

Master thesis presentation

Blade bulbous-bow concept application research using commercial CFD software

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Marine Engineer



- Previous education: Saint-Petersburg State Marine Technical University (SMTU)
- Field of interest: Seakeeping; Hull Optimization; Ship Theory; Safe Operation of a ship, marine technologies in maritime area
- Seeking Career & objectives: Naval Designer, Project Engineer, Research Engineer in hull form and ship structure optimization study branches.

Example 1. Benetti's F-125



<http://www.charterworld.com/news/f125-yacht-hull-arrives-benetti-yard-italys-viareggio>

F-125



F-125



Length on waterline –
31.0 meters

Maximum beam –
8.23 meters

Half load draught –
2.01 meters

High-speed range –
17.5-22 knots

<https://www.pressreader.com/italy/superyacht/20170109/282428463876372>

F-125. Now how it looks on a serial ship:



<https://sandpeoplecommunication.wordpress.com/2013/12/16/benetti-news-from-the-yard-november-december-2013>

Next example: ILUMEN 28M



<http://robbreport.com/motors/marine/dominators-ilumen-now-more-spacious-and-preparing-launch-231479/>

ILUMEN 28M



Length on waterline
– 28 meters

Maximum beam –
8.23 meters

Half load draught –
1.85 meters

High-speed range –
17-29 knots

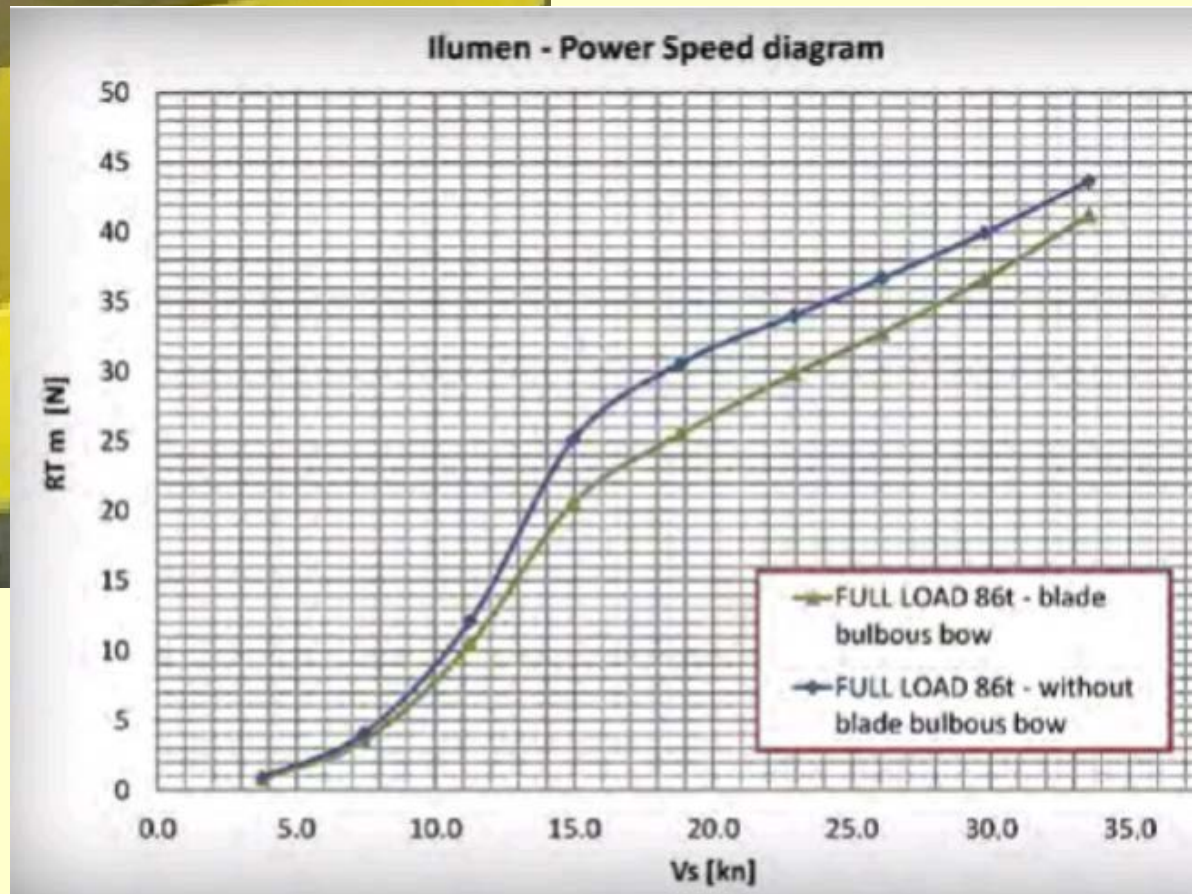
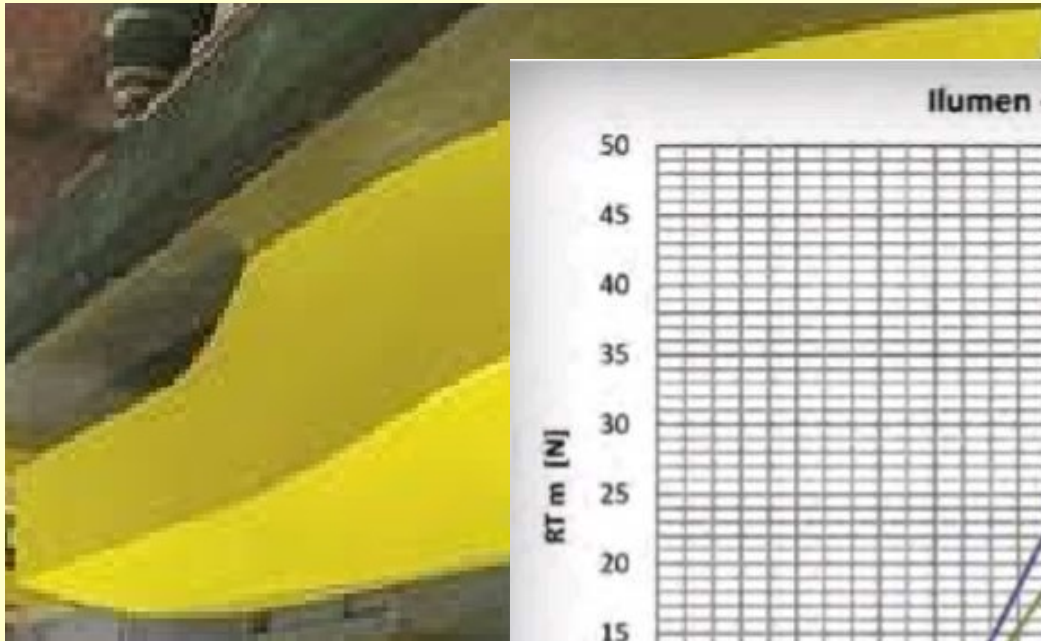
<https://www.superyachttimes.com/yacht-news/dominator-ilumen-28m-taking-shape-in-italy>

ILUMEN 28M in towing tank

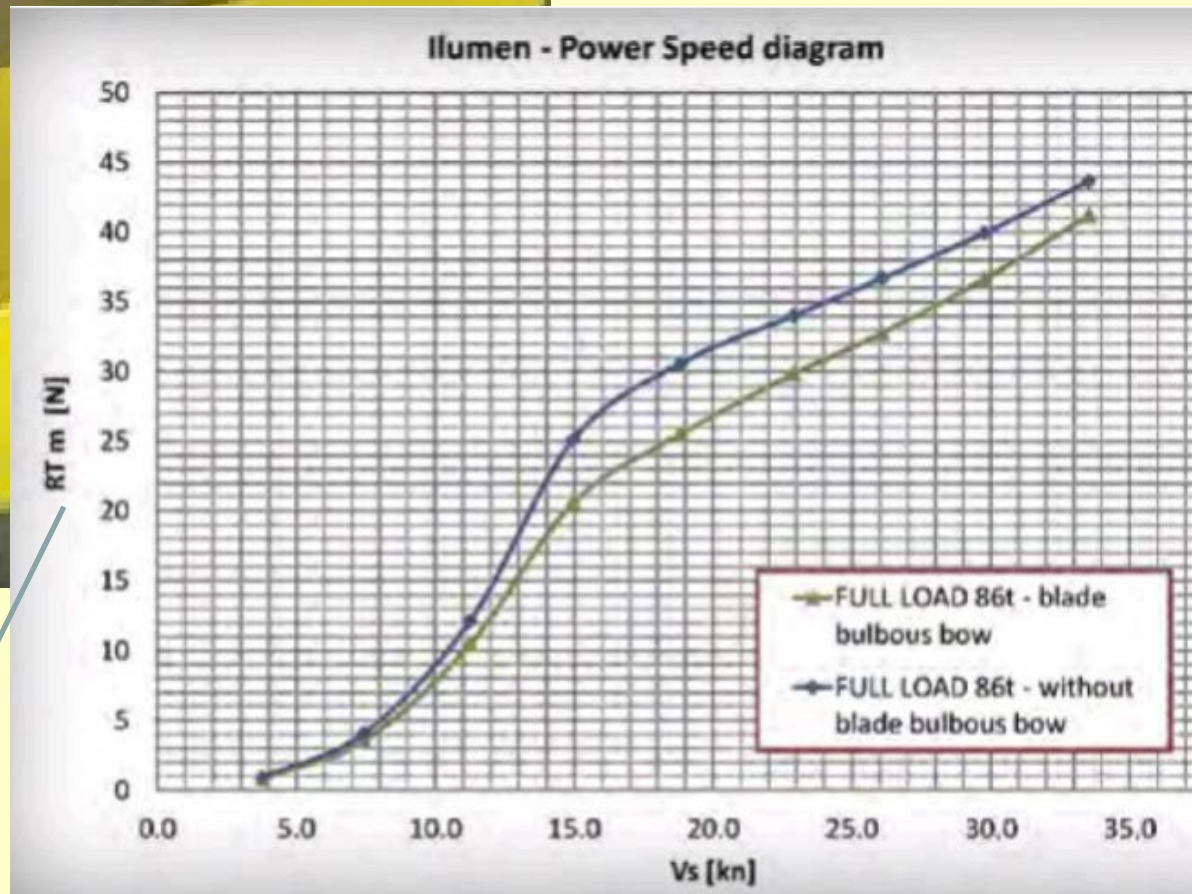
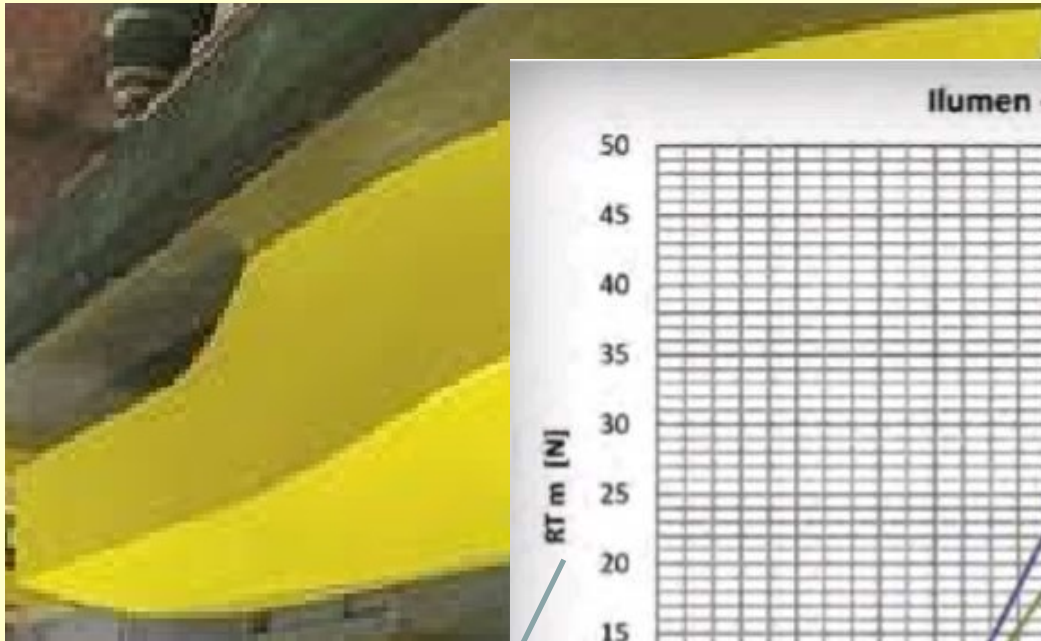


<https://www.pressreader.com/italy/superyacht/20170109/282428463876372>

ILUMEN 28M in towing tank



ILUMEN 28M in towing tank

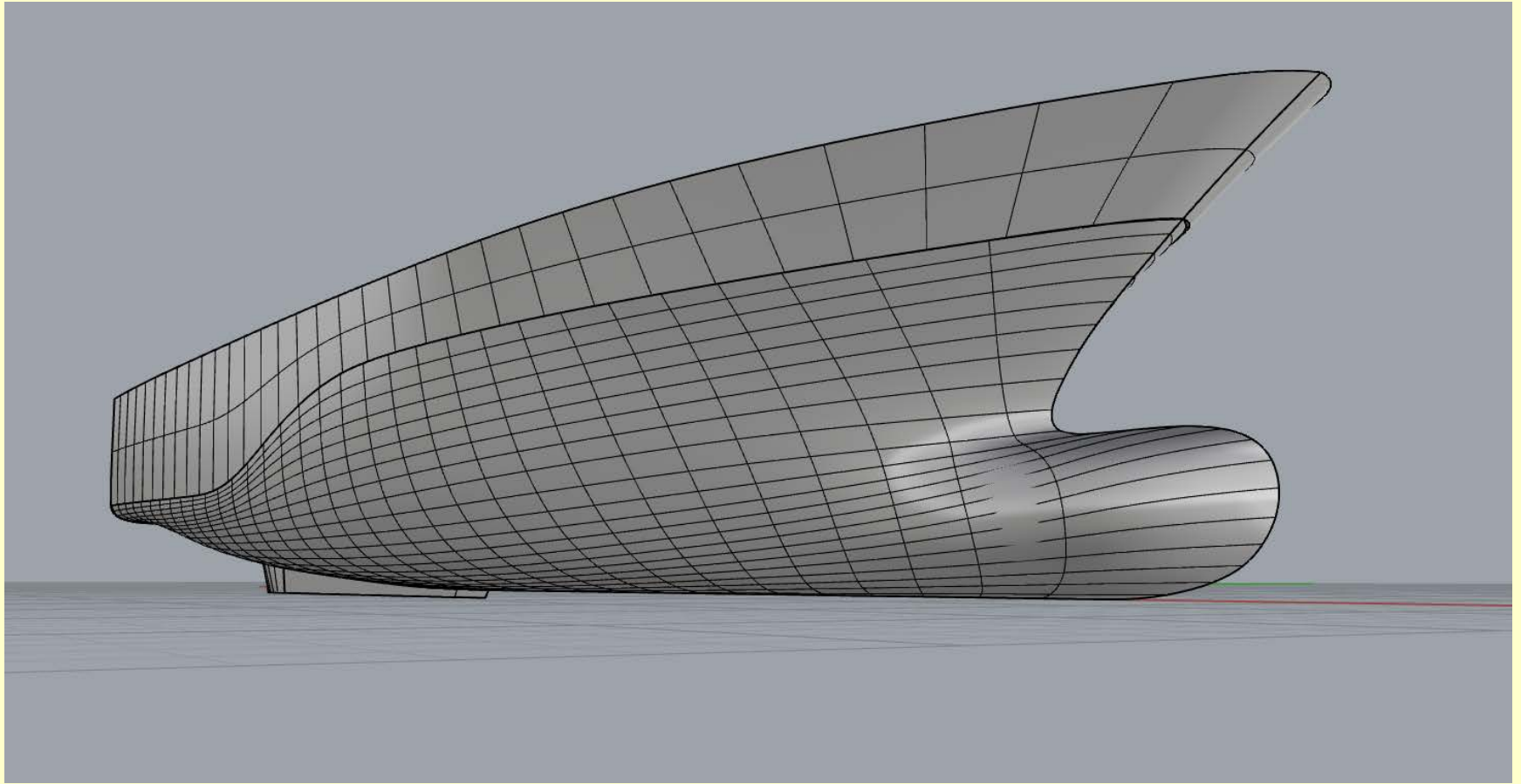


TOTAL RESISTANCE –
pay attention on this!

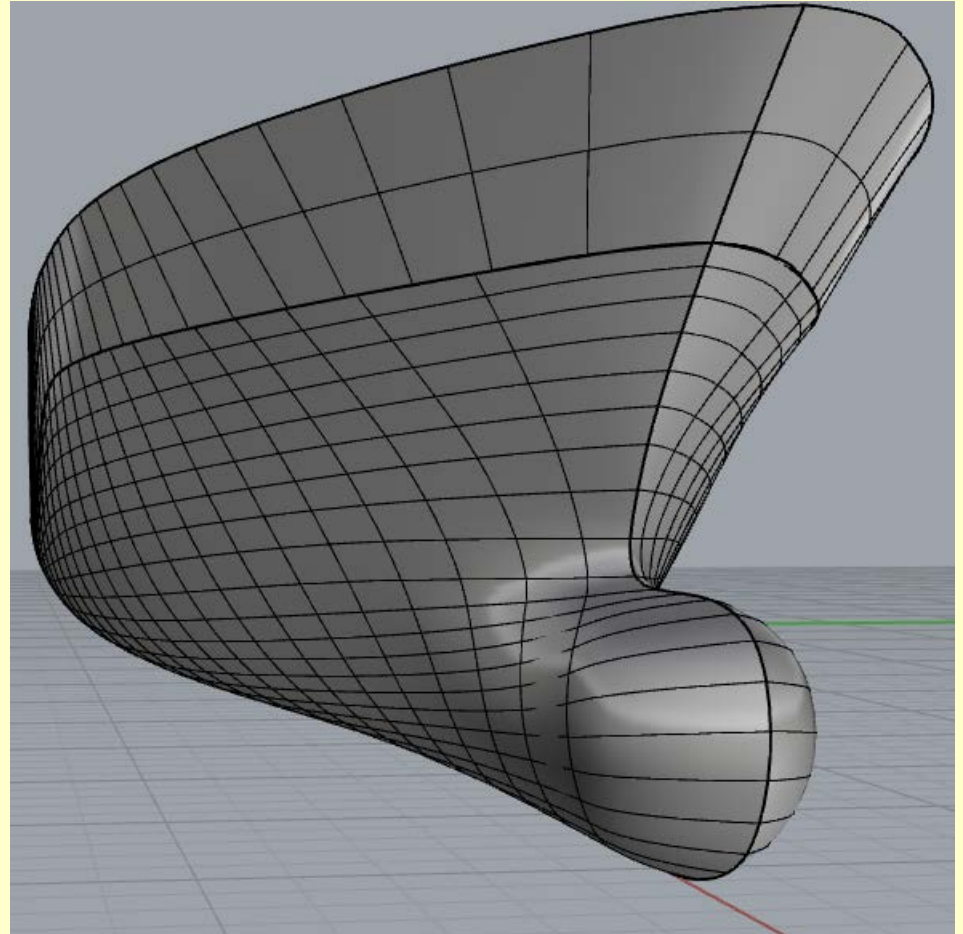
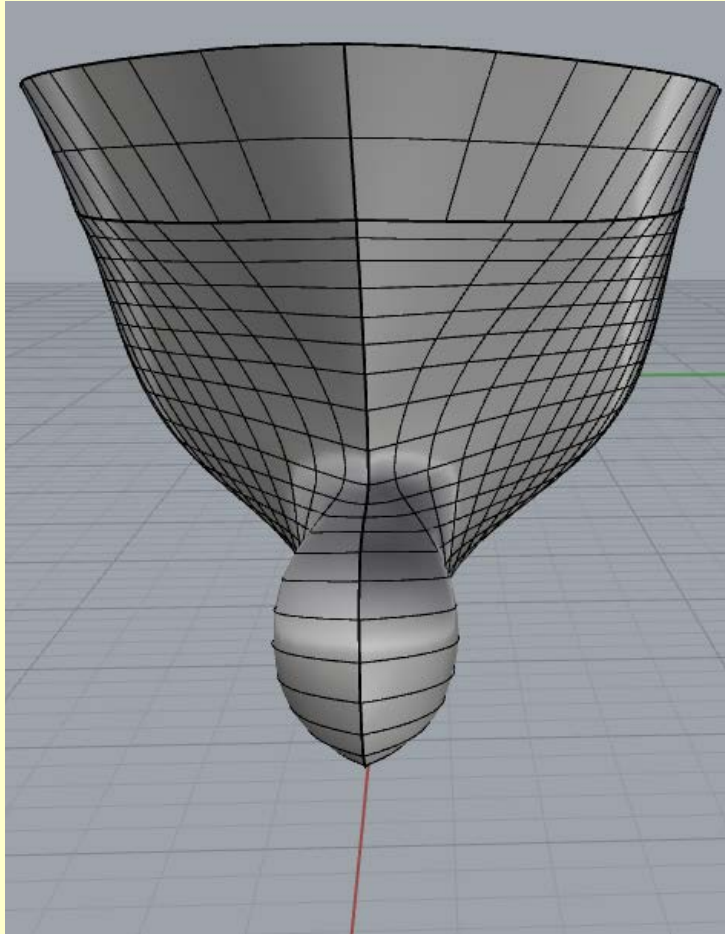
Which force
component had been
mostly reduced?

The Object of Interest

Rhinoceros software was used to build the model of the yacht



The Object of Interest



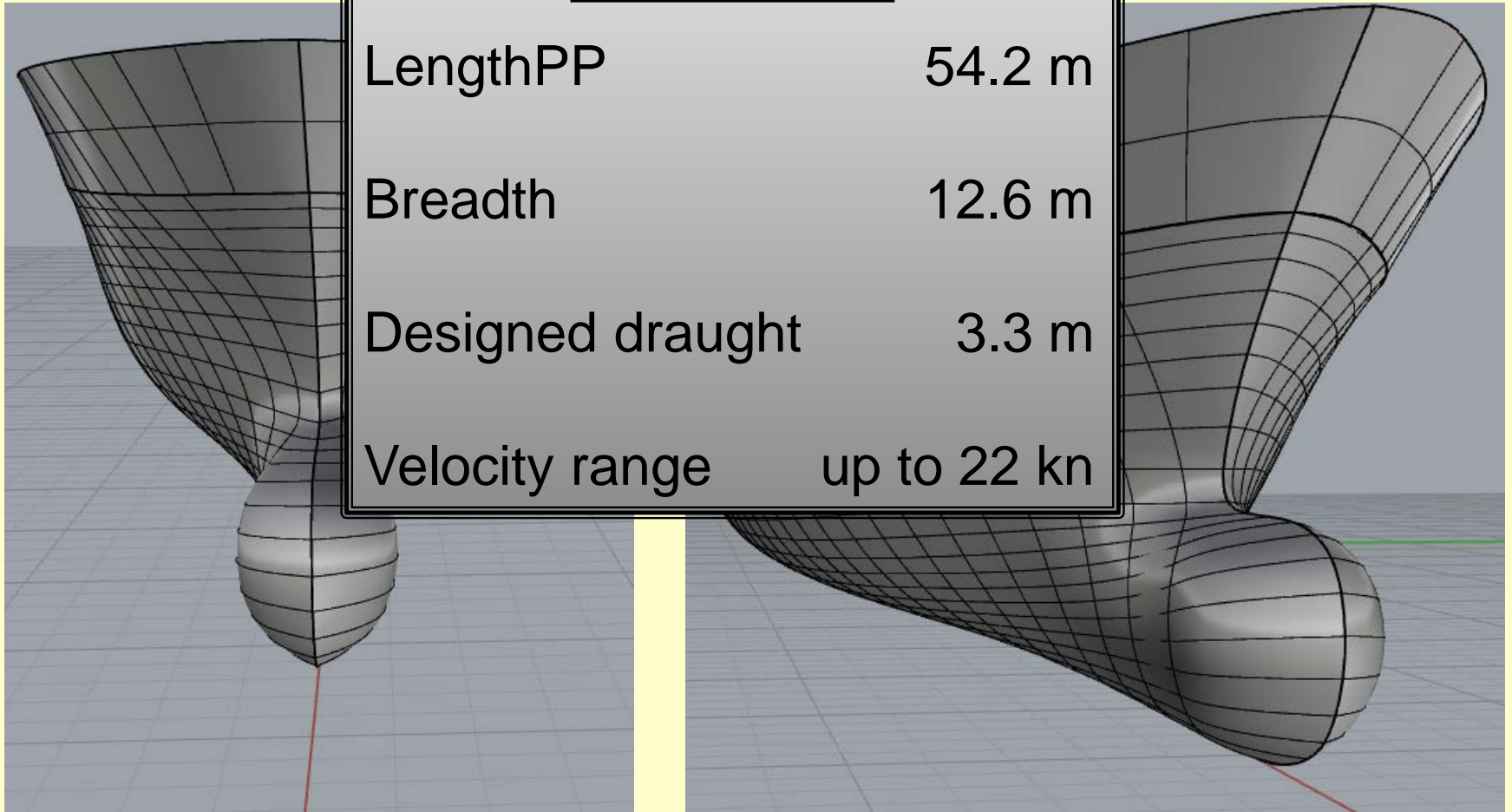
General arrangements and some technical information:

LengthPP 54.2 m

Breadth 12.6 m

Designed draught 3.3 m

Velocity range up to 22 kn

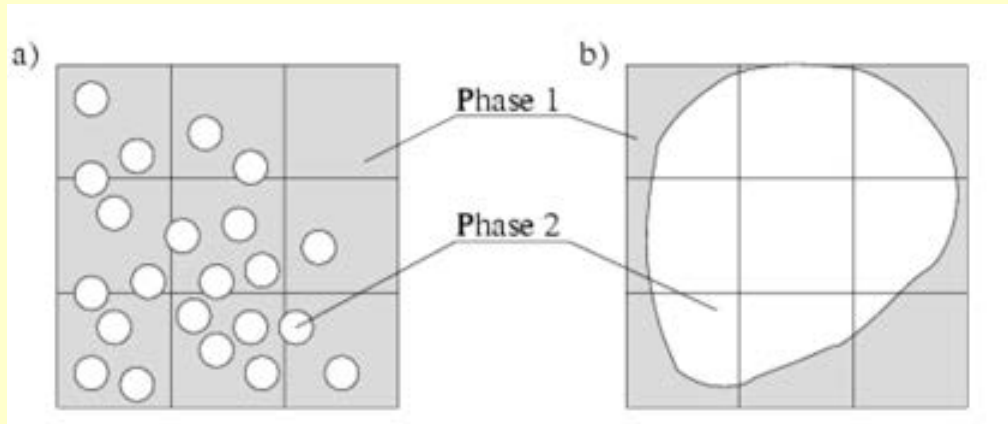


CFD

[Star-CCM+ CFD software was chosen]

- Set rules of physics
- Change a flow as ever you want
- Change a ship and an experimental domain models so many times as you need

What mesh size is better? Calculation quality vs. Time spent



The lower the cell size the more accurate the results of simulation

*Image has been taken from the Star-CCM+ 11 ver. manual

HOWEVER: the lower the cell size, the longer the time spent to compute a problem. Where is the golden middle???

Mesh convergence study

- Let's define some geometrical parameter to use it as a relative value:

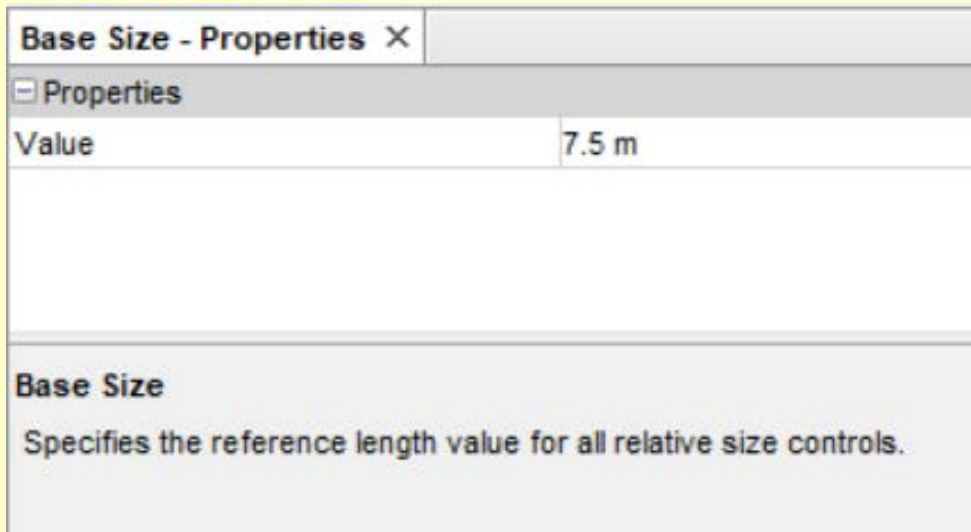
In Star-CCM+ it is a “Base size” argument

- What is it?

It's a value, percentage of which may characterize an elemental size (**length**) of a computing cell

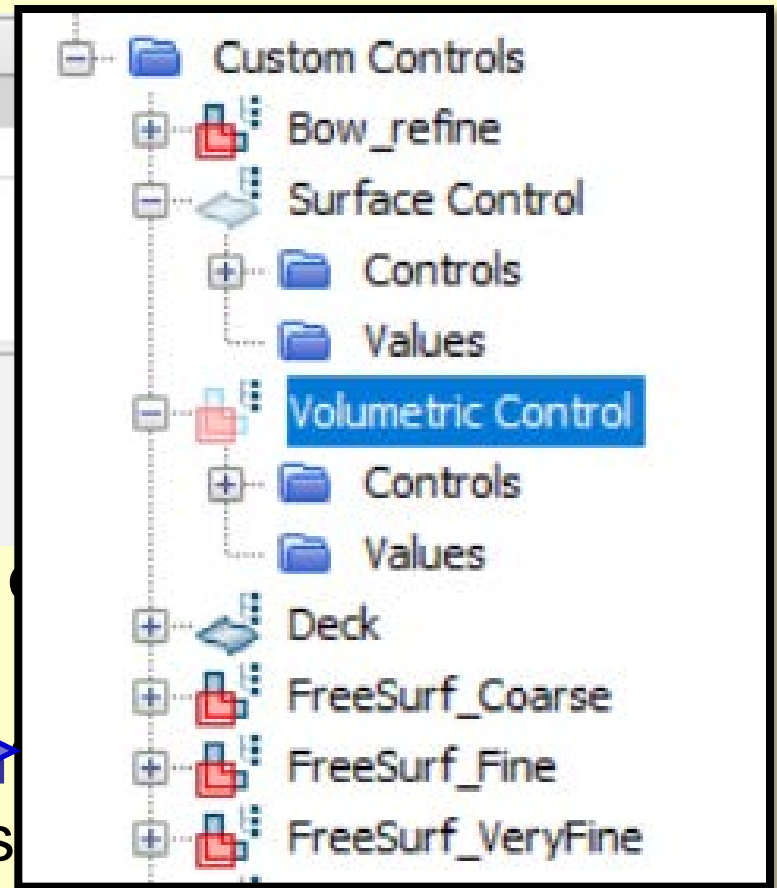
- How long should be this **length**? => any easy to operate with setting different cells sizes

Mesh convergence study

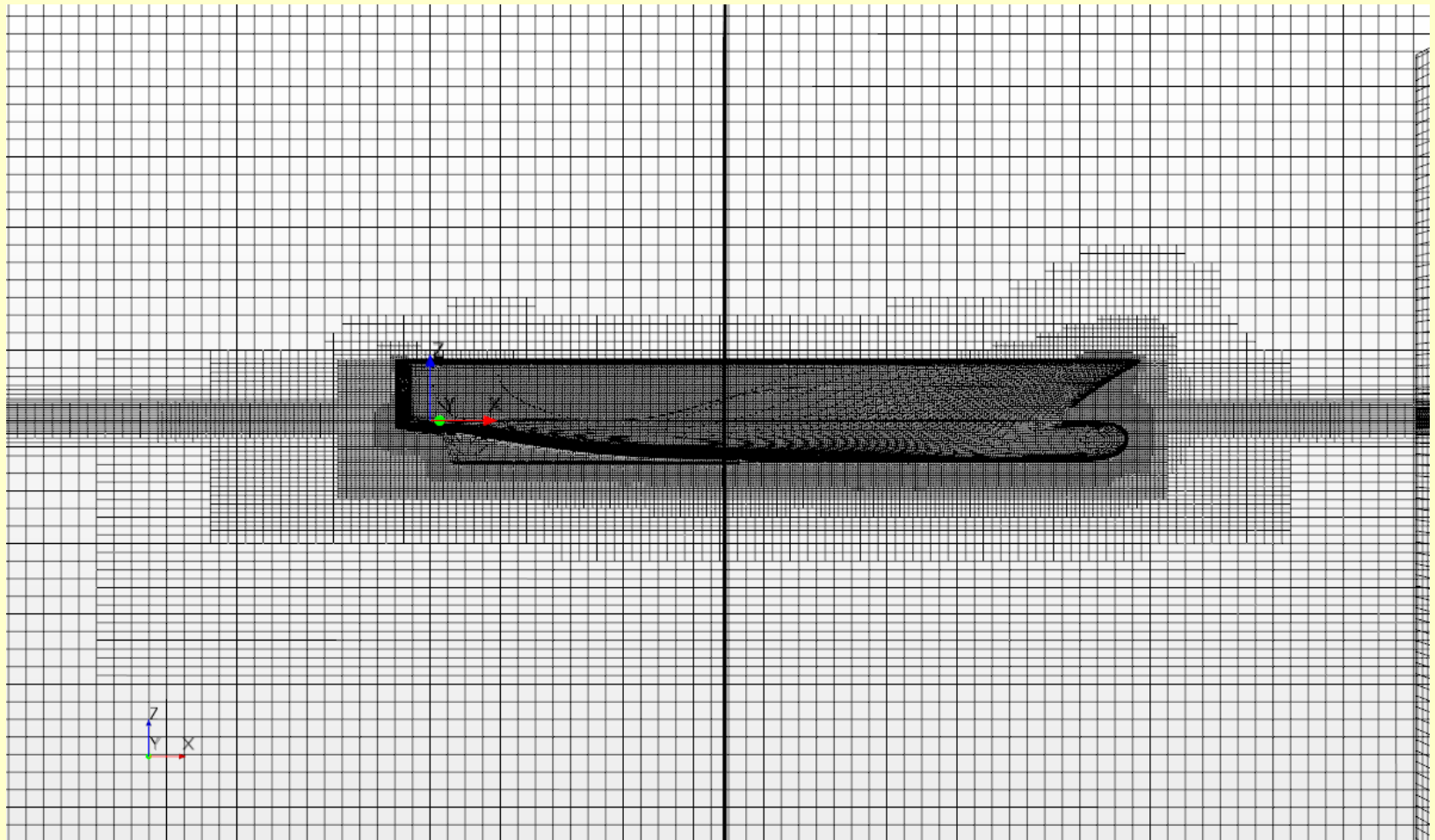


an elemental size (length)

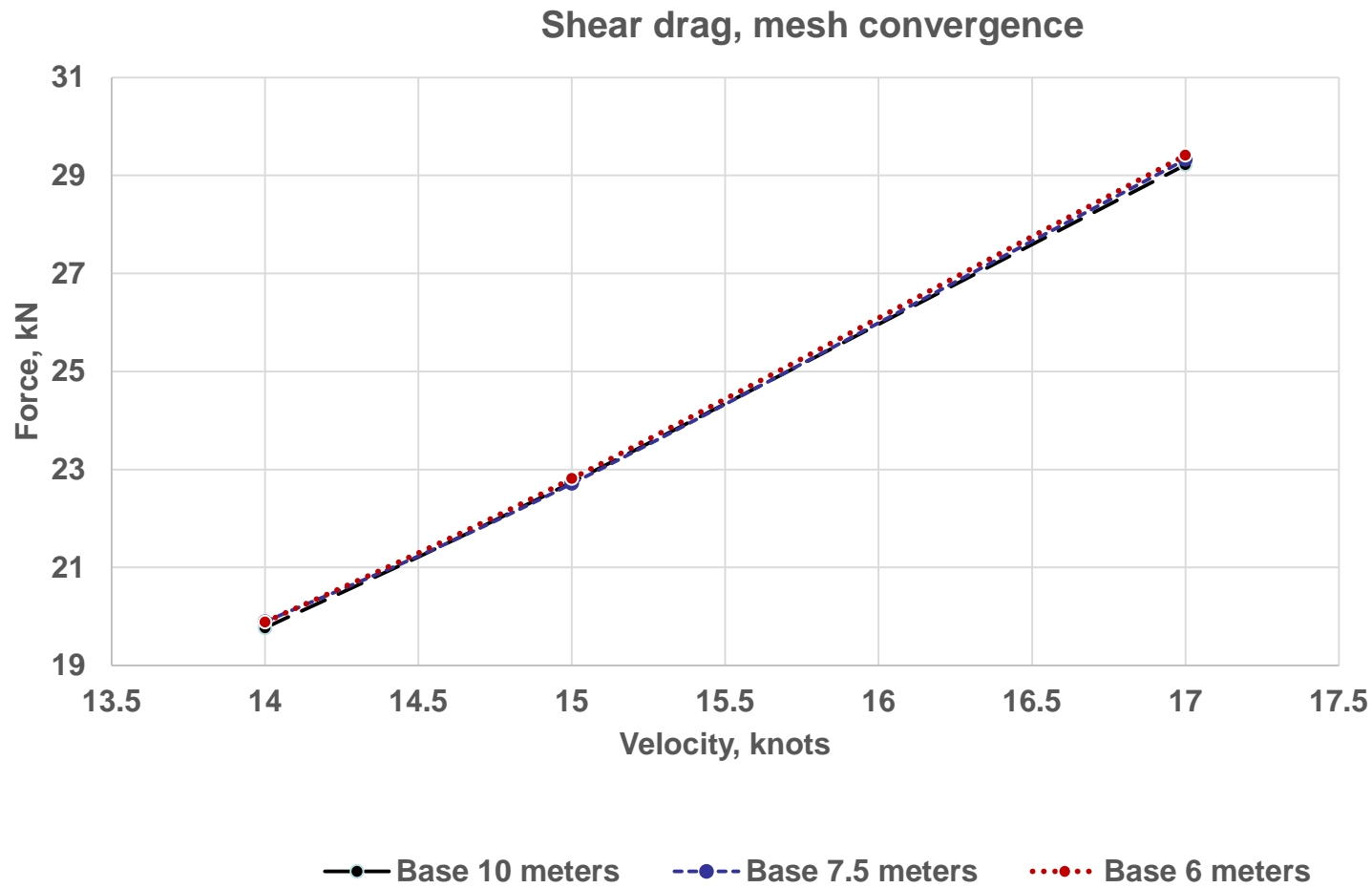
- How long should the mesh be with setting different cells sizes



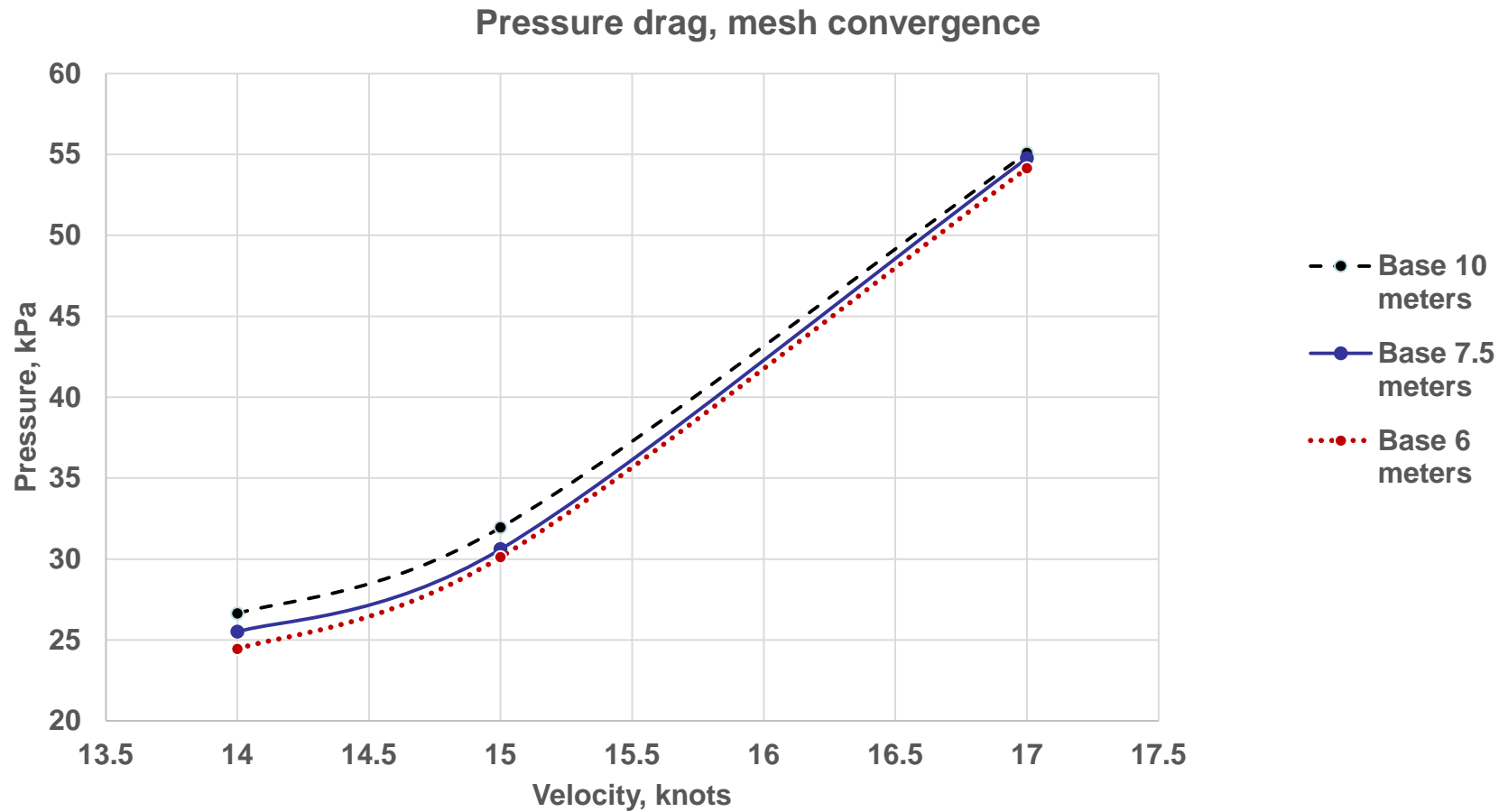
Mesh convergence study



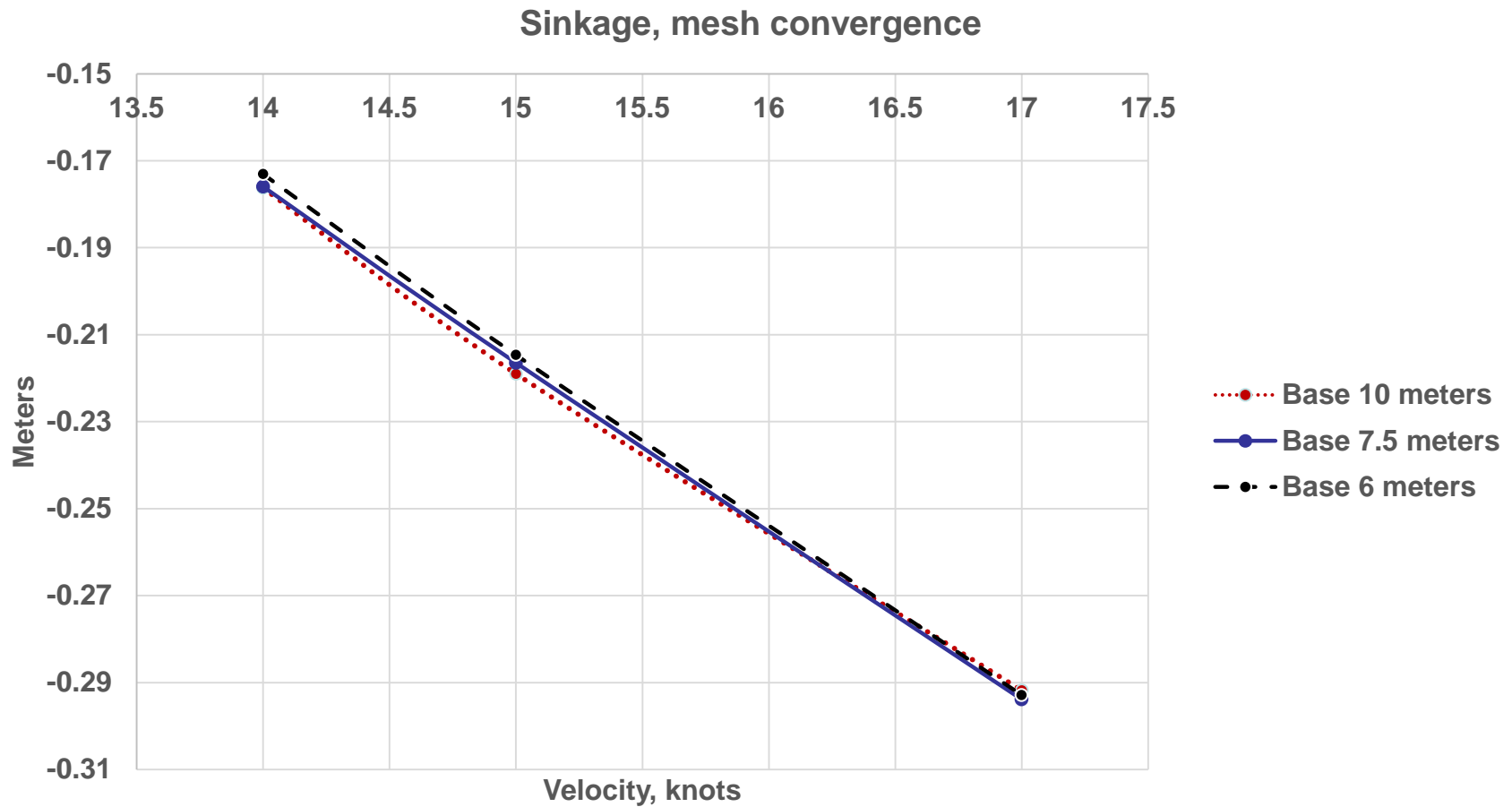
Mesh convergence study



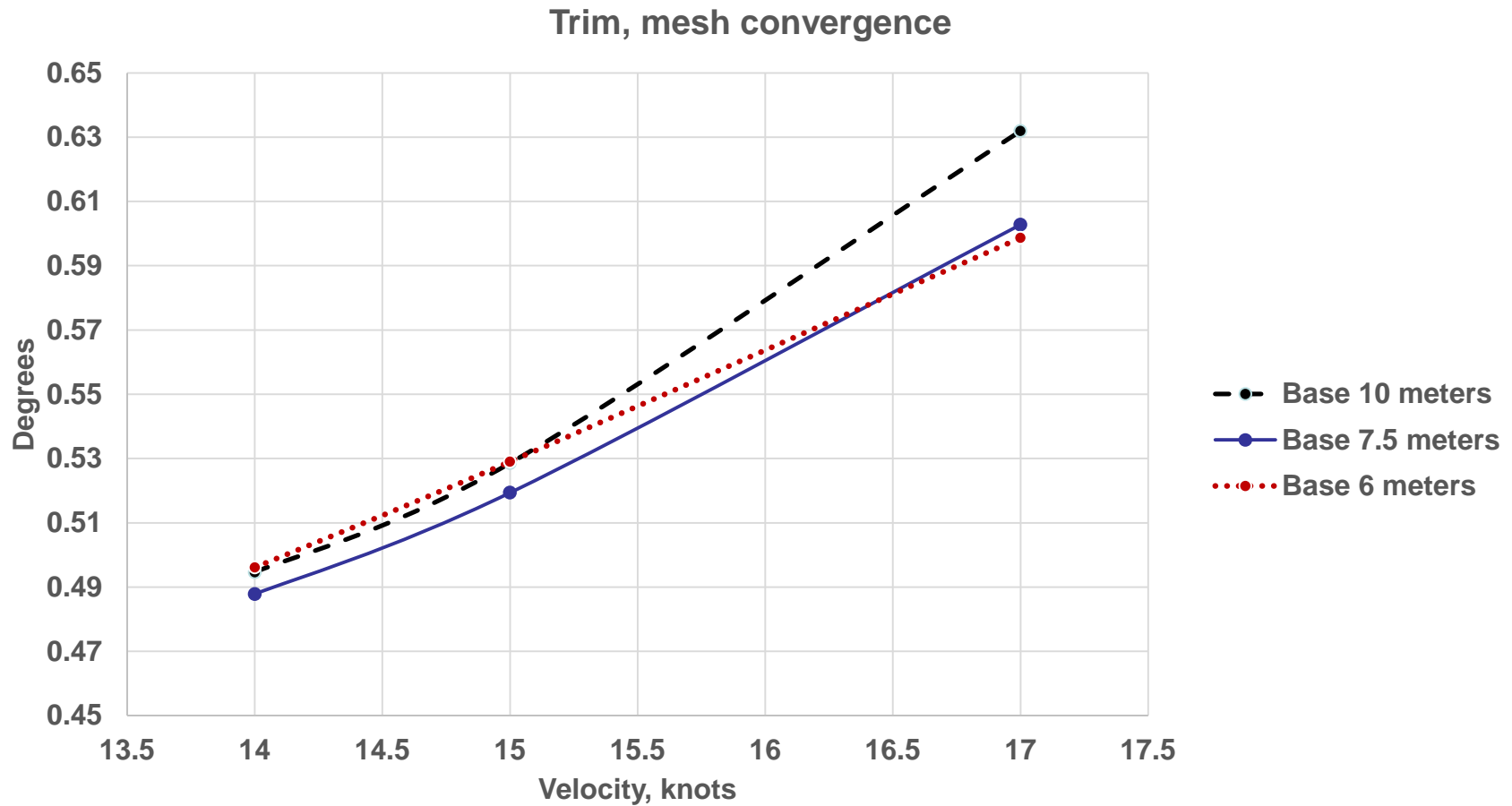
Mesh convergence study



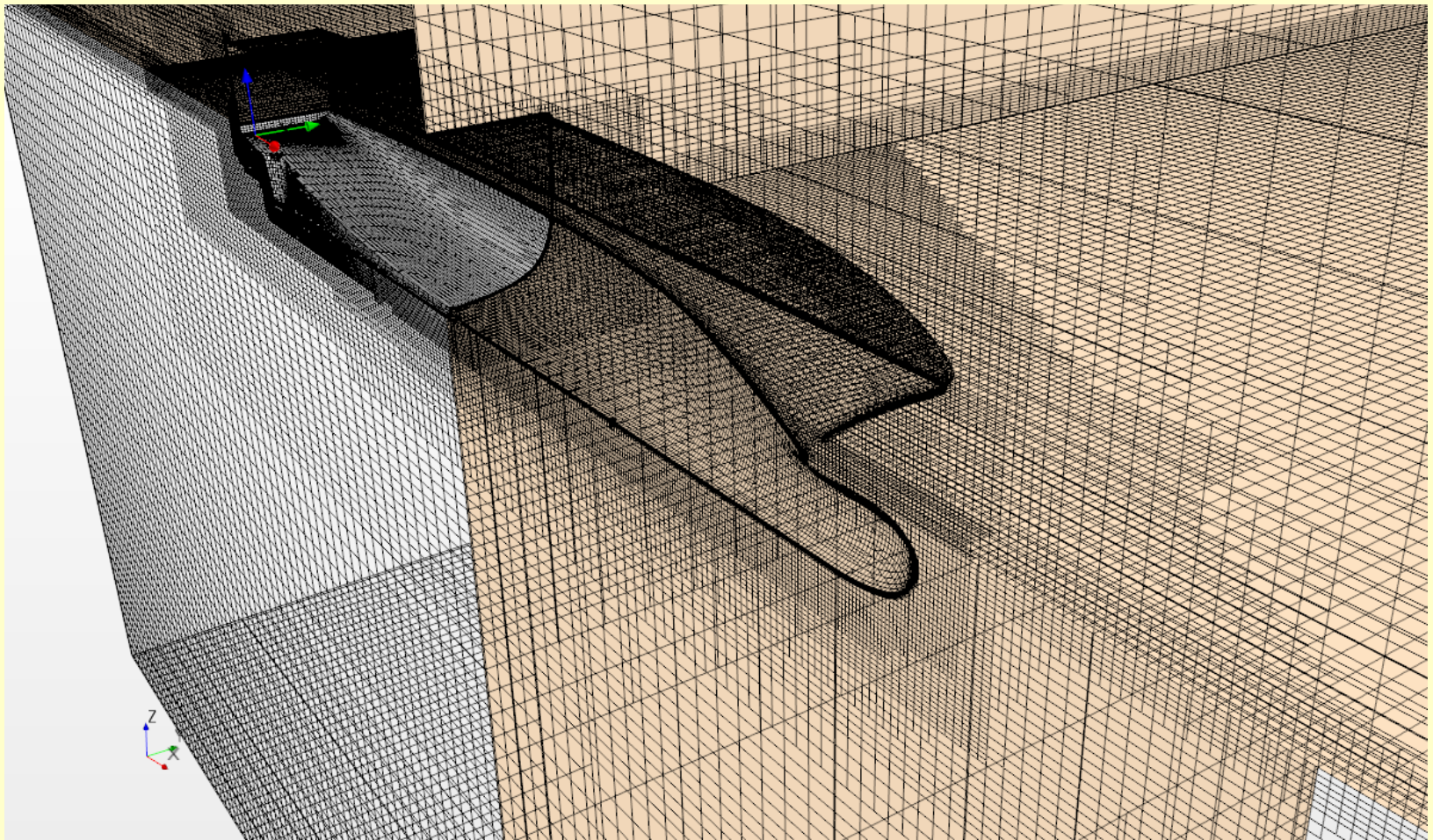
Mesh convergence study



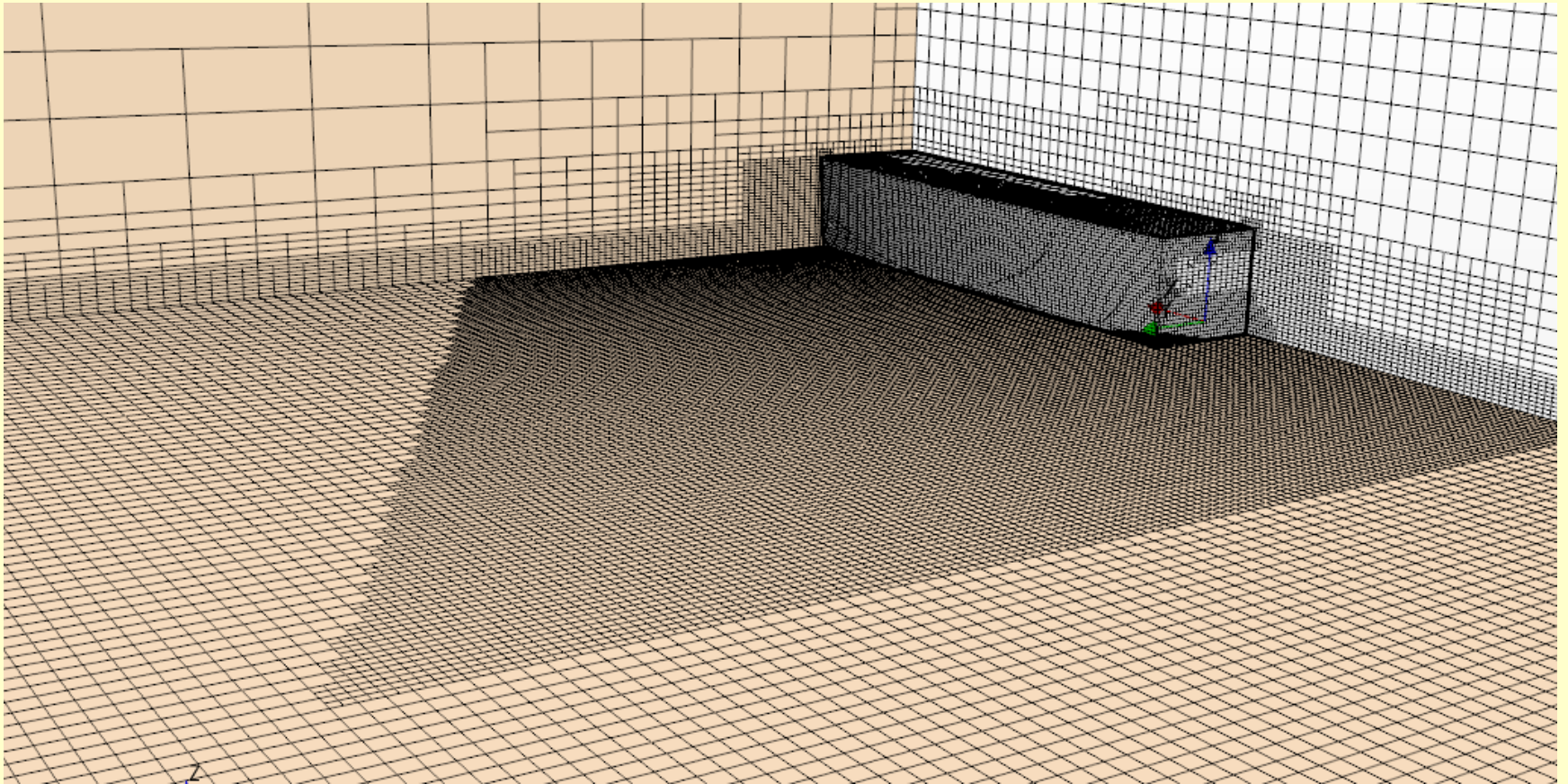
Mesh convergence study



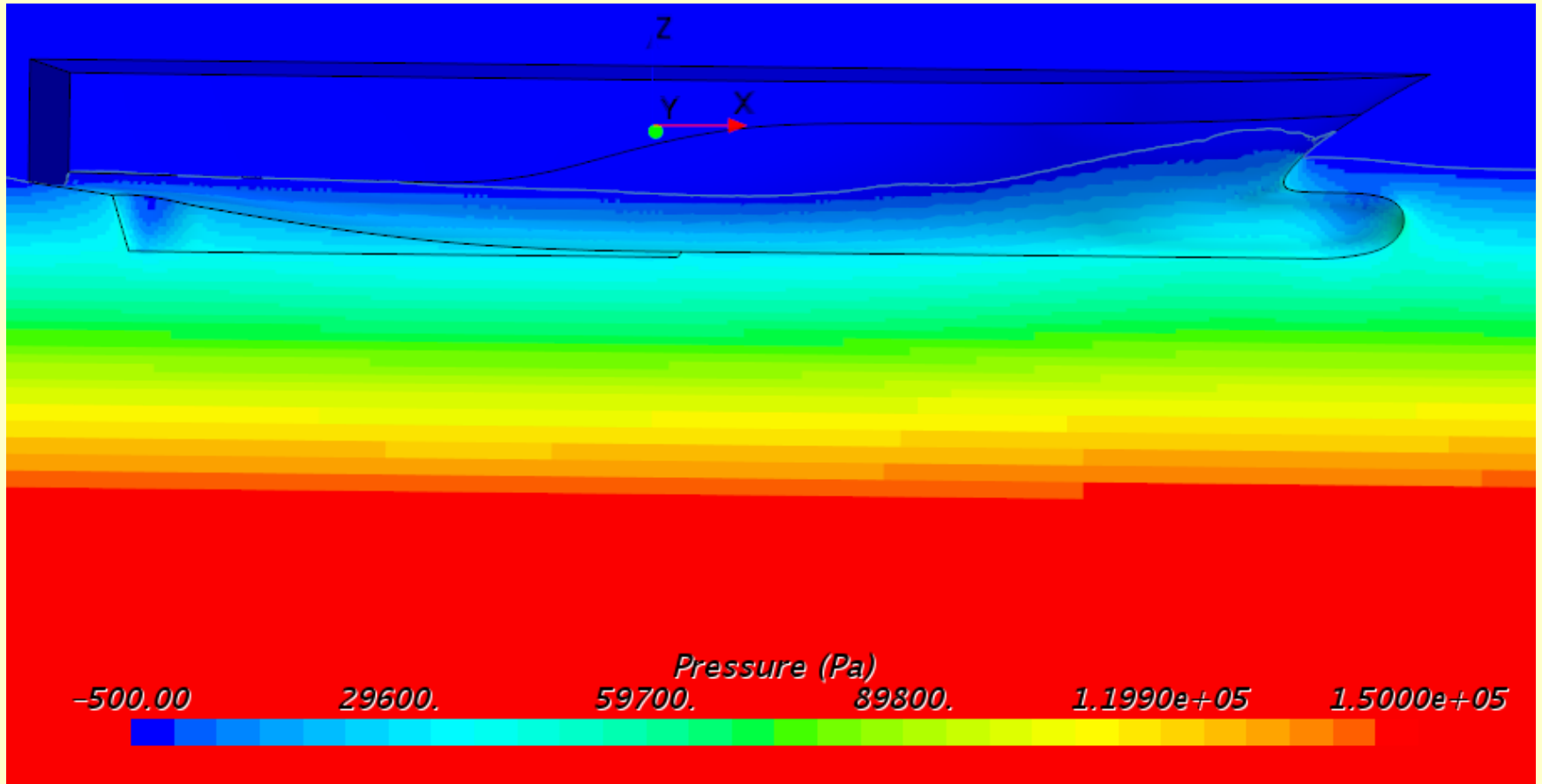
Mesh convergence study



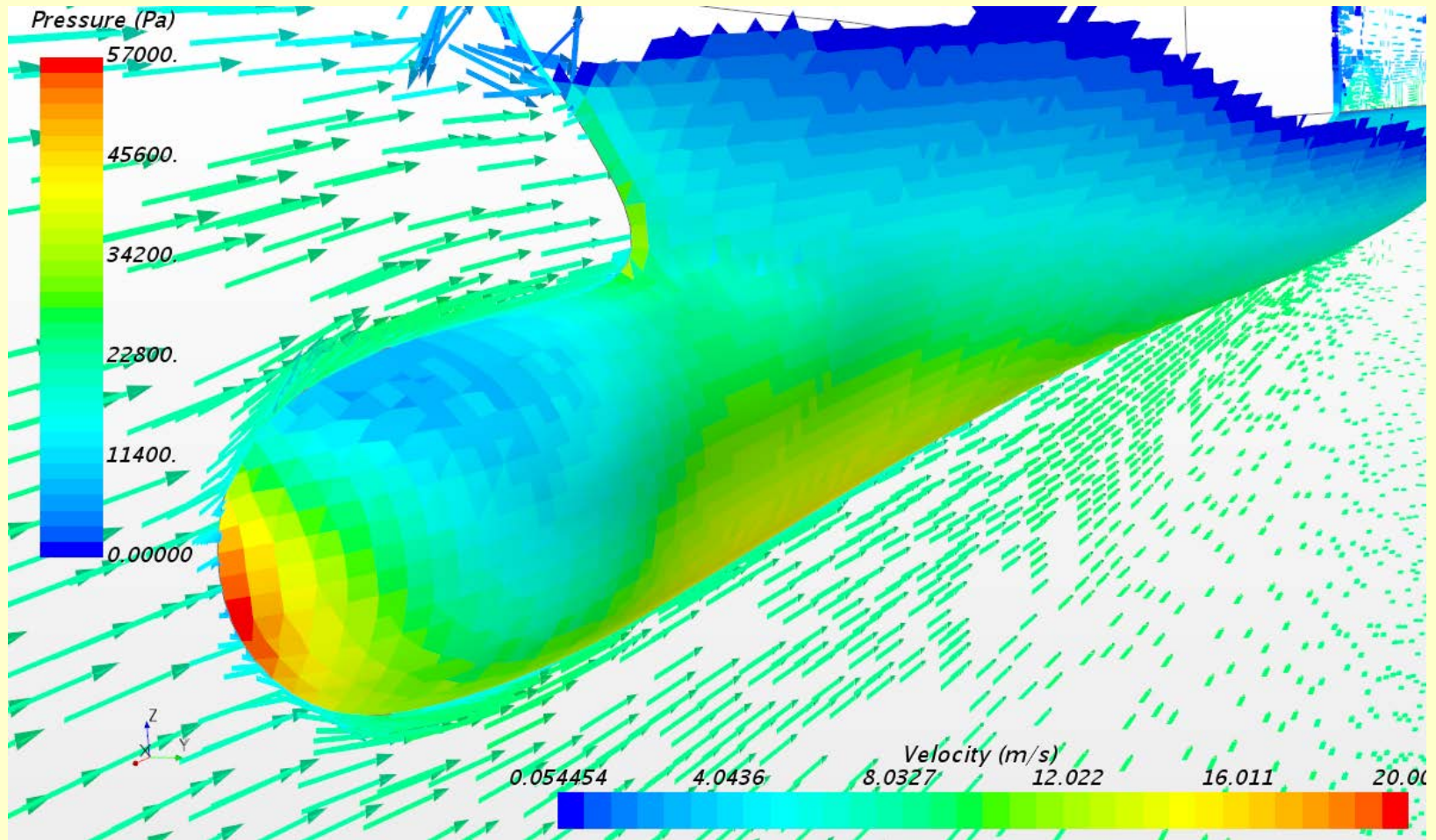
Mesh convergence study



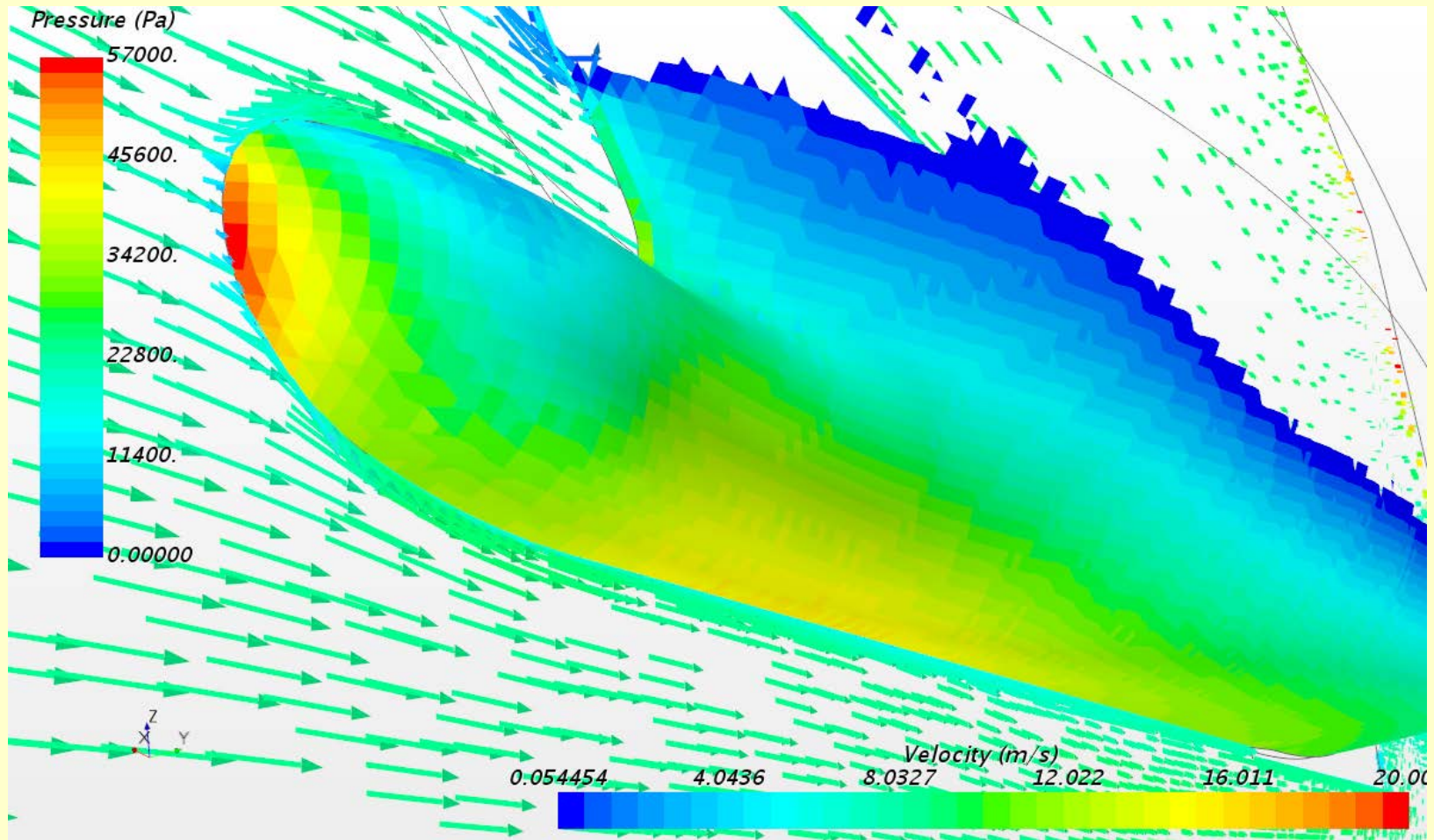
Yacht with the bulbous bow



Yacht with the bulbous bow

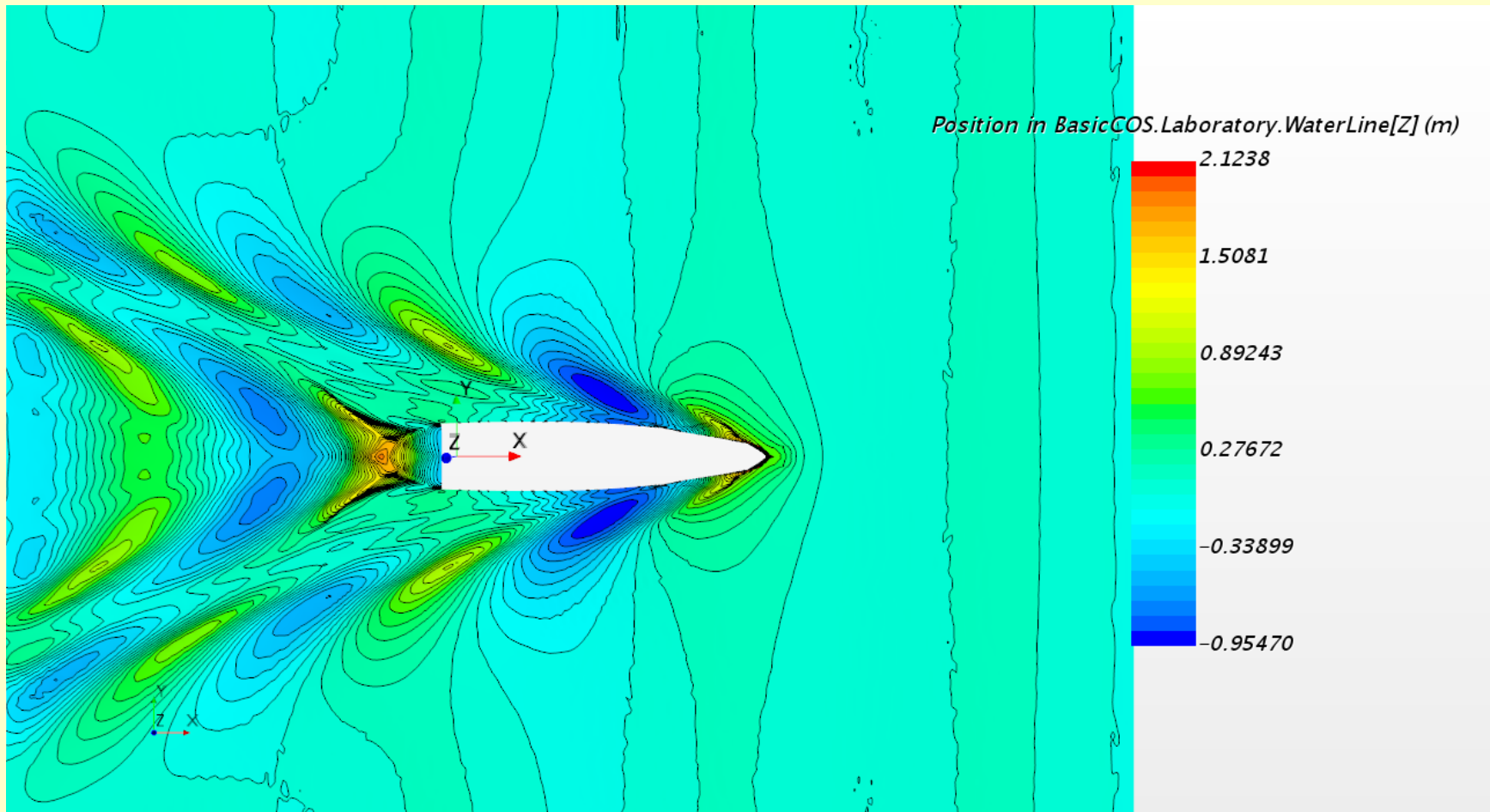


Yacht with the bulbous bow

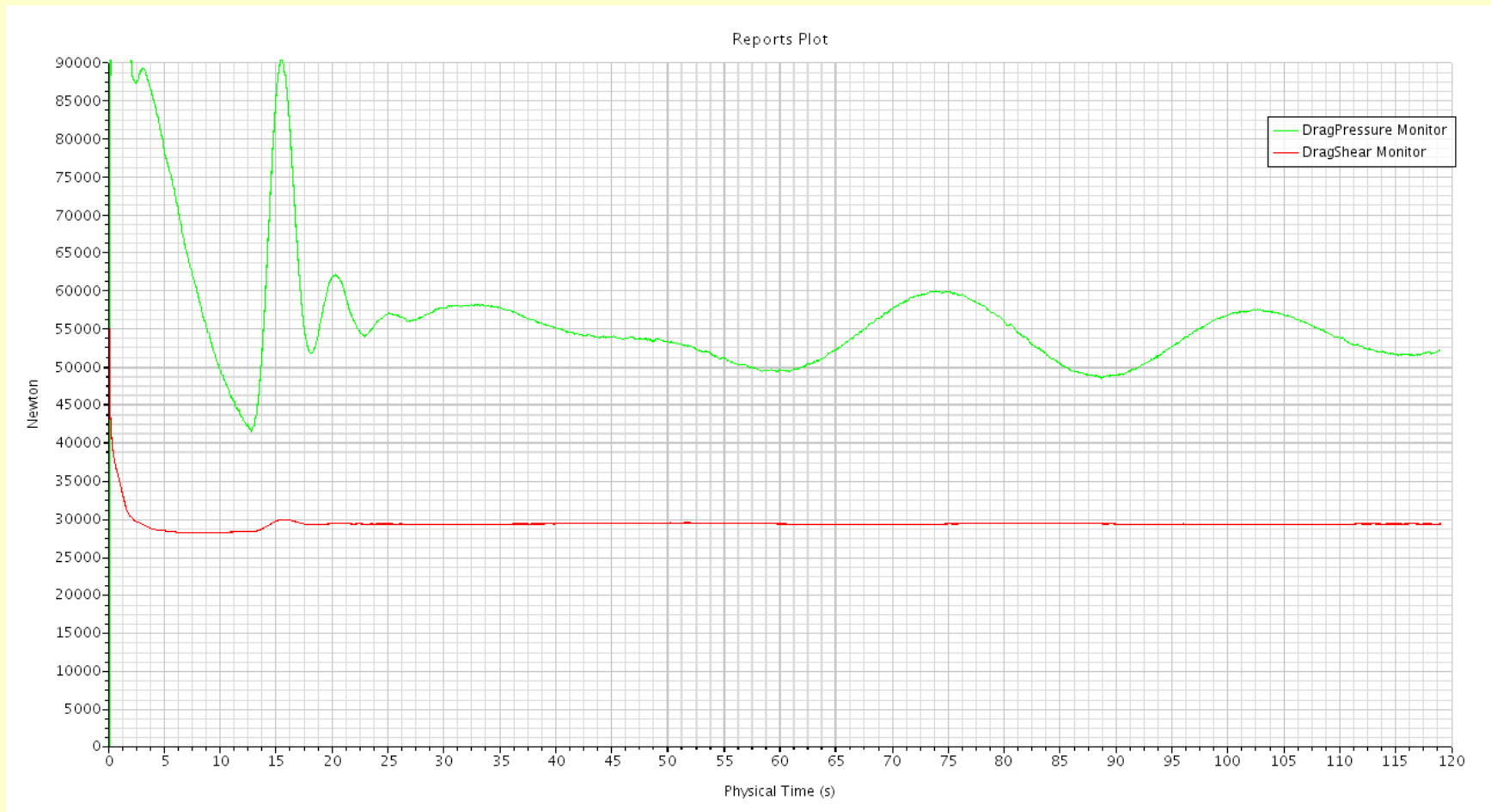


Yacht with the bulbous bow

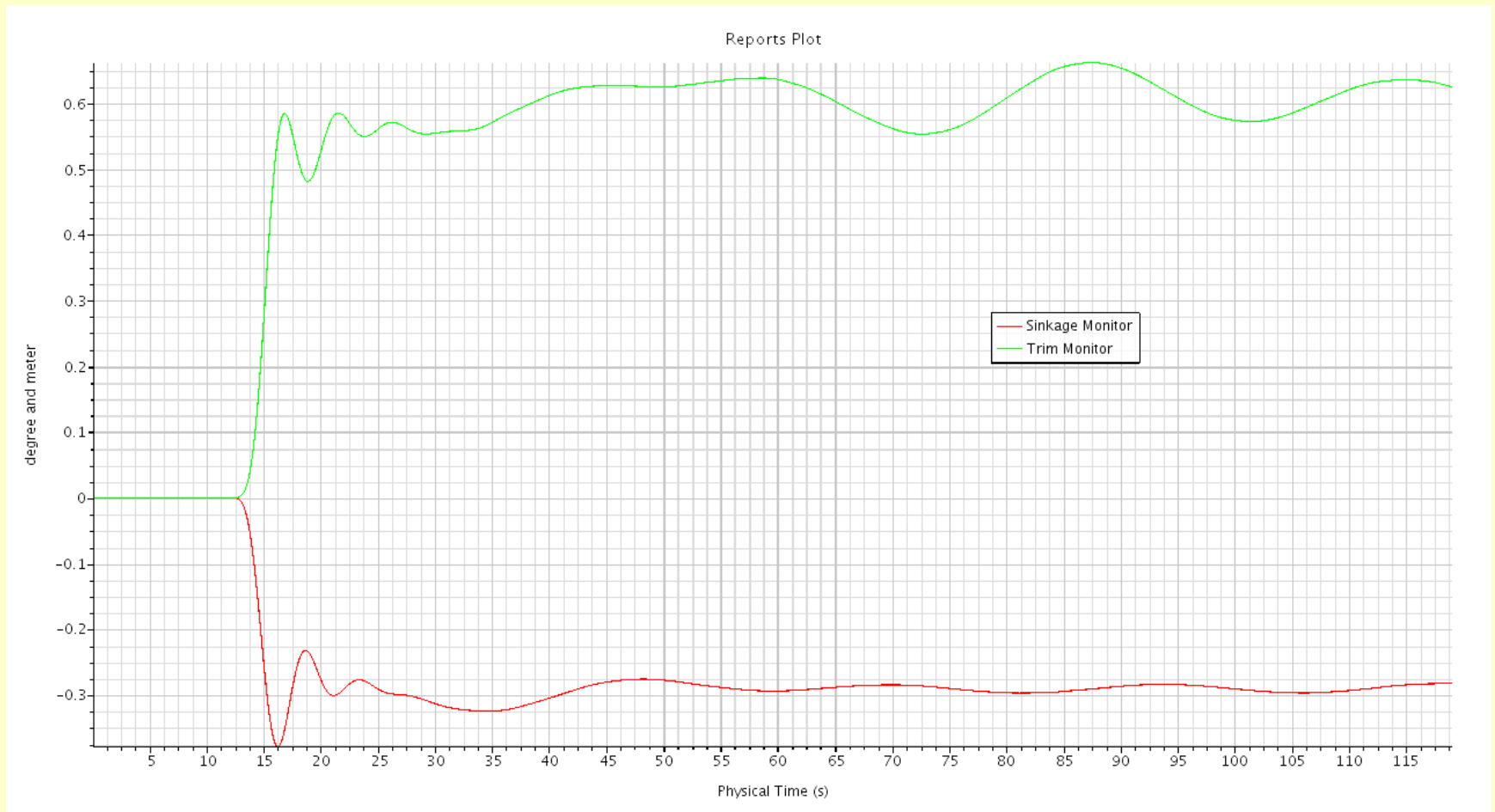
Kelvin waves



Gathered reference DATA: Resistance components (17 knots)

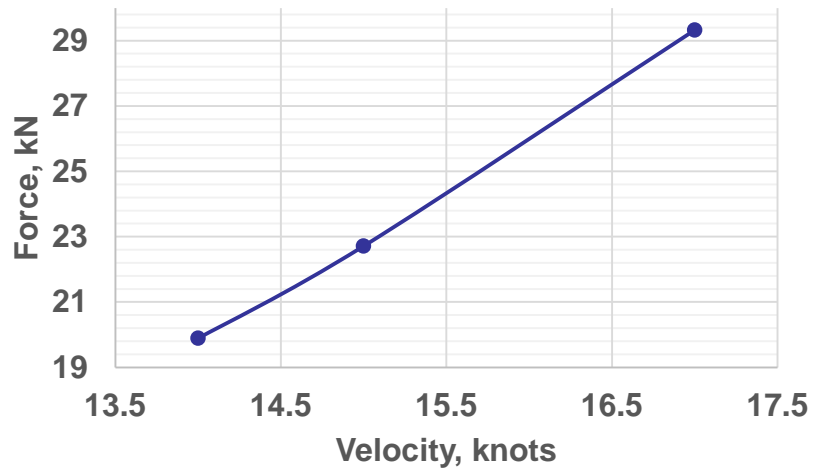


Gathered reference DATA: ship motions (17 knots)

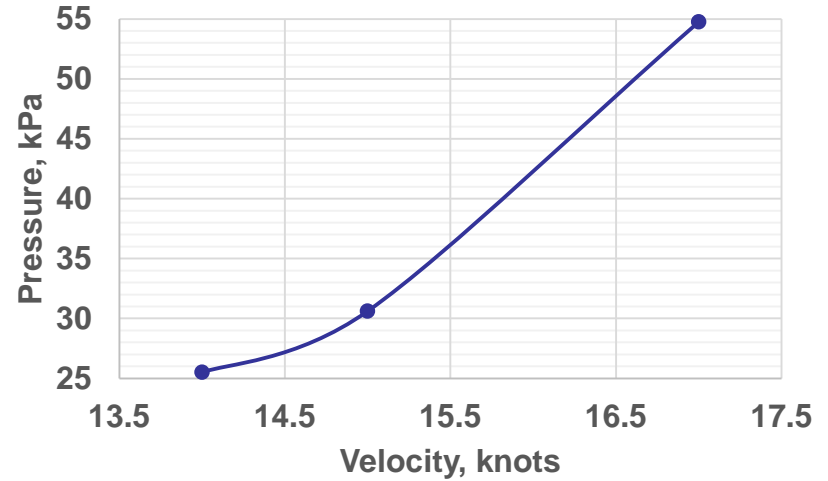


REFERENCE DATA COLLECTED

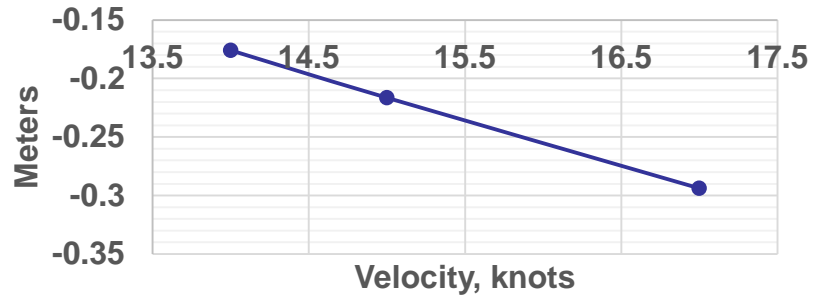
Shear drag



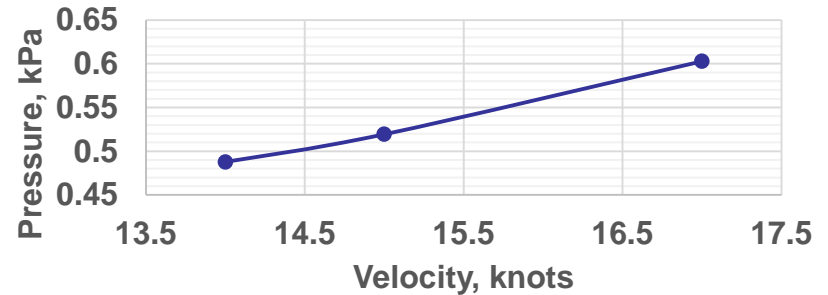
Pressure drag



Sinkage

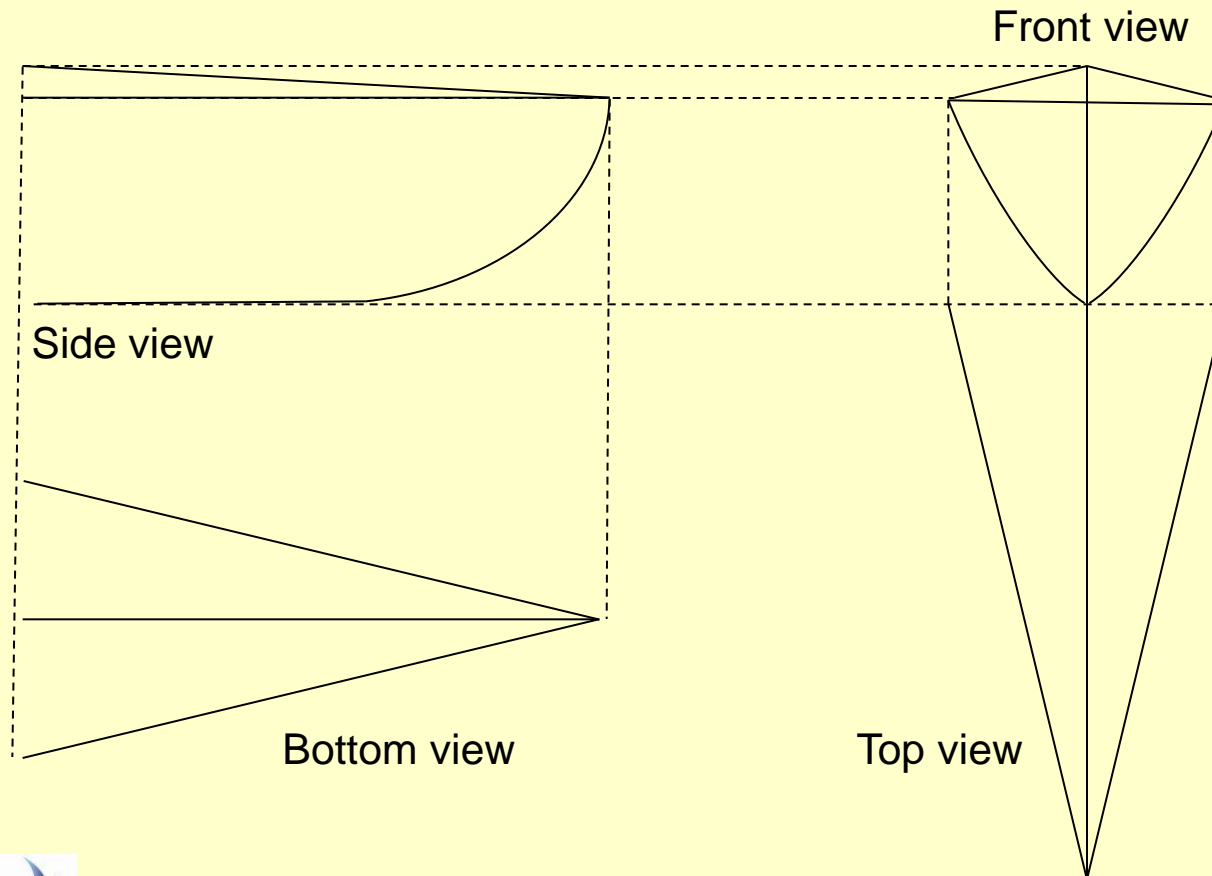


Trim

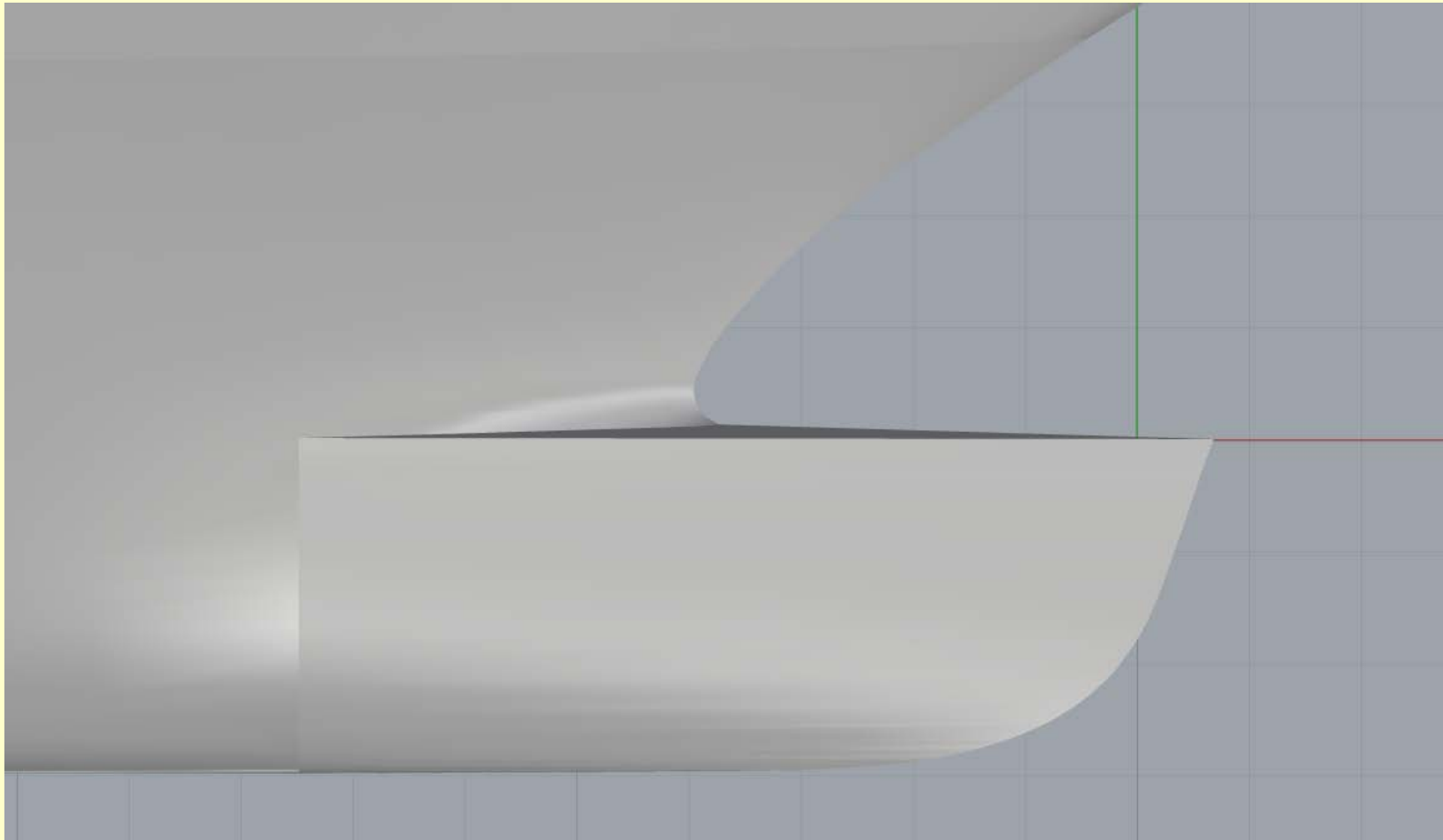


Changing the bulbous bow to a blade one

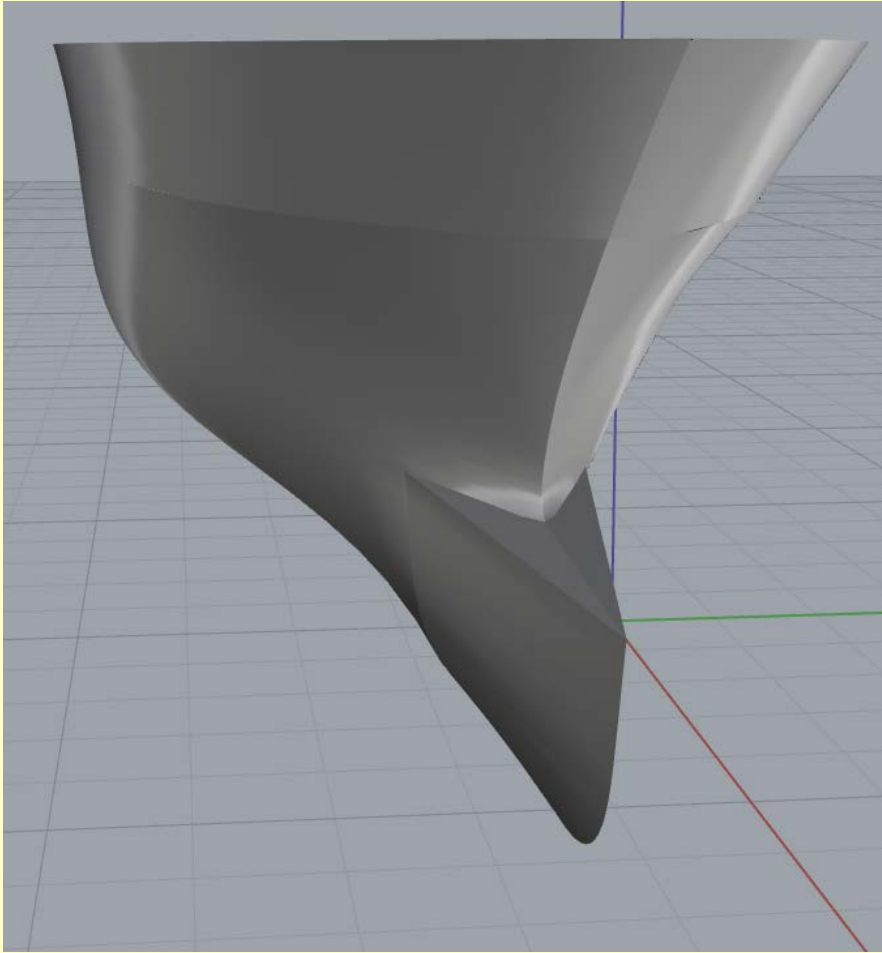
- Features of the blade bow concept should be noticed:



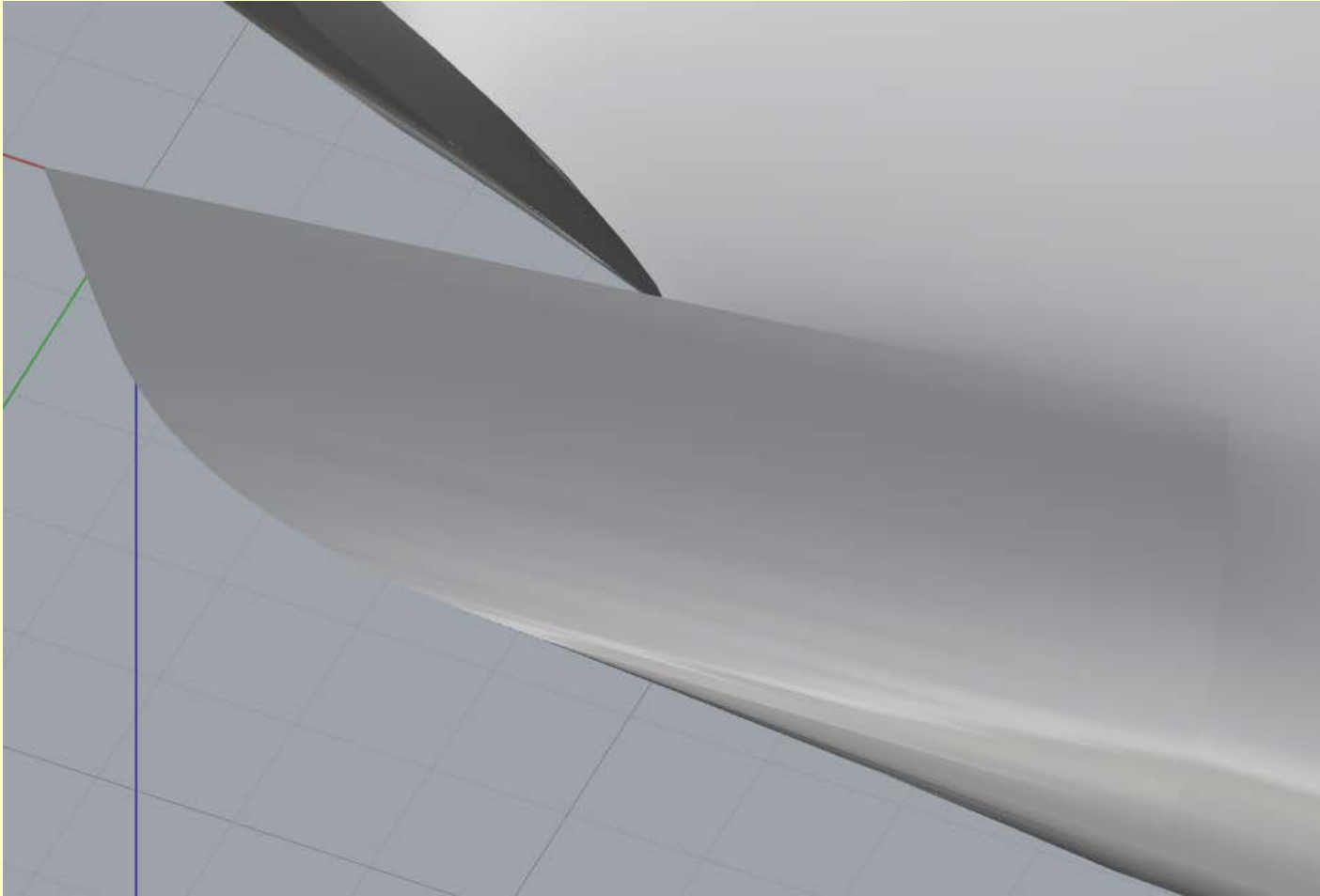
Blade bow. First design



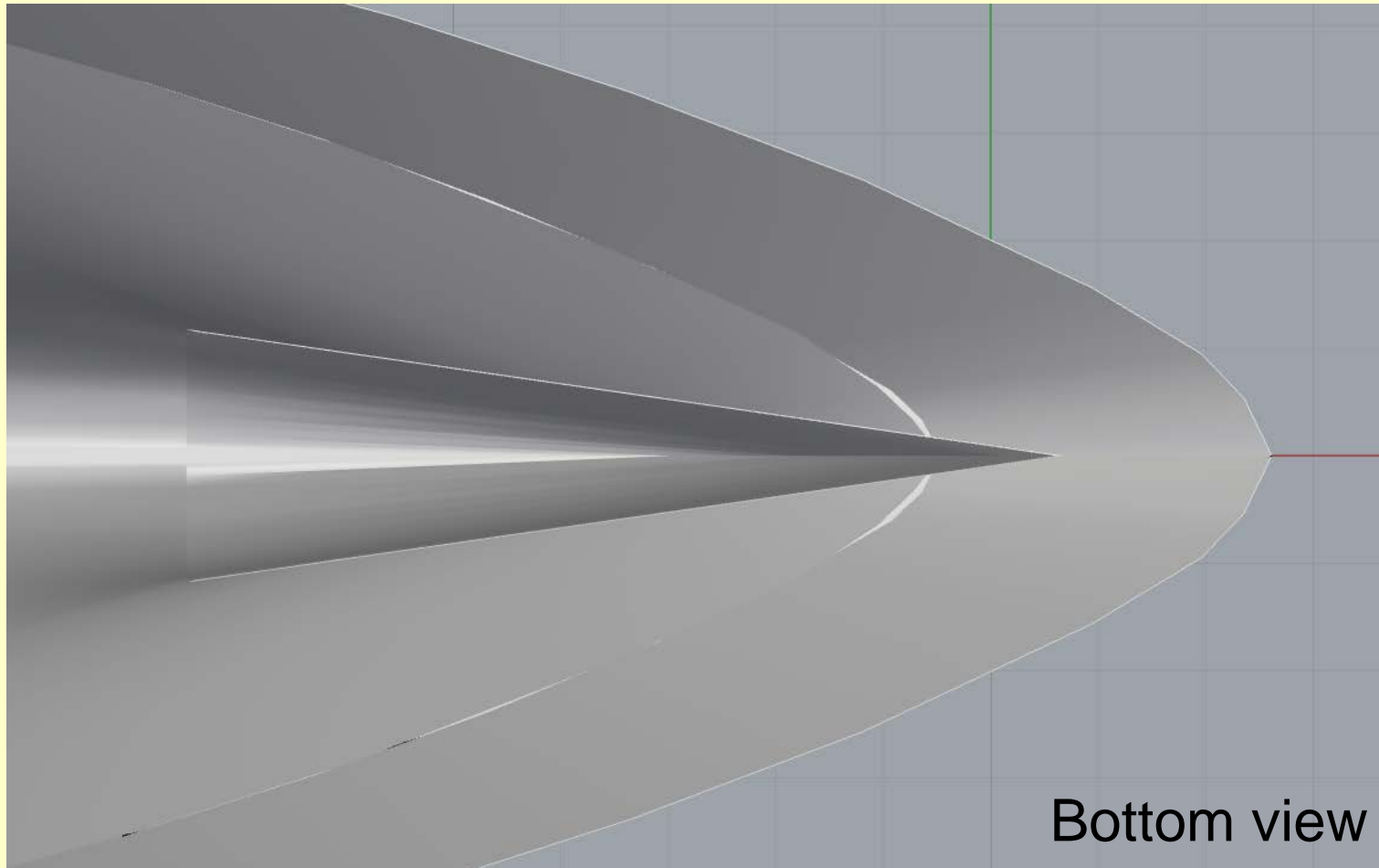
Blade bow. First design



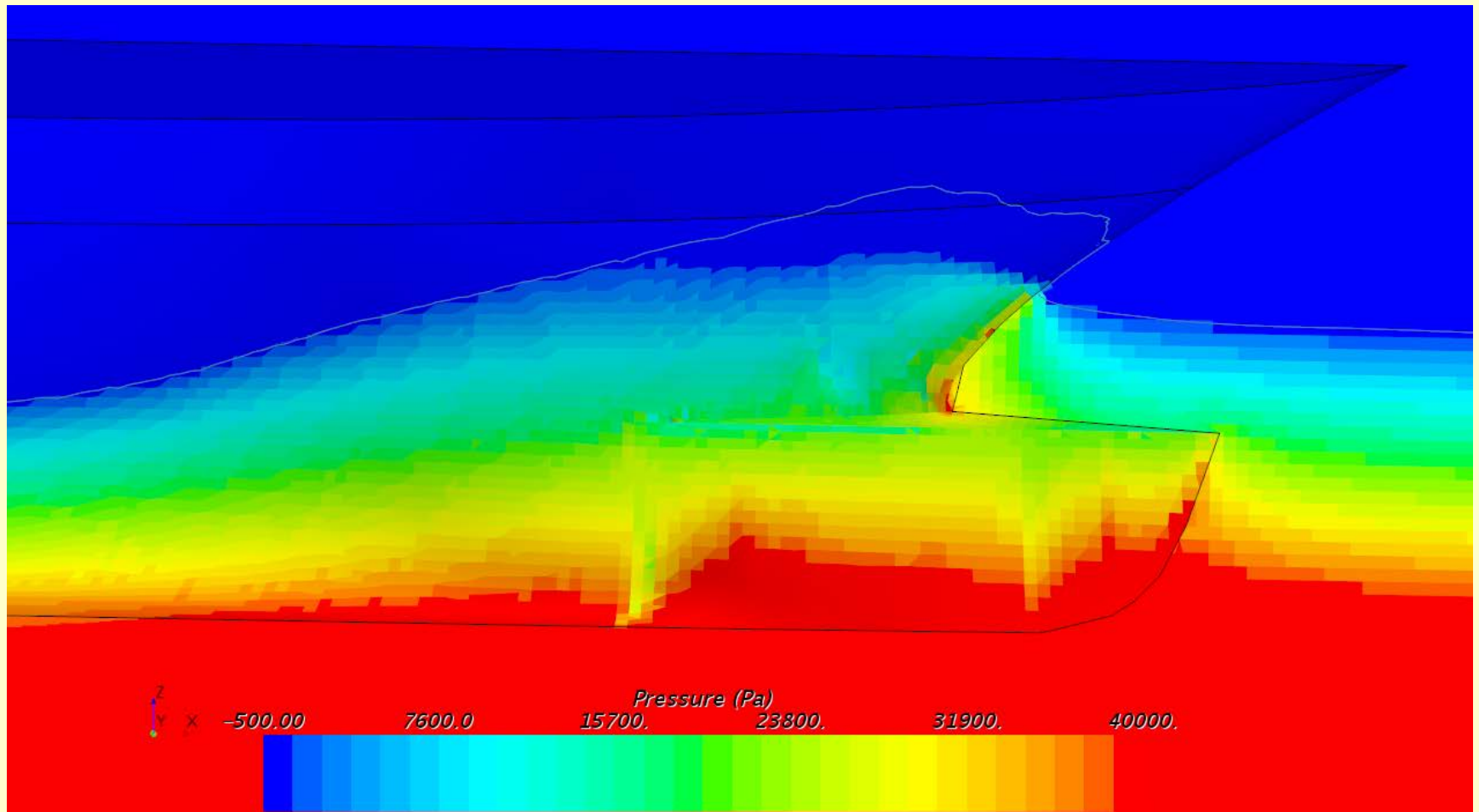
Blade bow. First design



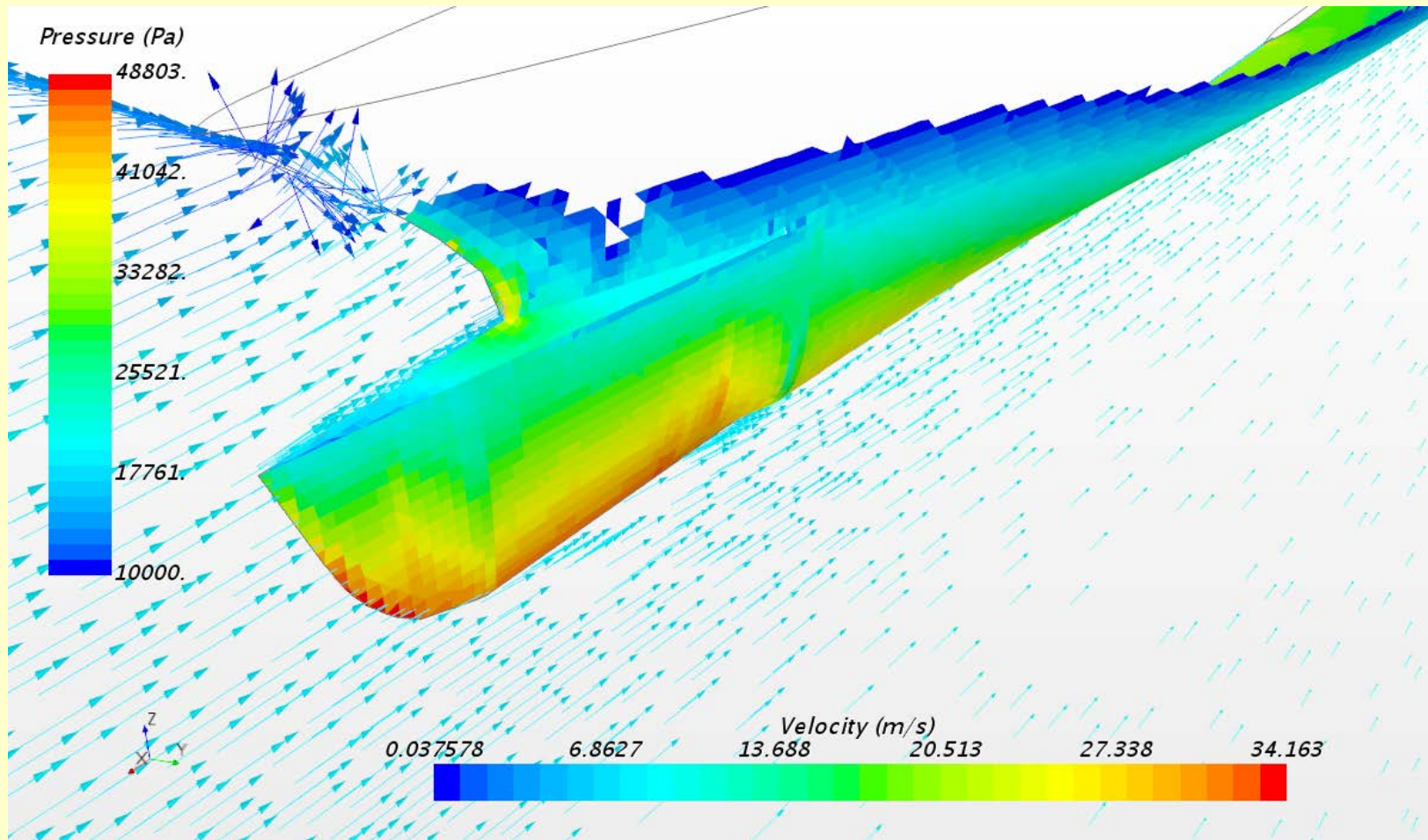
Blade bow. First design



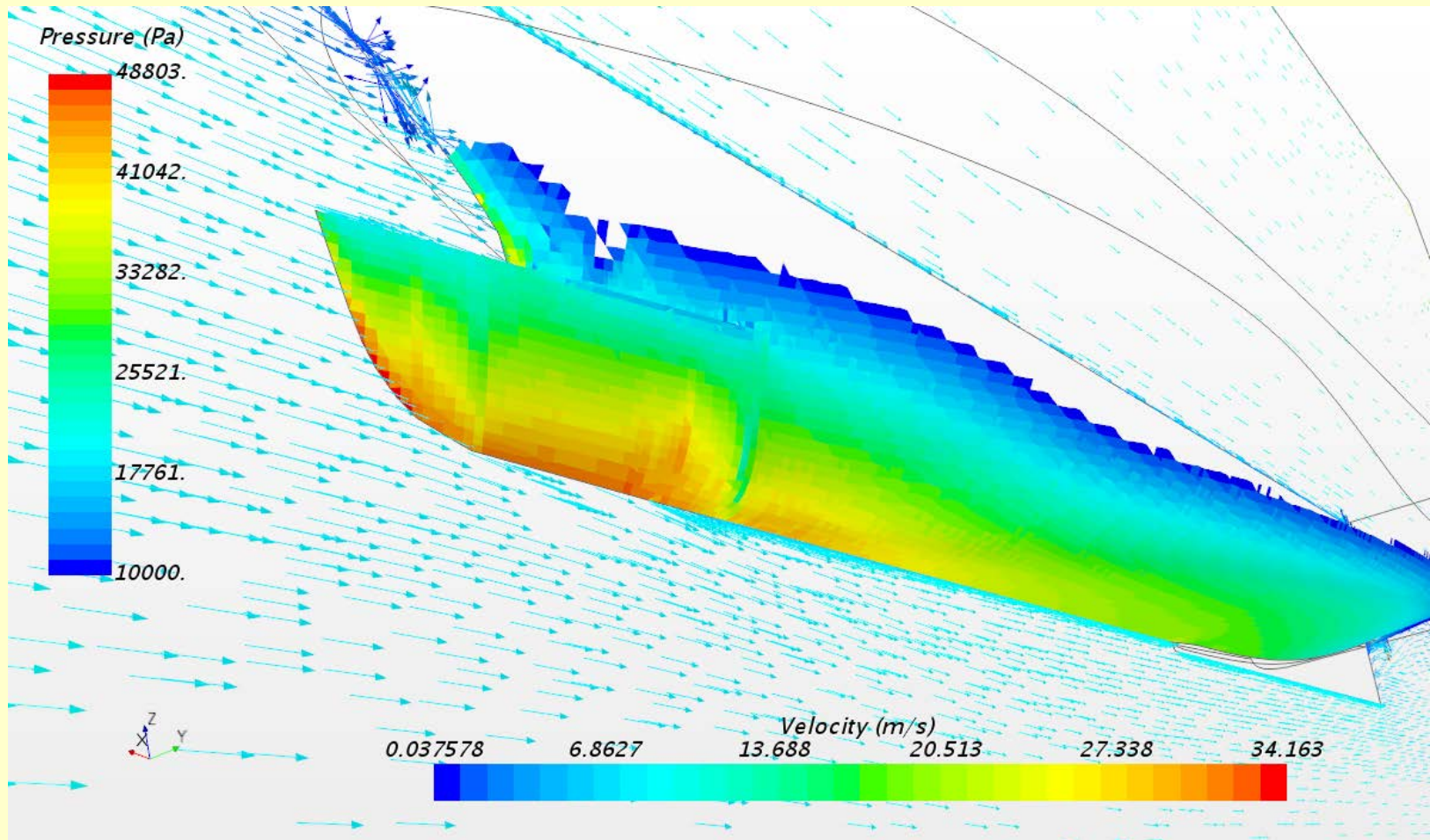
Blade bow, 1st design. Produced wave profile on 17 knots forwarding



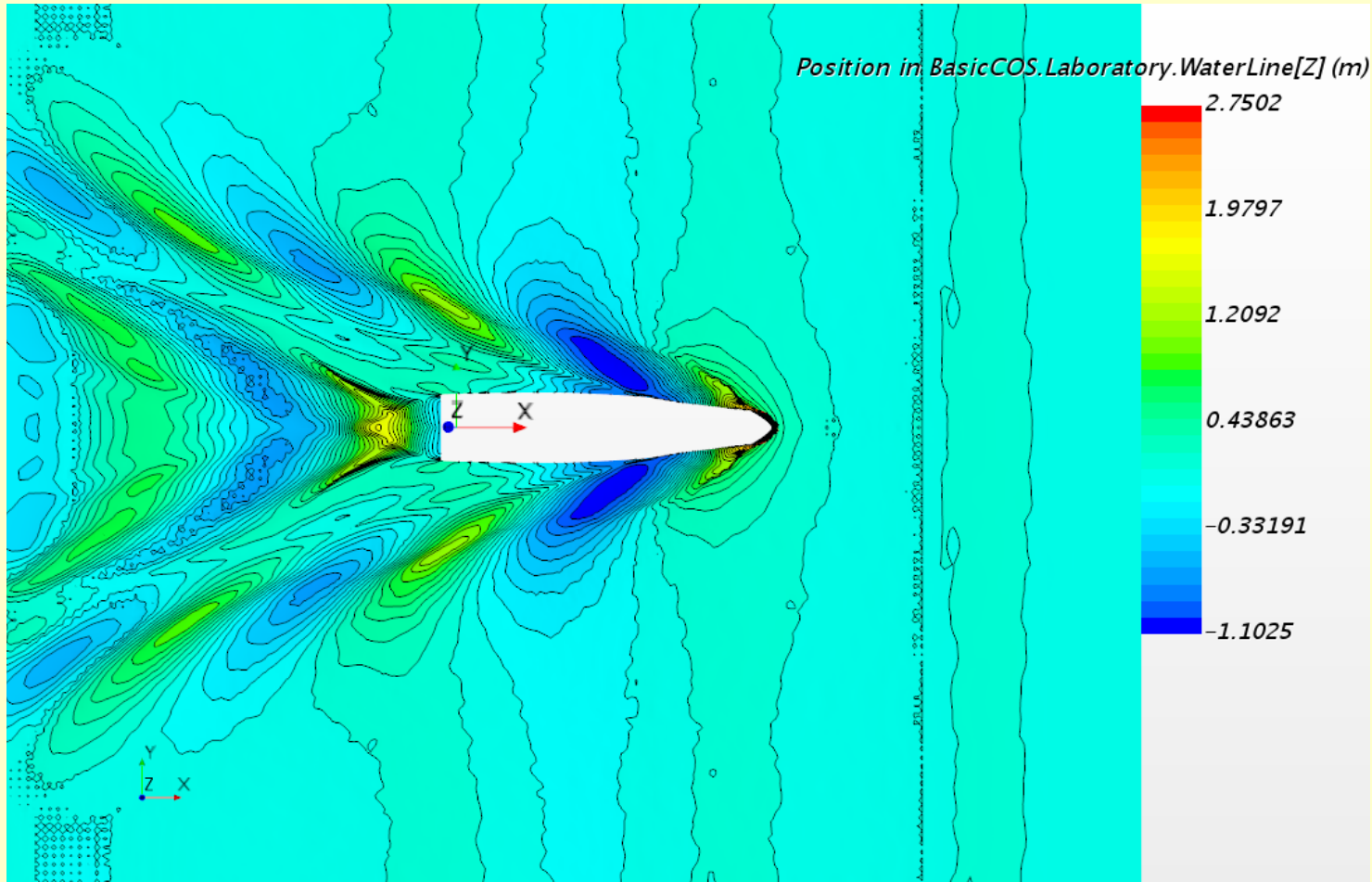
17 knots



17 knots

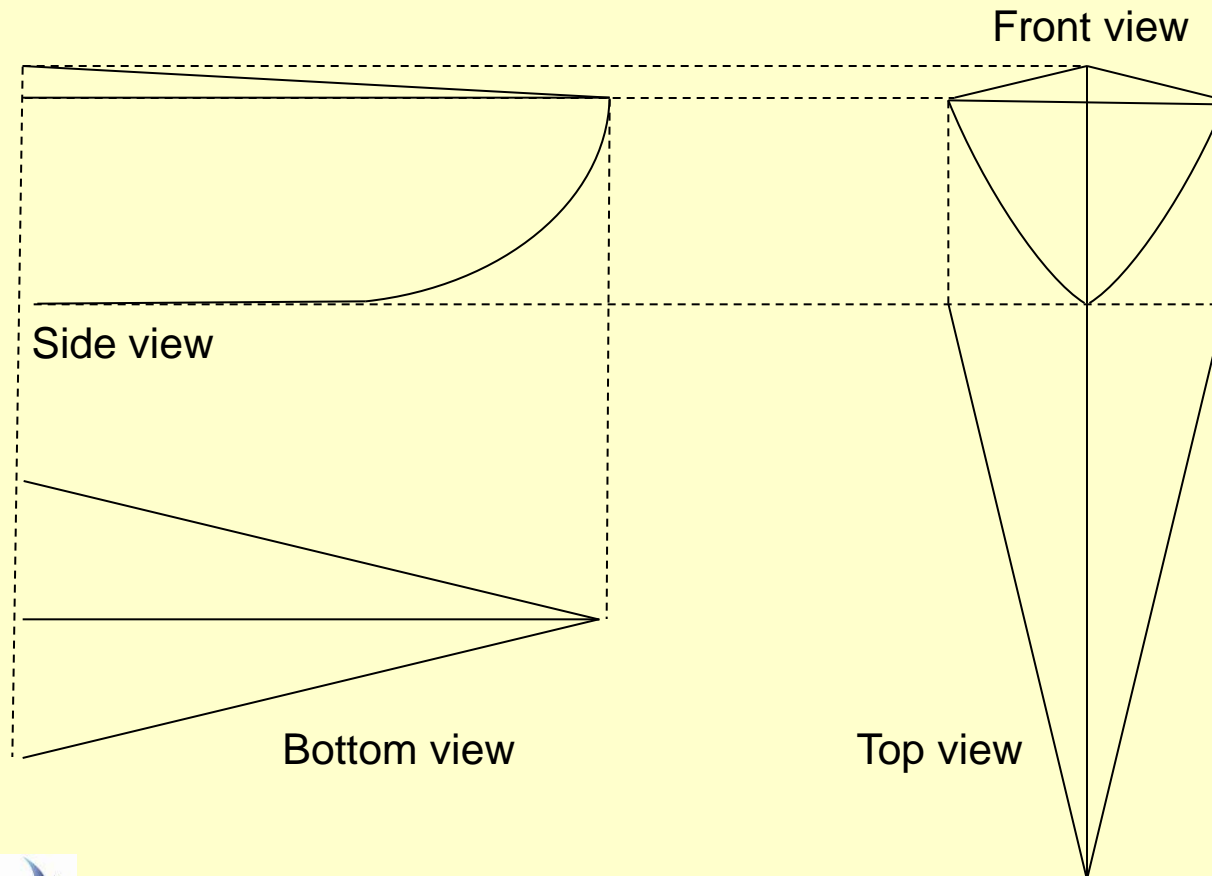


17 knots. Blade bow

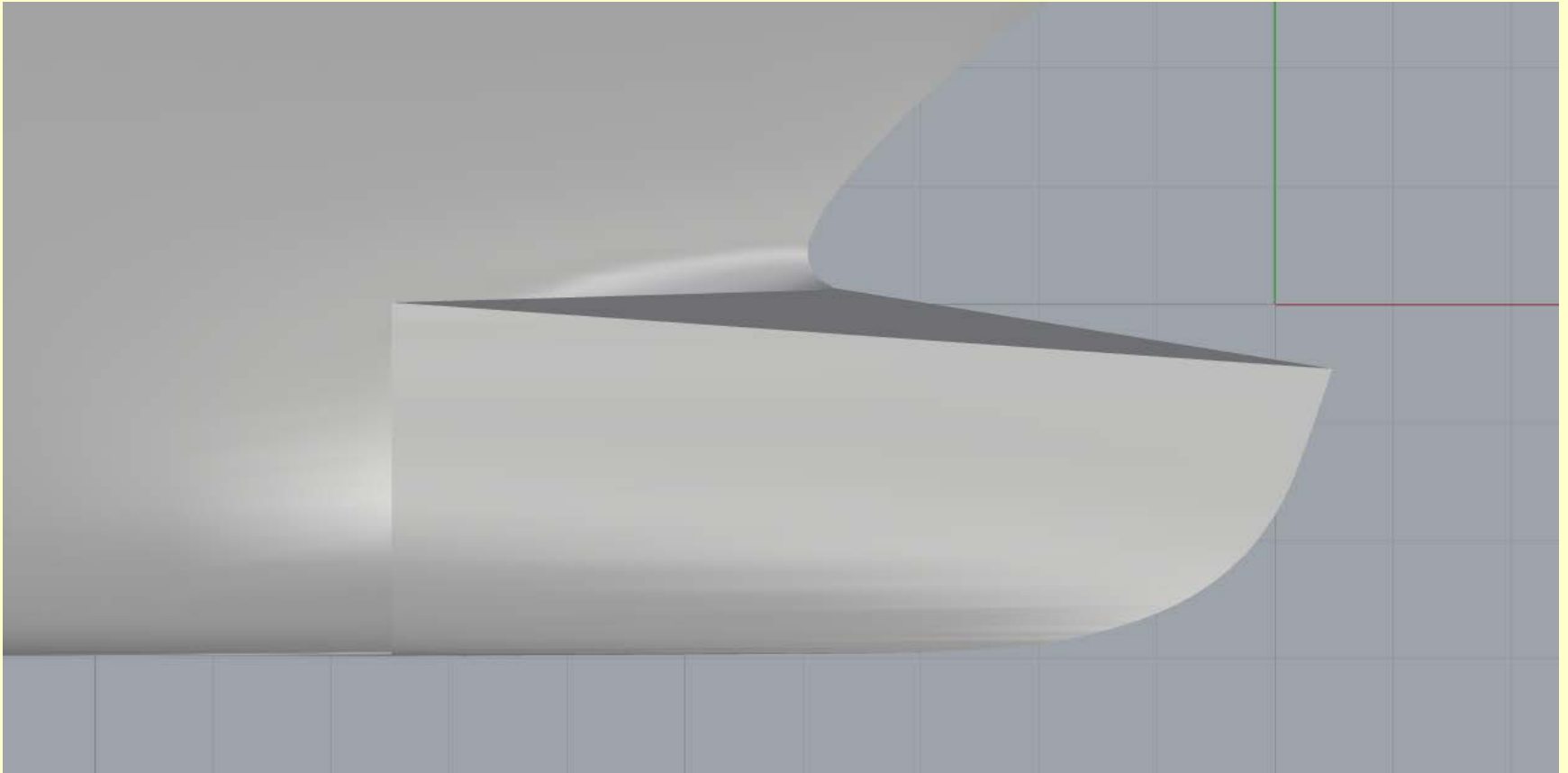


Changing the bulbous bow to a blade one

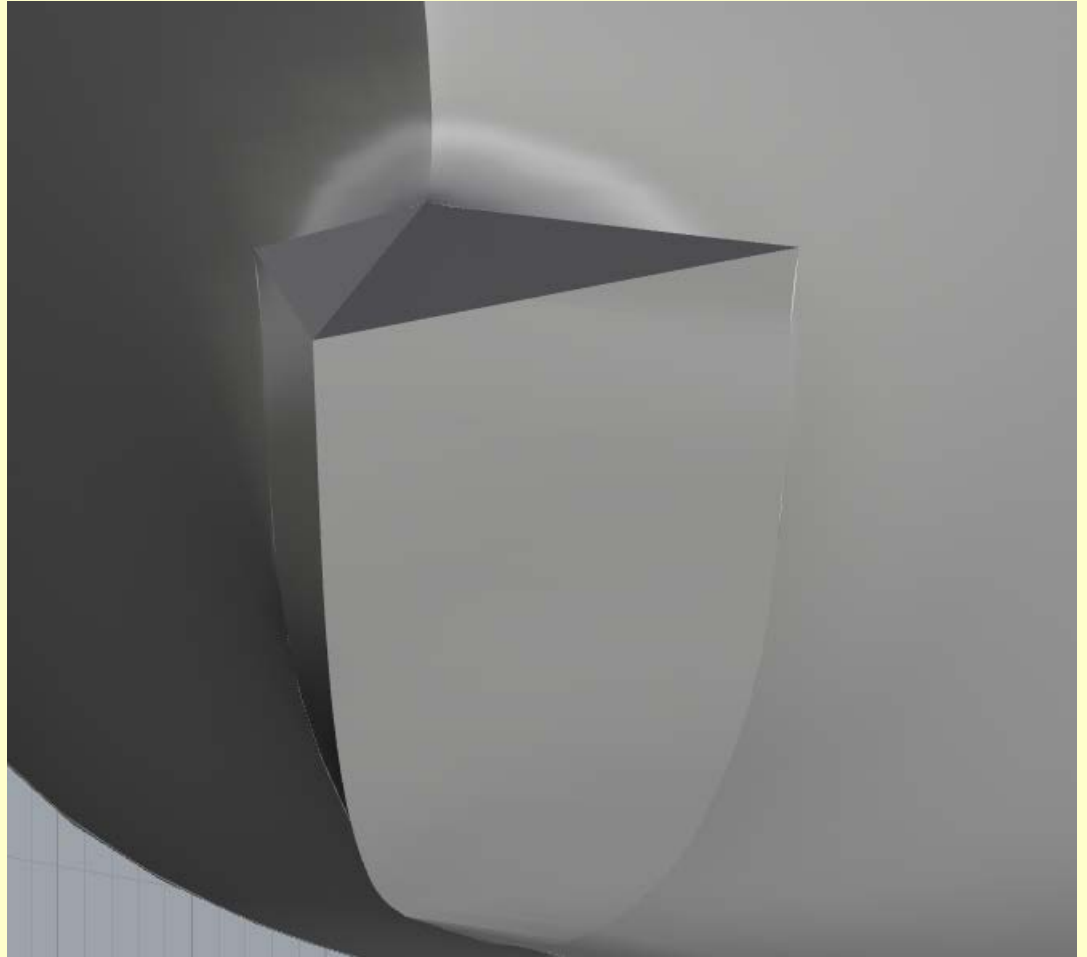
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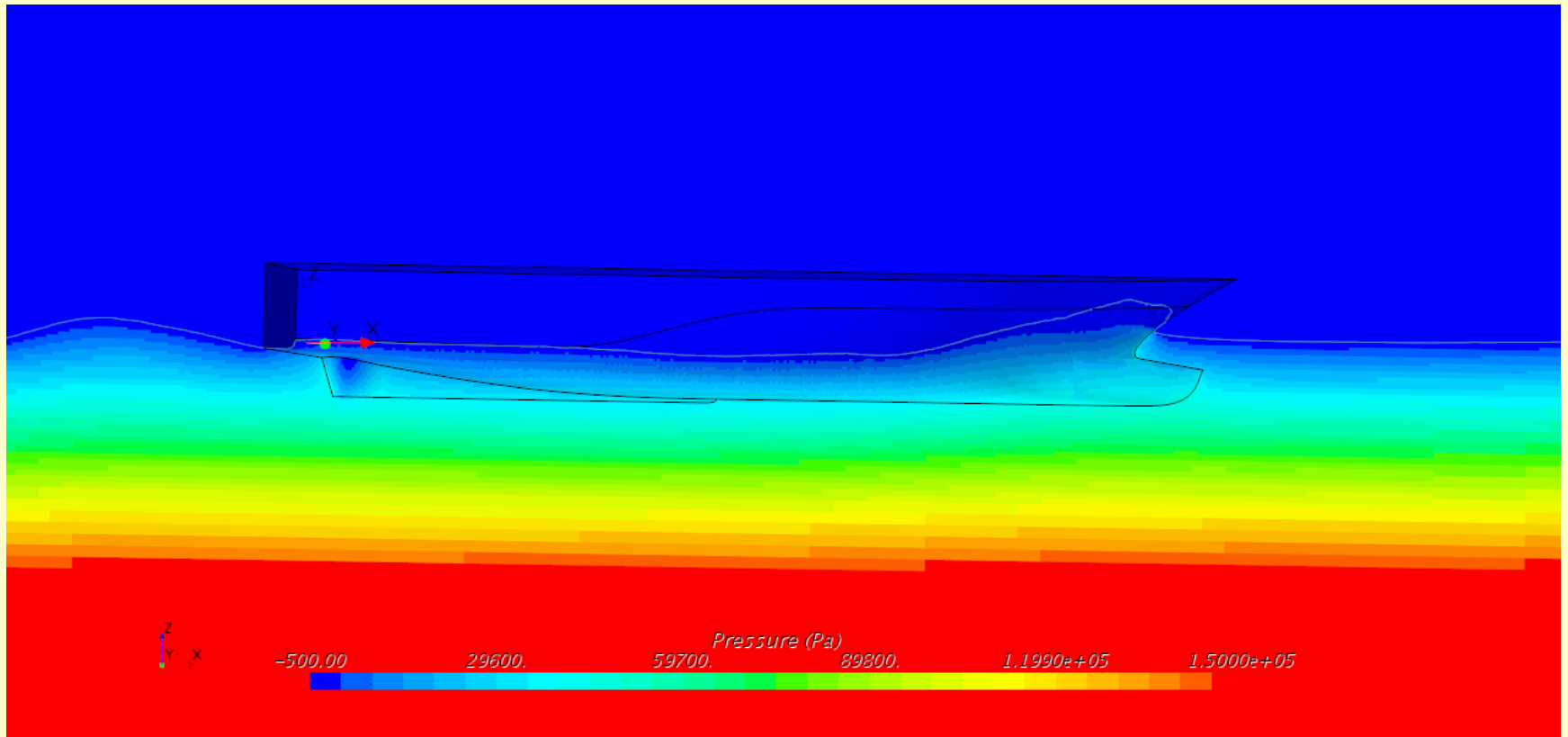
Blade bow, 2nd variant



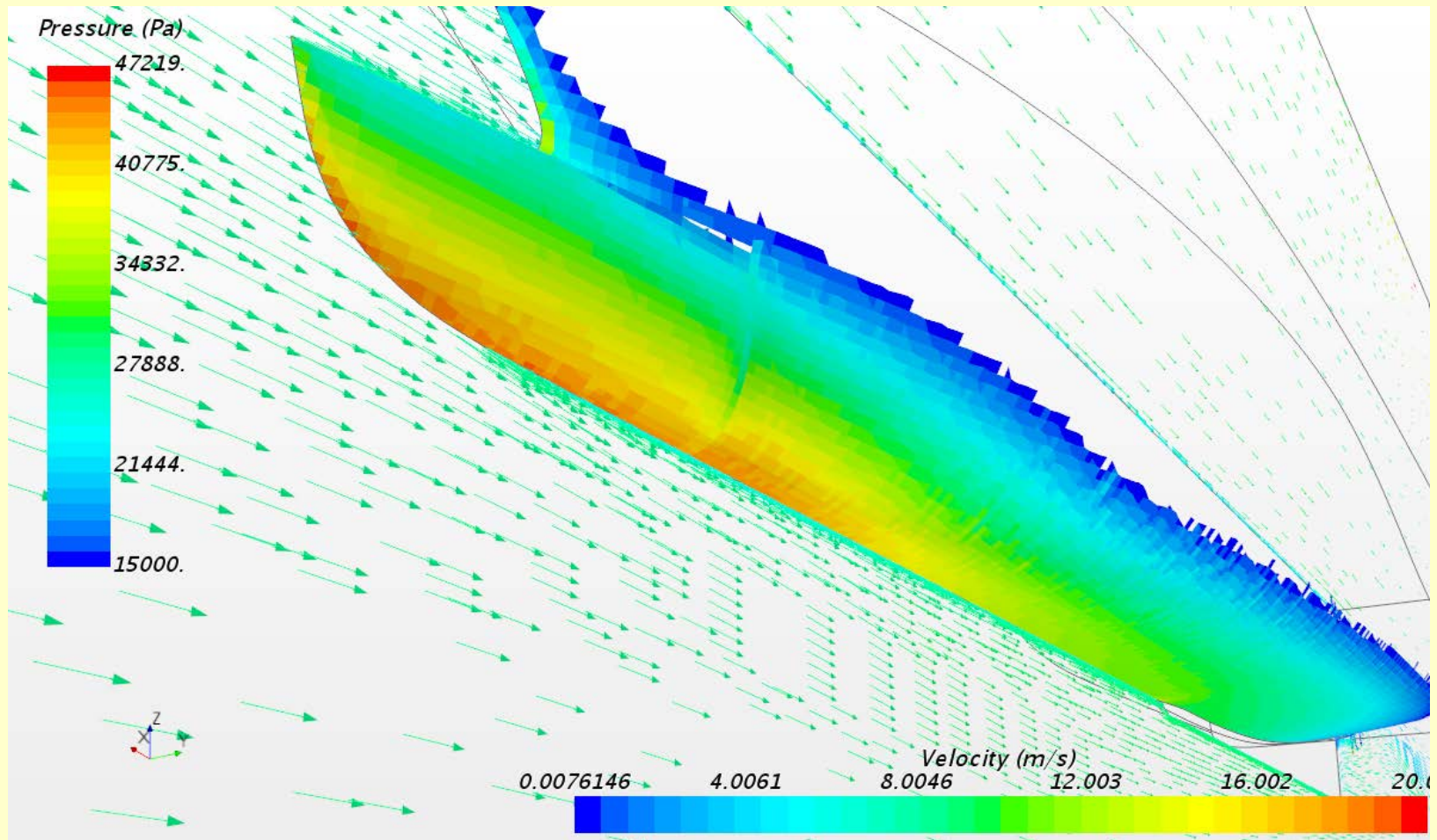
Blade bow, 2nd variant



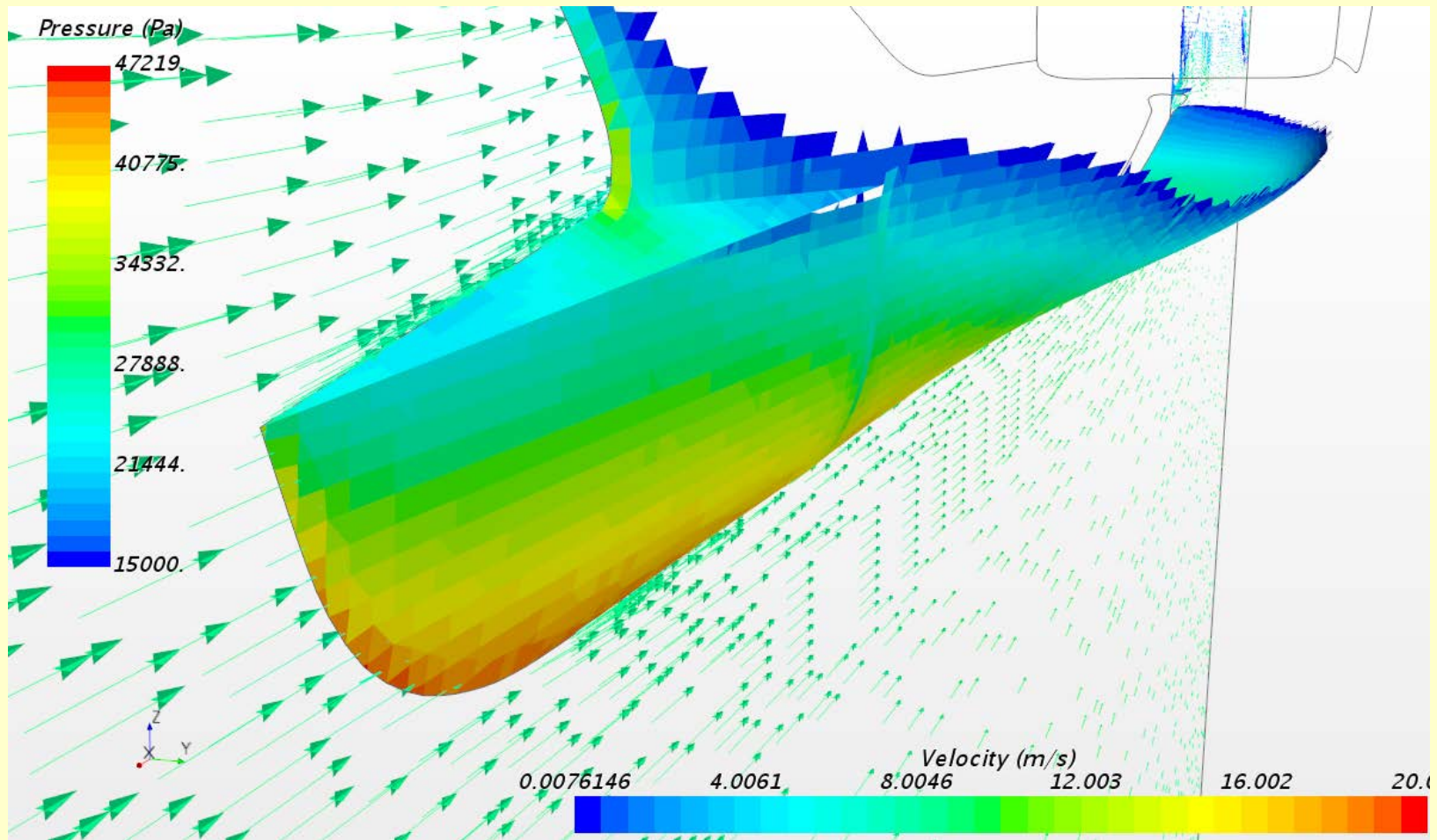
17 knots. Blade bow, 2nd variant



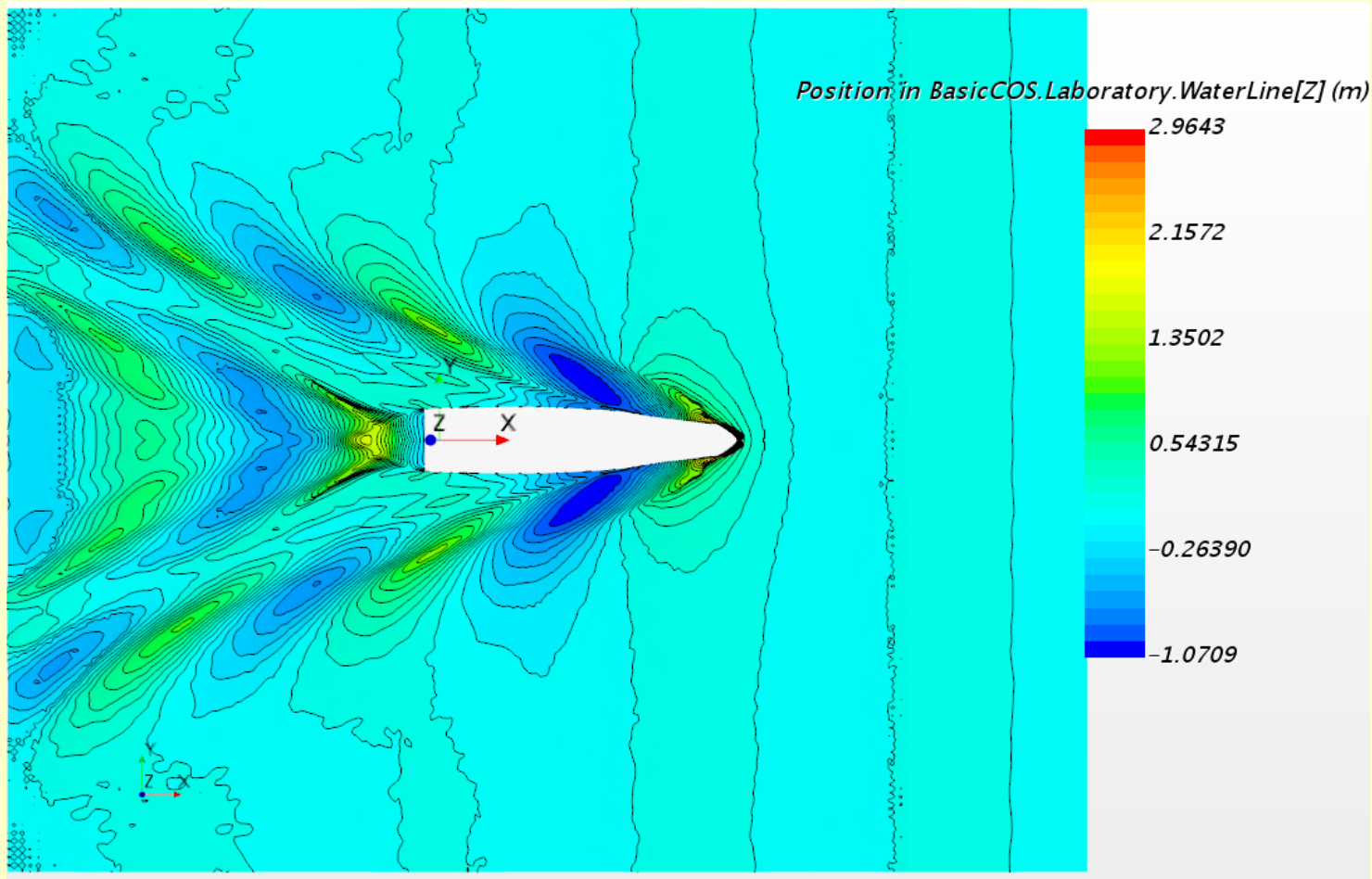
17 knots. Blade bow, 2nd variant



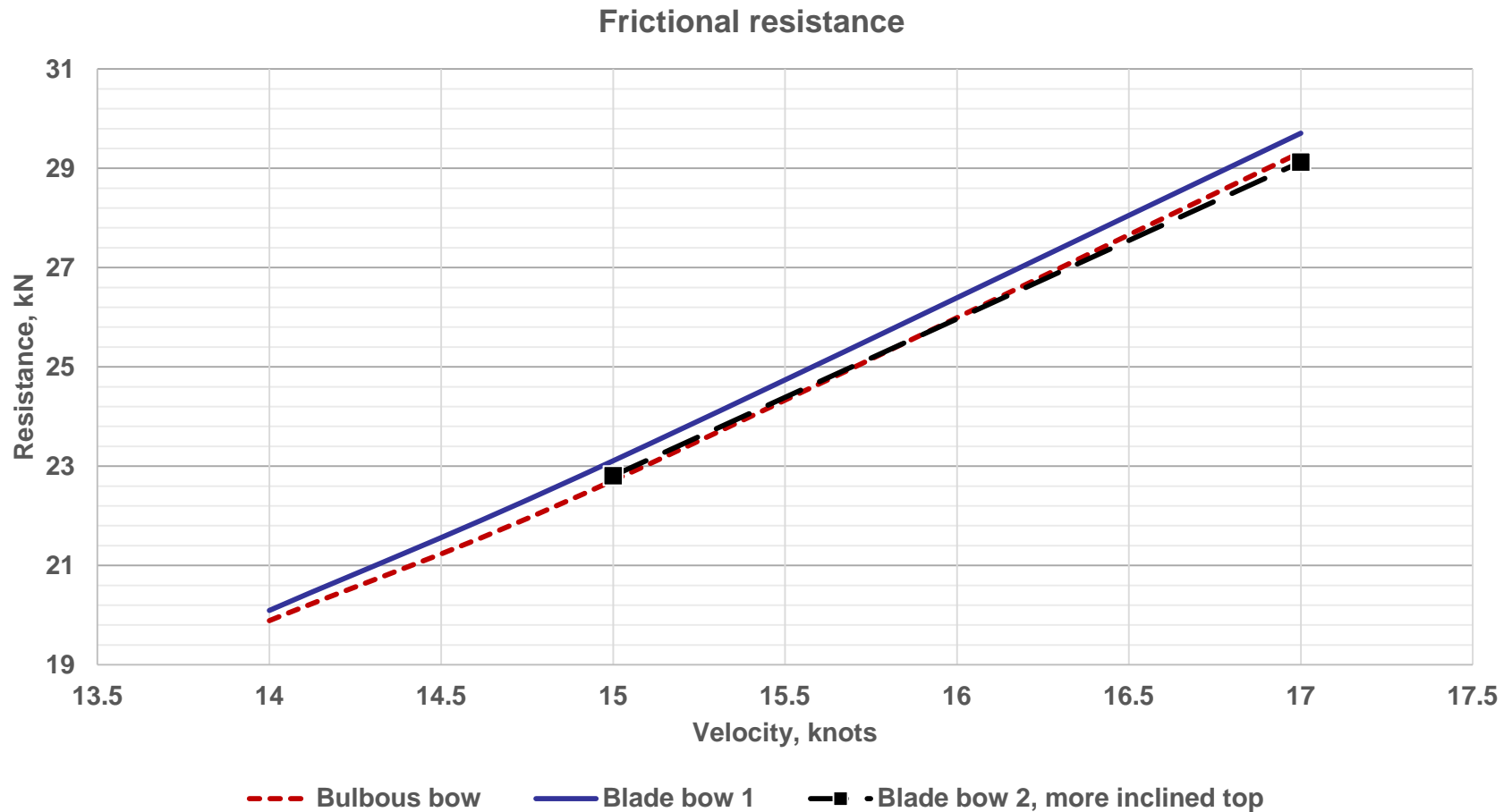
17 knots. Blade bow, 2nd variant



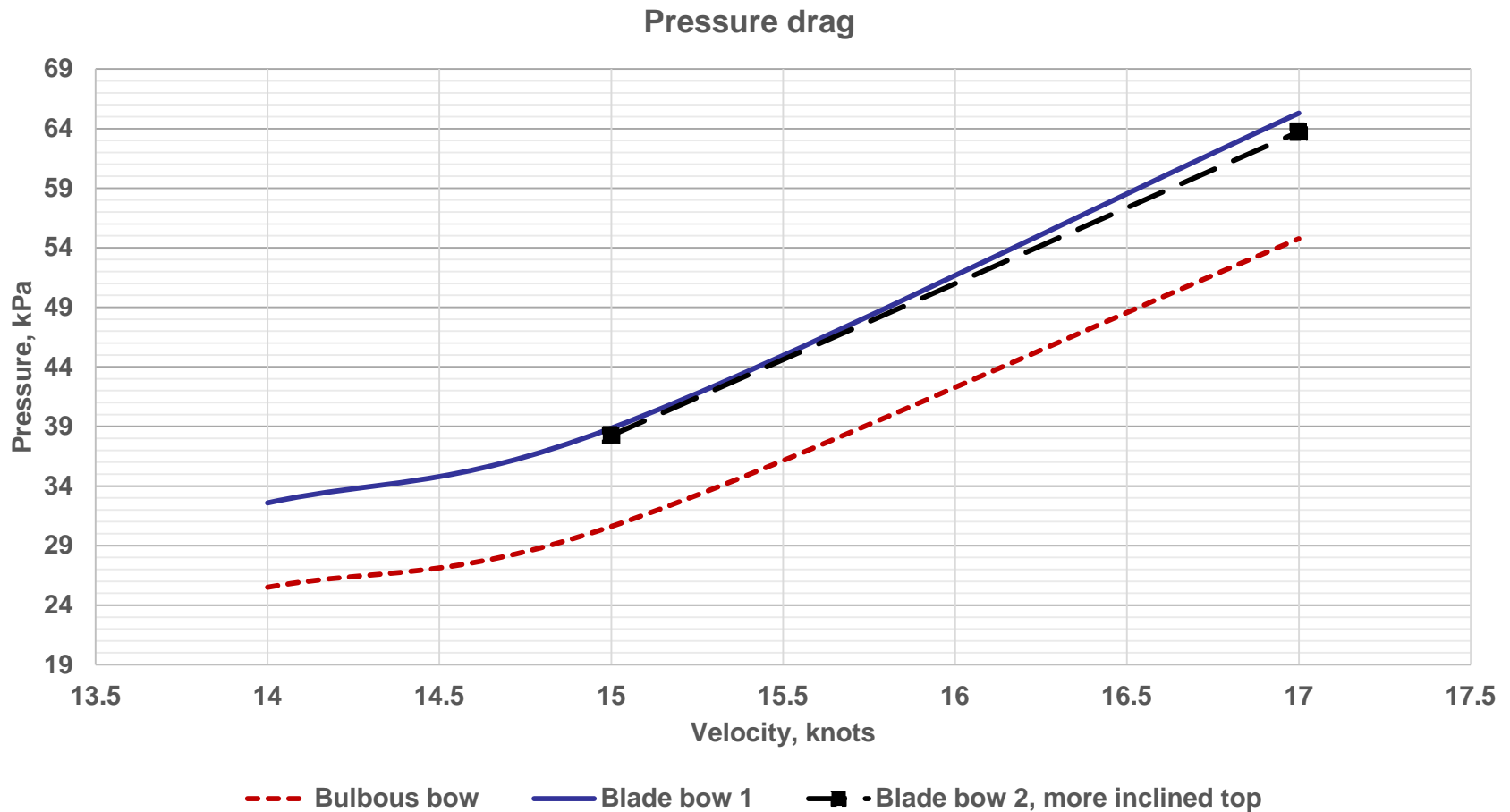
17 knots. Blade bow, 2nd variant



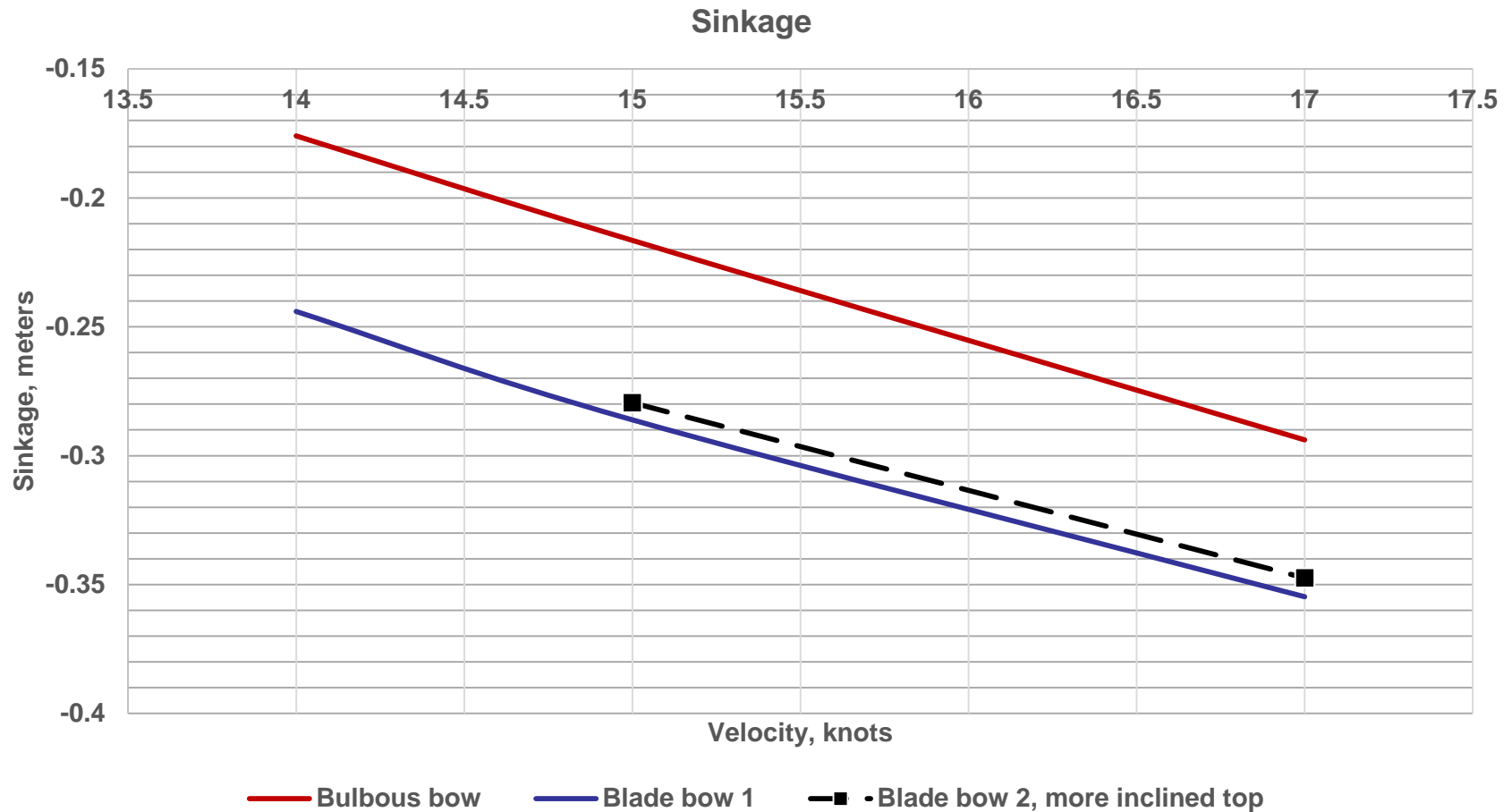
Friction comparison



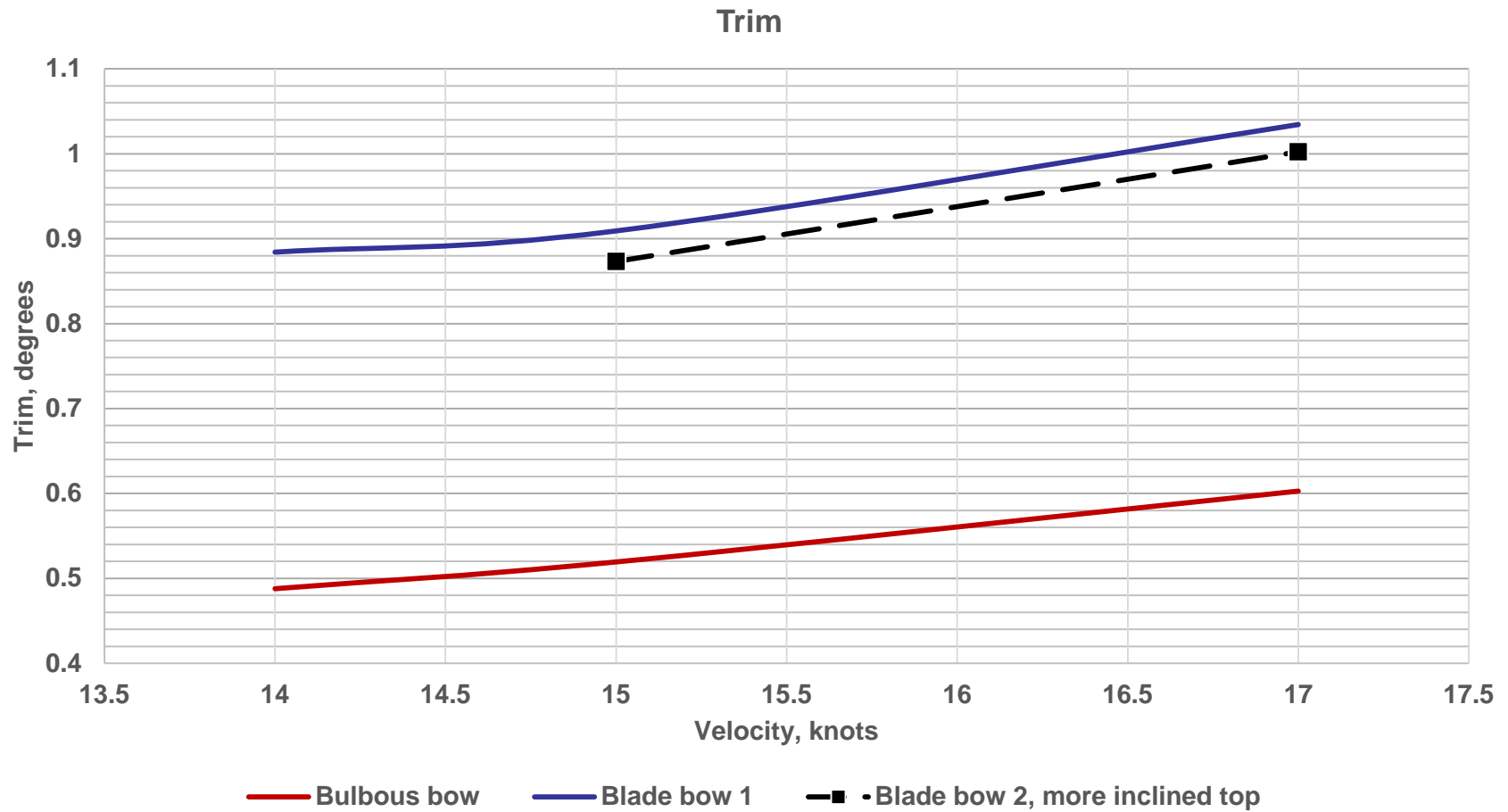
Pressure drag comparison



Sinkage comparison



Trim comparison



So, what do we have now...

- Trim had been changed (involving or separately from the sinkage - ?)
- Pressure drag increased – in what areas of the bow?
- Frictional drag is almost the same

CONCLUSION

- The bow shape gives direct influence on ship motions behavior. **Changing the bow we will change the trim and sinkage, in particular;**
- The pressure drag of the yacht's new shape had been increased – **how to reduce it, modifying the bow? The new problem to future additional research;**
- The blade bow does not function as the initial one – **does not help against wave producing effect. How to optimize the bow in connection to this aspect?** This is a new problem appeared – to be studied in optimization study subject.