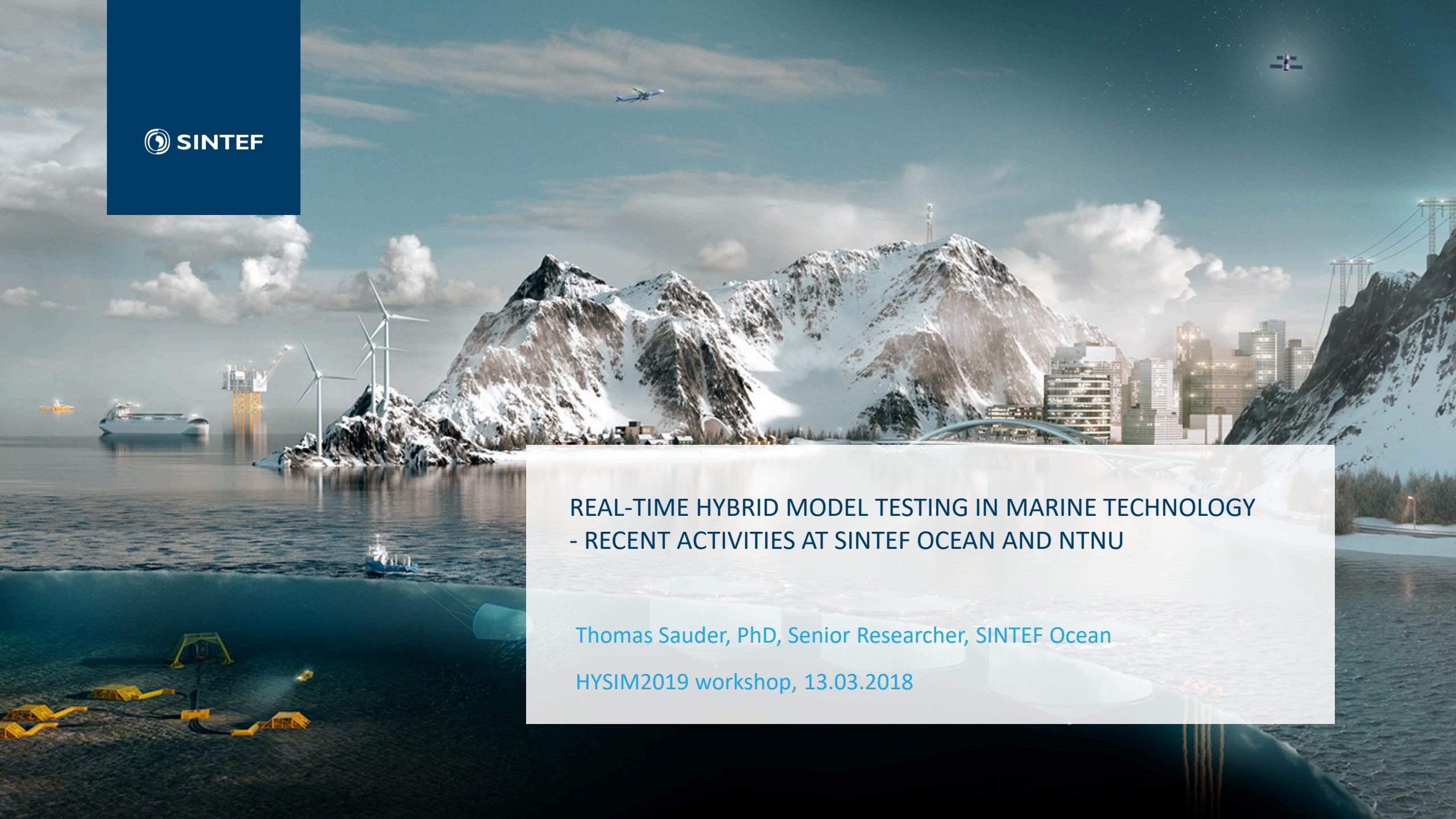

REAL-TIME HYBRID MODEL TESTING IN MARINE TECHNOLOGY - RECENT ACTIVITIES AT SINTEF OCEAN AND NTNU

Thomas Sauder, PhD, Senior Researcher, SINTEF Ocean

HYSIM2019 workshop, 13.03.2018

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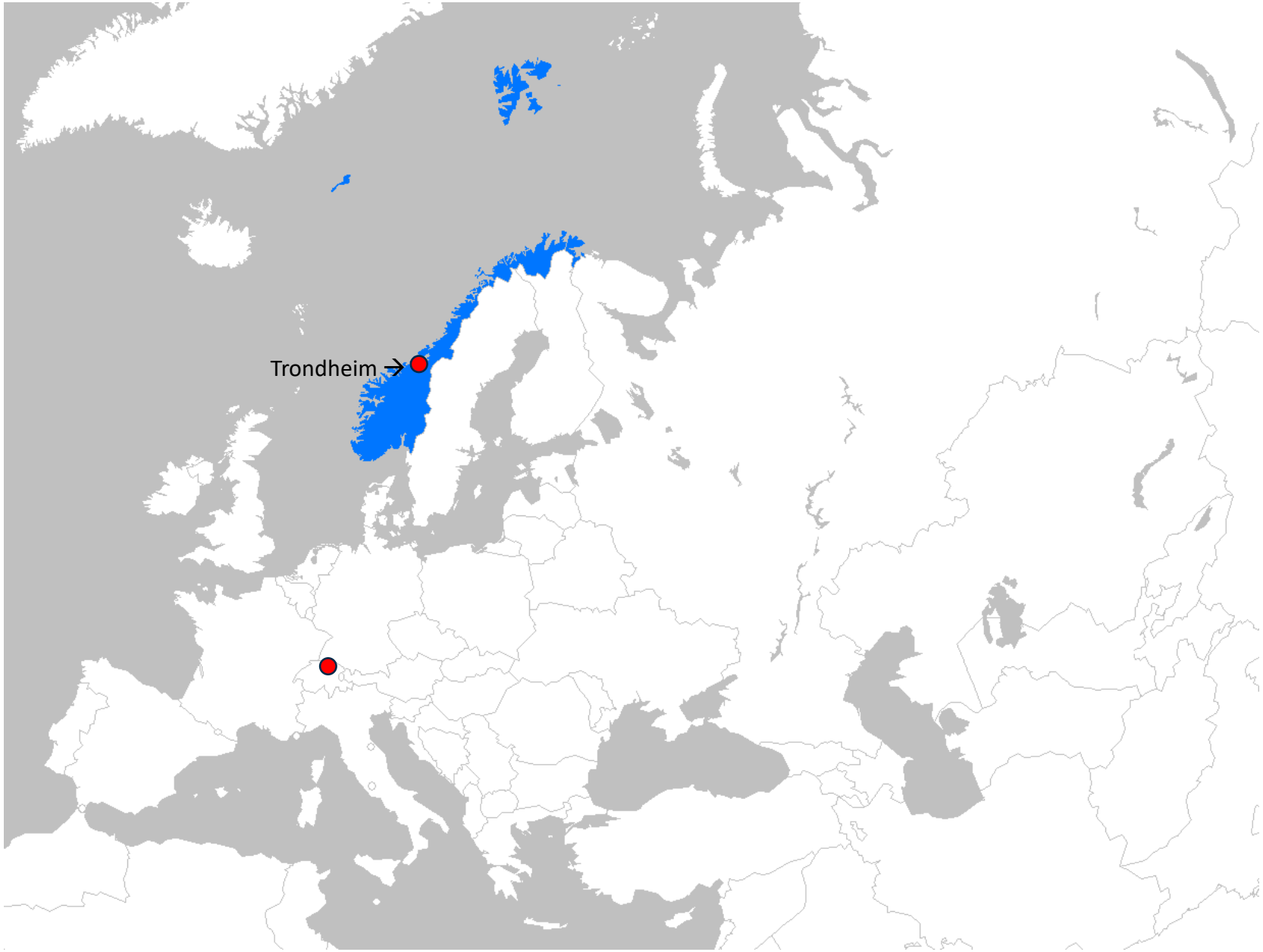
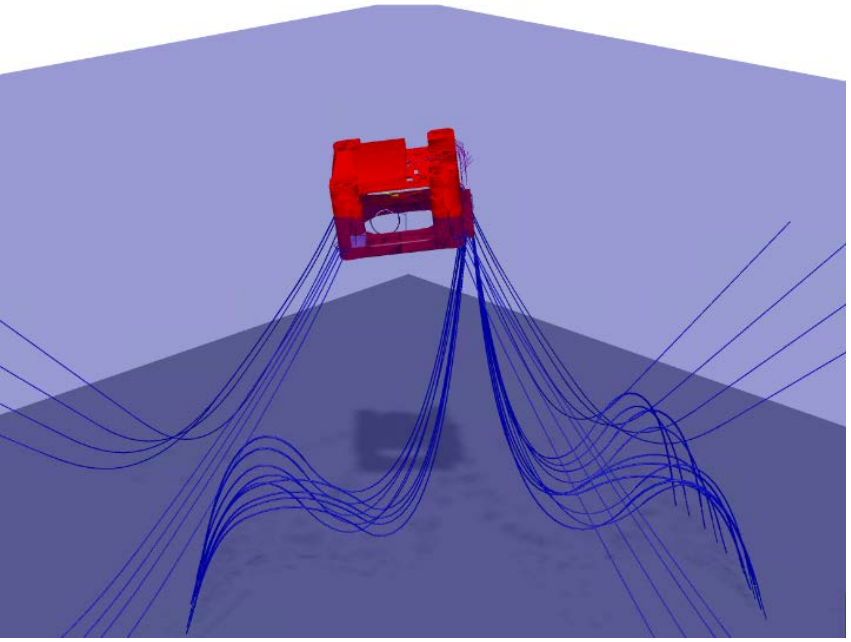
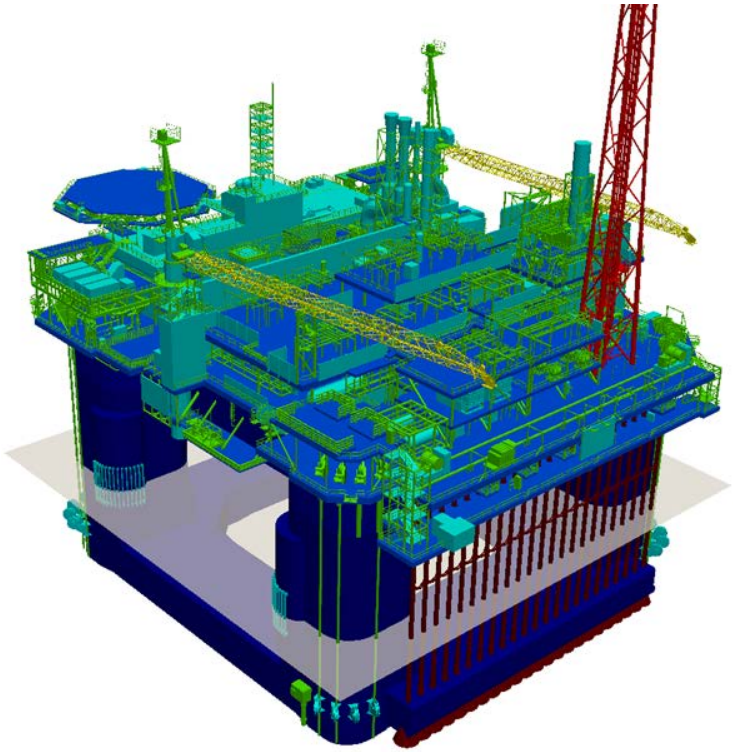
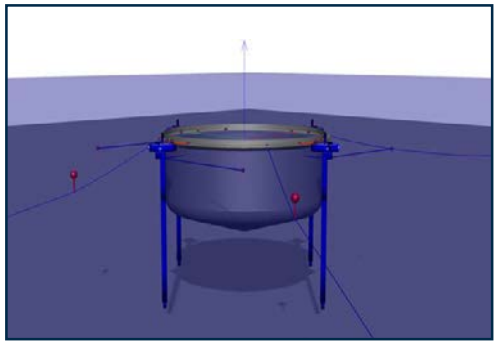

Trondheim

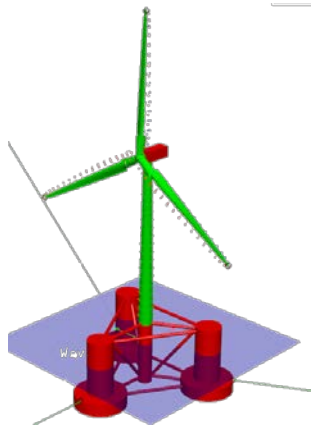
The Marine Technology Centre in Trondheim

University	Research Institute (private, non-for-profit)
NTNU	SINTEF



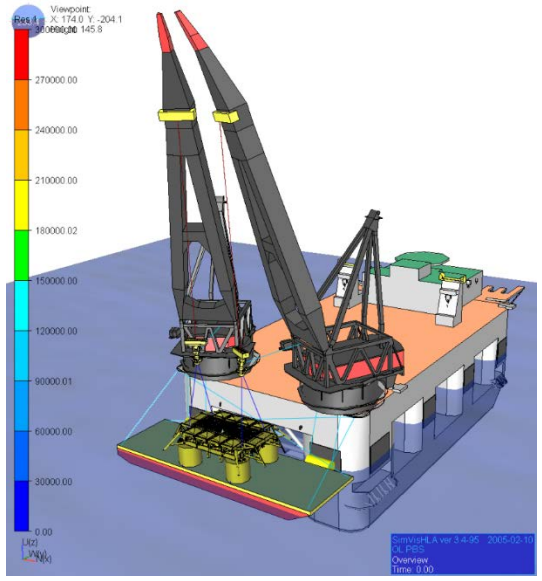






AKER KVÆRNER

DR. TECHN.
OLAV OLSEN
SINTEF Ocean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Marine Technology VS Earthquake engineering

- Rate dependant phenomena (e.g. wave radiation damping) → real-time is a must
- Use of *Froude-scaling* for wave-related phenomena

→ Hybrid testing should be performed in *Froude scaled*-real-time (~5x-10x faster than r.t.)

- "Ill-conditioned problems" in space and time
- Load control
- Characteristic loads in *N,* not *kN*
- Systems' natural periods are in general much larger than in earthquake engineering

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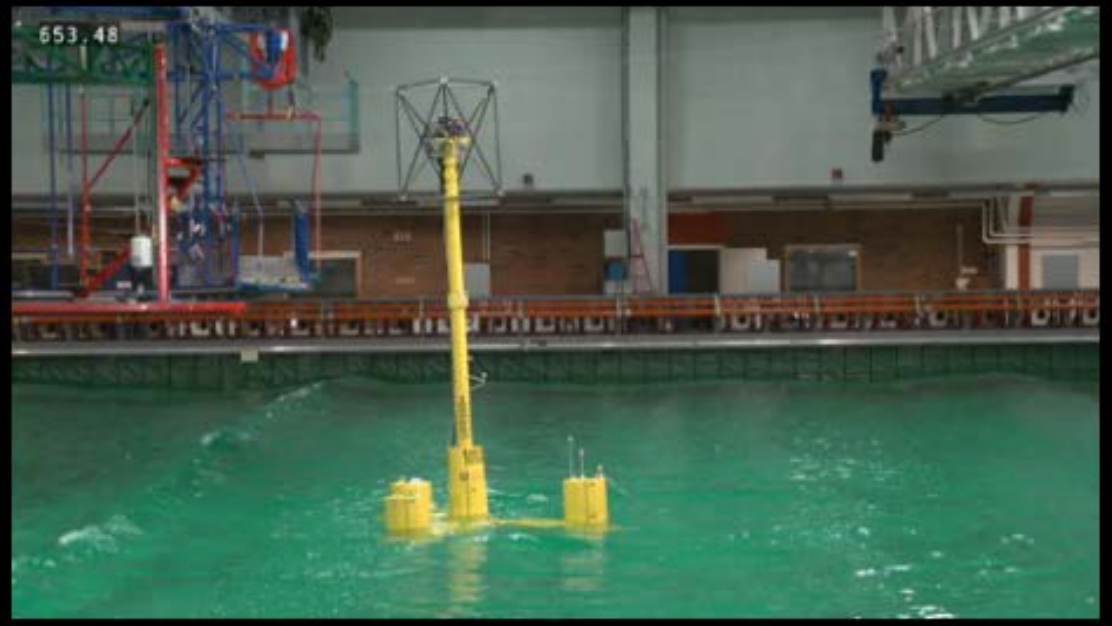
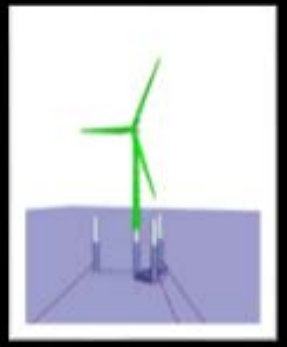
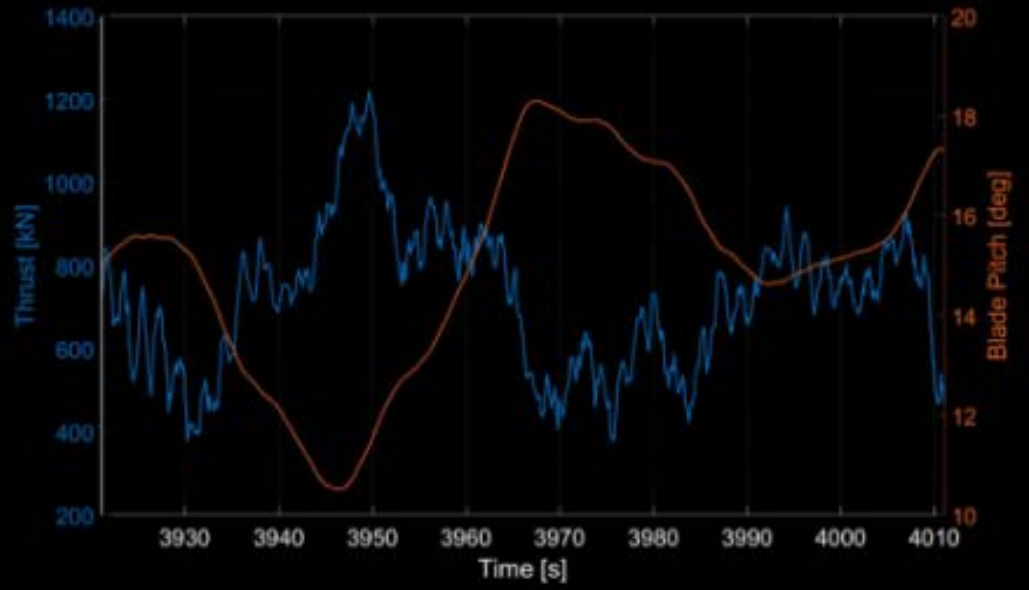
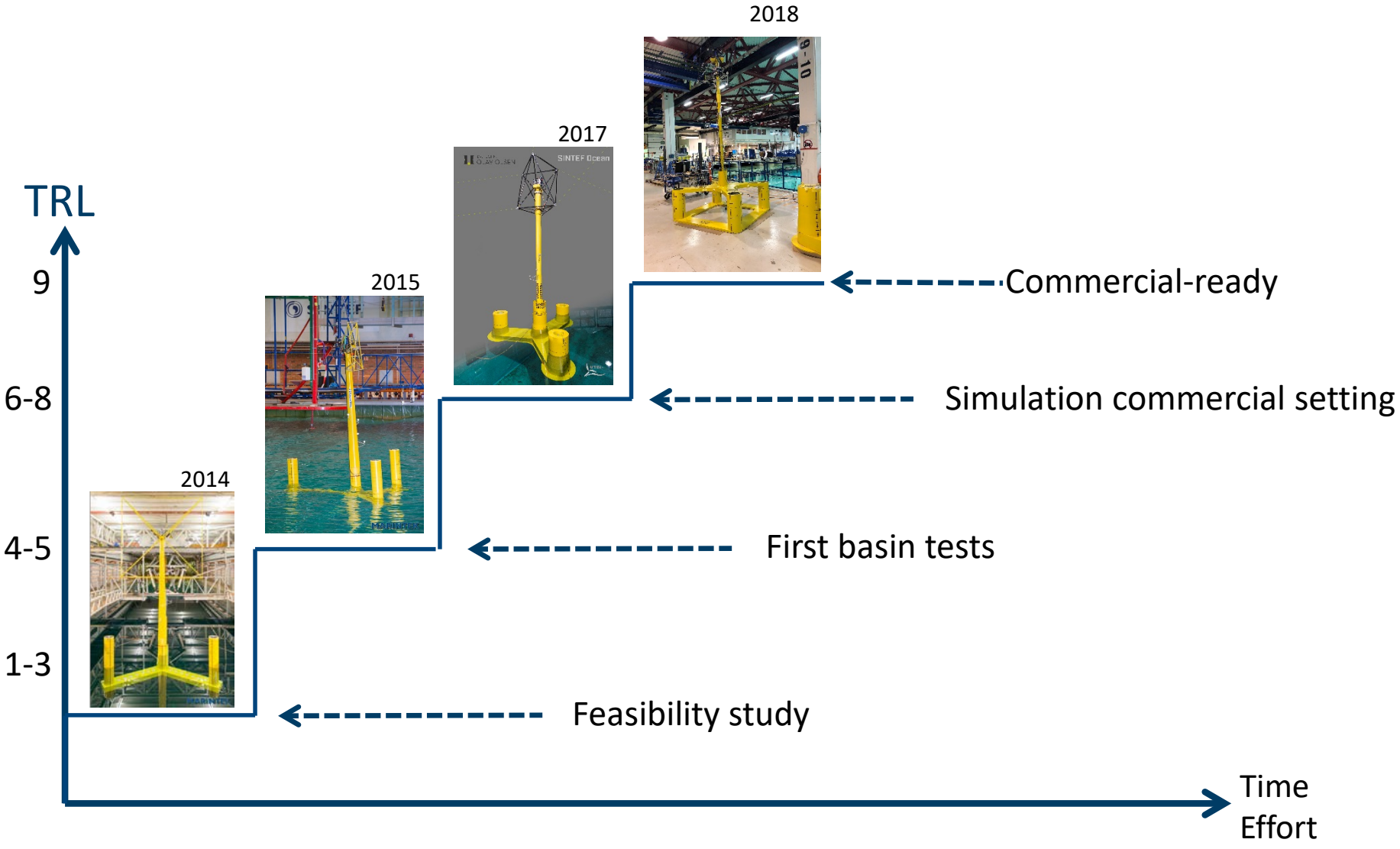
Ocean basin
@SINTEF Ocean



Aero simulation
(NREL's "FAST" code)






2018
2017
2015
2014
TRL
9
6-8
4-5
1-3
Commercial-ready
Simulation commercial setting
First basin tests
Feasibility study
Time
Effort

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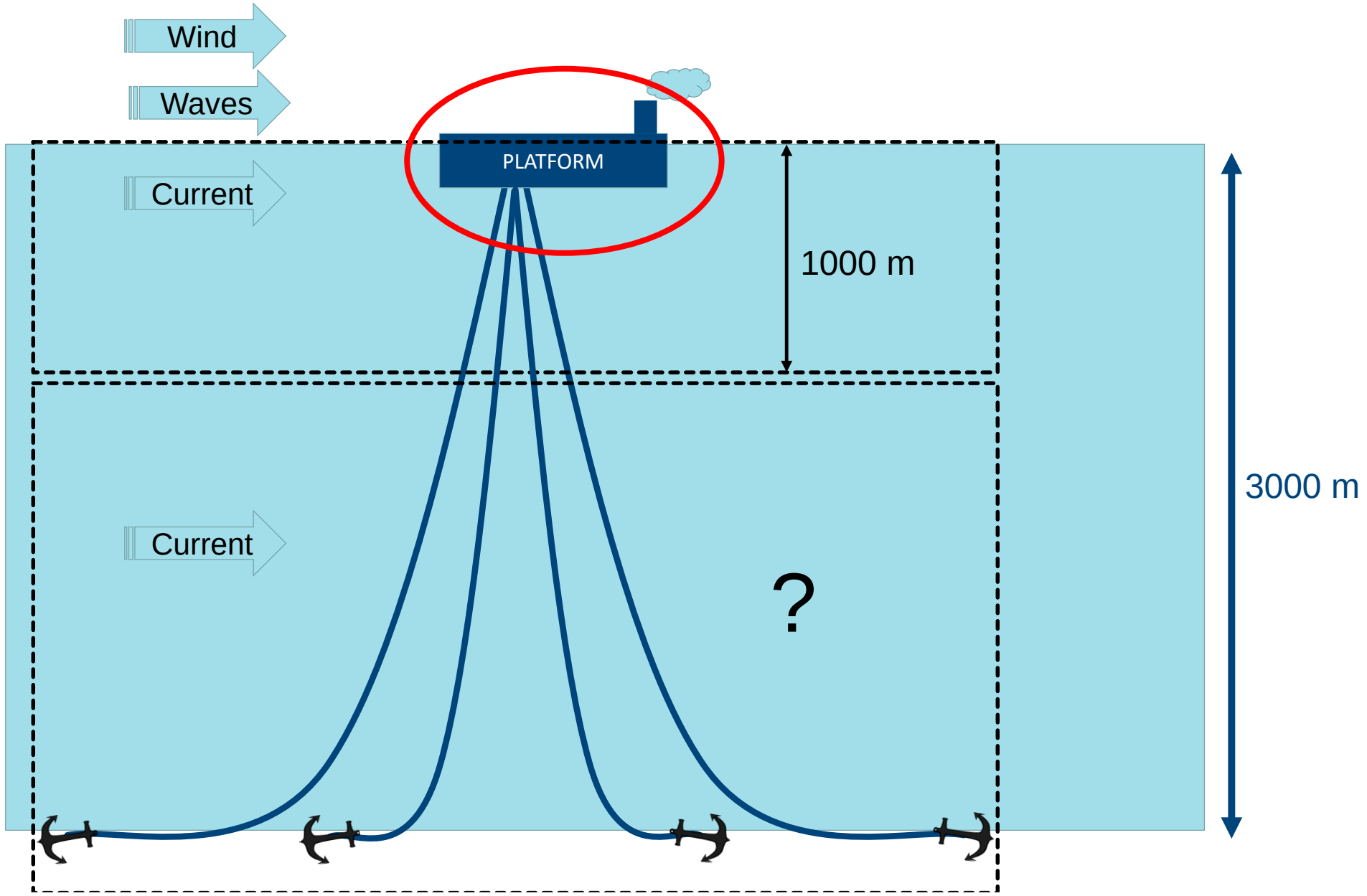
Wind
Waves
Current
PLATFORM
1000 m
Current
?
3000 m

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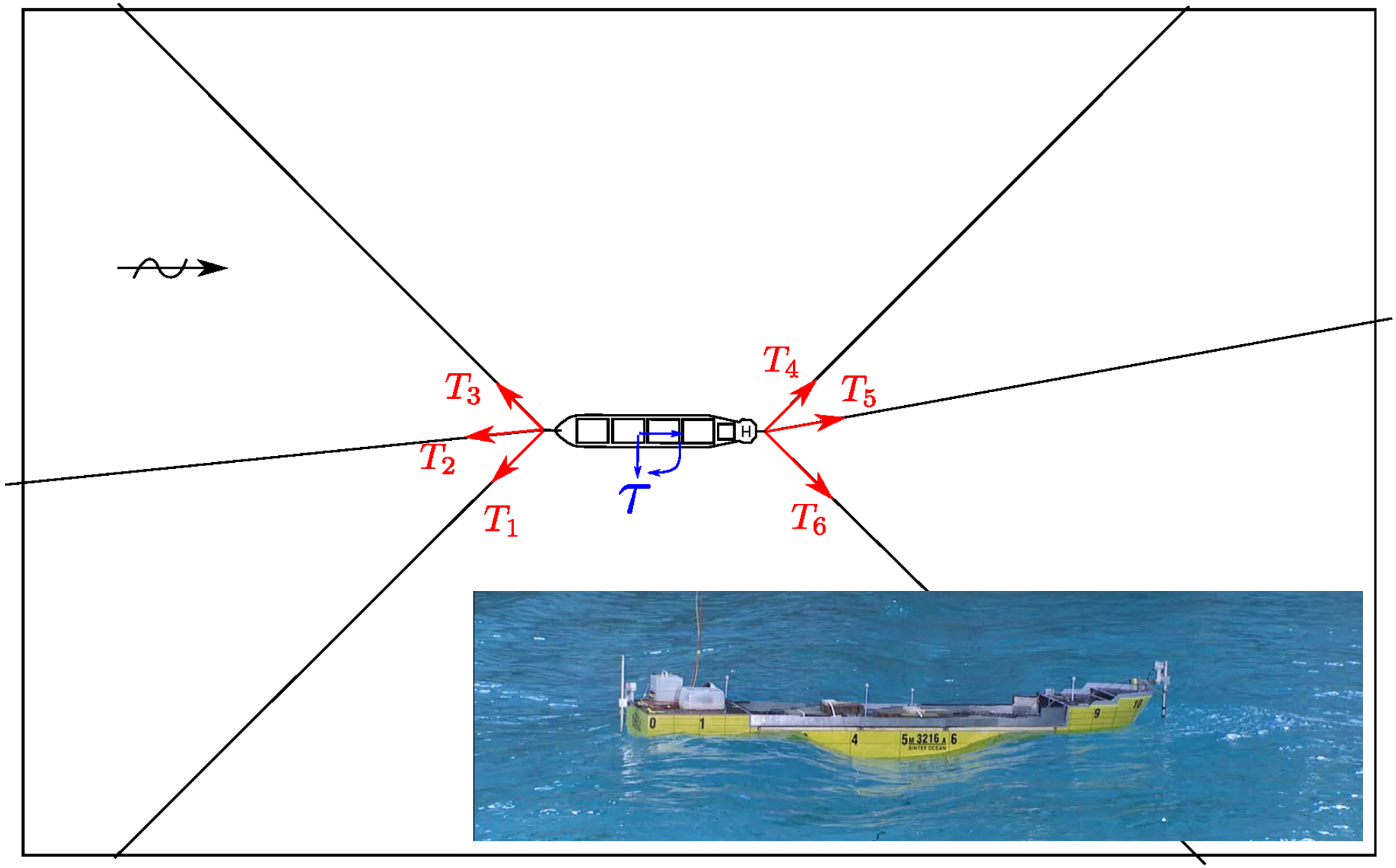
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T_2
T_3
T_4
T_5
T_6
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References

Questions?
Thomas.Sauder@sintef.no

Thys, M., Chabaud, V., Sauder, T., Eliassen, L., Sæther, L. O., and Magnussen, O. B. (2018). Real-time hybrid model testing of a semi-submersible 10 MW floating wind turbine, and advances in the test method. In *ASME 2018 1st International Offshore Wind Technical Conference*, San Fransisco.

Sauder, T., Chabaud, V., Thys, M., Bachynski, E. E., and Sæther, L. O. (2016). Real-time Hybrid Model Testing of a Braceless Semi-submersible Wind turbine. Part I: The Hybrid Approach. In *ASME 2016 35th International Conference on Ocean, Offshore and Arctic Engineering, No OMAE2016-54435*.

Testing of floating wind turbines

Sauder, T., Marelli, S., Larsen, K., and Sørensen, A. J. (2018). Active truncation of slender marine structures: Influence of the control system on fidelity. *Applied Ocean Research*, 74:154–169.

Sauder, T., Marelli, S., and Sørensen, A. J. (2019). Probabilistic Robust Design of Control Systems for High-Fidelity Cyber-Physical Testing. *Automatica*, 101:111–119.

Fidelity
Influence control system
Active truncation

SINTEF