

Methodology for floating offshore wind turbine Major Component Replacement (MCR) - Webinar



FLoating Offshore Wind Operations and Maintenance (FLOWTOM) project

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PARTNERSHIP:



With the financial support of:



2. Basin tests for numerical model validation

Part I – Specification of wave tank tests

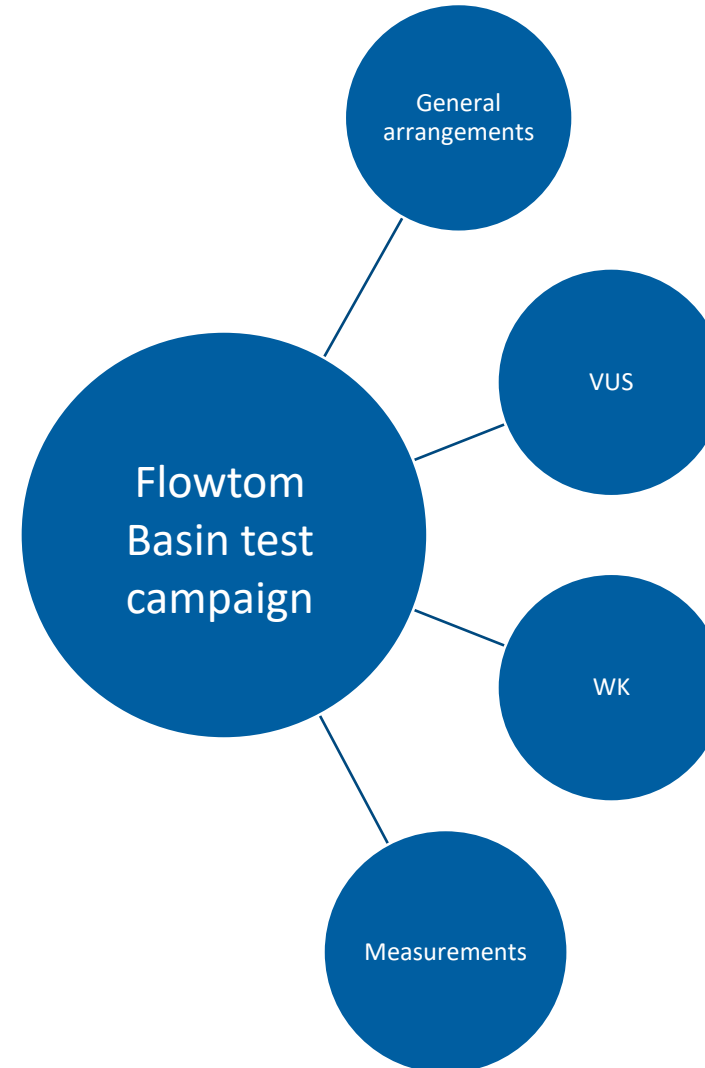


Benoit Augier, IFREMER

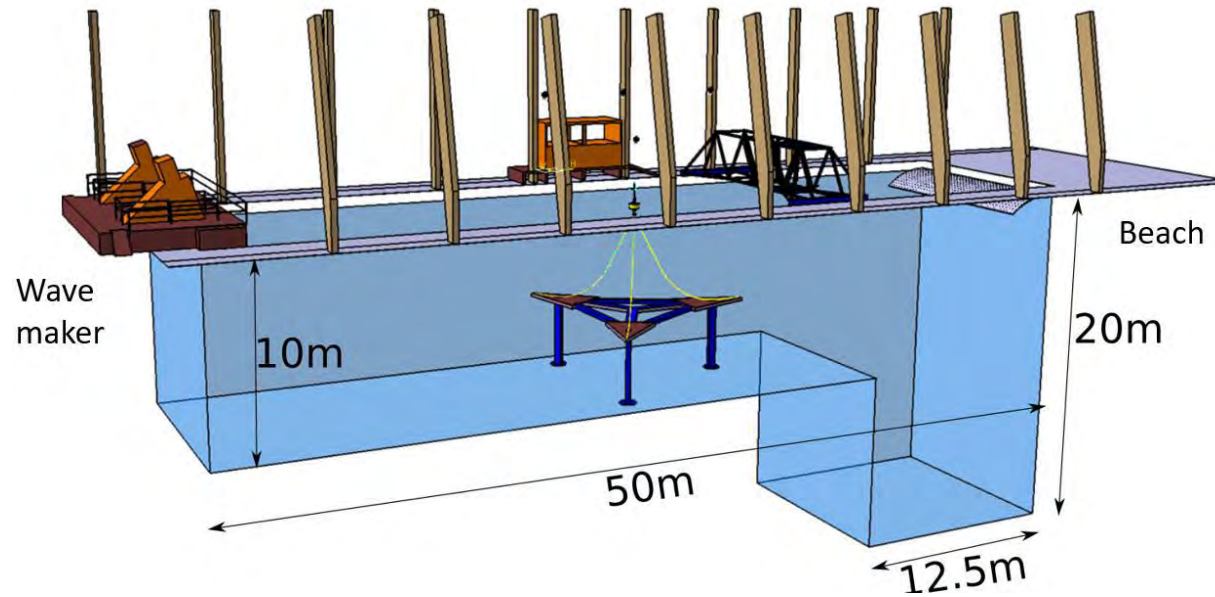


Basin Test Specification – Objectives

- Objectives
 - Accurate representation of two floating mock-ups with their respective mooring
 - Anchoring system for the VUS
 - DP system for the WK
 - Different wave orientations and sea states
 - Data for numerical and experimental comparison

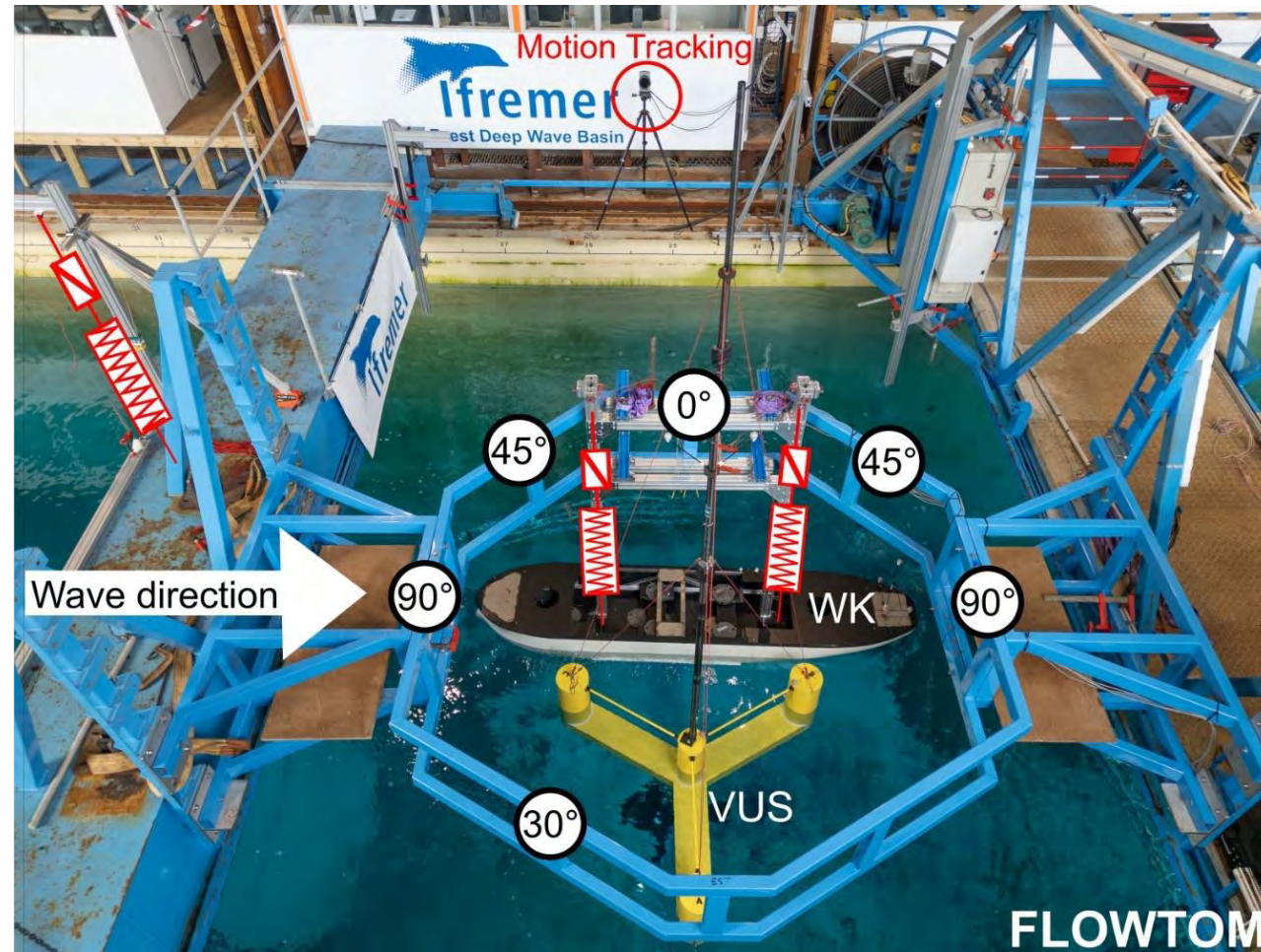


Basin Test Specification – Basin test Overview

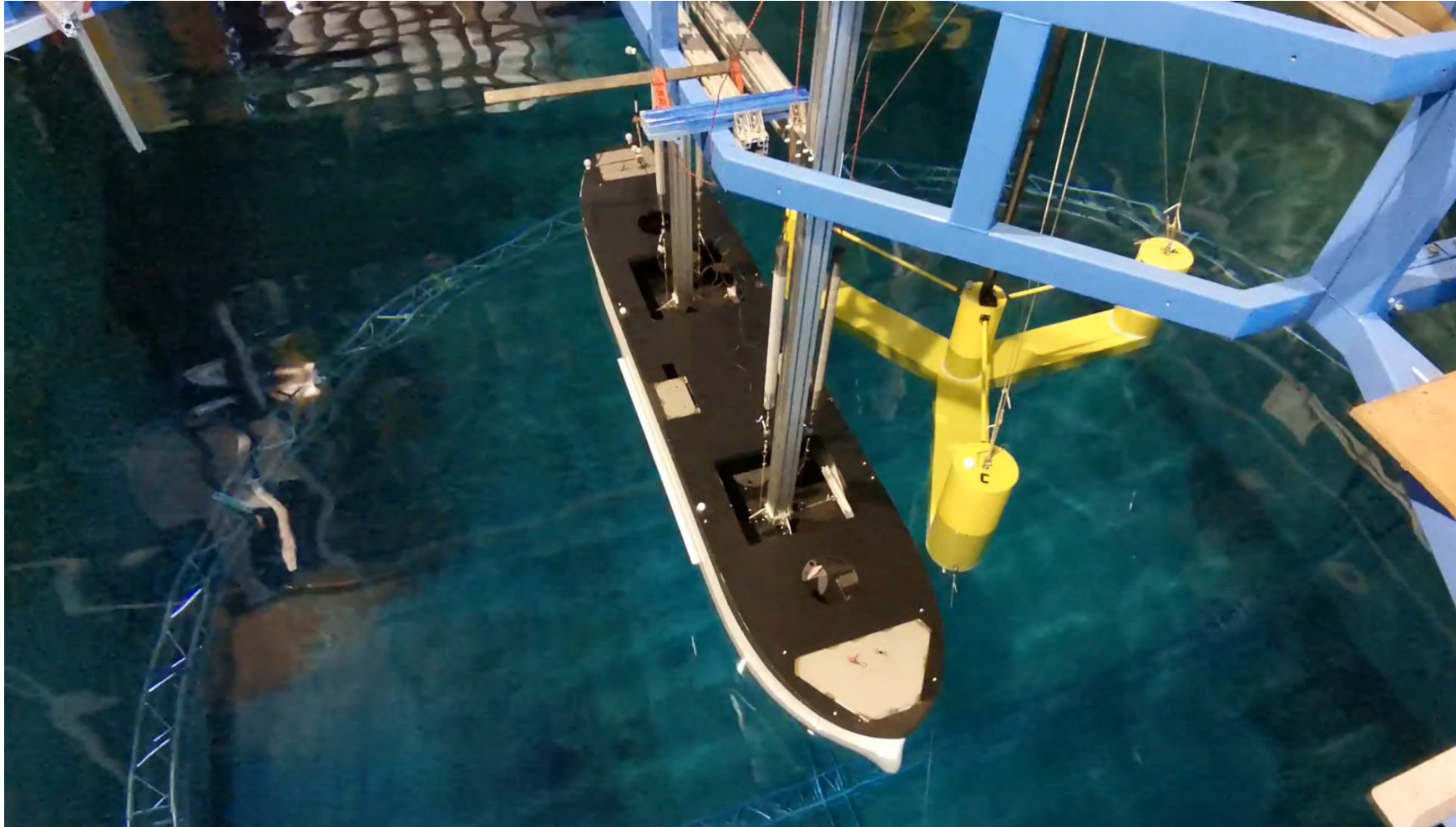


Parameter	Unit	Scale factor
Length	m	λ
Surface	m ²	λ^2
Volume/mass	m ³	λ^3
Time	s	$\sqrt{\lambda}$
Speed	m s ⁻¹	$\sqrt{\lambda}$
Acceleration	m s ⁻²	1
Angle	°	1
Force	N	λ^3
Stiffness	N/m	λ^2
Inertia	kg m ²	λ^5

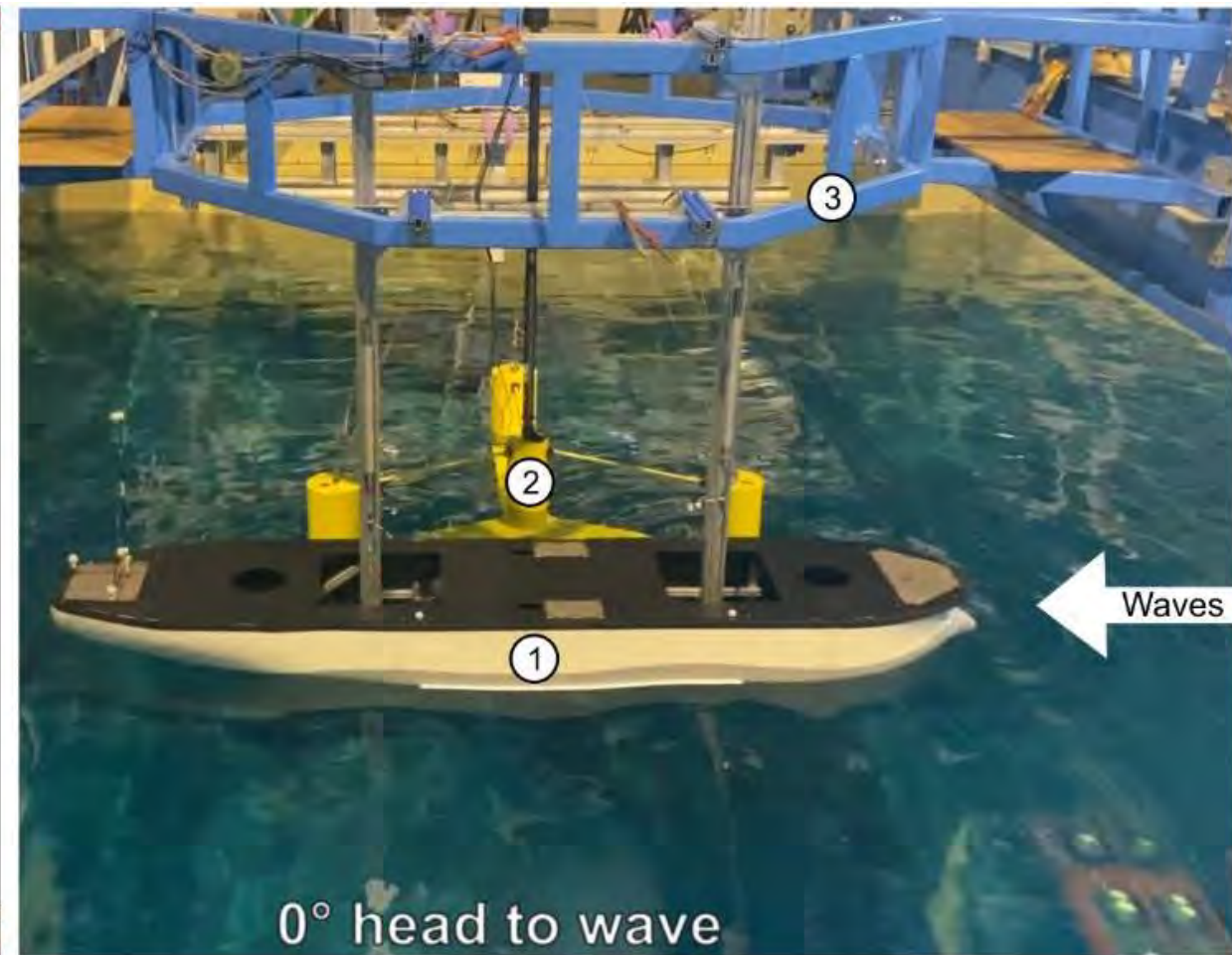
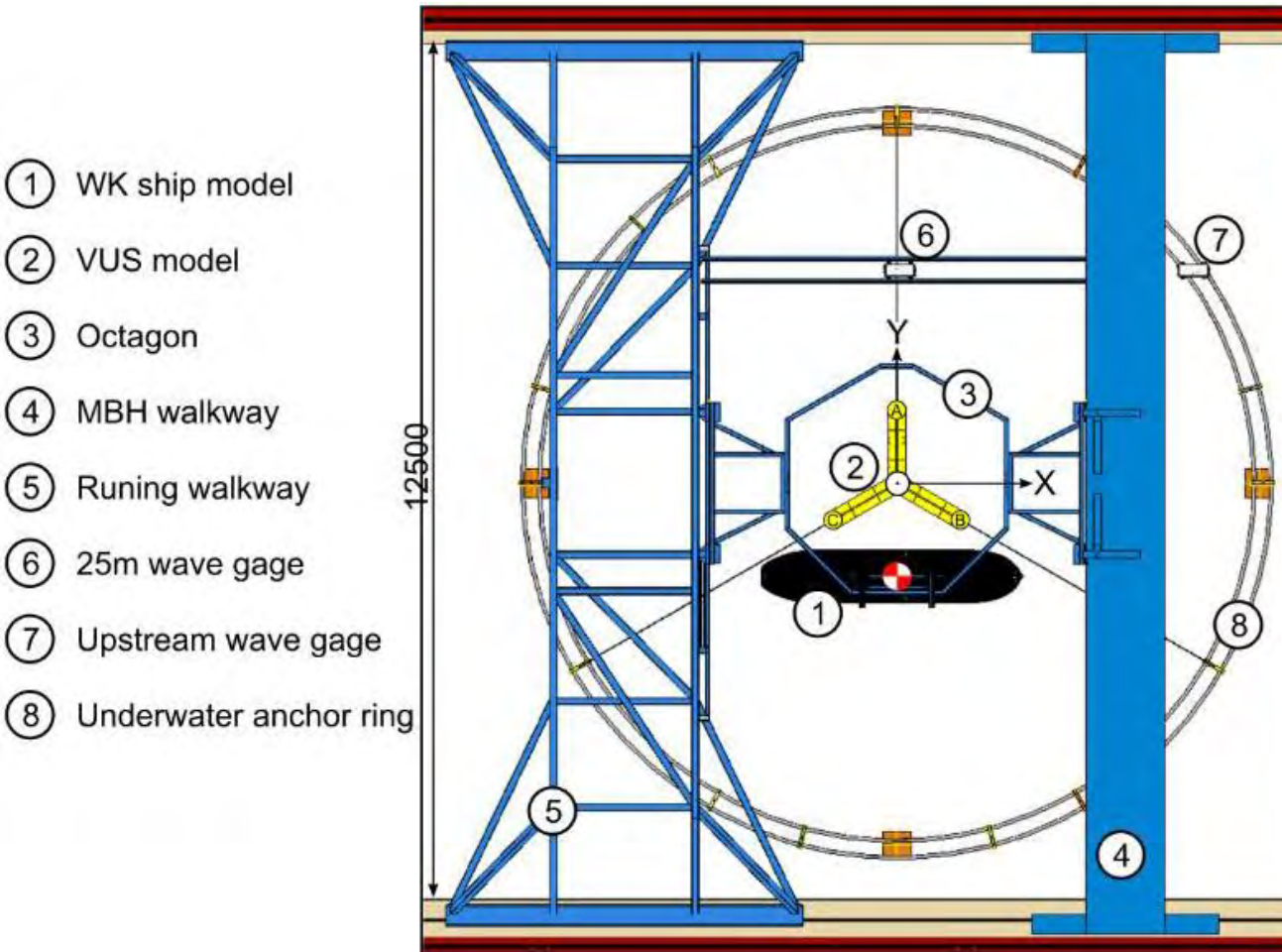
Basin Test Specification – Basin test Overview



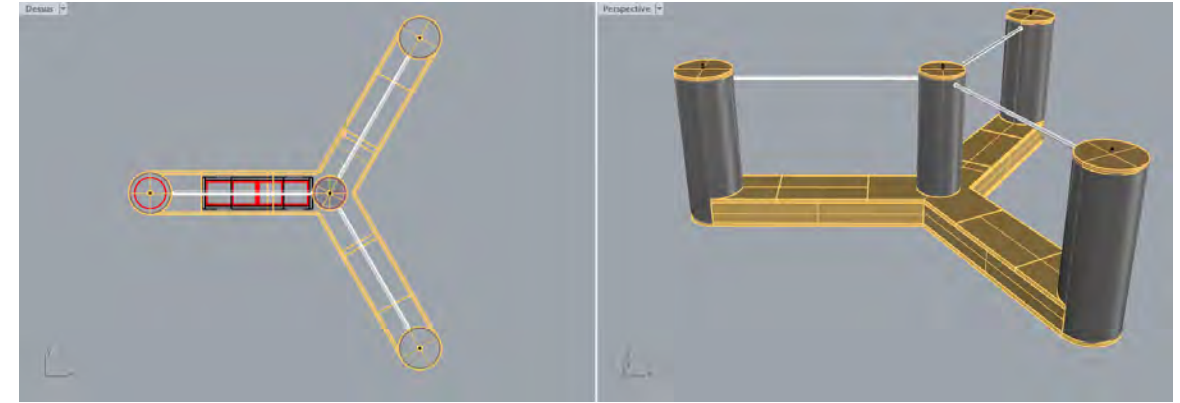
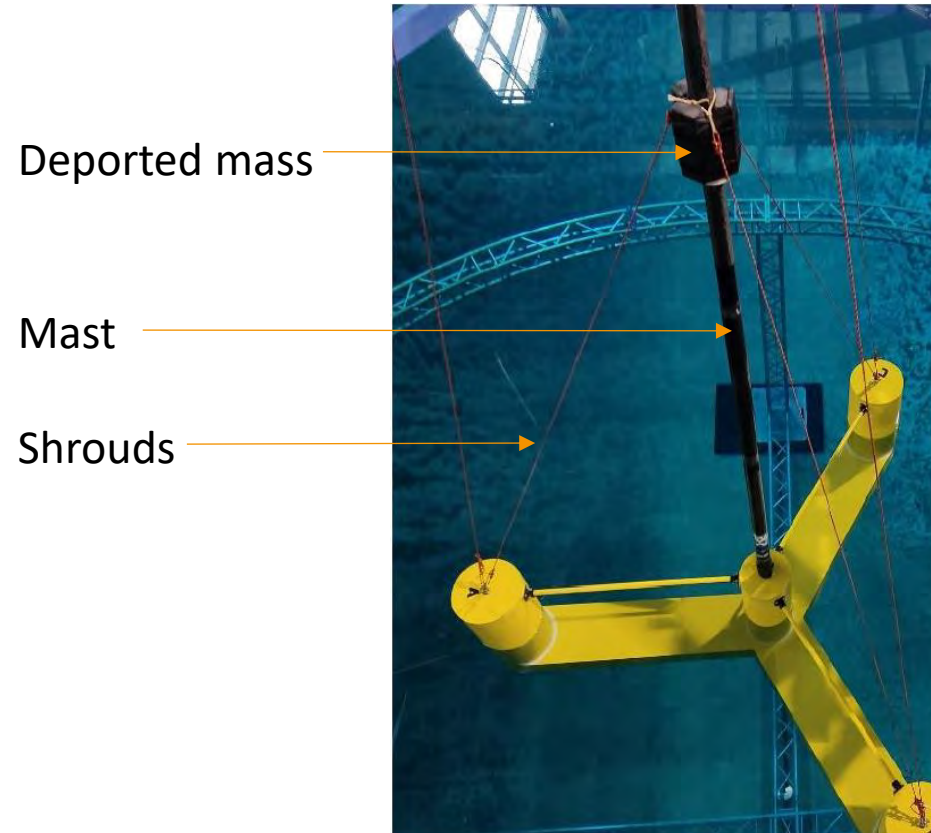
Basin Test Specification – Basin test Overview



Basin Test Specification – Basin test Overview



- Mock-up

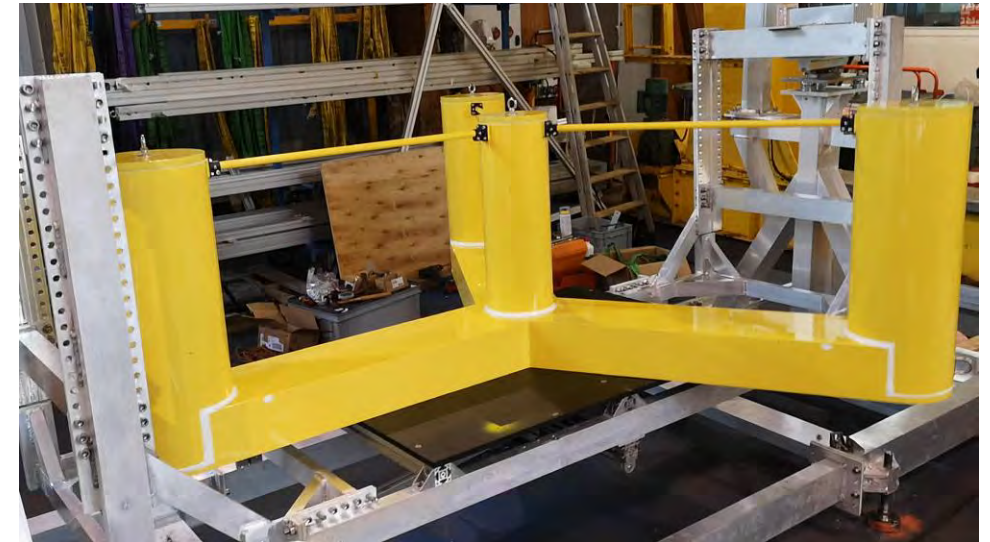


Parameter	Deadweight (kg)	External columns diameter (m)	Central column diameter (m)	Distance between outer diameter of external and central columns (m)
Scale 1:1	2,04E+07	12,5	10	51,75
Scaling factor	λ^3	λ	λ	λ
Scale 1:50	163,22	0,25	0,2	1,035
Measurement 1:50	163,58	0,25	0,2	1,035
Difference	0,2%	0,0%	0,0%	0,0%

Basin Test Specification – Floating Offshore Wind Turbine: VoltturnUS-S

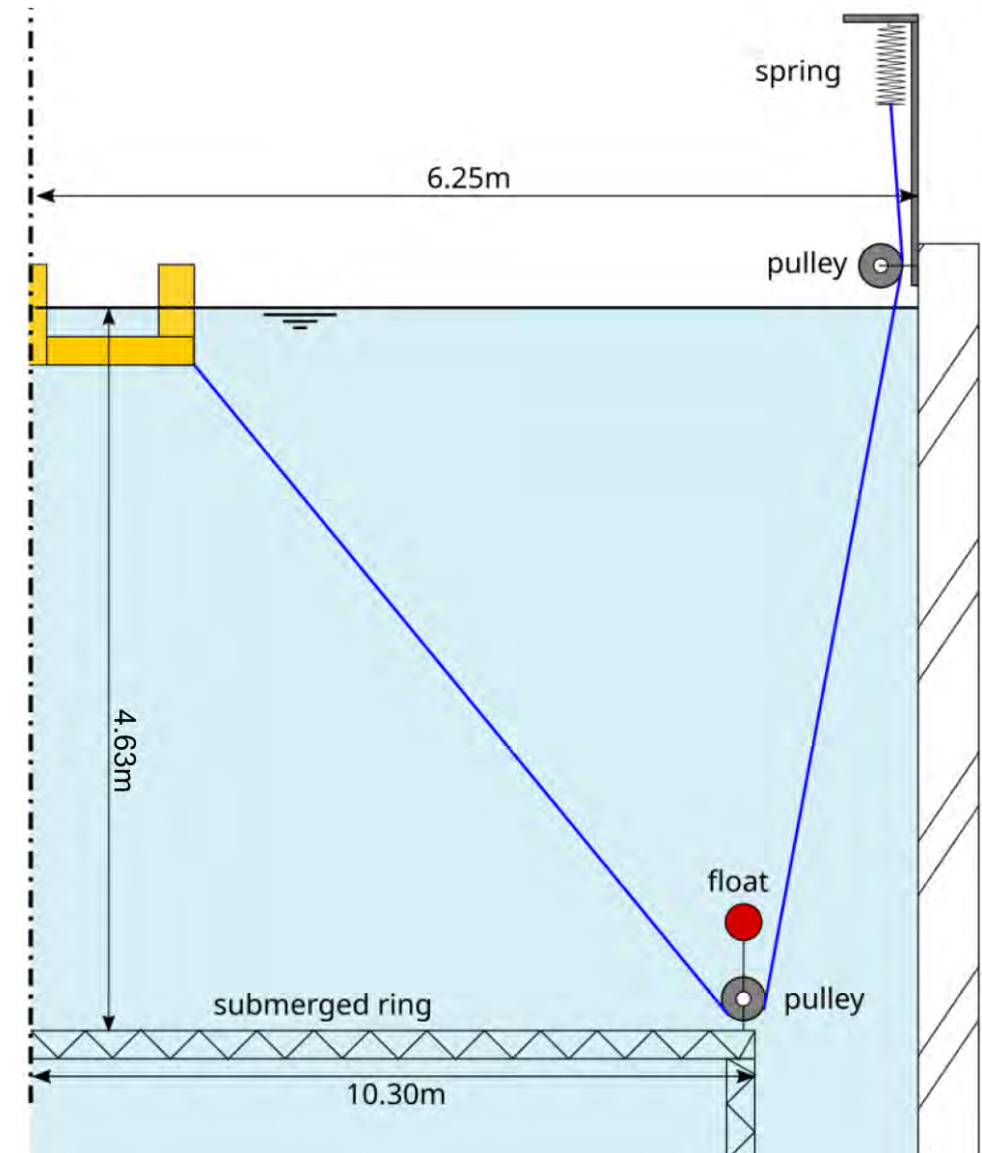
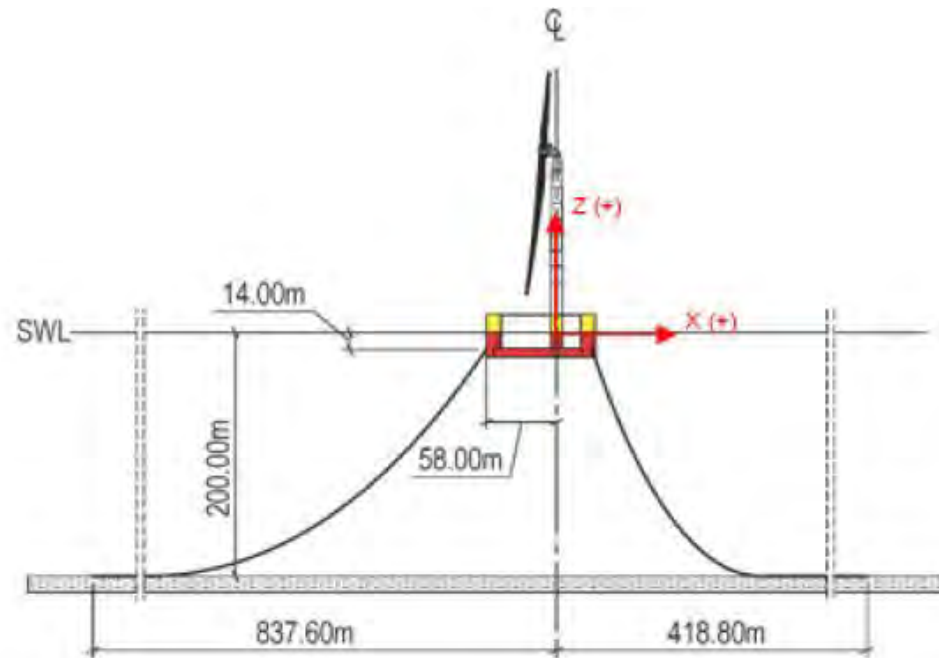
- Specs

Parameter	Floater draught (m)	cog-x/y (m)	cog-z / SWL (m)	Inertia Roll I_{xx} (kg.m ²)	Inertia Pitch I_{yy} (kg.m ²)	Inertia Yaw I_{zz} (kg.m ²)
Scale 1:1	20	0 (centered)	-2,137	4,48E+10	4,47E+10	2,39E+10
Scaling factor	λ	λ	λ	λ^5	λ^5	λ^5
Scale 1:50	0,4	0	0,357	143,33	143,04	76,61
Measurement 1:50	0,4	0	0,360	149,57	149,57	76,20
Difference	0,0%	0,0%	0,9%	4,4%	4,6%	-0,5%



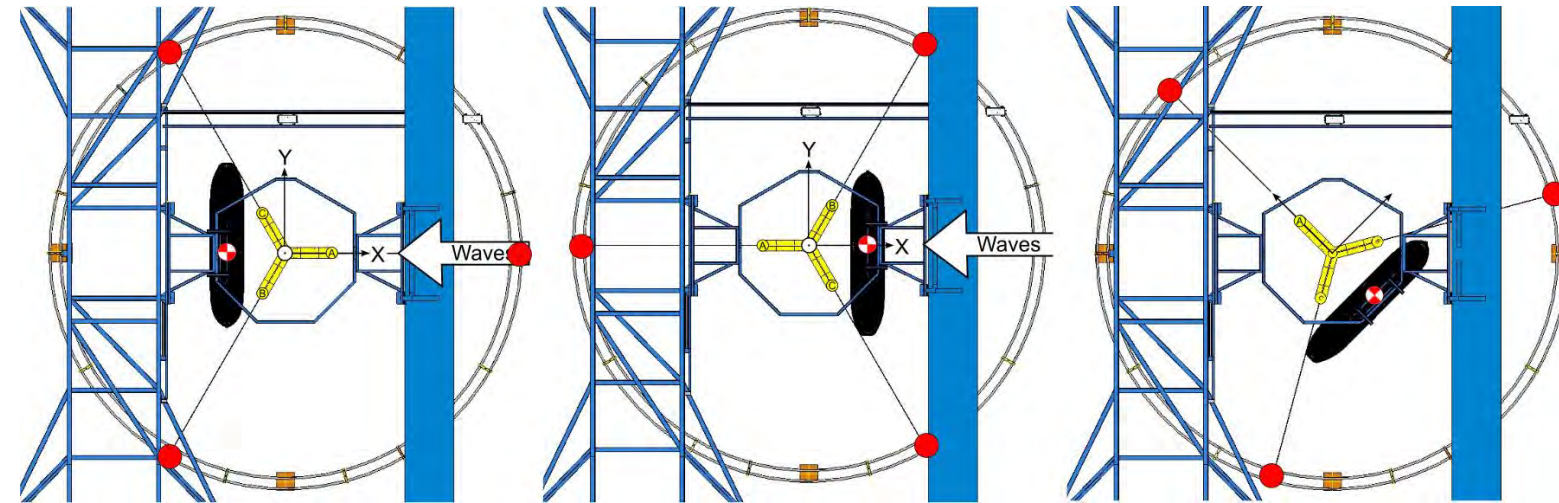
- Moorings

- 3 Dyneema lines connected to the submerged ring
- 3 springs at the surface
- Waves orientation changed with different connection points around the ring



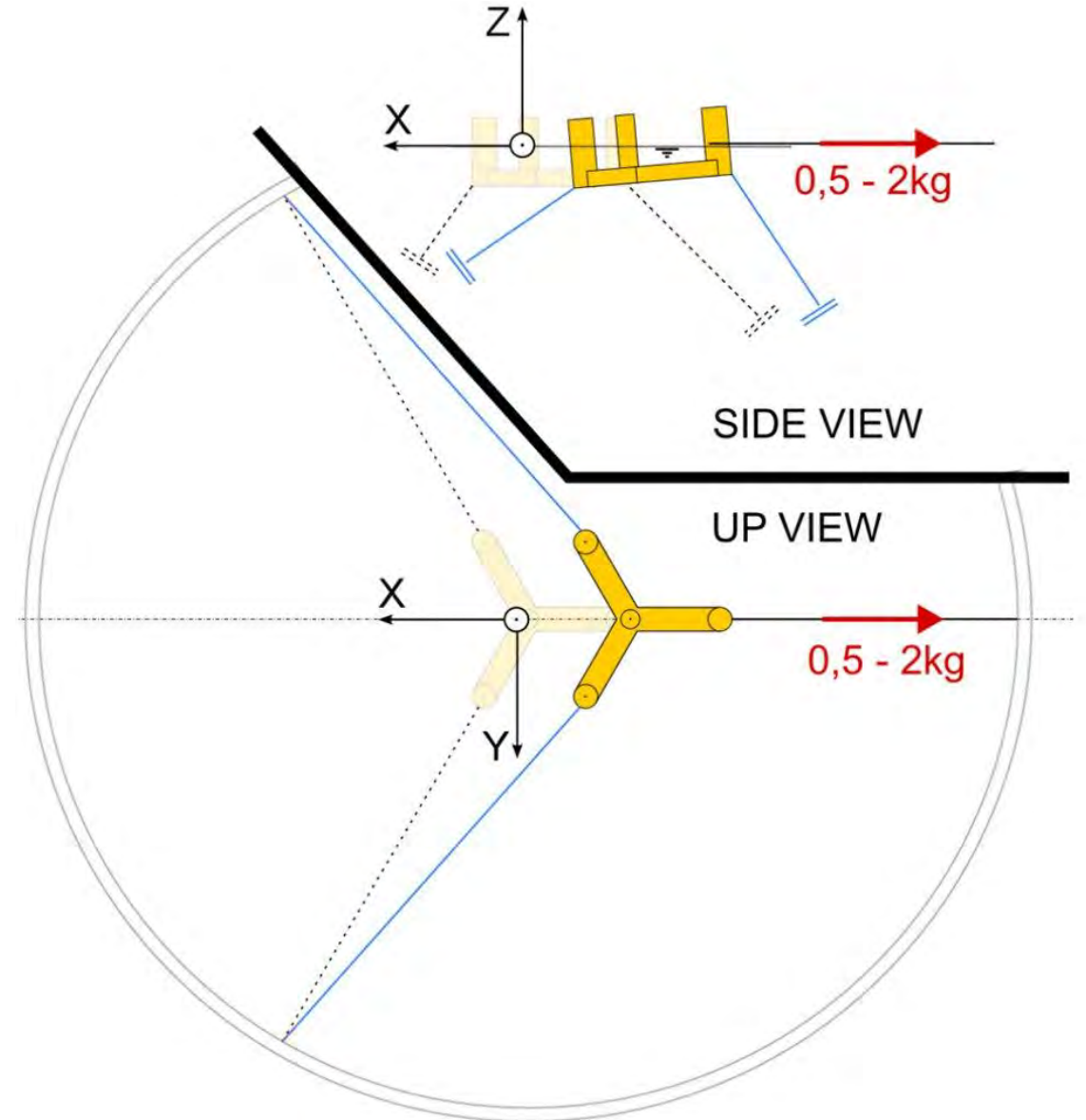
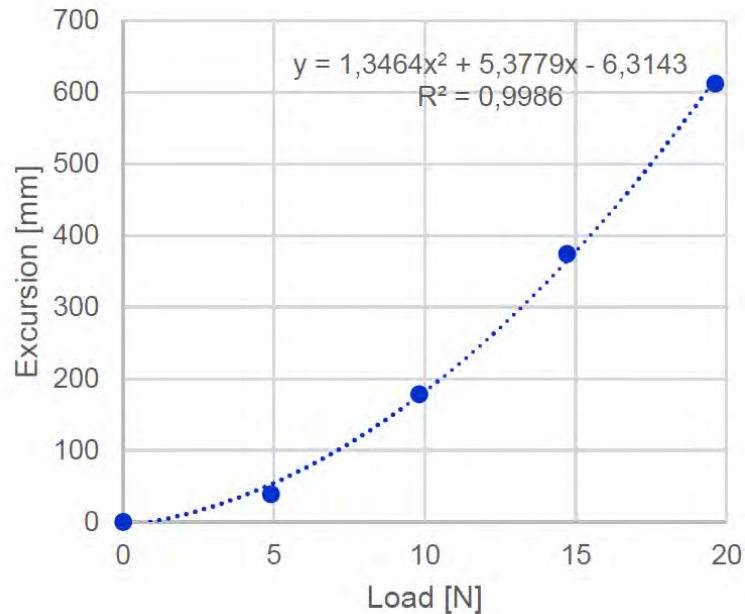
- Moorings
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Scale 1:1		Parameter	Basin test scale 1:50	
Unit	Value		Value	Unit
Geometry				
kN	1 135	Pretension	9.08	N
kN/m	120.0	Axial stiffness	48,0	N/m
m	9.5	Spring elongation at pretension	18.9	cm



- Moorings

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- 3 springs at the surface
- Waves orientation changed with different connection points around the ring

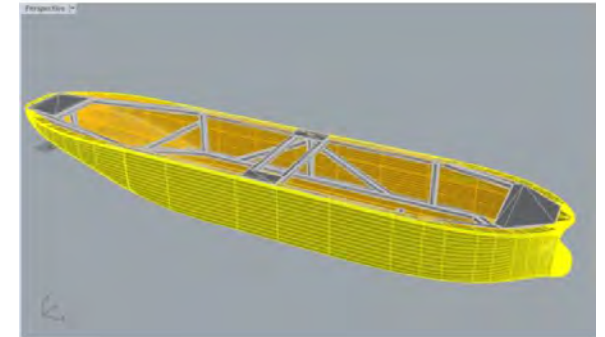
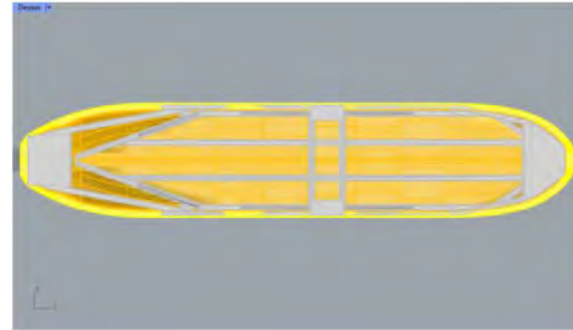


Basin Test Specification – Maintenance Operation Vessel: WK

- Mock-up

Specifications Windsor

Parameter	Length (m)	Beam (m)	Draught (m)	Deadweight (t->kg)
Scale 1:1	185	37,5	18	48502,6
Scaling Factor (cf §6.1)	λ	λ	λ	λ^3
Scale 1:50	3,7	0,75	0,36	388,0208
Measurement 1:50	3,7	0,75	0,36	383,56
Difference	0,0%	0,0%	0,0%	-1,1%



Basin Test Specification – Maintenance Operation Vessel: WK

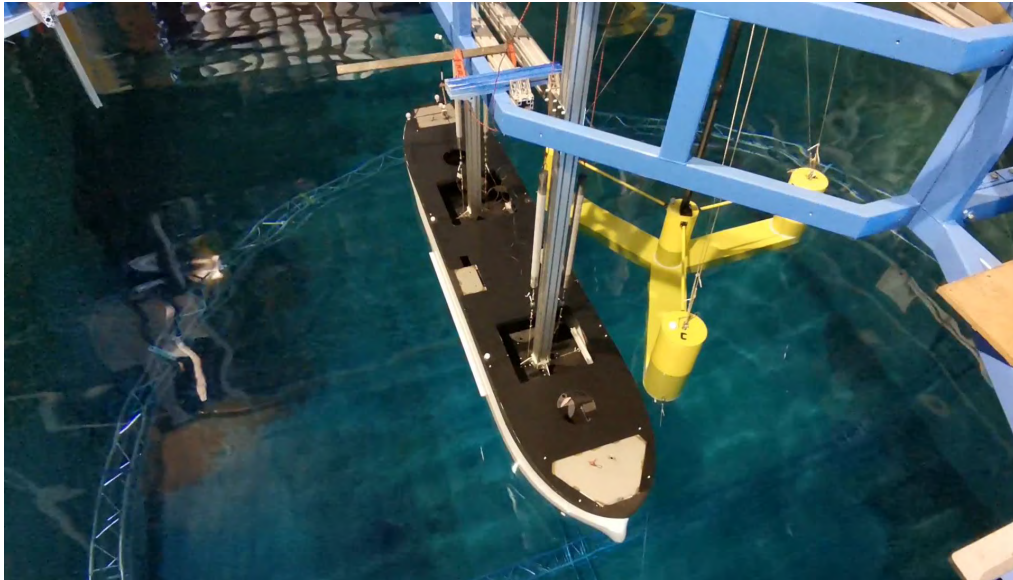
- Specs

Specifications WK

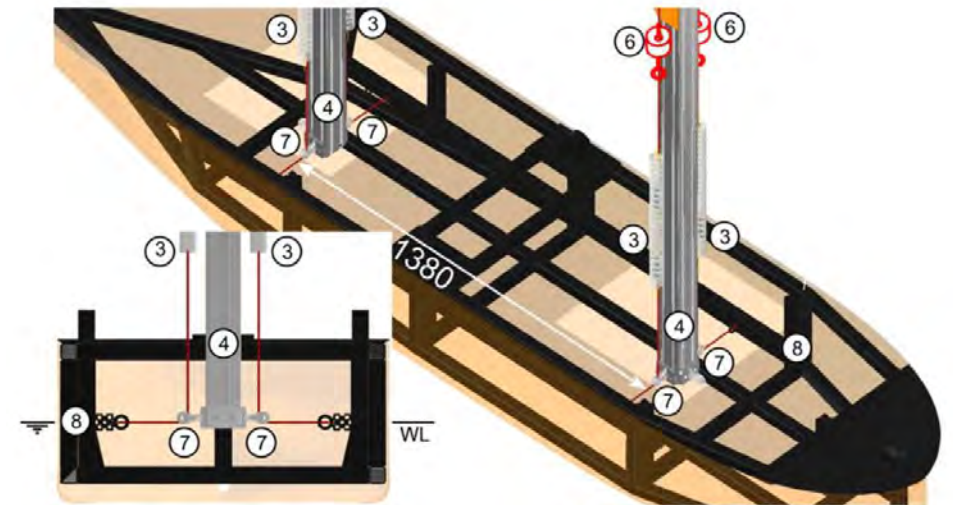
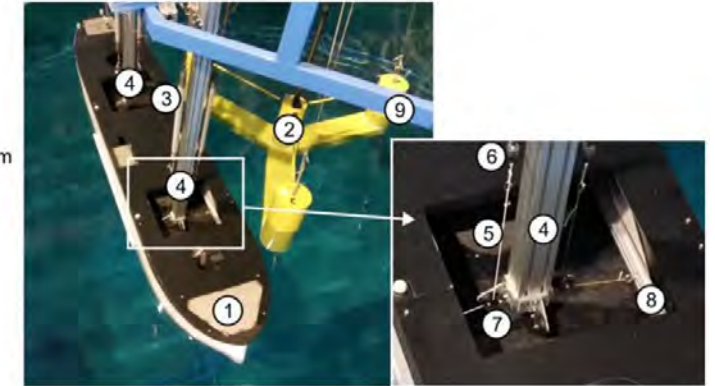
Parameter	Draught (after final weighing) (m)	cog-x (m) (from stern)	cog-y (m)	cog-z (m)	Inertia Roll Ixx (kg.m ²)	Inertia Pitch Iyy (kg.m ²)	Inertia Yaw Izz (kg.m ²)	Inertia Roll Ixx (kg.m ²)
Scale 1:1	9	96,71	0	10,03	6,98E+09	1,0487E+11	8,8849E+10	6,98E+09
Scaling Factor (cf §6.1)	λ	λ	λ	λ	λ^5	λ^5	λ^5	λ^5
Scale 1:50	0,18	2,0068	0	0,2006	22,35	335,60	284,32	22,35
Measurement 1:50	0,18	2,0068	0	0,2065	22,94	343,34	351,927978	22,94
Difference	0,0%	0,0%	0,0%	2,9%	2,6%	2,3%	23,8%	2,6%



- Mooring



- ① WK ship model
- ② VUS model
- ③ Springs x 4
- ④ "H" frame vertical beam
- ⑤ Lines x 4
- ⑥ Load sensors
- ⑦ Pulleys x 4
- ⑧ WK internal frame
- ⑨ Octagon

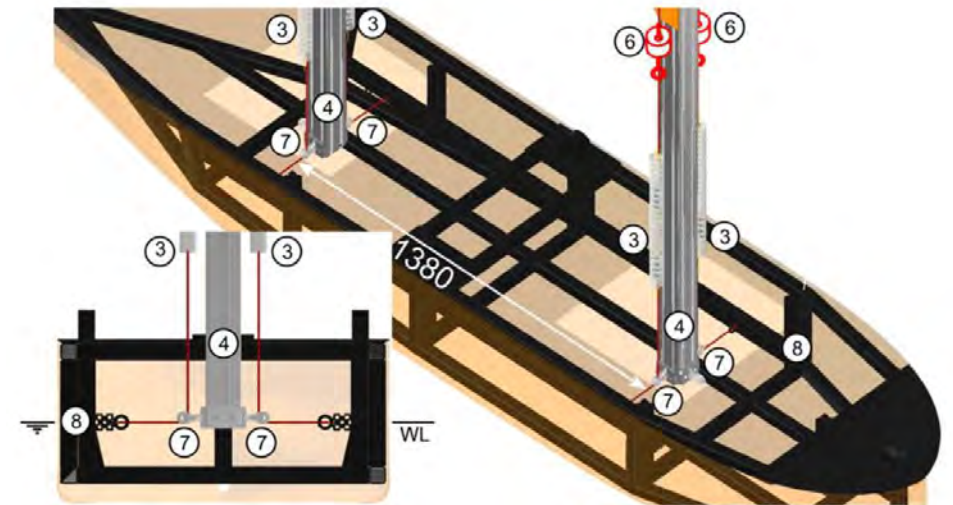
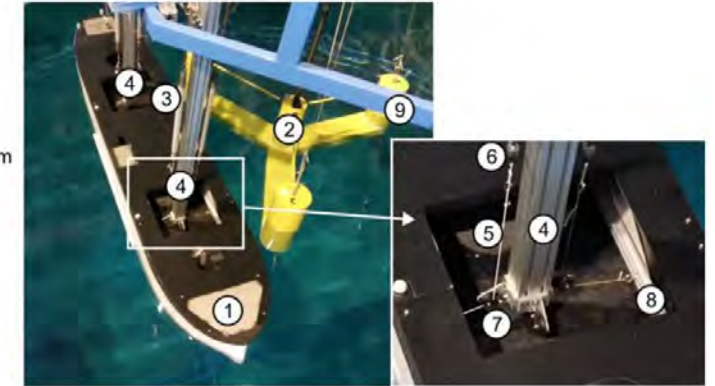


- Mooring

Specifications Windsor

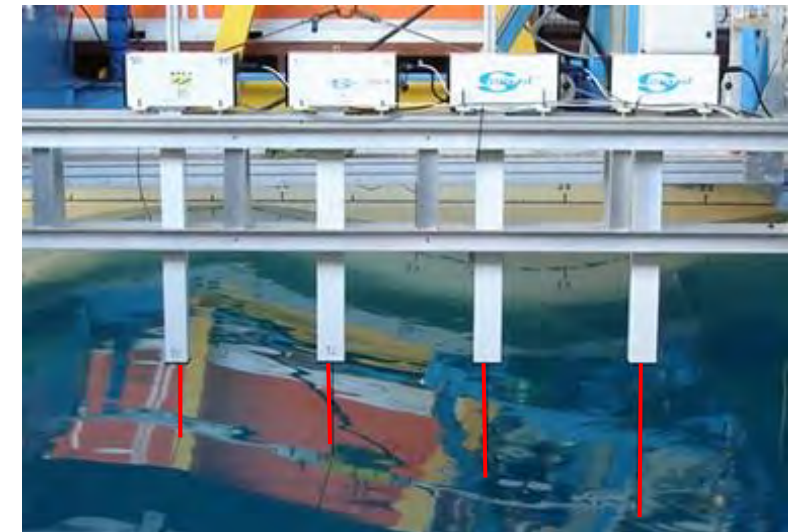
Parameter	DP Surge stiffness (N/m)	DP Sway stiffness (N/m)	DP Yaw stiffness (N.m)
Scale 1:1	5,92E+05	1,01E+06	1,74E+09
Scaling Factor	λ^2	λ^2	λ^4
Scale 1:50	236,80	404,00	278,40
Measurement 1:50	1114	398	220
Difference	370,4%	-1,5%	-21,0%

- ① WK ship model
- ② VUS model
- ③ Springs x 4
- ④ "H" frame vertical beam
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Basin Test Specification – Basin test measurements

1	time	sec	
2	H1	N	WK moorings: Load sensors above springs
3	H2	N	
4	H3	N	
5	H4	N	
6	unused	V	
7	ColonneA	N	VUS moorings: load sensors above springs along the basin
8	ColonneB	N	
9	ColonneC	N	
10	HouleAmont	mm	Wave Elevation: Wave probes @5m and @25m
11	Houle25m	mm	
12	VUS_Body X	mm	VUS 6-dof: Qualisys motion tracking system
13	VUS_Body Y	mm	
14	VUS_Body Z	mm	
15	VUS_Body Roll	deg	
16	VUS_Body Pitch	deg	
17	VUS_Body Yaw	deg	
18	VUS_Body Residual	mm	WK 6-dof: Qualisys motion tracking system
19	WK_body X	mm	
20	WK_body Y	mm	
21	WK_body Z	mm	
22	WK_body Roll	deg	
23	WK_body Pitch	deg	
24	WK_body Yaw	deg	
25	WK_body Residual	mm	



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21	WK_body Z	mm	
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23	WK_body Pitch	deg	
24	WK_body Yaw	deg	
25	WK_body Residual	mm	

