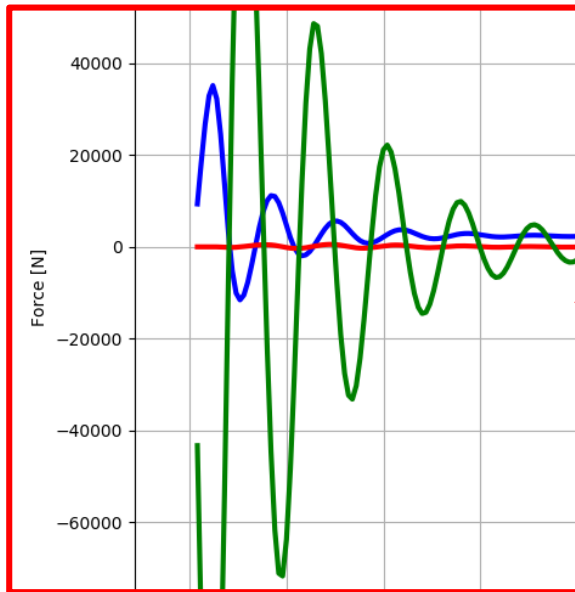
- To **view** just the cut:
 - Click on **View Style** option
 - Turn off the light bulbs next to the Kratos entries
 - Set Culling: No, to show results on cut



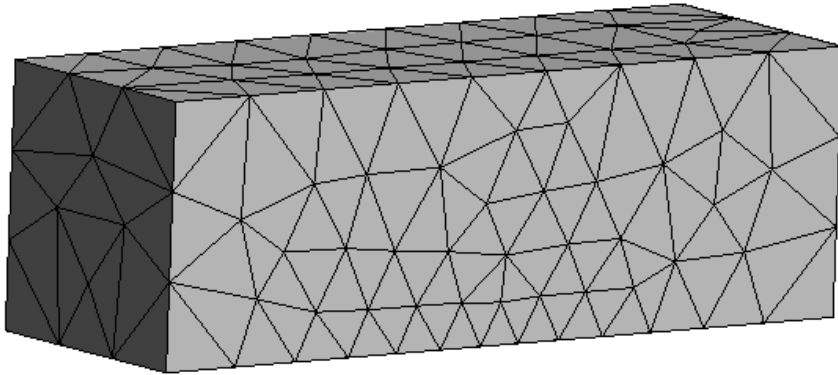
- Visualize the time evolution of the velocity using *Ctrl + m*
- The figure shows results for the *velocity in X direction* in the last timestep:



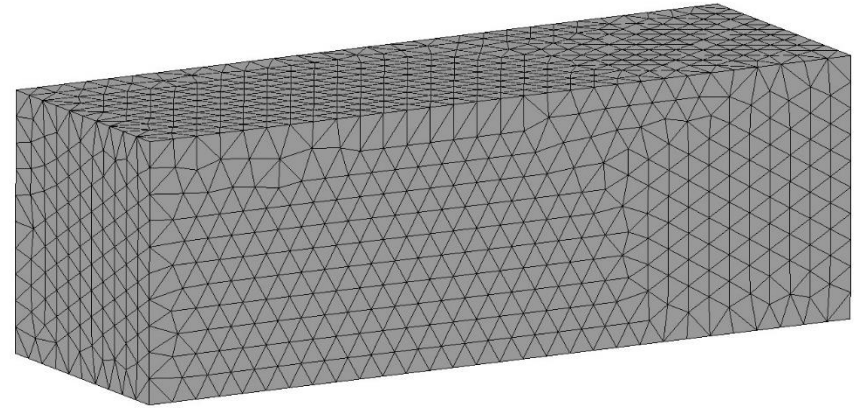
- Copy “[plot_aerodynamic_force_results.py](#)” into your GID project folder and run the python file
- The results should look like this:



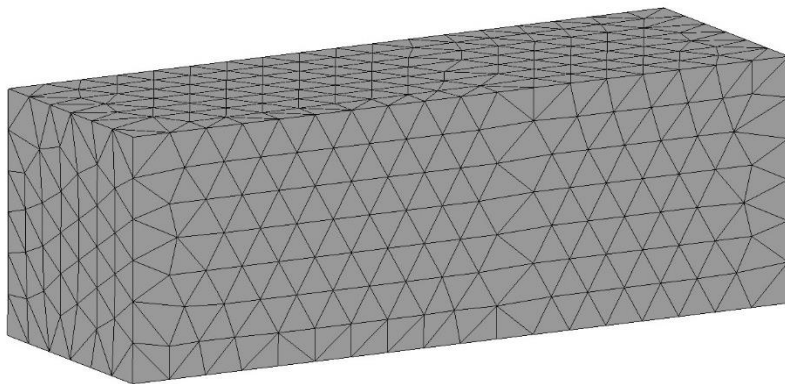
Very coarse



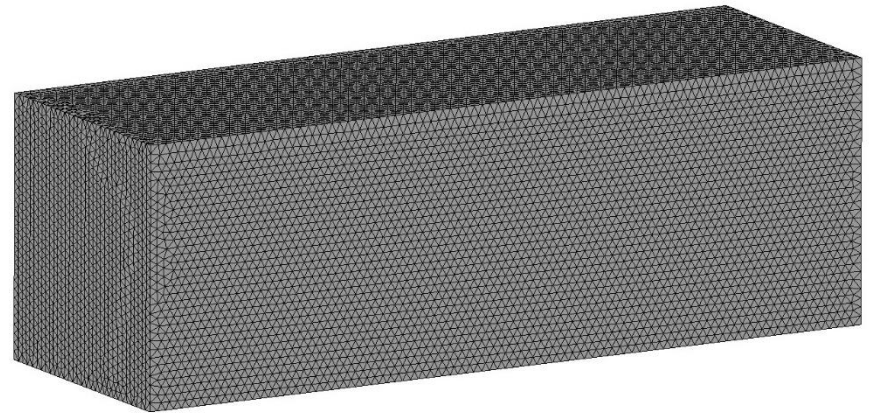
Medium



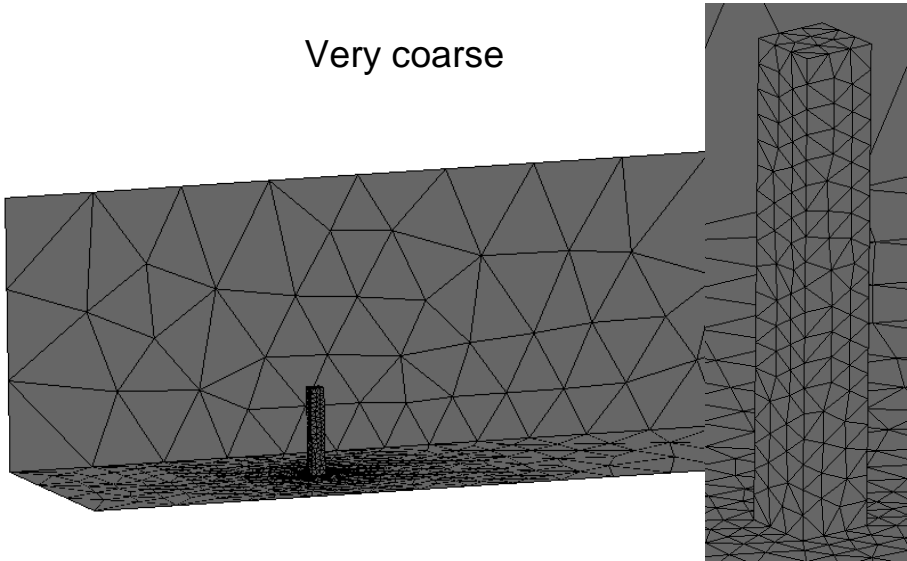
Coarse



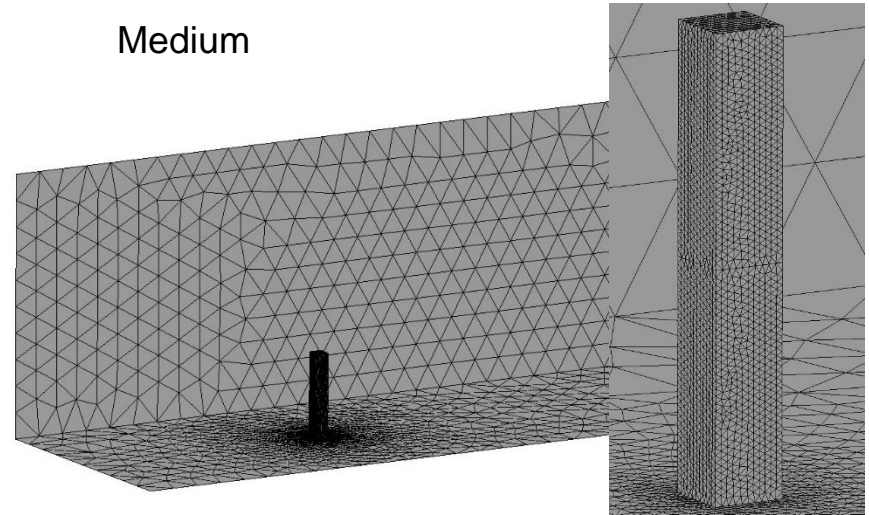
Fine



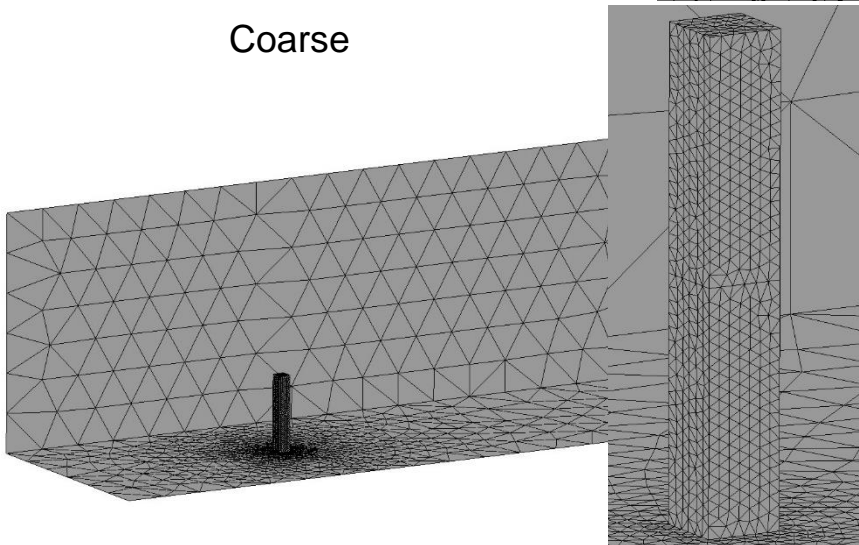
Very coarse



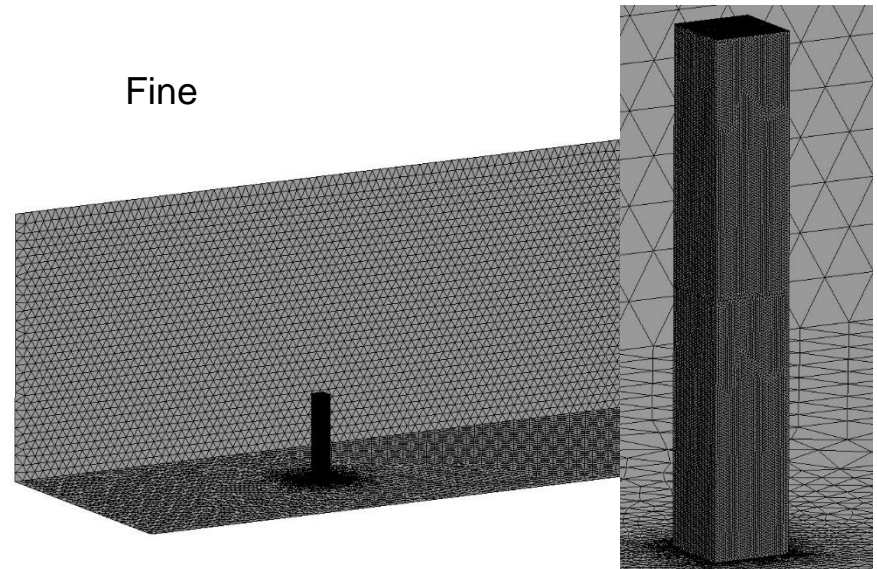
Medium



Coarse

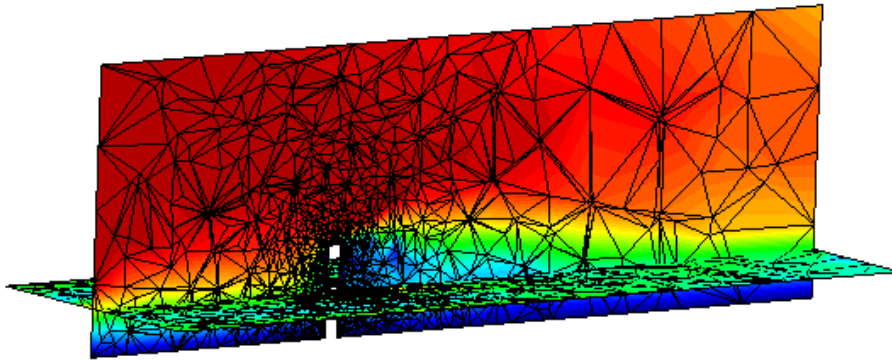


Fine

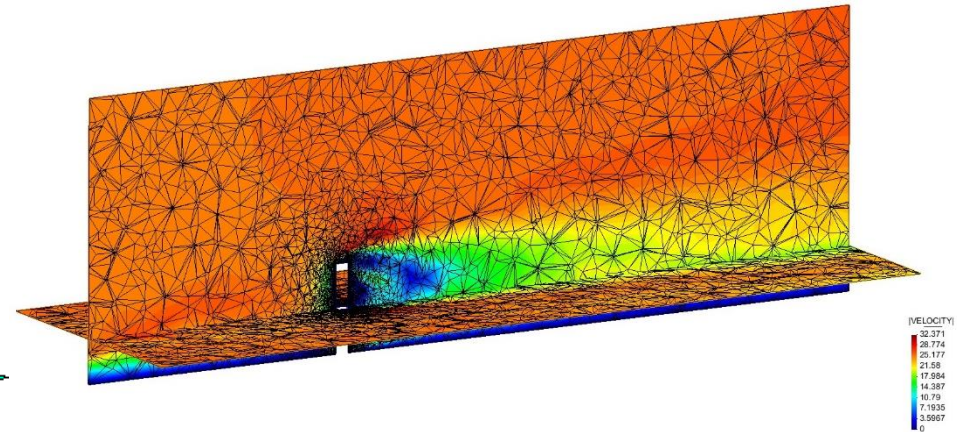


Result visualization – velocity magnitude

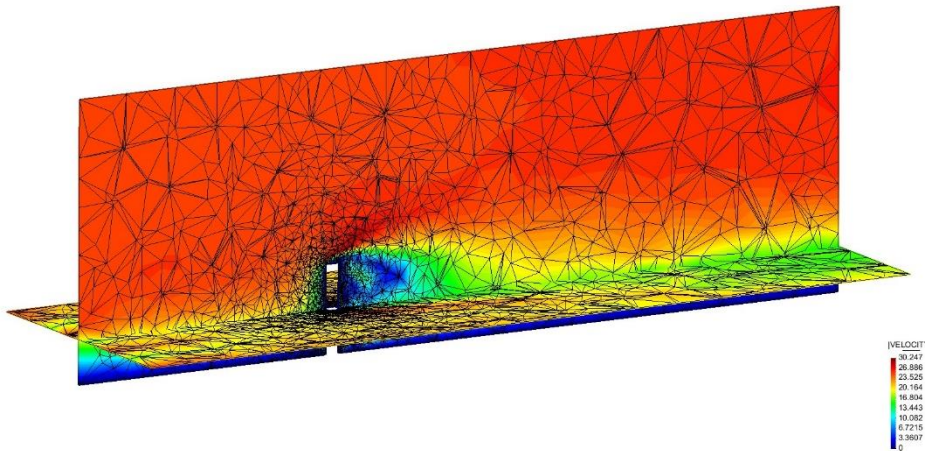
Very coarse



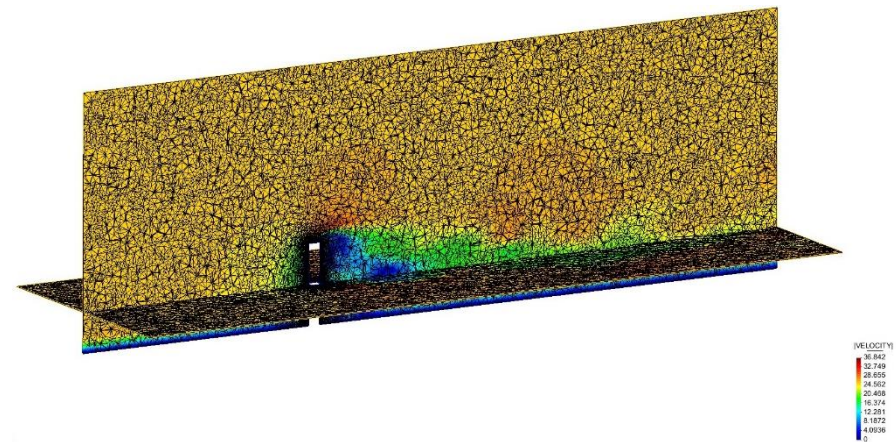
Medium



Coarse



Fine



Refinement plot

