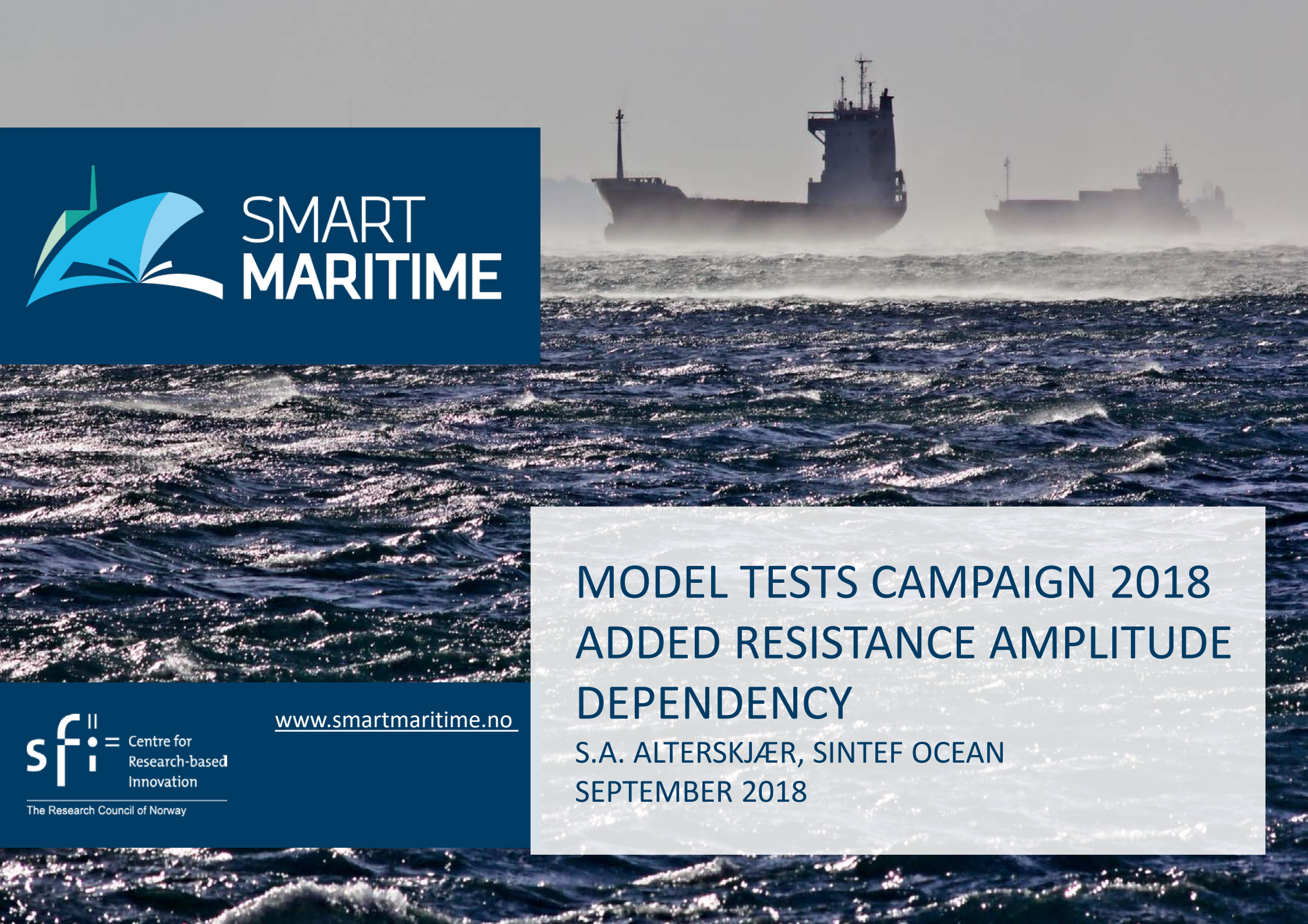

SMART MARITIME

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sfi Centre for Research-based Innovation

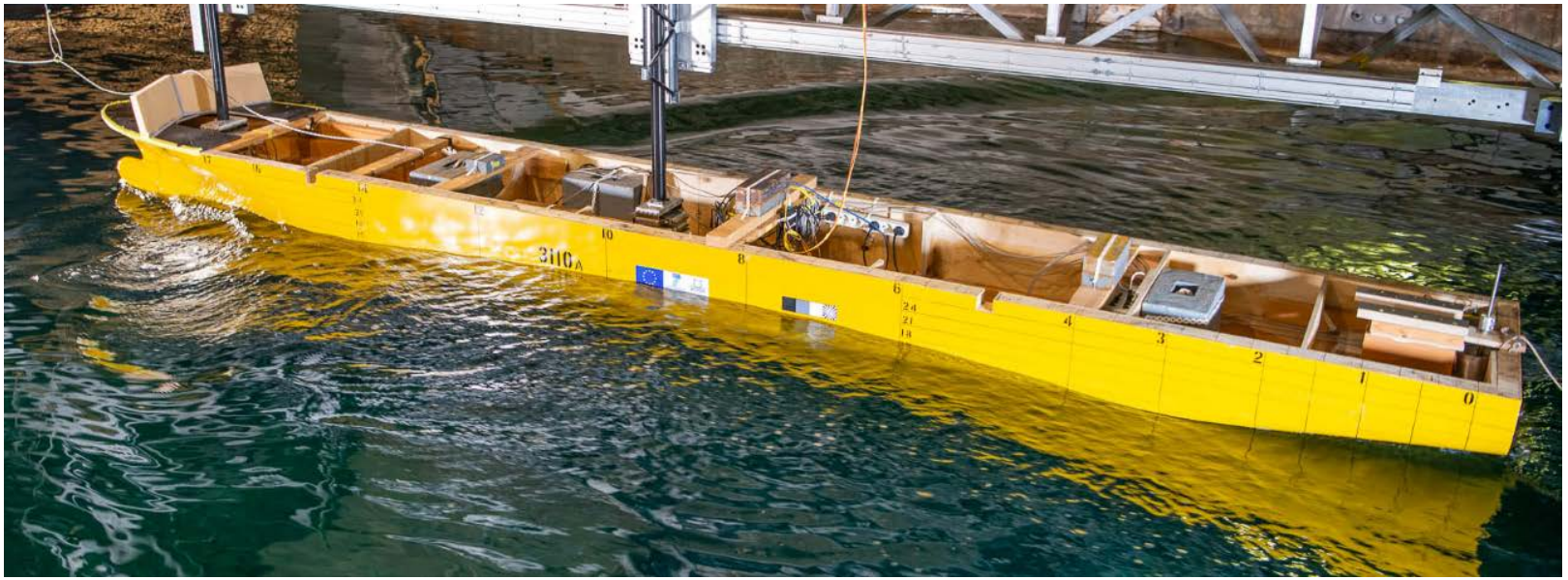
The Research Council of Norway

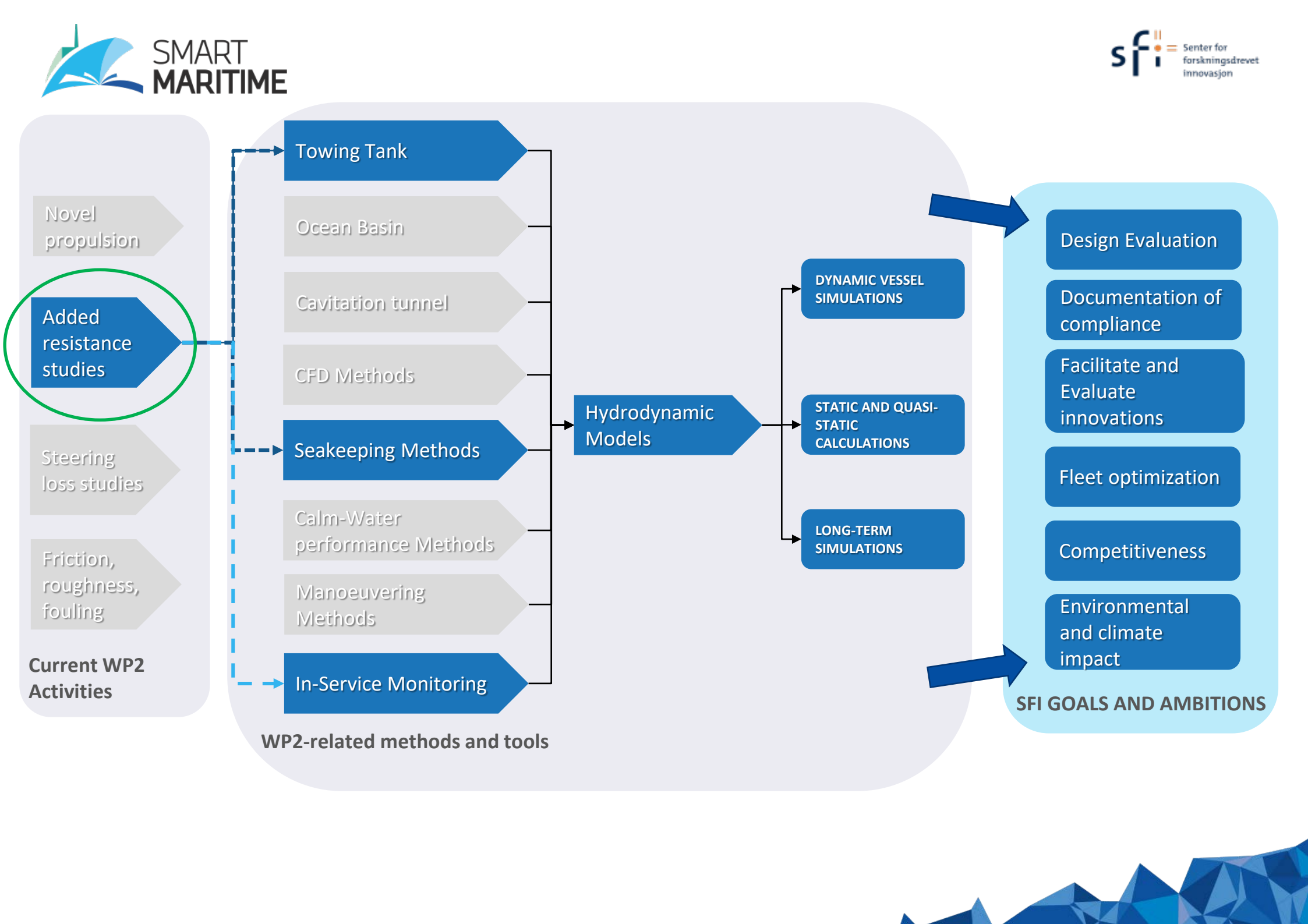
MODEL TESTS CAMPAIGN 2018 ADDED RESISTANCE AMPLITUDE DEPENDENCY

S.A. ALTERSKJÆR, SINTEF OCEAN

SEPTEMBER 2018

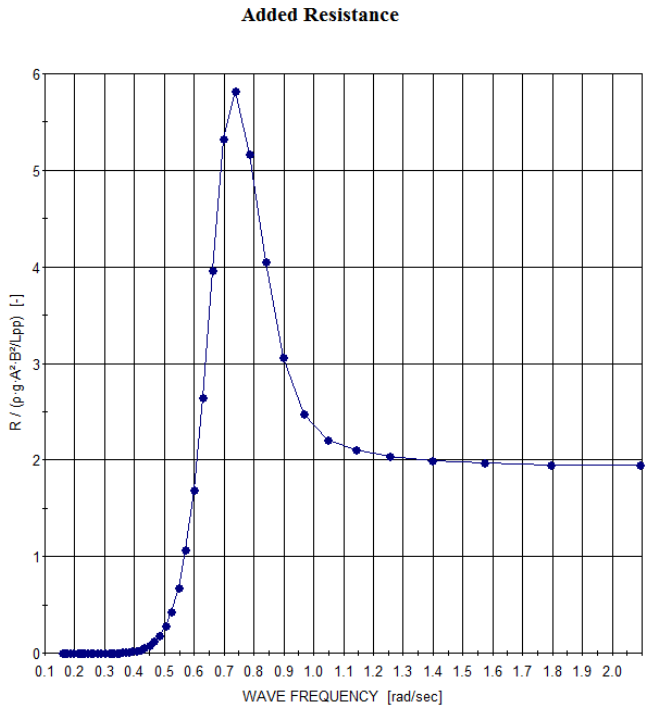
Model test campaign 2018 – Added Resistance

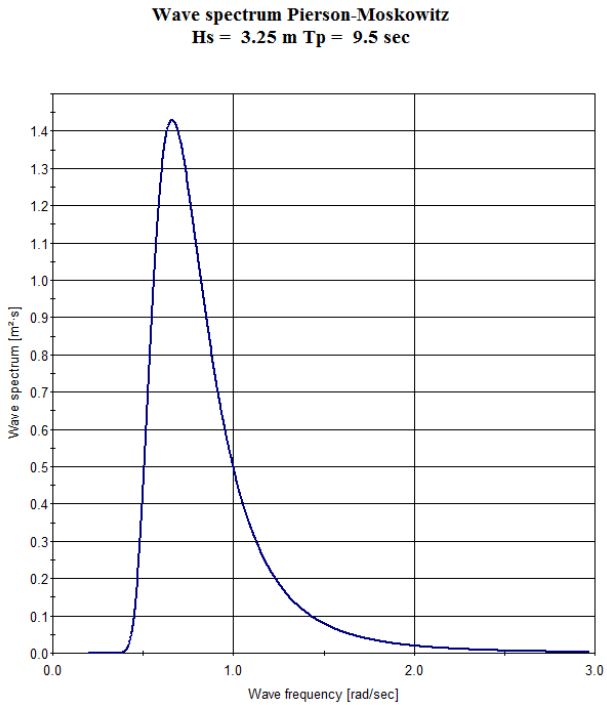



SMART MARITIME
Senter for forskningsdrevet innovasjon
Novel propulsion
Added resistance studies
Steering loss studies
Friction, roughness, fouling
Current WP2 Activities
Towing Tank
Ocean Basin
Cavitation tunnel
CFD Methods
Seakeeping Methods
Calm-Water performance Methods
Manoeuvering Methods
In-Service Monitoring
WP2-related methods and tools
Hydrodynamic Models
DYNAMIC VESSEL SIMULATIONS
STATIC AND QUASI-STATIC CALCULATIONS
LONG-TERM SIMULATIONS
Design Evaluation
Documentation of compliance
Facilitate and Evaluate innovations
Fleet optimization
Competitiveness
Environmental and climate impact
SFI GOALS AND AMBITIONS

Background

- Added Resistance transfer functions are commonly applied to calculated the added resistance in arbitrary sea states:
  - $R_{AW} = 2\int_0^\infty S(\omega)\frac{R_W(\omega,V_S)}{\zeta_A^2}d\omega$
- The transfer function can be derived from potential flow methods, model tests in regular waves or CFD calculations in regular waves.

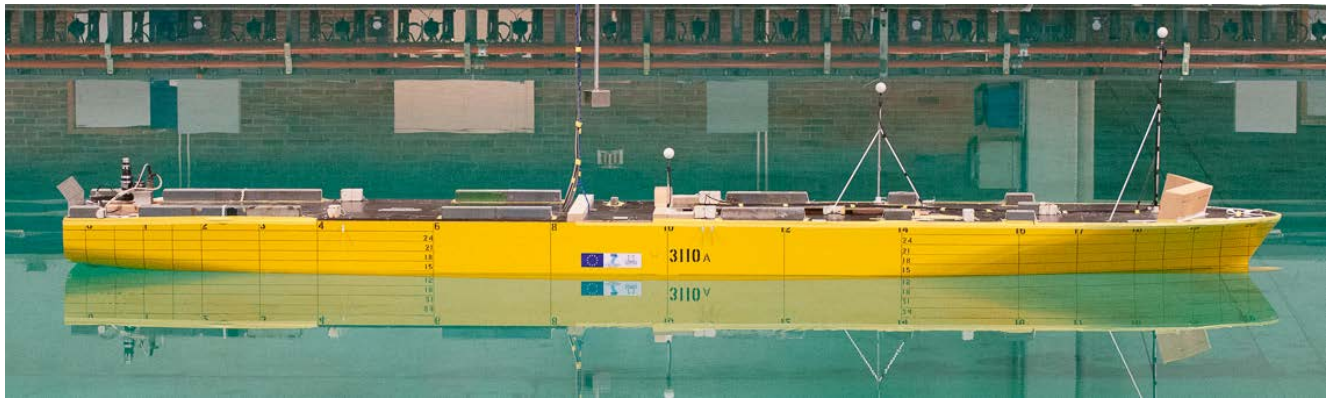




Background

- However, we know that the superposition principle is not completely applicable. This is also the experience when tuning numerical models to model test results in irregular waves.
- This phenomenon needs to be considered in for instance the following:
  - Establishing model test programs
  - Choosing numerical modelling methods
  - Validation and comparisons of numerical tools
- A model test campaign was thus set up to quantify this effect for an open vessel geometry, i.e. the Duisburg Test Case.

Hull Model

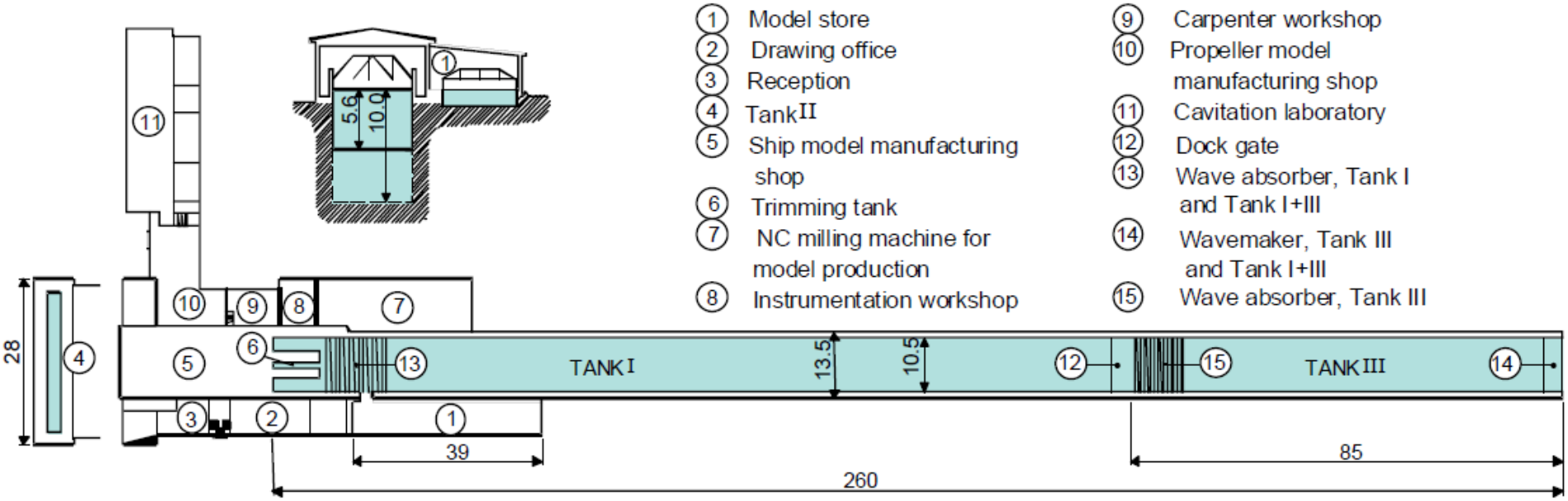


- Sintef Ocean Model M3110 (Previously used in the SHOPERA - Energy Efficient Safe SHip OPERAtion)

HULL MODEL NO.: **M3110A** Model Scale: 63.650
Loading condition: Design WL
Draught AP/FP: 14.500 / 14.500 [m]

	Symbol	Unit	SHIP	MODEL
Length overall	L_{OA}	[m]	372.394	5.851
Length betw. perp.	L_{PP}	[m]	355.000	5.577
Breadth moulded	B	[m]	51.000	0.801
Draught at $L_{PP}/2$	T	[m]	14.500	0.228
Trim (pos. aft)	t	[m]	0.000	0.000
Displacement	Δ	[t]	178693.3	0.676
Block coefficient*	C_B	[-]	0.6608	0.6608
Wetted surface	S	[m^2]	22162.99	5.471

Test Setup in the Towing Tank



Test Setup


- Spring-suspended in surge
- Fixed in sway and yaw
- Free to (roll), pitch and heave

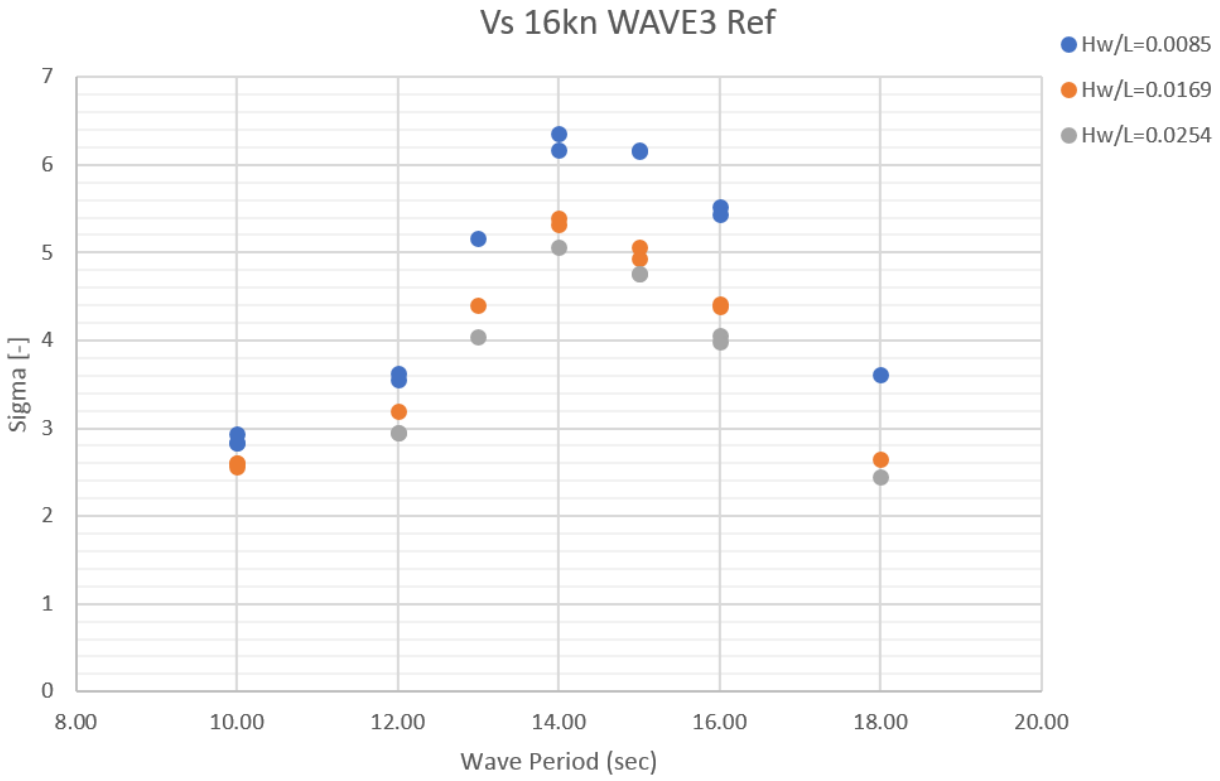
Test Matrix, Calm water and head waves

- Calm water reference resistance curve
- Regular waves
  - Wave period range λ/Lpp = [0.44 – 1.43]
  - 3 Wave heights Hw/Lpp = [0.0085, 0.0169, 0.0254]
  - Speeds 12, 16 and 20 knots
- Irregular wave tests
  - 16 knots
  - 3 sea states
- Several repetition runs => 140 test recordings

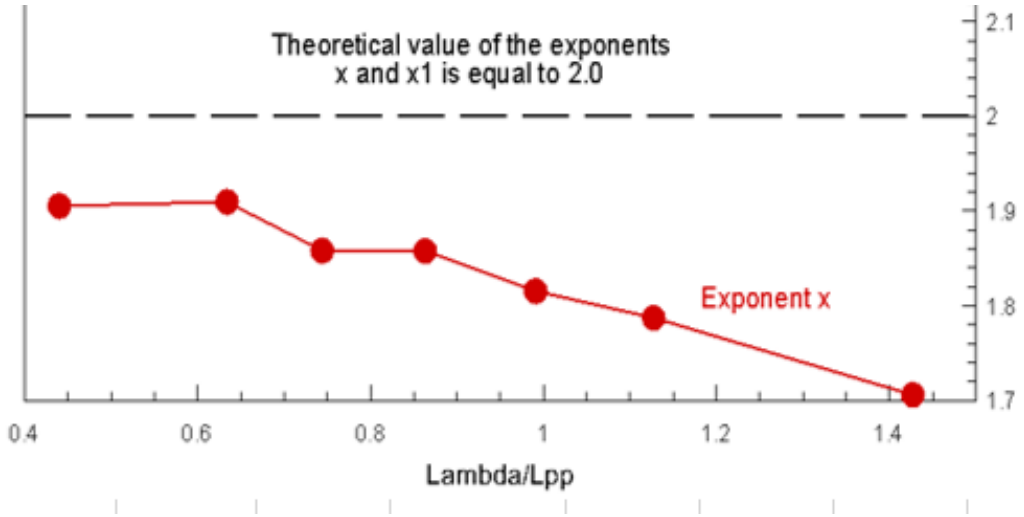
Automized testing

- The lack of such studies in the past partially comes from the cost of carrying out model tests in waves for large test matrices
- The project took advantage of SINTEF Ocean's internal development of automized test techniques including a dedicated test rig.

Analyses and results



Analyses and results



Matching of Hw/Lpp = 0.0085 and Hw/Lpp = 0.0169