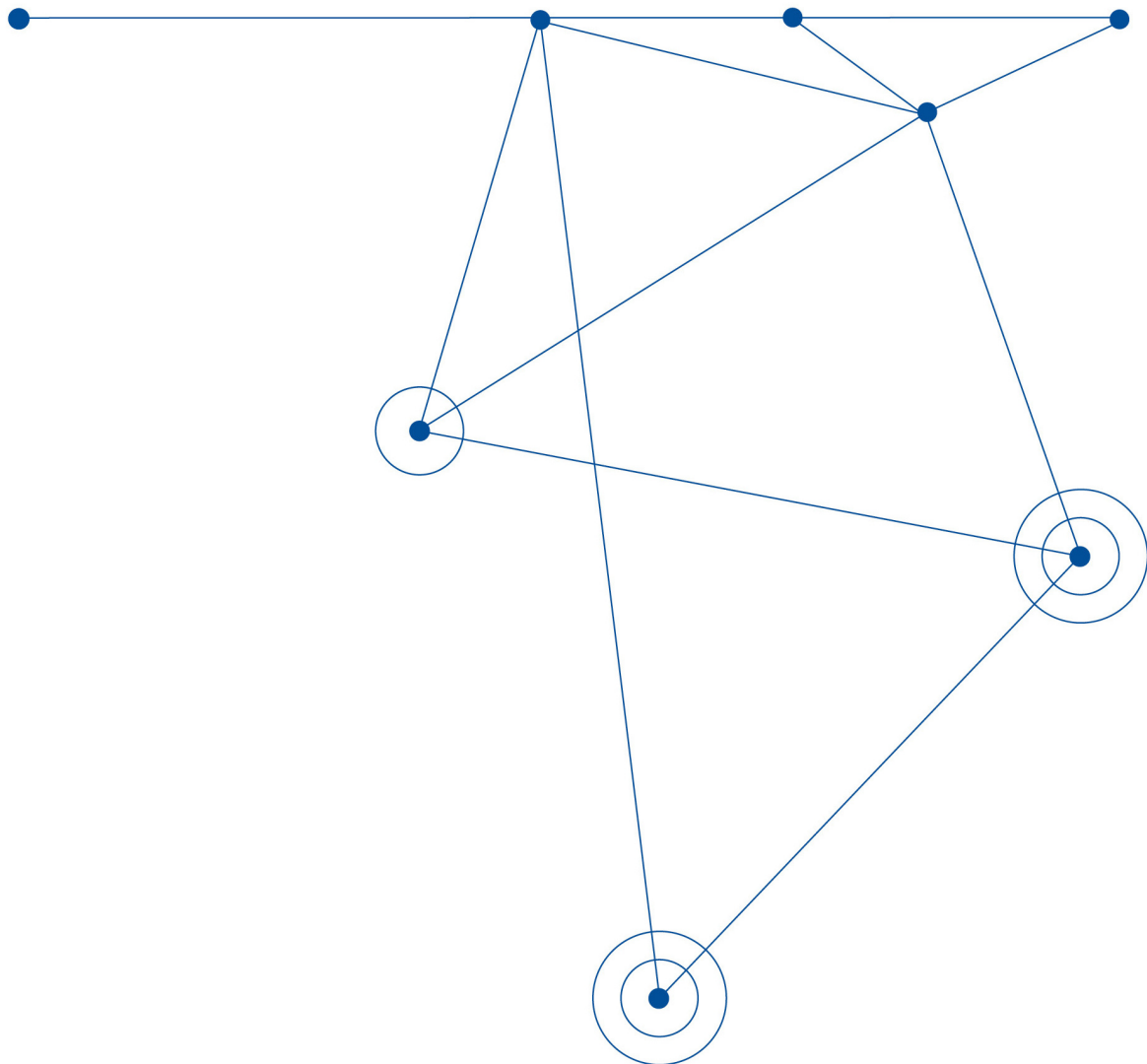


MARINET₂ TIDAL "ROUND ROBIN" DATASET

Comparisons between towing and circulating tanks test results for a tidal energy converter submitted to wave and current interactions

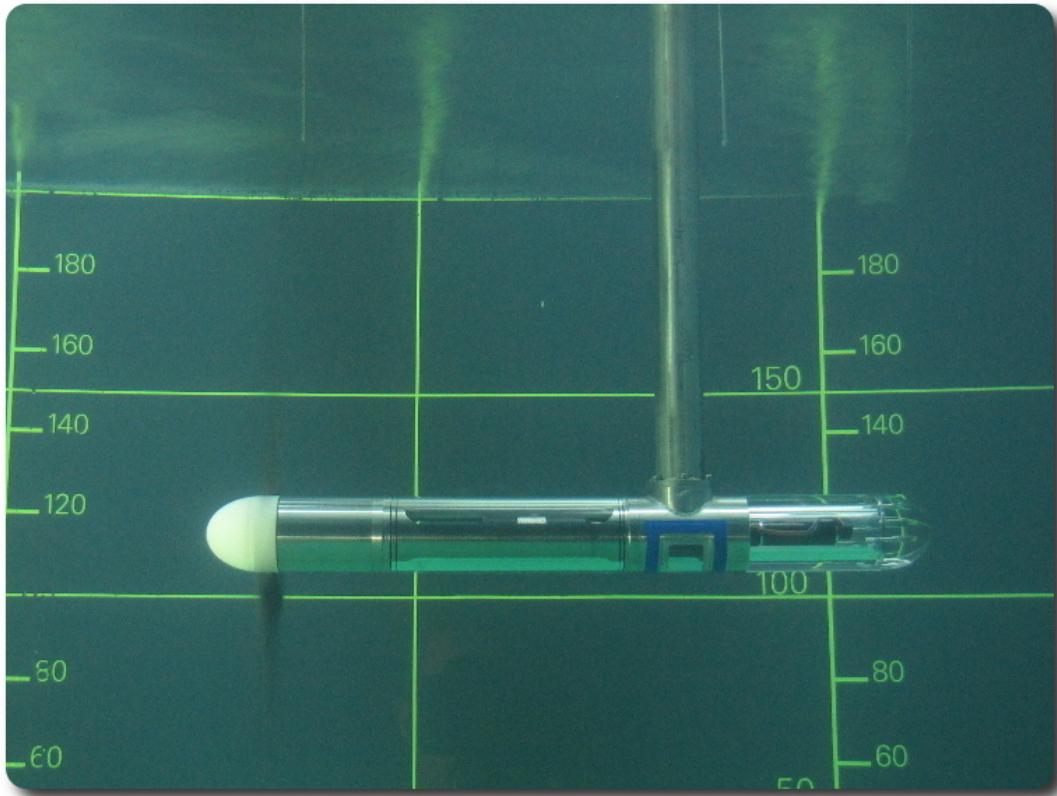




PDG/REM/RDT/LCSM
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MARINET2 TIDAL "ROUND ROBIN" DATASET

Comparisons between towing and circulating tanks test results for a tidal energy converter submitted to wave and current interactions



Fiche documentaire

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Résumé / Abstract : This document presents the dataset of a comparative "Round Robin" testing programme, which has been conducted as part of the MaRINET2 program. The main purpose of this investigation is to evaluate the impact of different experimental facilities on a horizontal axis tidal turbine model when it is exposed to wave and current interactions. The aim of the trials was to test the turbine in three different test facilities to explore the sensitivity of the results to the choice of facility. The facilities comprised one towing tank and two circulating water channels. Performance assessments in terms of torque, drag, blade root forces, wave and inflow speed are recorded for various wave and current conditions.	
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Introduction

This dataset corresponds to the tests undertaken for the comparative Tidal "Round Robin" testing activities carried out under the H2020 MaRINET2 programme. The aim of the tests was to evaluate the impact of a facility on a horizontal axis marine turbine model when it is subjected to waves superimposed on unidirectional current. To facilitate the experiments, the exact same turbine model was used in three different facilities: two circulating tanks and a towing tank. The same instrumentation to monitor the flow was also maintained and it was mainly composed of an Acoustic Doppler Velocimeter and wave gauges.

This dataset has already been partially presented by Gaurier et al. (2019) and is used in the papers of Gaurier et al. (2020) and Martinez et al. (2021).

1 Experimental facilities

The experiments of this Round Robin program were carried out at the circulating flume tank of IFREMER (Gaurier et al. 2018) (figure 1), the tow tank of CNR-INM (Institute of Marine Engineering 2019) (figure 2) and the FLOWAVE circular combined wave and current test tank (Sutherland et al. 2017) (figure 3) of the University of Edinburgh. These facilities were selected on the basis that their dimensions along with the rotor diameter of the turbine, $D = 0.724$ m, translate into low blockage ratio conditions, as seen in table 1. The turbine was kept at a constant depth of 1.0 m and a variety of instruments to measure the flow conditions were mounted in close proximity to the turbine.

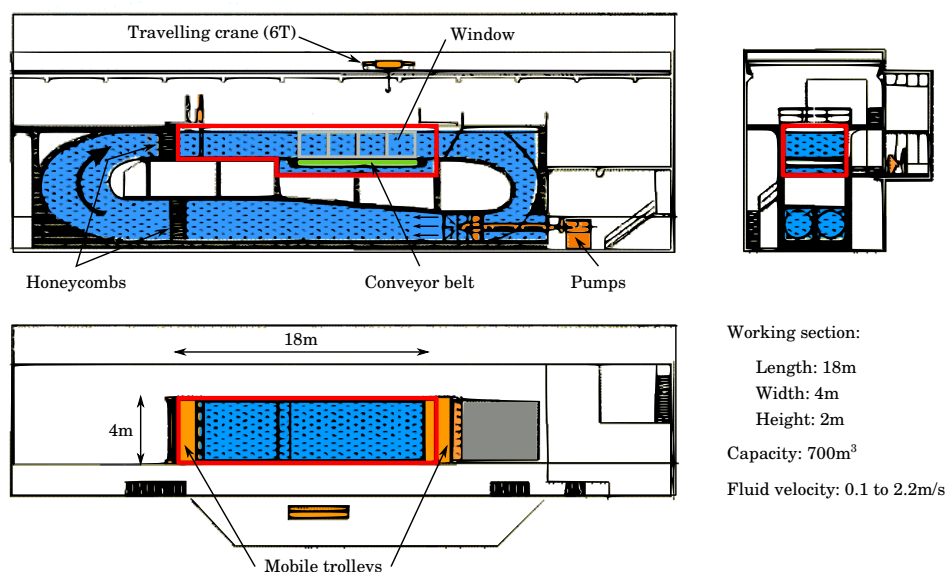


Figure 1 – Side views (top) and top view (bottom) of the flume tank of IFREMER at Boulogne-sur-mer, France

Additional details on the IFREMER and CNR-INM tanks can be found in the first Round Robin Tests (RRT) paper of Gaurier et al. (2015) and in Sutherland et al. (2017) for the FLOWAVE tank. The turbine was fixed on a moving carriage in the towing tank and on a customised mounting frame in both the flume tanks, as shown in figure 4.

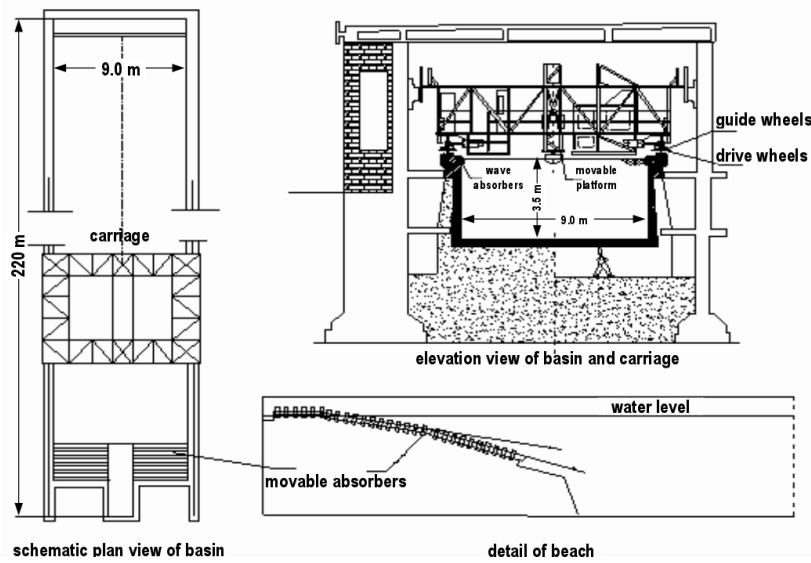


Figure 2 – Schematic of the towing tank of CNR-INM at Rome, Italy

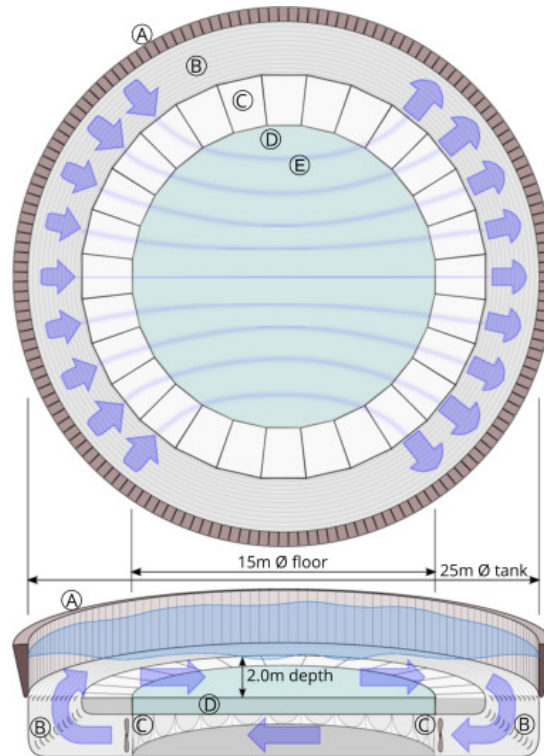


Figure 3 – Schematic of the FLOWAVE circular combined wave and current test tank at Edinburgh, UK

Table 1 – Testing facilities main characteristics. Note that the maximum velocity is limited in the flume tanks when including waves. The diameter of the FLOWAVE tank is 25 m according to schematic 3, but an equivalent usable length of 15 m is usually considered.

Laboratory name	IFREMER	CNR-INM	FLOWAVE
Type of tank	flume	towing	flume
Length [m]	18	220	15
Width × Depth [m]	4 × 2	9 × 3.5	15 × 2
Blockage ratio [%]	5.1	1.3	1.4
Speed range [m/s]	0.1 to 2.2	0.1 to 10	0.1 to 1.6
Turbulence int. [%]	1.5 to 15	NA	5 to 11
Wave freq. [Hz]	0.5 to 2	0.4 to 1.25	0.2 to 1.2
Wave max. amp. [mm]	150	450	450

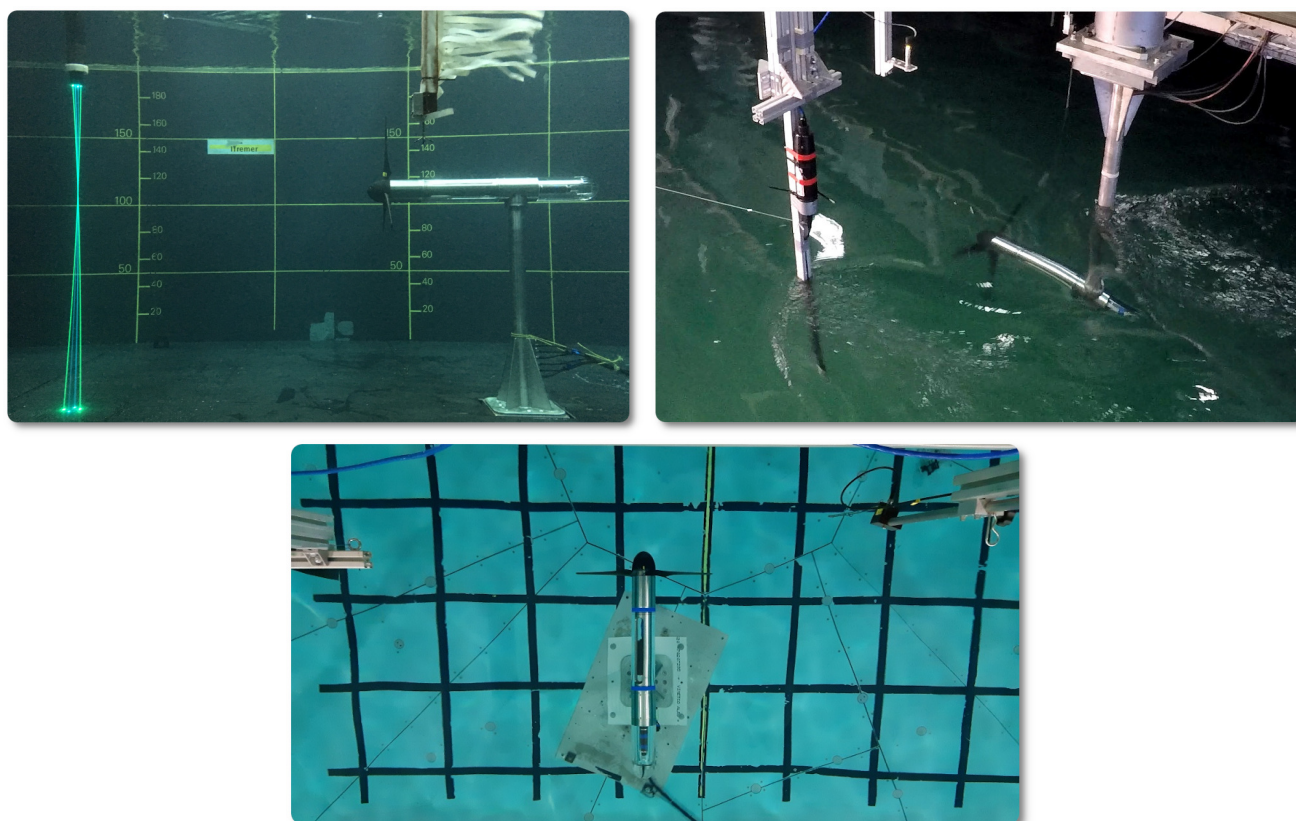


Figure 4 – The 3-bladed instrumented turbine in the wave and current flume tank of IFREMER (top left-hand side), in the towing tank of CNR-INM (top right-hand side) and in the FLOWAVE circular wave and current tank (bottom)

2 Turbine model description

A three bladed horizontal axis turbine developed by IFREMER is used in this RRT campaign. The turbine is 0.724 m in diameter (D) and a motor speed control unit is used to set various turbine rotational speeds. The blades were designed based on a NACA 63-418 profile and a full geometrical description is given in Gaurier et al. (2015).

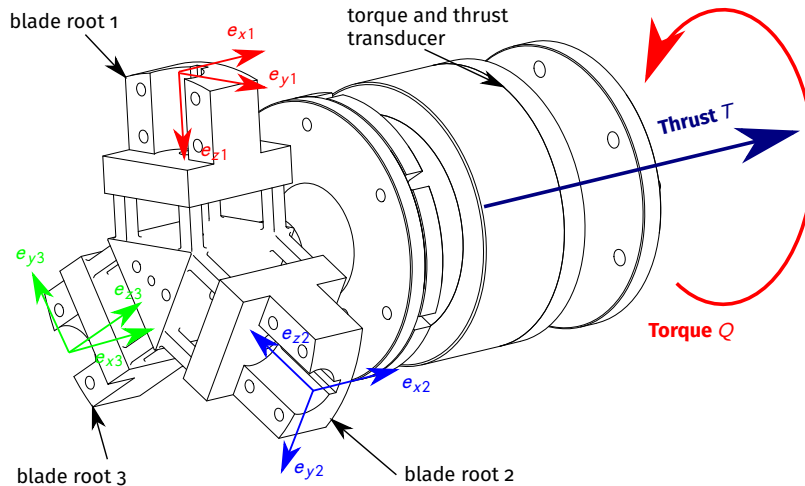


Figure 5 – The blade root load cell with its three coordinate systems and the torque and thrust transducer

The generic turbine model is upgraded compared to the one used in Gaurier et al. (2015), following the design proposed by Payne et al. (2017). This advanced prototype is now equipped with a torque Q and thrust T transducer enabling these two main parameters applied to the rotor to be measured. Each blade root is furthermore equipped with an individual load-cell. These load-cells enable 5 different channels to be measured: 2 forces [F_x ; F_y] and 3 moments [M_x ; M_y ; M_z]. The measured forces correspond to the blade load contribution to torque (e_{xi}) and thrust (e_{yi}), respectively. The in and out of plane bending moments around each of the blades are captured by measuring the edge-wise bending moment (e_{xi}), the flap-wise bending moment (e_{yi}) and the pitching moment (e_{zi}), with $i = 1 - 3$ corresponding to the blade coordinate system (see schematic 5). The initial angle position is set when blade 1 is at the top dead centre.

This waterproof transducer is positioned upstream of the seals of the machine to prevent measuring friction effects. This new transducer is custom made by the French company Sixaxes (SixAxes 2017) in partnership with IFREMER. The measurement range is summarised in table 2. The shielded cables coming from this transducer are routed through a slip-ring enabling the free rotation of the cables and prevent their entanglement. These low voltage signals are amplified by an electronic signal processing unit, located outside of the turbine and on the dry. The motor shaft is connected to the turbine shaft through a motor-gearbox (ratio 1:26) enabling suitable torque and rotation speed ratings.

Table 2 – Transducer measuring ranges

Blade root load-cell		Torque and thrust transducer	
F_{xi}	200 N	Thrust	500 N
F_{yi}	200 N	Torque	50 Nm
M_{xi}	50 Nm		
M_{yi}	100 Nm		
M_{zi}	20 Nm		

All signals are acquired using National Instruments hardware and in-house electronics developed by IFRE-

MER staff. The signals are sampled at a frequency (f_s) of 128 Hz. Flow measurements and water surface elevation are also utilised and synchronised with the turbine instrumentations by means of a short impulse trigger signal.

3 Experimental setup

The first part of the testing campaign including the turbine, comprises tests without wave interactions, thus the flow velocity or carriage velocity is set to 0.8 and 1.0 m/s until a full power curve has been established with at least ten points to construct the performance curves corresponding to the turbine.

The second part of the testing protocol includes four regular waves in-line with the current: wave frequencies between 0.5 and 0.7 Hz and wave amplitudes between 35 and 75 mm and one irregular wave represented with a JONSWAP spectra, as presented in table 3. The selection of these wave parameters (amplitude and frequency) was chosen based on the limitations set by each facility.

Table 3 – Test parameters

case	type	flow speed [m/s]	wave freq. [Hz]	wave height [mm]
1	current	0.8		
2	regular	0.8	0.6	150
3	regular	0.8	0.5	70
4	current	1.0		
5	regular	1.0	0.7	150
6	regular	1.0	0.6	110
7	irregular	0.8	0.6	100
8	regular	0.8	0.7	max.

The flow stream is measured while the turbine is in operation using a Nortek Vectrino Acoustic Doppler Velocimeter (ADV) (Nortek AS 2017). The ADV is placed in line with the turbine hub at a distance of 1.2 m along the cross section of the tank (see figure 6). At IFREMER and FLOWAVE, seeding particles are deposited in the tanks and continuous flow circulation permits a uniform dispersion in the flow stream. For the experiments at CNR-INM, a seeding mast is placed 4.0 m upfront of the ADV, in order to ensure a good measurement quality. It is worth mentioning that the seeding mast is initially installed at a depth of 1.56 m for runs 1 to 45. This is moved up to 0.67 m from run 48 (included) and onwards until the end of the campaign. Further explanation of the test run numbering can be found in section 5. At the IFREMER facility, a bi-dimensional Laser Doppler Velocimeter (LDV) is also used in the experiments and it is located 2D upstream of the position of the turbine. A detailed description of this instrument can be found in Gaurier et al. (2018).

A number of wave probes are placed next to the turbine to measure the wave parameters set for each of the case scenarios. Three resistive wave probes are used at IFREMER and FLOWAVE: probes 1-3 as seen in figure 6. A mix of resistive, ultrasound and dynamic wave probes are used in the CNR-INM tow tank: probes 3-6 as seen in figure 6, where probes 4 and 6 are ultrasound wave gauges and probe 5 is a dynamic wave gauge. One single identical resistive wave probe is used in all facilities (probe 3).

4 Flow and wave characterization

The flow stream is characterized in each of the facility without the turbine and for every generated wave and current flow condition. During these tests, ADV and wave gauges only are used in synchronization. The position of the ADV is adjusted to be exactly that of the turbine when operated, i.e. at $x = 0$. Depending on the facility, 3 or 5 ADV measurement points among the 7 displayed on figure 7 are acquired over the turbine swept area in order to quantify a potential vertical or lateral velocity gradient: points P_0 , P_1 , P_2 , P_5 and P_6 are acquired at IFREMER, points P_0 , P_1 and P_2 are acquired at CNR-INM and points P_0 , P_1 , P_2 , P_3 and P_4 are acquired at FLOWAVE. These records are used to characterize the incoming (far upstream) velocity U_∞ .

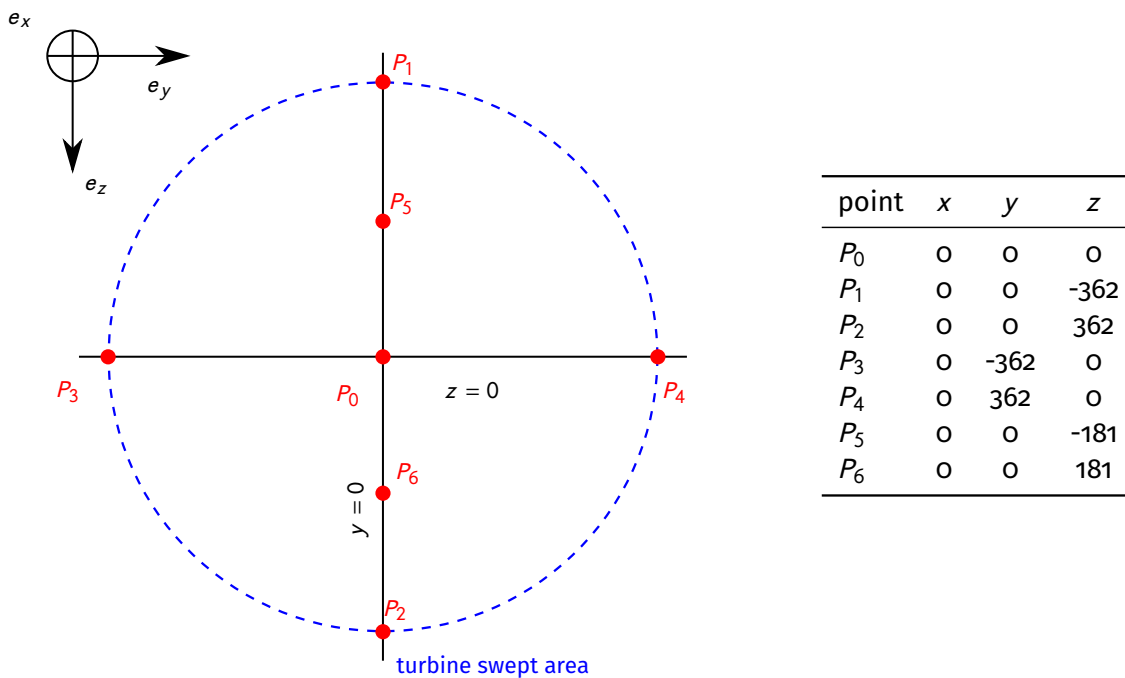


Figure 7 – Front view of the ADV measurement points depicted by red circles inside the turbine swept area and their coordinates expressed in mm

5 File description

For the three facilities, the provided files are organised in two different folders named `wave_current_characterization` and `tests`. The first folder includes the data related to the flow characterisation and the second folder includes the data recorded during the trials with the turbine.

The basename of all the data files is `run`. A number is systematically added to this basename, making every run unique. This run number is the same and corresponds to the various synchronized acquisitions of the ADV, LDV, turbine parameters and wave gauges.

Tables ?? to ?? sum up the name of all the data files and their corresponding flow conditions: velocity settings, wavemaker amplitudes and frequencies and turbine rotation speed.

5.1 ADV files

The content of the ADV files is composed of 20 columns. The second column represents the time and columns 5 to 8 correspond to the velocities u , v , w_1 and w_2 respectively. The time is in s and the velocities are in m/s. The vertical component of the velocity is given twice (w_1 and w_2) due to the 4 headed configuration of the ADV. It is expected that both readings are of a similar magnitude. However, it has been observed that the ADV presents unusual responses recurrently due to phase wrapping issues. Nortek gives additional informations for processing these files in the paper of Rusello (2009).

5.2 LDV files

Similarly the LDV file is composed of 7 columns. A brief description of each one can be found below:

- the first column corresponds to the row number
- columns 2 - 4 are related to the Arrival Time (AT) in ms, the Transit Time (TT) in μ s and the value of the particle velocity in m/s for the first component of the velocity: u
- columns 5 - 7 are related to the Arrival Time (AT) in ms, the Transit Time (TT) in μ s and the value of the particle velocity in m/s for the second component of the velocity: v

The Arrival Time is the time at which the particle has been seen by the laser. The Transit Time is the time during which the particle remains in the working volume.

As the laser is in non-coincident mode, the number of particles perceived by each component is different. A particular attention has to be made for the second component of the velocity which has usually a lower number of values. Its corresponding columns are then filled-in with zeros in order to have the same length than the other component.

5.3 Turbine files

The content of the turbine data files is constituted of several columns including:

- the wave probes measurements, expressed in mm
- the turbine rotation speed expressed in RPM
- the turbine thrust expressed in N
- the turbine torque expressed in Nm
- the turbine blade root load-cells with the 15 components expressed in N or Nm

5.4 Additional CNR-INM files

The acquisition files related to the wave probe records obtained at CNR-INM include four or five columns and are summarised below:

- the first column is related to the acquisition time in s
- the surface elevation measured by the wave probes 4 and 6 (U.S.) expressed in mm
- the surface elevation measured by the wave probe 5 (Kenek) expressed in mm. Because this probe has a smaller measurement range, it was not used for all the cases. This column is not inside every file.

- the last column includes the carriage velocity expressed in m/s provided by CNR-INM

Please note that a top load-cell has been used in this facility as well. This 6-components load-cell was fixed at the very top of the tower, i.e. outside of the water.

5.5 Run names and numbers for the flow characterization

Tables presented below show the run names and numbers and their corresponding flow characteristics, for every facility.

carriage		wavemaker		acquisition		ADV position			observations
vel. [m/s]		amp. [m]	freq. [Hz]	name [-]	zero [-]	x [mm]	y [mm]	z [mm]	
0.0		0.000	0.00	z10	Zero off	0	0	0	-
0.8		0.074	0.48	r68	Zero off	0	0	362	Cases 1 & 2 – ADV problem
1.0		0.075	0.52	r69	Zero off	0	0	362	Cases 4 & 5 – ADV problem
0.0		0.000	0.00	z11	Zero off	0	0	0	-
0.8		0.074	0.48	r70	Zero off	0	0	0	Cases 1 & 2 – ADV problem
1.0		0.075	0.52	r72	Zero off	0	0	0	cases 4 & 5
0.0		0.000	0.00	z12	Zero off	0	0	0	-
0.8		0.074	0.48	r74	Zero off	0	0	-362	cases 1 & 2
1.0		0.075	0.52	r75	Zero off	0	0	-362	cases 4 & 5

Figure 8 – Run names and numbers for the flow characterization at the CNR-INM facility (with no turbine). See section 4 for the ADV measurement positions.

tank settings		wavemaker		acquisition		ADV position			observations
vel. [m/s]	turb. [%]	amp. [m]	freq. [Hz]	name [-]	zero [-]	x [mm]	y [mm]	z [mm]	
0.0	1.5	0.000	0.0	zero020	Zero off	0.0	0.0	0.0	without wavemaker
0.8	1.5	0.000	0.0	run206	Zero on with zero020	0.0	0.0	-362.0	Case 1
0.8	1.5	0.000	0.0	run207	Zero on with zero020	0.0	0.0	-181.0	Tacq=128s
0.8	1.5	0.000	0.0	run208	Zero on with zero020	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.000	0.0	run209	Zero on with zero020	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.000	0.0	run210	Zero on with zero020	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero021	Zero off	0.0	0.0	0.0	without wavemaker
1.0	1.5	0.000	0.0	run211	Zero on with zero021	0.0	0.0	-362.0	Case 4
1.0	1.5	0.000	0.0	run212	Zero on with zero021	0.0	0.0	-181.0	Tacq=128s
1.0	1.5	0.000	0.0	run213	Zero on with zero021	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.000	0.0	run214	Zero on with zero021	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.000	0.0	run215	Zero on with zero021	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero022	Zero off	0.0	0.0	0.0	with parked wavemaker
0.8	1.5	0.000	0.0	run216	Zero on with zero022	0.0	0.0	-362.0	Case 1 WM
0.8	1.5	0.000	0.0	run217	Zero on with zero022	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.000	0.0	run218	Zero on with zero022	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.000	0.0	run219	Zero on with zero022	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.000	0.0	run220	Zero on with zero022	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero023	Zero off	0.0	0.0	0.0	with parked wavemaker
1.0	1.5	0.000	0.0	run221	Zero on with zero023	0.0	0.0	-362.0	Case 4 WM
1.0	1.5	0.000	0.0	run222	Zero on with zero023	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.000	0.0	run223	Zero on with zero023	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.000	0.0	run224	Zero on with zero023	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.000	0.0	run225	Zero on with zero023	0.0	0.0	362.0	

Figure 9 – Run names and numbers 206 to 225 for the flow characterization at the IFREMER facility (with no turbine). See section 4 for the ADV measurement positions.

tank settings		wavemaker		acquisition		ADV position			observations
vel. [m/s]	turb. [%]	amp. [m]	freq. [Hz]	name [-]	zero [-]	x [mm]	y [mm]	z [mm]	
0.0	1.5	0.000	0.0	zero024	Zero off	0.0	0.0	0.0	with wavemaker
0.8	1.5	0.155	0.6	run226	Zero on with zero024	0.0	0.0	-362.0	Case 2
0.8	1.5	0.155	0.6	run227	Zero on with zero024	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.155	0.6	run228	Zero on with zero024	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.155	0.6	run229	Zero on with zero024	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.155	0.6	run230	Zero on with zero024	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero025	Zero off	0.0	0.0	0.0	with wavemaker
0.8	1.5	0.095	0.5	run231	Zero on with zero025	0.0	0.0	-362.0	Case 3
0.8	1.5	0.095	0.5	run232	Zero on with zero025	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.095	0.5	run233	Zero on with zero025	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.095	0.5	run234	Zero on with zero025	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.095	0.5	run235	Zero on with zero025	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero026	Zero off	0.0	0.0	0.0	with wavemaker
1.0	1.5	0.145	0.7	run236	Zero on with zero026	0.0	0.0	-362.0	Case 5
1.0	1.5	0.145	0.7	run237	Zero on with zero026	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.145	0.7	run238	Zero on with zero026	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.145	0.7	run239	Zero on with zero026	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.145	0.7	run240	Zero on with zero026	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero027	Zero off	0.0	0.0	0.0	with wavemaker
1.0	1.5	0.145	0.6	run241	Zero on with zero027	0.0	0.0	-362.0	Case 6
1.0	1.5	0.145	0.6	run242	Zero on with zero027	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.145	0.6	run243	Zero on with zero027	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.145	0.6	run244	Zero on with zero027	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.145	0.6	run245	Zero on with zero027	0.0	0.0	362.0	

Figure 10 – Run names and numbers 226 to 245 for the flow characterization at the IFREMER facility (with no turbine). See section 4 for the ADV measurement positions.

tank settings		wavemaker		acquisition		ADV position			observations
vel. [m/s]	turb. [%]	amp. [m]	freq. [Hz]	name [-]	zero [-]	x [mm]	y [mm]	z [mm]	
0.0	1.5	0.000	0.0	zero028	Zero off	0.0	0.0	0.0	with wavemaker
0.8	1.5	jonswap		run246	Zero on with zero028	0.0	0.0	-362.0	Case 7
0.8	1.5	jonswap		run247	Zero on with zero028	0.0	0.0	-181.0	Tacq=512s
0.8	1.5	jonswap		run248	Zero on with zero028	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	jonswap		run249	Zero on with zero028	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	jonswap		run250	Zero on with zero028	0.0	0.0	362.0	
0.0	1.5	0.000	0.0	zero029	Zero off	0.0	0.0	0.0	with parked wavemaker
0.8	1.5	0.000	0.0	run251	Zero on with zero029	0.0	0.0	-362.0	Case 1 WM
0.8	1.5	0.000	0.0	run252	Zero on with zero029	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.000	0.0	run253	Zero on with zero029	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.000	0.0	run254	Zero on with zero029	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.000	0.0	run255	Zero on with zero029	0.0	0.0	362.0	repeat
0.8	1.5	0.155	0.6	run256	Zero on with zero029	0.0	0.0	-362.0	Case 2
0.8	1.5	0.155	0.6	run257	Zero on with zero029	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.155	0.6	run258	Zero on with zero029	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.155	0.6	run259	Zero on with zero029	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.155	0.6	run260	Zero on with zero029	0.0	0.0	362.0	repeat
0.8	1.5	0.095	0.5	run261	Zero on with zero029	0.0	0.0	-362.0	Case 3
0.8	1.5	0.095	0.5	run262	Zero on with zero029	0.0	0.0	-181.0	Tacq=256s
0.8	1.5	0.095	0.5	run263	Zero on with zero029	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	0.095	0.5	run264	Zero on with zero029	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	0.095	0.5	run265	Zero on with zero029	0.0	0.0	362.0	repeat

Figure 11 – Run names and numbers 246 to 265 (repeat measurements) for the flow characterization at the IFREMER facility (with no turbine). See section 4 for the ADV measurement positions.

tank settings		wavemaker		acquisition		ADV position			observations
vel. [m/s]	turb. [%]	amp. [m]	freq. [Hz]	name [-]	zero [-]	x [mm]	y [mm]	z [mm]	
0.0	1.5	0.000	0.0	zero030	Zero off	0.0	0.0	0.0	with parked wavemaker
1.0	1.5	0.000	0.0	run266	Zero on with zero030	0.0	0.0	-362.0	Case 4 WM
1.0	1.5	0.000	0.0	run267	Zero on with zero030	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.000	0.0	run268	Zero on with zero030	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.000	0.0	run269	Zero on with zero030	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.000	0.0	run270	Zero on with zero030	0.0	0.0	362.0	repeat
1.0	1.5	0.145	0.7	run271	Zero on with zero030	0.0	0.0	-362.0	Case 5
1.0	1.5	0.145	0.7	run272	Zero on with zero030	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.145	0.7	run273	Zero on with zero030	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.145	0.7	run274	Zero on with zero030	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.145	0.7	run275	Zero on with zero030	0.0	0.0	362.0	repeat
0.0	1.5	0.000	0.0	zero031	Zero off	0.0	0.0	0.0	with wavemaker
1.0	1.5	0.145	0.6	run276	Zero on with zero030	0.0	0.0	-362.0	Case 6
1.0	1.5	0.145	0.6	run277	Zero on with zero030	0.0	0.0	-181.0	Tacq=256s
1.0	1.5	0.145	0.6	run278	Zero on with zero030	0.0	0.0	0.0	Facq=128Hz
1.0	1.5	0.145	0.6	run279	Zero on with zero030	0.0	0.0	181.0	Fadv=64Hz
1.0	1.5	0.145	0.6	run280	Zero on with zero030	0.0	0.0	362.0	repeat
0.8	1.5	jonswap		run281	Zero on with zero030	0.0	0.0	-362.0	Case 7
0.8	1.5	jonswap		run282	Zero on with zero030	0.0	0.0	-181.0	Tacq=512s
0.8	1.5	jonswap		run283	Zero on with zero030	0.0	0.0	0.0	Facq=128Hz
0.8	1.5	jonswap		run284	Zero on with zero030	0.0	0.0	181.0	Fadv=64Hz
0.8	1.5	jonswap		run285	Zero on with zero030	0.0	0.0	362.0	repeat

Figure 12 – Run names and numbers 266 to 285 (repeat measurements) for the flow characterization at the IFREMER facility (with no turbine). See section 4 for the ADV measurement positions.

The flow characterization has been simultaneously done with 2 ADV systems at FLOWAVE. Please read the ReadMe.txt file on the corresponding folder for details on the run names and numbers.

5.6 Run names and numbers for the turbine performance measurements

Tables presented below show the run names and numbers and their corresponding flow characteristics and turbine rotation speeds, for every facility.

carriage vel. [m/s]	rotation		wavemaker		acquisition		observations
	TSR [-]	RPM [tr/min]	Amp. [m]	Freq. [Hz]	name [-]	zero [-]	
0.0	0.0	0	0.000	0.000	zero001	Zero off	
0.8	0.0	0	0.000	0.000	run001	Zero on with zero001	Case 1
0.8	1.0	549	0.000	0.000	run002	Zero on with zero001	
0.8	2.0	1097	0.000	0.000	run003	Zero on with zero001	
0.8	2.5	1372	0.000	0.000	run004	Zero on with zero001	
0.8	3.0	1646	0.000	0.000	run005	Zero on with zero001	
0.8	3.5	1920	0.000	0.000	run006	Zero on with zero001	
0.8	4.0	2195	0.000	0.000	run007	Zero on with zero001	
0.8	4.5	2469	0.000	0.000	run008	Zero on with zero001	
0.8	5.0	2743	0.000	0.000	run009	Zero on with zero001	
0.8	6.0	3292	0.000	0.000	run010	Zero on with zero001	
0.8	7.0	3841	0.000	0.000	run011	Zero on with zero001	
0.0	0.0	0	0.000	0.000	zero002	Zero off	
1.0	0.0	0	0.000	0.000	run012	Zero on with zero002	Case 4
1.0	1.0	686	0.000	0.000	run013	Zero on with zero002	
1.0	2.0	1372	0.000	0.000	run014	Zero on with zero002	
1.0	2.5	1715	0.000	0.000	run015	Zero on with zero002	
1.0	3.0	2058	0.000	0.000	run016	Zero on with zero002	
1.0	3.5	2401	0.000	0.000	run017	Zero on with zero002	
1.0	4.0	2743	0.000	0.000	run018	Zero on with zero002	
1.0	4.5	3086	0.000	0.000	run019	Zero on with zero002	
1.0	5.0	3429	0.000	0.000	run020	Zero on with zero002	
1.0	6.0	4115	0.000	0.000	run021	Zero on with zero002	
1.0	7.0	4801	0.000	0.000	run022	Zero on with zero002	
1.0	4.0	2743	0.000	0.000	run067	Zero on with zero009	
0.0	0.0	0	0.000	0.000	zero003	Zero off	
0.8	3.5	1920	0.034	0.412	run024	Zero on with zero003	Case 3
0.8	4.0	2195	0.034	0.412	run025	Zero on with zero003	
0.8	4.5	2469	0.034	0.412	run026	Zero on with zero003	
0.8	5.0	2743	0.034	0.412	run027	Zero on with zero003	
0.0	0.0	0	0.000	0.000	zero004	Zero off	
0.8	3.5	1920	0.074	0.480	run029	Zero on with zero004	Case 2
0.8	4.5	2469	0.074	0.480	run031	Zero on with zero004	
0.8	5.0	2743	0.074	0.480	run032	Zero on with zero004	
0.0	0.0	0	0.000	0.000	zero005	Zero off	
1.0	3.5	2401	0.056	0.462	run034	Zero on with zero005	Case 6
1.0	4.0	2743	0.056	0.462	run035	Zero on with zero005	
1.0	4.5	3086	0.056	0.462	run066	Zero on with zero009	
1.0	5.0	3429	0.056	0.462	run038	Zero on with zero005	
1.0	3.0	2058	0.056	0.462	run039	Zero on with zero005	

Figure 13 – Run names and numbers 1 to 39 for the turbine performance measurements carried out at the CNR-INM facility.

carriage vel. [m/s]	rotation		wavemaker		acquisition		observations
	TSR [-]	RPM [tr/min]	Amp. [m]	Freq. [Hz]	name [-]	zero [-]	
0.0	0.0	0	0.000	0.000	zero006	Zero off	
1.0	3.0	2058	0.075	0.524	run040	Zero on with zero006	Case 5
1.0	3.5	2401	0.075	0.524	run041	Zero on with zero006	
1.0	4.0	2743	0.075	0.524	run042	Zero on with zero006	
0.0	0.0	0	0.000	0.000	zero007	Zero off	
1.0	4.5	3086	0.075	0.524	run043	Zero on with zero007	
1.0	5.0	3429	0.075	0.524	run044	Zero on with zero007	
0.8	4.0	2195	jonswap		run063	Zero on with zero009	Case 7
0.8	4.0	2195	jonswap		run064	Zero on with zero009	
0.8	4.0	2195	jonswap		run065	Zero on with zero009	
0.8	4.0	2195	0.150	0.412	run052	Zero on with zero007	ADV problem
0.8	4.5	2469	0.150	0.412	run053	Zero on with zero007	Case 8
REPEAT							
0.8	3.0	1646	0.034	0.412	run048	Zero on with zero007	seeding mast up !
0.8	4.0	2195	0.034	0.412	run049	Zero on with zero007	Case 3
0.8	3.0	1646	0.074	0.480	run050	Zero on with zero007	Case 2
0.8	4.0	2195	0.074	0.480	run051	Zero on with zero007	
0.0	0.0	0	0.000	0.000	zero009	Zero off	
1.0	3.0	2058	0.075	0.524	run058	Zero on with zero009	Case 5
1.0	4.0	2743	0.075	0.524	run059	Zero on with zero009	
1.0	3.0	2058	0.056	0.462	run060	Zero on with zero009	Case 6
1.0	4.0	2743	0.056	0.462	run061	Zero on with zero009	Missing ADV file!

Figure 14 – Run names and numbers 40 to 61 for the turbine performance measurements carried out at the CNR-INM facility.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero001	Zero off	without wavemaker
0.8	1.5	0.0	0	0.000	0.0	run001	Zero on with zero001	Case 1
0.8	1.5	1.0	549	0.000	0.0	run002	Zero on with zero001	Tacq=128s
0.8	1.5	2.0	1097	0.000	0.0	run003	Zero on with zero001	Facq=128Hz
0.8	1.5	2.5	1372	0.000	0.0	run004	Zero on with zero001	
0.8	1.5	3.0	1646	0.000	0.0	run005	Zero on with zero001	Fadv=64Hz
0.8	1.5	3.5	1920	0.000	0.0	run006	Zero on with zero001	
0.8	1.5	4.0	2195	0.000	0.0	run007	Zero on with zero001	
0.8	1.5	4.5	2469	0.000	0.0	run008	Zero on with zero001	
0.8	1.5	5.0	2743	0.000	0.0	run009	Zero on with zero001	
0.8	1.5	6.0	3292	0.000	0.0	run010	Zero on with zero001	
0.8	1.5	7.0	3841	0.000	0.0	run011	Zero on with zero001	
0.0	1.5	0.0	0	0.000	0.0	zero002	Zero off	without wavemaker
1.0	1.5	0.0	0	0.000	0.0	run012	Zero on with zero002	Case 4
1.0	1.5	1.0	686	0.000	0.0	run013	Zero on with zero002	Tacq=128s
1.0	1.5	2.0	1372	0.000	0.0	run014	Zero on with zero002	Facq=128Hz
1.0	1.5	2.5	1715	0.000	0.0	run015	Zero on with zero002	
1.0	1.5	3.0	2058	0.000	0.0	run016	Zero on with zero002	Fadv=64Hz
1.0	1.5	3.5	2401	0.000	0.0	run017	Zero on with zero002	
1.0	1.5	4.0	2743	0.000	0.0	run018	Zero on with zero002	
1.0	1.5	4.5	3086	0.000	0.0	run019	Zero on with zero002	
1.0	1.5	5.0	3429	0.000	0.0	run020	Zero on with zero002	
1.0	1.5	6.0	4115	0.000	0.0	run021	Zero on with zero002	
1.0	1.5	7.0	4801	0.000	0.0	run022	Zero on with zero002	
0.0	1.5	0.0	0	0.000	0.0	zero004	Zero off	with parked wavemaker
0.8	1.5	0.0	0	0.000	0.0	run030	Zero on with zero004	Case 1 WM
0.8	1.5	1.0	549	0.000	0.0	run031	Zero on with zero004	Tacq=256s
0.8	1.5	2.0	1097	0.000	0.0	run032	Zero on with zero004	Facq=128Hz
0.8	1.5	2.5	1372	0.000	0.0	run033	Zero on with zero004	
0.8	1.5	3.0	1646	0.000	0.0	run034	Zero on with zero004	Fadv=64Hz
0.8	1.5	3.5	1920	0.000	0.0	run035	Zero on with zero004	
0.8	1.5	4.0	2195	0.000	0.0	run036	Zero on with zero004	
0.8	1.5	4.5	2469	0.000	0.0	run037	Zero on with zero004	
0.8	1.5	5.0	2743	0.000	0.0	run038	Zero on with zero004	
0.8	1.5	6.0	3292	0.000	0.0	run039	Zero on with zero004	
0.8	1.5	7.0	3841	0.000	0.0	run040	Zero on with zero004	

Figure 15 – Run names and numbers 1 to 40 for the turbine performance measurements carried out at the IFREMER facility.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero005	Zero off	with parked wavemaker
1.0	1.5	0.0	0	0.000	0.0	run041	Zero on with zero005	Case 4 WM
1.0	1.5	1.0	686	0.000	0.0	run042	Zero on with zero005	Tacq=256s
1.0	1.5	2.0	1372	0.000	0.0	run043	Zero on with zero005	Facq=128Hz
1.0	1.5	2.5	1715	0.000	0.0	run044	Zero on with zero005	
1.0	1.5	3.0	2058	0.000	0.0	run045	Zero on with zero005	Fadv=64Hz
1.0	1.5	3.5	2401	0.000	0.0	run046	Zero on with zero005	
1.0	1.5	4.0	2743	0.000	0.0	run047	Zero on with zero005	
1.0	1.5	4.5	3086	0.000	0.0	run048	Zero on with zero005	
1.0	1.5	5.0	3429	0.000	0.0	run049	Zero on with zero005	
1.0	1.5	6.0	4115	0.000	0.0	run050	Zero on with zero005	
1.0	1.5	7.0	4801	0.000	0.0	run051	Zero on with zero005	
0.0	1.5	0.0	0	0.000	0.0	zero006	Zero off	with wavemaker
0.8	1.5	0.0	0	0.155	0.6	run052	Zero on with zero006	Case 2
0.8	1.5	1.0	549	0.155	0.6	run053	Zero on with zero006	Tacq=256s
0.8	1.5	2.0	1097	0.155	0.6	run054	Zero on with zero006	Facq=128Hz
0.8	1.5	2.5	1372	0.155	0.6	run055	Zero on with zero006	
0.8	1.5	3.0	1646	0.155	0.6	run056	Zero on with zero006	Fadv=64Hz
0.8	1.5	3.5	1920	0.155	0.6	run057	Zero on with zero006	
0.8	1.5	4.0	2195	0.155	0.6	run058	Zero on with zero006	
0.8	1.5	4.5	2469	0.155	0.6	run059	Zero on with zero006	
0.8	1.5	5.0	2743	0.155	0.6	run060	Zero on with zero006	
0.8	1.5	6.0	3292	0.155	0.6	run061	Zero on with zero006	
0.8	1.5	7.0	3841	0.155	0.6	run062	Zero on with zero006	
0.0	1.5	0.0	0	0.000	0.0	zero007	Zero off	with wavemaker
0.8	1.5	0.0	0	0.095	0.5	run063	Zero on with zero007	Case 3
0.8	1.5	1.0	549	0.095	0.5	run064	Zero on with zero007	Tacq=256s
0.8	1.5	2.0	1097	0.095	0.5	run065	Zero on with zero007	Facq=128Hz
0.8	1.5	2.5	1372	0.095	0.5	run066	Zero on with zero007	
0.8	1.5	3.0	1646	0.095	0.5	run067	Zero on with zero007	Fadv=64Hz
0.8	1.5	3.5	1920	0.095	0.5	run068	Zero on with zero007	
0.8	1.5	4.0	2195	0.095	0.5	run069	Zero on with zero007	
0.8	1.5	4.5	2469	0.095	0.5	run070	Zero on with zero007	
0.8	1.5	5.0	2743	0.095	0.5	run071	Zero on with zero007	
0.8	1.5	6.0	3292	0.095	0.5	run072	Zero on with zero007	
0.8	1.5	7.0	3841	0.095	0.5	run073	Zero on with zero007	

Figure 16 – Run names and numbers 41 to 73 for the turbine performance measurements carried out at the IFREMER facility.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero008	Zero off	with wavemaker
1.0	1.5	0.0	0	0.145	0.7	run074	Zero on with zero008	Case 5
1.0	1.5	1.0	686	0.145	0.7	run075	Zero on with zero008	Tacq=256s
1.0	1.5	2.0	1372	0.145	0.7	run076	Zero on with zero008	Facq=128Hz
1.0	1.5	2.5	1715	0.145	0.7	run077	Zero on with zero008	
1.0	1.5	3.0	2058	0.145	0.7	run078	Zero on with zero008	Fadv=64Hz
1.0	1.5	3.5	2401	0.145	0.7	run079	Zero on with zero008	
1.0	1.5	4.0	2743	0.145	0.7	run080	Zero on with zero008	
1.0	1.5	4.5	3086	0.145	0.7	run081	Zero on with zero008	
1.0	1.5	5.0	3429	0.145	0.7	run082	Zero on with zero008	
1.0	1.5	6.0	4115	0.145	0.7	run083	Zero on with zero008	
1.0	1.5	7.0	4801	0.145	0.7	run084	Zero on with zero008	
0.0	1.5	0.0	0	0.000	0.0	zero009	Zero off	with wavemaker
1.0	1.5	0.0	0	0.145	0.6	run085	Zero on with zero009	Case 6
1.0	1.5	1.0	686	0.145	0.6	run086	Zero on with zero009	Tacq=256s
1.0	1.5	2.0	1372	0.145	0.6	run087	Zero on with zero009	Facq=128Hz
1.0	1.5	2.5	1715	0.145	0.6	run088	Zero on with zero009	
1.0	1.5	3.0	2058	0.145	0.6	run089	Zero on with zero009	Fadv=64Hz
1.0	1.5	3.5	2401	0.145	0.6	run090	Zero on with zero009	
1.0	1.5	4.0	2743	0.145	0.6	run091	Zero on with zero009	
1.0	1.5	4.5	3086	0.145	0.6	run092	Zero on with zero009	
1.0	1.5	5.0	3429	0.145	0.6	run093	Zero on with zero009	
1.0	1.5	6.0	4115	0.145	0.6	run094	Zero on with zero009	
1.0	1.5	7.0	4801	0.145	0.6	run095	Zero on with zero009	
0.0	1.5	0.0	0	0.000	0.0	zero010	Zero off	with wavemaker
0.8	1.5	0.0	0	jonswap		run096	Zero on with zero010	Case 7
0.8	1.5	1.0	549	jonswap		run097	Zero on with zero010	Tacq=512s
0.8	1.5	2.0	1097	jonswap		run098	Zero on with zero010	Facq=128Hz
0.8	1.5	2.5	1372	jonswap		run099	Zero on with zero010	
0.8	1.5	3.0	1646	jonswap		run100	Zero on with zero010	Fadv=64Hz
0.8	1.5	3.5	1920	jonswap		run101	Zero on with zero010	
0.8	1.5	4.0	2195	jonswap		run102	Zero on with zero010	
0.8	1.5	4.5	2469	jonswap		run103	Zero on with zero010	
0.8	1.5	5.0	2743	jonswap		run104	Zero on with zero010	
0.8	1.5	6.0	3292	jonswap		run105	Zero on with zero010	
0.8	1.5	7.0	3841	jonswap		run106	Zero on with zero010	

Figure 17 – Run names and numbers 74 to 106 for the turbine performance measurements carried out at the IFREMER facility.

REPEATS								
tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero011	Zero off	with wavemaker
0.8	1.5	0.0	0	0.155	0.6	run107	Zero on with zero011	Case 2
0.8	1.5	1.0	549	0.155	0.6	run108	Zero on with zero011	Tacq=256s
0.8	1.5	2.0	1097	0.155	0.6	run109	Zero on with zero011	Facq=128Hz
0.8	1.5	2.5	1372	0.155	0.6	run110	Zero on with zero011	
0.8	1.5	3.0	1646	0.155	0.6	run111	Zero on with zero011	Fadv=64Hz
0.8	1.5	3.5	1920	0.155	0.6	run112	Zero on with zero011	
0.8	1.5	4.0	2195	0.155	0.6	run113	Zero on with zero011	
0.8	1.5	4.5	2469	0.155	0.6	run114	Zero on with zero011	
0.8	1.5	5.0	2743	0.155	0.6	run115	Zero on with zero011	
0.8	1.5	6.0	3292	0.155	0.6	run116	Zero on with zero011	
0.8	1.5	7.0	3841	0.155	0.6	run117	Zero on with zero011	
0.0	1.5	0.0	0	0.000	0.0	zero012	Zero off	with wavemaker
0.8	1.5	0.0	0	0.095	0.5	run118	Zero on with zero012	Case 3
0.8	1.5	1.0	549	0.095	0.5	run119	Zero on with zero012	Tacq=256s
0.8	1.5	2.0	1097	0.095	0.5	run120	Zero on with zero012	Facq=128Hz
0.8	1.5	2.5	1372	0.095	0.5	run121	Zero on with zero012	
0.8	1.5	3.0	1646	0.095	0.5	run122	Zero on with zero012	Fadv=64Hz
0.8	1.5	3.5	1920	0.095	0.5	run123	Zero on with zero012	
0.8	1.5	4.0	2195	0.095	0.5	run124	Zero on with zero012	
0.8	1.5	4.5	2469	0.095	0.5	run125	Zero on with zero012	
0.8	1.5	5.0	2743	0.095	0.5	run126	Zero on with zero012	
0.8	1.5	6.0	3292	0.095	0.5	run127	Zero on with zero012	
0.8	1.5	7.0	3841	0.095	0.5	run128	Zero on with zero012	
0.0	1.5	0.0	0	0.000	0.0	zero013	Zero off	with wavemaker
1.0	1.5	0.0	0	0.145	0.7	run129	Zero on with zero013	Case 5
1.0	1.5	1.0	686	0.145	0.7	run130	Zero on with zero013	Tacq=256s
1.0	1.5	2.0	1372	0.145	0.7	run131	Zero on with zero013	Facq=128Hz
1.0	1.5	2.5	1715	0.145	0.7	run132	Zero on with zero013	
1.0	1.5	3.0	2058	0.145	0.7	run133	Zero on with zero013	Fadv=64Hz
1.0	1.5	3.5	2401	0.145	0.7	run134	Zero on with zero013	
1.0	1.5	4.0	2743	0.145	0.7	run135	Zero on with zero013	
1.0	1.5	4.5	3086	0.145	0.7	run136	Zero on with zero013	
1.0	1.5	5.0	3429	0.145	0.7	run137	Zero on with zero013	
1.0	1.5	6.0	4115	0.145	0.7	run138	Zero on with zero013	
1.0	1.5	7.0	4801	0.145	0.7	run139	Zero on with zero013	

Figure 18 – Run names and numbers 107 to 139 (repeat measurements) for the turbine performance measurements carried out at the IFREMER facility.

REPEATS								
tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero014	Zero off	with wavemaker
1.0	1.5	0.0	0	0.145	0.6	run140	Zero on with zero014	Case 6
1.0	1.5	1.0	686	0.145	0.6	run141	Zero on with zero014	Tacq=256s
1.0	1.5	2.0	1372	0.145	0.6	run142	Zero on with zero014	Facq=128Hz
1.0	1.5	2.5	1715	0.145	0.6	run143	Zero on with zero014	
1.0	1.5	3.0	2058	0.145	0.6	run144	Zero on with zero014	Fadv=64Hz
1.0	1.5	3.5	2401	0.145	0.6	run145	Zero on with zero014	
1.0	1.5	4.0	2743	0.145	0.6	run146	Zero on with zero014	
1.0	1.5	4.5	3086	0.145	0.6	run147	Zero on with zero014	
1.0	1.5	5.0	3429	0.145	0.6	run148	Zero on with zero014	
1.0	1.5	6.0	4115	0.145	0.6	run149	Zero on with zero014	
1.0	1.5	7.0	4801	0.145	0.6	run150	Zero on with zero014	
0.0	1.5	0.0	0	0.000	0.0	zero015	Zero off	with wavemaker
0.8	1.5	0.0	0	jonswap		run151	Zero on with zero015	Case 7
0.8	1.5	1.0	549	jonswap		run152	Zero on with zero015	Tacq=512s
0.8	1.5	2.0	1097	jonswap		run153	Zero on with zero015	Facq=128Hz
0.8	1.5	2.5	1372	jonswap		run154	Zero on with zero015	
0.8	1.5	3.0	1646	jonswap		run155	Zero on with zero015	Fadv=64Hz
0.8	1.5	3.5	1920	jonswap		run156	Zero on with zero015	
0.8	1.5	4.0	2195	jonswap		run157	Zero on with zero015	
0.8	1.5	4.5	2469	jonswap		run158	Zero on with zero015	
0.8	1.5	5.0	2743	jonswap		run159	Zero on with zero015	
0.8	1.5	6.0	3292	jonswap		run160	Zero on with zero015	
0.8	1.5	7.0	3841	jonswap		run161	Zero on with zero015	
0.0	1.5	0.0	0	0.000	0.0	0.000	Zero off	with parked wavemaker
0.8	1.5	0.0	0	0.000	0.0	run162	Zero on with zero016	Case 1 WM
0.8	1.5	1.0	549	0.000	0.0	run163	Zero on with zero016	Tacq=256s
0.8	1.5	2.0	1097	0.000	0.0	run164	Zero on with zero016	Facq=128Hz
0.8	1.5	2.5	1372	0.000	0.0	run165	Zero on with zero016	
0.8	1.5	3.0	1646	0.000	0.0	run166	Zero on with zero016	Fadv=64Hz
0.8	1.5	3.5	1920	0.000	0.0	run167	Zero on with zero016	
0.8	1.5	4.0	2195	0.000	0.0	run168	Zero on with zero016	
0.8	1.5	4.5	2469	0.000	0.0	run169	Zero on with zero016	
0.8	1.5	5.0	2743	0.000	0.0	run170	Zero on with zero016	
0.8	1.5	6.0	3292	0.000	0.0	run171	Zero on with zero016	
0.8	1.5	7.0	3841	0.000	0.0	run172	Zero on with zero016	

Figure 19 – Run names and numbers 140 to 172 (repeat measurements) for the turbine performance measurements carried out at the IFREMER facility.

REPEATS								
tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	amp. [m]	freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero017	Zero off	with parked wavemaker
1.0	1.5	0.0	0	0.000	0.0	run173	Zero on with zero017	Case 4 WM
1.0	1.5	1.0	686	0.000	0.0	run174	Zero on with zero017	Tacq=256s
1.0	1.5	2.0	1372	0.000	0.0	run175	Zero on with zero017	Facq=128Hz
1.0	1.5	2.5	1715	0.000	0.0	run176	Zero on with zero017	
1.0	1.5	3.0	2058	0.000	0.0	run177	Zero on with zero017	Fadv=64Hz
1.0	1.5	3.5	2401	0.000	0.0	run178	Zero on with zero017	
1.0	1.5	4.0	2743	0.000	0.0	run179	Zero on with zero017	
1.0	1.5	4.5	3086	0.000	0.0	run180	Zero on with zero017	
1.0	1.5	5.0	3429	0.000	0.0	run181	Zero on with zero017	
1.0	1.5	6.0	4115	0.000	0.0	run182	Zero on with zero017	
1.0	1.5	7.0	4801	0.000	0.0	run183	Zero on with zero017	
0.0	1.5	0.0	0	0.000	0.0	zero018	Zero off	without wavemaker
0.8	1.5	0.0	0	0.000	0.0	run184	Zero on with zero018	Case 1
0.8	1.5	1.0	549	0.000	0.0	run185	Zero on with zero018	Tacq=128s
0.8	1.5	2.0	1097	0.000	0.0	run186	Zero on with zero018	Facq=128Hz
0.8	1.5	2.5	1372	0.000	0.0	run187	Zero on with zero018	
0.8	1.5	3.0	1646	0.000	0.0	run188	Zero on with zero018	Fadv=64Hz
0.8	1.5	3.5	1920	0.000	0.0	run189	Zero on with zero018	
0.8	1.5	4.0	2195	0.000	0.0	run190	Zero on with zero018	
0.8	1.5	4.5	2469	0.000	0.0	run191	Zero on with zero018	
0.8	1.5	5.0	2743	0.000	0.0	run192	Zero on with zero018	
0.8	1.5	6.0	3292	0.000	0.0	run193	Zero on with zero018	
0.8	1.5	7.0	3841	0.000	0.0	run194	Zero on with zero018	
0.0	1.5	0.0	0	0.000	0.0	zero019	Zero off	without wavemaker
1.0	1.5	0.0	0	0.000	0.0	run195	Zero on with zero019	Case 4
1.0	1.5	1.0	686	0.000	0.0	run196	Zero on with zero019	Tacq=128s
1.0	1.5	2.0	1372	0.000	0.0	run197	Zero on with zero019	Facq=128Hz
1.0	1.5	2.5	1715	0.000	0.0	run198	Zero on with zero019	
1.0	1.5	3.0	2058	0.000	0.0	run199	Zero on with zero019	Fadv=64Hz
1.0	1.5	3.5	2401	0.000	0.0	run200	Zero on with zero019	
1.0	1.5	4.0	2743	0.000	0.0	run201	Zero on with zero019	
1.0	1.5	4.5	3086	0.000	0.0	run202	Zero on with zero019	
1.0	1.5	5.0	3429	0.000	0.0	run203	Zero on with zero019	
1.0	1.5	6.0	4115	0.000	0.0	run204	Zero on with zero019	
1.0	1.5	7.0	4801	0.000	0.0	run205	Zero on with zero019	

Figure 20 – Run names and numbers 173 to 205 (repeat measurements) for the turbine performance measurements carried out at the IFREMER facility.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	Amp. [m]	Freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero001	Zero off	
0.8	1.5	0.0	0	0.000	0.0	run001	Zero on with zero001	Case 1
0.8	1.5	1.0	549	0.000	0.0	run002	Zero on with zero001	
0.8	1.5	2.0	1097	0.000	0.0	run003	Zero on with zero001	
0.8	1.5	2.5	1372	0.000	0.0	run004	Zero on with zero001	
0.8	1.5	3.0	1646	0.000	0.0	run005	Zero on with zero001	
0.8	1.5	3.5	1920	0.000	0.0	run006	Zero on with zero001	
0.8	1.5	4.0	2195	0.000	0.0	run007	Zero on with zero001	
0.8	1.5	4.5	2469	0.000	0.0	run008	Zero on with zero001	
0.8	1.5	5.0	2743	0.000	0.0	run009	Zero on with zero001	
0.8	1.5	6.0	3292	0.000	0.0	run010	Zero on with zero001	
0.8	1.5	7.0	3841	0.000	0.0	run011	Zero on with zero001	
1.0	1.5	0.0	0	0.000	0.0	run012	Zero on with zero001	
1.0	1.5	1.0	686	0.000	0.0	run013	Zero on with zero001	Case 4
1.0	1.5	2.0	1372	0.000	0.0	run014	Zero on with zero001	
1.0	1.5	2.5	1715	0.000	0.0	run015	Zero on with zero001	
1.0	1.5	3.0	2058	0.000	0.0	run016	Zero on with zero001	
1.0	1.5	3.5	2401	0.000	0.0	run017	Zero on with zero001	
1.0	1.5	4.0	2743	0.000	0.0	run018	Zero on with zero001	
1.0	1.5	4.5	3086	0.000	0.0	run019	Zero on with zero001	
1.0	1.5	5.0	3429	0.000	0.0	run020	Zero on with zero001	
1.0	1.5	6.0	4115	0.000	0.0	run021	Zero on with zero001	
1.0	1.5	7.0	4801	0.000	0.0	run022	Zero on with zero001	
0.0	1.5	0.0	0	0.000	0.0	zero003	Zero off	
0.8	1.5	0.0	0	0.075	0.6	run042	Zero on with zero003	Case 2
0.8	1.5	1.0	549	0.075	0.6	run043	Zero on with zero003	
0.8	1.5	2.0	1097	0.075	0.6	run044	Zero on with zero003	
0.8	1.5	2.5	1372	0.075	0.6	run045	Zero on with zero003	
0.8	1.5	3.0	1646	0.075	0.6	run046	Zero on with zero003	
0.8	1.5	3.5	1920	0.075	0.6	run047	Zero on with zero003	
0.8	1.5	4.0	2195	0.075	0.6	run048	Zero on with zero003	
0.8	1.5	4.5	2469	0.075	0.6	run049	Zero on with zero003	
0.8	1.5	5.0	2743	0.075	0.6	run050	Zero on with zero003	
0.8	1.5	6.0	3292	0.075	0.6	run051	Zero on with zero003	
0.8	1.5	7.0	3841	0.075	0.6	run052	Zero on with zero003	

Figure 21 – Run names and numbers 1 to 52 for the turbine performance measurements carried out at the FLOWAVE facility.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	Amp. [m]	Freq. [Hz]	name [-]	zero [-]	
0.0	1.5	0.0	0	0.000	0.0	zero004	Zero off	
0.8	1.5	0.0	0	0.035	0.5	run059	Zero on with zero004	Case 3
0.8	1.5	1.0	549	0.035	0.5	run060	Zero on with zero004	
0.8	1.5	2.0	1097	0.035	0.5	run061	Zero on with zero004	
0.8	1.5	2.5	1372	0.035	0.5	run062	Zero on with zero004	
0.8	1.5	3.0	1646	0.035	0.5	run063	Zero on with zero004	
0.8	1.5	3.5	1920	0.035	0.5	run064	Zero on with zero004	
0.8	1.5	4.0	2195	0.035	0.5	run065	Zero on with zero004	
0.8	1.5	4.5	2469	0.035	0.5	run066	Zero on with zero004	
0.8	1.5	5.0	2743	0.035	0.5	run067	Zero on with zero004	
0.8	1.5	6.0	3292	0.035	0.5	run068	Zero on with zero004	
0.8	1.5	7.0	3841	0.035	0.5	run069	Zero on with zero004	
0.8	1.5	0.0	0	jonwap		run070	Zero on with zero004	
0.8	1.5	1.0	549	jonwap		run071	Zero on with zero004	Case 7
0.8	1.5	2.0	1097	jonwap		run072	Zero on with zero004	
0.8	1.5	2.5	1372	jonwap		run073	Zero on with zero004	
0.8	1.5	3.0	1646	jonwap		run074	Zero on with zero004	
0.8	1.5	3.5	1920	jonwap		run075	Zero on with zero004	
0.8	1.5	4.0	2195	jonwap		run076	Zero on with zero004	
0.8	1.5	4.5	2469	jonwap		run077	Zero on with zero004	
0.8	1.5	5.0	2743	jonwap		run078	Zero on with zero004	
0.8	1.5	6.0	3292	jonwap		run079	Zero on with zero004	
0.8	1.5	7.0	3841	jonwap		run080	Zero on with zero004	
0.0	1.5	0.0	0	0.000	0.0	zero005	Zero off	
1.0	1.5	0.0	0	0.110	0.5	run081	Zero on with zero005	Case 5 BIS
1.0	1.5	1.0	686	0.110	0.5	run082	Zero on with zero005	
1.0	1.5	2.0	1372	0.110	0.5	run083	Zero on with zero005	
1.0	1.5	2.5	1715	0.110	0.5	run084	Zero on with zero005	
1.0	1.5	3.0	2058	0.110	0.5	run085	Zero on with zero005	
1.0	1.5	3.5	2401	0.110	0.5	run086	Zero on with zero005	
1.0	1.5	4.0	2743	0.110	0.5	run087	Zero on with zero005	
1.0	1.5	4.5	3086	0.110	0.5	run088	Zero on with zero005	
1.0	1.5	5.0	3429	0.110	0.5	run089	Zero on with zero005	
1.0	1.5	6.0	4115	0.110	0.5	run090	Zero on with zero005	
1.0	1.5	7.0	4801	0.110	0.5	run091	Zero on with zero005	

Figure 22 – Run names and numbers 59 to 91 for the turbine performance measurements carried out at the FLOWAVE facility. Please note the case 5 is named "Case 5 **BIS**" because the wave frequency is 0.5 Hz instead of 0.7 Hz as carried out at CNR-INM or IFREMER. This wave frequency was impossible to carry out at FLOWAVE with a flow velocity of 1.0 m/s.

tank settings		rotation		wavemaker		acquisition		observations
vel. [m/s]	turb. [%]	TSR [-]	RPM [tr/min]	Amp. [m]	Freq. [Hz]	name [-]	zero [-]	
1.0	1.5	0.0	0	0.055	0.6	run092	Zero on with zero005	
1.0	1.5	1.0	686	0.055	0.6	run093	Zero on with zero005	Case 6
1.0	1.5	2.0	1372	0.055	0.6	run094	Zero on with zero005	
1.0	1.5	2.5	1715	0.055	0.6	run095	Zero on with zero005	
1.0	1.5	3.0	2058	0.055	0.6	run096	Zero on with zero005	
1.0	1.5	3.5	2401	0.055	0.6	run097	Zero on with zero005	
1.0	1.5	4.0	2743	0.055	0.6	run098	Zero on with zero005	
1.0	1.5	4.5	3086	0.055	0.6	run099	Zero on with zero005	
1.0	1.5	5.0	3429	0.055	0.6	run100	Zero on with zero005	
1.0	1.5	6.0	4115	0.055	0.6	run101	Zero on with zero005	
1.0	1.5	7.0	4801	0.055	0.6	run102	Zero on with zero005	
REPEAT								
0.8	1.5	2.0	1097	0.000	0.0	run053	Zero on with zero003	
0.8	1.5	4.0	2195	0.000	0.0	run054	Zero on with zero003	Case 1
0.8	1.5	7.0	3841	0.000	0.0	run055	Zero on with zero003	
1.0	1.5	2.0	1372	0.000	0.0	run056	Zero on with zero003	
1.0	1.5	4.0	2743	0.000	0.0	run057	Zero on with zero003	Case 4
1.0	1.5	7.0	4801	0.000	0.0	run058	Zero on with zero003	

Figure 23 – Run names and numbers 92 to 102 (and repeat measurements) for the turbine performance measurements carried out at the FLOWAVE facility.

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