CENER

NATIONAL RENEWABLE ENERGY CENTRE

21st EERA DeepWind conference

Pressure distribution solution in time domain of FOWTs with fully coupled multi -fidelity approach

January 2024

Guillén Campaña-Alonso

Beatriz Méndez-López

What do I need to perform a structural analysis of my floating platform

Pressure distribution to be employed as input for the structural code

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What do I need to perform a structural analysis of my floating platform

Pressure distribution to be employed as input for the structural code

WT influence taken into account

Keep it affordable!

Approaches

Approaches

Full CFD

- Aerodynamics highly demanding
- No elasticity considered
- No control system considered

Classic approach

Approaches

Full CFD

- Aerodynamics highly demanding
- Aeroelasticity considered
- No control system considered

Engineering

- Morison inaccuracy in non-slender bodies
- No instantaneous pressure distribution with potential tools (time domain sims)

Classic approach

Approaches

Full CFD

- Aerodynamics highly demanding
- Flexibility considered
- No control system considered

Engineering

- Morison inaccuracy in non-slender bodies
- No instantaneous pressure distribution with potential tools (time domain sims)

Classic approach

OF^2

- High fidelity hydrodynamics
- Pressure distribution available at each time step
- Drastic reduction of computational effort w.r.t full CFD

CENER´s solution

Detailed explanation of the coupling between OpenFOAM and OpenFAST

Paper OF2

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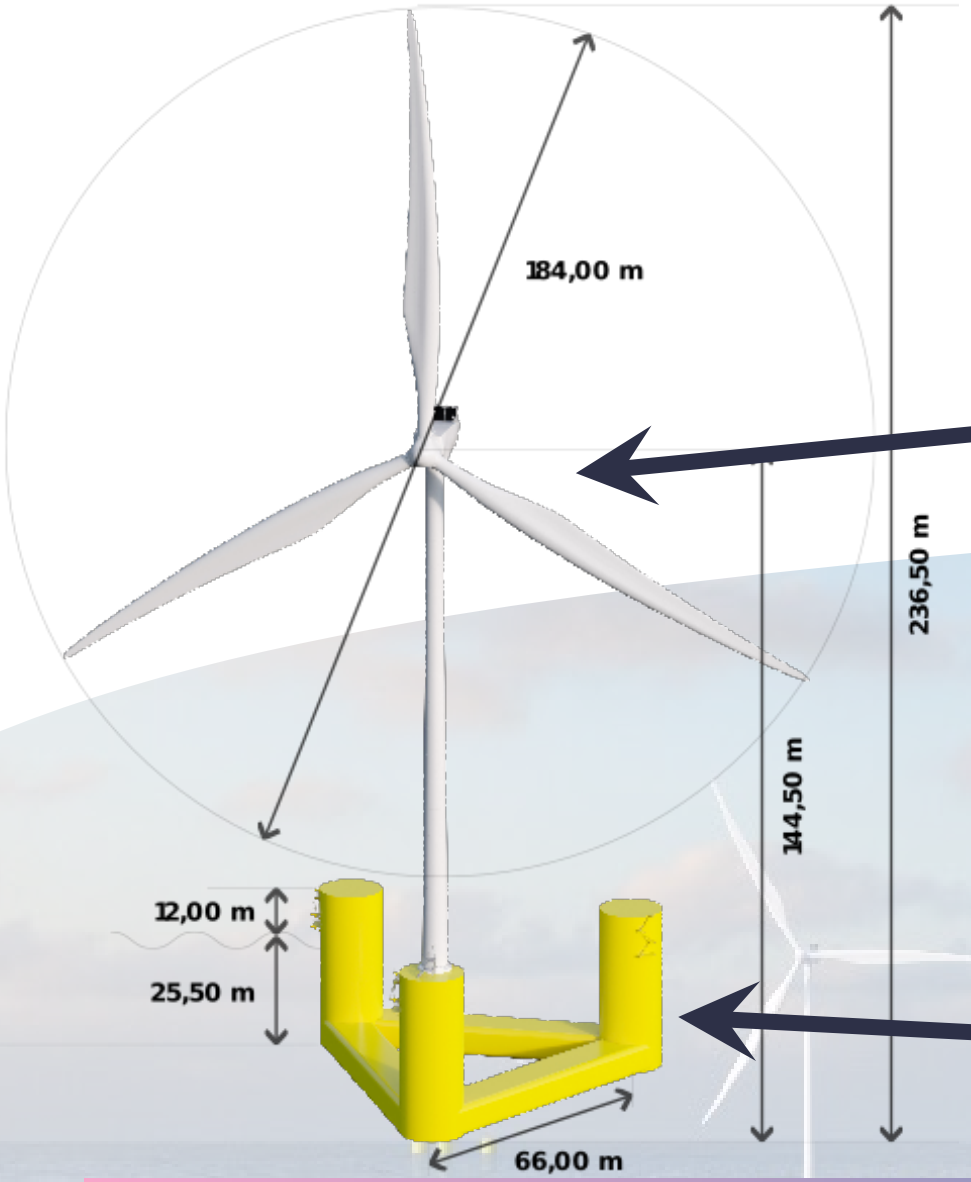

INWIND 10MW

Delta Wind

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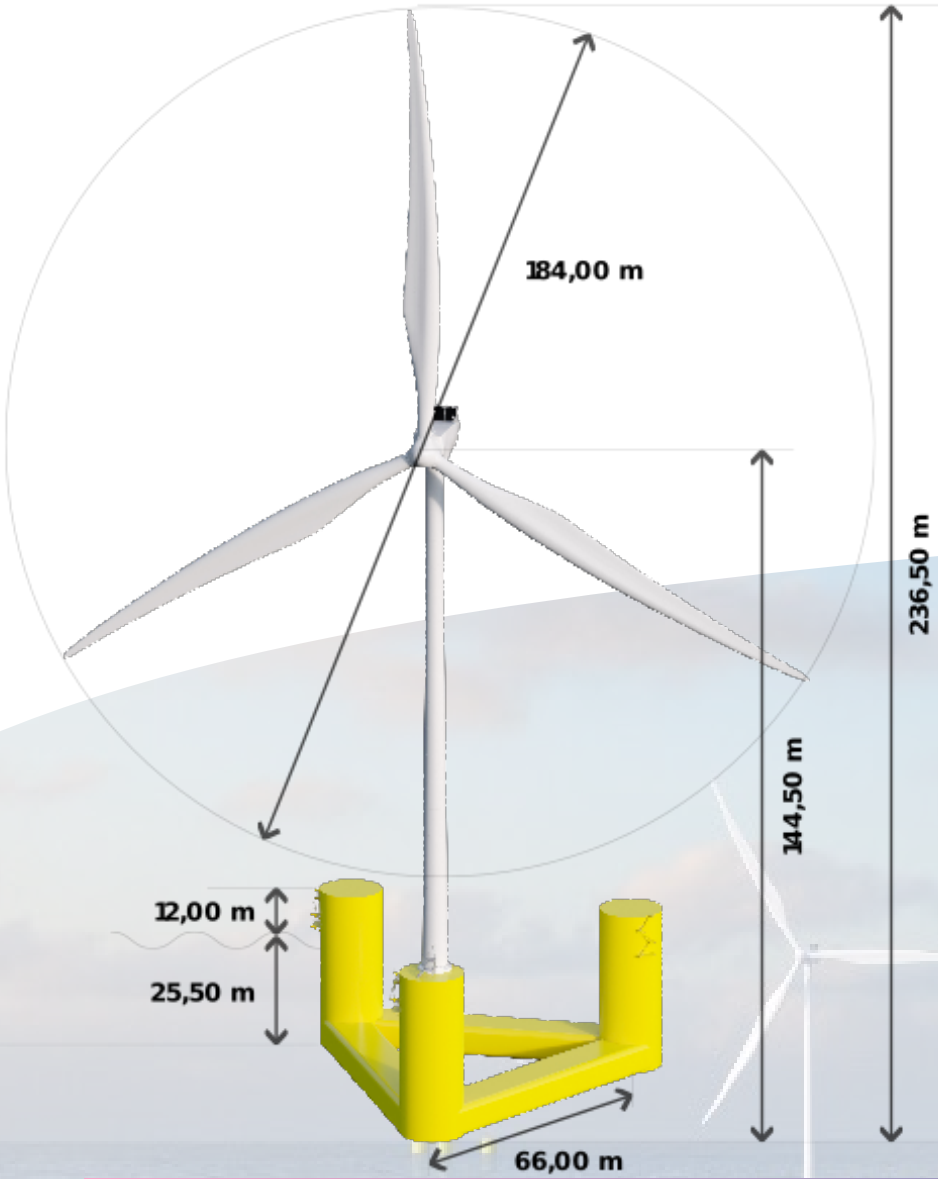
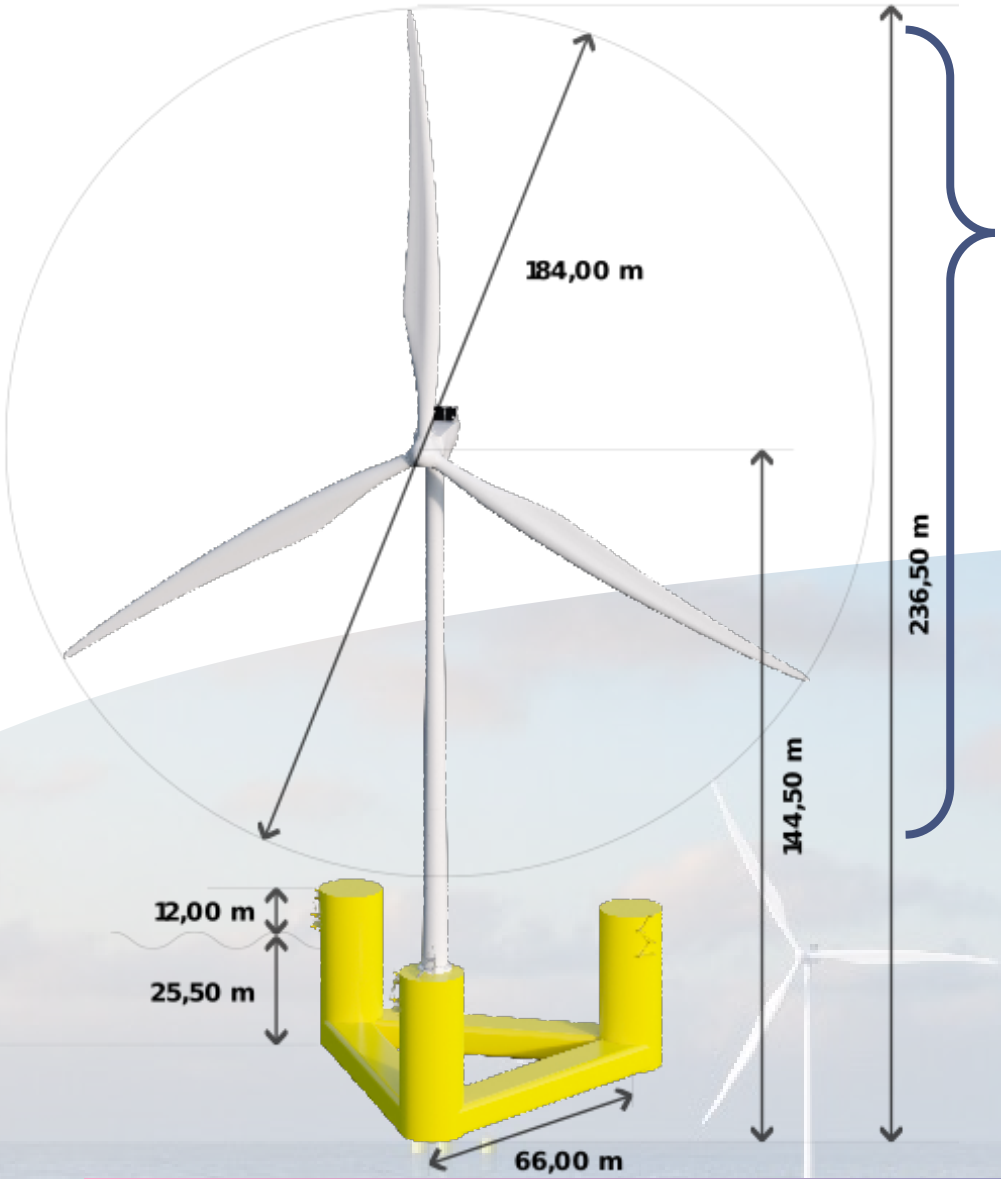
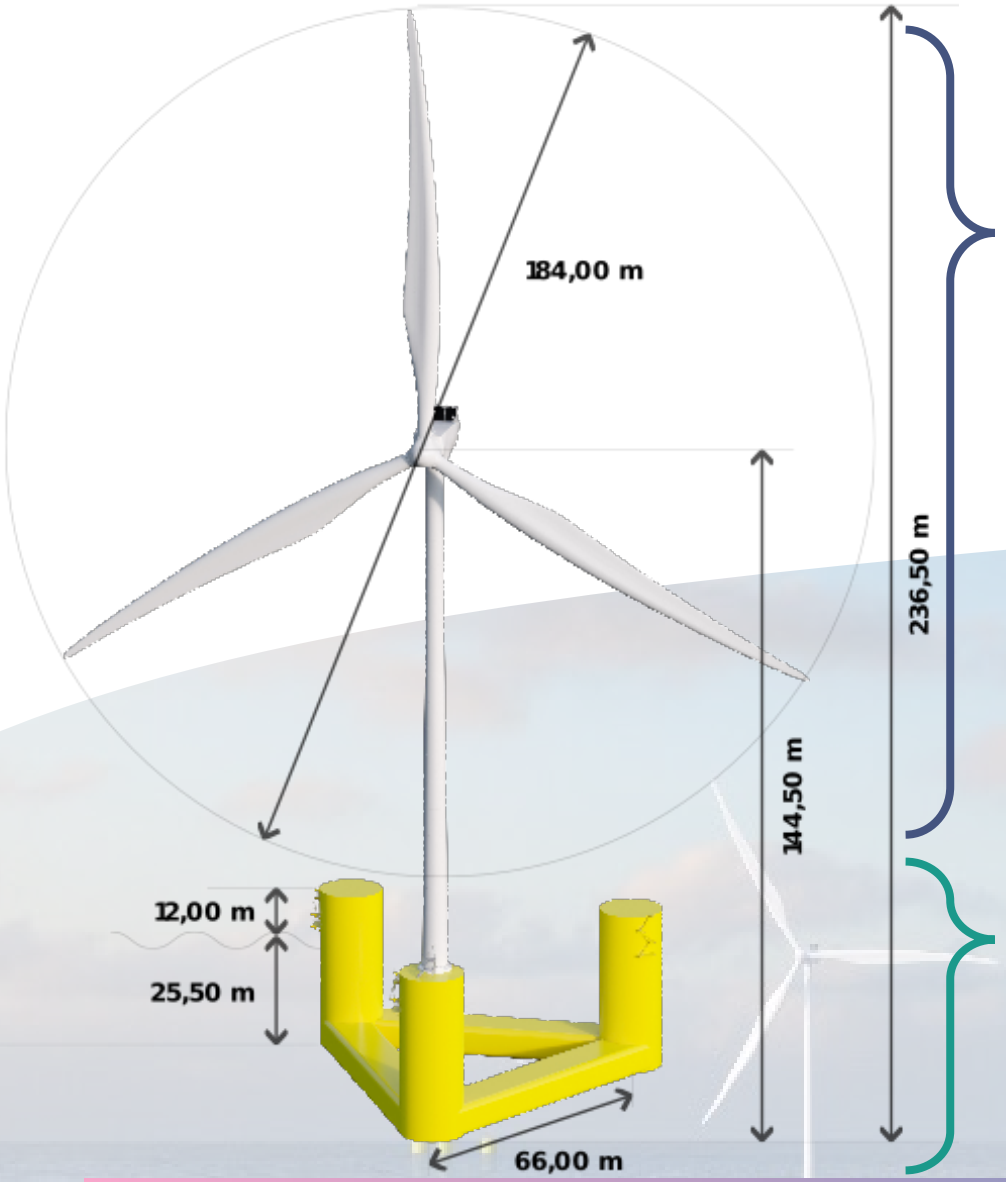

184,00 m
236,50 m
144,50 m
12,00 m
25,50 m
66,00 m



OpenFAST:

- Multi-fidelity aerodynamics
- Elasticity
- Control



OpenFAST:

- Multi-fidelity aerodynamics
- Elasticity
- Control

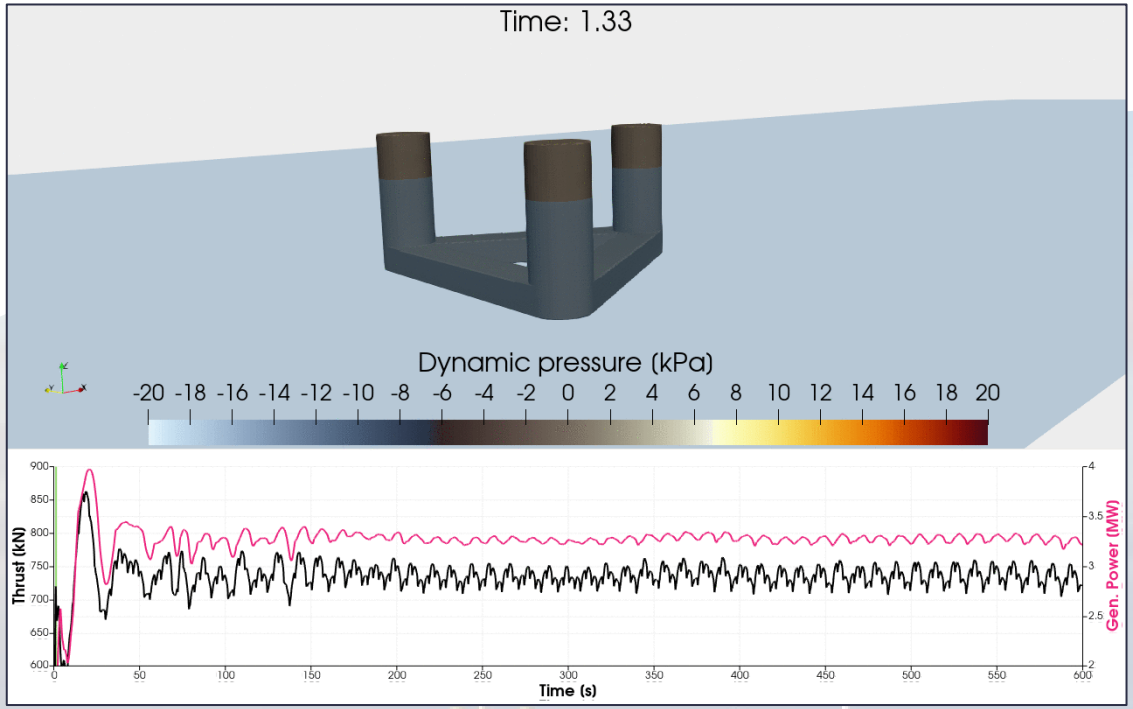
OpenFOAM:

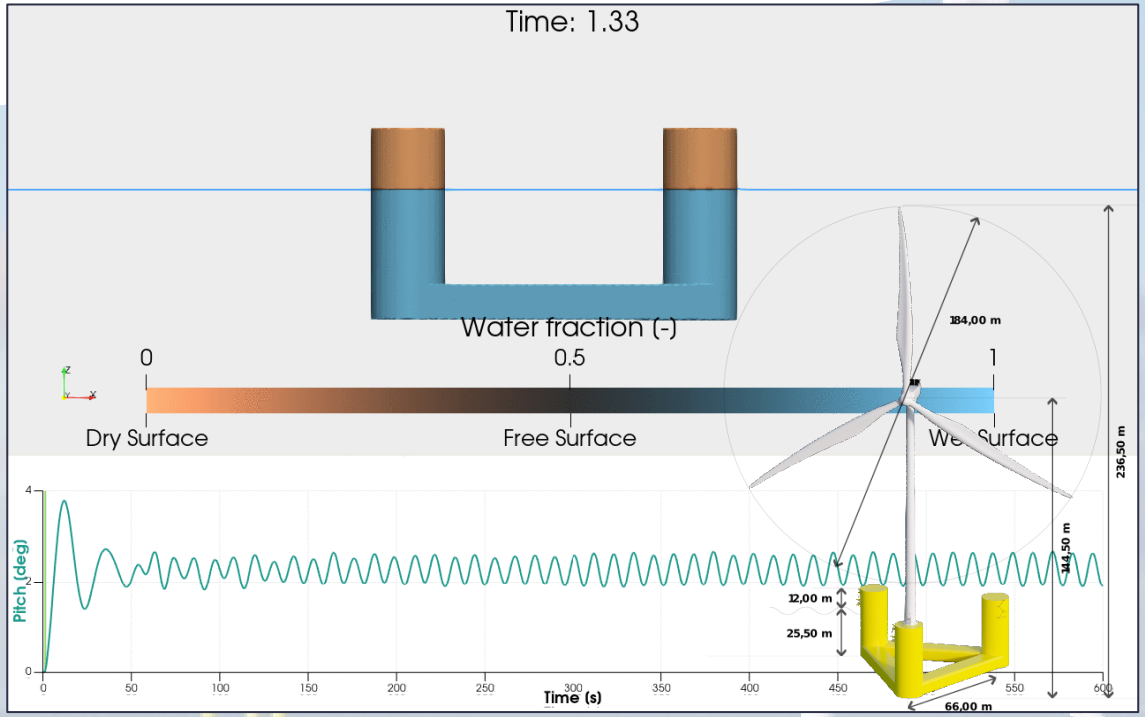
- Hydrodynamic loads
- Pressure distribution
- Coupled with MoorDyn

Regular wave

$U_\infty = 8\ ms^{-1}$

$H = 5.49\ m$
$T = 11.29\ s$





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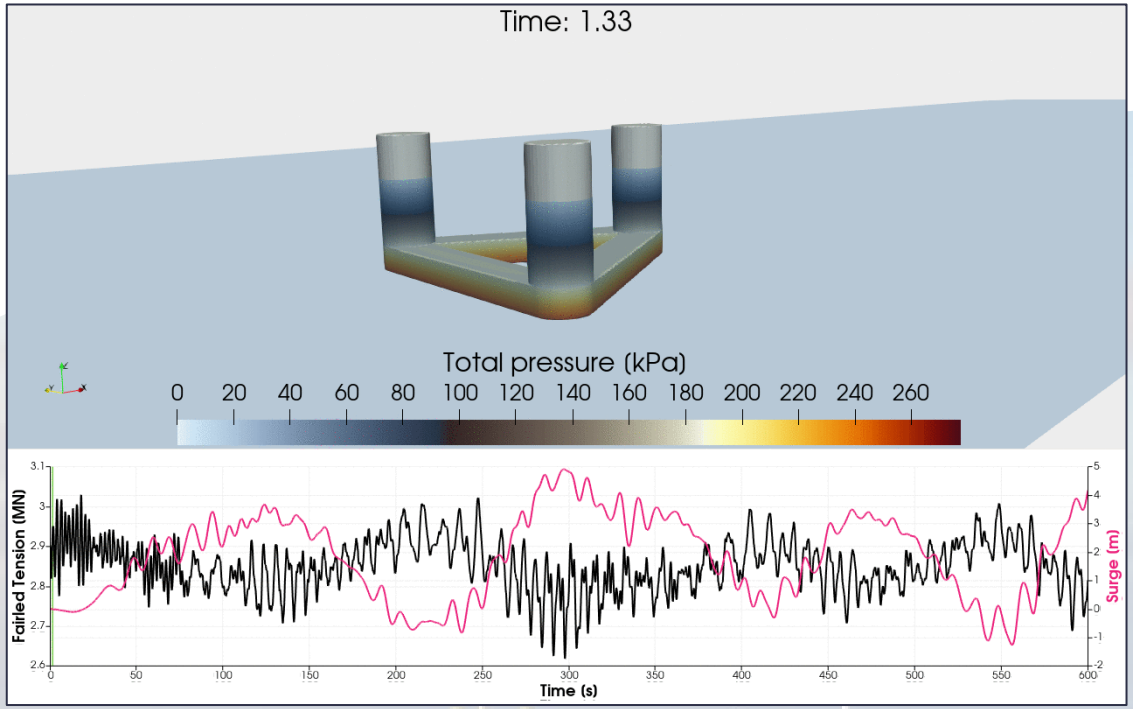
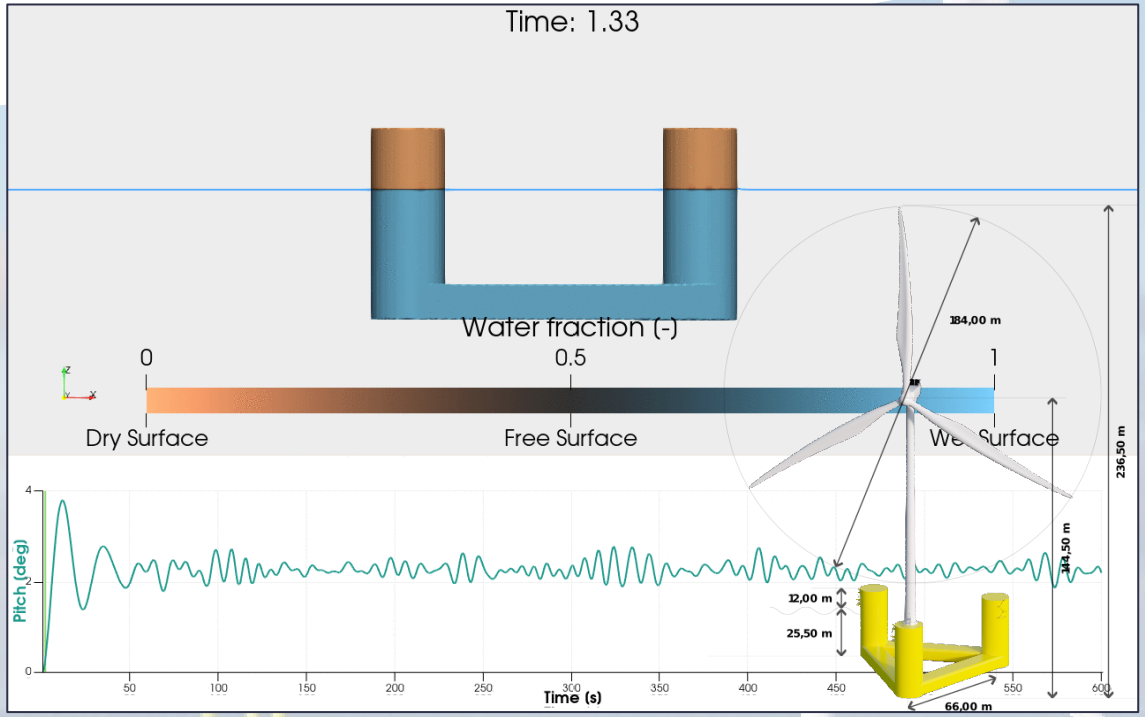
Irregular wave

$U_\infty = 8\ ms^{-1}$

$H_s = 5.49\ m$

$T_p = 11.29\ s$





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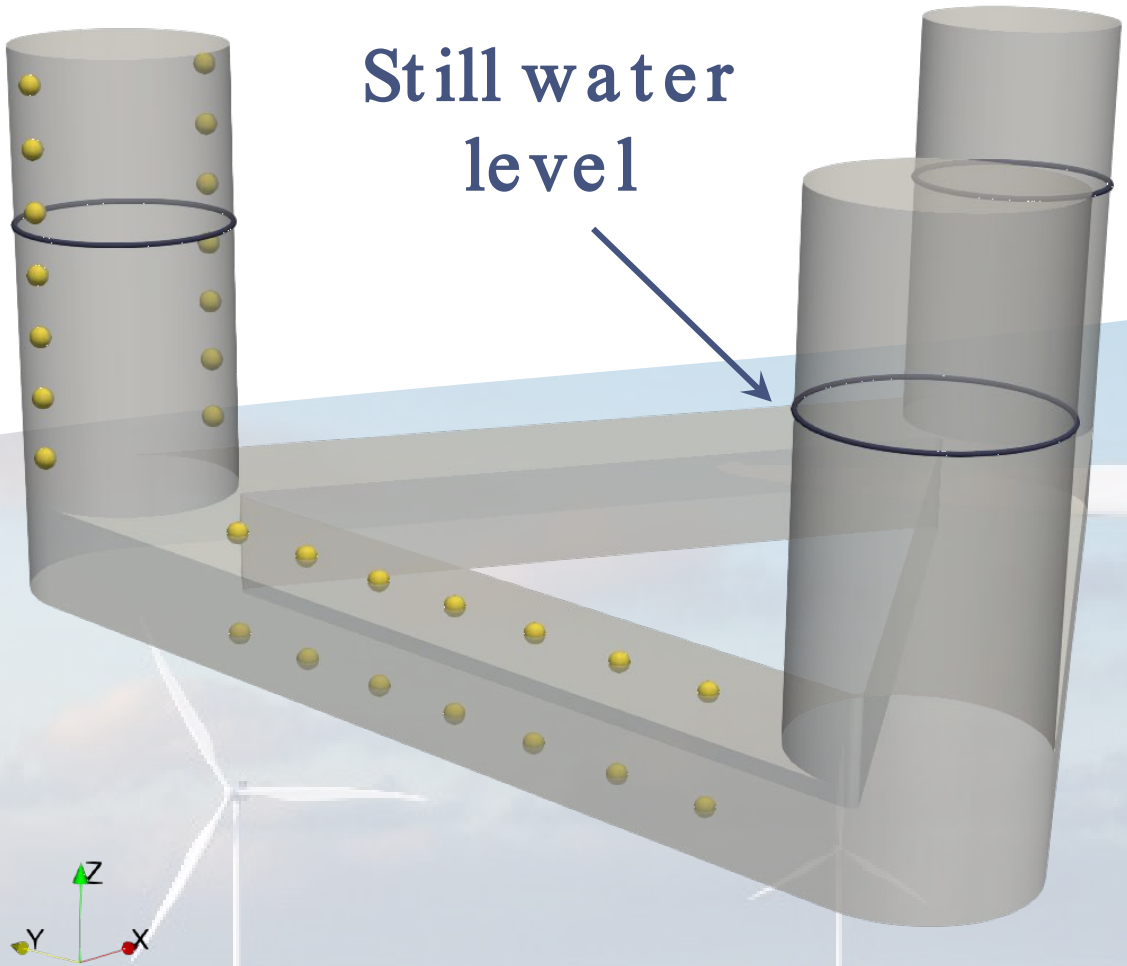
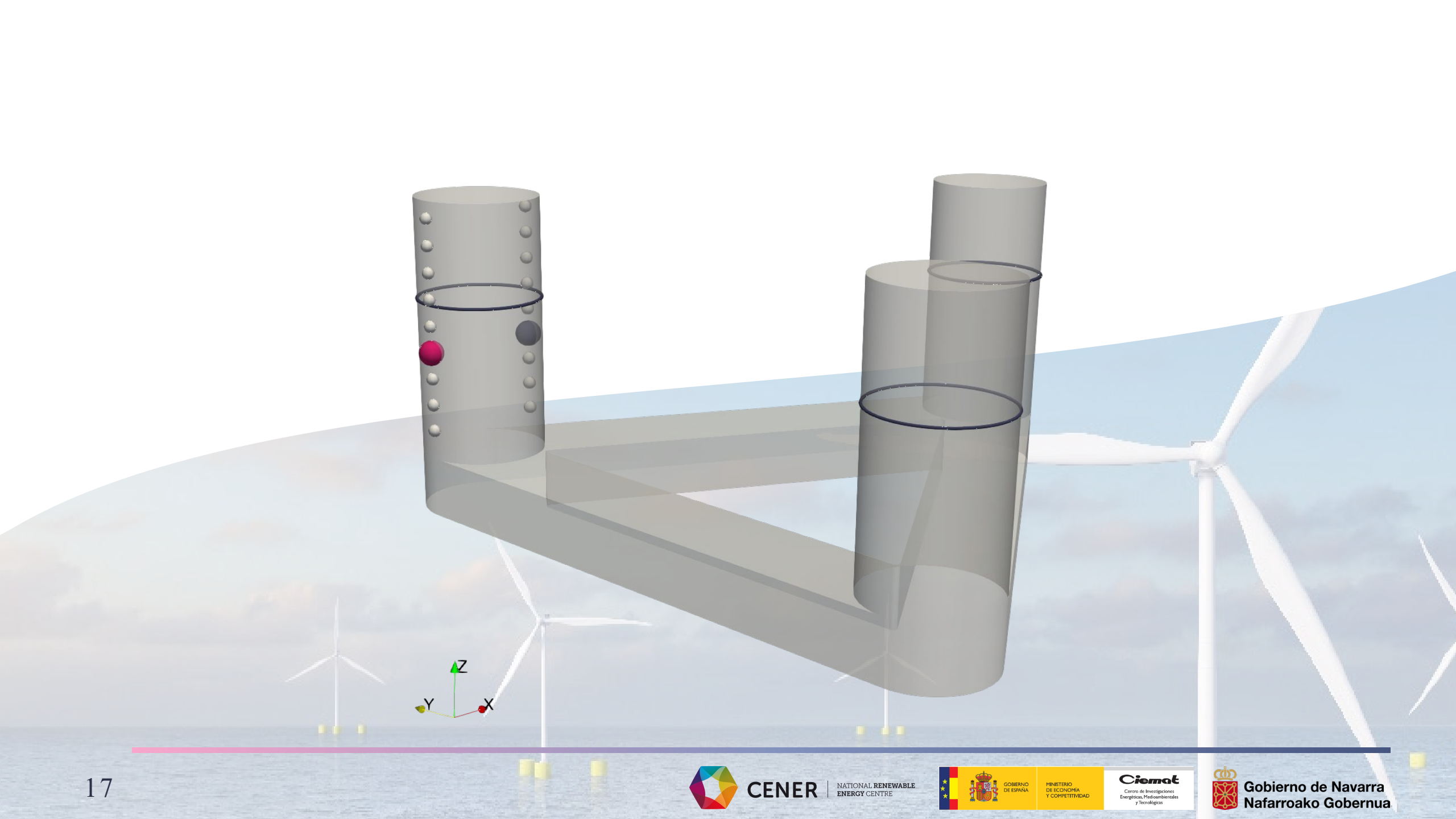
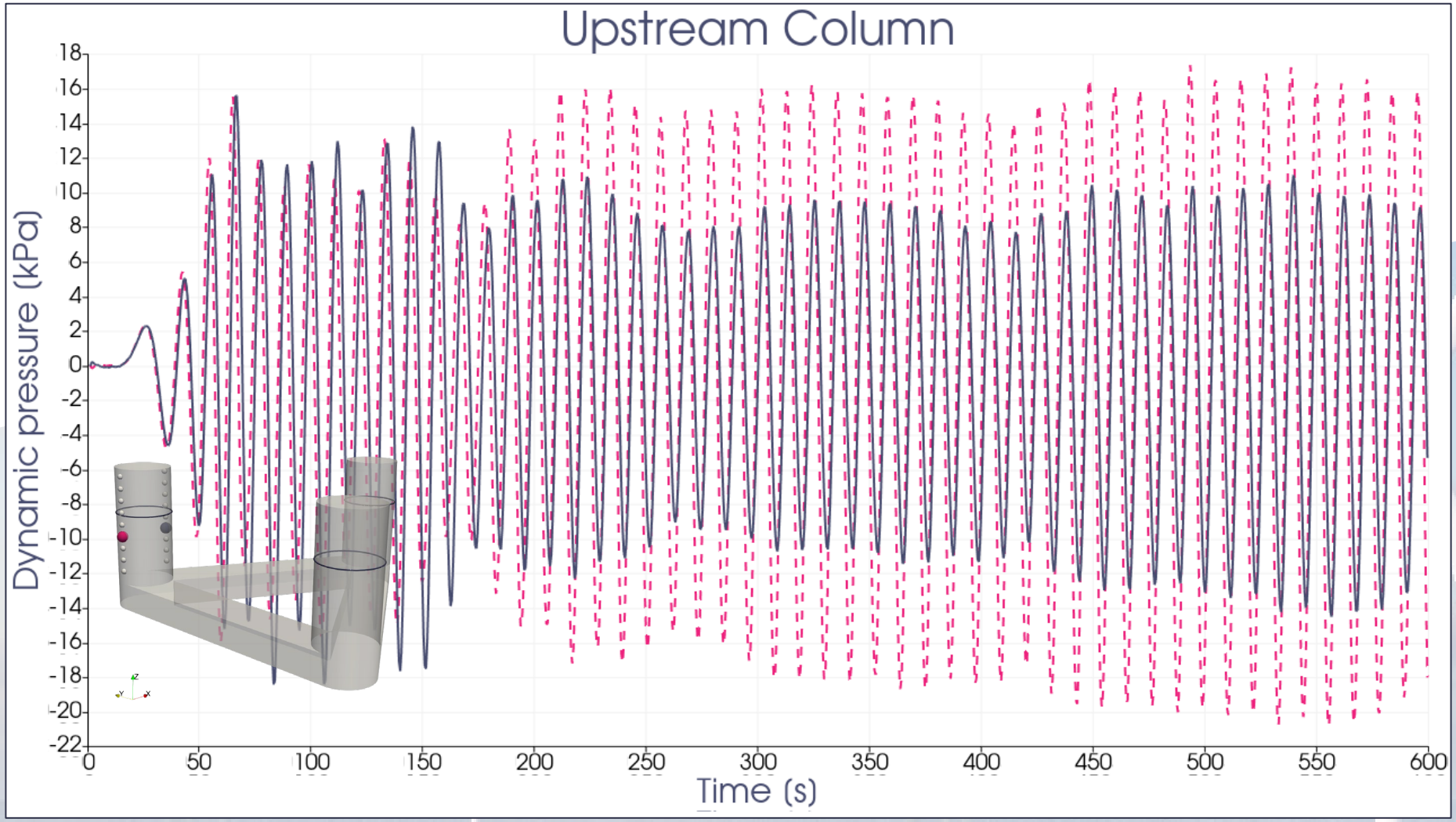
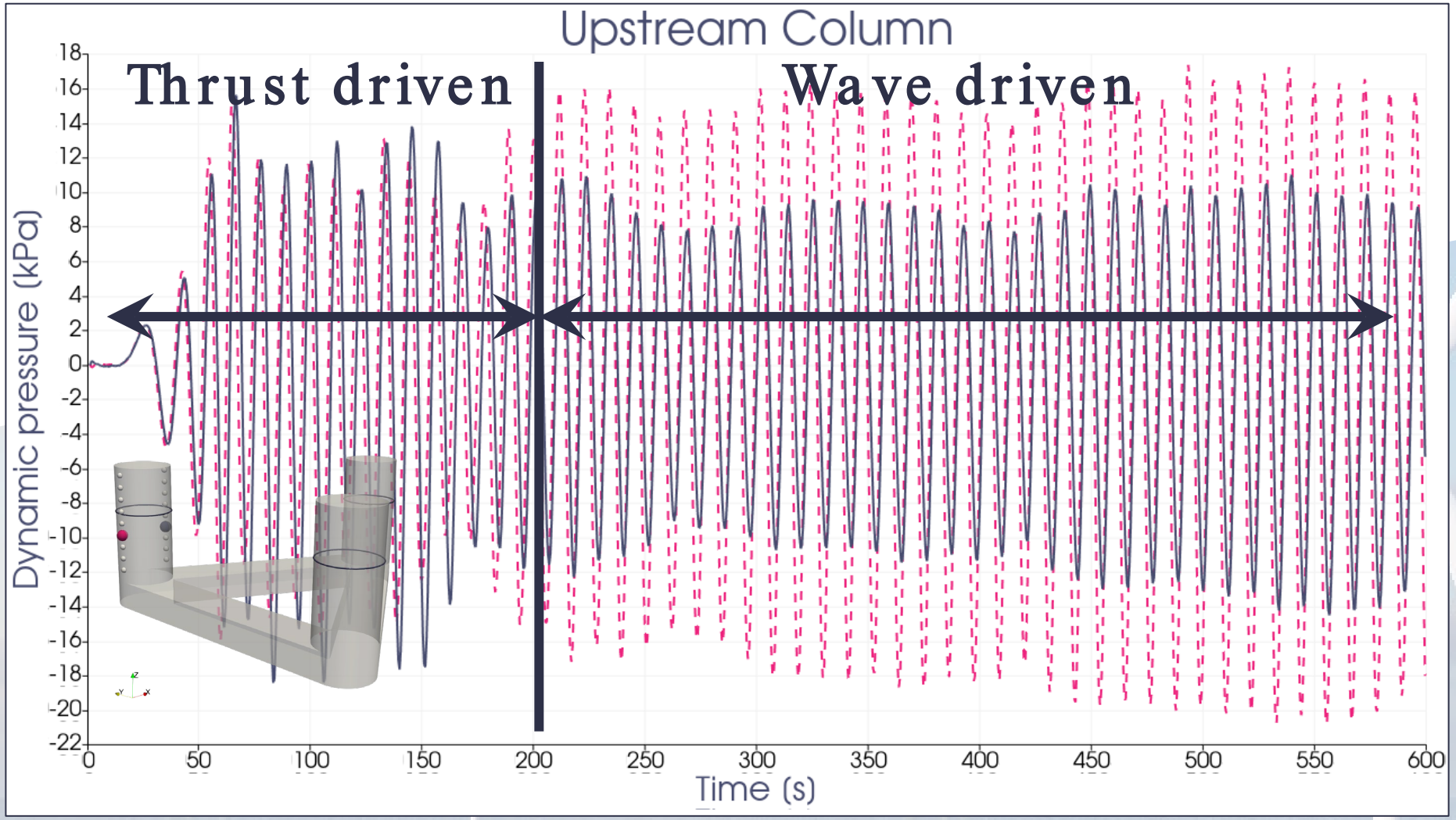




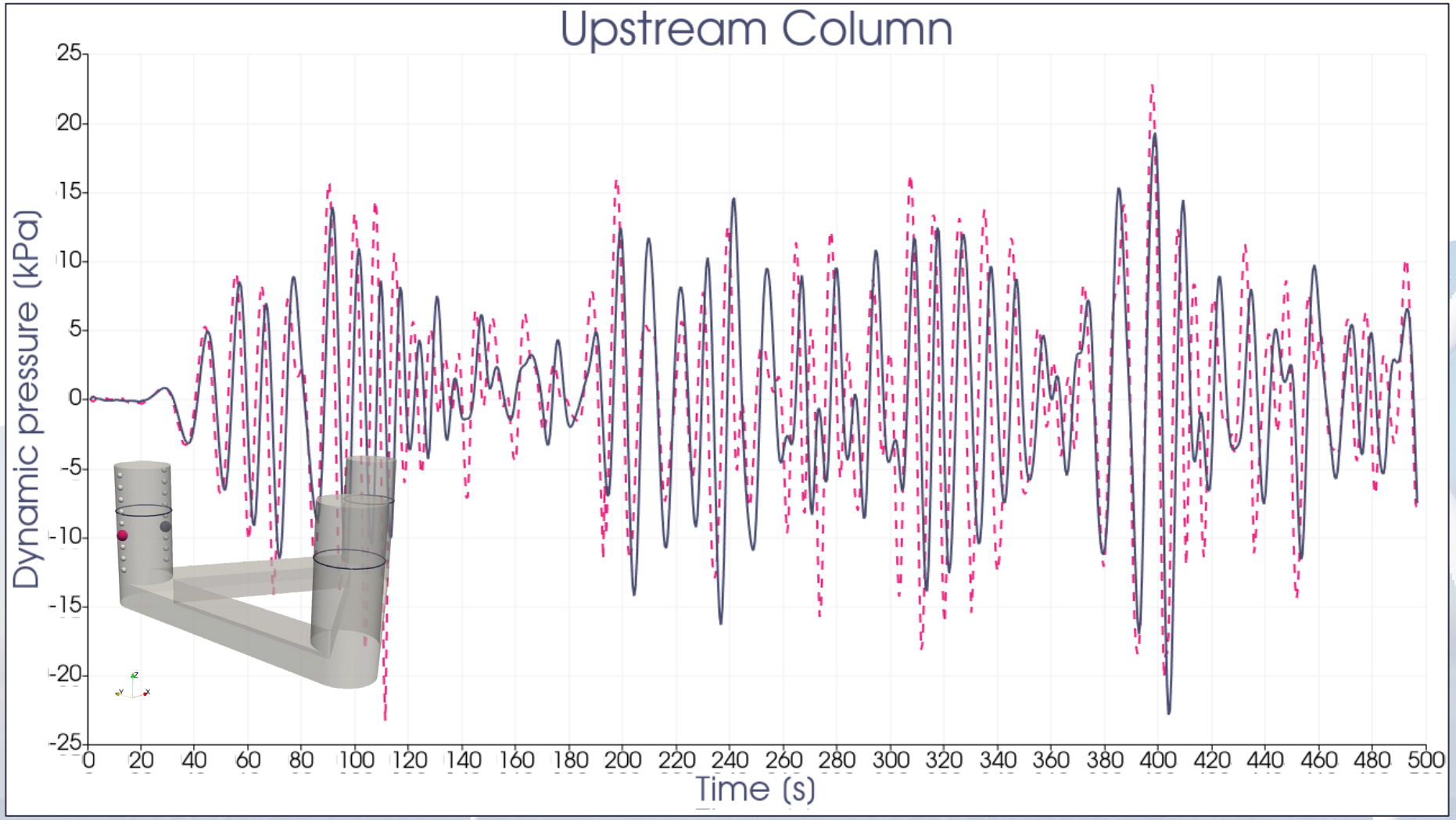
Regular wave



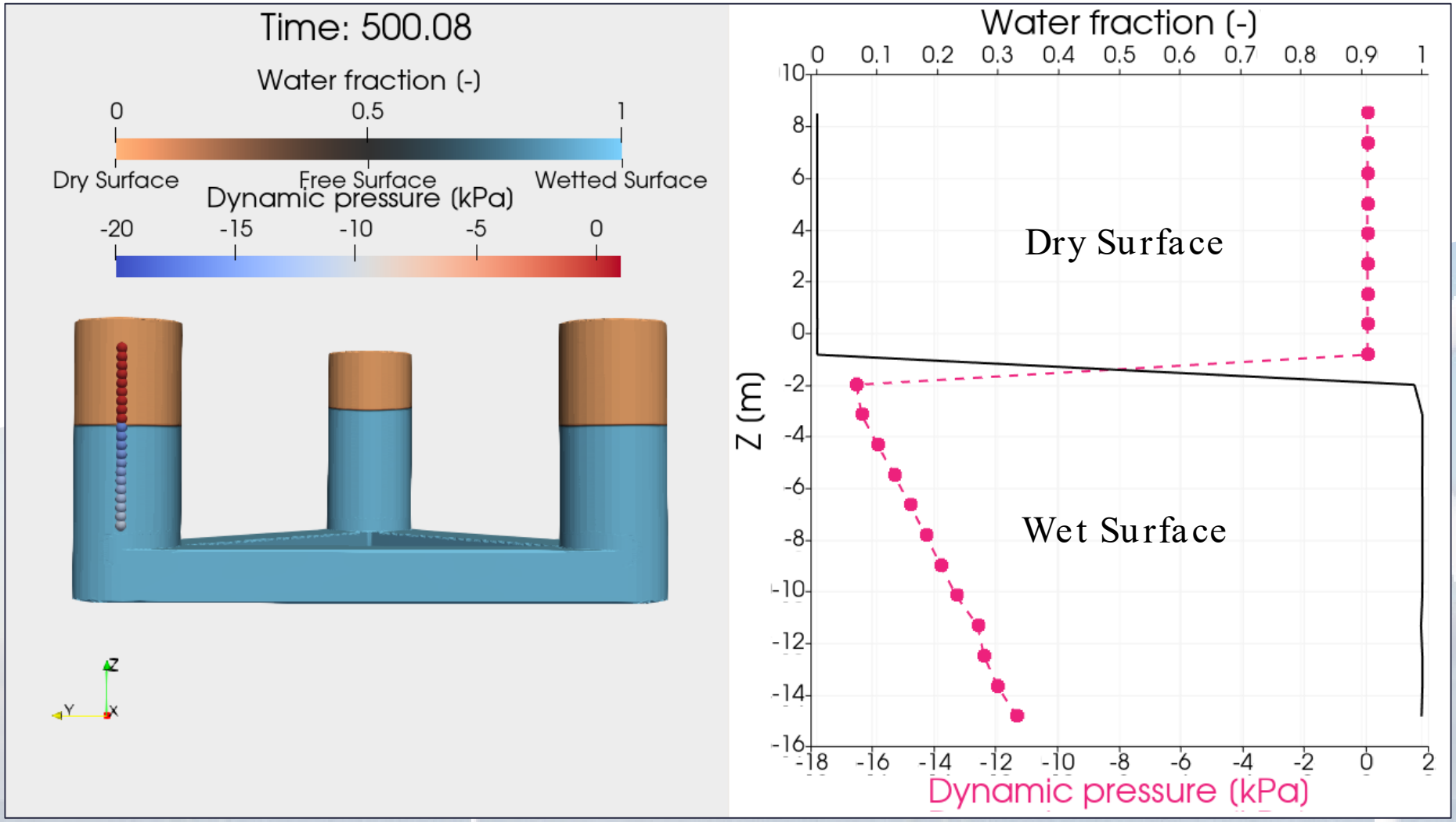
Regular wave



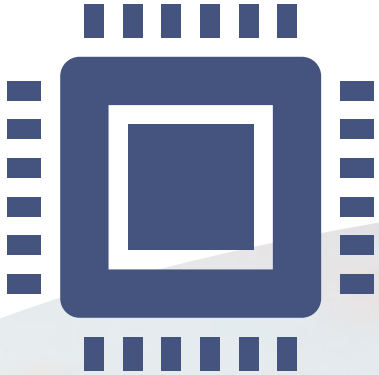
Irregular wave



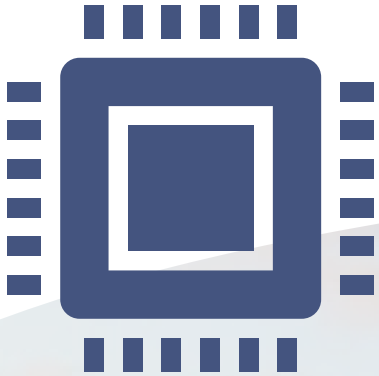
Regular wave



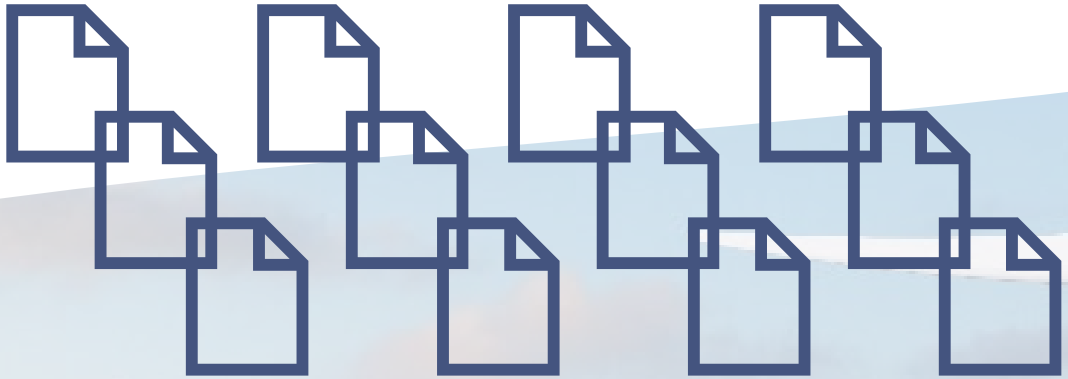
Simulation



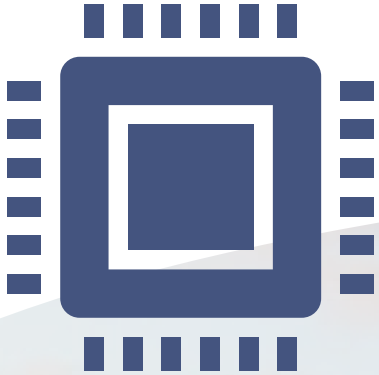
Simulation



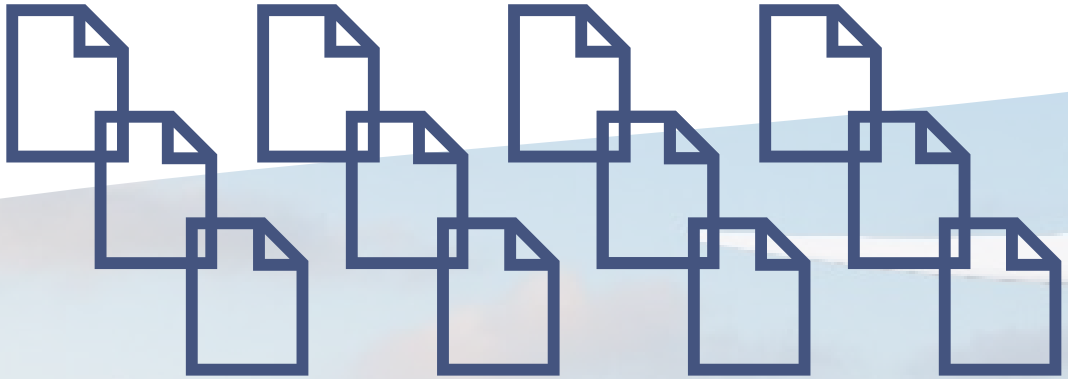
Results



Simulation

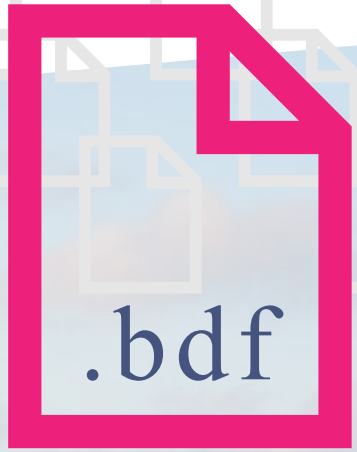


Results



Insights

Simulation Results Insights



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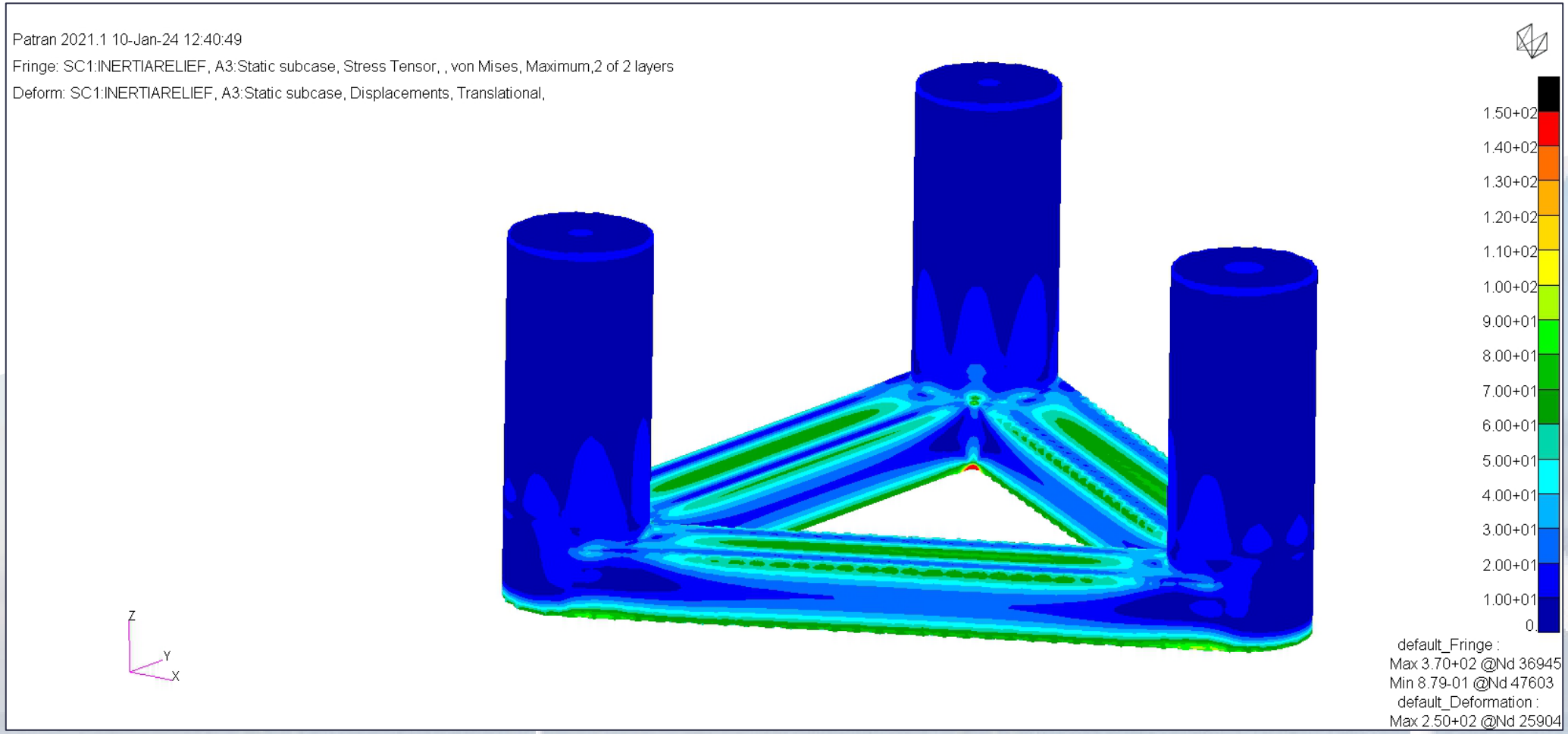
Von Mises stress distribution



1

WT and mooring influence included in simulation

1

WT and mooring influence included in simulation

2

Pressure distribution time series obtained

1

WT and mooring influence included in simulation

2

Pressure distribution time series obtained

3

Detailed structural analysis is now available

1

WT and mooring influence included in simulation

2

Pressure distribution time series obtained

3

Detailed structural analysis is now available

1

WT and mooring influence included in simulation

2

Pressure distribution time series obtained

3

Detailed structural analysis is now available

Deep understanding of complex hydrodynamics

1

WT and mooring influence included in simulation

2

Pressure distribution time series obtained

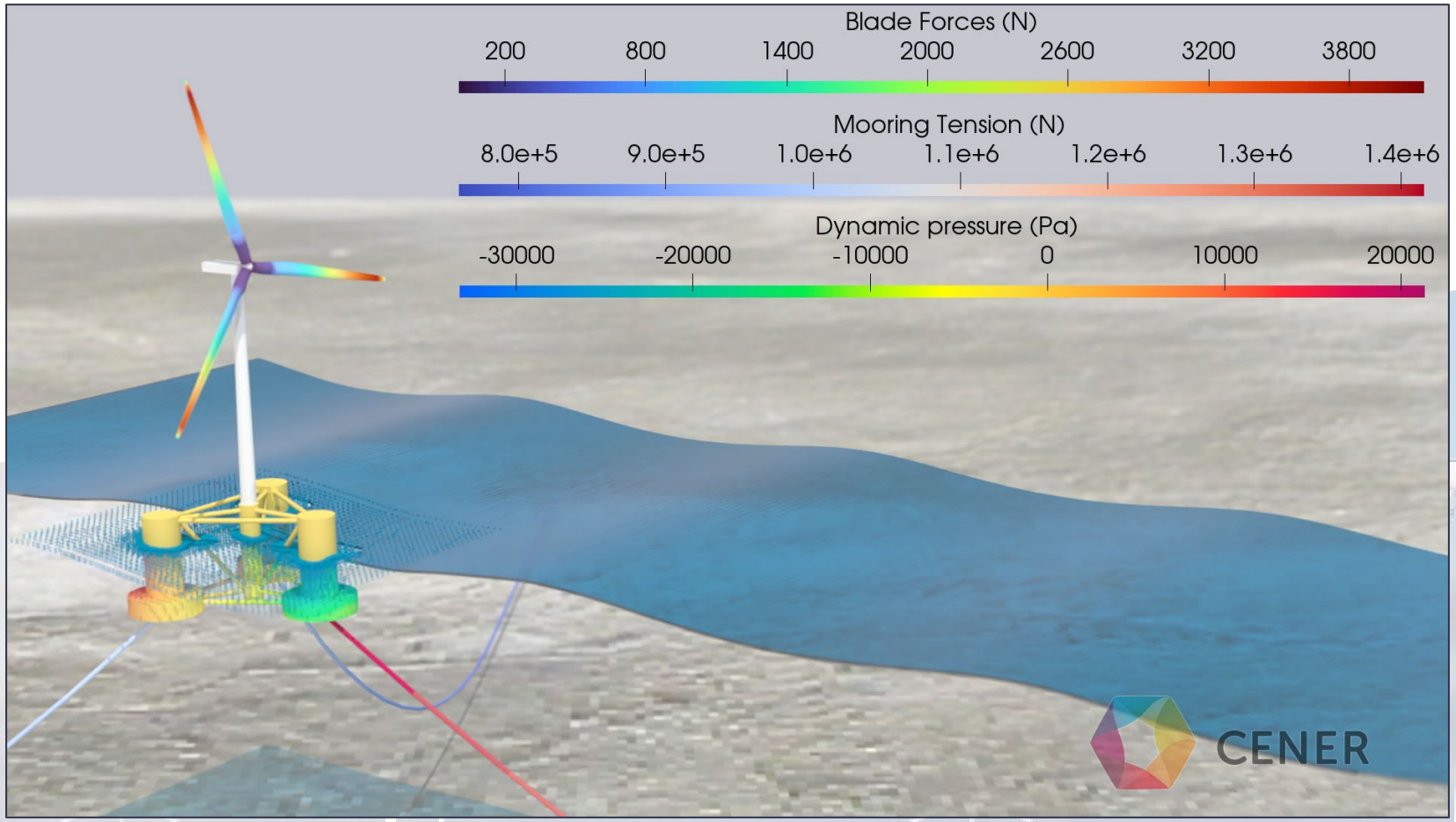
3

Detailed structural analysis is now available

Deep understanding of complex hydrodynamics

High fidelity loads for detailed design

Thank you!



www.cener.com gcampana@cener.com bmendez@cener.com info@cener.com

Computational cost

7,562,629

600 s

Ethernet 10Gbps

Regular wave

40.2 h

3 x 64

2x AMD EPYC 7543 32-Core Processor, 128 Gb RAM

2x Intel(R) Xeon(R) Gold 6126, 128 Gb RAM

AMD EPYC 7773X, 256 Gb RAM

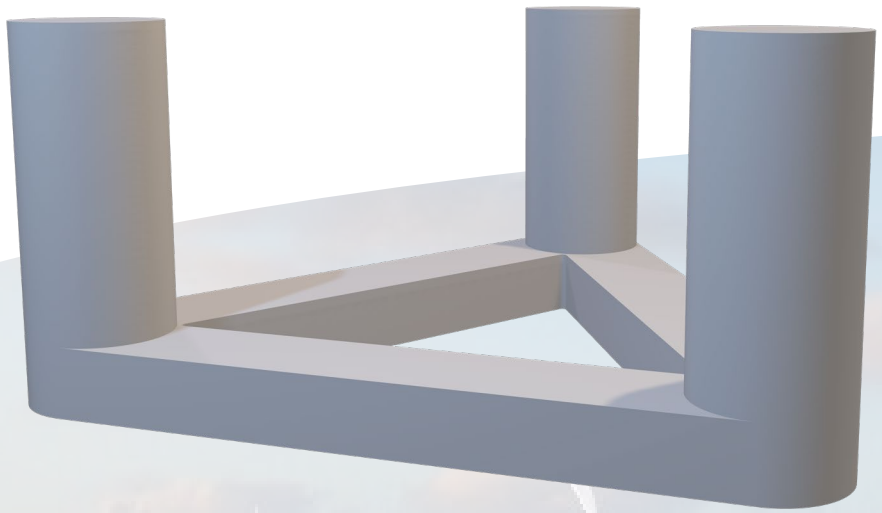
Irregular wave

85.1 h

3 x 64

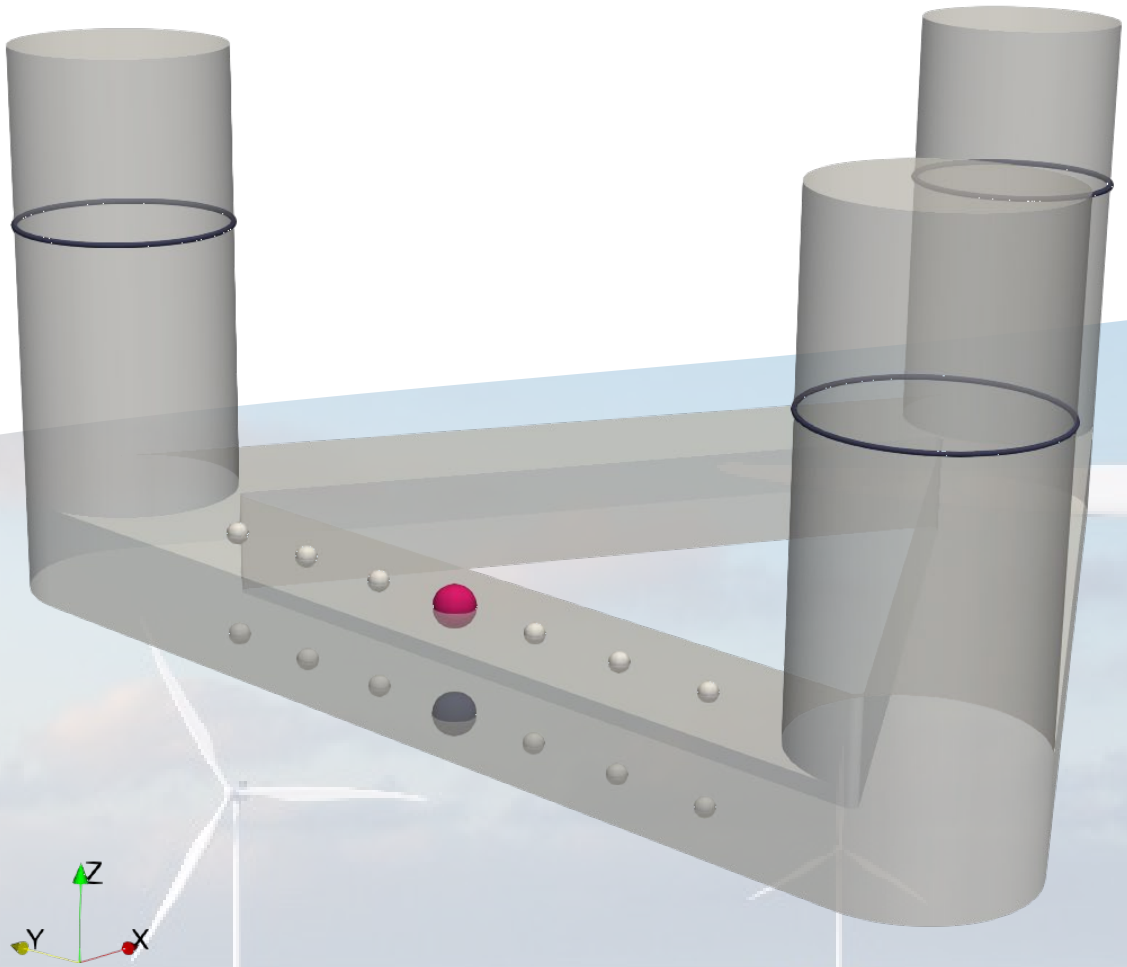
2x AMD EPYC 7543 32-Core Processor, 128 Gb RAM

DeltaWind platform

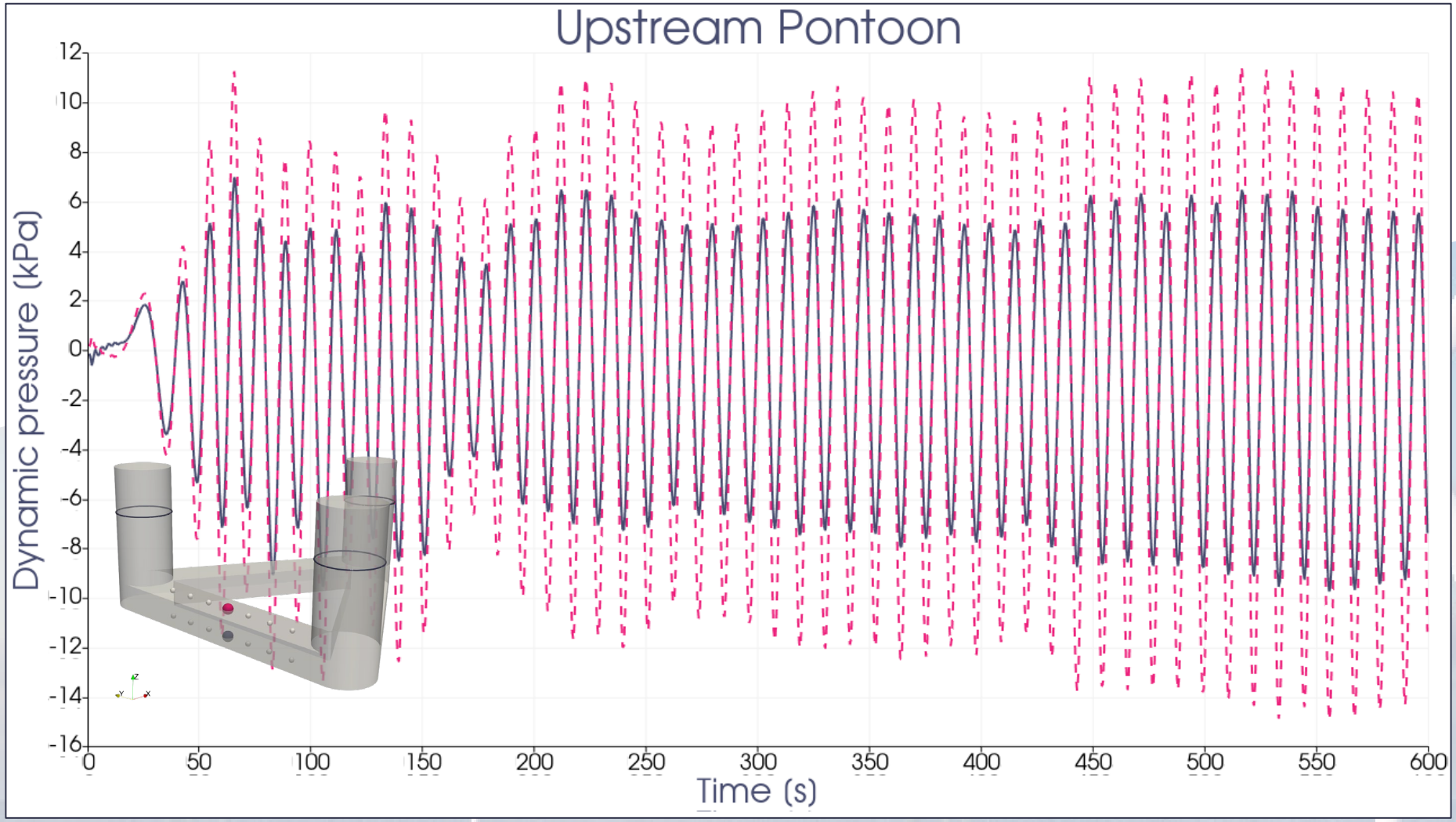


Column distance	66 m
Draft	25.5 m
Height	37.5 m
Column Ø	14.5 m
Pontoon width	10.875 m
Pontoon height	7 m
Mass	23548 tons

Pontoon points



Regular wave



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Irregular wave