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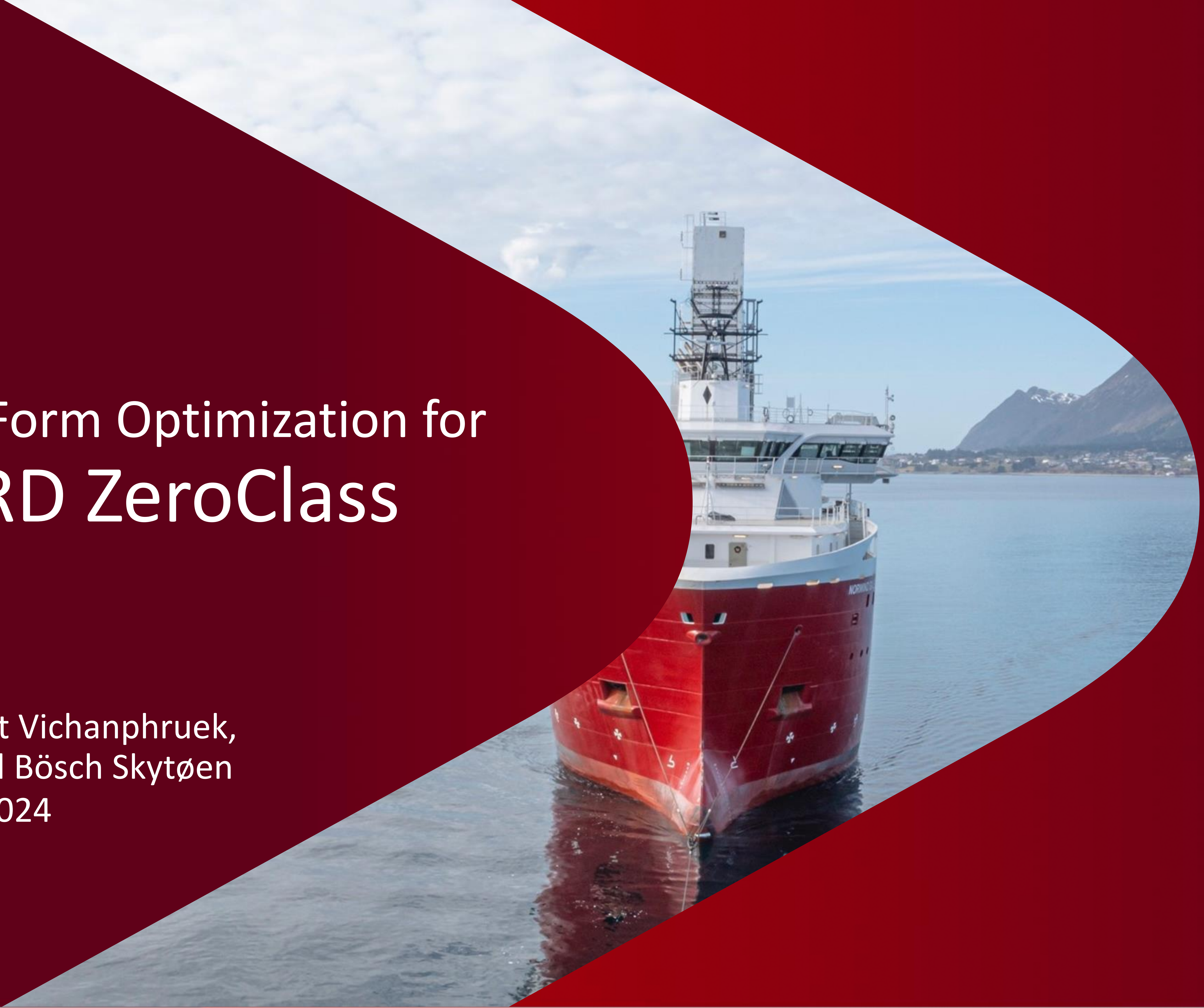
# Hull Form Optimization for VARD ZeroClass



Nuttarat Vichanphruek,
Lennard Bösch Skytøen
11.09.2024

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a Fincantieri company

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THE VARD VISION

# To lead the green and technological transition transition in maritime operations.

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a Fincantieri company

# VARD at a glance

Shipyards

7

Countries

12

HQ in Ålesund, Norway

Several specialised entities

Employees

8000

Order book

Updated Q2 2024

32

Deliveries since 2000

400+

VARD is the Offshore expert in the global Fincantieri group

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# Global design capabilities

Employees

600+

Concepts sold

Since 1988

400+

Yards

Since
2005

45+

Deliveries


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# Benchmark

## - a decade of development

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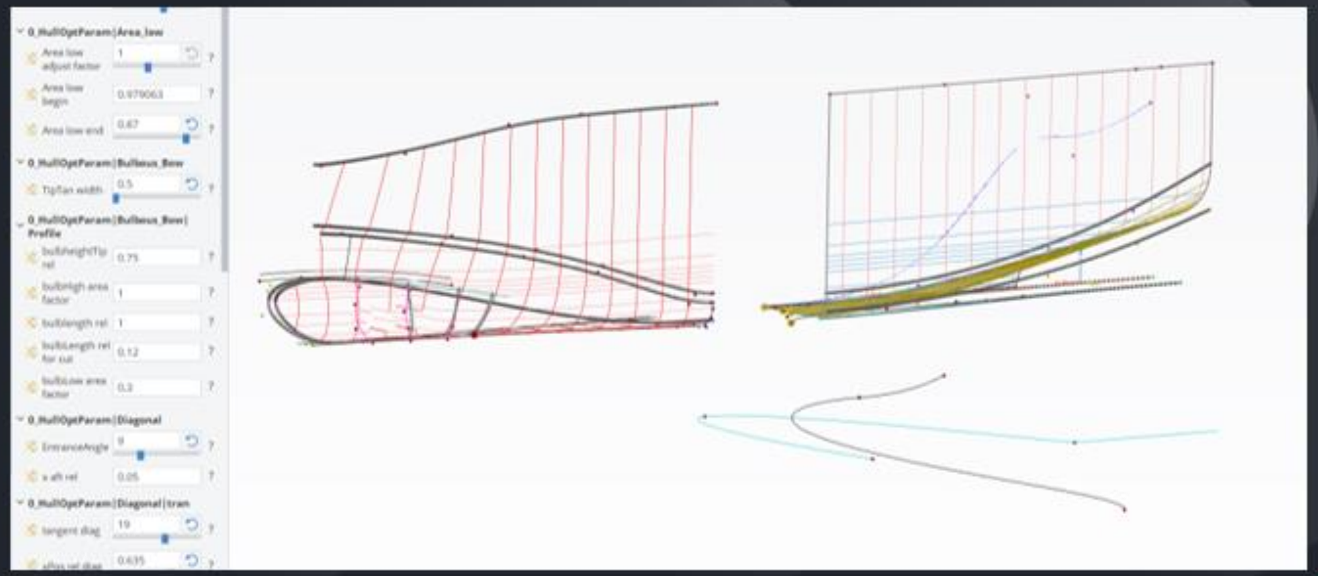
# Hull Form



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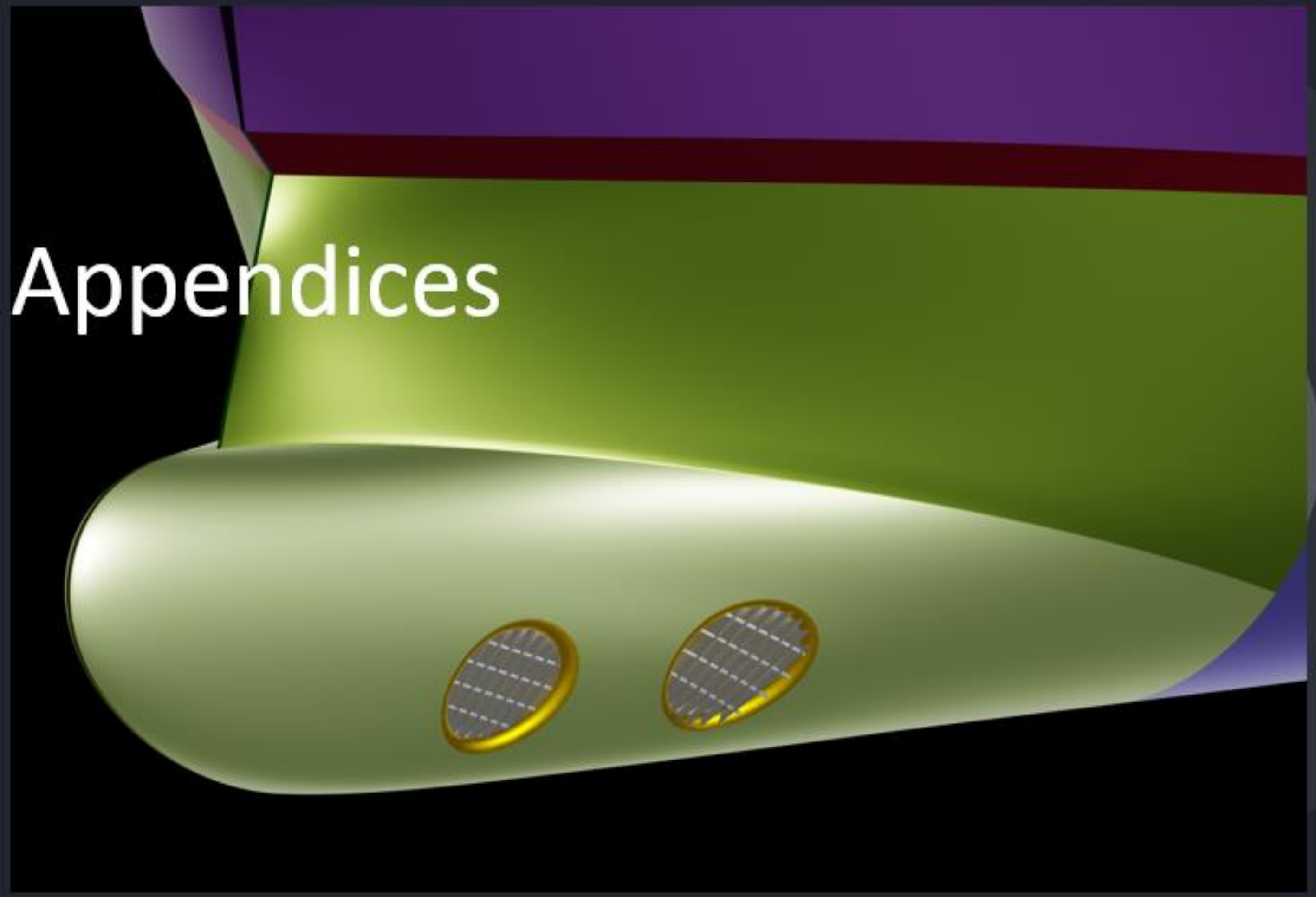
# Appendices



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# Benchmark

## - a decade of development

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# Benchmark

## - a decade of development

| | Rt | Cadx |
|---|---|---|
| Vs | Reduction | Improvement |
| 11 | 32.0% | 24.4 % |
| 13 | 25.5% | 23.0 % |
| 15 | 11.2% | 12.8 % |



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# How?

- In-House Cluster: 740 cores across 20 nodes
- (wo)manpower ( 4 dedicated hull designers )
    - 2 Research Engineers
- Software solutions
    - CFD (RANS): Star CCM+, Lemma (NiceFlow), Shipflow XCHAP
    - CFD (Potential Flow): ShipX, Shipflow Motions/Xpan
    - CAD: Rhino, Caeses

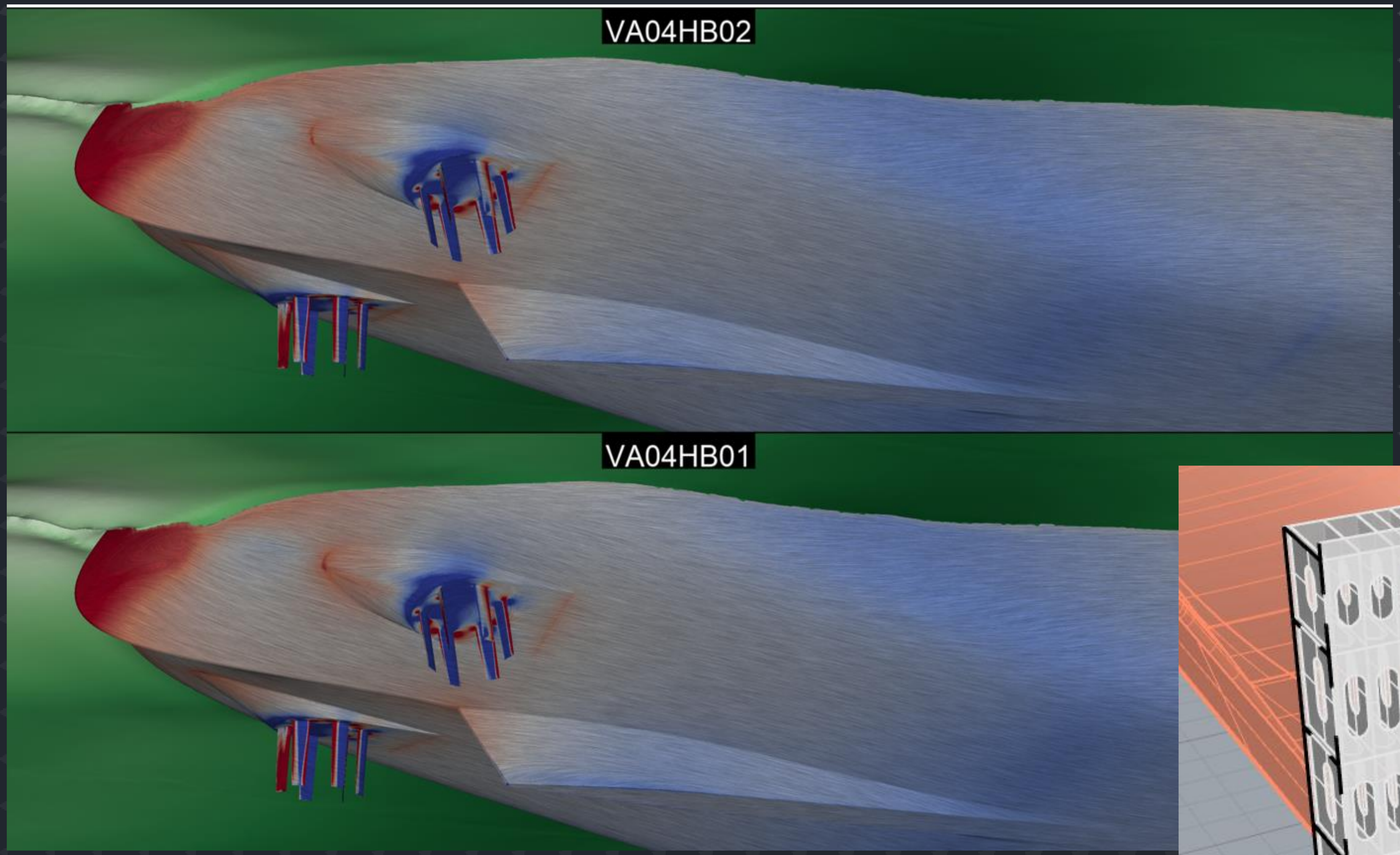
# When?

Concept Development (Pre-Signing)

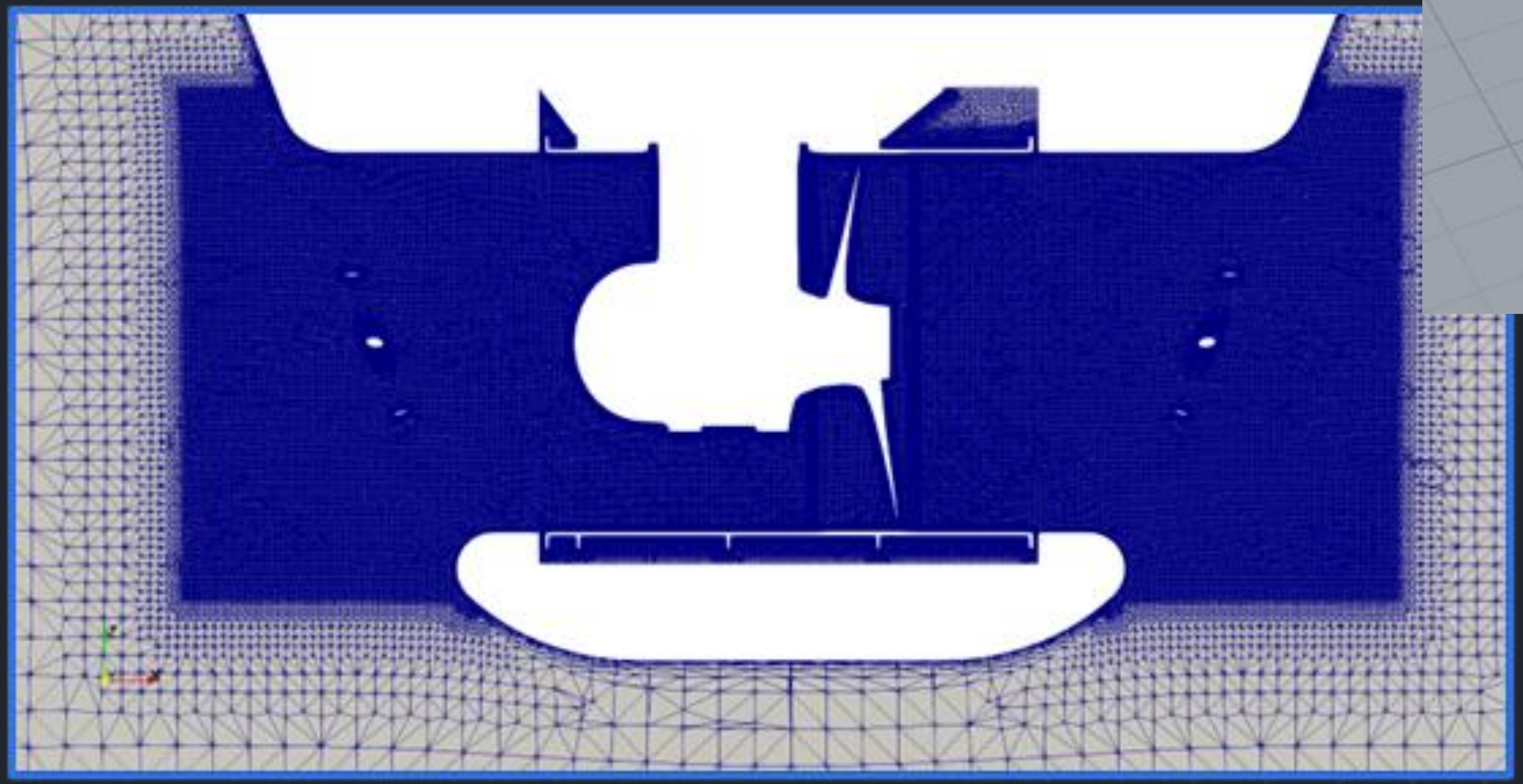
Client Collaboration

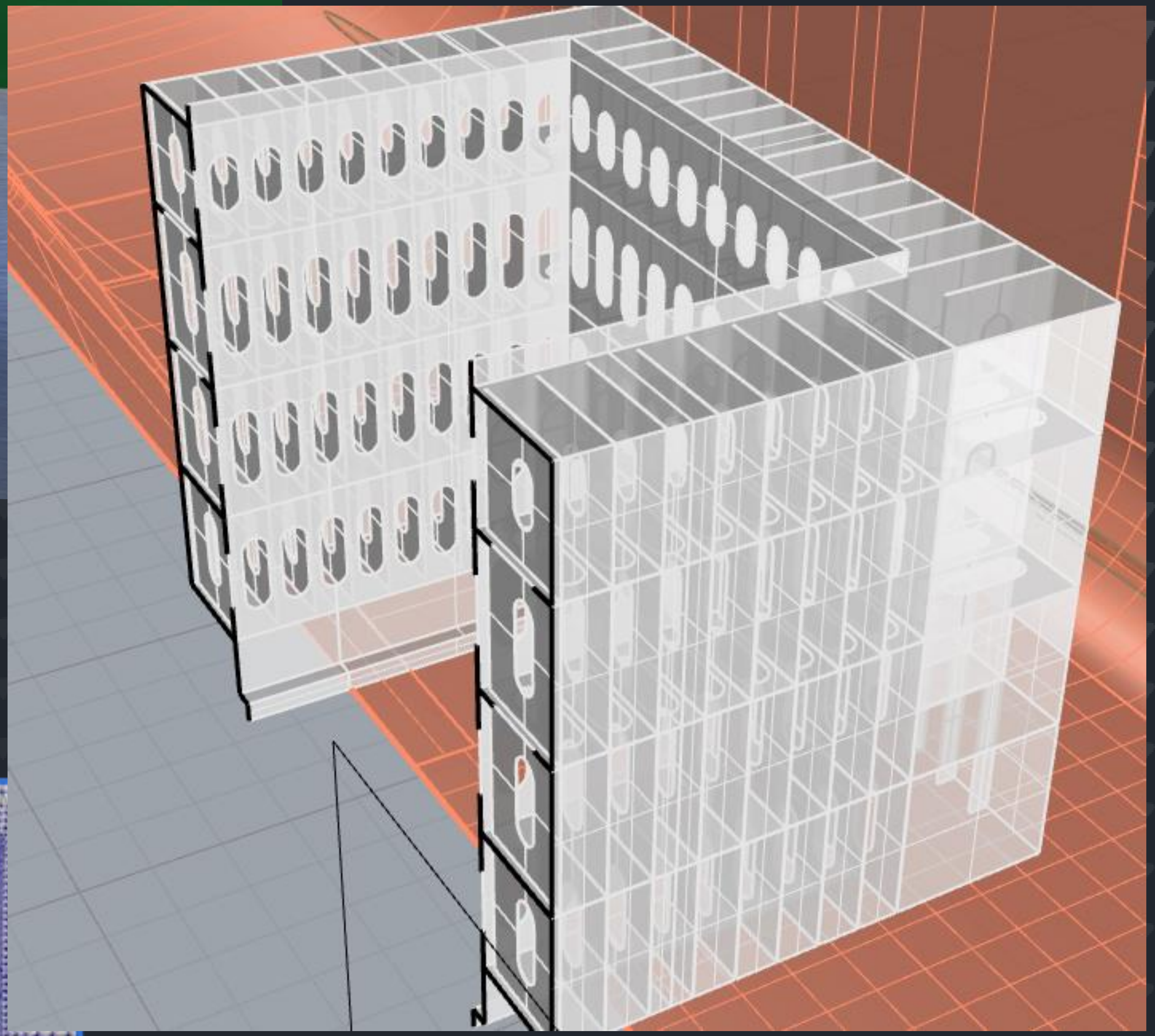
Custom Vessel Development in 1 Month

# Why *Caeses?*



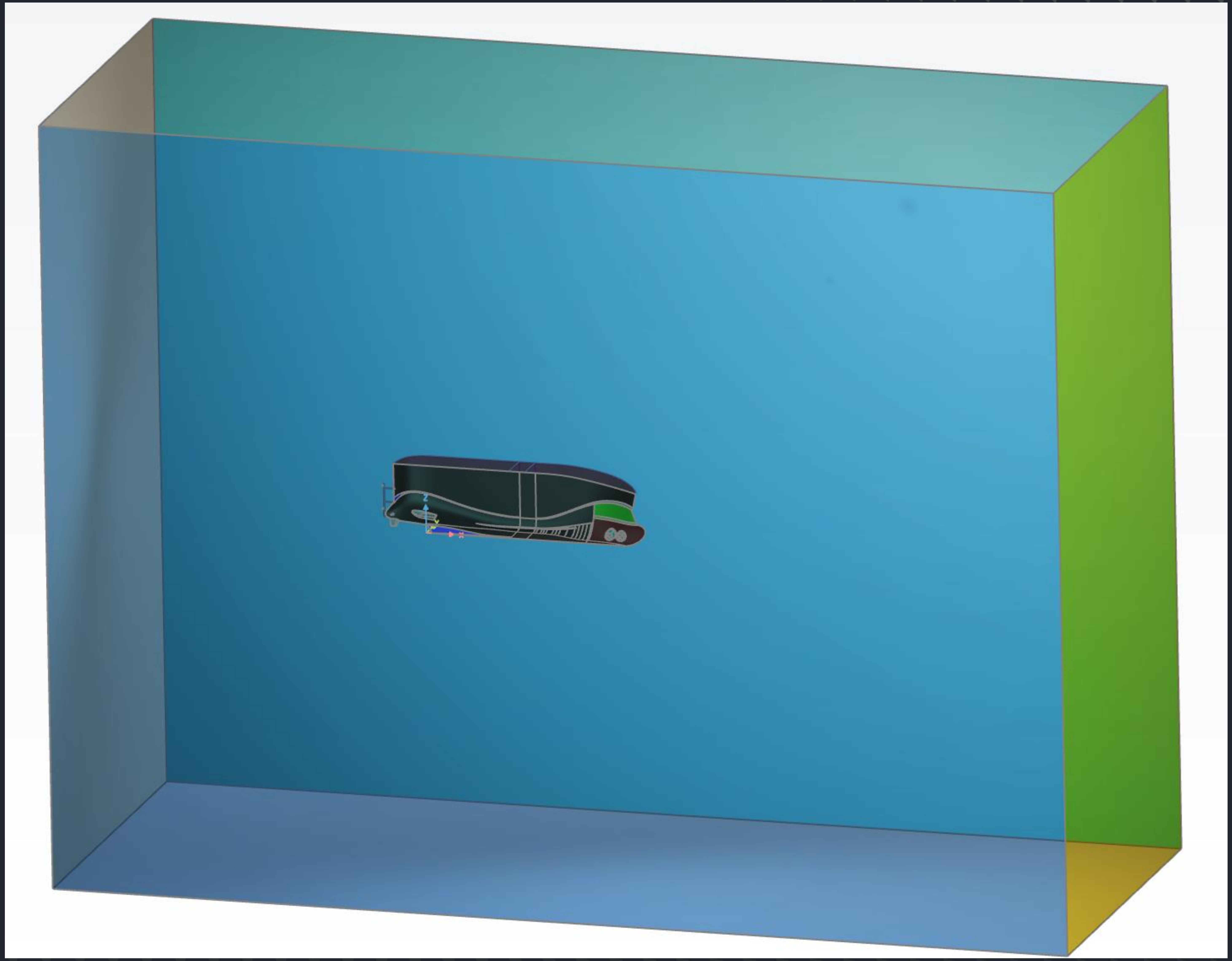

- Hull form optimization
- Fast development of custom appendices





# Why *Caeses?*

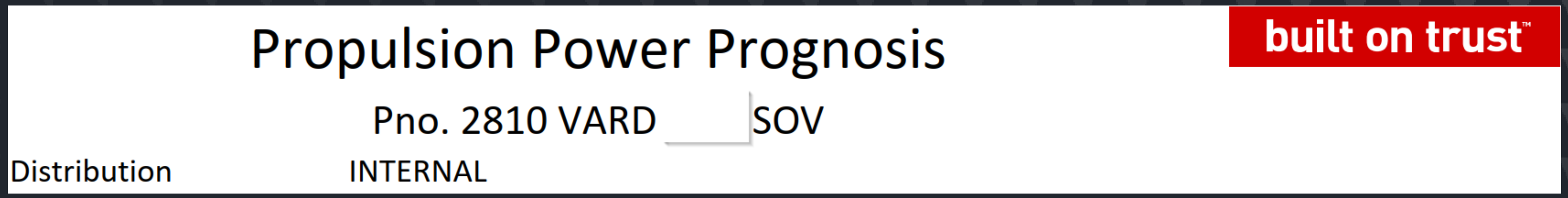
- Hull form optimization
- Fast development of custom appendices
- Smooth surfaces →Clean geometry for CFD



# Where?

Hull

# Where?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Propulsion Power Prognosis
Pno. 2810 VARD SOV
Distribution INTERNAL

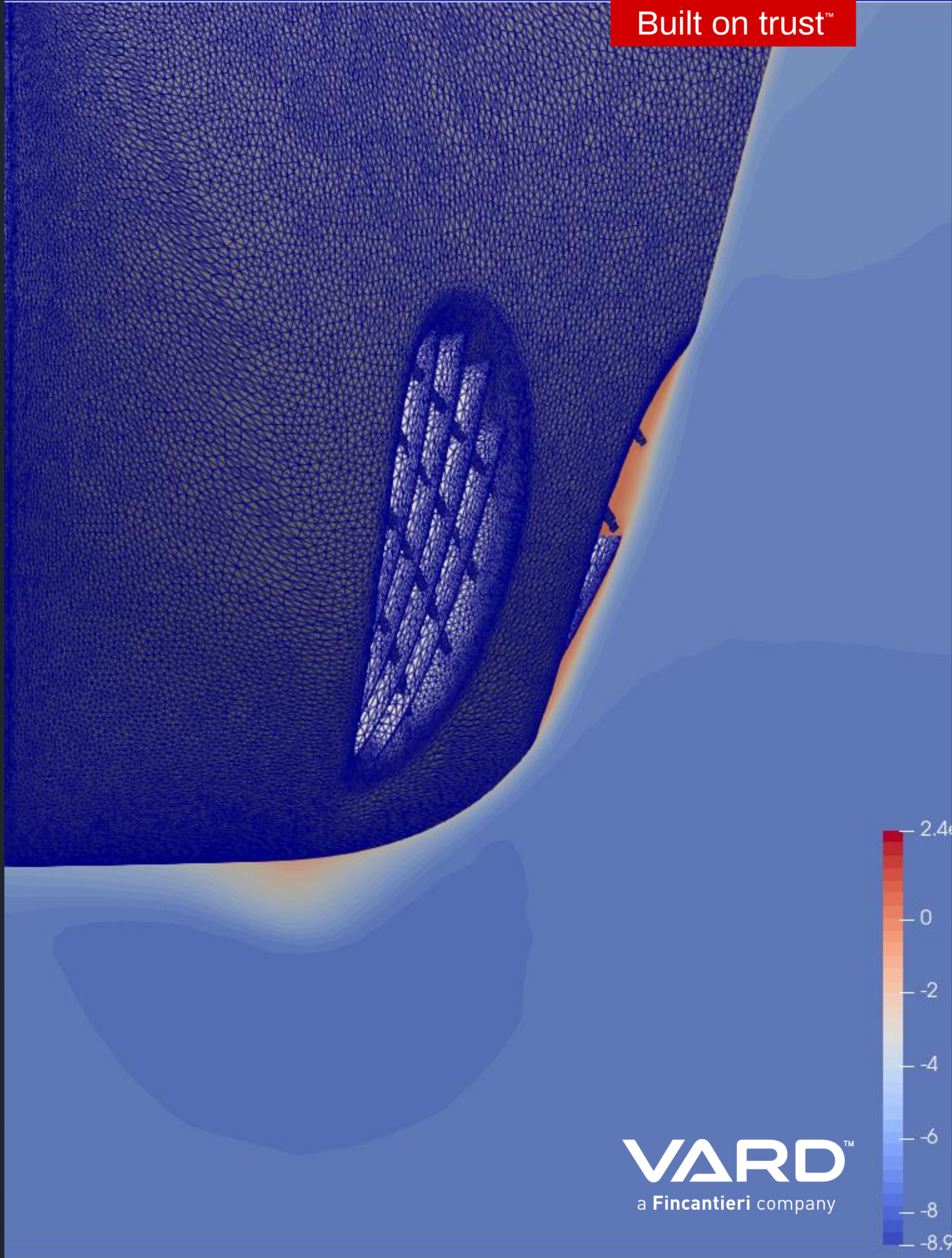
# Where?

Contracted Speed

Fuel Efficiency

Hull

General Arrangement



# Where?

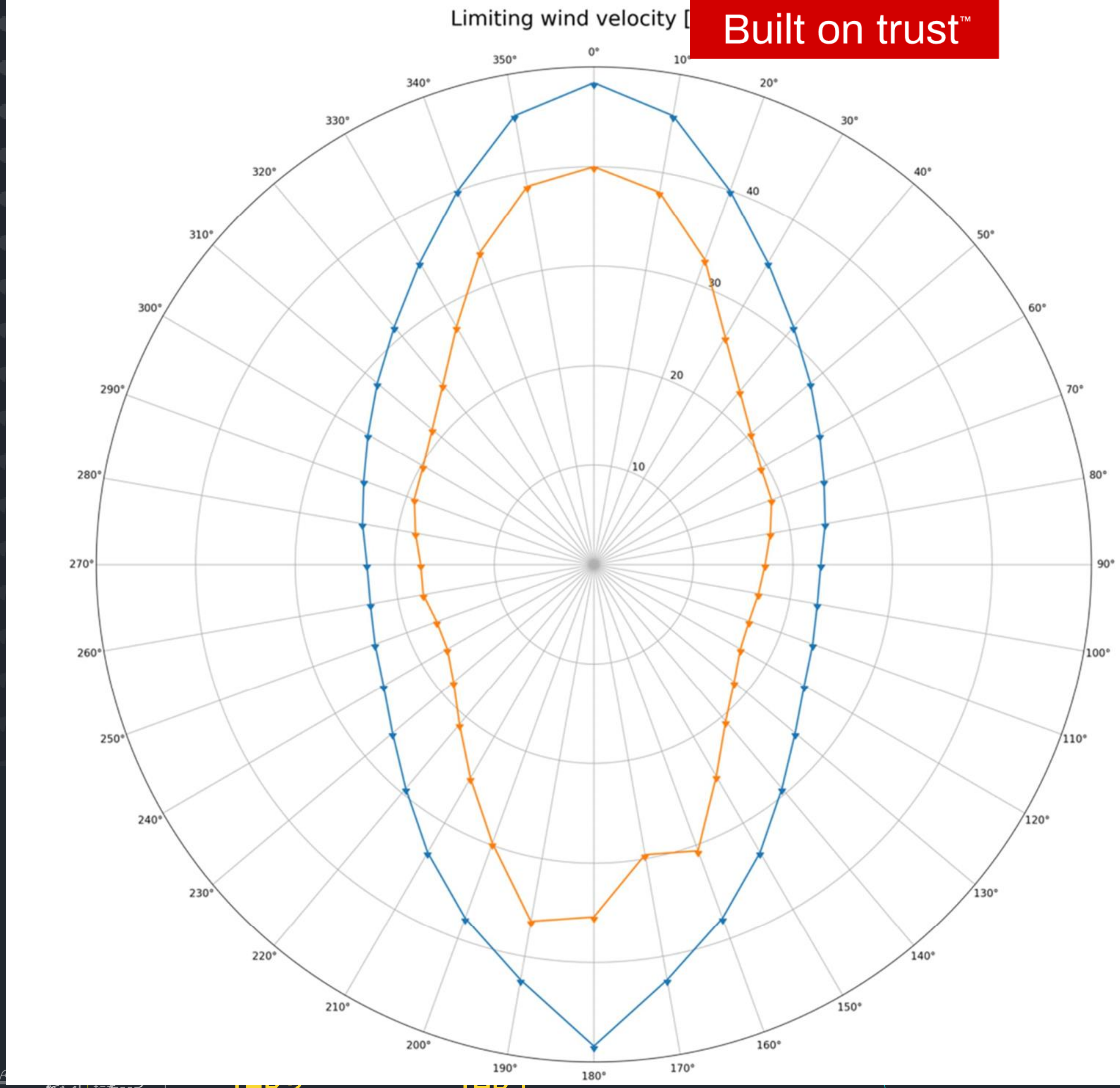
Contracted Speed

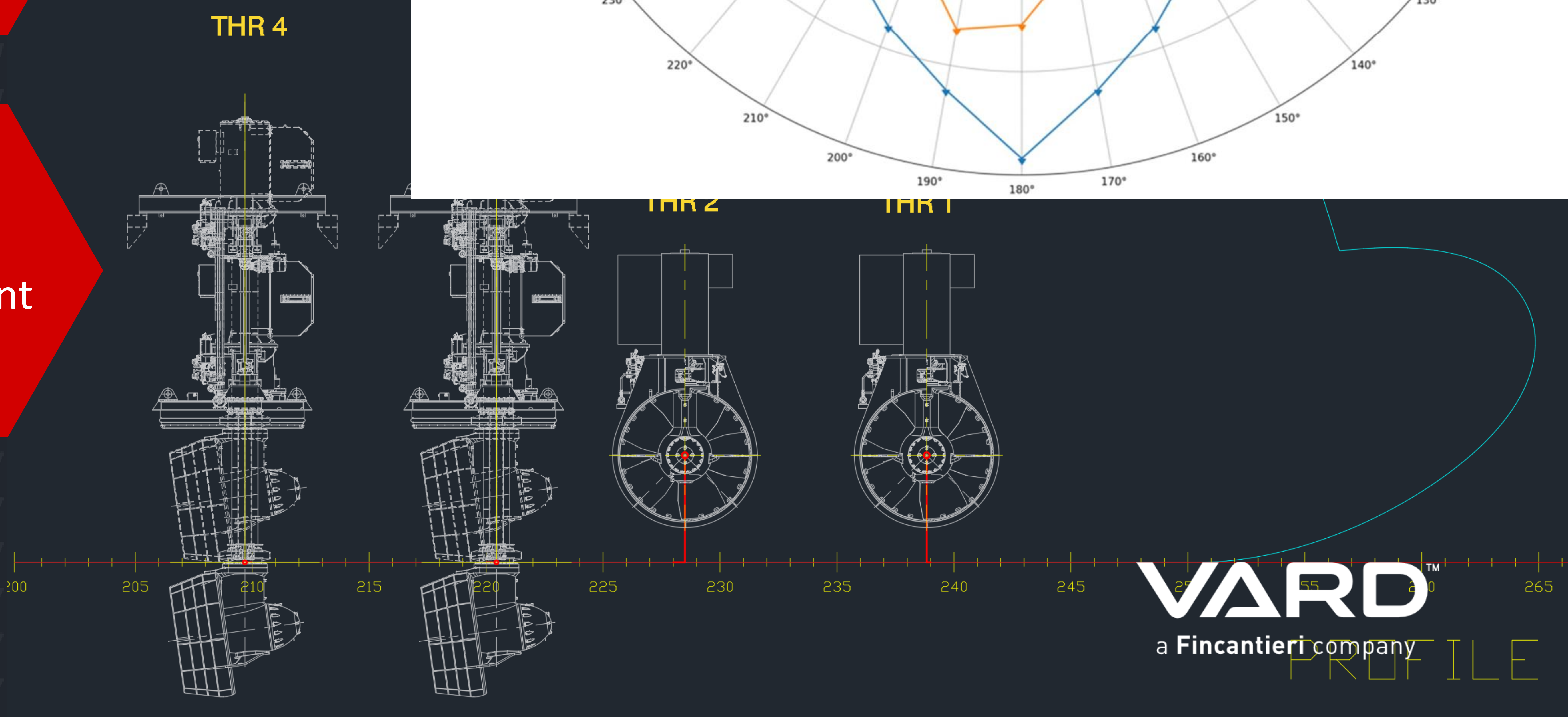
Fuel Efficiency

Hull

General Arrangement

DP capability

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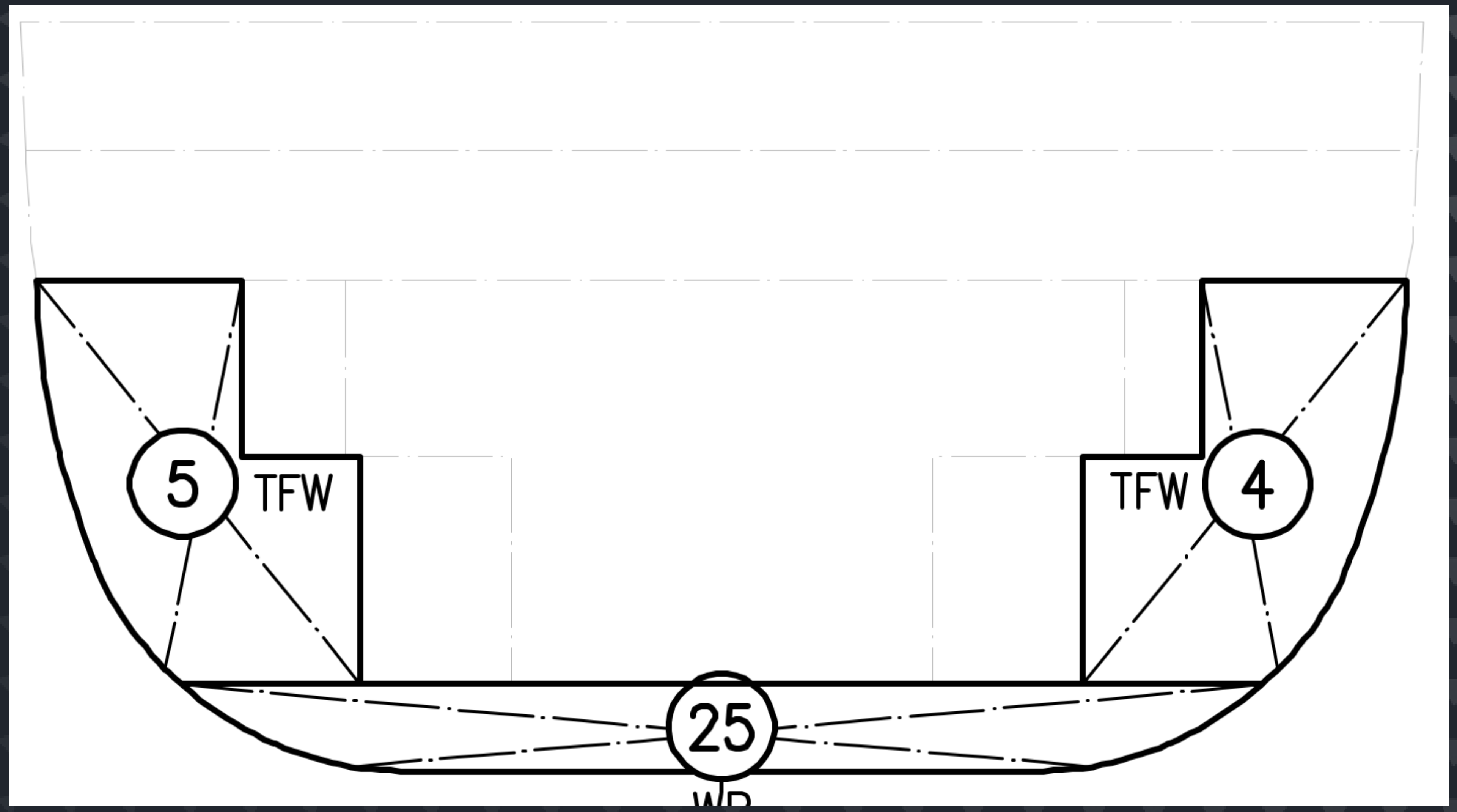
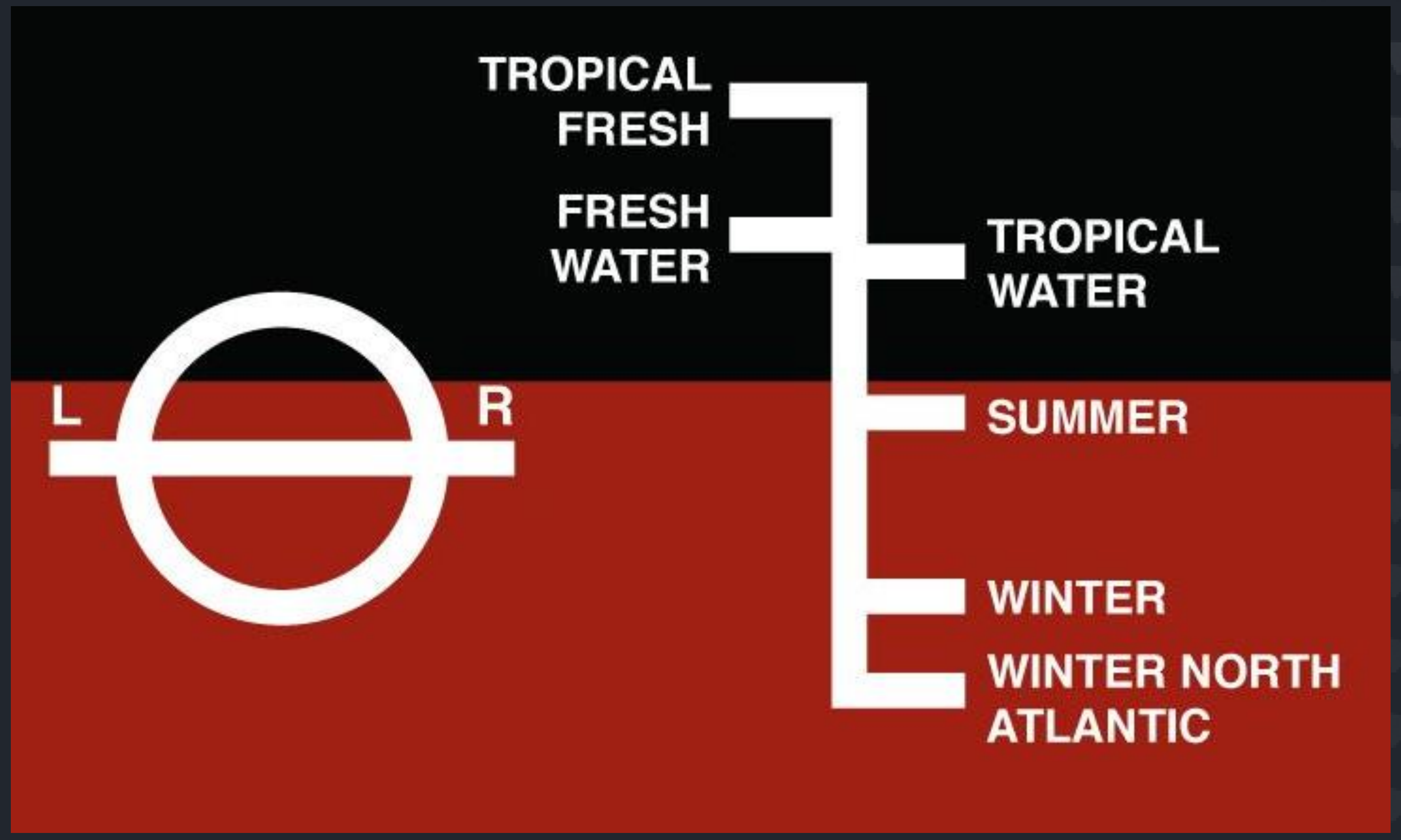
# Where?


Contracted Speed
Fuel Efficiency
Hull
Weight
General Arrangement
DP capability

# Where?


Contracted Speed
Stability
Fuel Efficiency
Hull
Weight
General Arrangement
DP capability

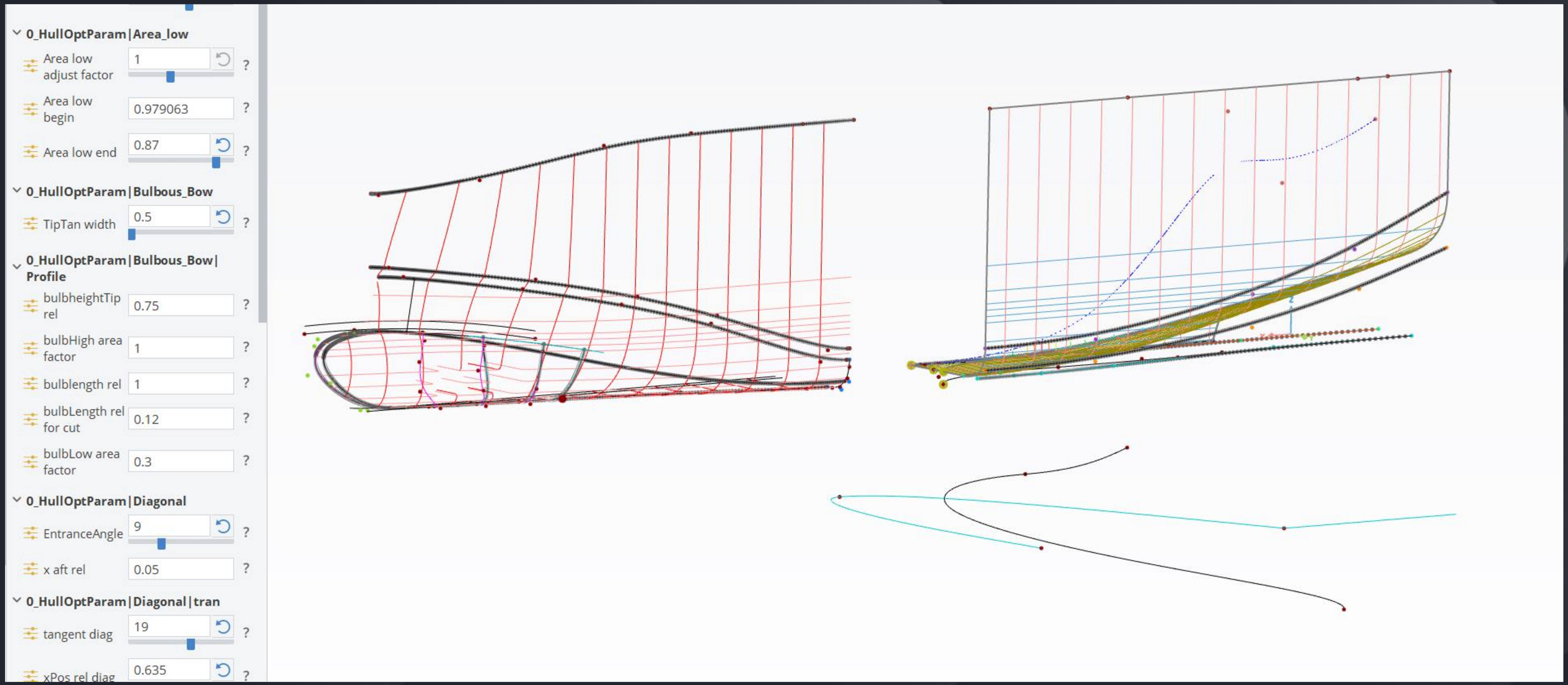

5
TFW
TFW
4
25


TROPICAL FRESH
FRESH WATER
TROPICAL WATER
L
R
SUMMER
WINTER
WINTER NORTH ATLANTIC

# Where?


→ Balancing Opposing Performance Metrics

# Hull Form

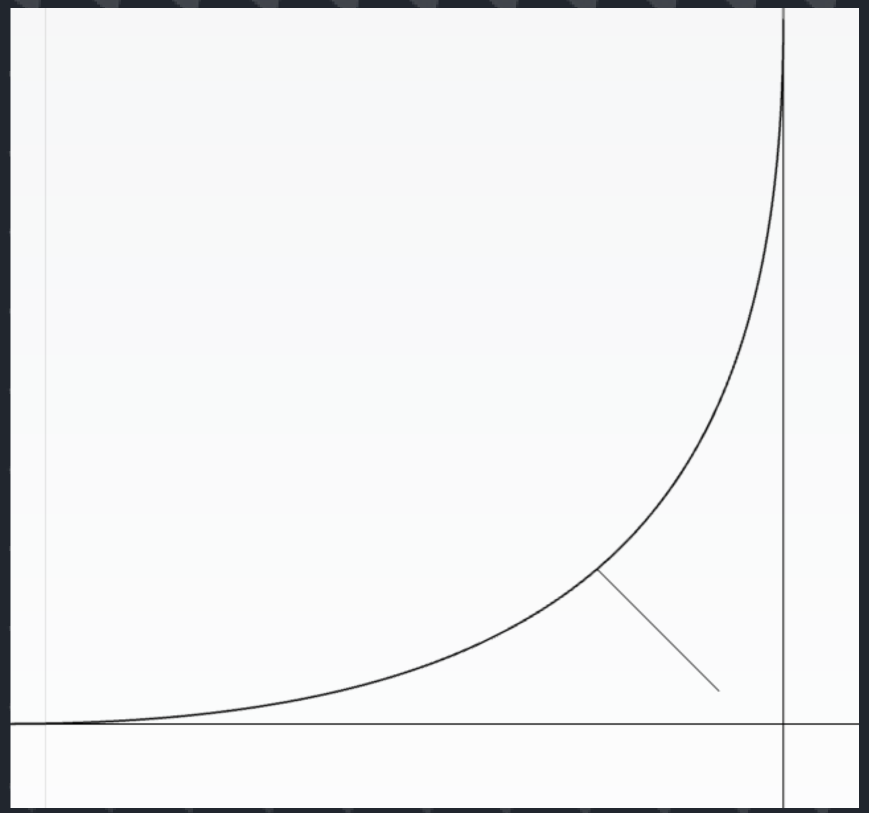


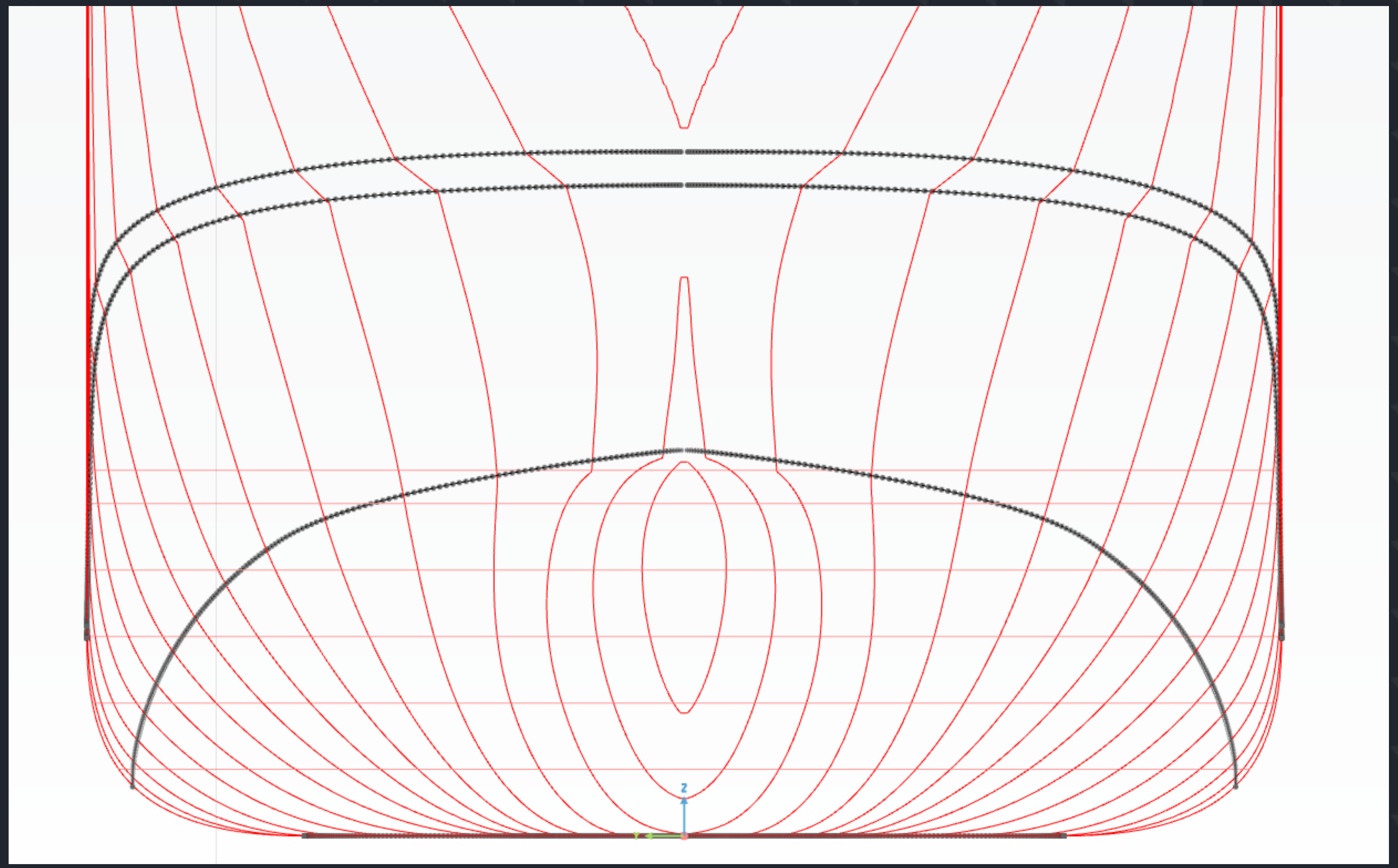
0_HullOptParam|Area_low
Area low adjust factor
1
Area low begin
0.979063
Area low end
0.87
0_HullOptParam|Bulbous_Bow
TipTan width
0.5
0_HullOptParam|Bulbous_Bow|Profile
bulbheightTip rel
0.75
bulbHigh area factor
1
bulblength rel
1
bulbLength rel for cut
0.12
bulbLow area factor
0.3
0_HullOptParam|Diagonal
EntranceAngle
9
x aft rel
0.05
0_HullOptParam|Diagonal|tran
tangent diag
19
xPos rel diag
0.635

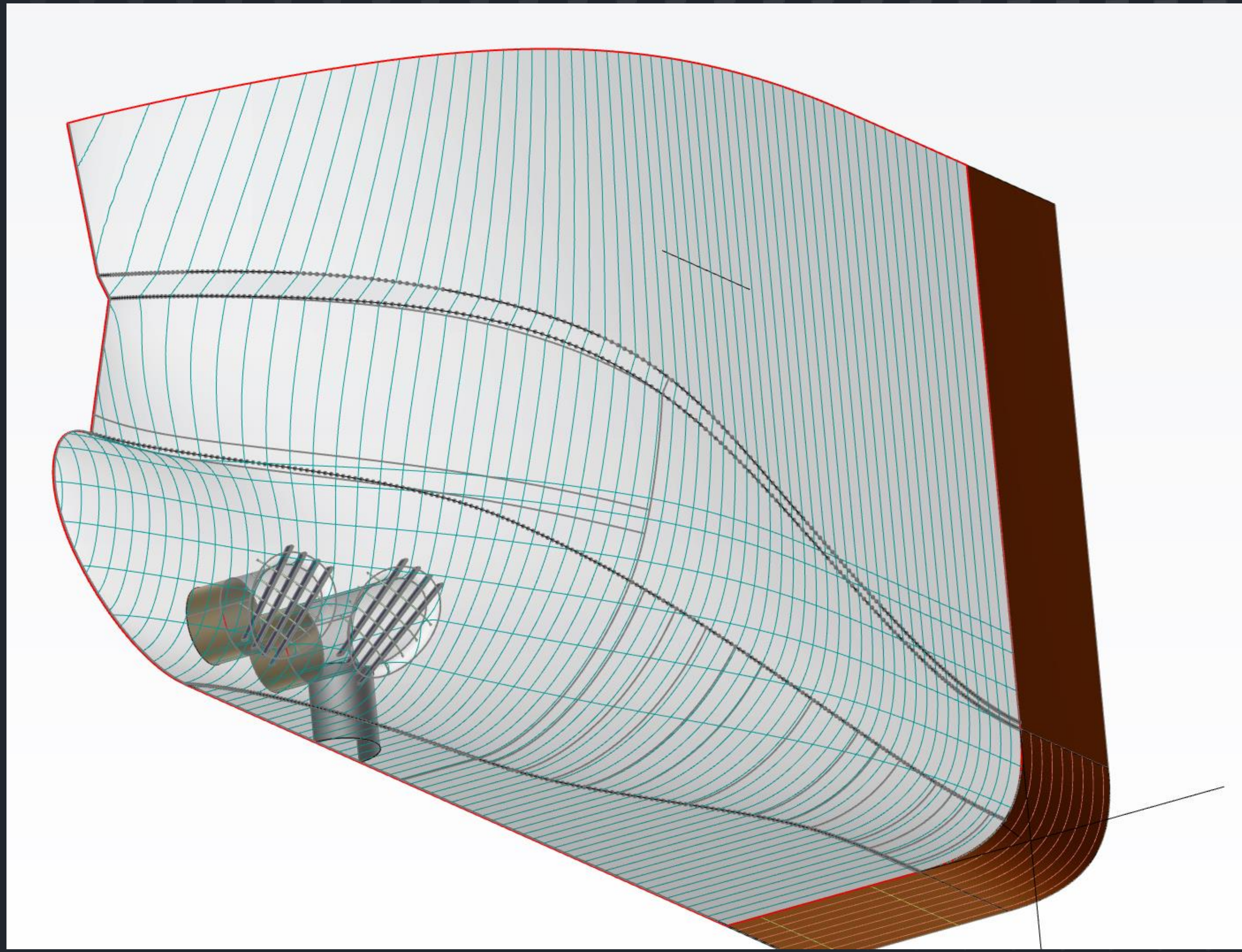
# CAESES model

Focus on the bow

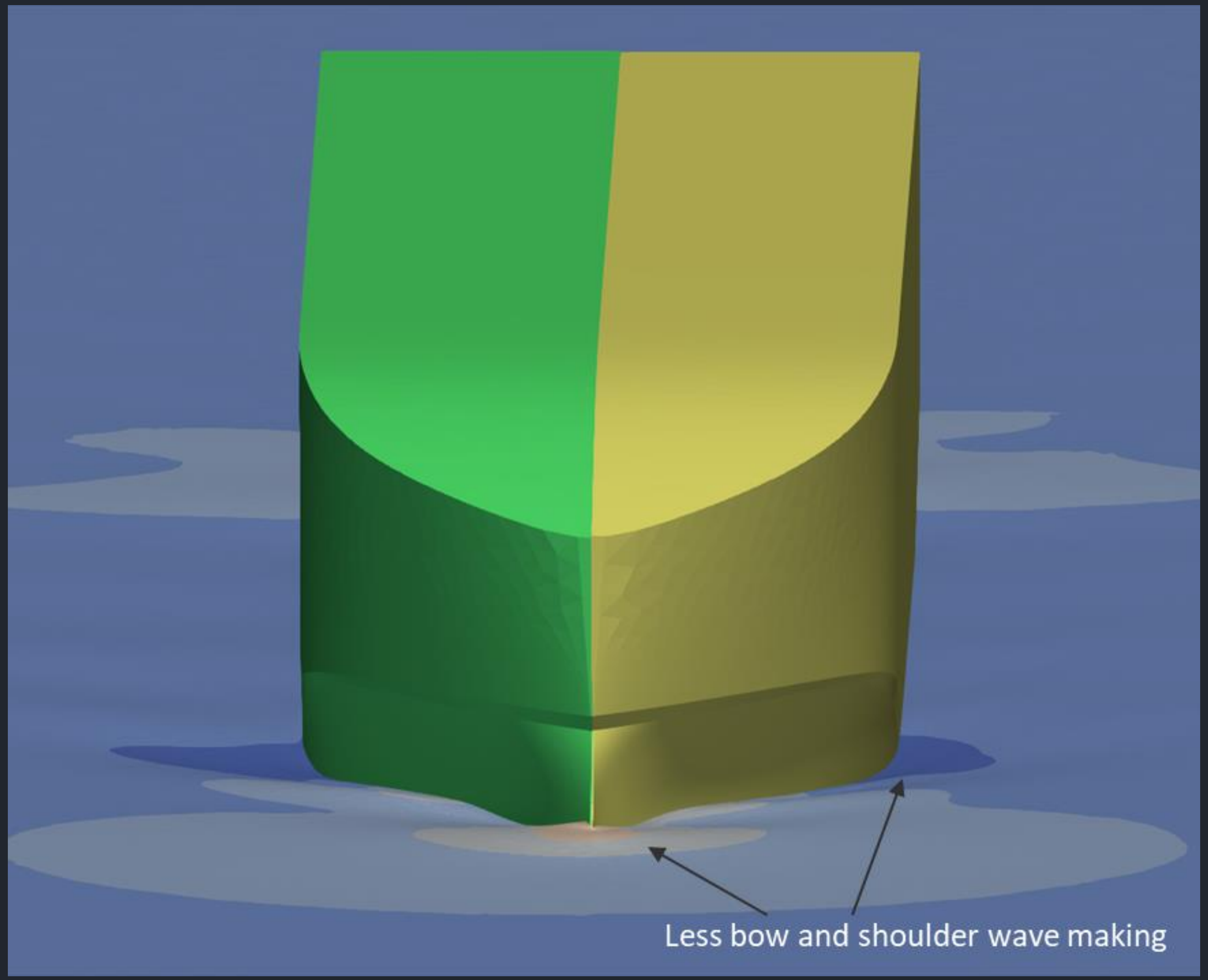
- Model the Bilge radius together with bilge keel
- Fix the main curves for all constraints we have.
- Optimize foreship with XPAN potential flow.



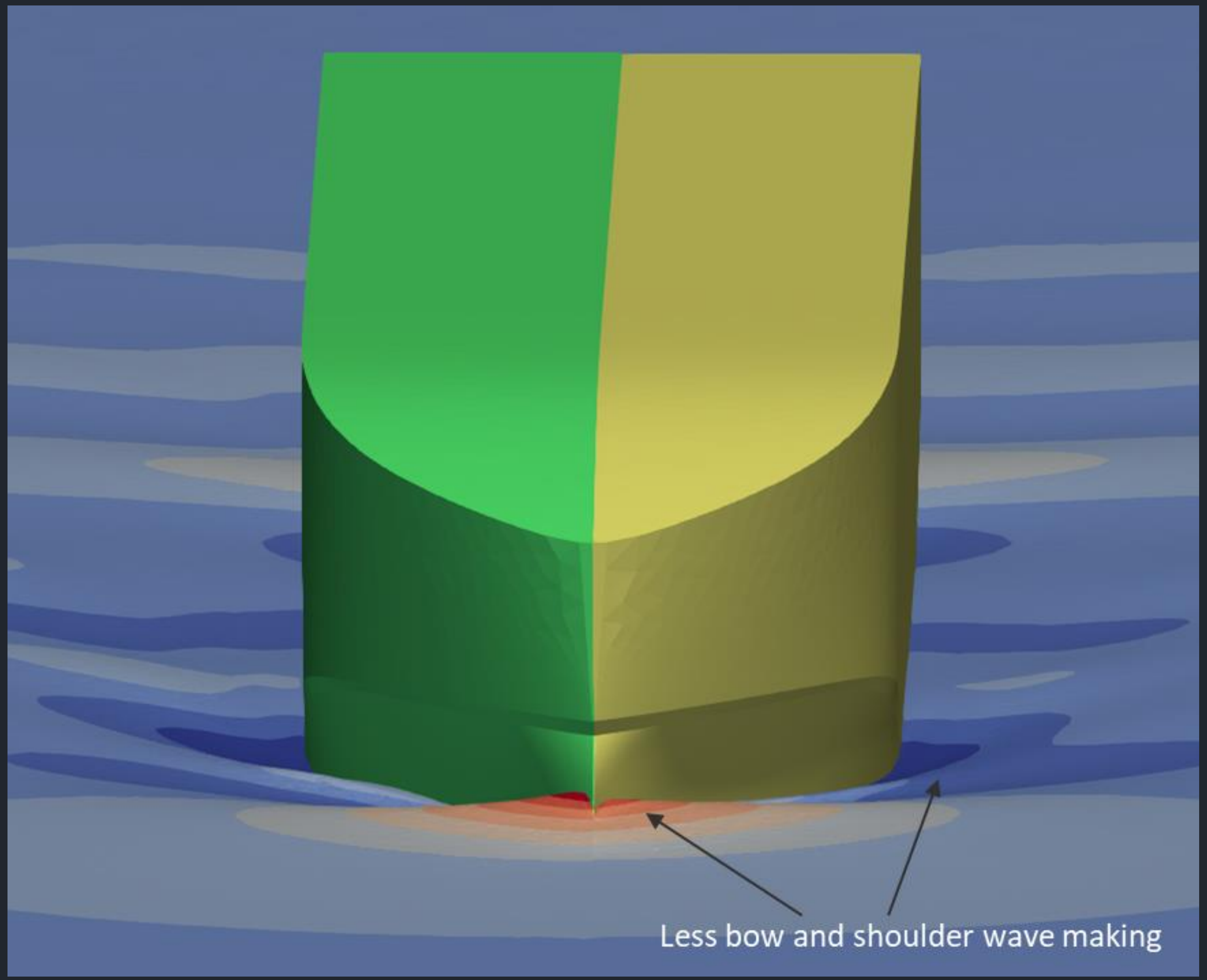




# Foreship Optimization




Wave pattern at 11 knots.




Wave pattern at 14 knots.

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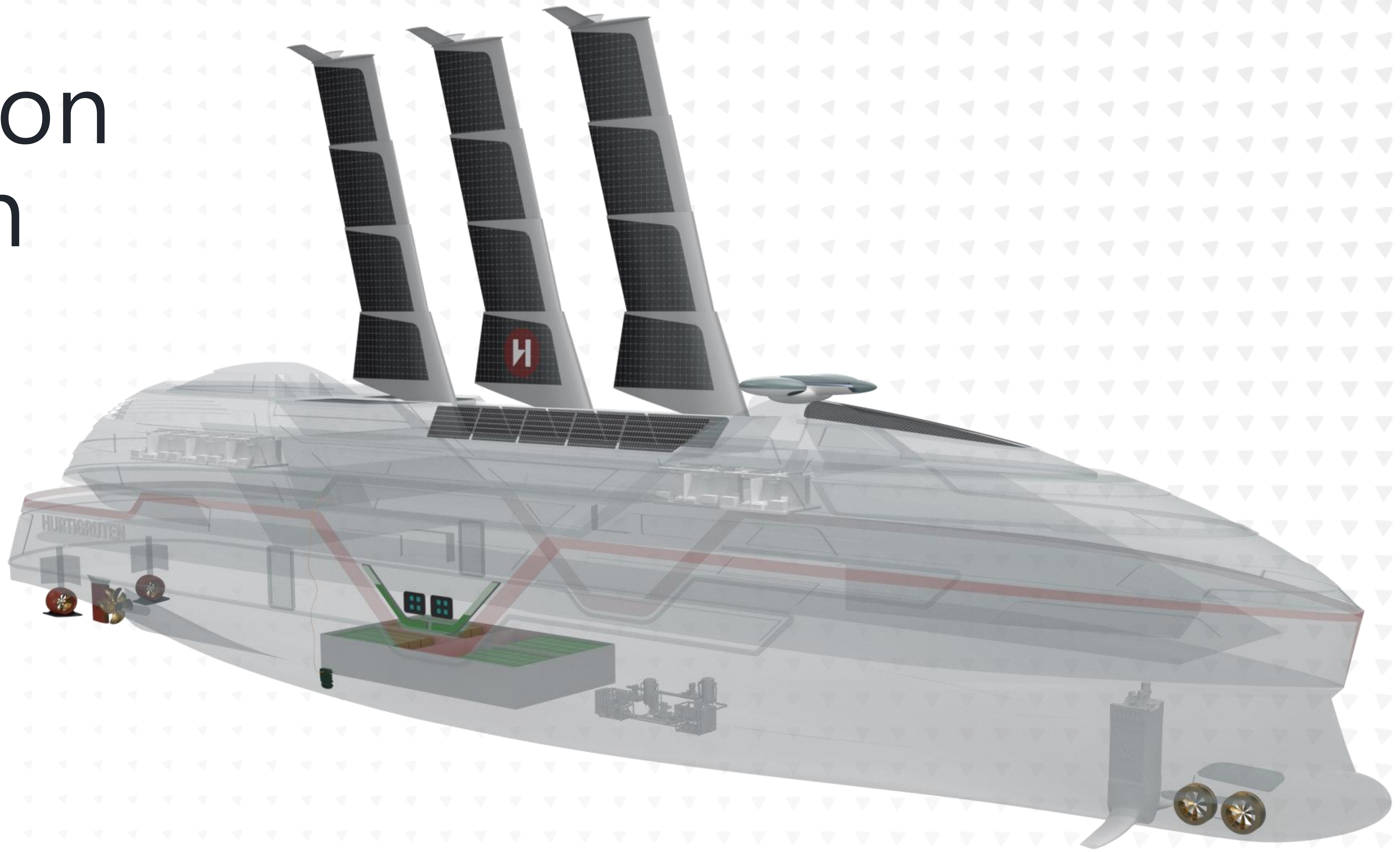
# Self Propulsion Optimisation



## The Sea Zero Consortium

HURTIGRUTEN NORWAY

Bergen Havn
BRUNVOLL
CAVOTEC

Corvus Energy
DNV
JOTUN

Norske Havner
pluq
SINTEF

Sjøfartsdirektoratet Norwegian Maritime Authority
SUSTAINABLE ENERGY | NORWEGIAN CATAPULT CENTRE
TEKNOTHERM

SeaZero

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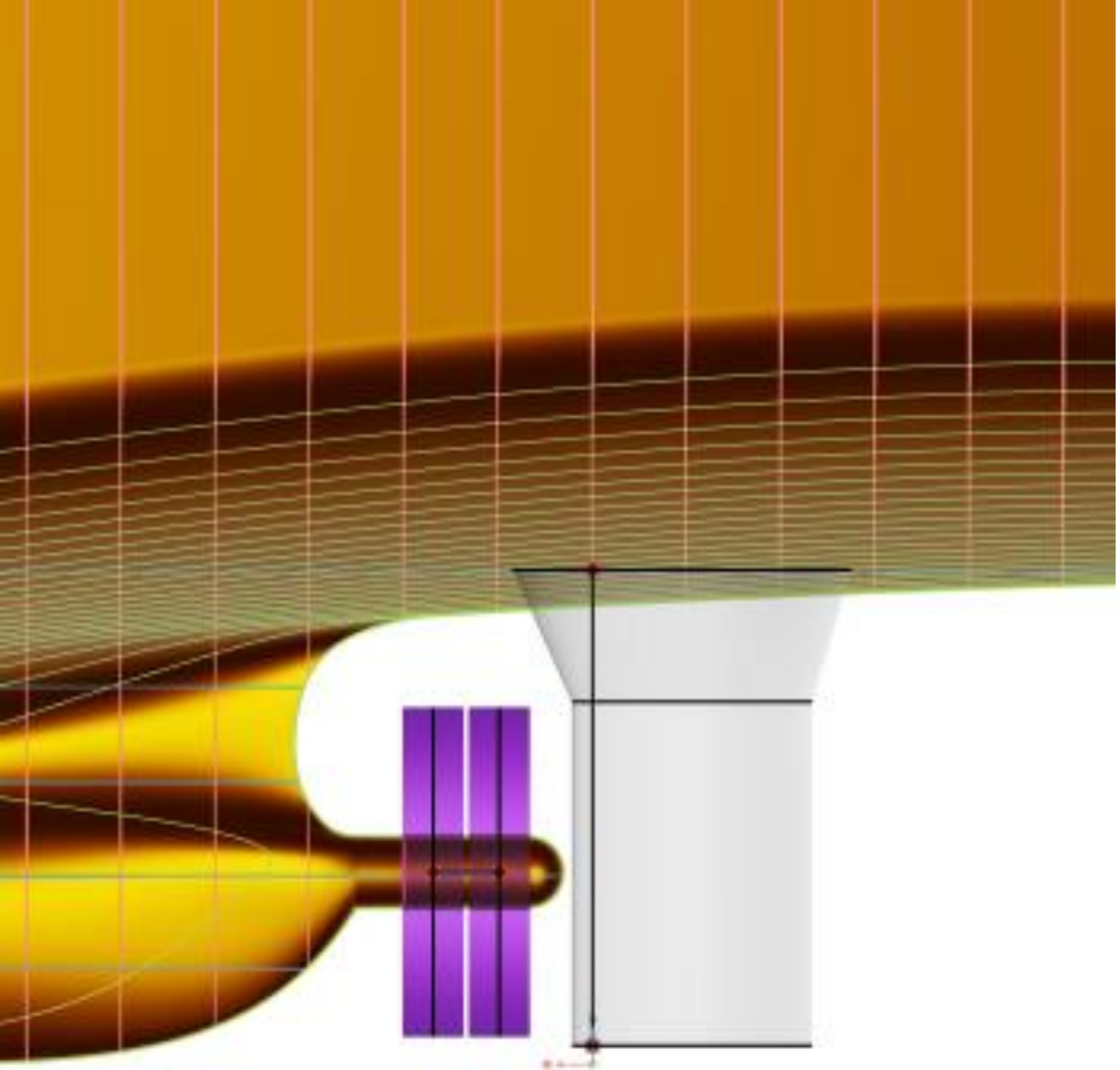
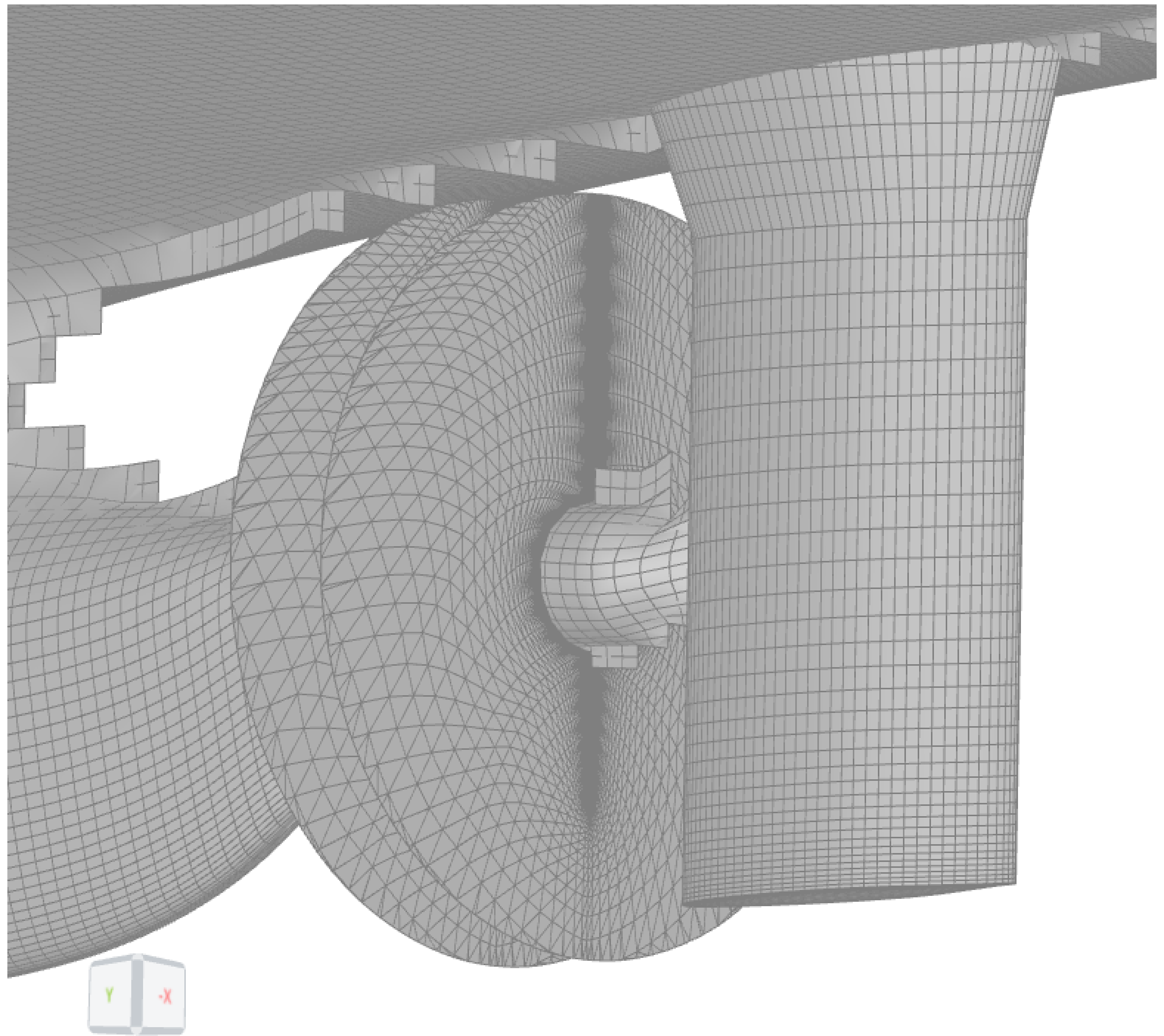
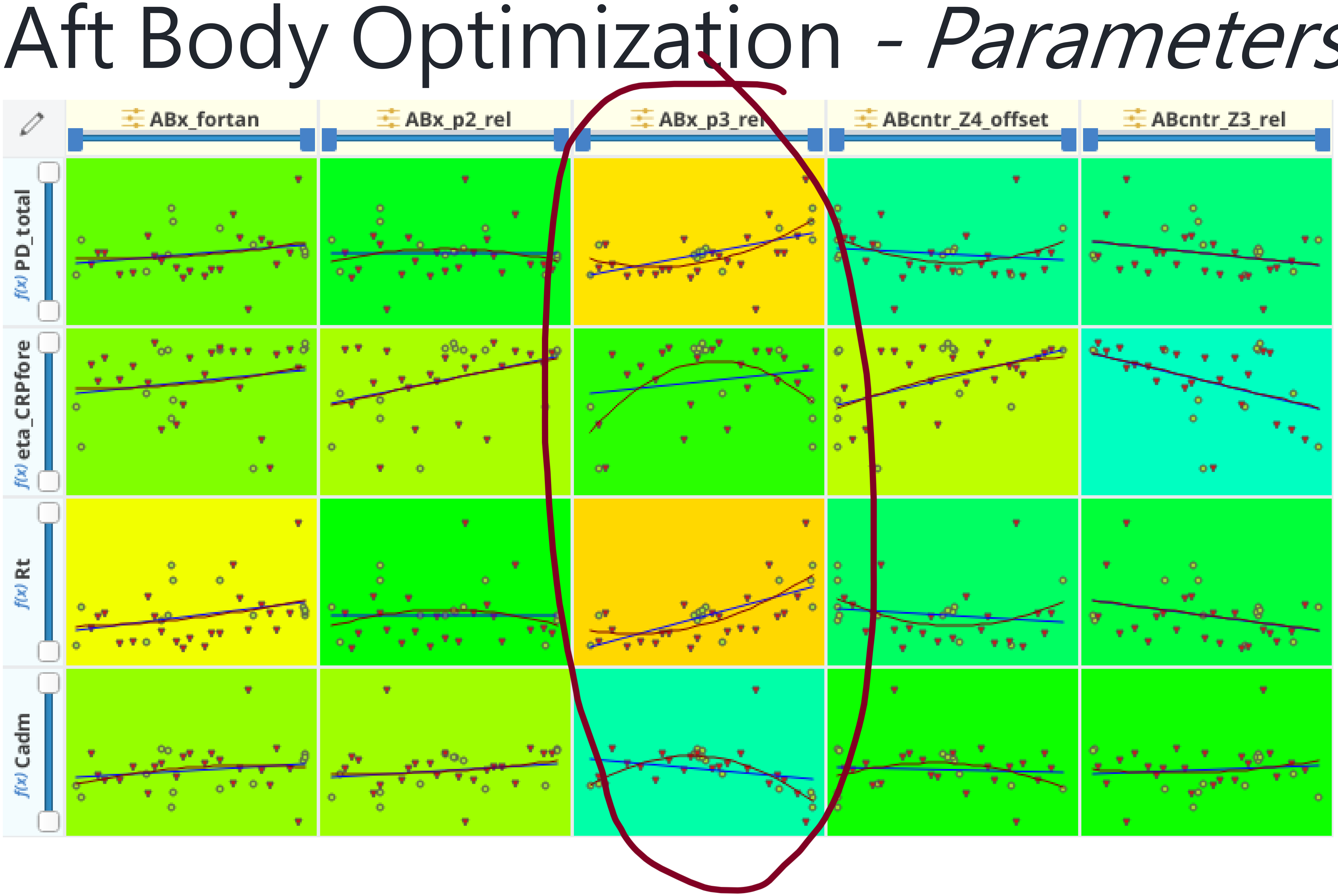


# Contra-Rotating-Propeller

Shipflow XCHAP

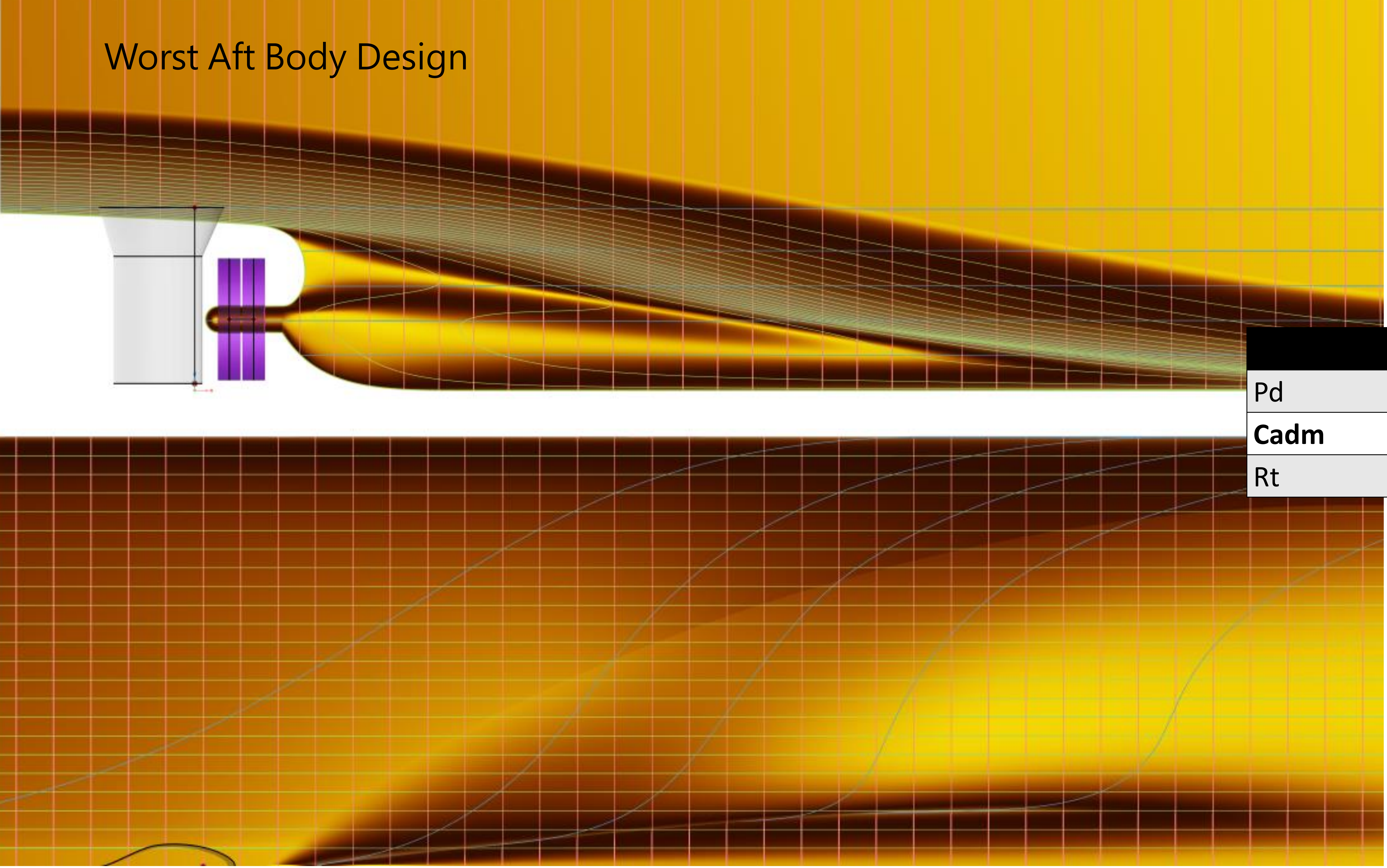


# Aft Body Optimization - *Parameters*



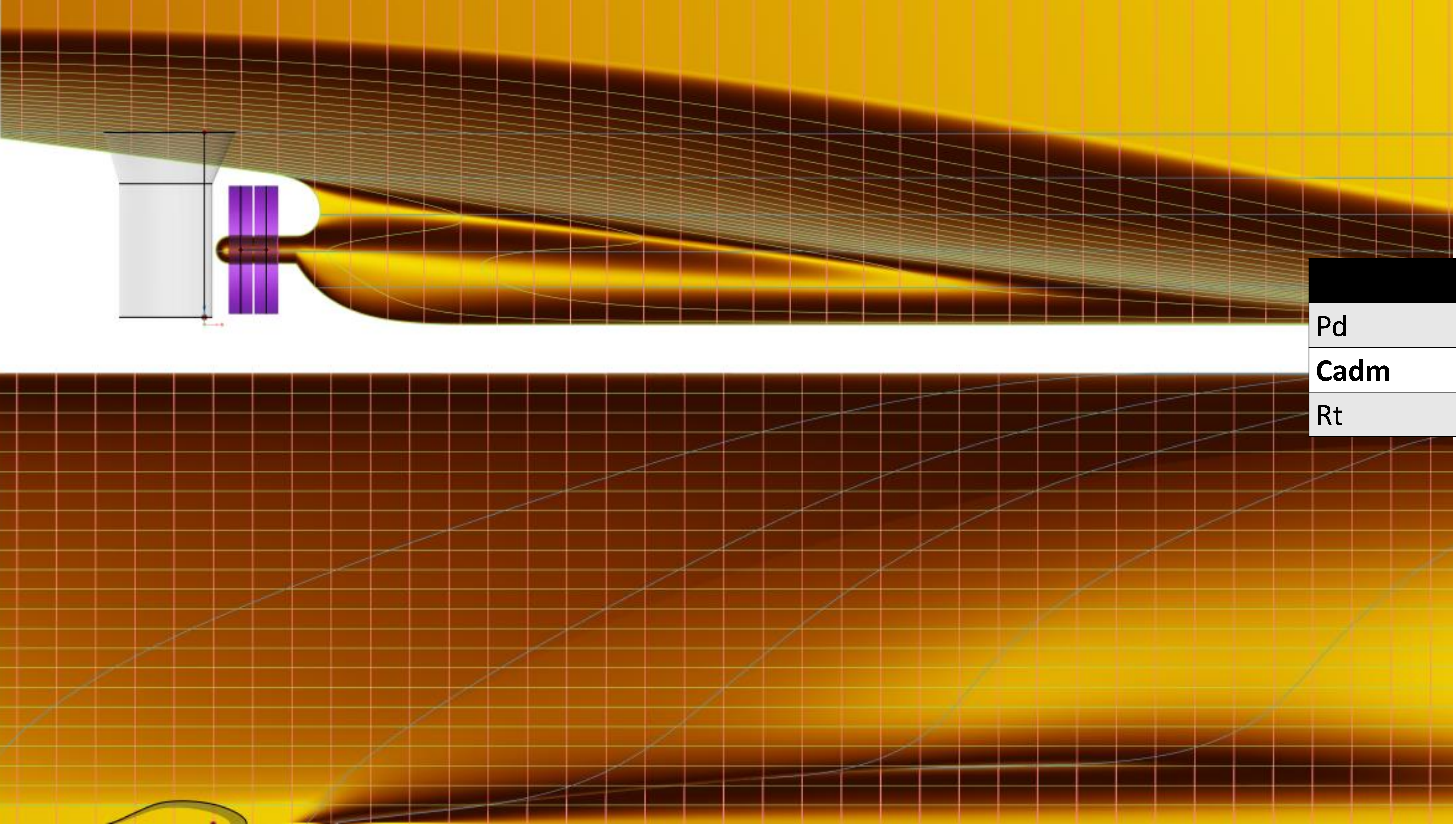

| Parameter |
|---|
| Relative p3 x position |
| Aft rise |
| Relative fore tangent length |
| Relative p2 x position |
| Relative Mid Rise |

# Worst Aft Body Design



| | |
|---|---|
| Pd | 100 % |
| **Cadm** | **581 [-]** |
| Rt | 100 % |

# Bad Aft Body Design



| [redacted] | |
|---|---|
| Pd | 95.0 % |
| **Cadm** | **606 [-]** |
| Rt | 94.9 % |

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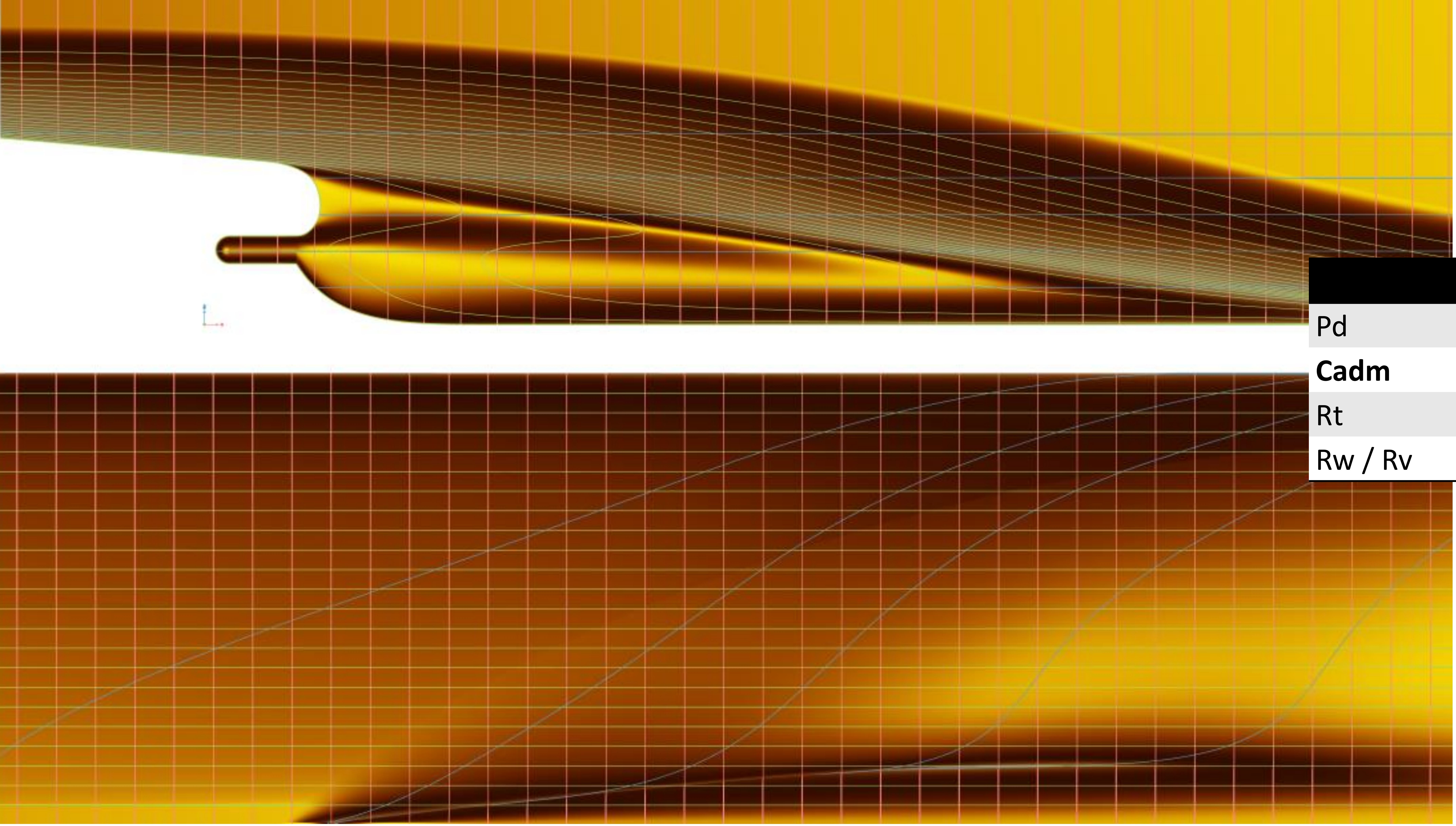
# Optimum Aft Body Design



| [redacted] | |
|---|---|
| Pd | 92.7 % |
| **Cadm** | **617 [-]** |
| Rt | 92.8 % |
| Rw / Rv | 6.1 % |

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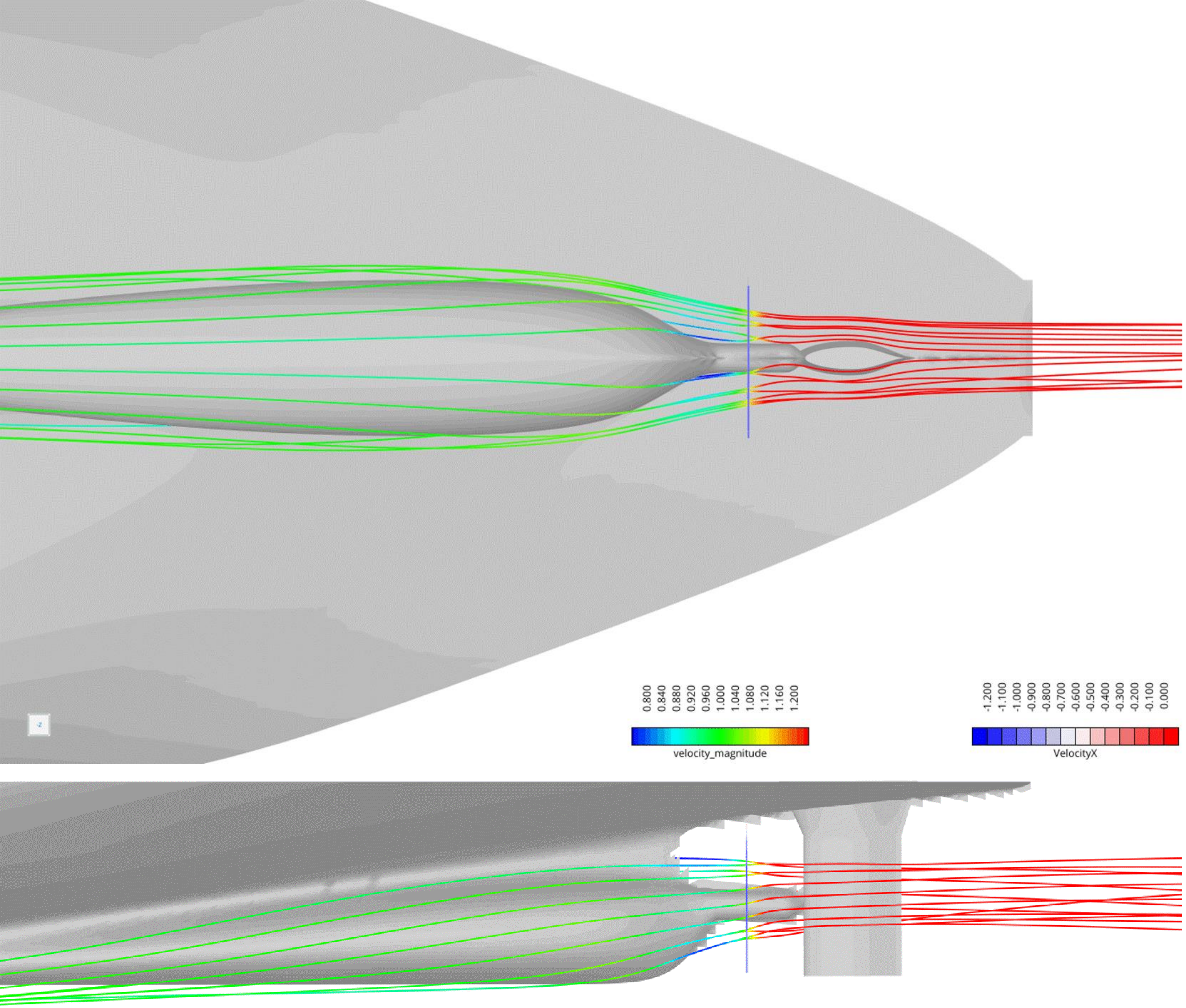
# Design space exploration
*(SOBOL)*

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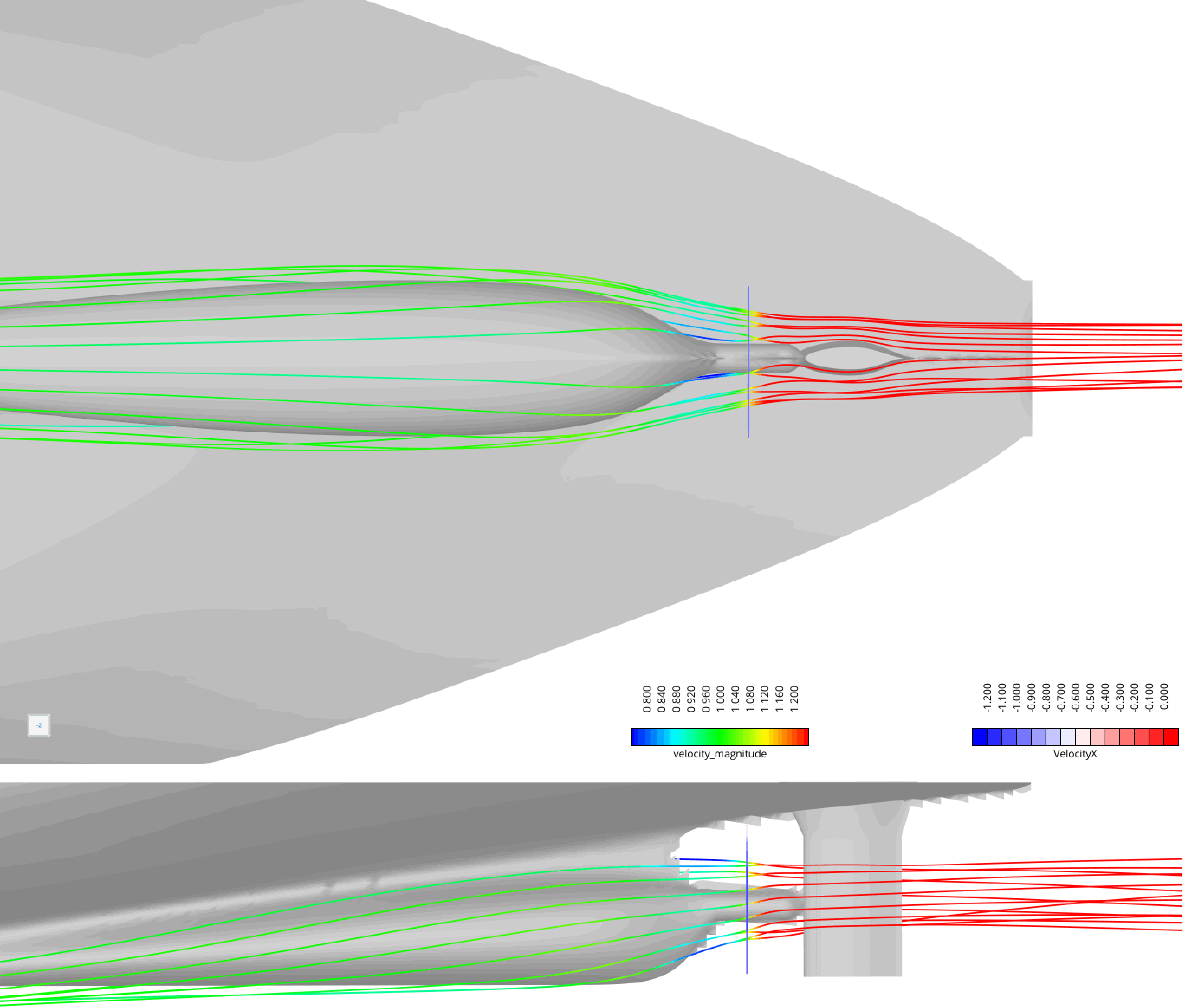
# Design space exploration
*(SOBOL)*

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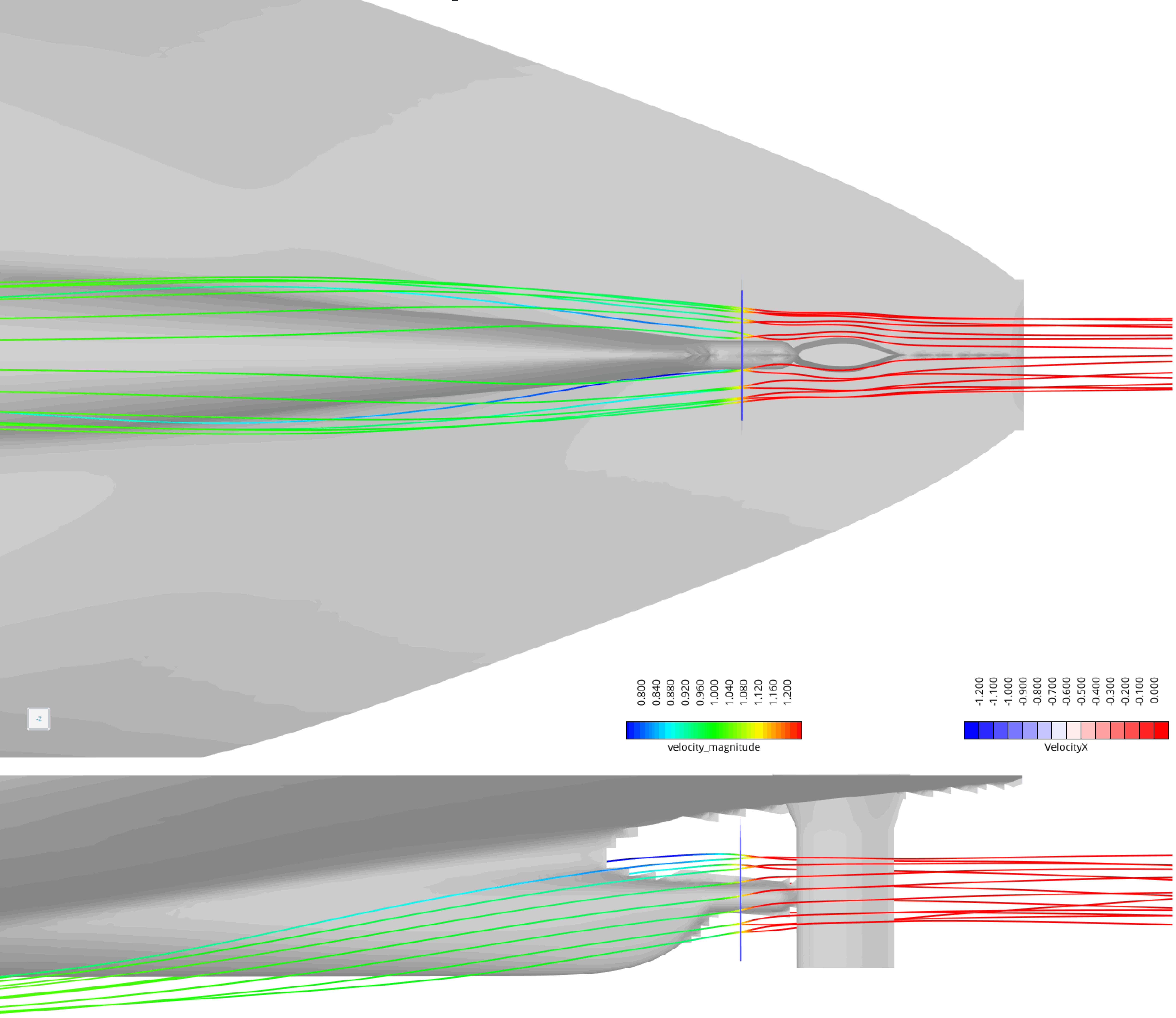
# Optimization with surrogate model

*(Dakota global optimization on response surface)*



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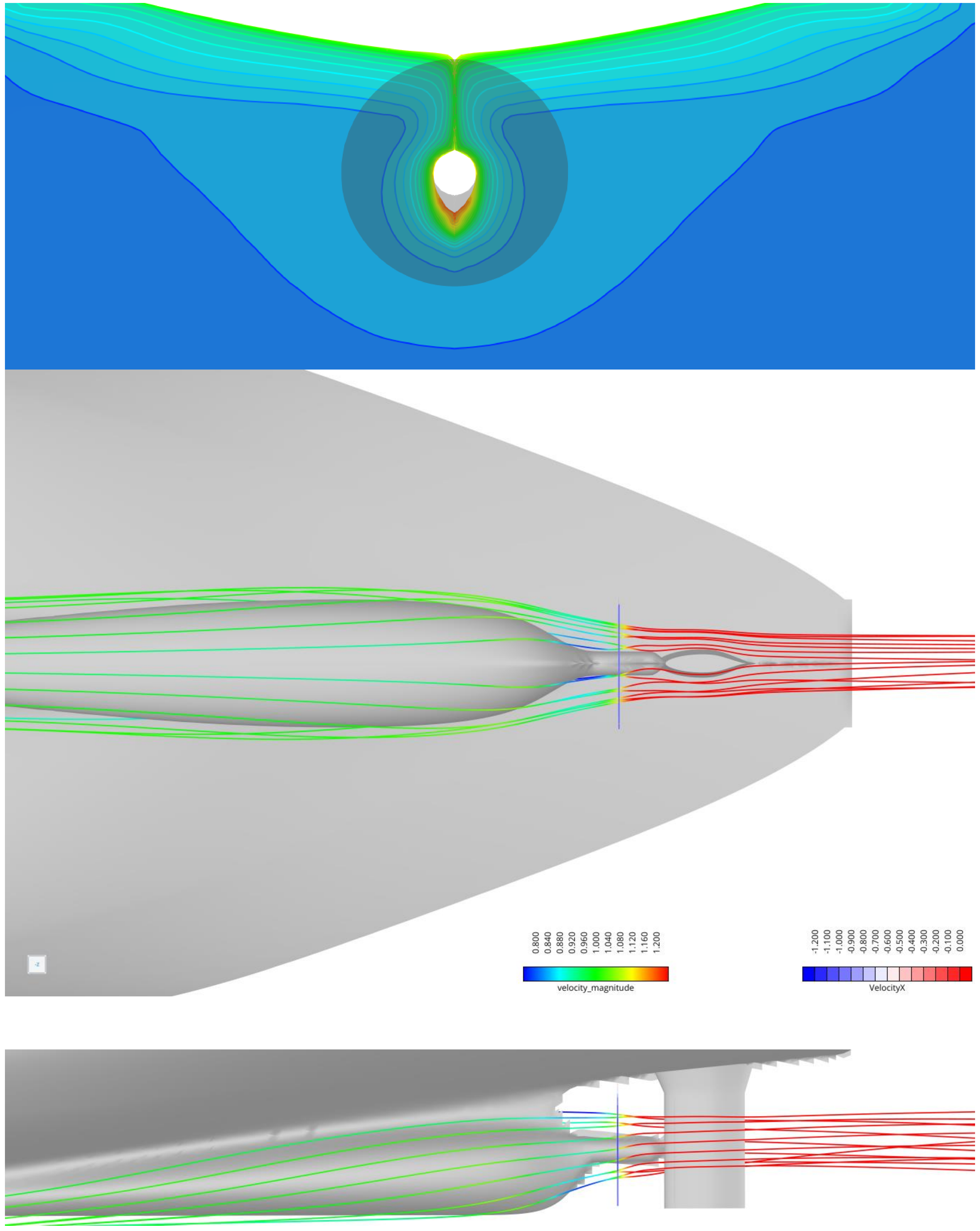
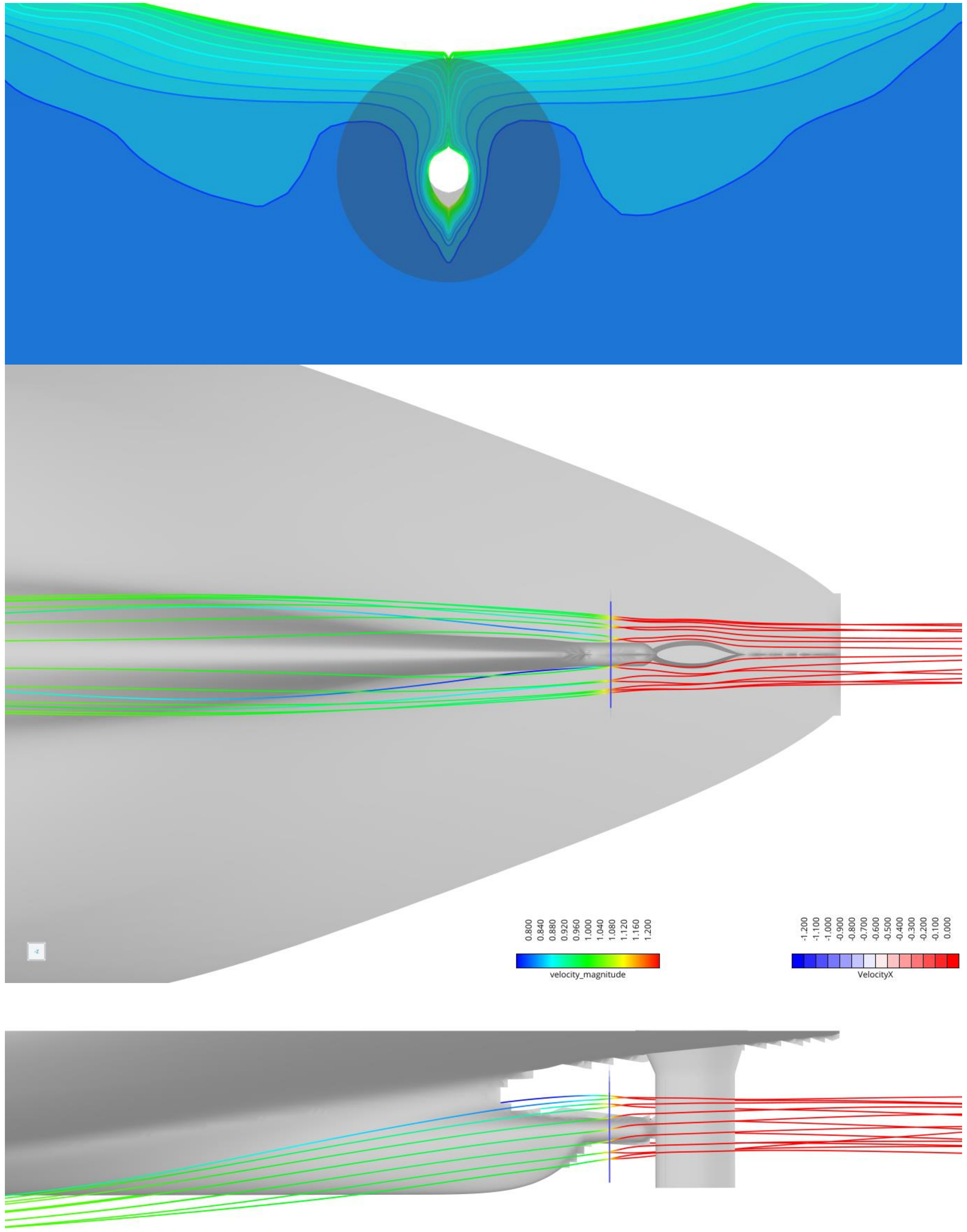
## Worst Skeg Design




## Optimized Skeg Design

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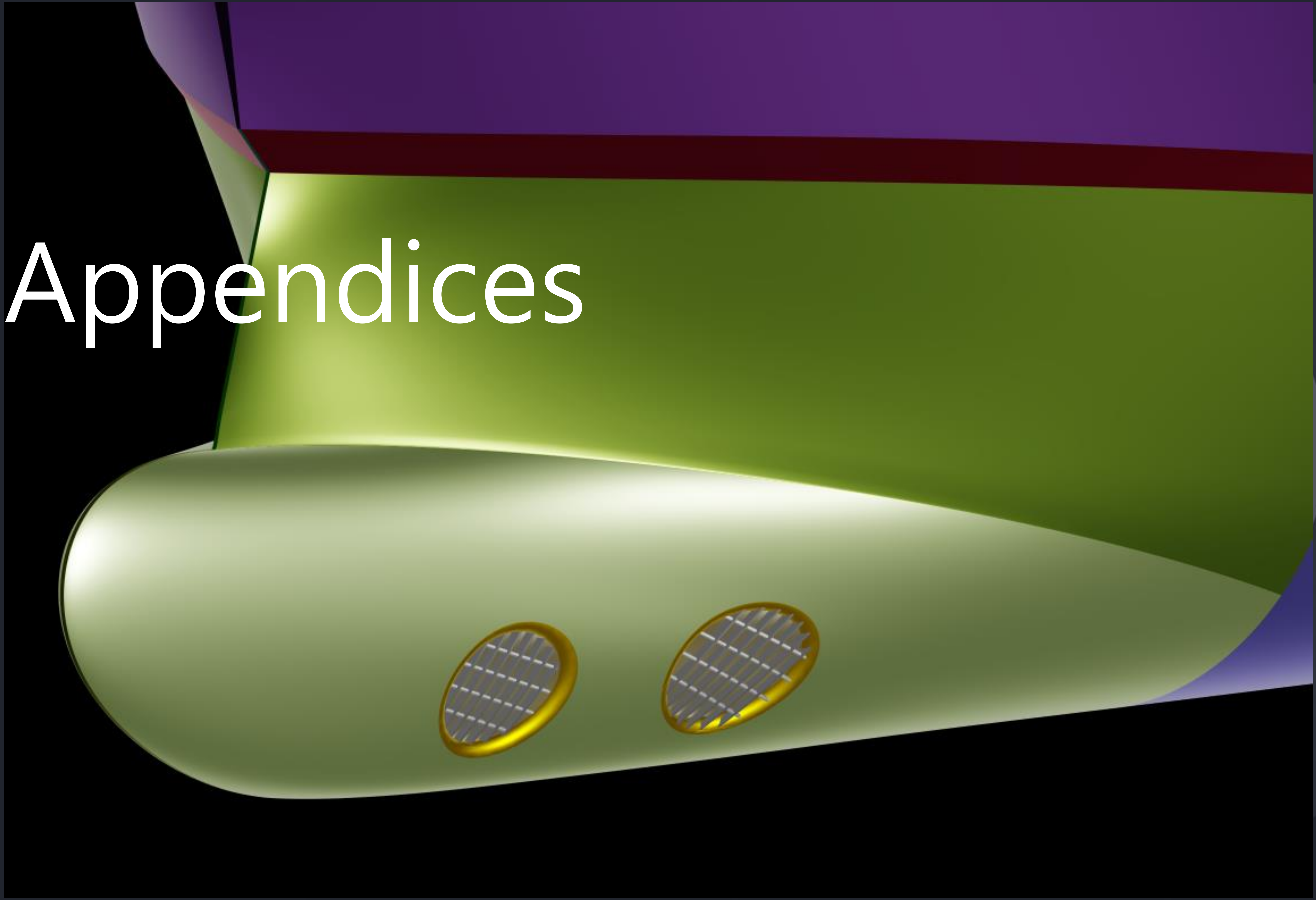
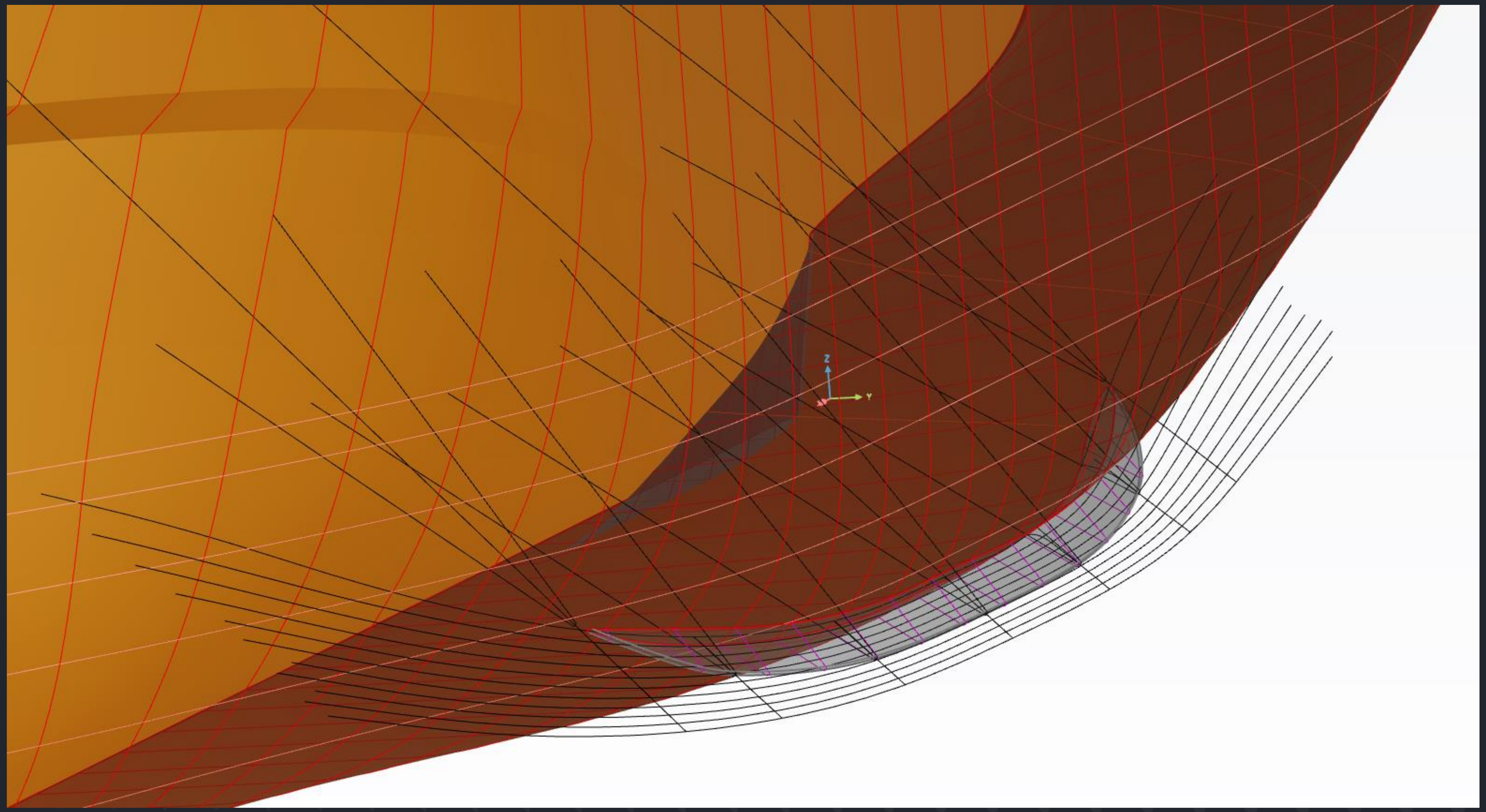
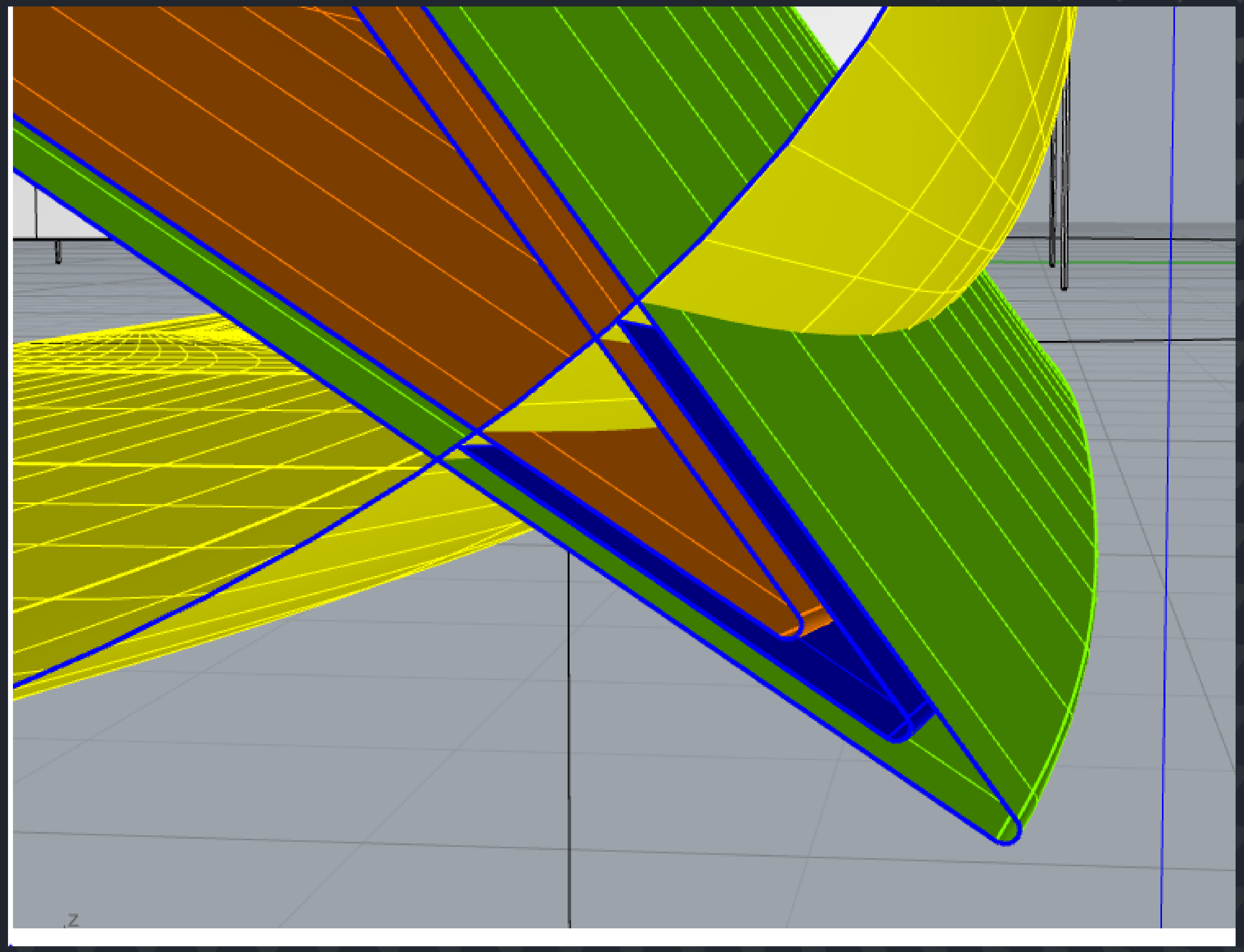
# Appendices



# Bilge keel

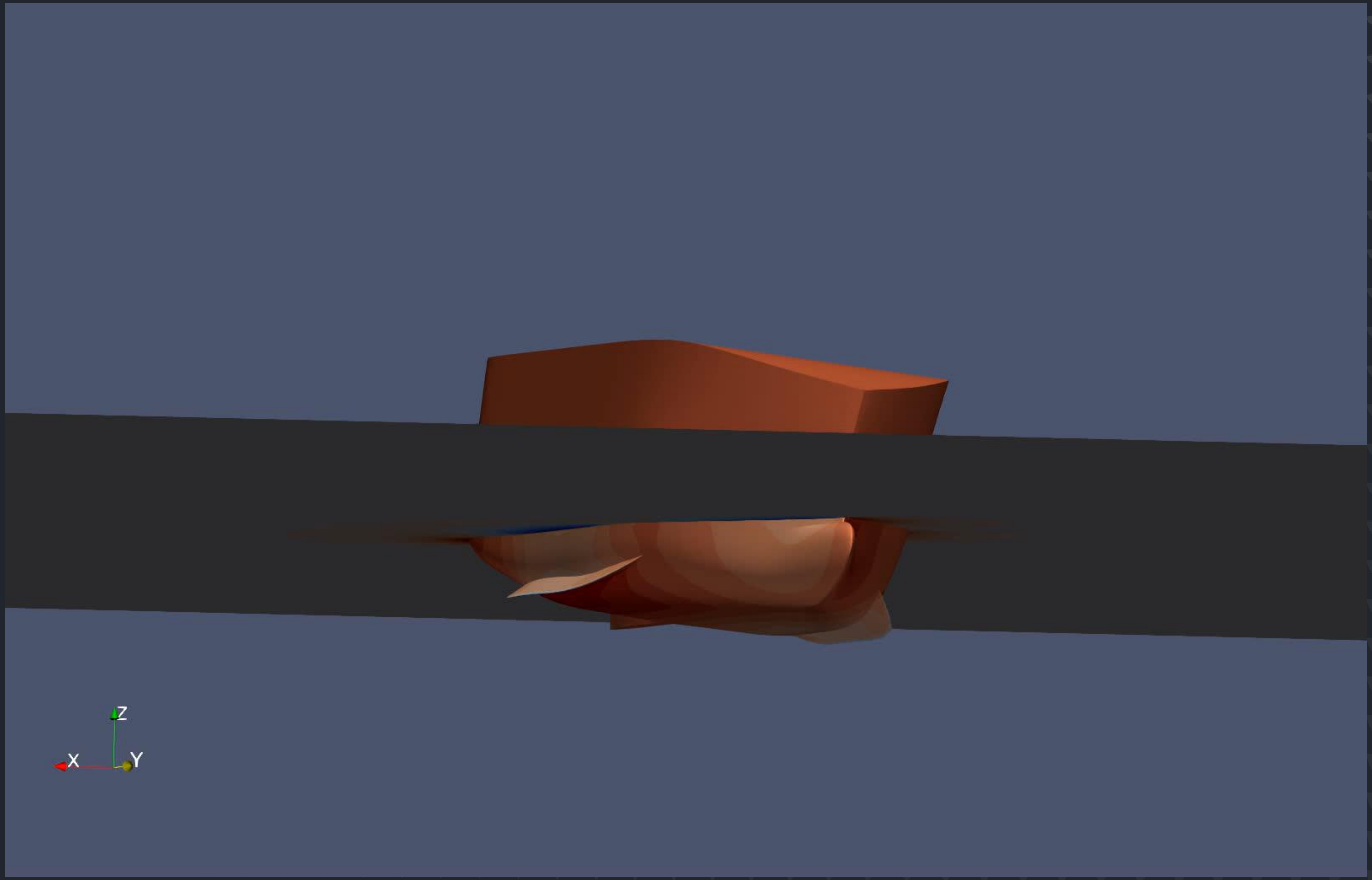
Increasing size of bilge keel for our SOV case study. Compromising between Resistance and Roll damping.





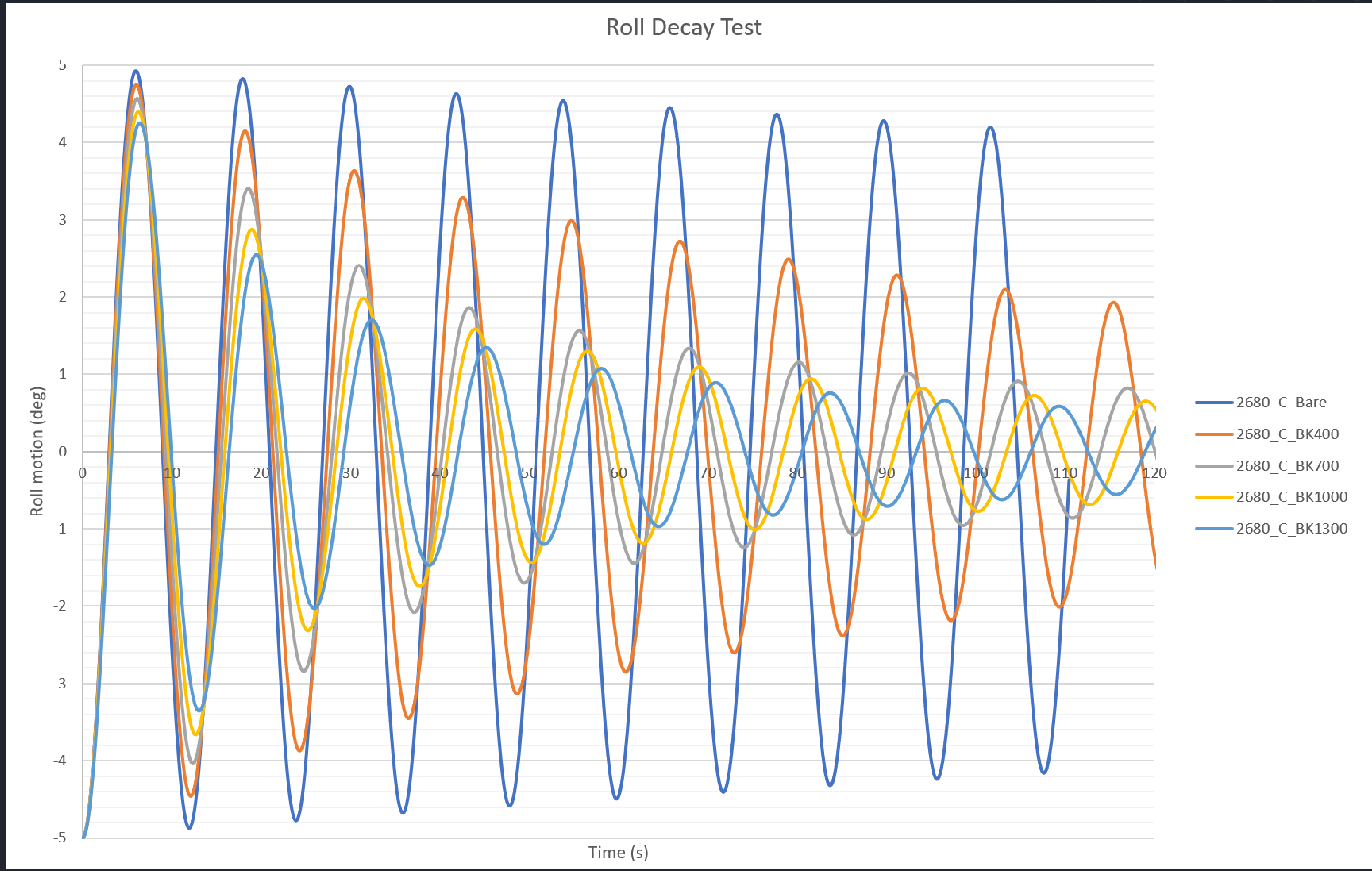
# Bilge keel

Example of roll decay run

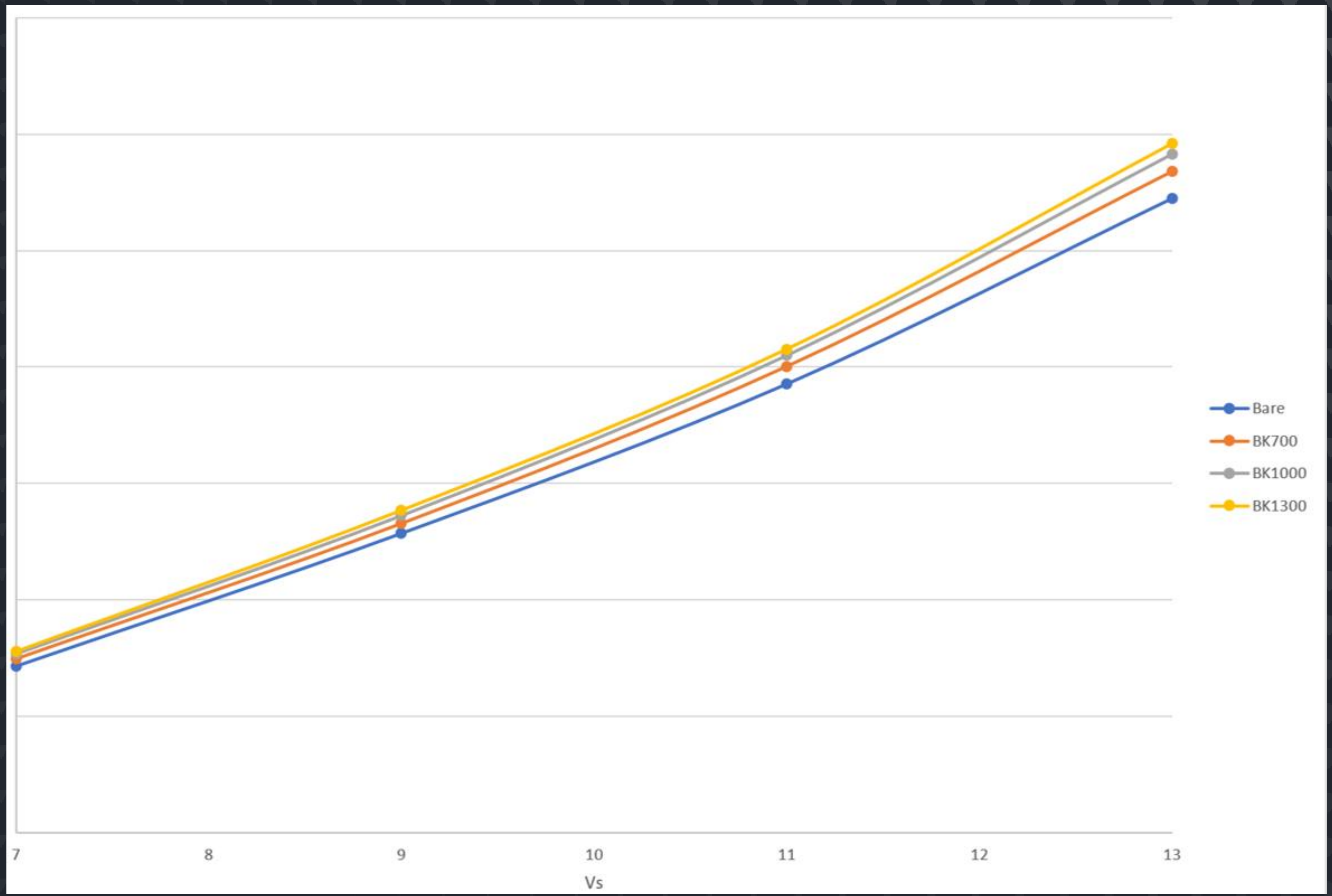


# Bilge keel

## Roll decay run

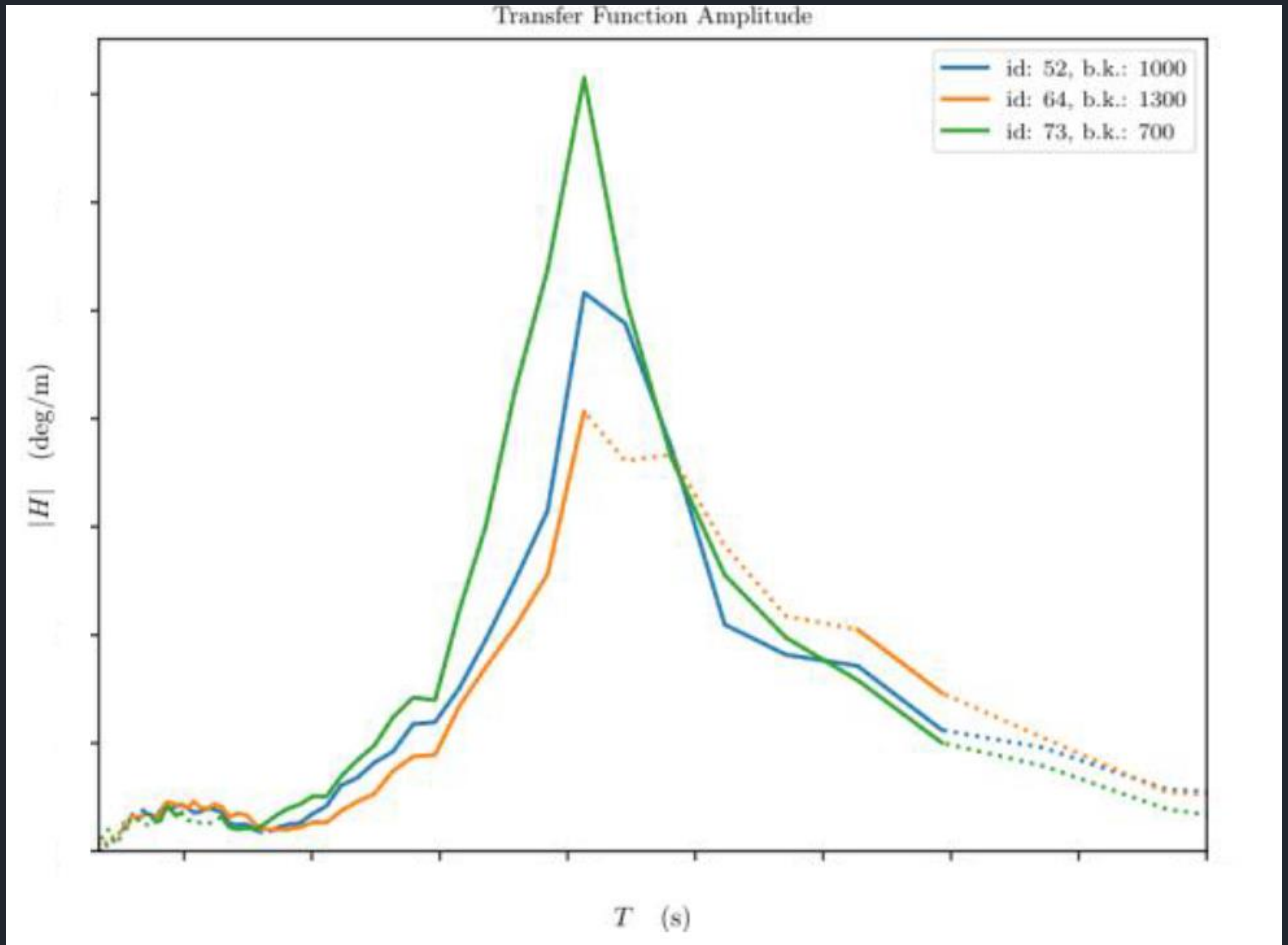



## Resistance

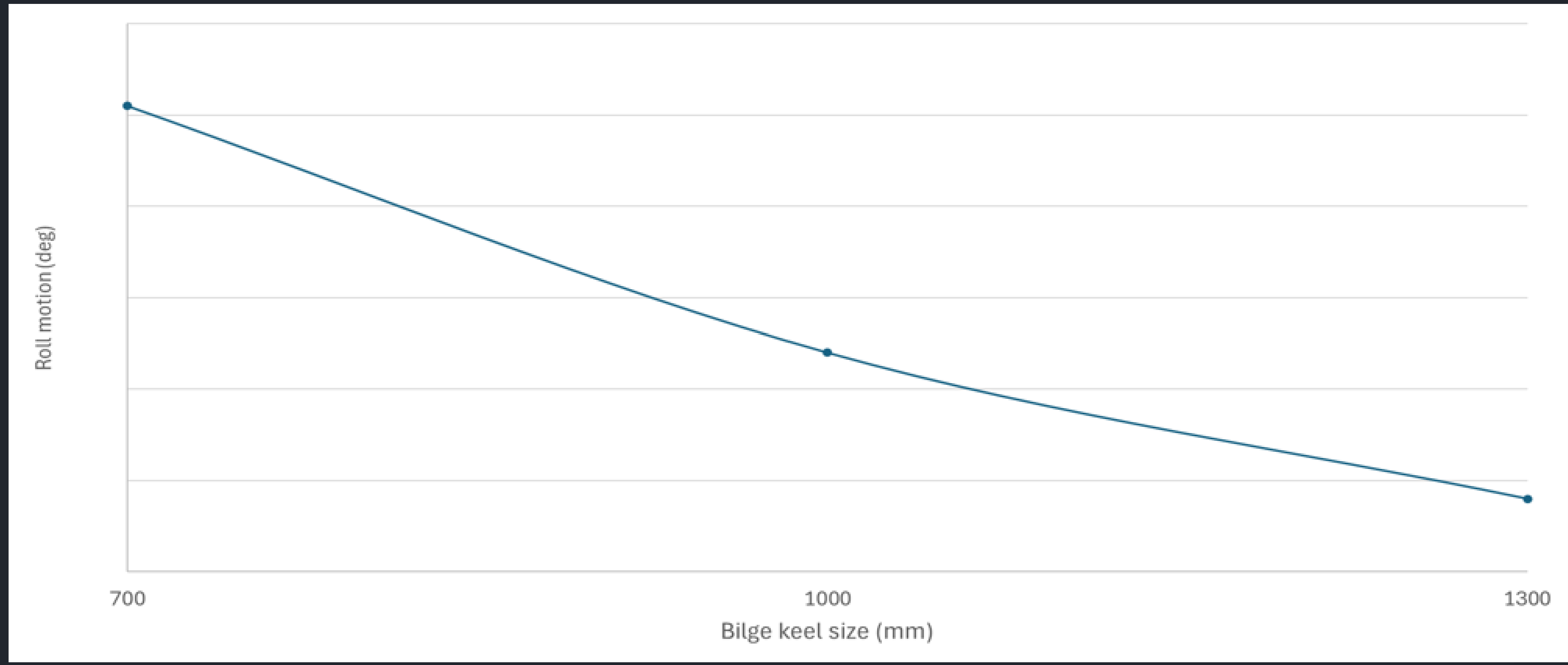


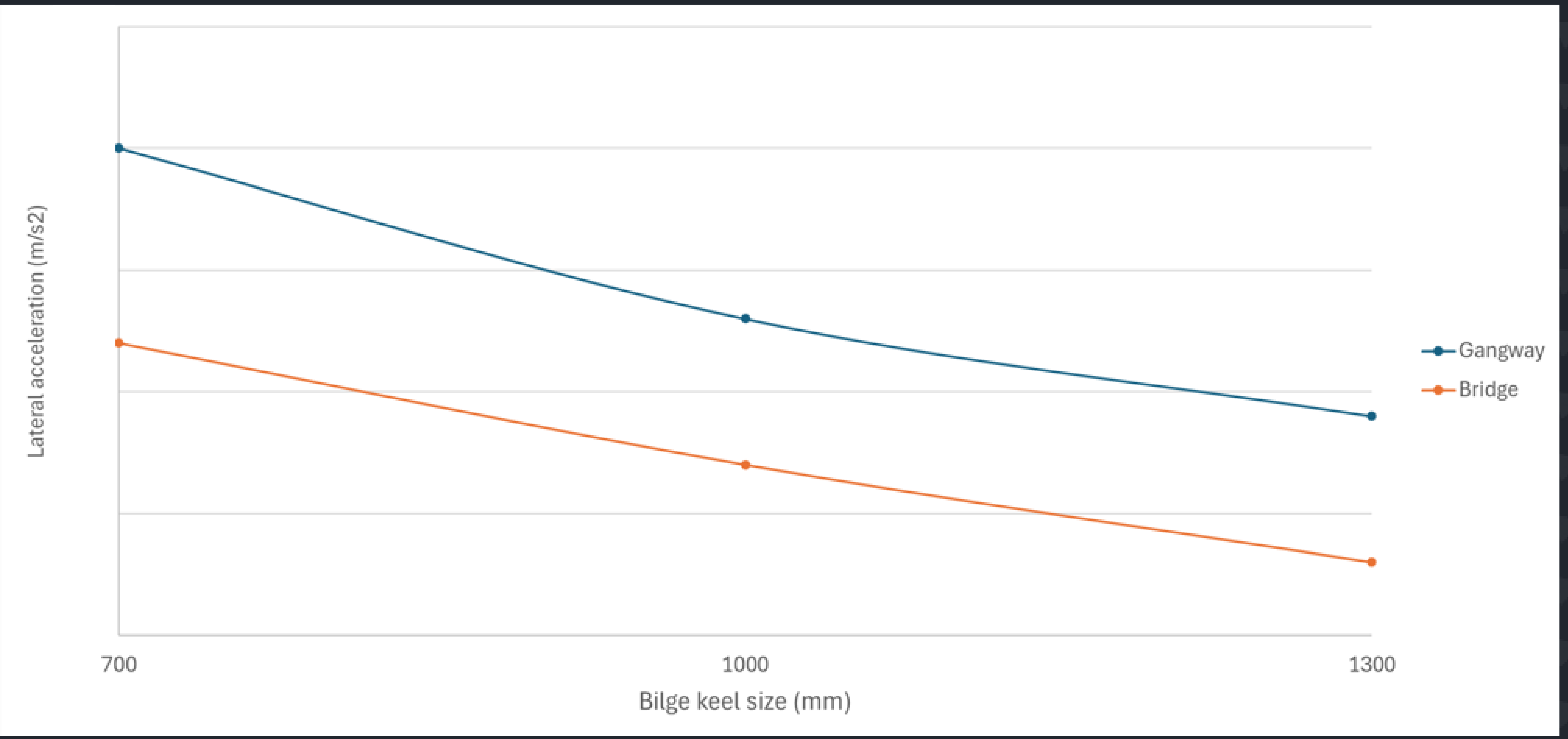
# Bilge keel

RAO run


Hs 2.5 m Tp 13 s bow quartering

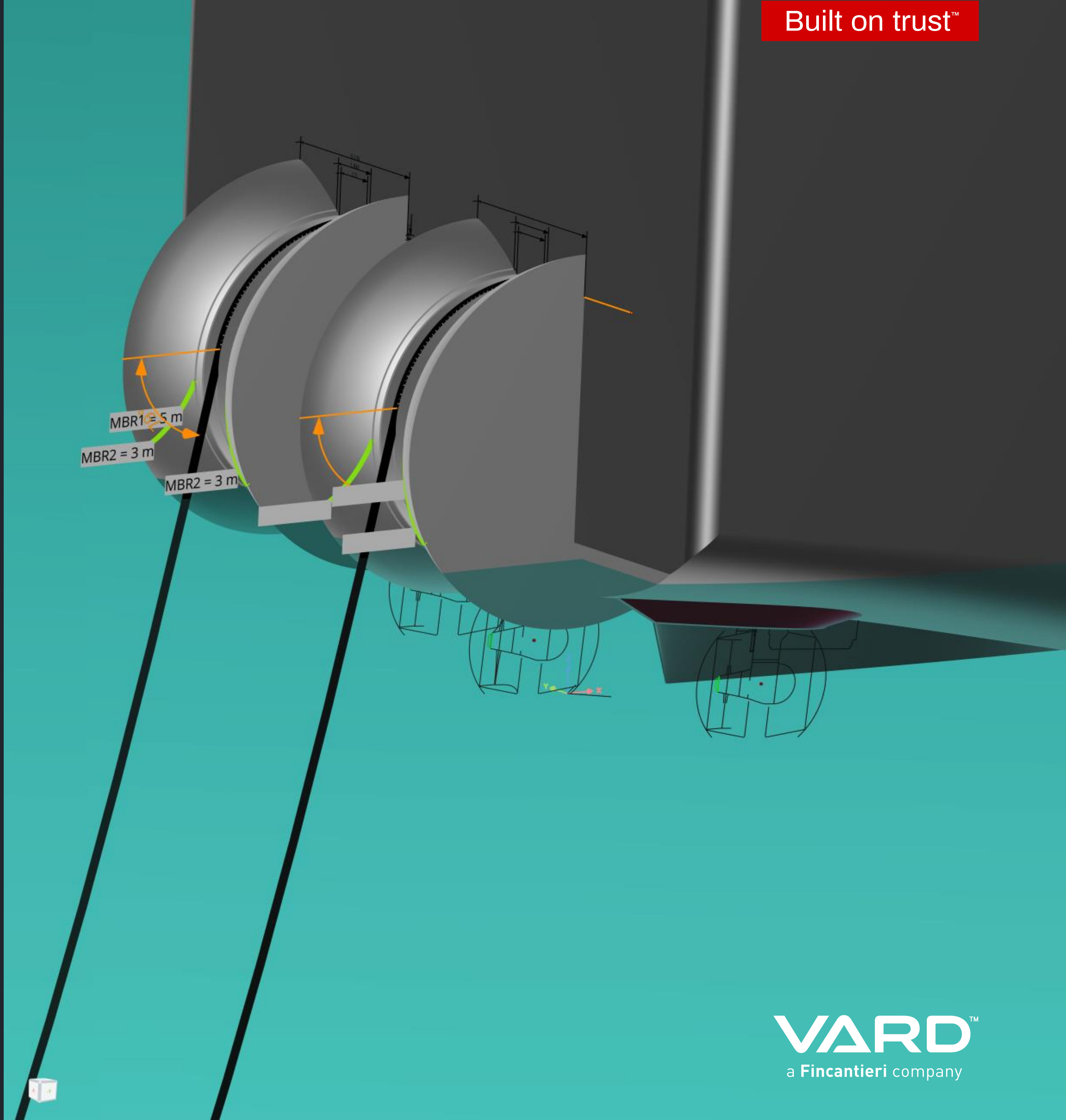


5690
Transfer Function Amplitude
id: 52, b.k.: 1000
id: 64, b.k.: 1300
id: 73, b.k.: 700
|H| (deg/m)
T (s)

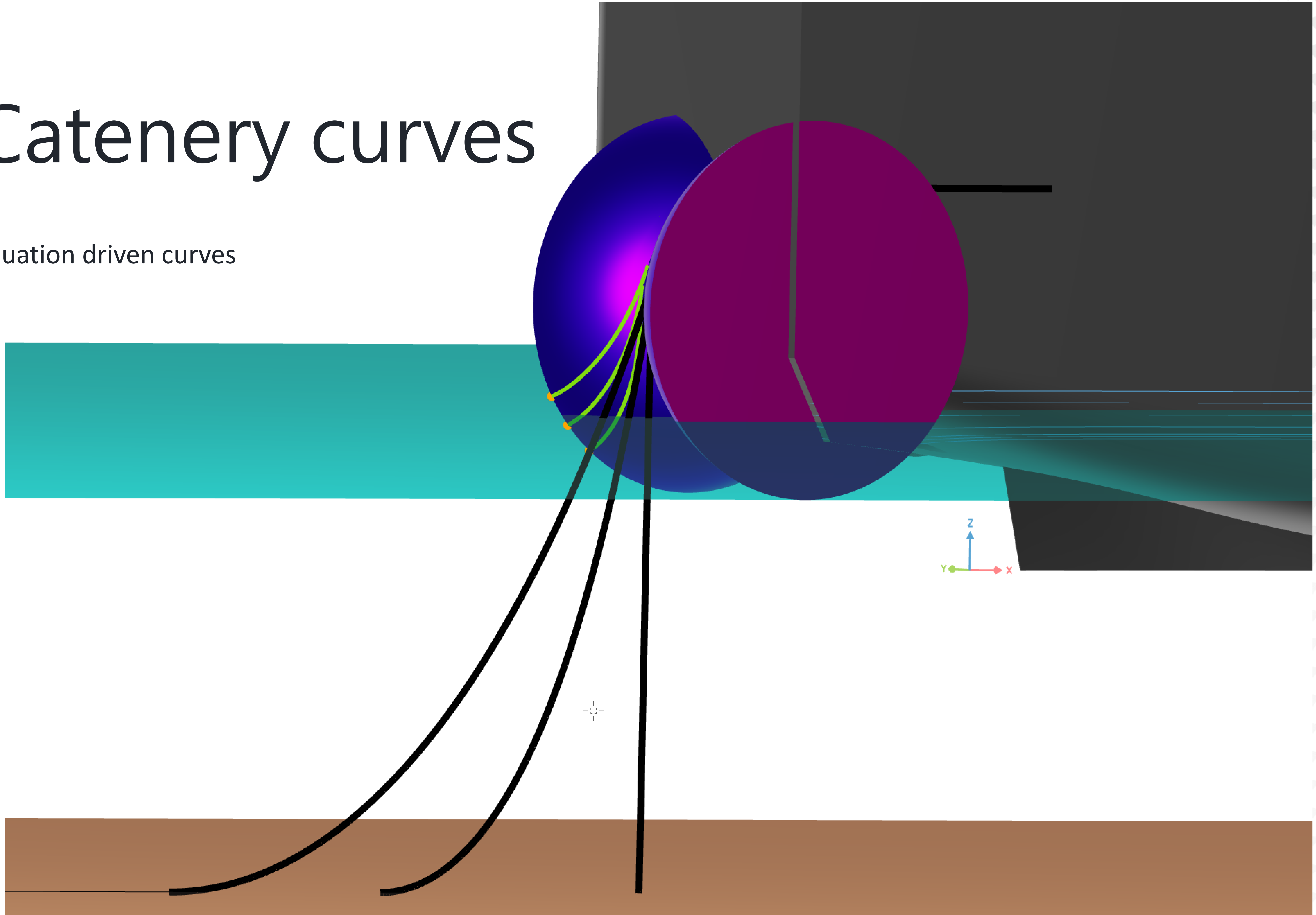
# Whisker

Cable Laying Vessel (CLV)



# Catenery curves

Equation driven curves



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# Thank you

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