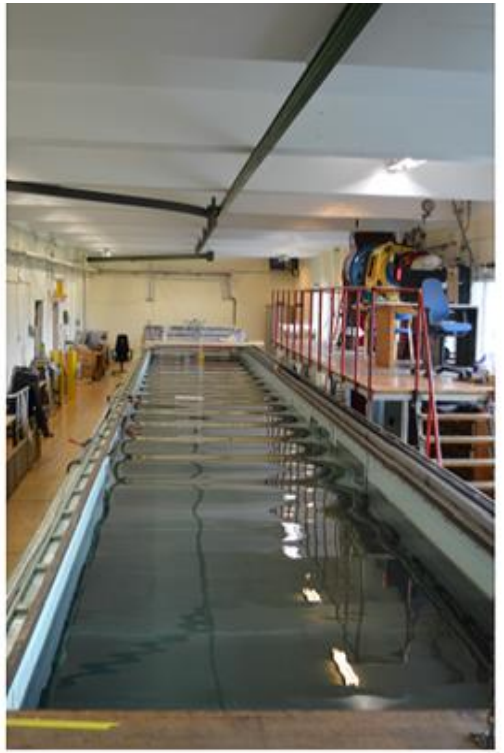
Comparison of laboratory wave generation techniques on response of a large monopile in irregular sea



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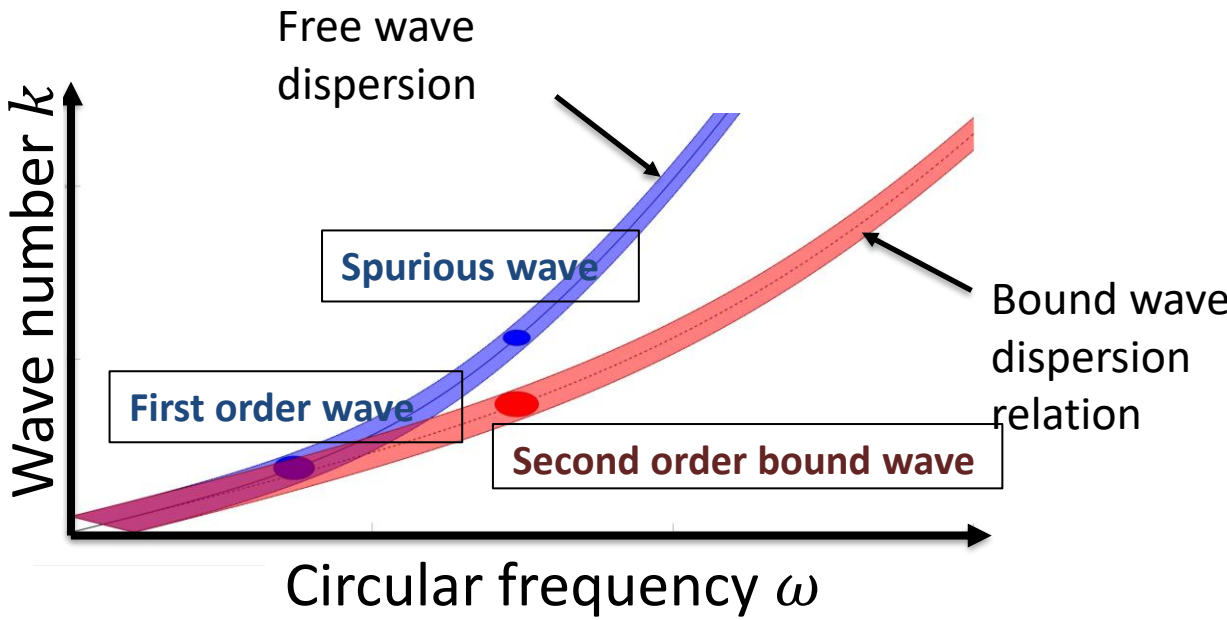
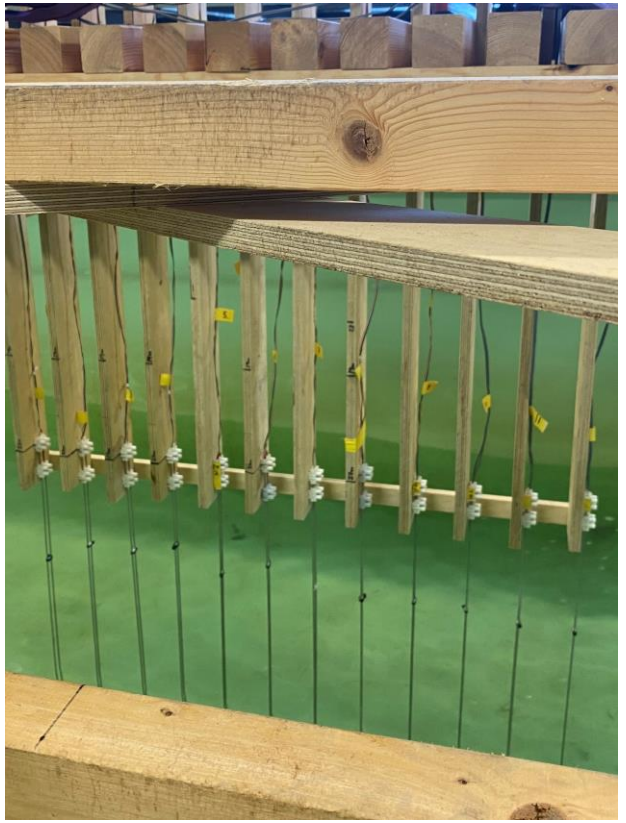
Background/Objectives

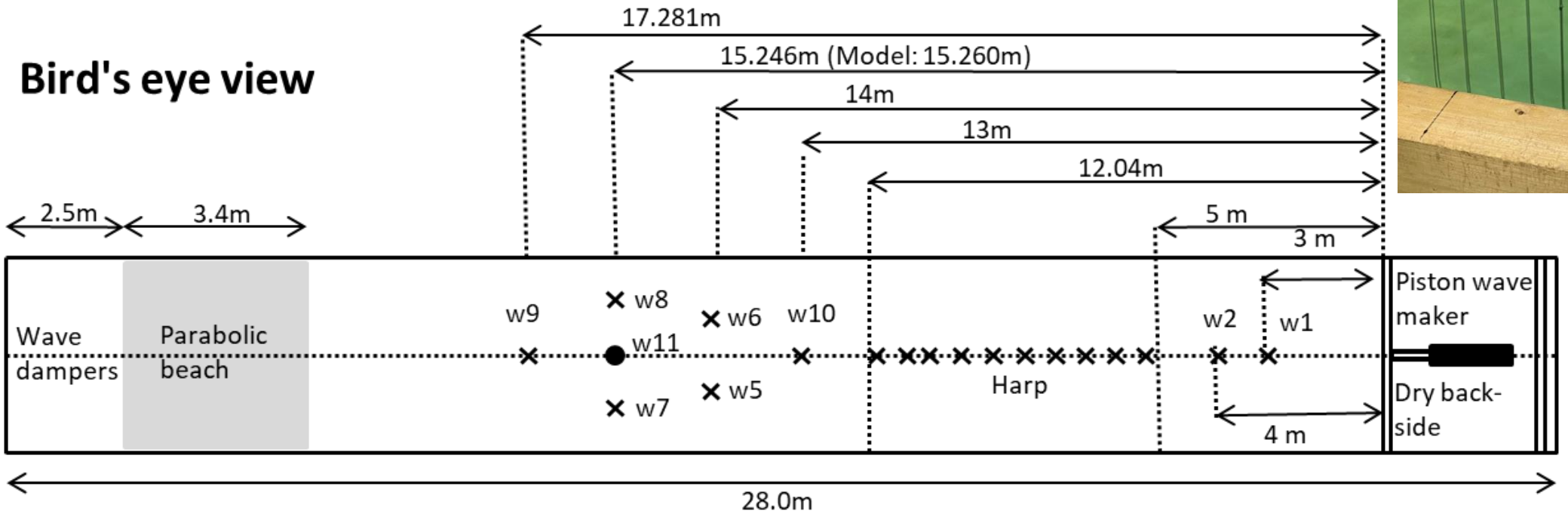
- Larger offshore wind turbines -> longer eigenperiods (5 sec)
- Model test uncertainties due to practical issues with wave generation
- ***How important is the second order wavemaker correction for the measured responses of a monopile with natural frequency close to twice the wave frequency?***
- Experimental investigation, scale 1:50



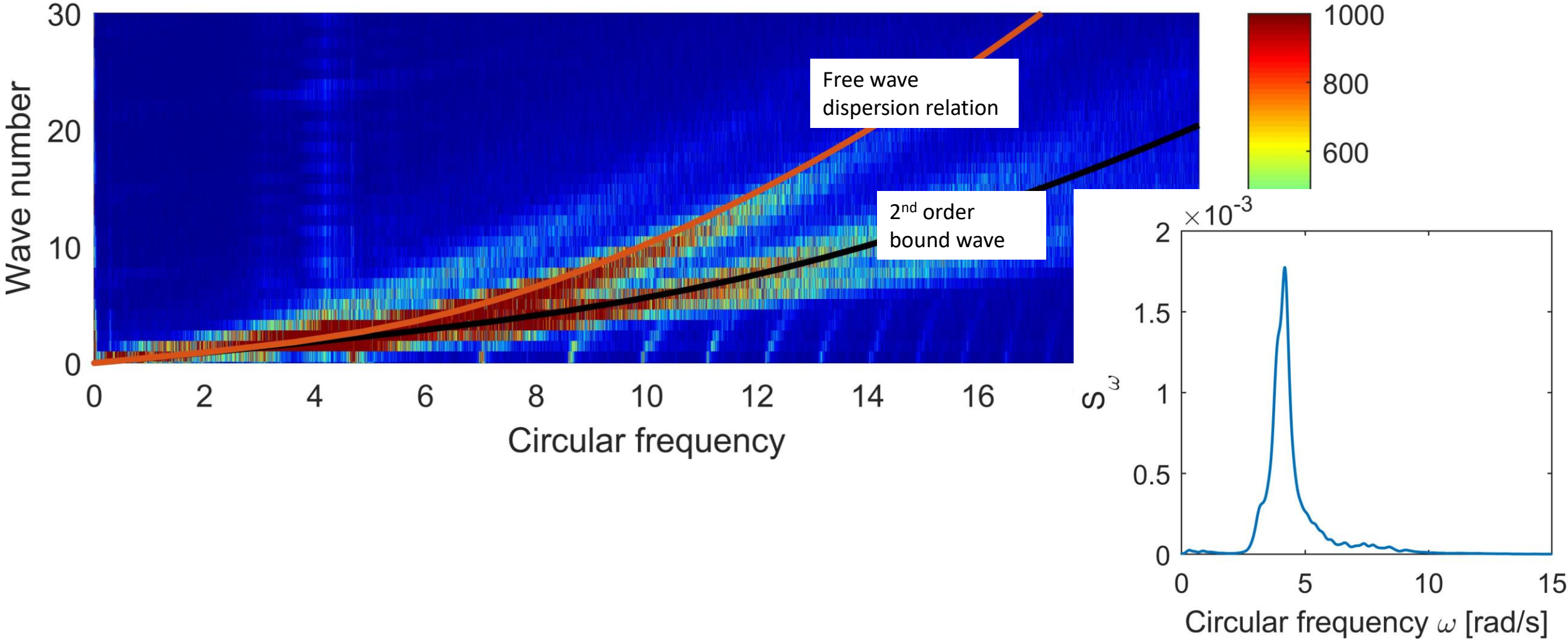
Experimental setup

- Wave elevation measurement along 7m length of the tank centerline with a step of 0.08m (86 measured points)
- Acceptable resolution for calculating 2D FFT

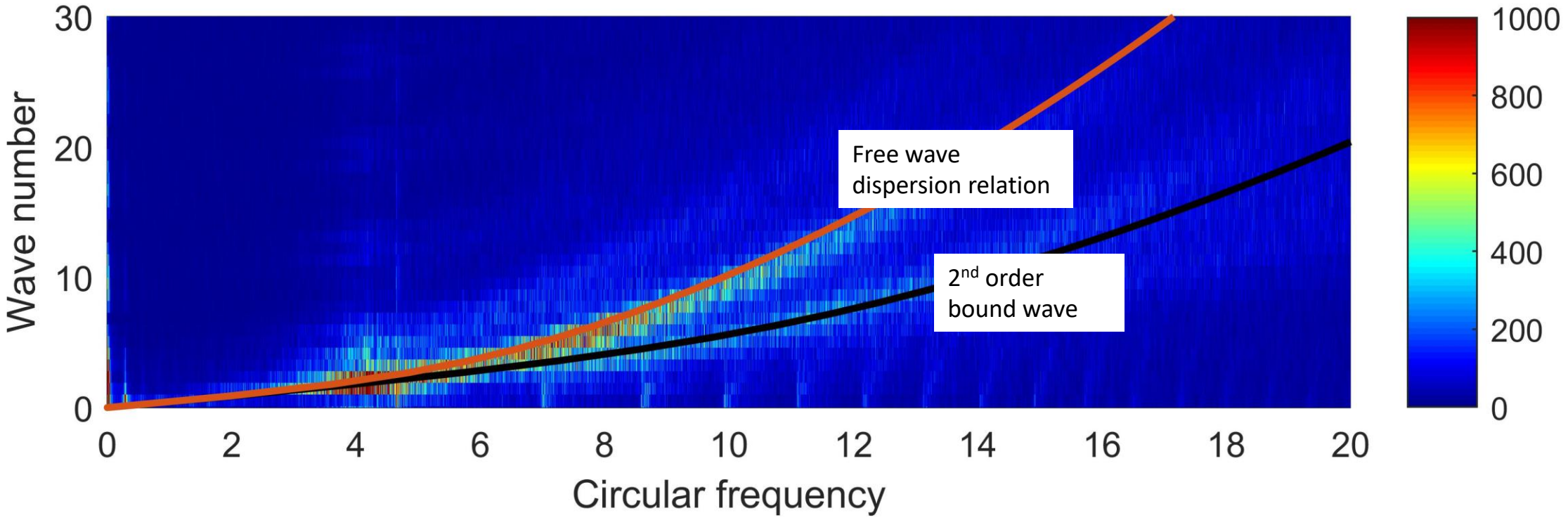




Dispersion relation: JONSWAP spectrum $T_p = 11$ s, $H_s = 8.6$ m (without correction)



Difference in the corresponding energy of free waves after applying second-order correction

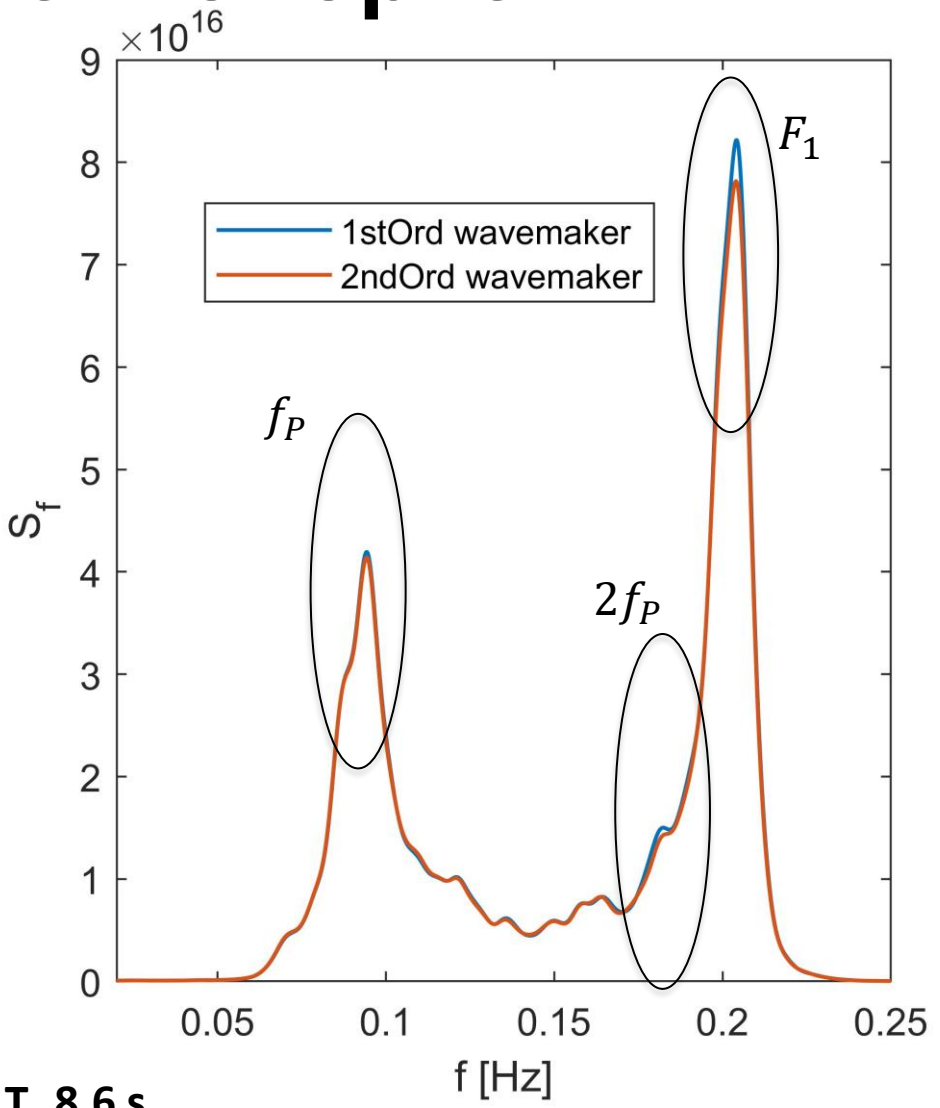


Tests with the flexible monopile

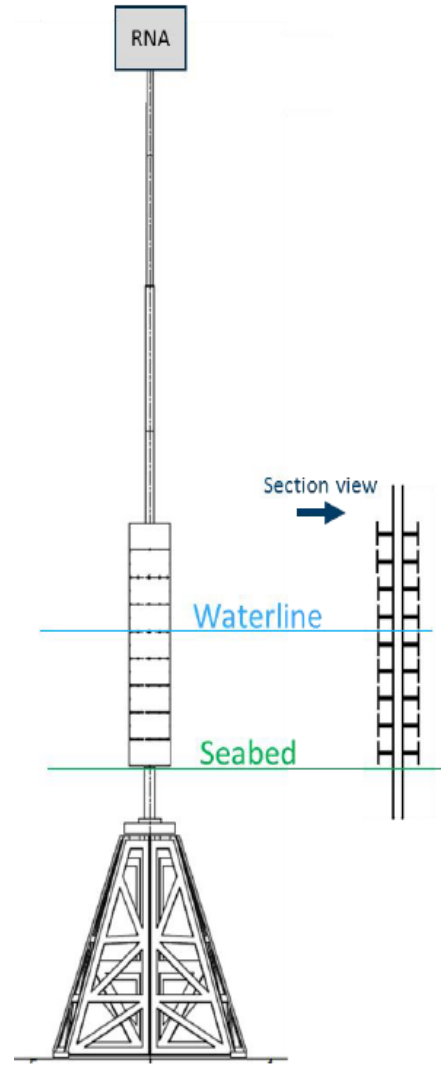
- Instrumentation: 11 wave probes, wavemaker position, strain gauges and 6DOF force transducer
- At full scale:
  - Water depth: 27 m
  - Monopile diameter: 9 m

First mode:
$f_1 = 0.2$ **(Hz)**
Damping ratio: 2%

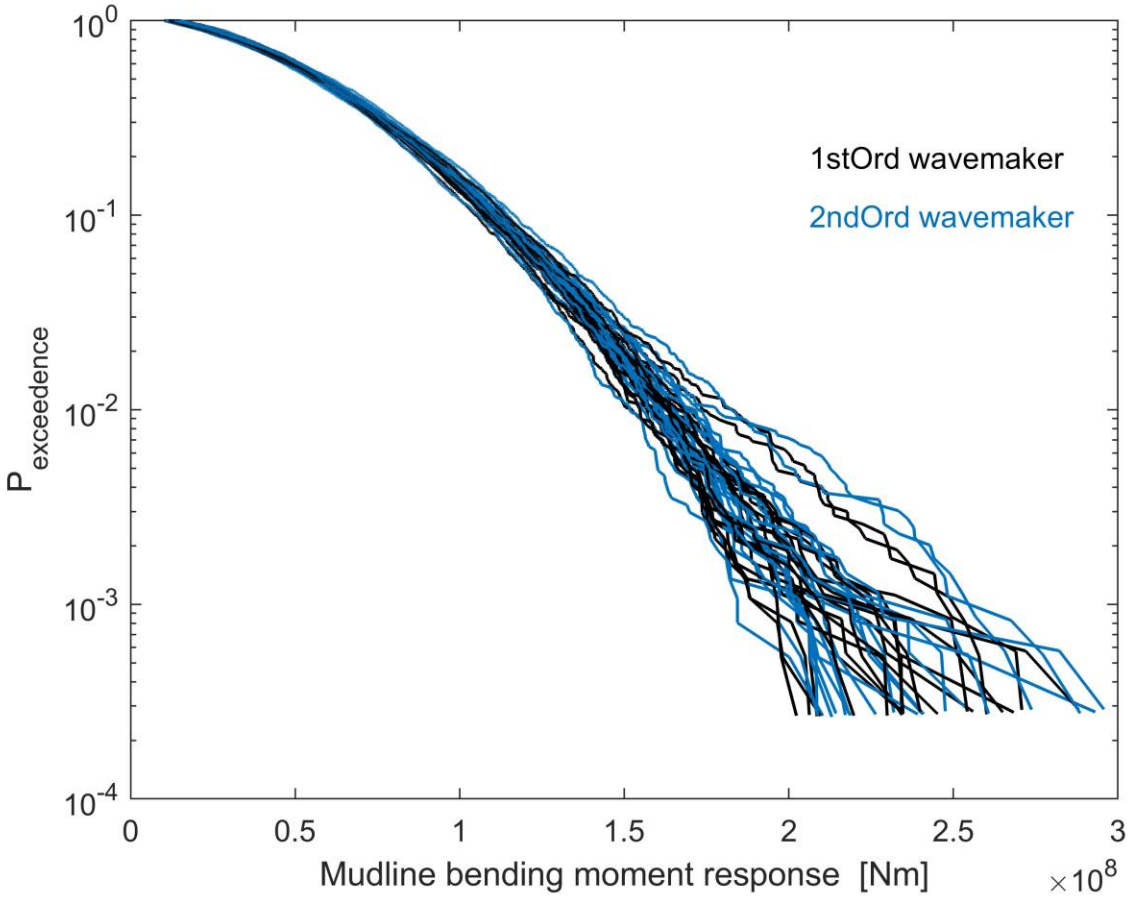
Second mode:
$f_2 = 1.57$ **(Hz)**
Damping ratio: 0.4%



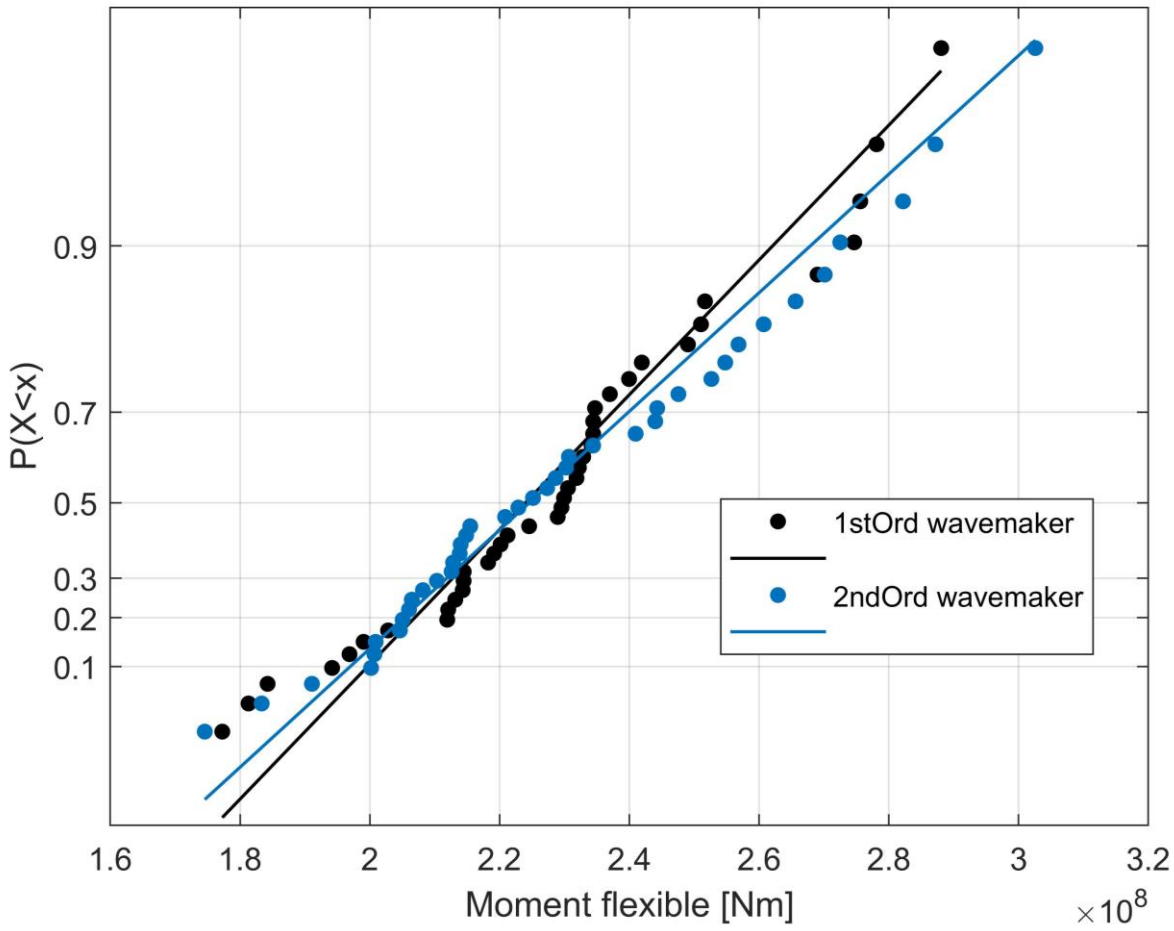
H_s 11 m, T_p 8.6 s



Bending moment, 20 realizations



Bending moment, 40 realizations



Statistically, minor effect on response measurements

Hs = 8.6 m, Tp = 11 s.