

VI MARINE ENERGY CONFERENCE



Numerical and experimental methods
for fluid dynamics
in offshore renewable energy applications



OUTLINE

1. AREAS OF ACTION JRL-ORE
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS
3. ALLIANCES AND COLLABORATIONS
4. DEVELOPED PROJECTS
5. ONGOING PROJECTS
6. SUMMARY

1. AREAS OF ACTION JRL-ORE

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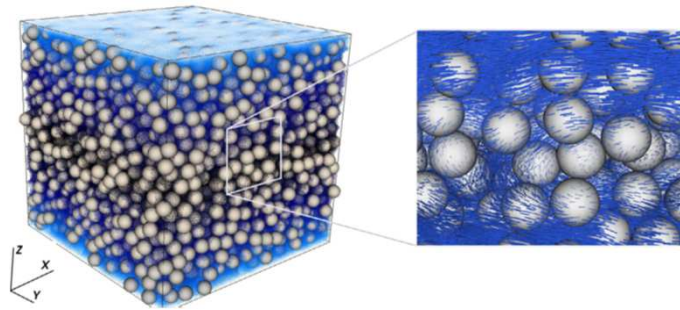


1. AREAS OF ACTION JRL-ORE

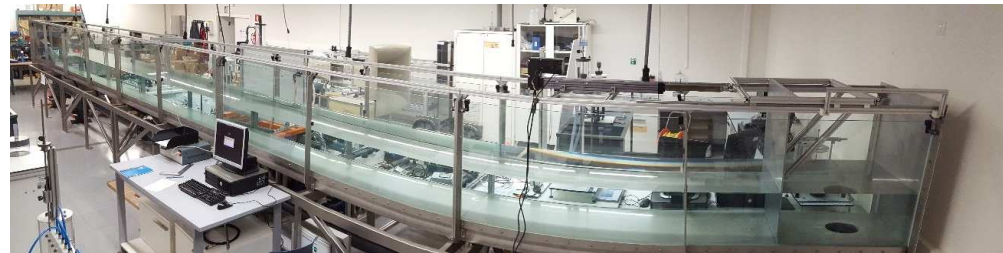
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SCIENTIFIC ACTIVITIES IN THE AREA OF FLUID DYNAMICS

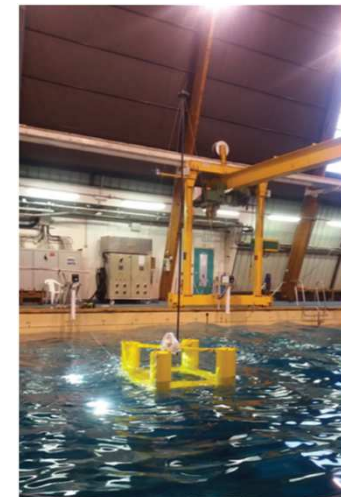
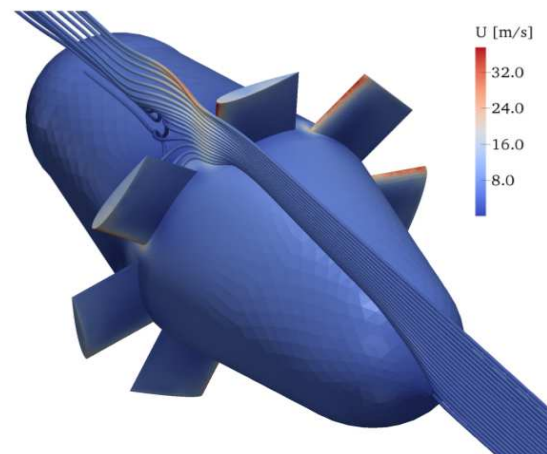
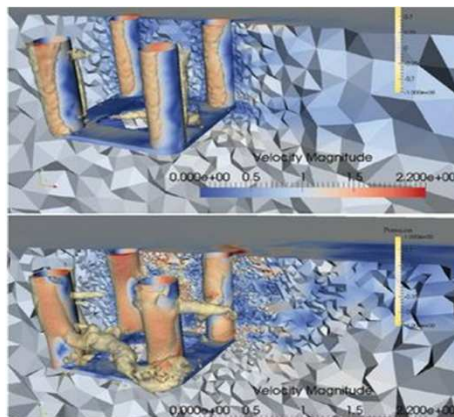
CFD for Non-Newtonian fluids



Experimental analysis of wave-(floating) structures interaction



CFD approaches for the resolution of multi-physics and multi-scale problems



2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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HUMAN RESOURCES



2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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SOFTWARE TOOLS

ANSYS®

PSIM

MATLAB®
SIMULINK®

XILINX®

Mentor
Graphics®

OrCAD™
CADENCE PCB SOLUTIONS

QUARTUS™

FENICS
PROJECT

STAR-CCM+®
Multidisciplinary Design exploration

PSS®E

EBIPED

Rhinoceros®

OpenFOAM

FAST v8

OrcaFlex

ALTERA®
MAX+plus® II

PowerFactory

2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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COMPUTATIONAL RESOURCES

Arina

3.664 Xeon cores - 64 Itanium2 cores - RAM memory ranging from 16 to 512 GB per node

Atlas

172 nodes - 4656 cores - and 42 TB of RAM

Hypathia

18 nodes (1 with Nvidia Tesla K40 GPU) - 624 cores - 4TB of RAM Memory - Infiniband network

i2basque

1072 processors - 1.27 TB RAM - 24 TB storage on disk and 6.21 Tflops

3 work stations

2 processors - 16 cores – 48 Gb RAM memory

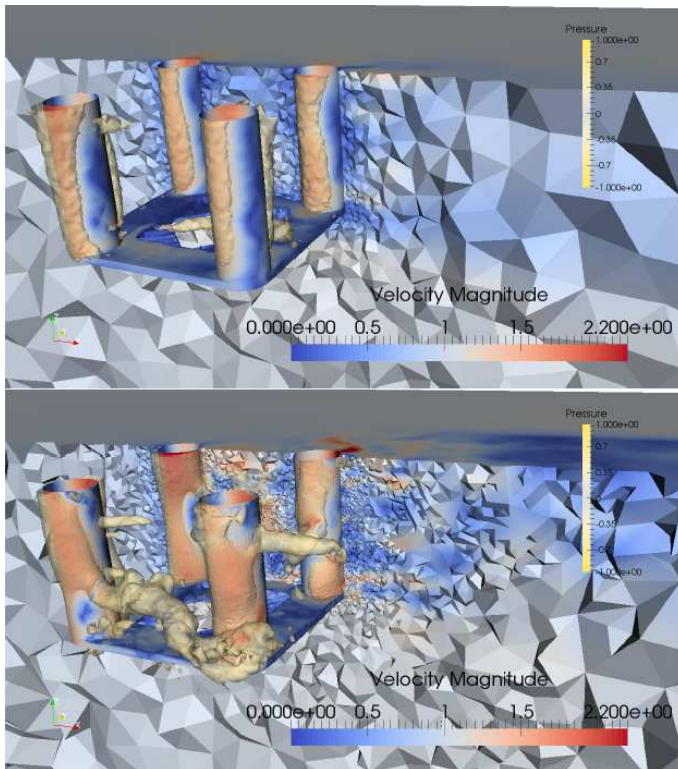
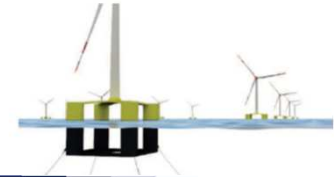
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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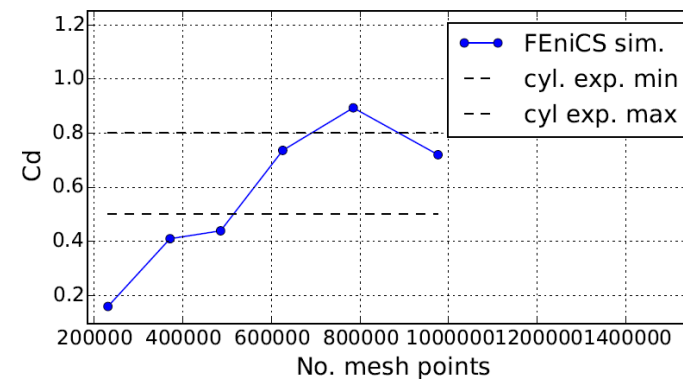
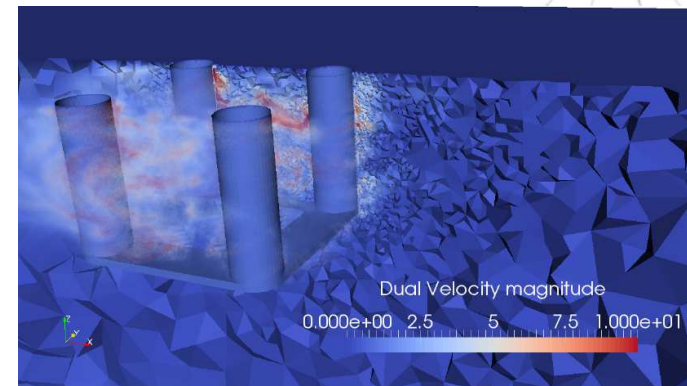
RESEARCH CAPABILITIES



Adaptive CFD methods for the hydrodynamics of offshore floating wind turbines using FeNICS-HPC



Solution on coarse initial mesh (top) and finest adaptive mesh (bottom)



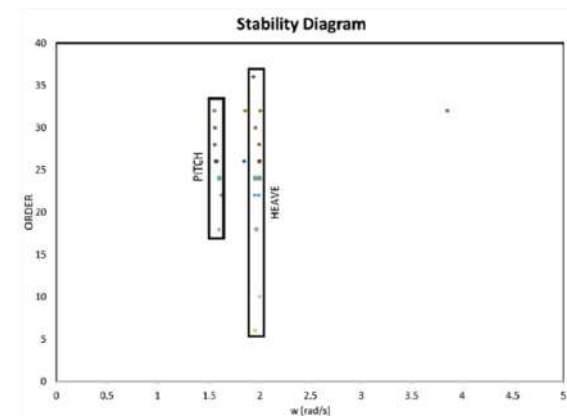
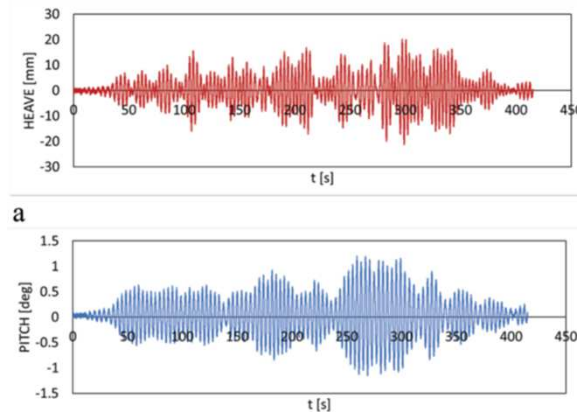
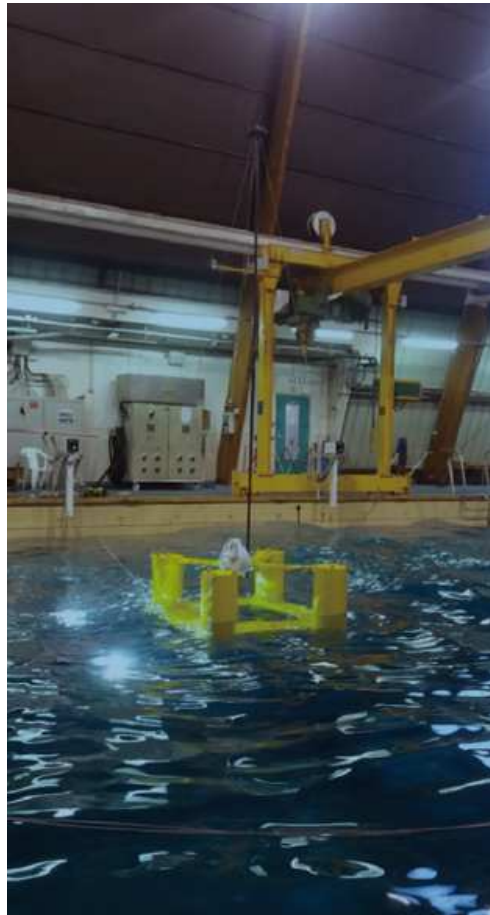
Estimation of drag coefficients and comparison with the experimental ones

2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH CAPABILITIES

Operational modal analysis techniques applied to experimental campaign for floating offshore wind semisubmersible platform



HYDRODYNAMIC CHARACTERISATION (NATURAL PERIODS AND DAMPING) OF OFFSHORE WIND PLATFORMS FROM REALISTIC SEAS

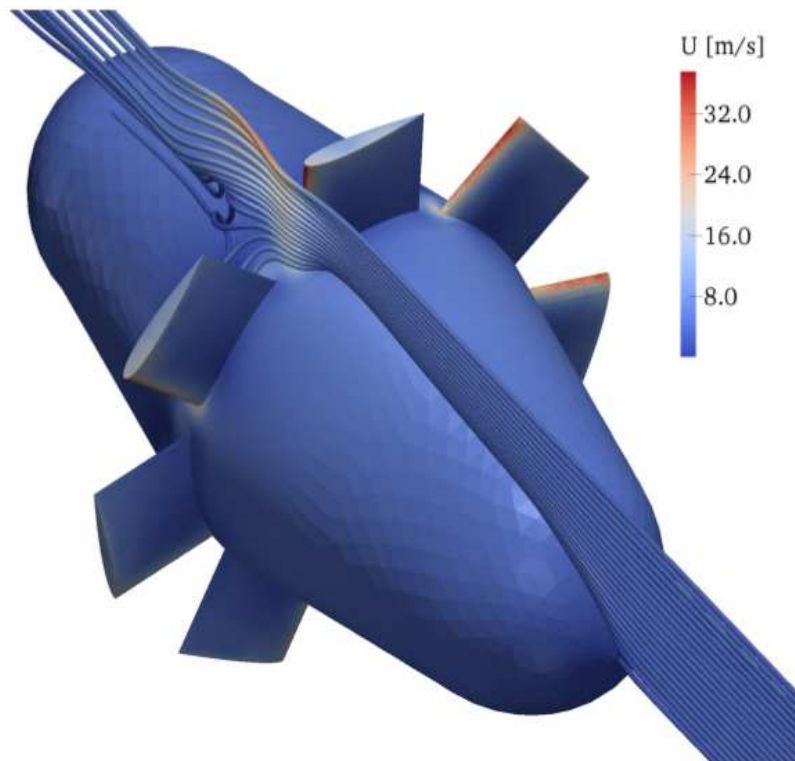
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH CAPABILITIES



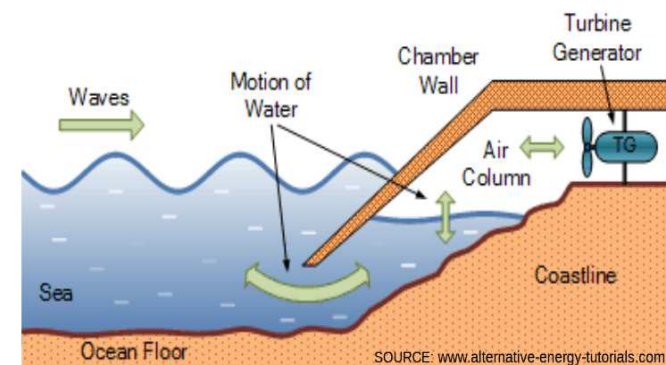
Simulation of the air flow in a wells turbine for an oscillating water column device



Deviation of the velocity streamlines passing the turbine



ESTIMATION OF EFFICIENCY OF THE TURBINE

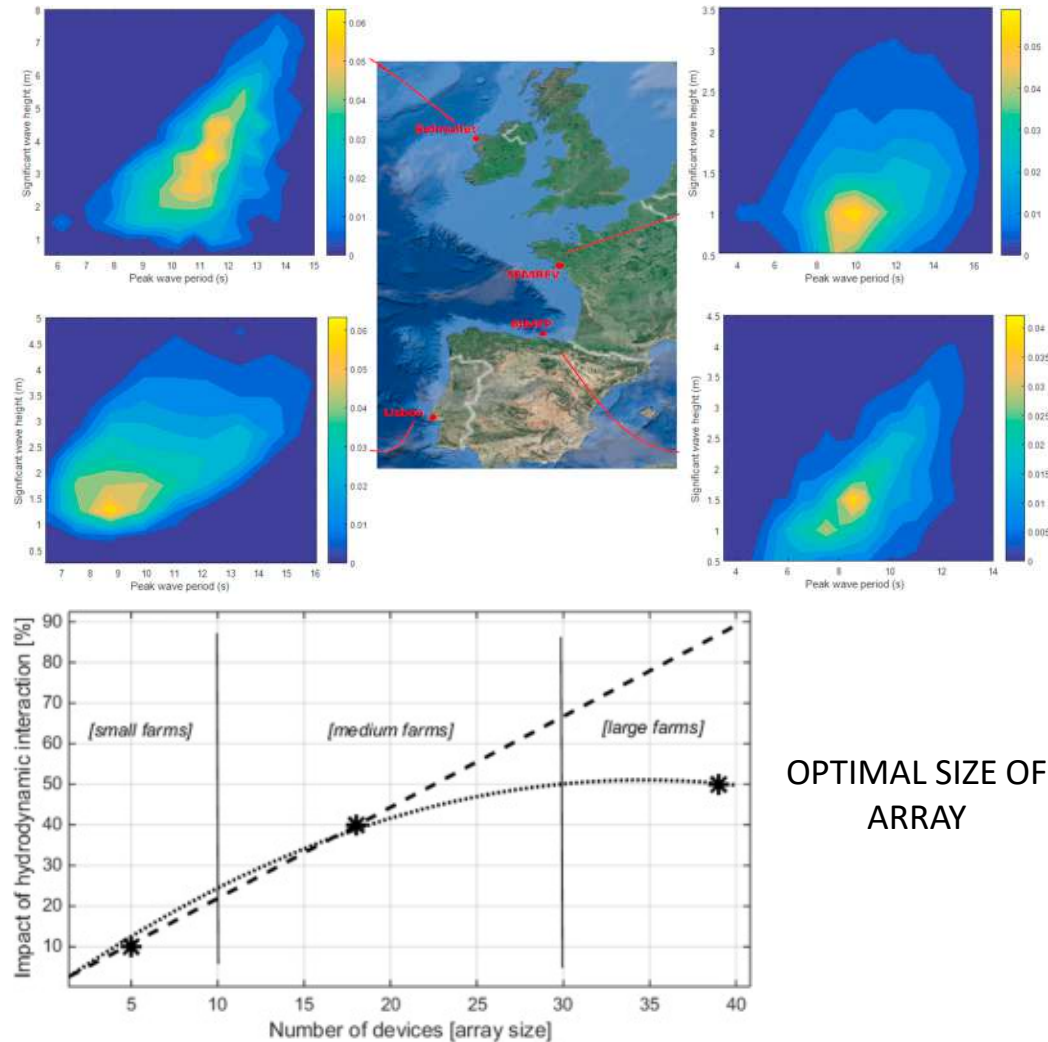
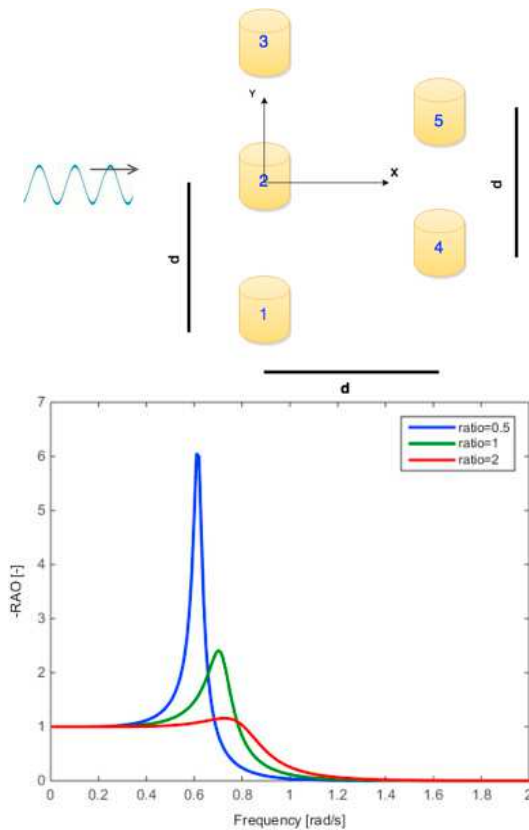


2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH CAPABILITIES

Hydrodynamic interaction in arrays of wave energy converters point absorbers based on BEM in various locations as a function of the slenderness



OPTIMAL SIZE OF
ARRAY

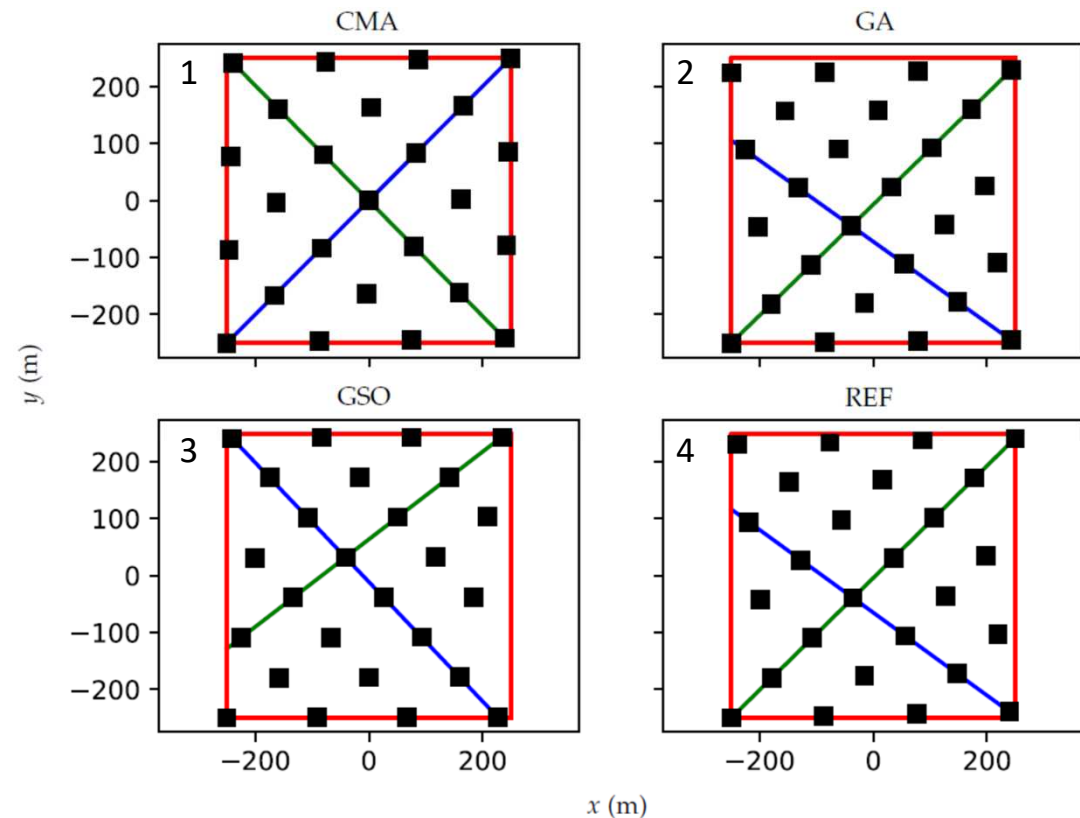
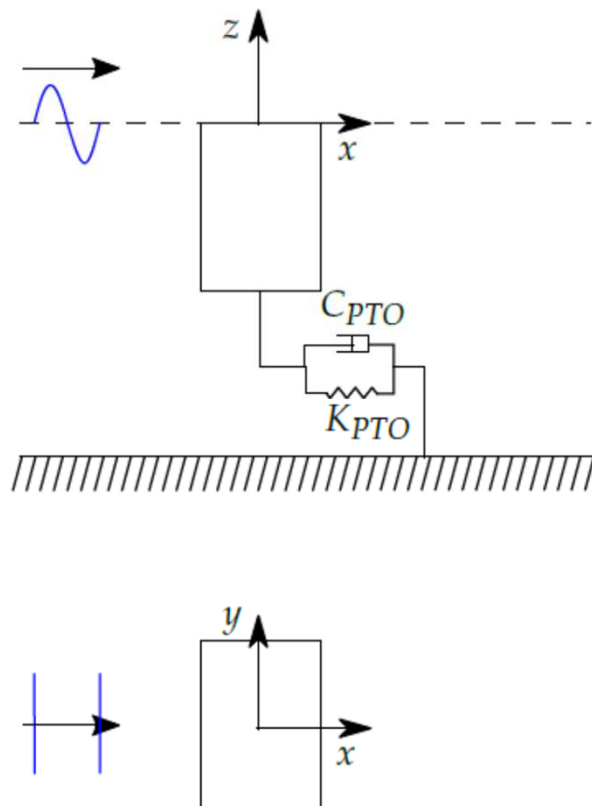
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH CAPABILITIES



Hydrodynamic interaction in arrays of wave energy converters point absorbers based on BEM and DSM based on genetic algorithms



OPTIMISATION OF LOCATION OF WAVE ENERGY CONVERTERS

2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH FACILITIES

HARSH LAB



Floating laboratory, installed in BiMEP for testing materials and components in real seas

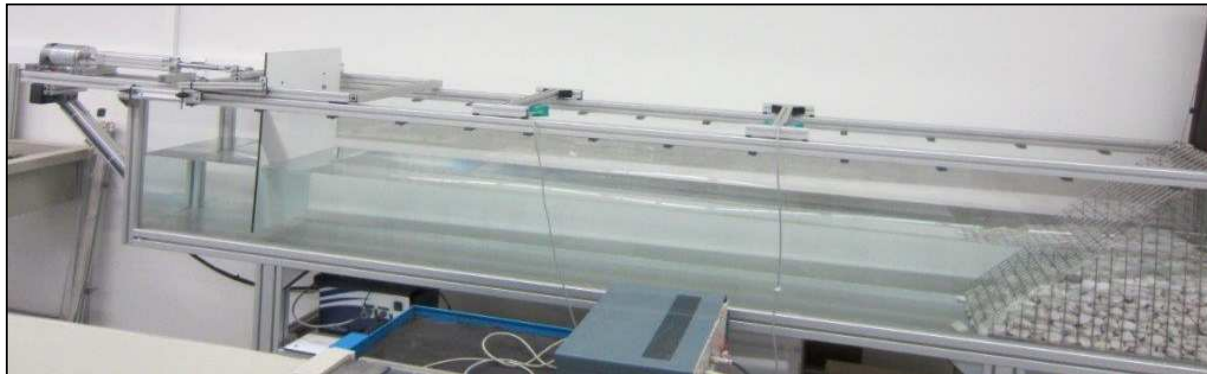
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH FACILITIES

WAVE FLUMES

wave flume: 2.95 m long, 0.50 m wide, and 0.5 m high



Experimental characteristics of the main components

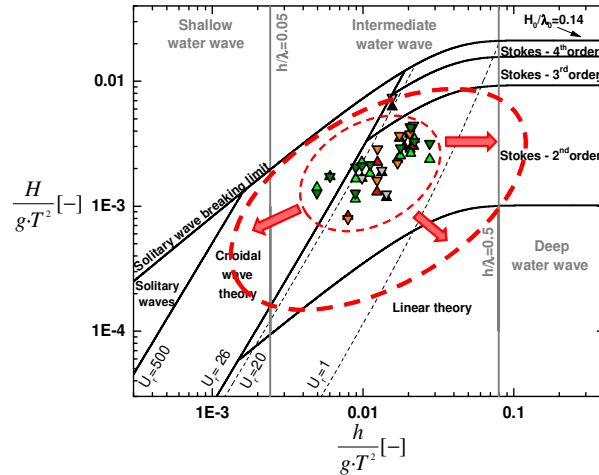
Motor of the Piston-type Wavemaker	
Linear induction type	LinMot ® P01-23x80x210
Power supply	CM CAMTEC HPV1000
Maximum electrical power	1 kW
Maximum stroke	0.210 m
Maximum force	255 N
Maximum peak velocity	6.0 m/s

Ultrasonic-type Wave probes	
Span	From 30 to 500 mm
Blind zone	From 0 to 30 mm
Resolution	0.2 mm
Response delay	50 ms
Temperature influence	0.1% of measured value

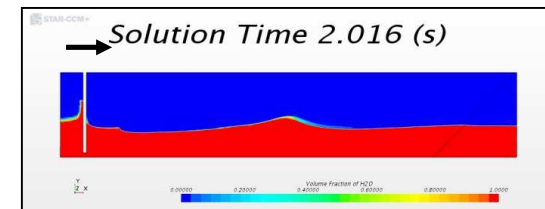
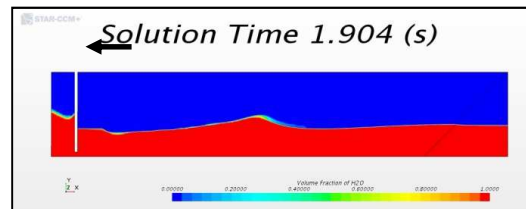
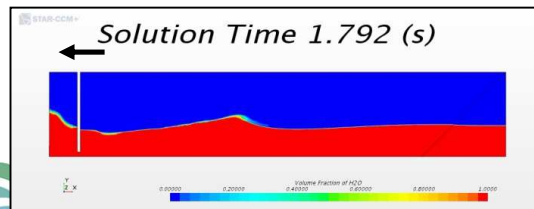
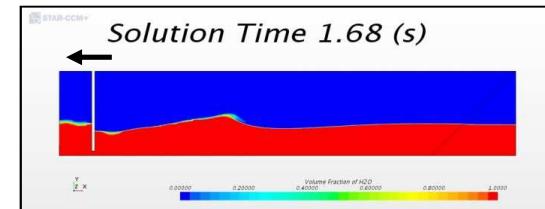
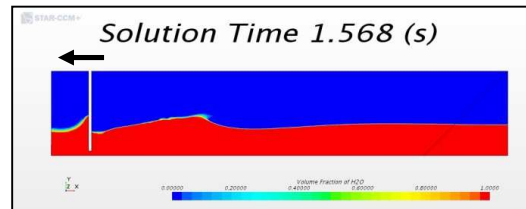
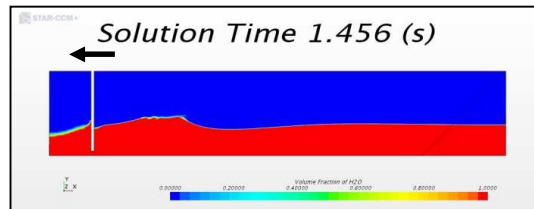
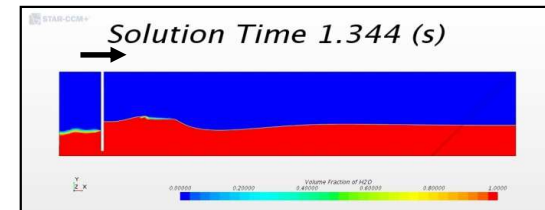
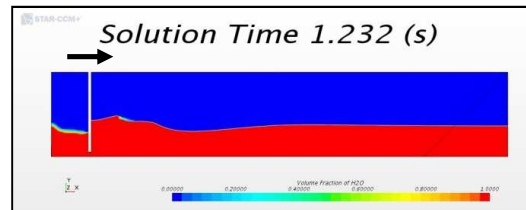
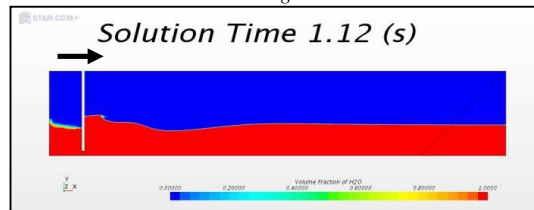
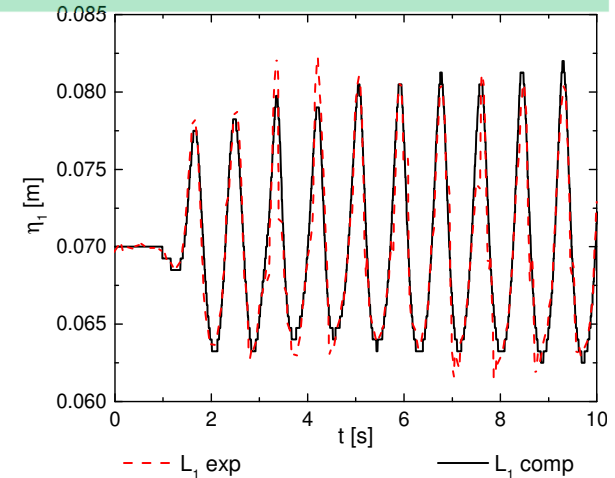
2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH CAPABILITIES



Produce and analyse a wide range of waves generated numerically and experimentally



2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH FACILITIES

WAVE FLUMES

Experimental wave flume: 12.5 m long, 0.60 m wide, and 0.7 m high



Characteristics of the main components

ASDA-A2 servo motor (ECMA-C2080-7RS)					
Rated output power (kW)	Rated torque (N·m)	Maximum torque (N·m)	Rated speed (r/min)	Maximum speed (r/min)	Rotor moment of inertia ($\cdot 10^{-4} \text{kg} \cdot \text{m}^2$)
0.75	2.39	7.16	3000	5000	1.13
Linear actuator (KM60-10)					
Nominal frame size (mm)	Screw lead (mm)	Maximum force (kN)	Linear speed at max rated rpm (mm/s)	Dynamic load rating (kN)	Maximum input torque (N·m)
60	10	3.0	833	6.8	6

2. CAPACITIES IN THE FIELD OF FLUID DYNAMICS

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RESEARCH FACILITIES

WAVE FLUMES



Experimental assessment of a fixed OWC coefficients as a damped harmonic oscillator



Experimental assessment of the response amplitude operator (RAO) in a fixed OWC



Scaled Model, at 1:64, of the Mutriku wave energy power plant

3. ALLIANCES AND COLLABORATIONS

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INTERNATIONAL



Wind Europe

Members

European Association on
Wind Energy



Ocean Energy Europe

Board Members

European Association on
Ocean Energy



EERA-OCEAN

Cochair

Joint programme on ocean
energy of the European
Energy Research Alliance



EERA-WIND

Associated partners

Joint programme on wind
energy of the European
Energy Research Alliance



ETIP-OCEAN

Members

European Technology and
Innovation Platform on
Ocean Energy



IEC TC114

Members

IEC TC on Marine energy –
wave, tidal and other water
current converters



IEC TC88

Offshore wind working
groups (fixed and
floating)

Wind energy generation
systems



IEA OES

Chairman (2013-2016).
Spanish delegates

Technology collaboration
program on ocean energy of
the international energy
agency



IEA WIND

Participant in working
group for Offshore Wind
(numerical modeling)

Technology collaboration
program on wind energy of
the international energy
agency



ICOE

Executive Committee
Member

International Conference on
Ocean Energy



3. ALLIANCES AND COLLABORATIONS

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NATIONAL / LOCAL



OTHER COLLABORATORS

Master in Renewable Energy in the Marine Environment (REM) (Erasmus Mundus)



E-CLEDER group of the Basque Government



Scientific External Collaborators



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4. DEVELOPED PROJECTS

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REFERENCE PROJECTS

Harsh

HARSH

DTOcean+

MaRINET2

MaRINET2

LIFES50+

LIFES50+

Opera

opera

ETIP Ocean 2

ETIPOCEAN

The blue growth farm



FLOW

flow

ICERMAR (2015 – 2016) and ICERMAR II (2016-2017)

tecnalia

azti
tecnalia

Unibertsitatea
Euskal Herriko
Unibertsitatea
Universidad
del País Vasco

(bcam)
basque center for applied mathematics

Objective: to overcome the current barriers to marine energy in order to definitively place the Basque Country as a global benchmark in this energy area with an important future projection



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euskampus
FUNDACIÓ

MATHEO (2019 – 2020)



Aim of the Project:

Develop mathematical models at the frontier of knowledge that facilitate the characterization of the interaction of large structures with the environment, in order to benefit the Basque companies involved in the offshore wind supply chain.

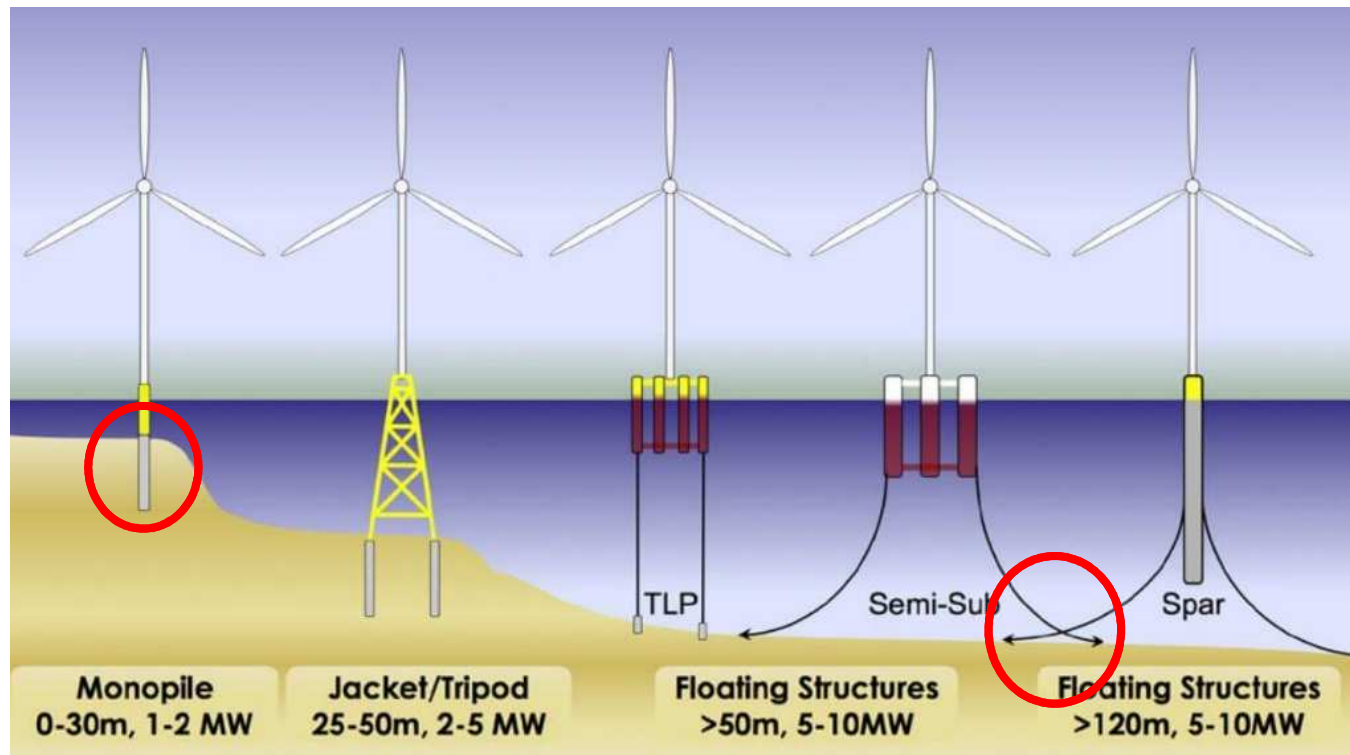
The main areas where advanced mathematical models are expected to be developed are:

- Smoothed Particle Hydrodynamics (SPH) models for a more precise analysis of the soil-structure interaction.
- Deep Learning techniques to infer the condition of structural components from real operating data.
- Advanced hybrid approaches to accurately quantify nonlinear phenomena (corrosion, overtopping) at the splash zone and soil/stationkeeping system interaction at the seabed.

5. ONGOING PROJECTS

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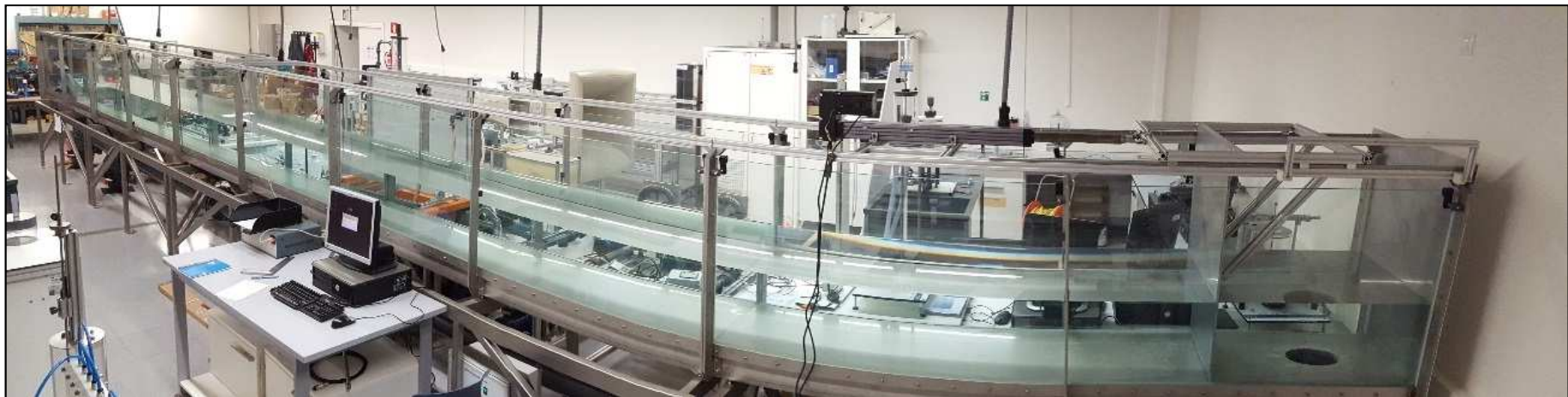
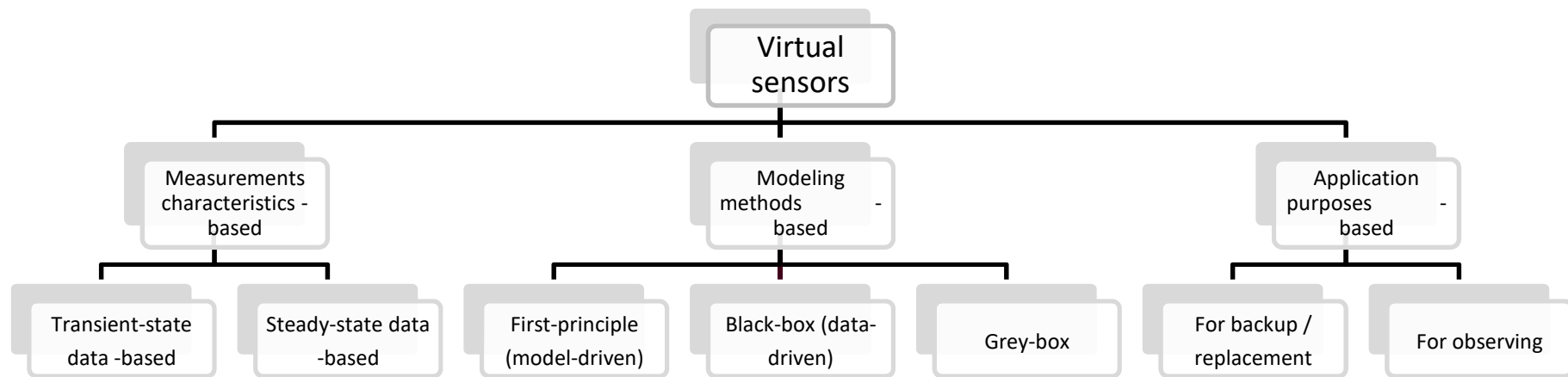
Soil –structure interaction for station-keeping of offshore wind platforms using meshless methods (SPH)



5. ONGOING PROJECTS

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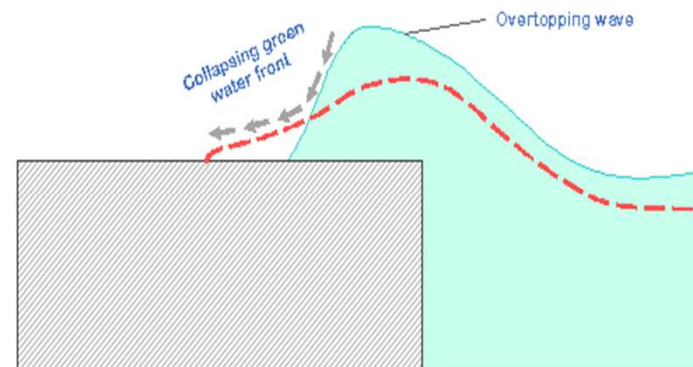
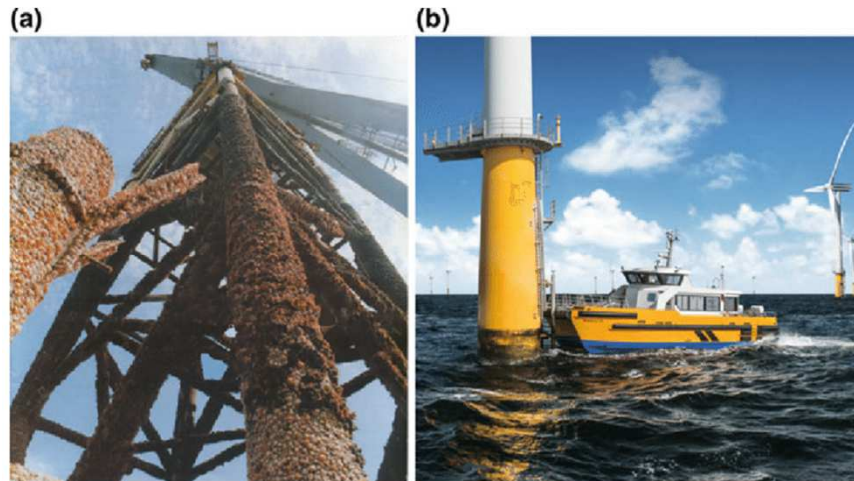
Digitalisation and virtual sensing based on operational or experimental data



5. ONGOING PROJECTS

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Influence of overtopping and corrosion on the hydrodynamics of platforms



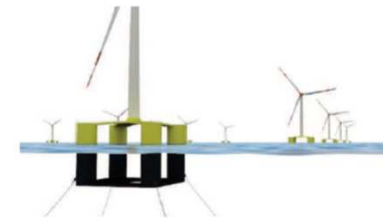
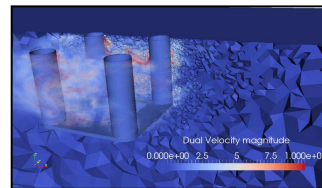
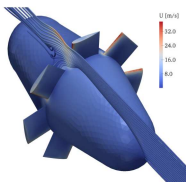
6. SUMMARY

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- Fluid dynamics group



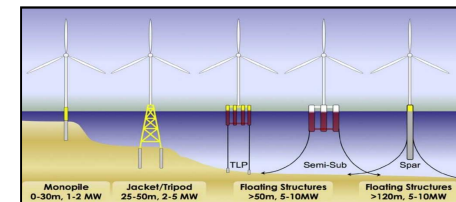
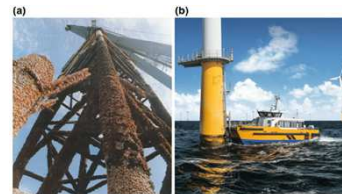
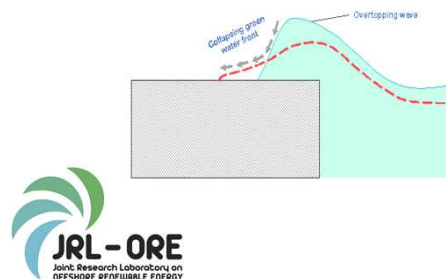
- The software tools and computational resources



- The experimental facilities



- The MATHEO project



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THANK YOU VERY MUCH
FOR YOUR ATTENTION

