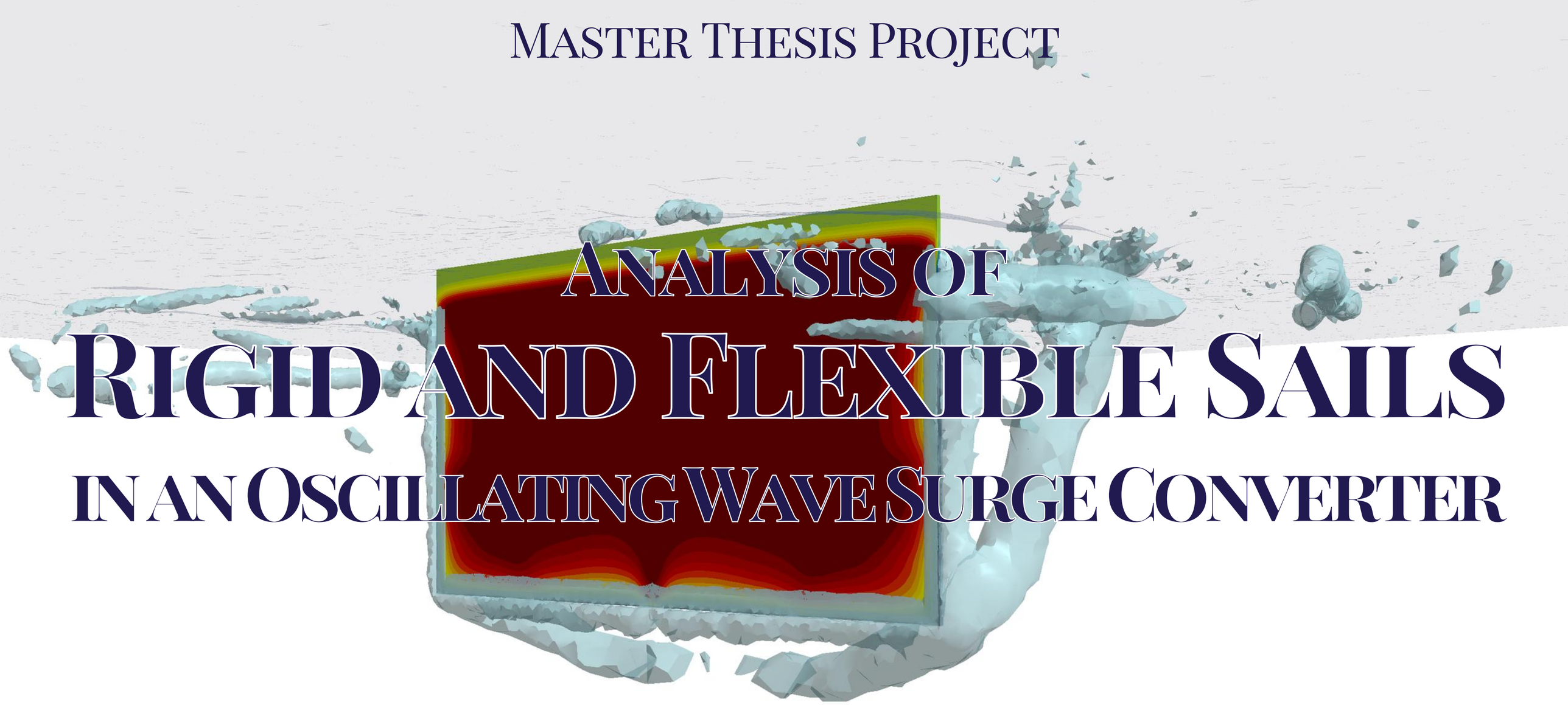
Master Thesis Project



Analysis of Rigid and Flexible Sails in an Oscillating Wave Surge Converter

Bogdan Bernic

M.Sc. Structural and Civil Engineering

Aalborg University, June 2025

Agenda

01. Introduction

Wavepiston system
COHSI-WEC project
Experimental campaigns

02. Experiments

Rigid and flexible sails
Test conditions

03. CFD Model

Rigid sail
Star-CCM+ model
Verification and validation

04. Video Analysis

Flexible sail
Experimental footage
Deflection measurements

INTRODUCTION

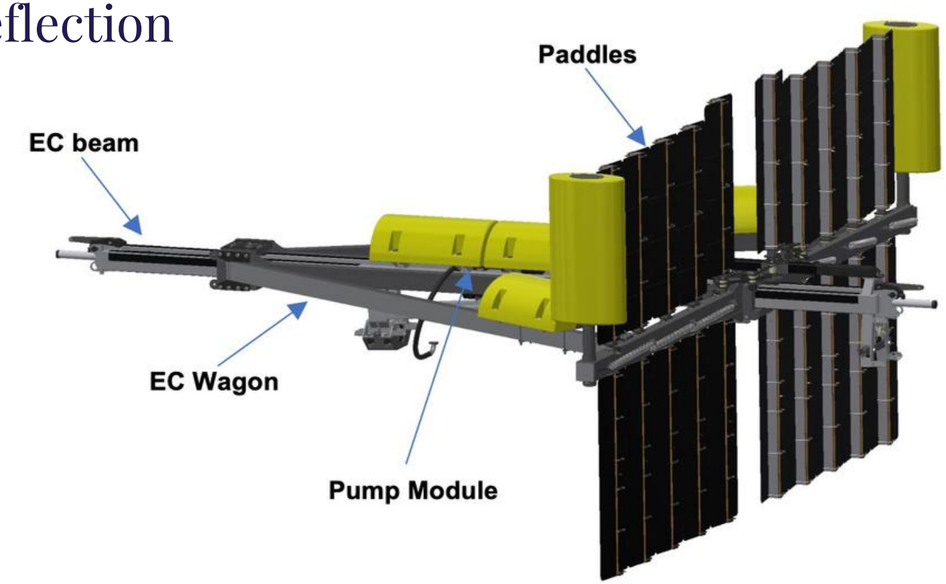
Wavepiston system – Prototype scale at PLOCAN (4m x 8m)

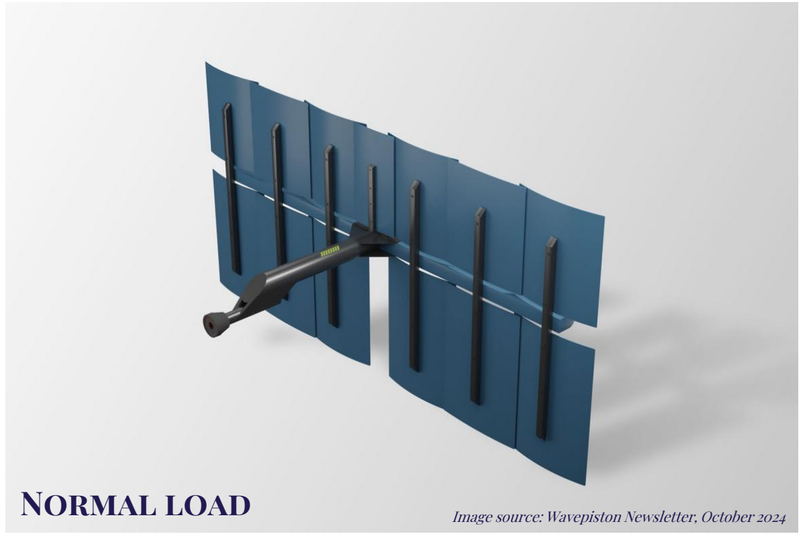
COHSI-WEC - Experimental campaign (I & II)

Added mass effects – 78 tons

Introduction of flexible sails

Measurement of deflection





NORMAL LOAD

Image source: Wavepiston Newsletter, October 2024

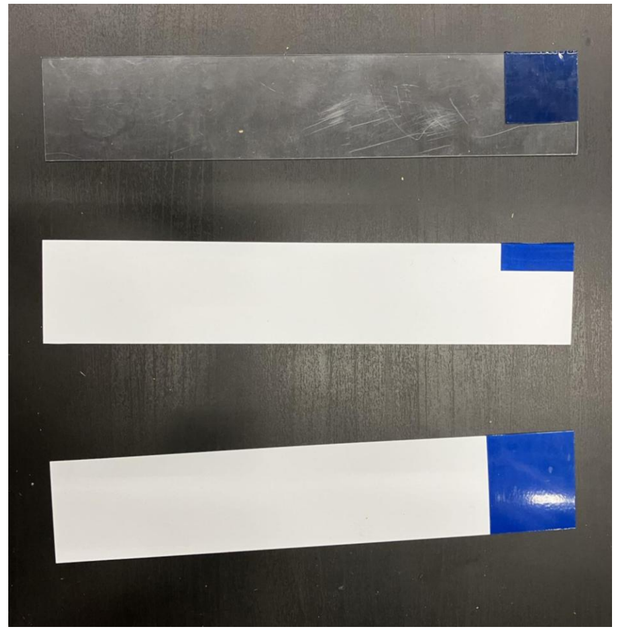
STORM LOAD

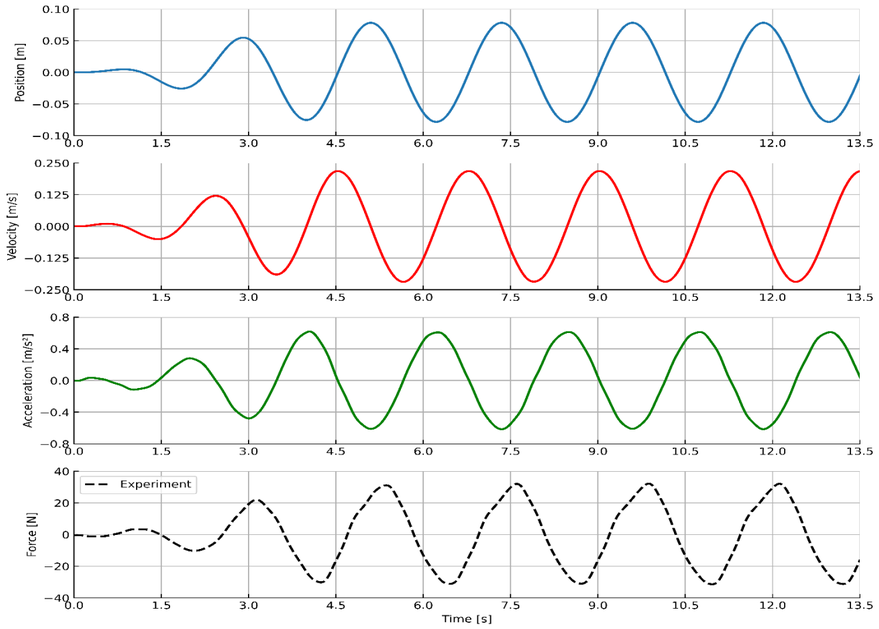
Image source: Wavepiston Newsletter, October 2024

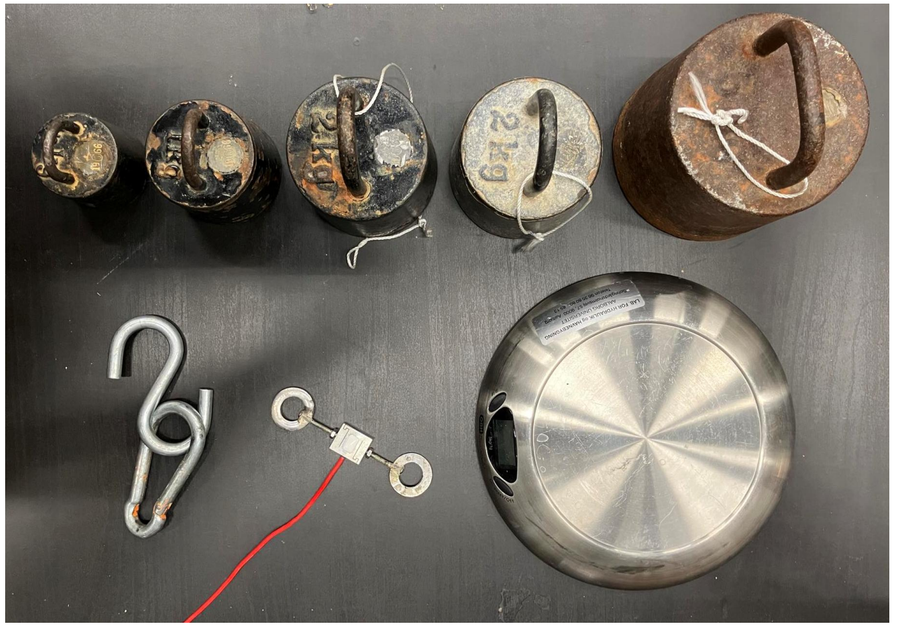
Reference: Andersen, J., Ferri, F., Eskilsson, C., Thomsen, S. G., & Folley, M. (2025).
Leveraging Flexibility in the Design of a Wave Energy Converter: Strongly Coupled Two-Way FSINumerical Modeling and Experimental Wave Tank Testing. Proc. SEMC 2025 9th Int. Conf. Str. Eng.Mech. Comp.

EXPERIMENTS

Campaign I (spring 2024) – Rigid sail
Campaign II (autumn 2024) – Flexible sail
1:16 Froude scale – 250 mm x 500 mm
PVC plates - K1, K2, K3
Prescribed motion RW06 - T = 2.25 sec, a = 7.8 cm

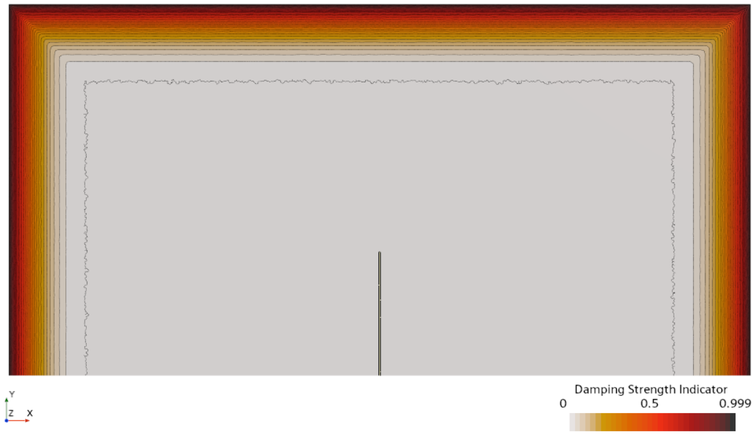


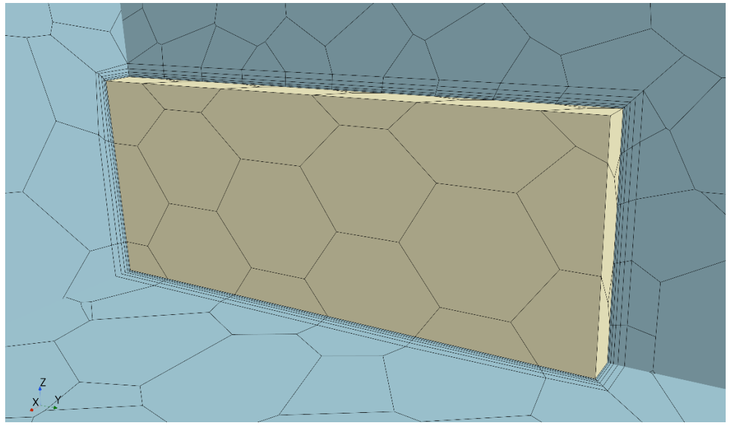


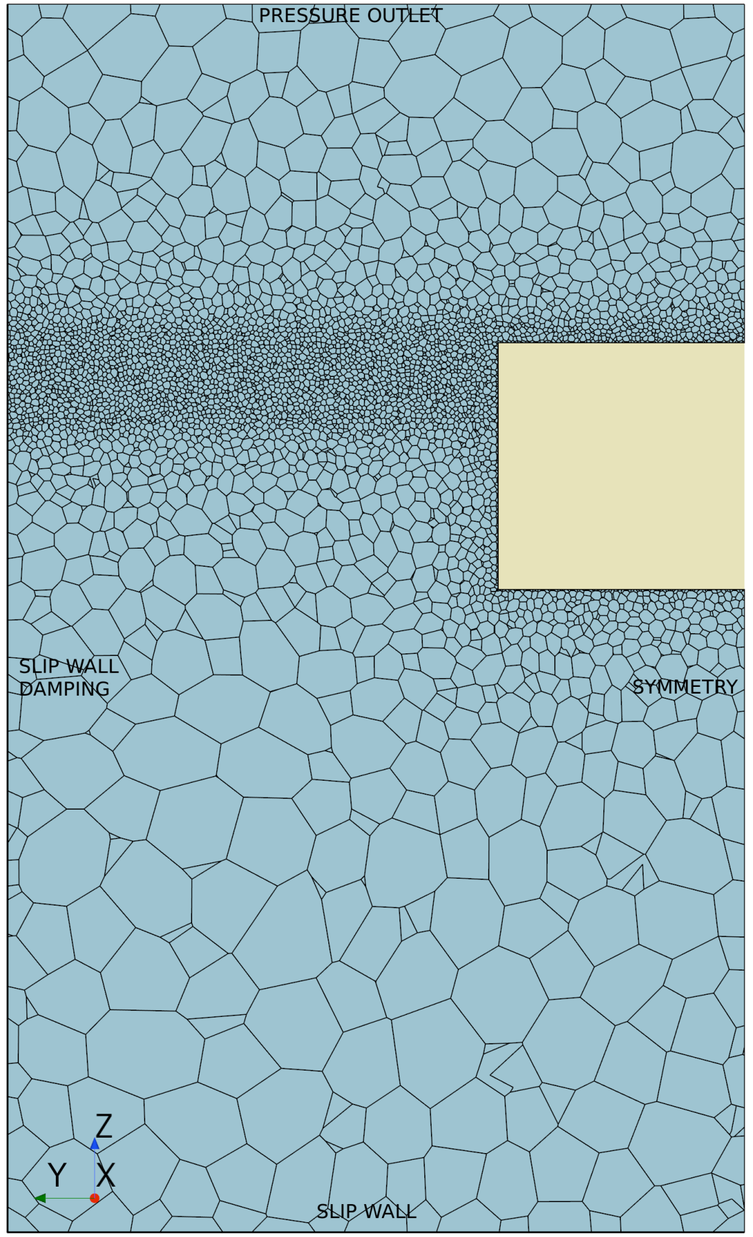


CFD Modelling

Simcenter Star-CCM+
Symmetry plane – reduce computational cost
Volume of Fluid (VOF) – water-air interface
Hybrid URANS-LES - turbulence model
Verification - Mesh size/time step resolutions
Validation - Experimental data







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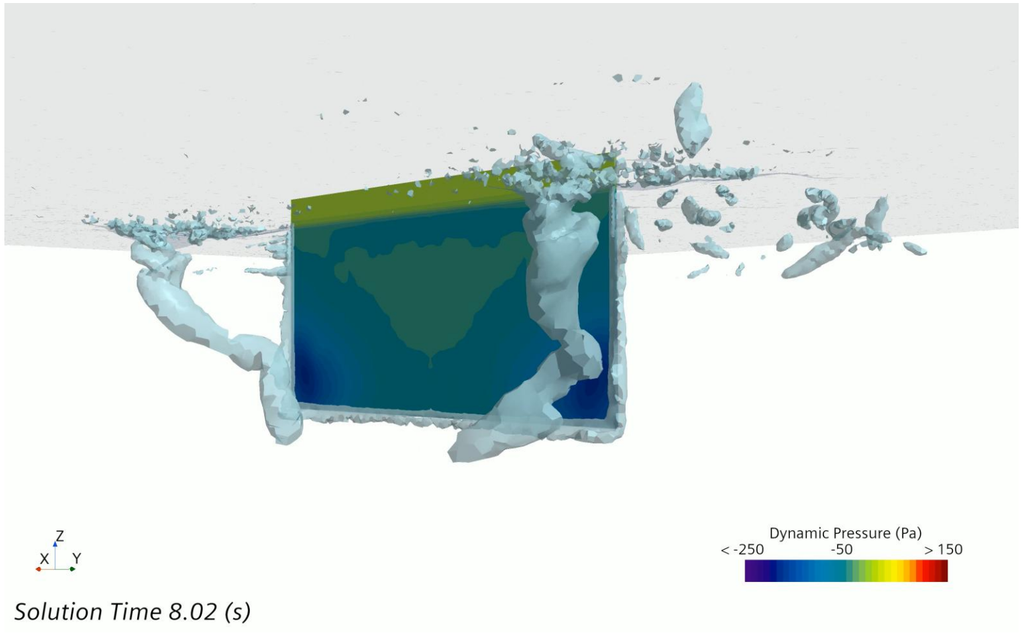
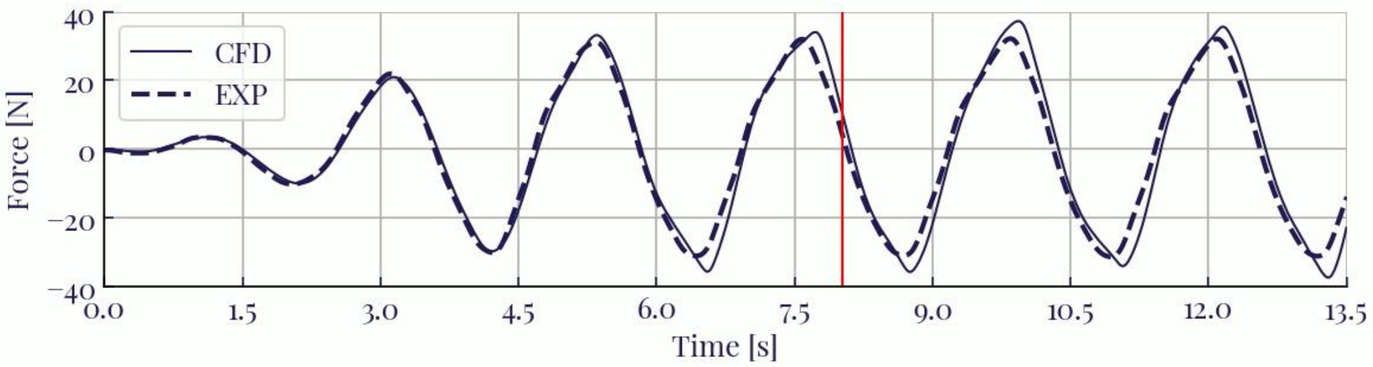
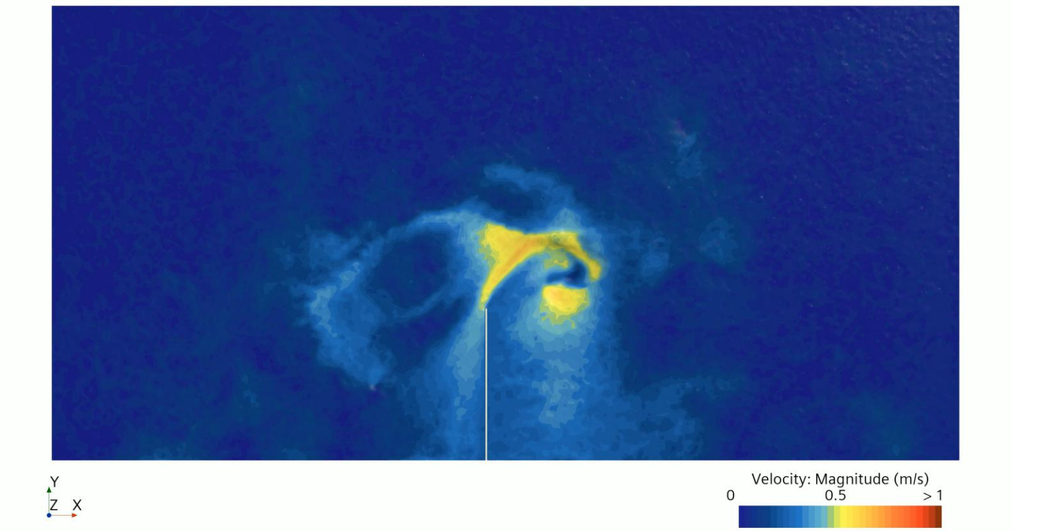


Solution Time 8.02 (s)

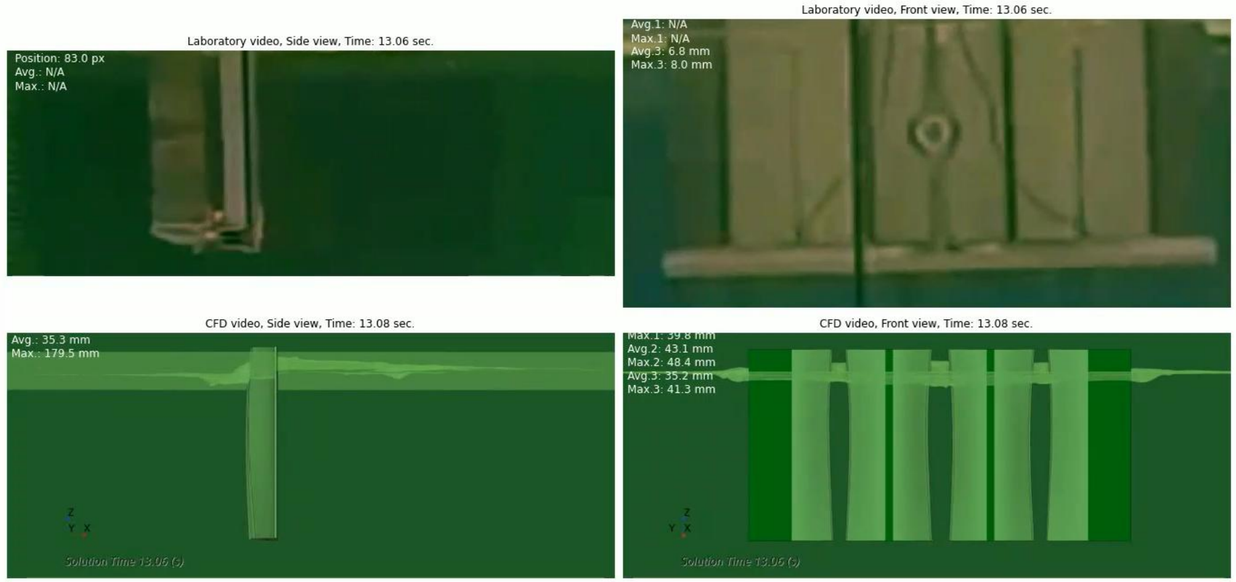


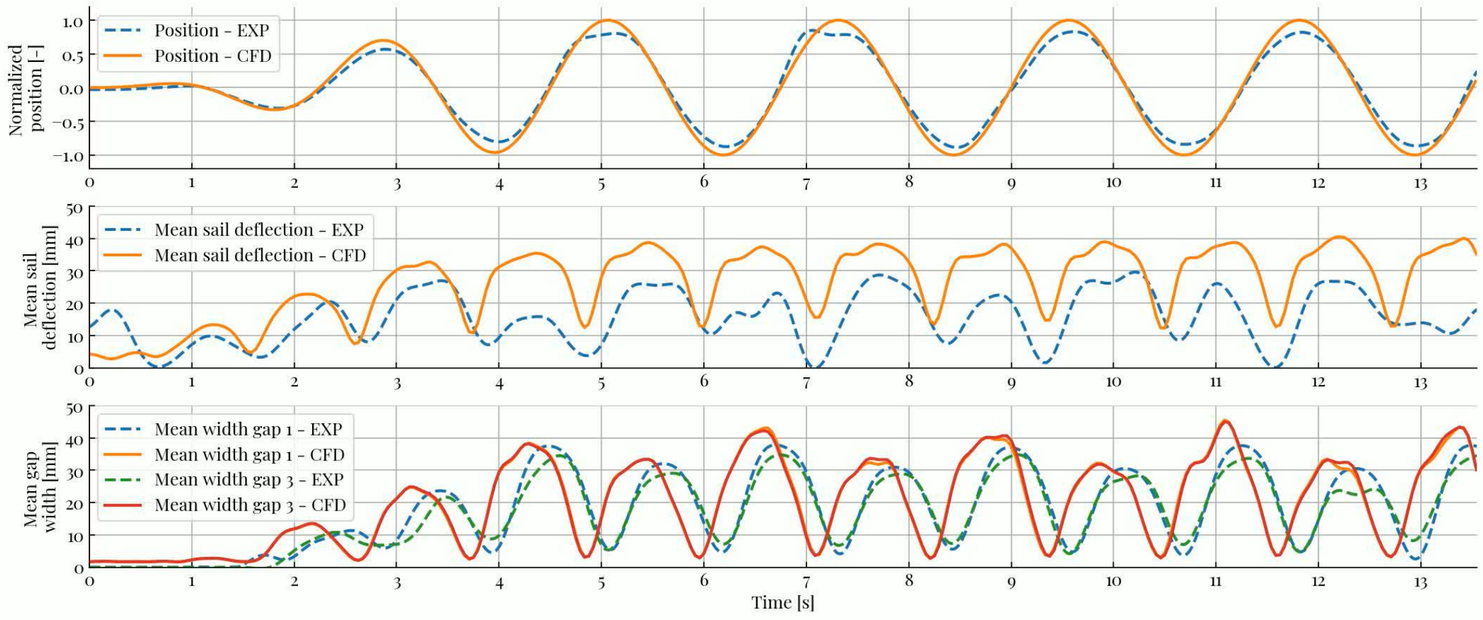


Solution Time 8.02 (s)

Video Analysis

Reduced effective surface area
Measurements of plate deflections (gap width)
Side and back view underwater footage
Edge detection – OpenCV library in Python
Side view – mean sail deflection
Back view – mean gap widths
Results synced using position of sail
Low-pass filter





CFD results and video source: Andersen, J., Ferri, F., Eskilsson, C., Thomsen, S. G., & Folley, M. (2025).
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Thank You For Your Attention