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An Investigation of the Effect of Biomimetic Tubercles on the Drag of a Flat Plate

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Presentation Layout

- Tubercles in previous research
- Tubercles in this research
- Geometrical model
- CFD results

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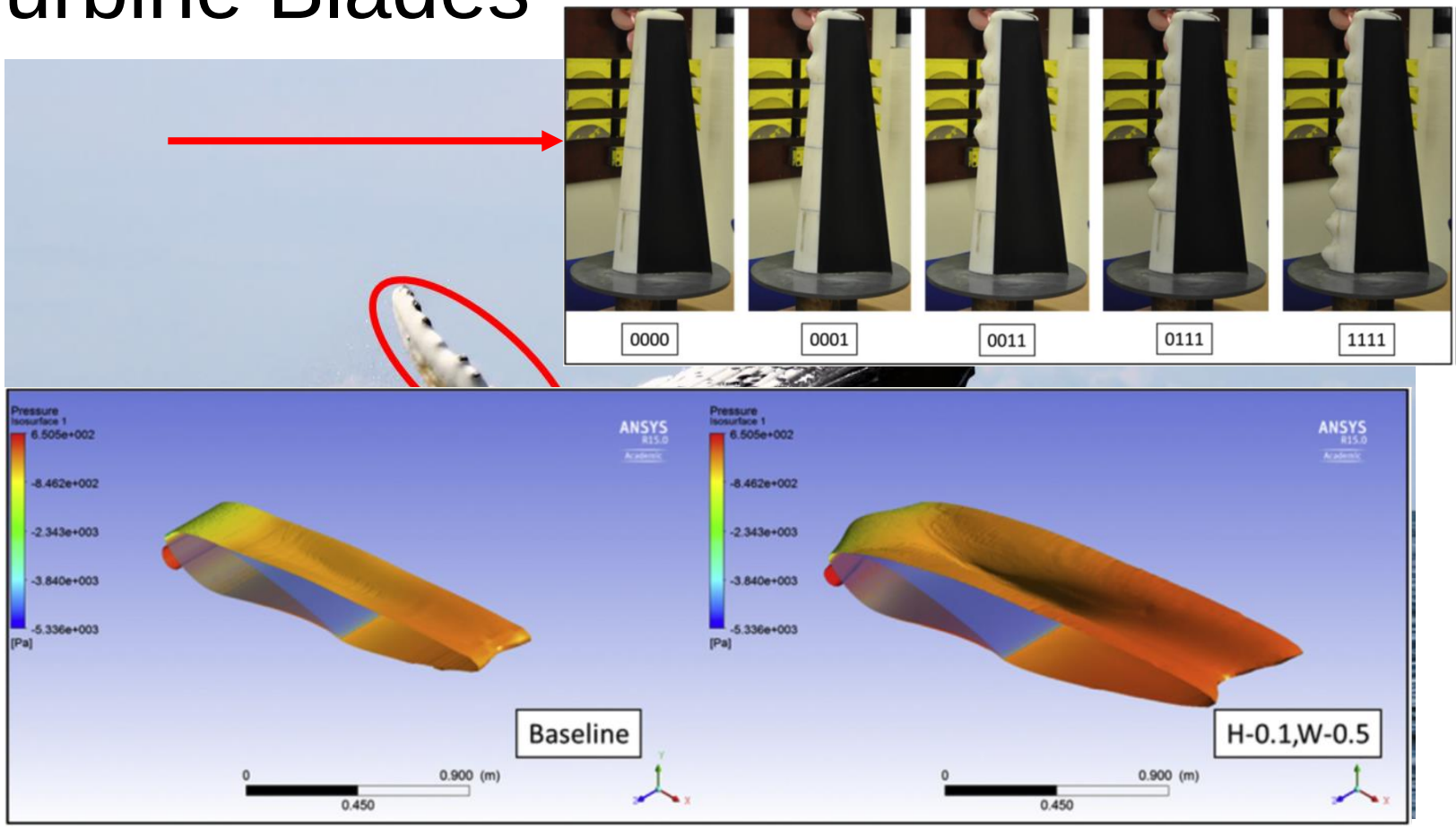
Humpback whales

Application of Tubercles on Tidal Turbine Blades



(Shi et al., 2016)

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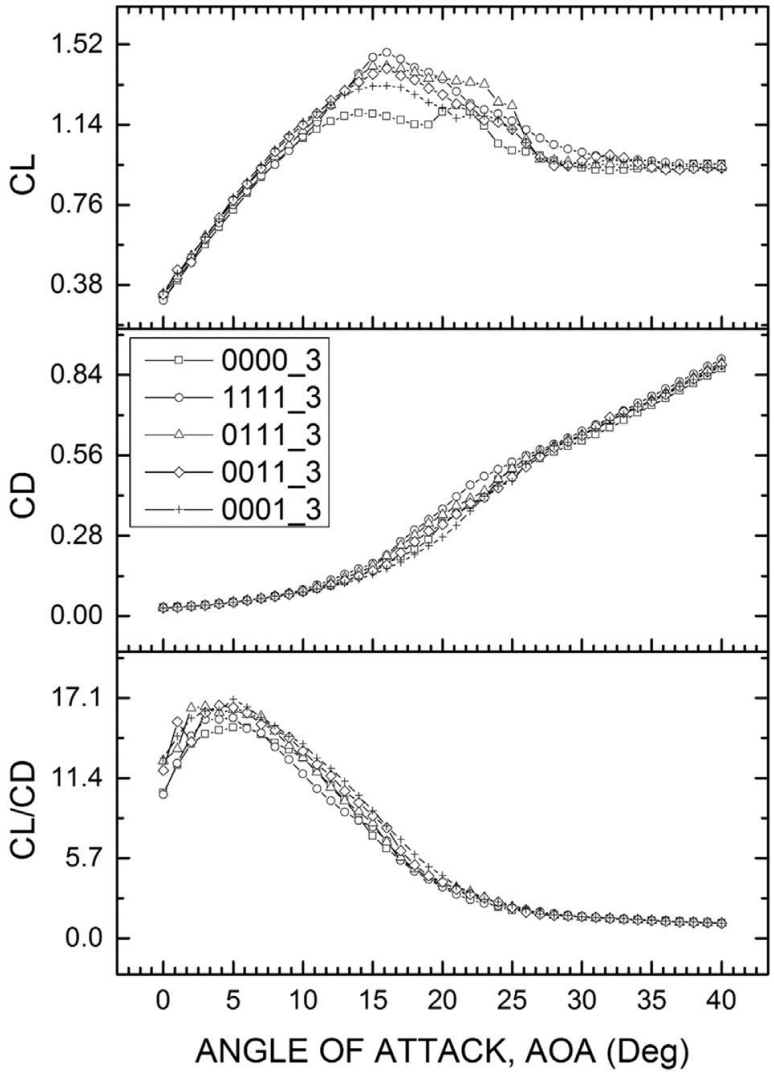
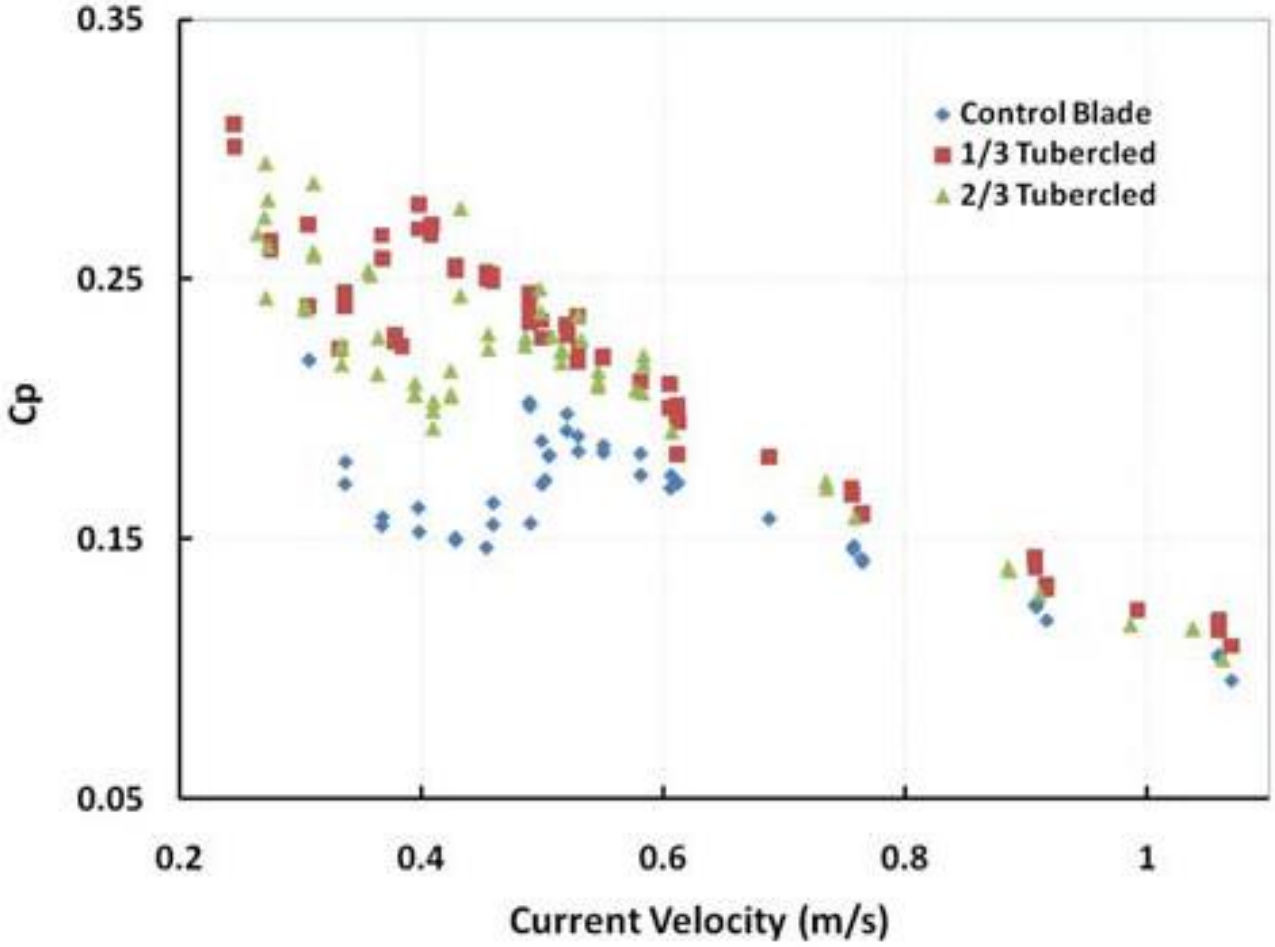
Comparison of different configurations



(Shi et al., 2016)



(Gruber et al., 2011)

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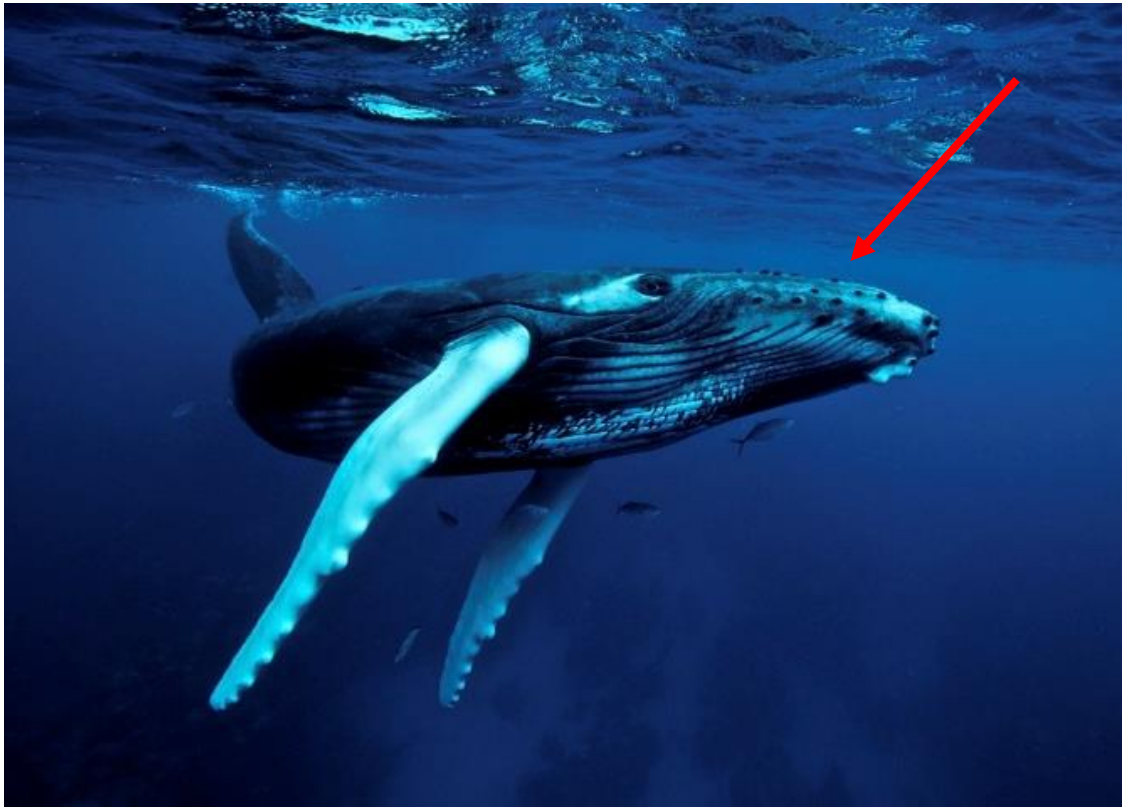
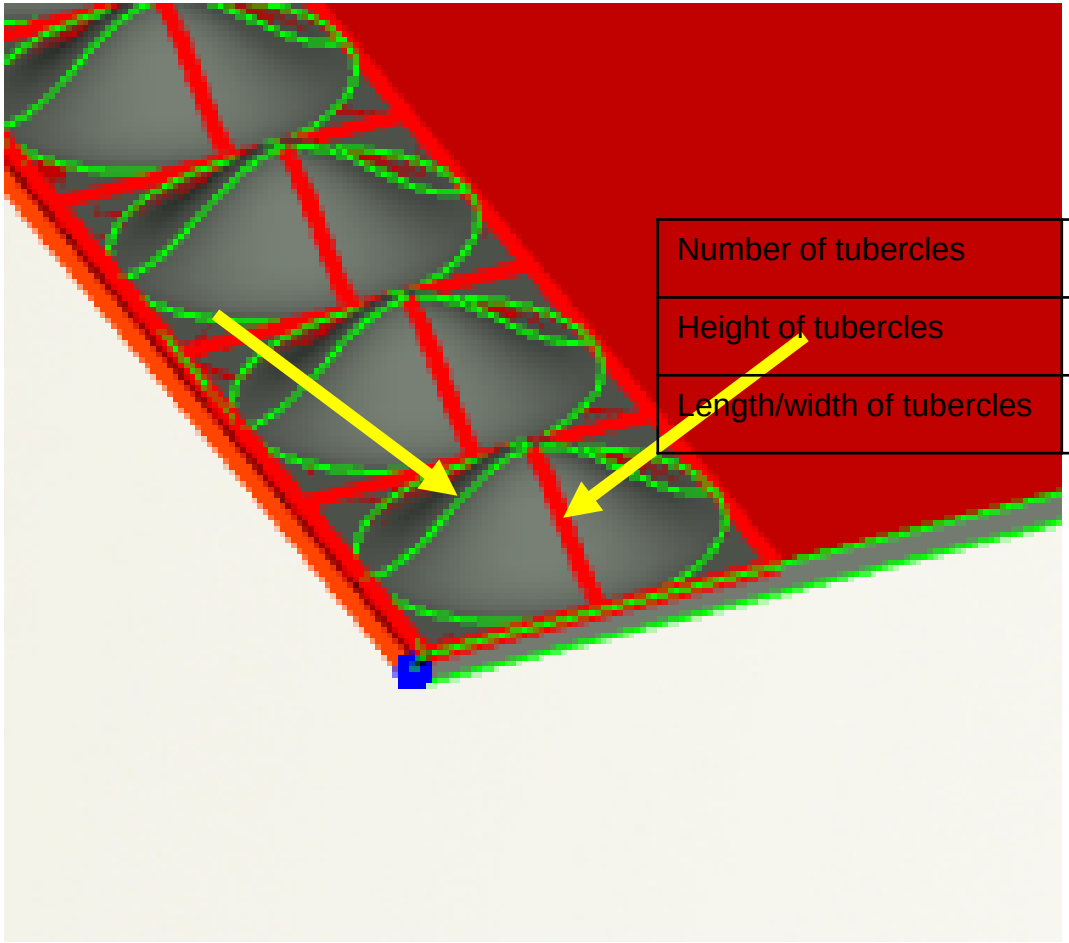
Some different types of tubercles



Investigation (CFD Simulations)

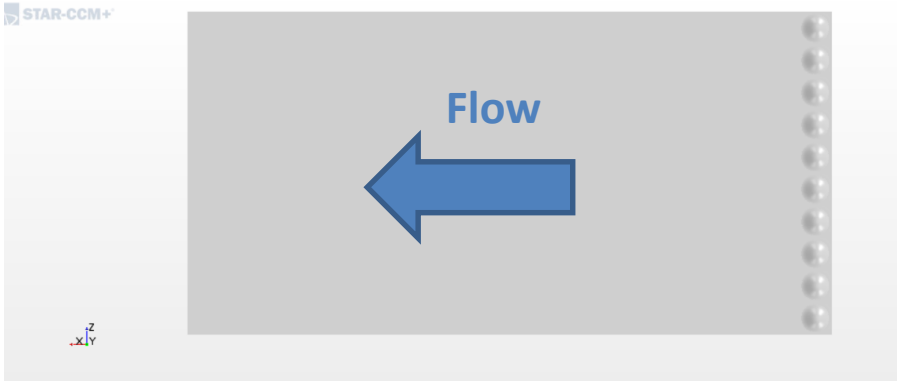
Application of single row of axisymmetric sinusoidal tubercles at different position along the stream-wise direction of a smooth flat plate.

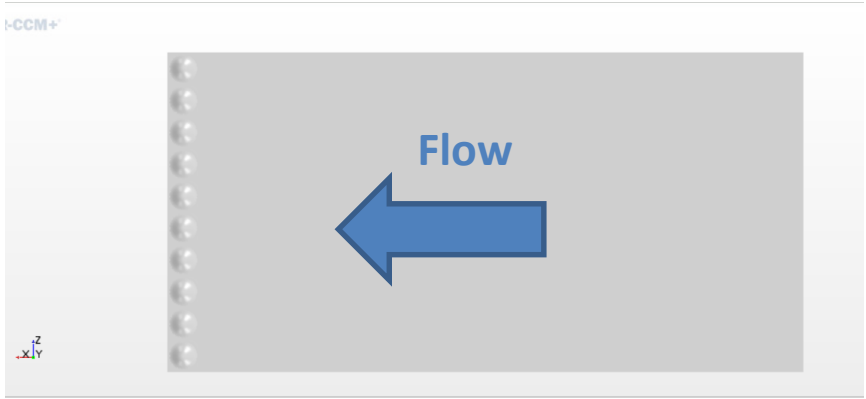
Model for CFD Studies

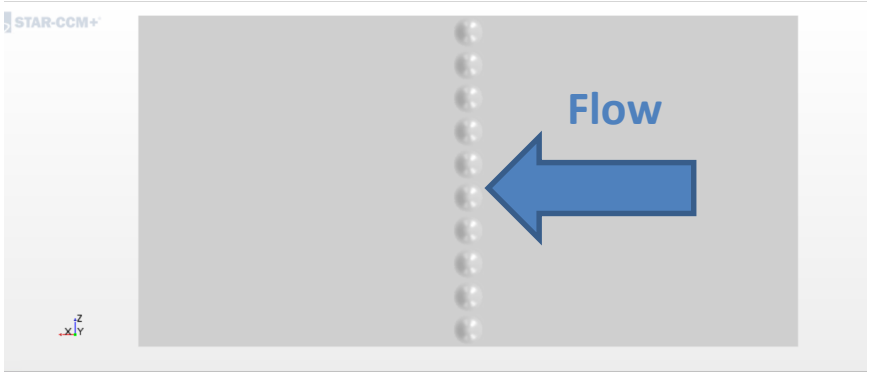


Number of tubercles	10
Height of tubercles	5 mm
Length/width of tubercles	5 mm

Model for CFD Studies

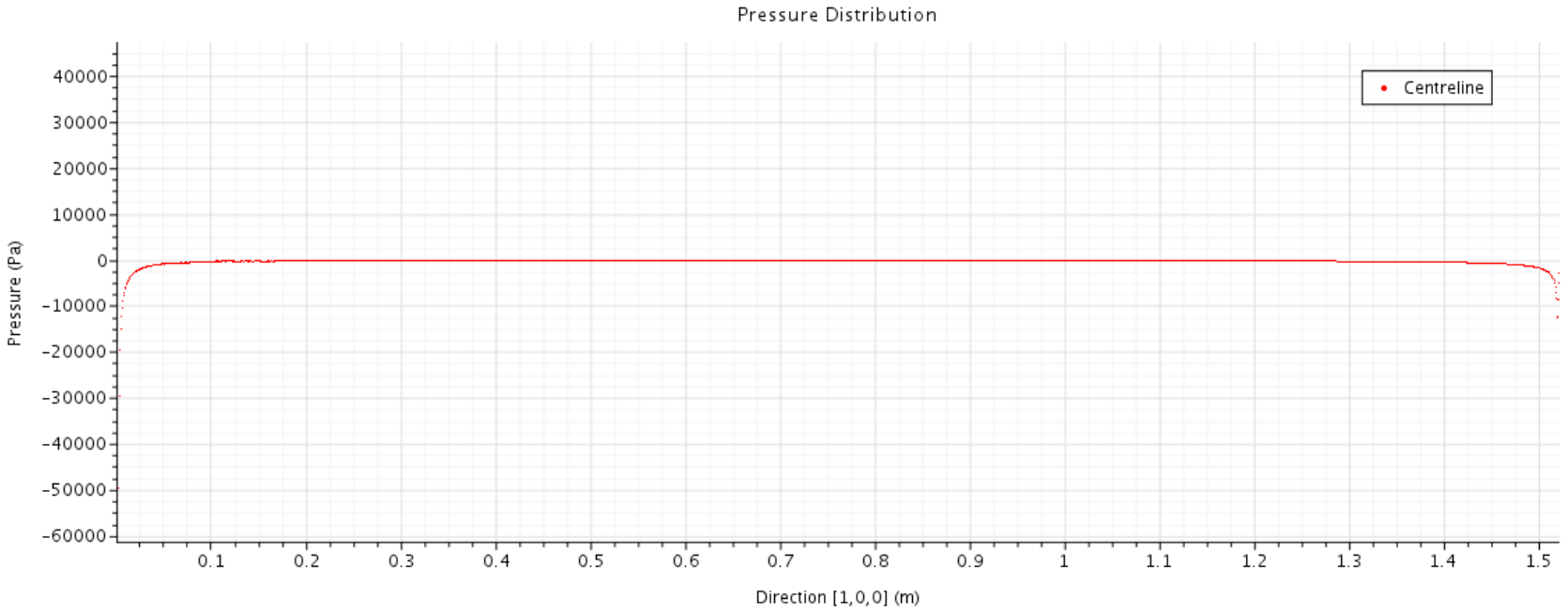




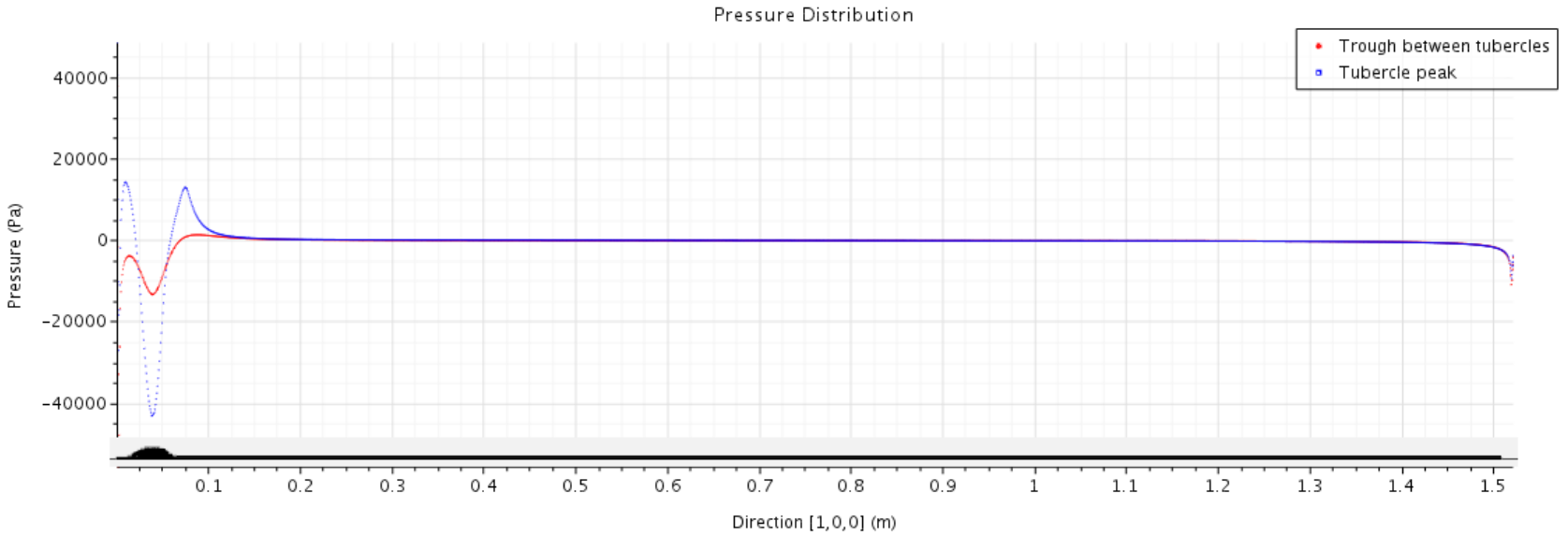


Length	1.52 m
Width	0.76 m
Thickness	3.2 mm
Reynolds number range	3.41E+06 – 1.71E+07

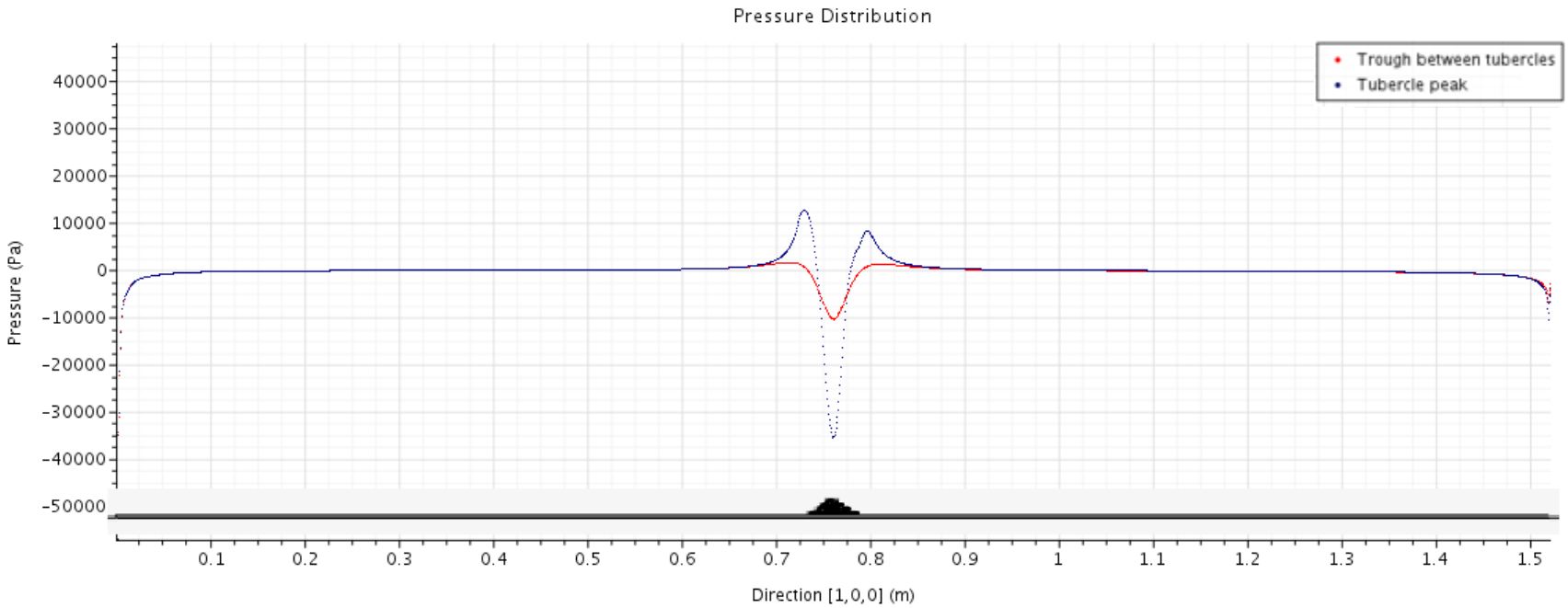
CFD results: Pressure Distribution (flat plate)



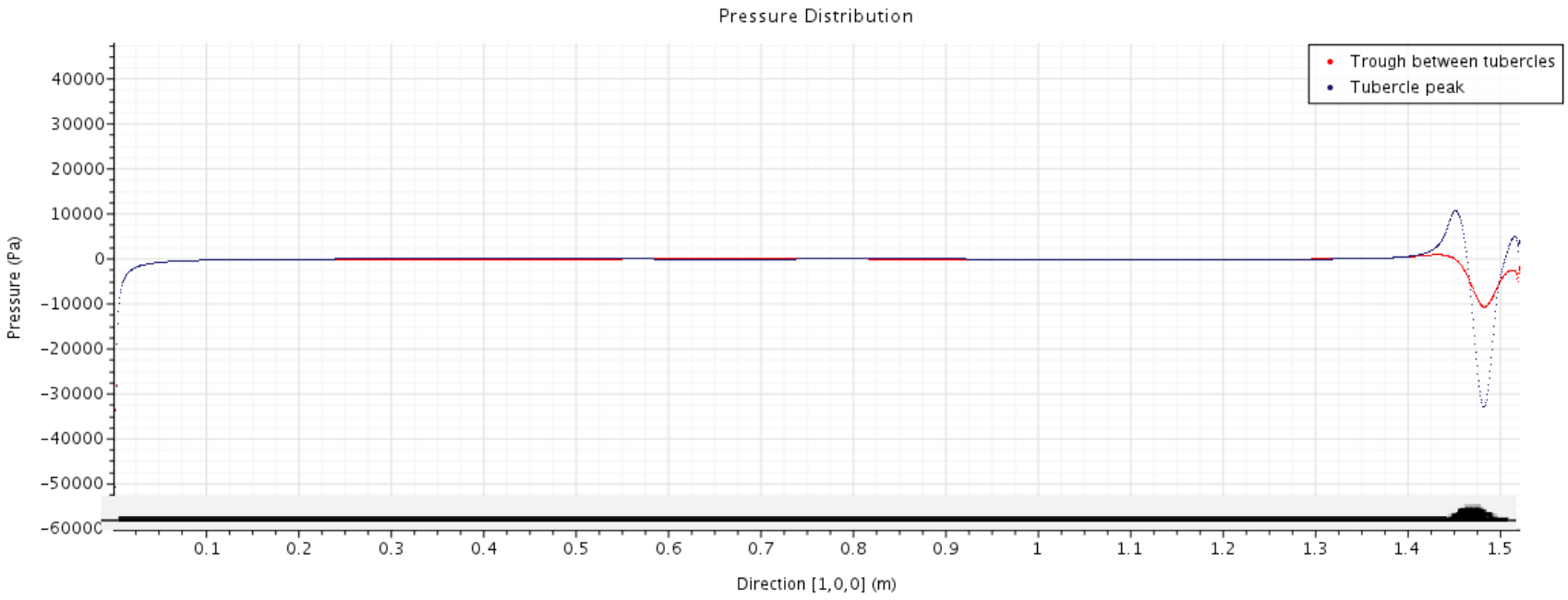
CFD results: Pressure Distribution (upstream)



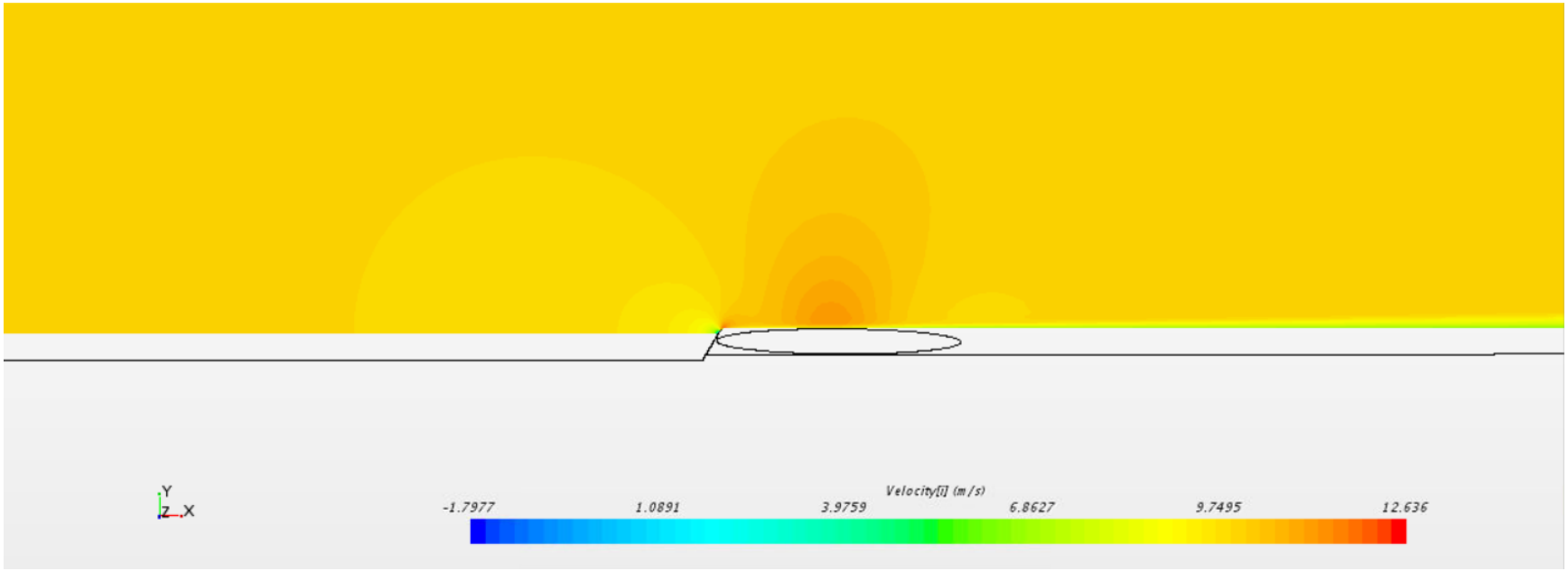
CFD results: Pressure Distribution (mid-length)



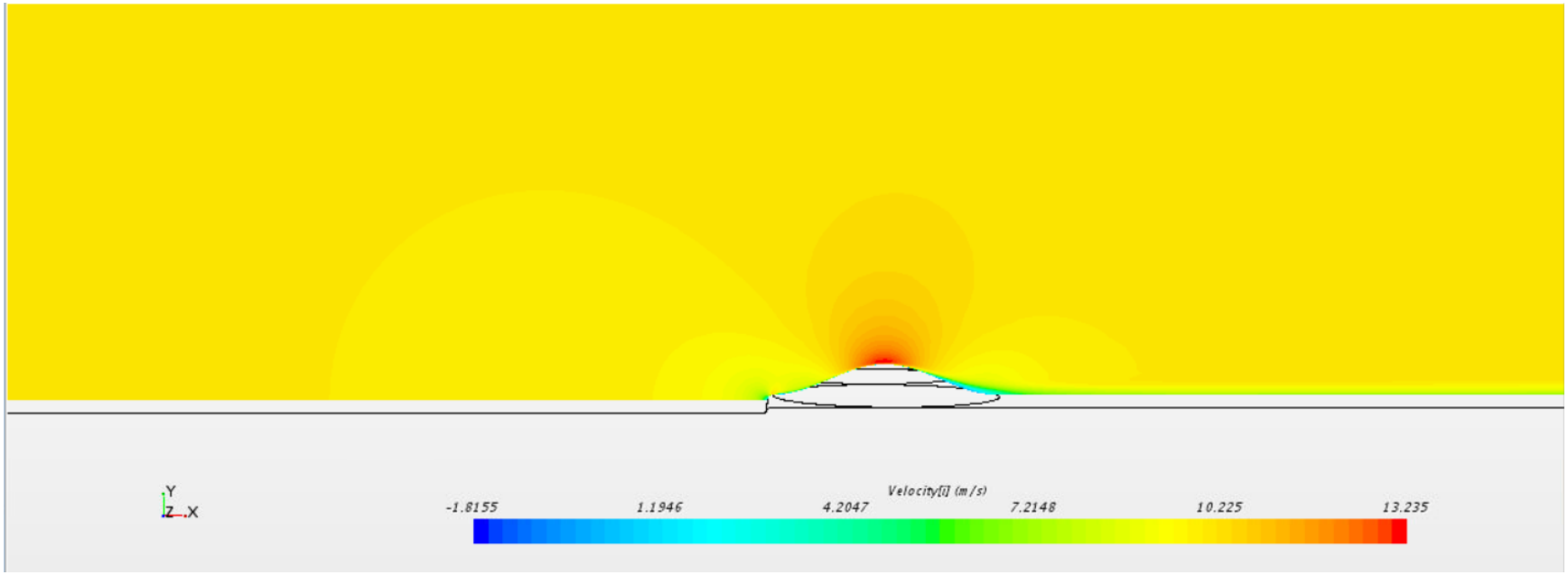
CFD results: Pressure Distribution (downstream)



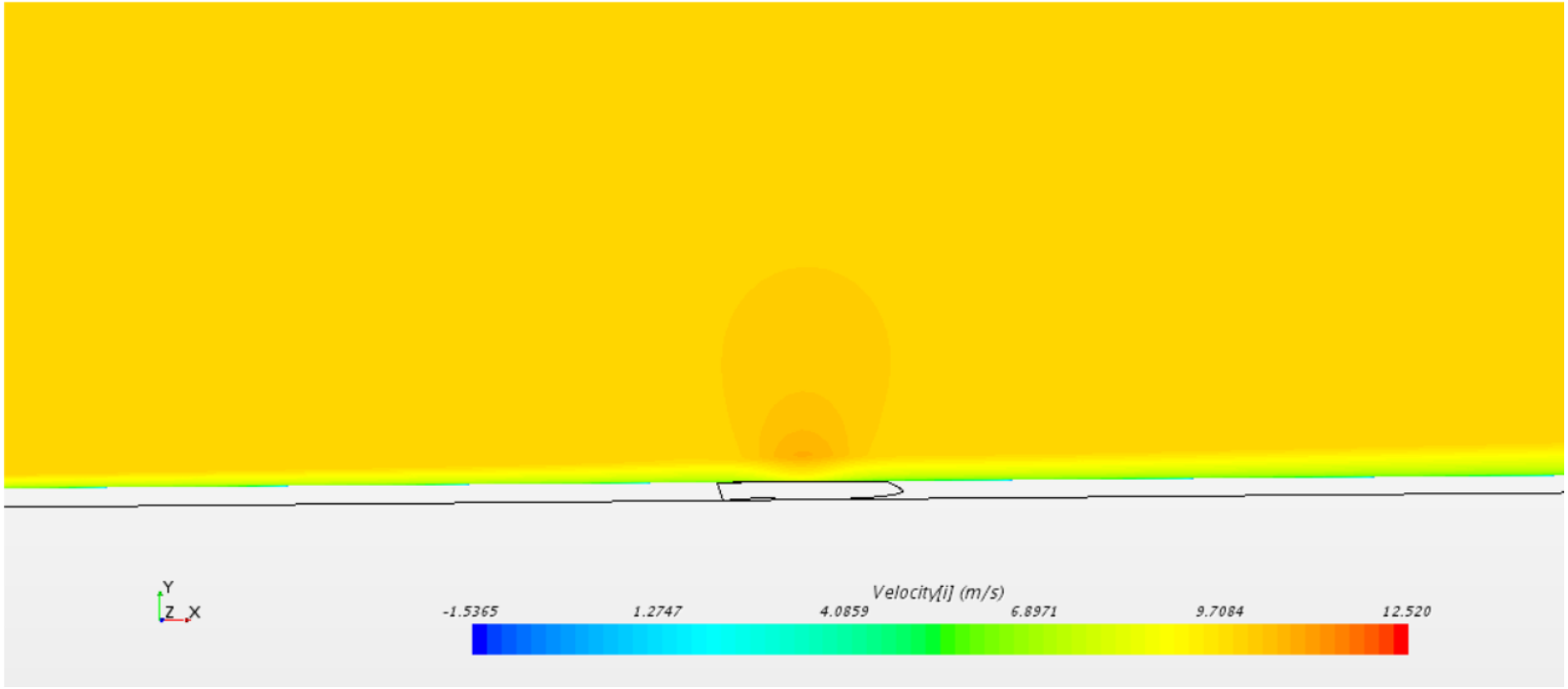
CFD results - Flow Velocity (trough upstream)



CFD results - Flow Velocity (tubercle peak upstream)



CFD results - Flow Velocity (trough mid-length)



CFD results - Flow Velocity (tubercle peak mid-length)

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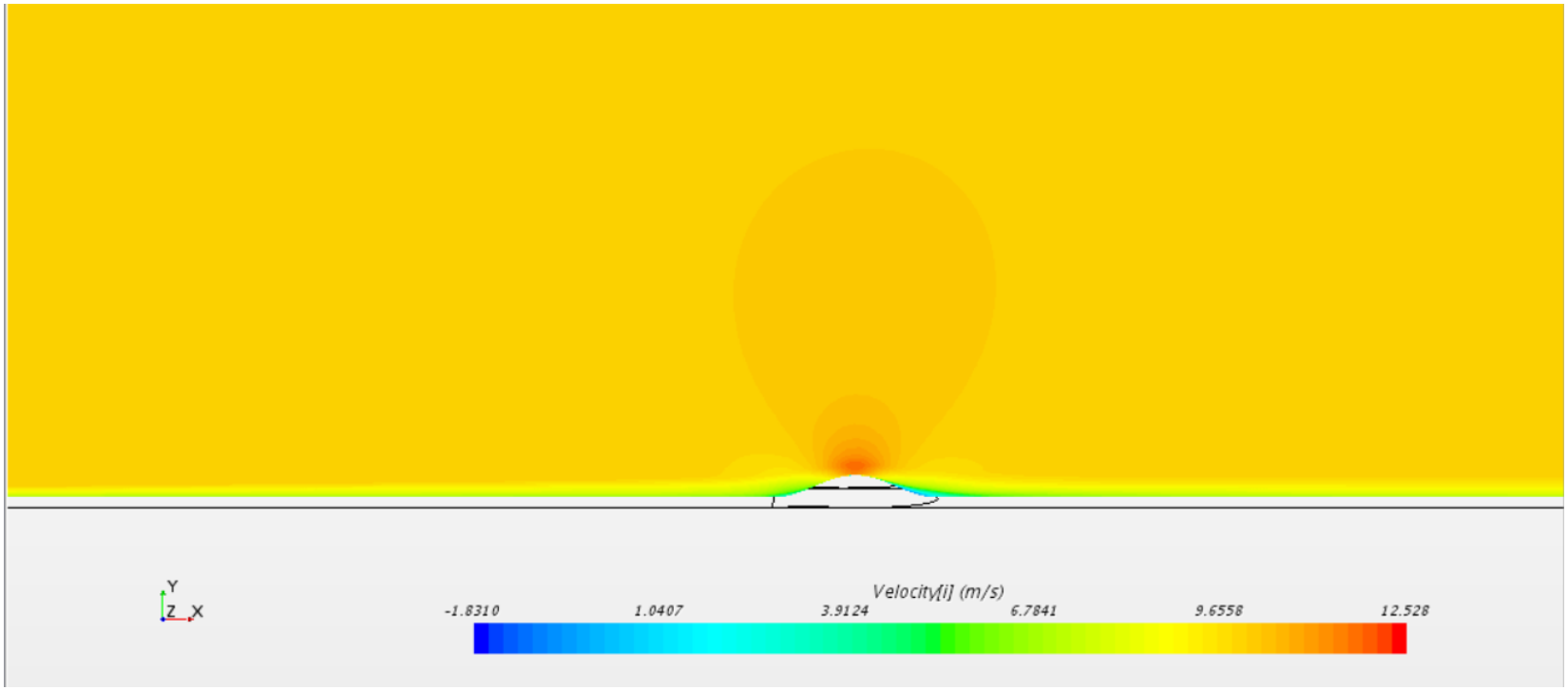
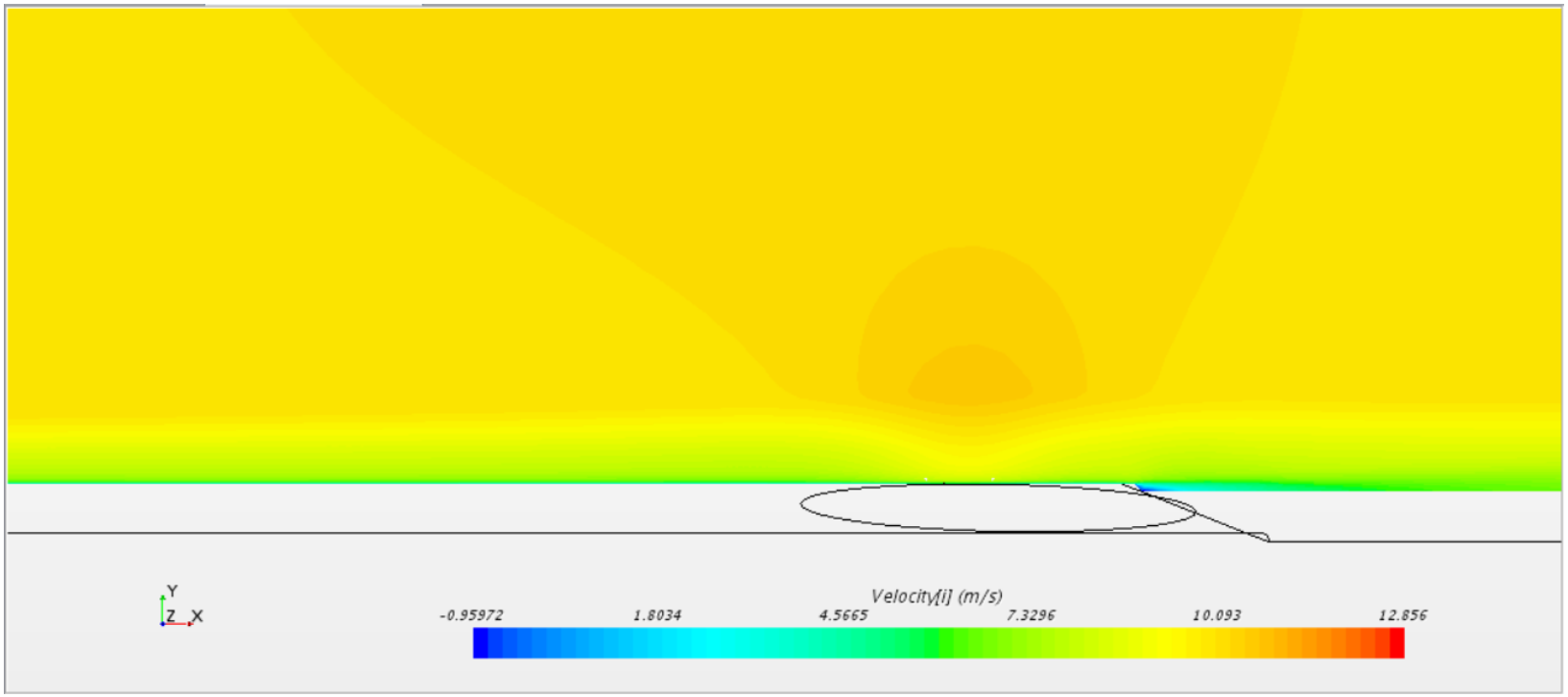
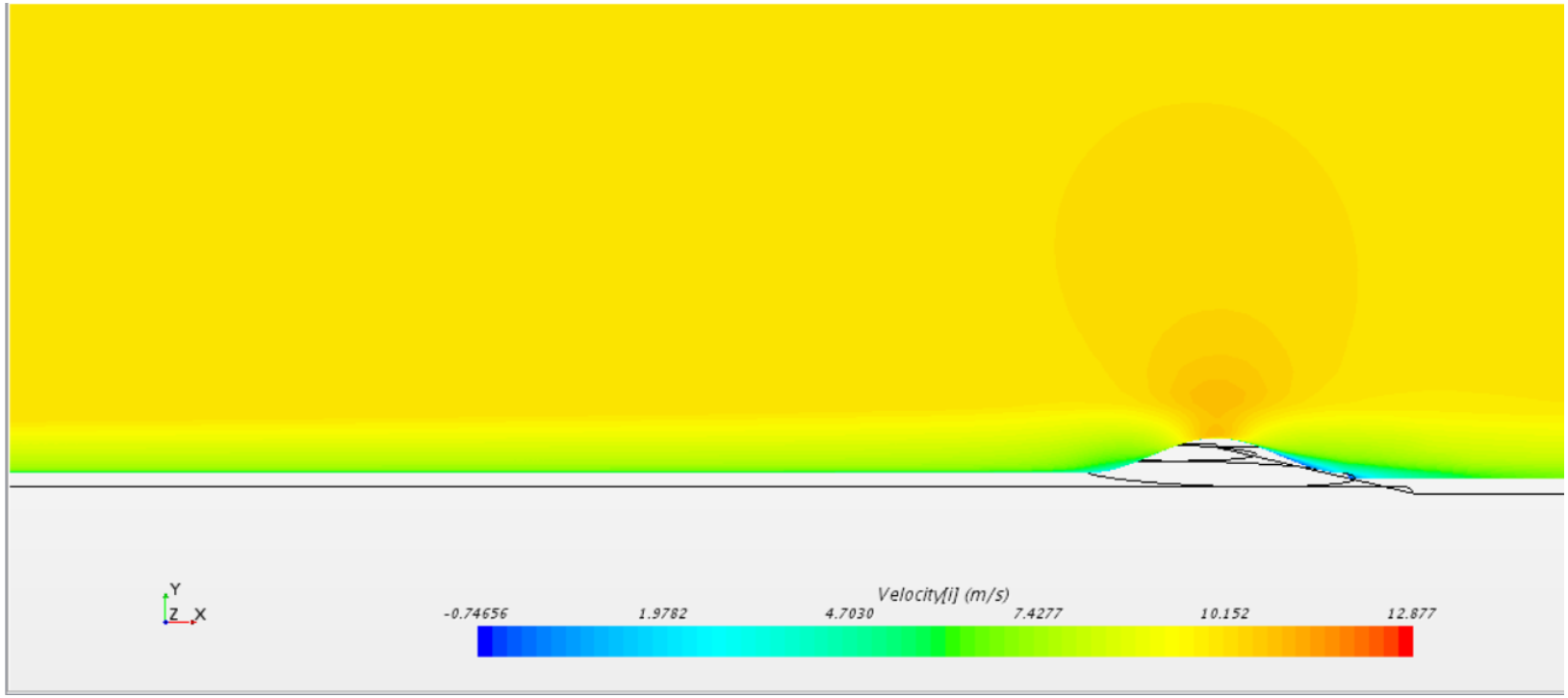


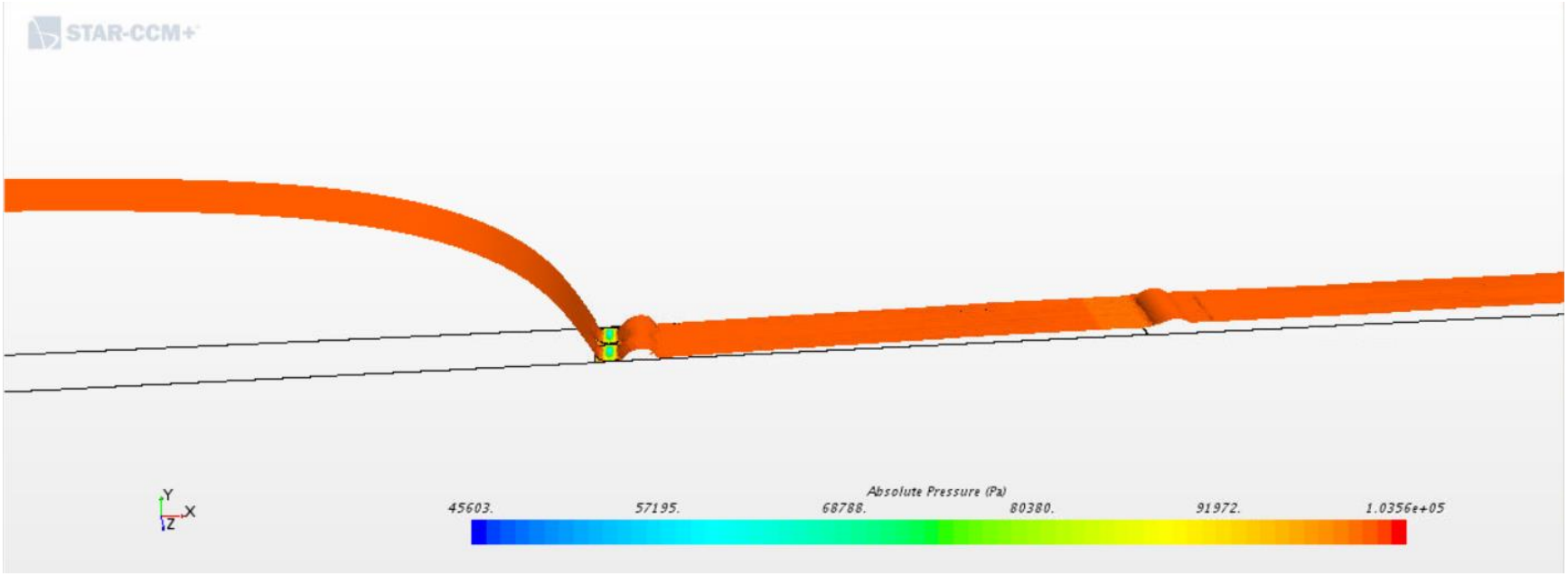
CFD results - Flow Velocity (trough downstream)



CFD results - Flow Velocity (tubercle peak downstream)



CFD Results - Boundary Layer Limit (upstream)



CFD Results - Boundary Layer Limit (mid-length)

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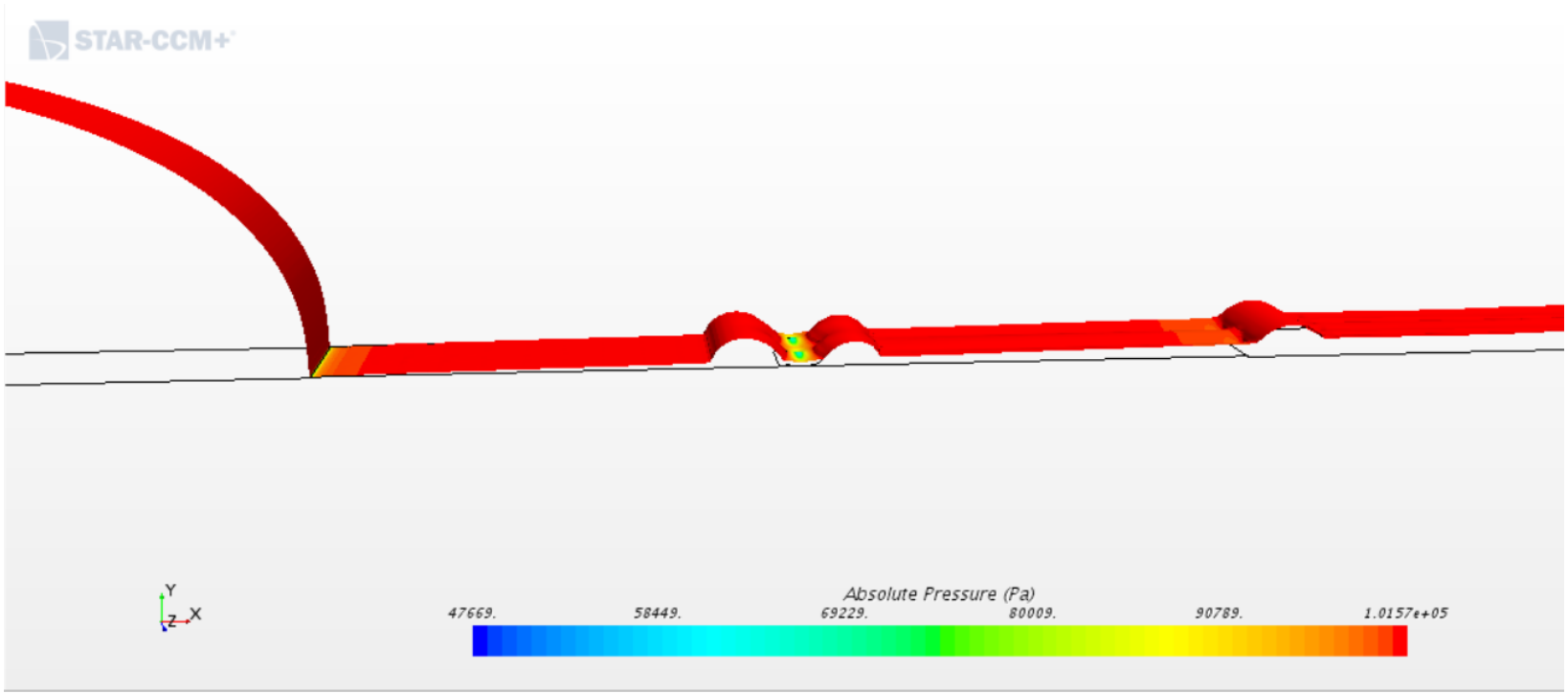
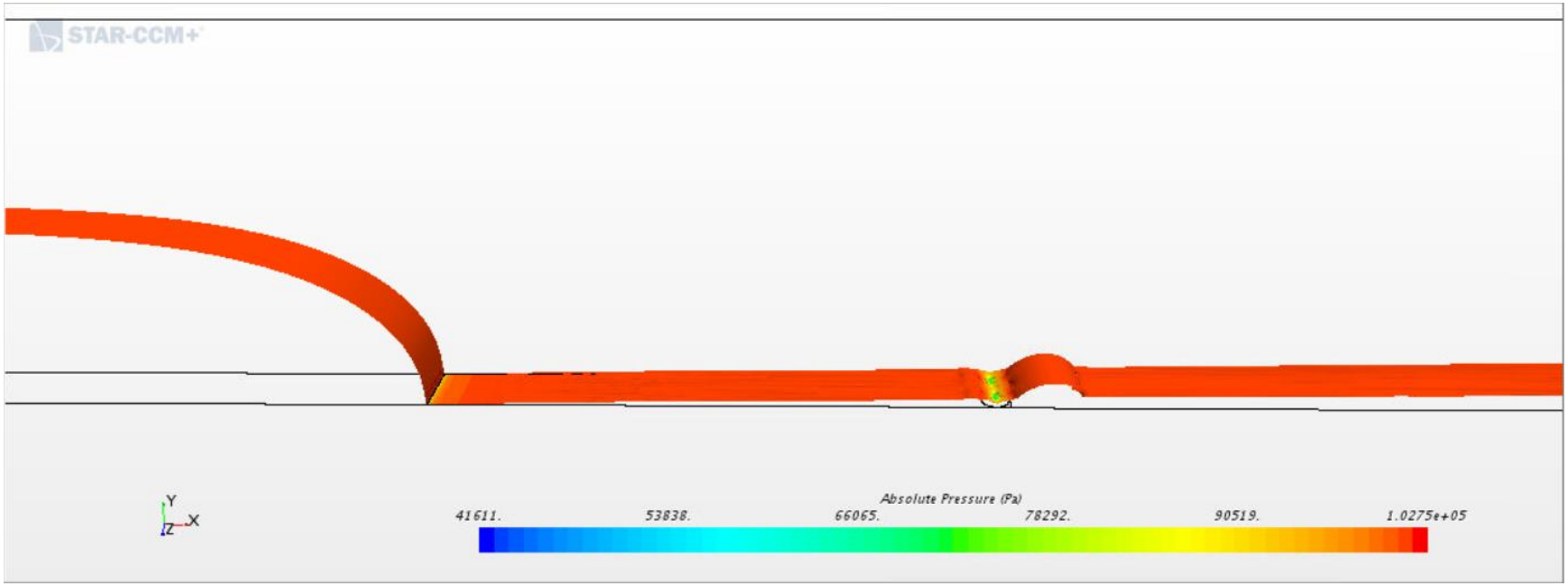
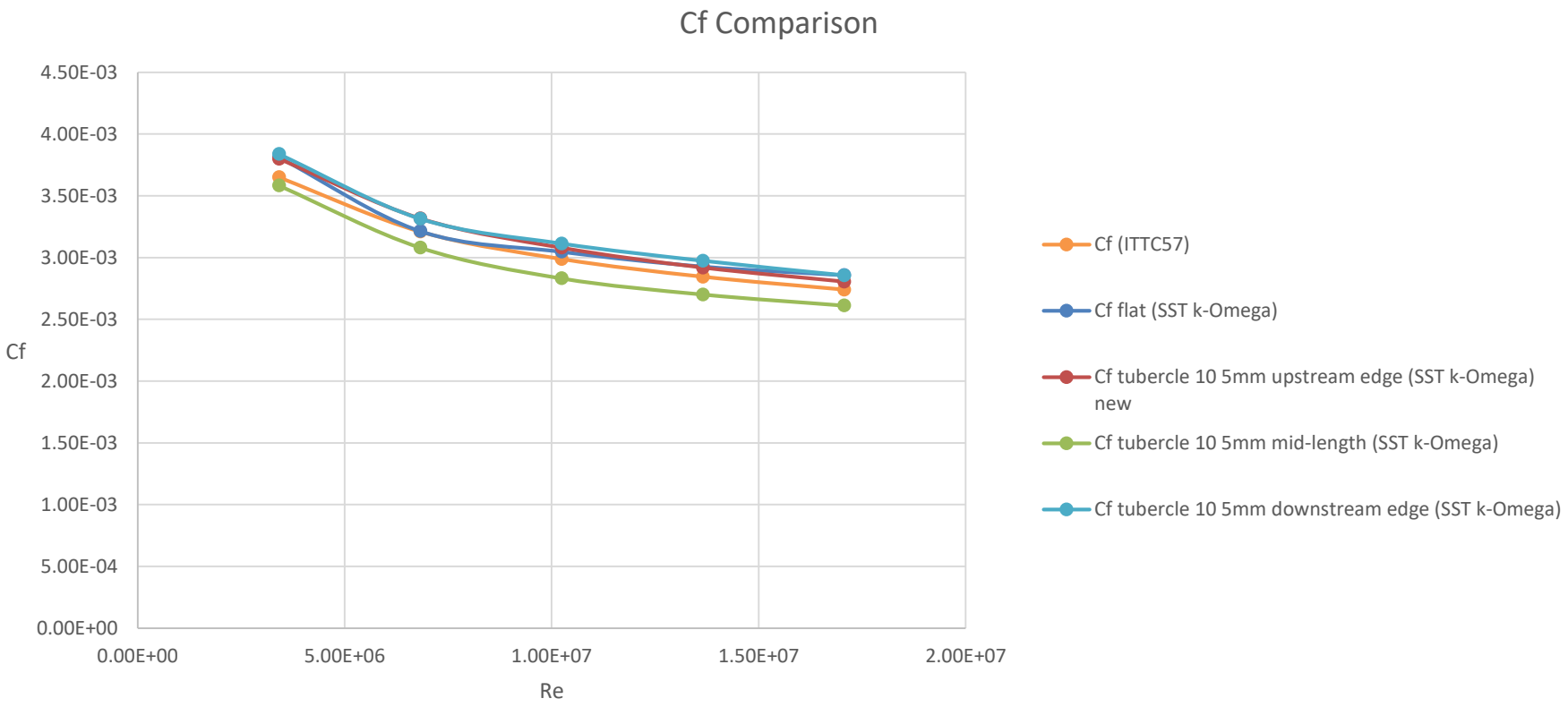


CFD Results - Boundary Layer Limit (downstream)



Drag Comparison



Future development

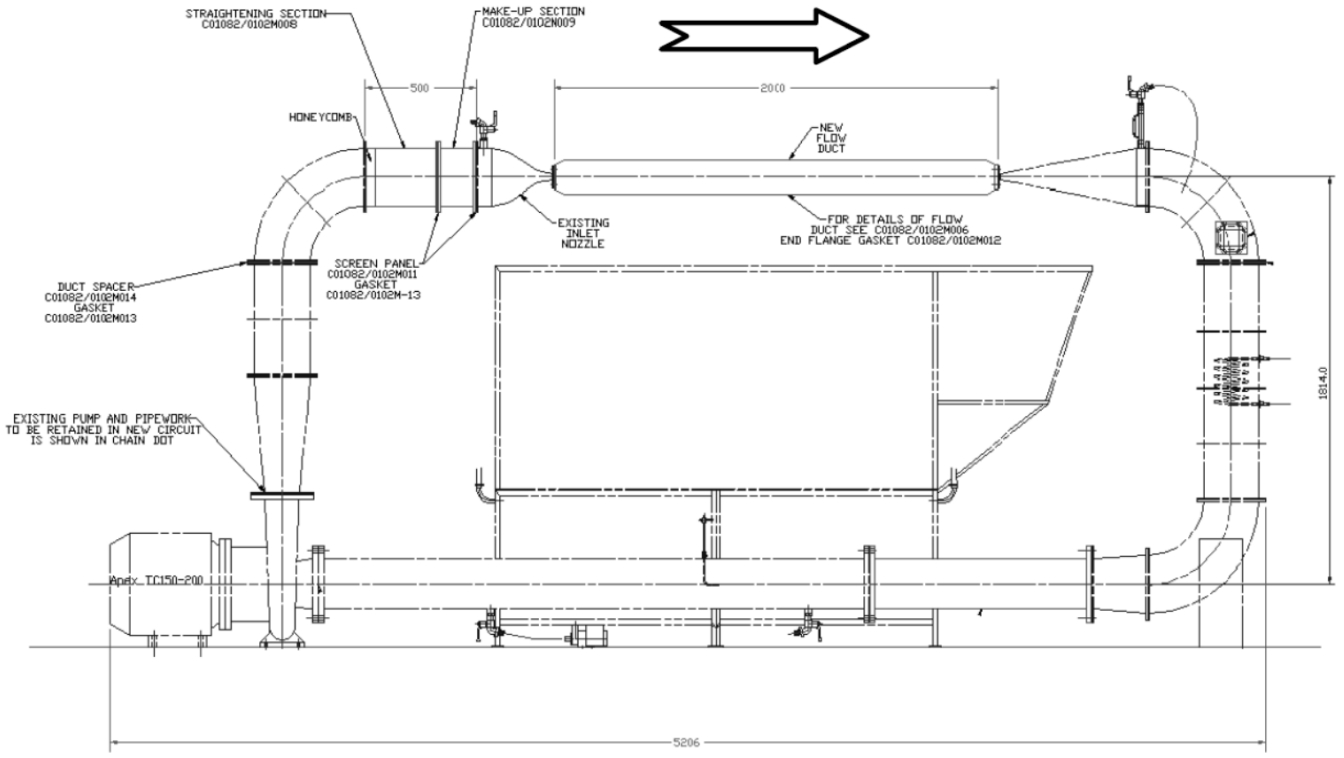
CFD simulations:

- Systematic variation of tubercle shape, number and spatial distribution
- Comparison of results in terms of drag, flow quality, pressure distribution

EFD:

- Fully Turbulent Flow Channel (FTFC) experiments on tubercles (flat plate)
- Towing tests on tubercles (flat plate, curved plate, ship model)

Fully Turbulent Flow Channel



(Politis et al.)

References

SHI, W., ATLAR, M., NORMAN, R., AKTAS, B. & TURKMEN, S. 2016. Numerical optimization and experimental validation for a tidal turbine blade with leading-edge tubercles. *Renewable Energy,* 96**,** 42-55.

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Thank you for your attention!

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