MARIN

BETTER SHIPS, BLUE OCEANS

Energy Islands, fixed, floating or hybrid?

William Otto

NSMB

sector initiative

1932

> 90 years of experience

active in 39 countries

Wageningen, Ede, Houston, Chesapeake

innovative & independent

industry & government

civil & defence

concept to operations

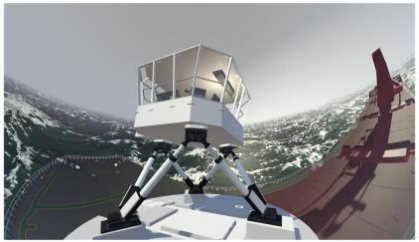
450+ colleagues

€ 60 M turnover

70% commercial, 30% funded

JIPs & networks

CONCEPT ⟷ DESIGN ⟷ OPERATION



Computations
CFD / Time Domain

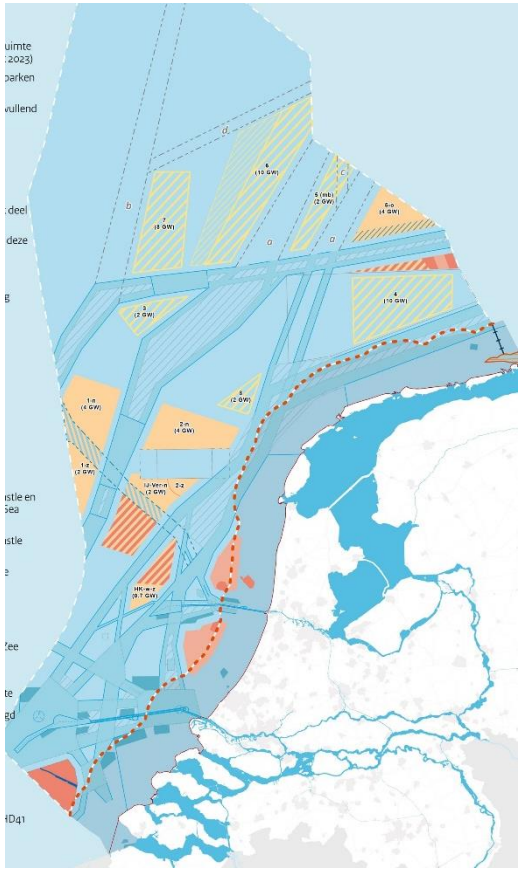
Model tests
Scaled reality

Simulators
Human Factors

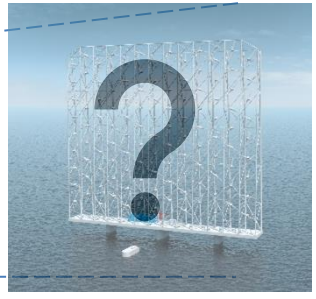
Monitoring
Data science/ AI

Why energy islands?

- Logistical hubs are needed for wind (&solar?)
  - Installation
  - Maintenance
  - Removal
- (sub)Stations are needed for
  - Energy conversion
  - Energy storage?
- Future farms are further from the coast
  - The further away, the more an island makes sense!

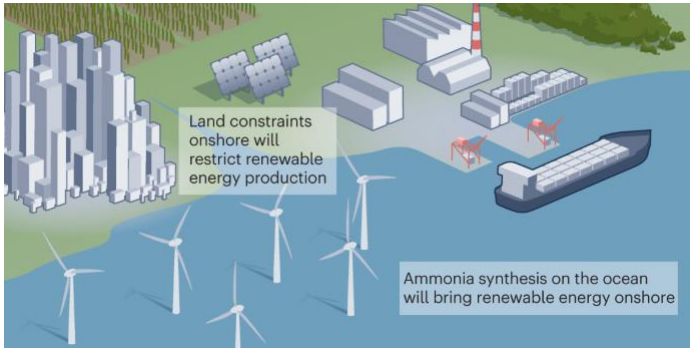


Who can predict the future offshore energy farm?



Who can predict the future energy system?

H2 factories?



Ammonia fuels?

HVDC stations?

Batteries?

Energy islands, fixed or floating?

Fixed islands lack flexibility

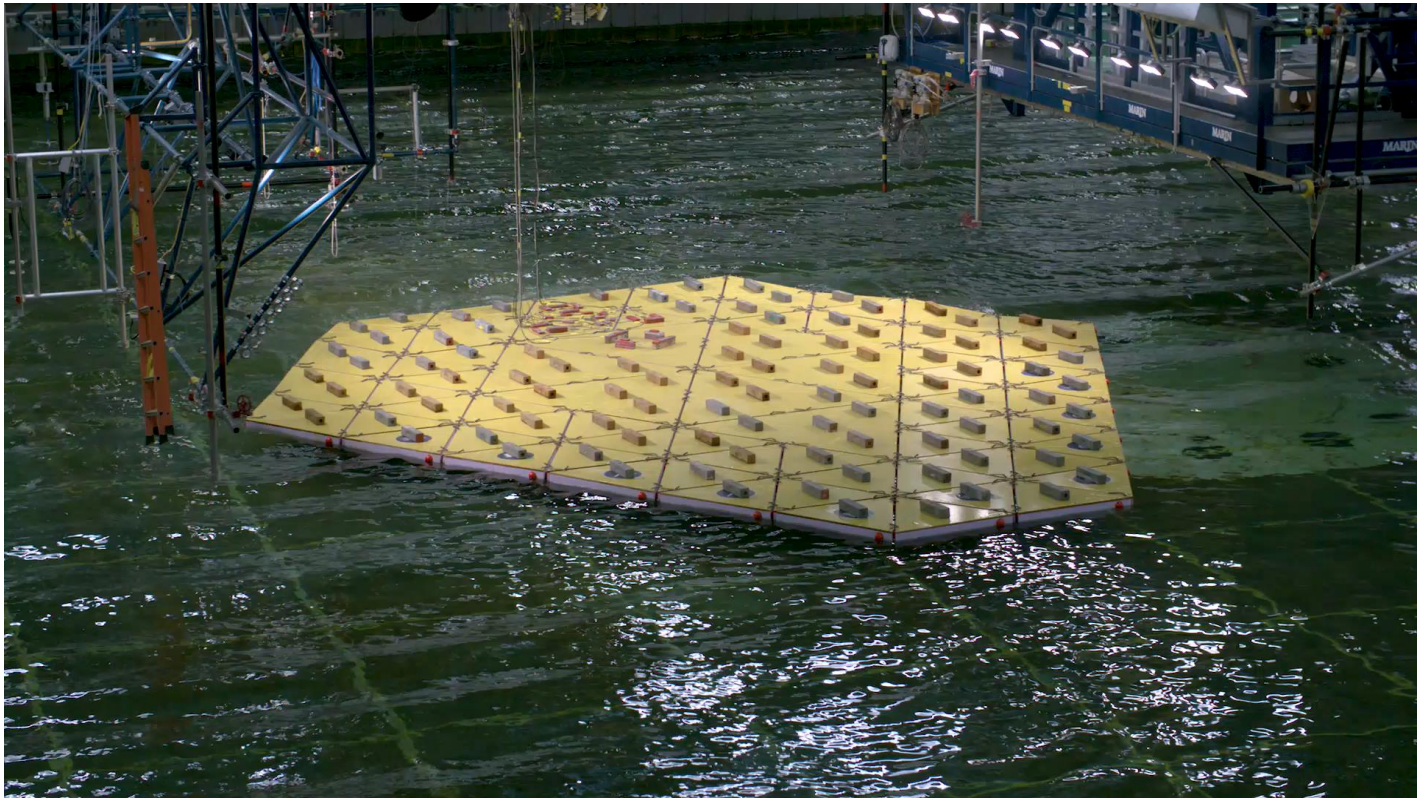
- What if the turbines radically change?
  - Quay sides are permanent
  - Island lay-out
- How to build a large factory on an island? (H2, or HVDC, or ammonia, storage ..)
  - Transportation of small modules and on-site construction
- What if you want to switch to a different energy carrier?

Fixed islands

Energy islands: Floating!

- Interconnected, large pontoons
- Pontoons, including factories/workshops, build in onshore yards
- Modular concept:
  - Lay-out can be re-arranged by shuffeling the pontoons
  - Island can grow or downscale by adding or removing pontoons
  - Pontoons can be re-located

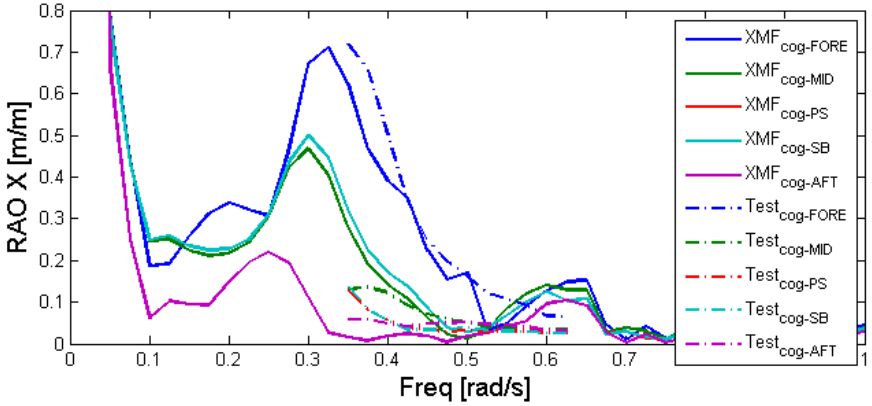
2017: Conceptual test for a large floating island

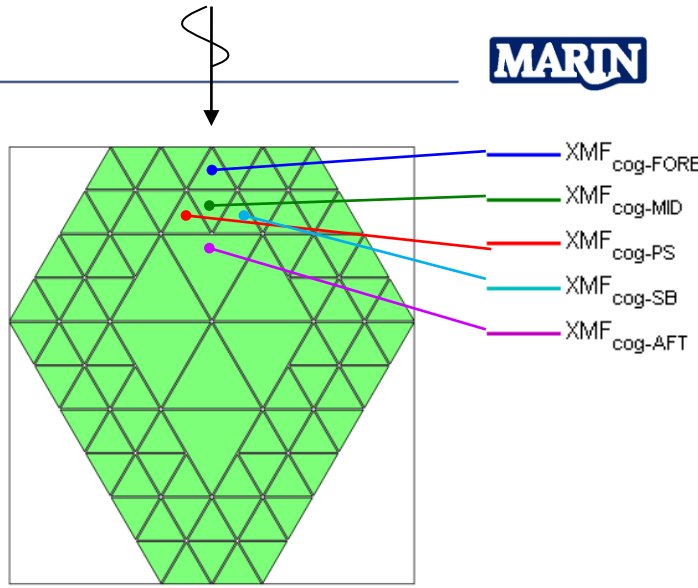


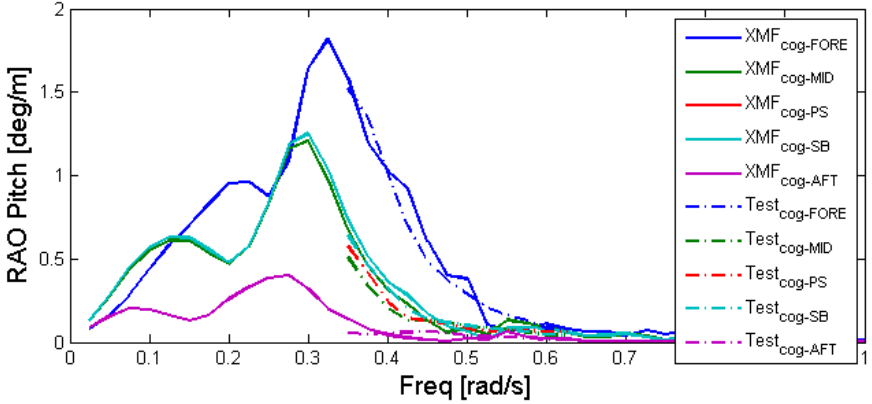
Why triangles?

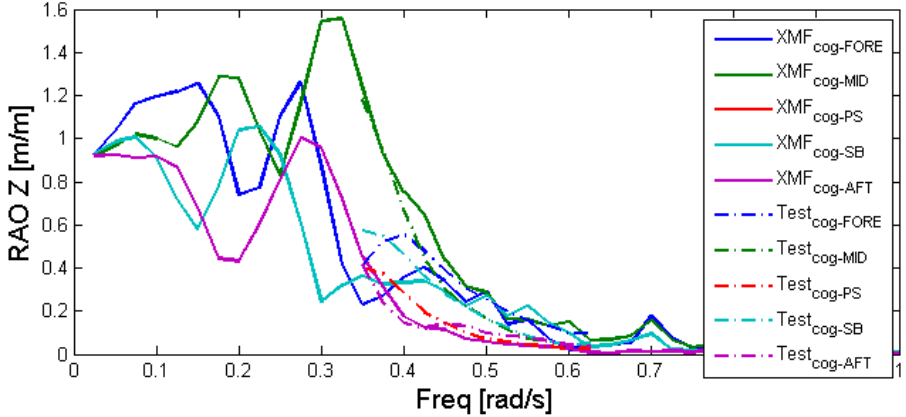
- Surface is piecewise flexible over multiple axes
- Limited degrees of freedom restrained by coupling for each element
- Standardised shape

Motions from simulations and tests





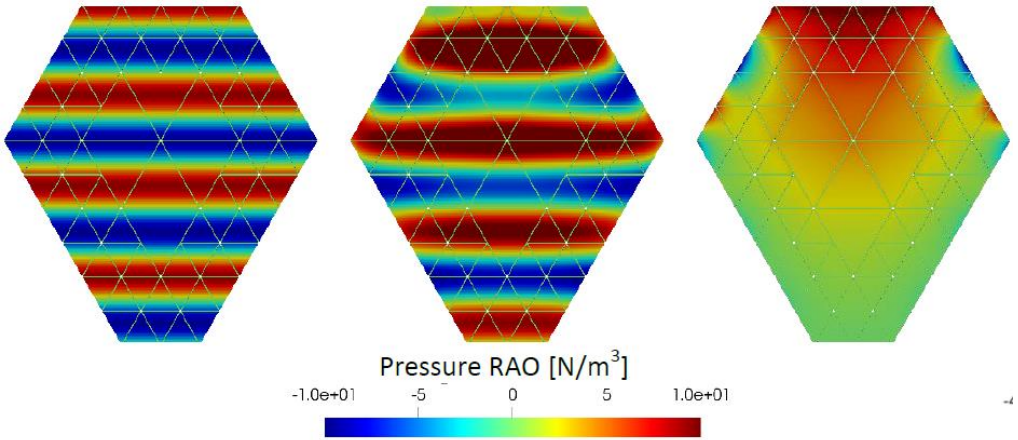




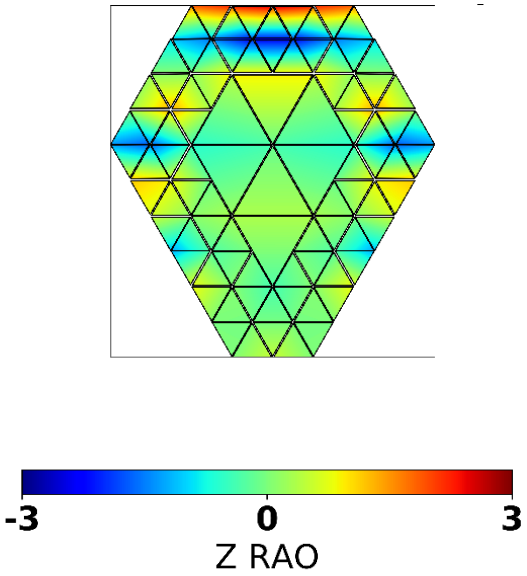
Response analysis 0.325 rad/s

Wave pressure

Undisturbed + Diffracted = Excitation

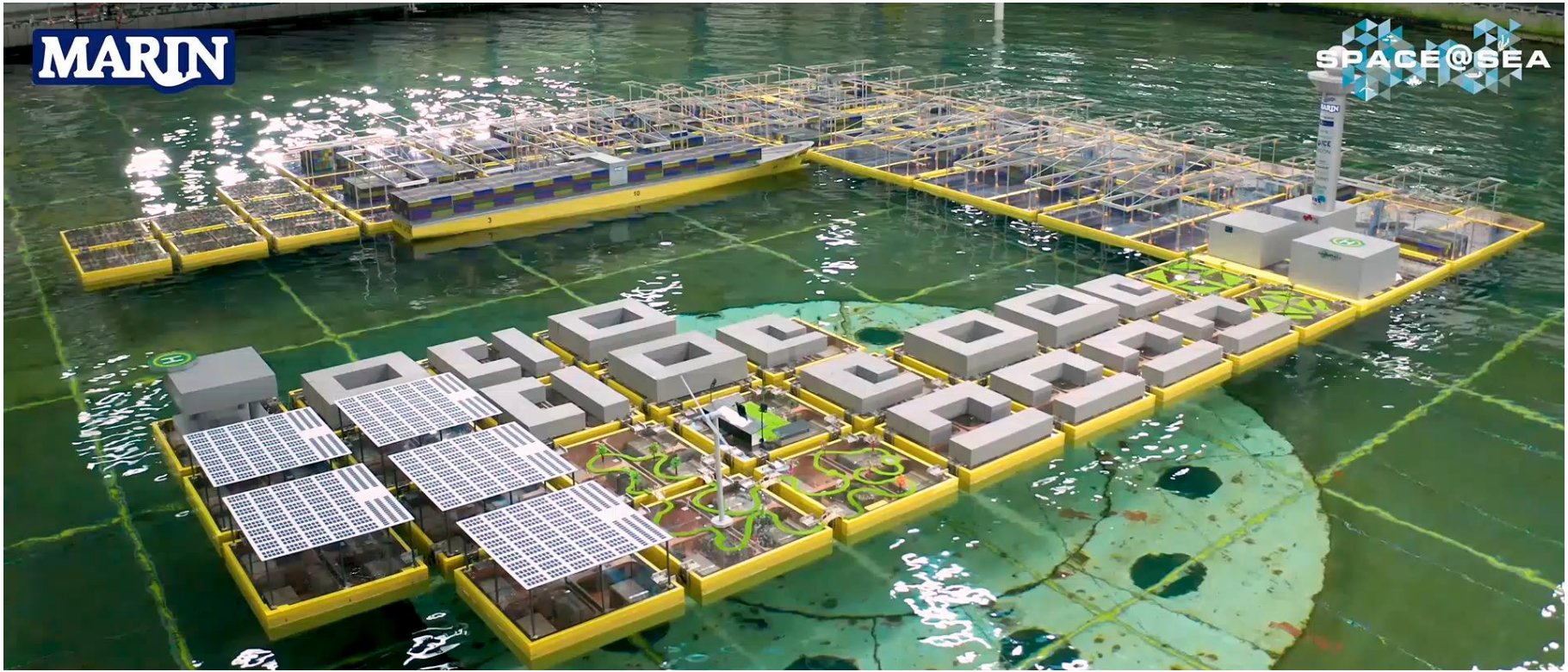


Vertical motion

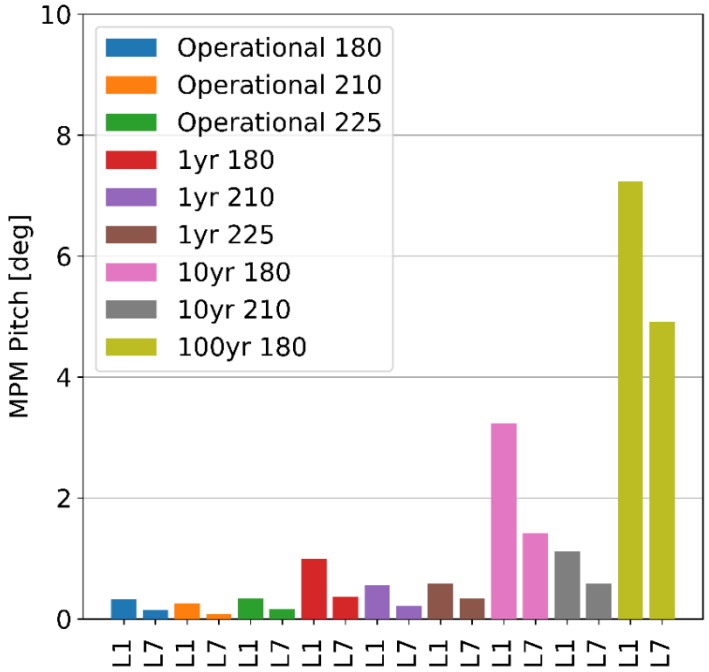


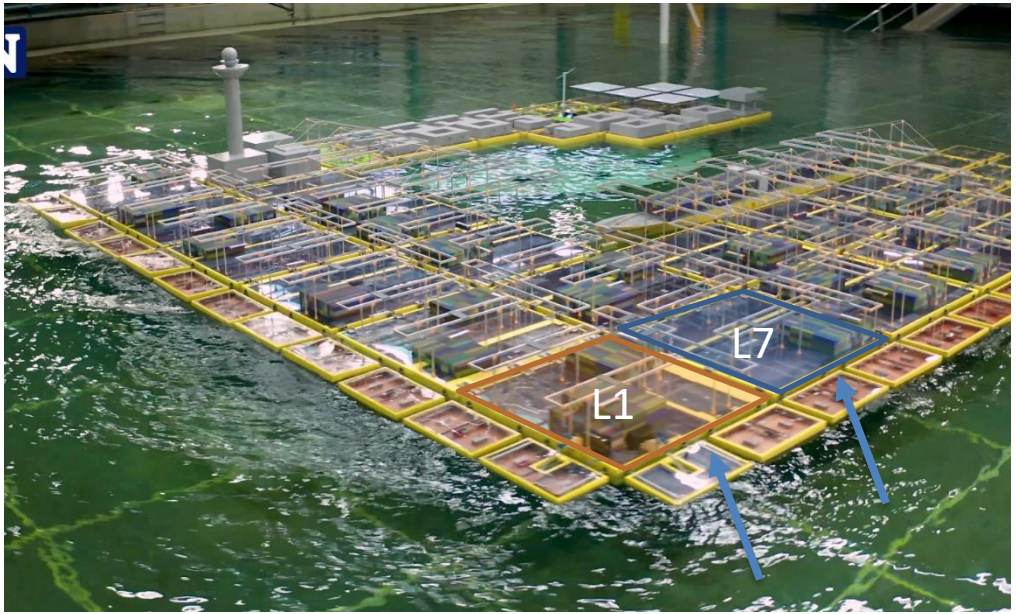
H2020 Space@Sea

H2020: Space@Sea

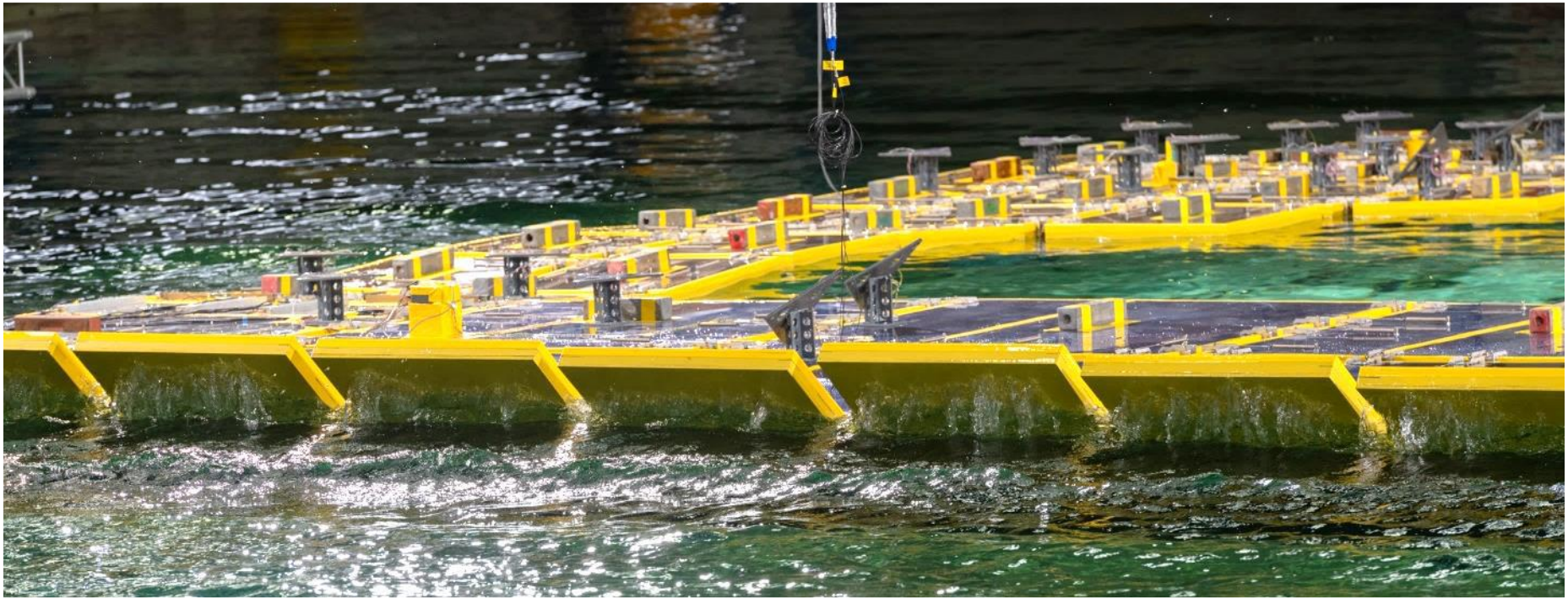


Pitch motions in Mediterranean





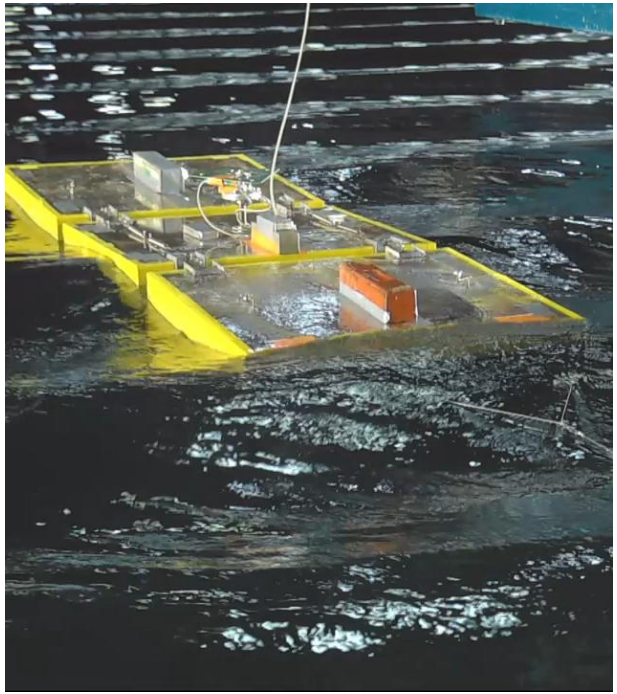
Working of wave absorbing islands in 100yr storm

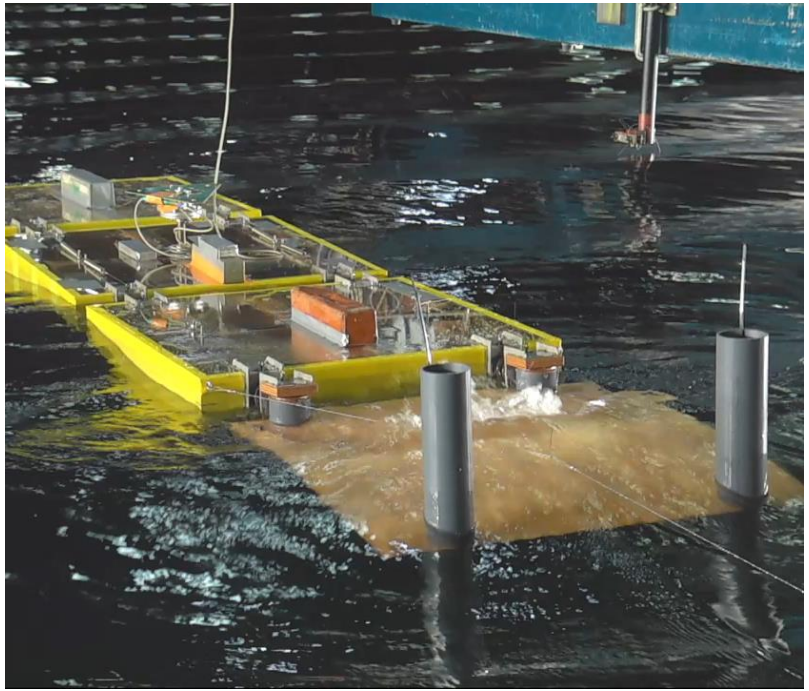


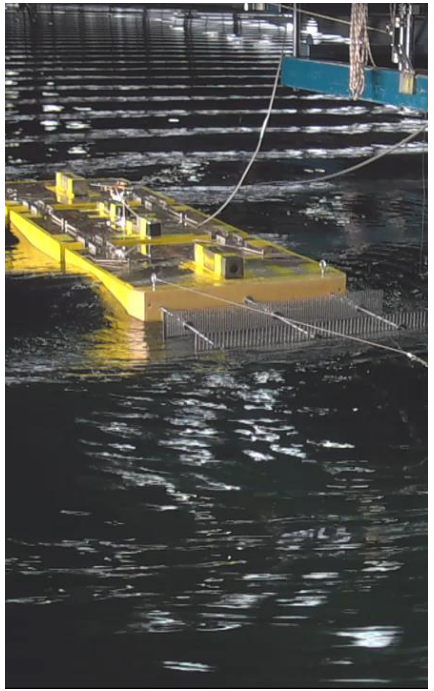
Conclusions Space@Sea

- Technically feasible in Mediterranean
- Very challenging in Dutch North Sea
  - Shallow water is more challenging for catenary mooring
  - Steep waves, harsh weather
- Improvement, how to reduce wave drift forces?

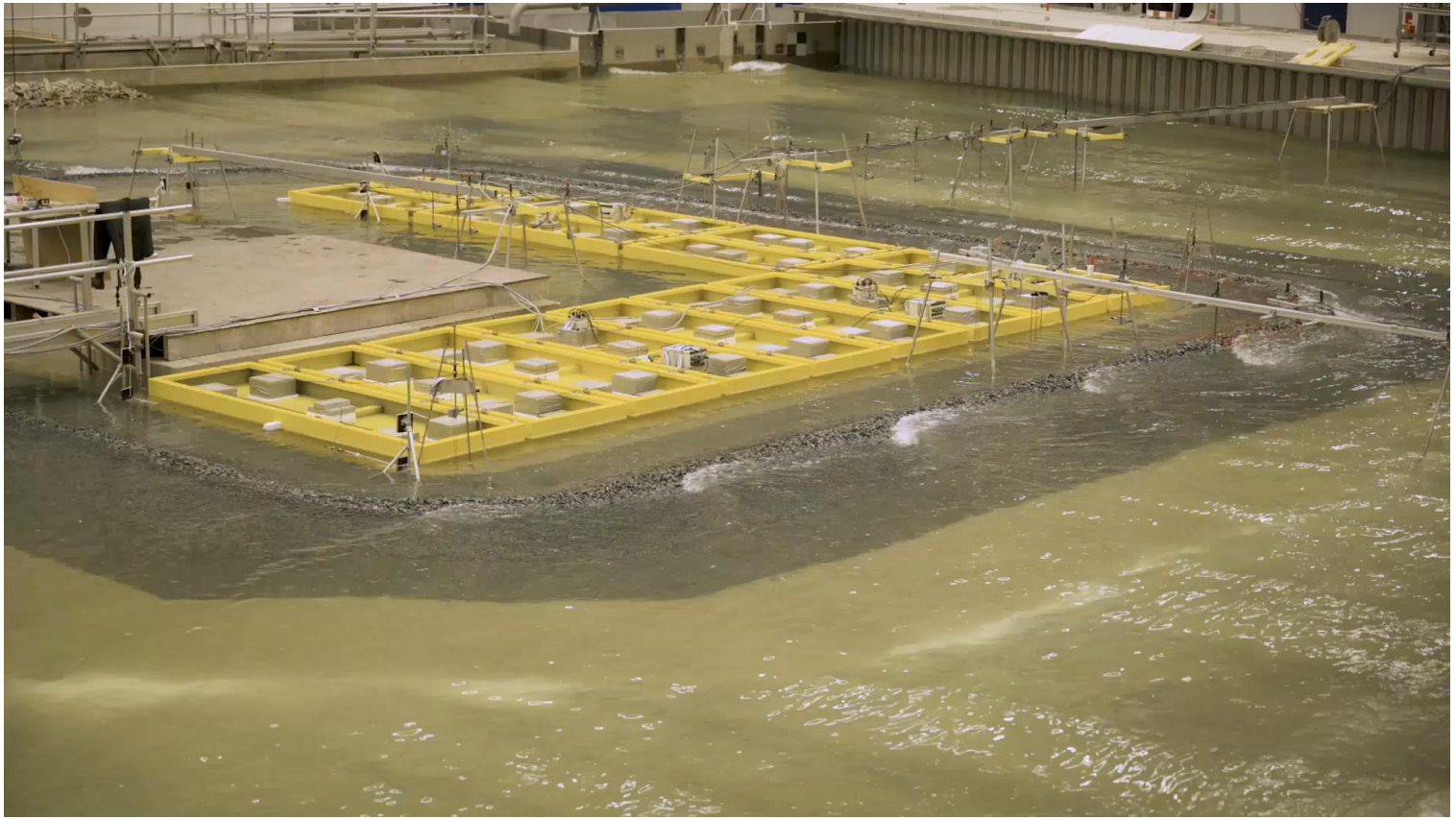
Reduce drift force with floating breakwater?



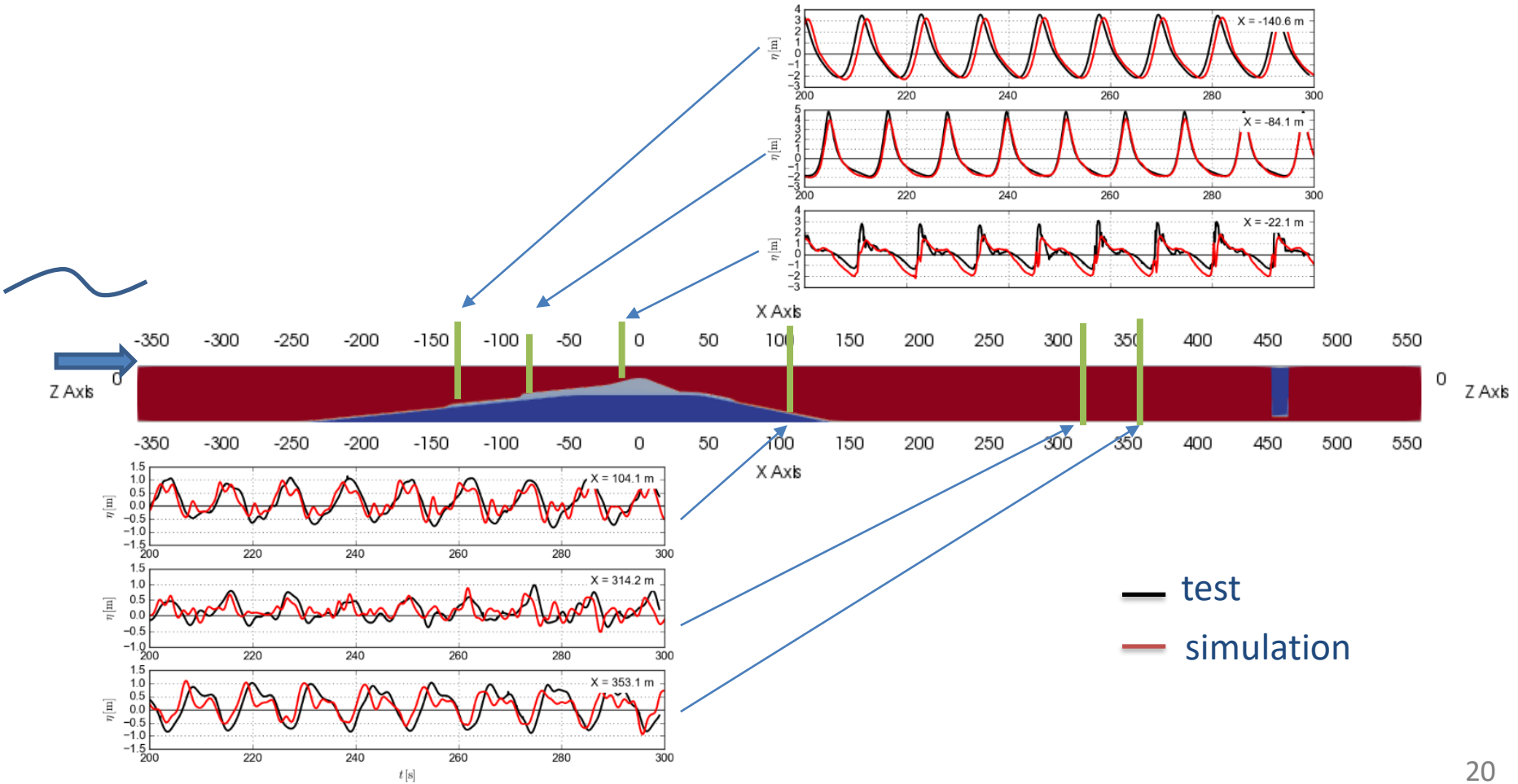




Or a fixed breakwater? Hybridenerseahub project



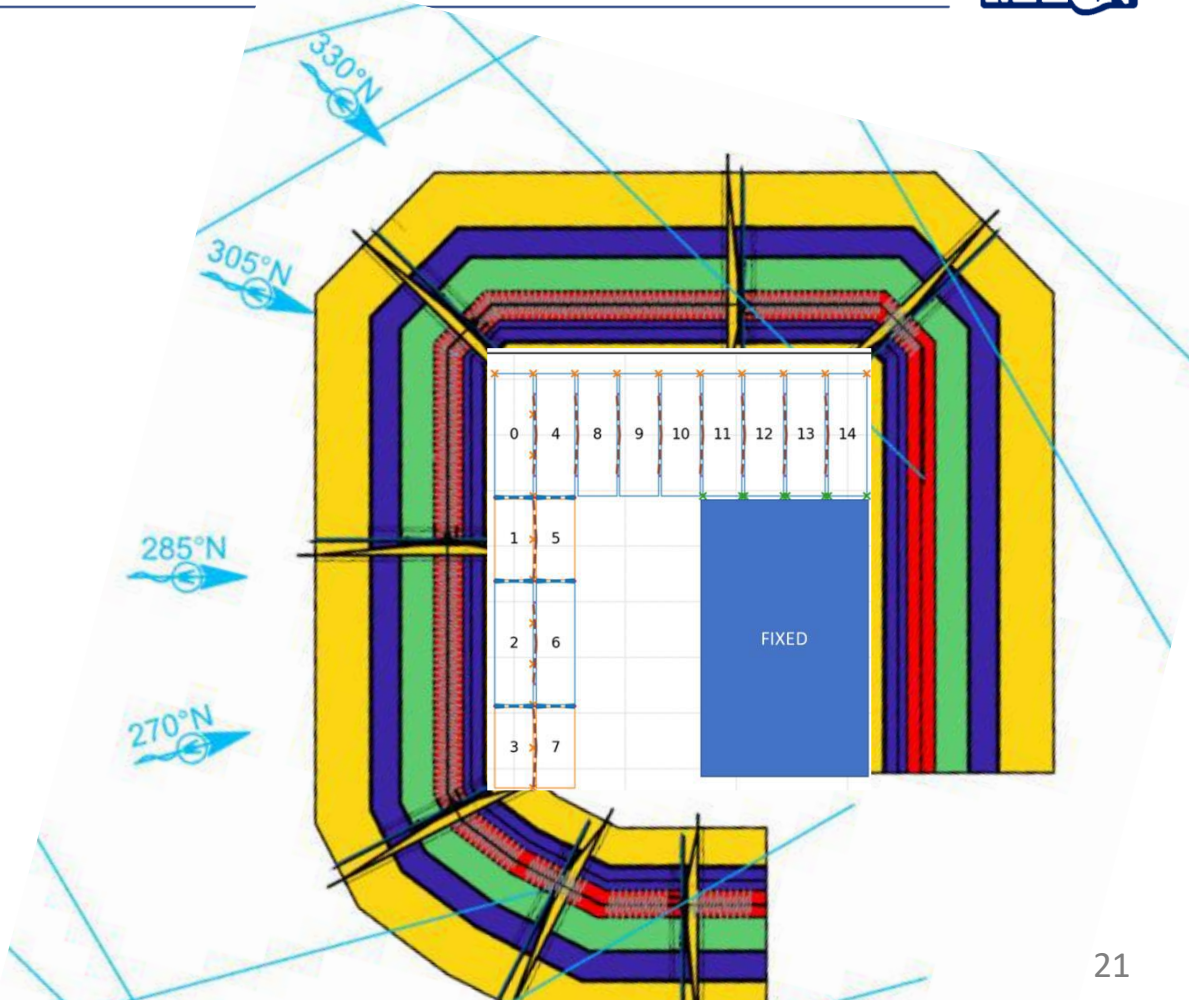
Computations and measurements



14 pontoons moored inside a breakwater

Main findings:

- Technically feasible
- CAPEX more expensive than fixed island (~+20%)
- But more future resilient



THANK YOU!