RESEARCH INVESTIGATIONS ON MULTI-PHYSIC AND MULTISCALE KEY TOPICS FOR FLOATING WIND TURBINE BEHAVIOR

LHEEA CENTRALE NANTES
cnrs

Aubrun,Sandrine
Gilloteaux, Jean-Christophe

D-ICE ENGINEERING

Kerkeni,Sofien

INNOSEA
An LOC Group company

Lynch, Mattias

Facilitating the maturation of Floating Wind Turbine

Design methodologies, Performance prediction, High Performance Computing, Multiphysic modelling, Complex environment, Similitude laws, Verification & Validation, Performance validation, Permitting, …

Preferential partnerships with

INNOSEA
An LOC Group company

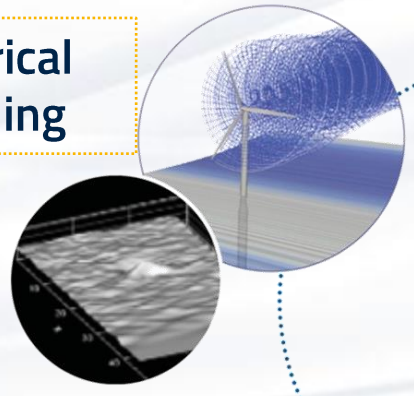
on Integrated Design Tools

&

D-ICE ENGINEERING

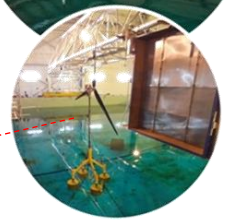
on FOWT&FOWF Control

Numerical modelling



SEMREV sea test site
- 1km² maritime zone.
- 20km off the coast
- grid connected: 8MW 25km-long cable

In situ monitoring and survey

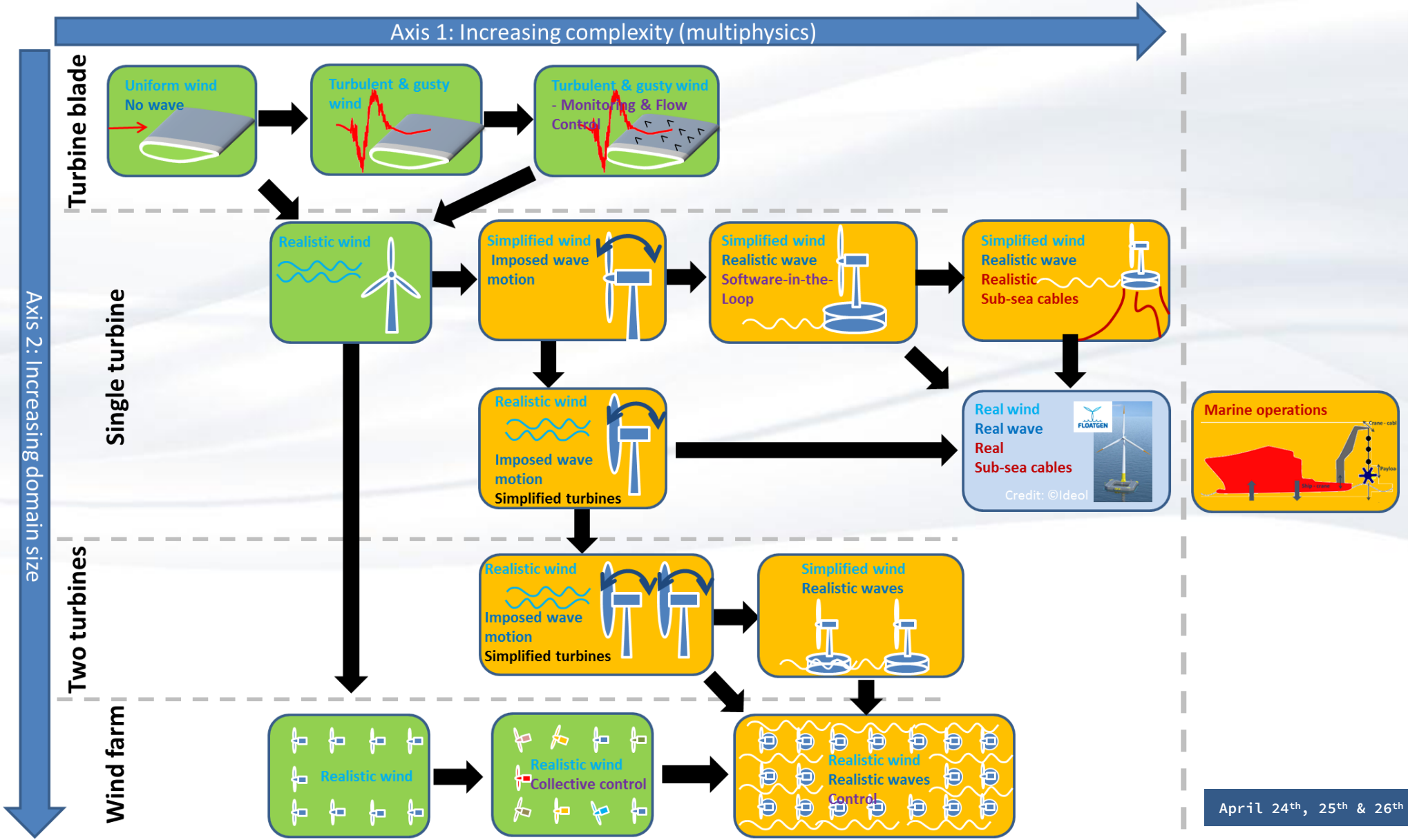


Model Tests

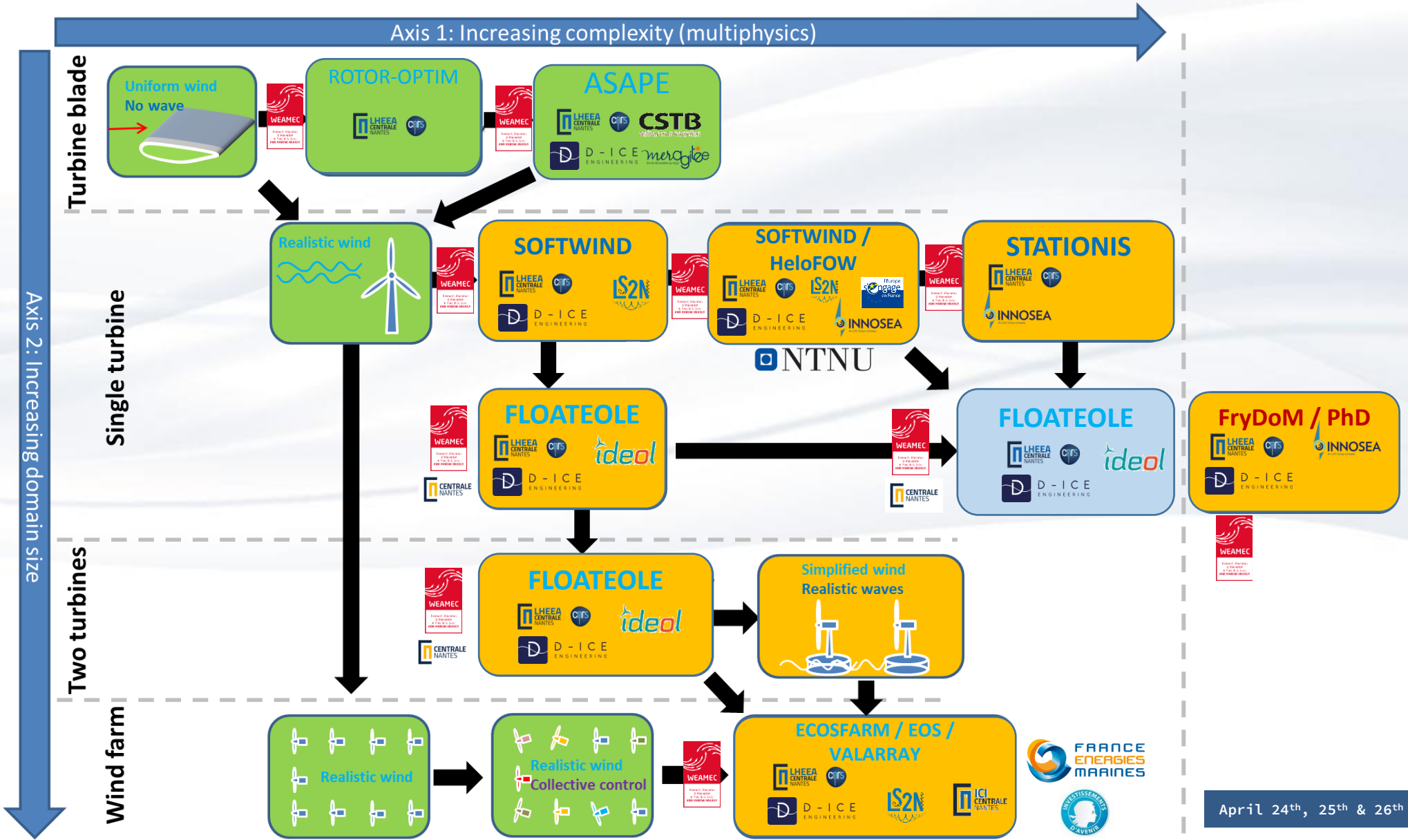
Ocean Engineering Tank:
- 50m x 30m x5m
- Equipped with a segmented wave maker composed of 48 flaps.
- FOWT model testing: drag disk, geometry scaled rotor, SIL.

From the first idea → To demonstration in real conditions

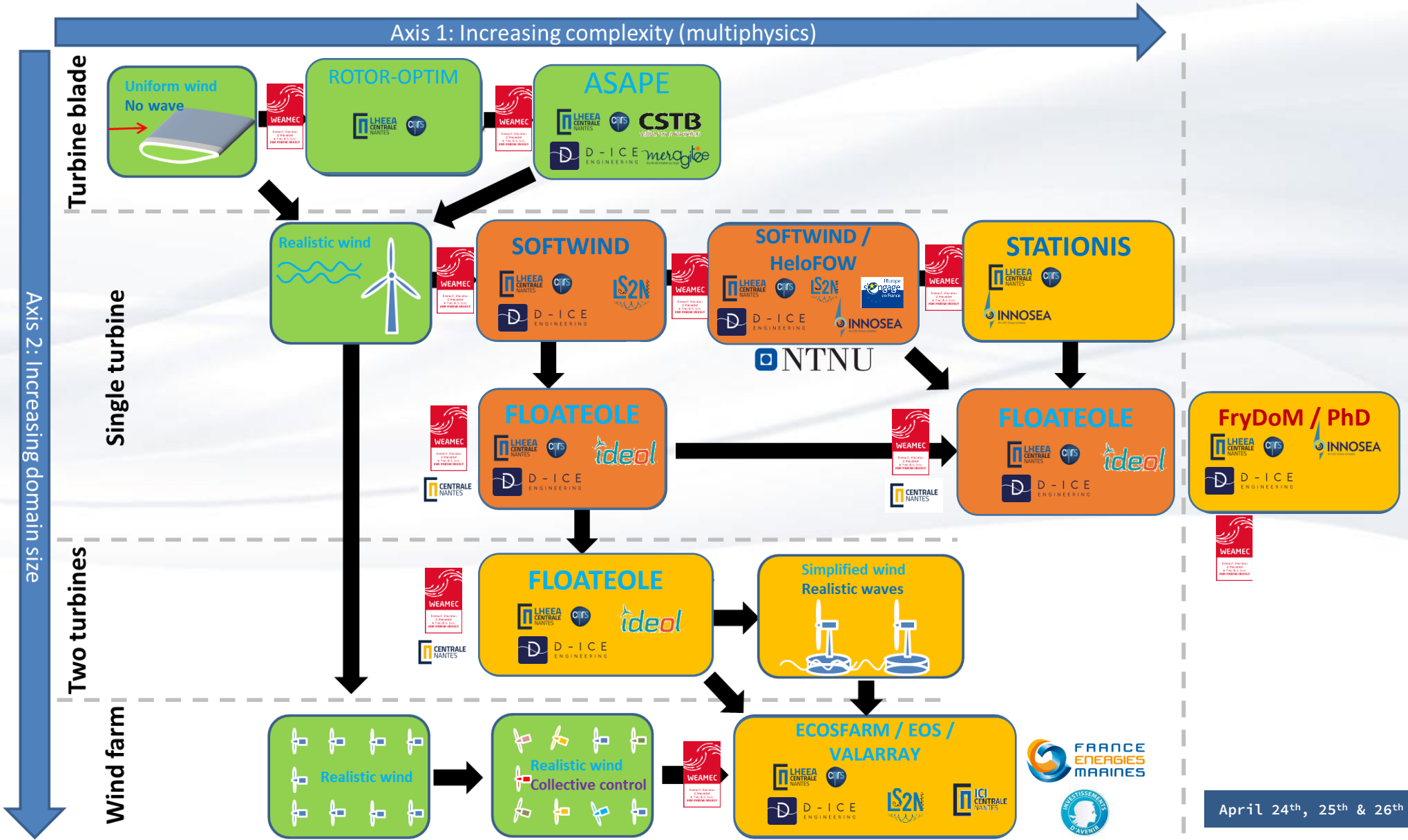
Facilitating the maturation of Floating Wind Turbine



Ongoing projects



Ongoing projects



HeLoFOW

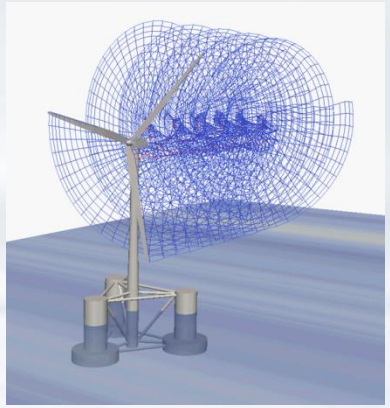
LHEEA CENTRALE NANTES
cnrs

Compliant, deformable floating platform designs expected to emerge.

INNOSEA
An LOC Group company

NTNU

Hydro-elastic modelling of floating wind turbines



- **Improvements of state-of-the-art aero-hydro-servo-elastic numerical tools** for the design and optimization of floating offshore wind platforms with higher-order wave load models (HOS developed by LHEEA).

- **Original experimental tests**: lack of experimental data on both the elastic deformations and the global forces and moments acting on a FOWT substructure precludes validation of numerical models.

Scientific and technical challenges :

- To adapt elastic model testing strategies to FOWT platforms
- *Coupling between a higher-order wave load model with a structural model*

WEAMEC
Research, Education & Innovation in Pays de la Loire
FOR MARINE ENERGY

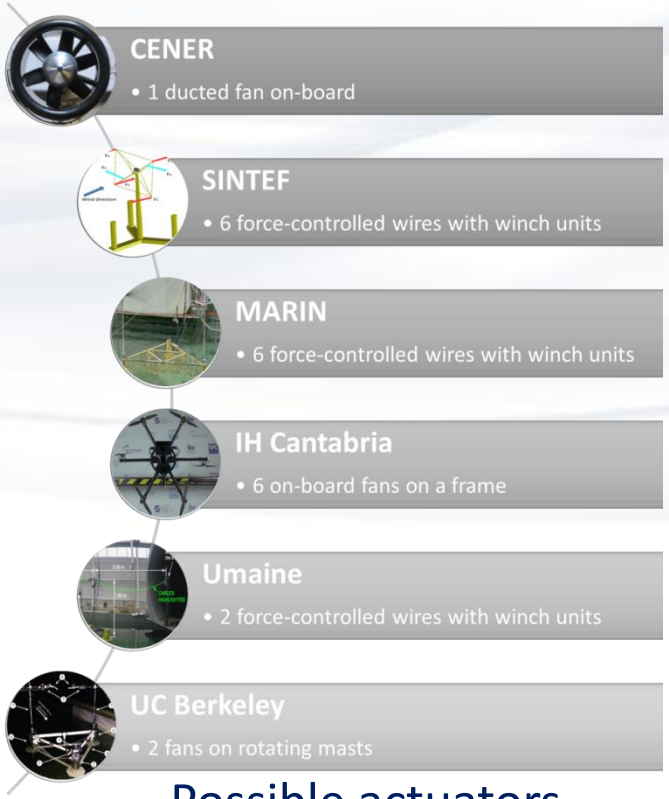
SoftWind

LHEEA CENTRALE NANTES
cnrs
D-ICE ENGINEERING
LS2N

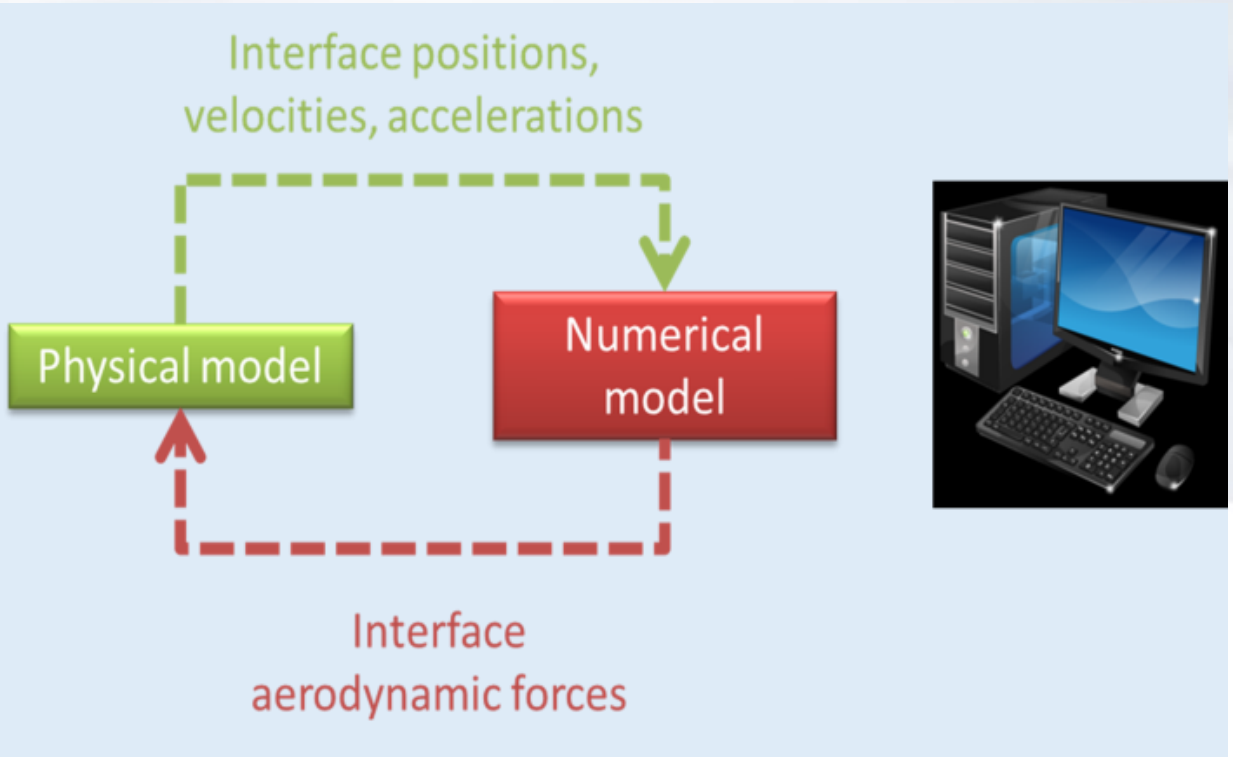
multidisciplinary approach to study the aero-hydro-servo coupling

Wave tank testing of control laws by means of Software-In-the-Loop approach

=> Test various control laws to identify the most efficient in terms of WT performance



Possible actuators

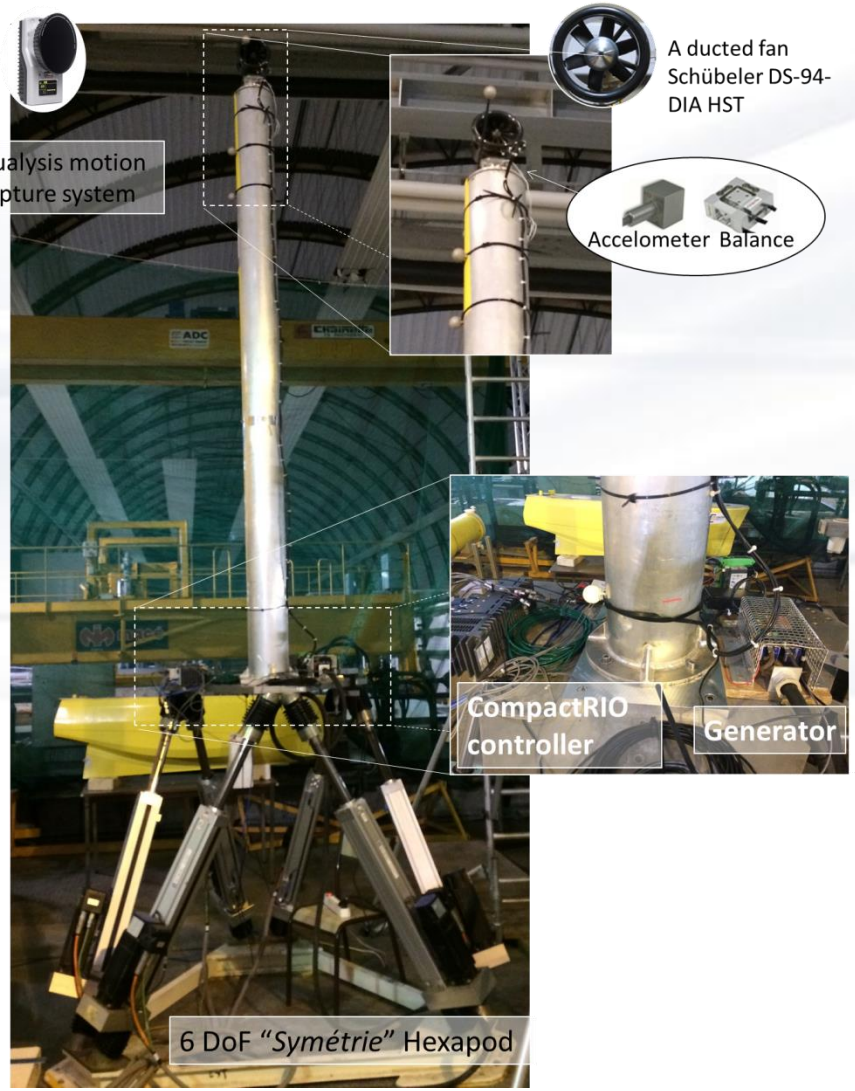


WEAMEC
Research, Education & Innovation in Pays de la Loire FOR MARINE ENERGY

SoftWind

LHEEA CENTRALE NANTES
cnrs
D-ICE ENGINEERING
LS2N

Current set-up with imposed motions

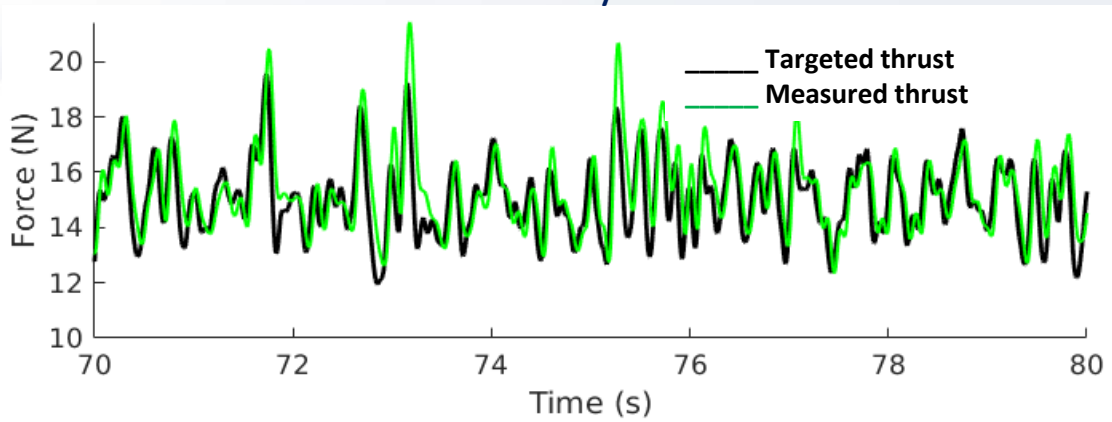


A test bench with a single actuator is currently tested. The purpose of this set up is the validation of :

- the communication protocols,
- the real-time execution of the numerical model,
- the motion and force observers,
- the preliminary actuator model identification.

Preliminary validation tests consist in imposed motions by means of a hexapod and will be followed by wave tank tests next September.

Preliminary tests



WEAMEC
Research, Education & Innovation in Pays de la Loire FOR MARINE ENERGY

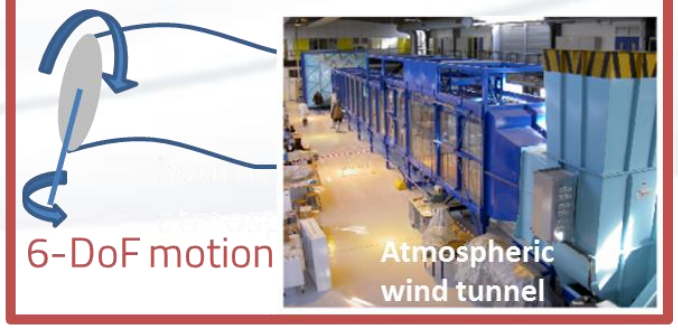
FLOATEOLE

Floating Wind farms = > wake interactions

Experimental characterization of the wave impact on the unsteady aerodynamical behavior of floating wind turbines

- Multidisciplinary approach to study the wind – wave – structure coupling
- Experiments performed in controlled and real conditions (wind tunnel and sea test site, respectively)

Aerodynamic behavior under floater motion emulation

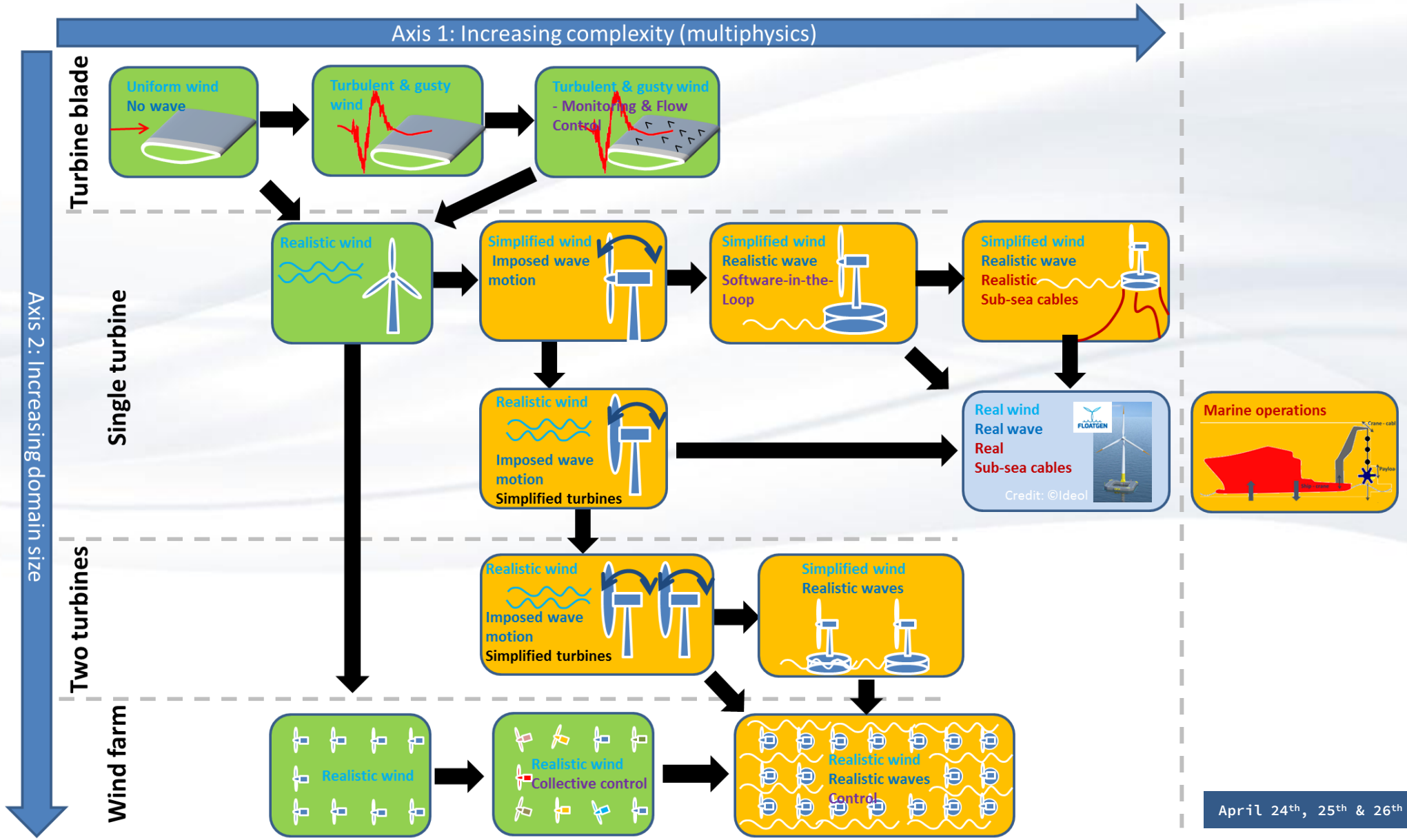


Wind resource and wake through LiDAR measurements

Scientific and technical challenges :

- Does the floater motion have an impact on the wind turbine wake development?
- Wind tunnel testing: Floater motion emulation at very reduced scale
- Sea testing: scanning LiDAR measurement on floating structures

Thank you

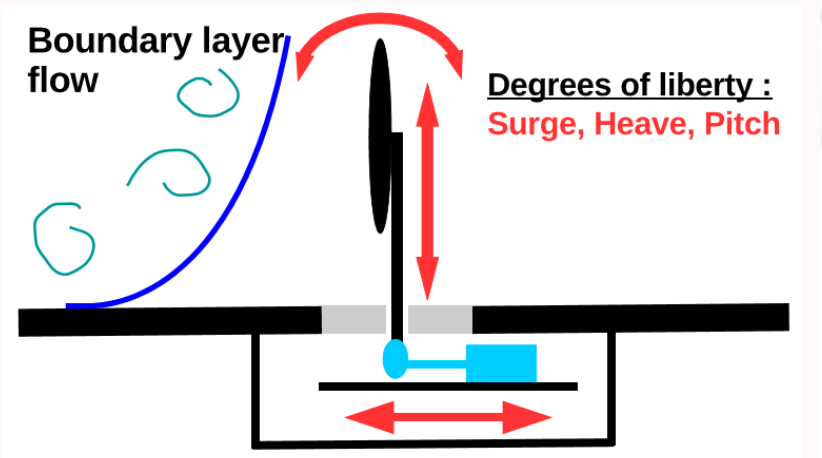

Axis 1: Increasing complexity (multiphysics)
Axis 2: Increasing domain size
Turbine blade
Single turbine
Two turbines
Wind farm
Uniform wind
No wave
Turbulent & gusty wind
Turbulent & gusty wind
- Monitoring & Flow Control
Realistic wind
Simplified wind
Imposed wave motion
Simplified wind
Realistic wave
Software-in-the-Loop
Simplified wind
Realistic wave
Realistic
Sub-sea cables
Realistic wind
Imposed wave motion
Simplified turbines
Real wind
Real wave
Real
Sub-sea cables
Credit: ©Ideol
Marine operations
Realistic wind
Imposed wave motion
Simplified turbines
Simplified wind
Realistic waves
Realistic wind
Realistic wind
Collective control
Realistic wind
Realistic waves
Control

Technical challenges

LHEEA CENTRALE NANTES · cnrs · D-ICE ENGINEERING · ideol

• Wind tunnel experiments

- Design a motion system that can emulate the floaters movements in different sea states
  - From idealised to extreme cases
  - For a reduction scale of 1:400

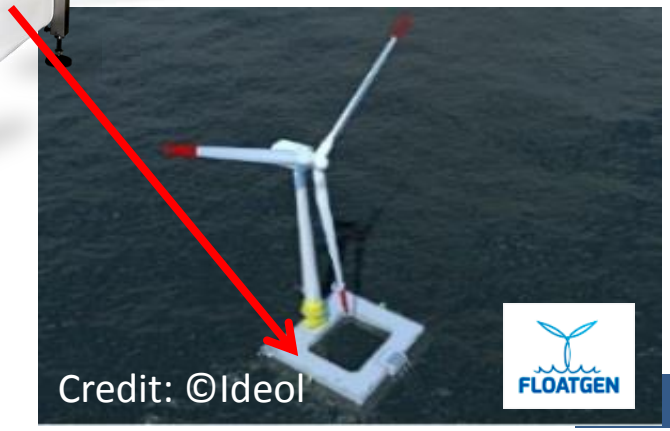


• Insite experiments

- Mitigate the influence of floater motions on the LiDAR measurements
  - Stabilizing platform
  - Control of the scanning head

Scanning Windcube

LEOSPHERE A VAISALA COMPANY



CENTRALE NANTES · WEAMEC Research, Education & Innovation in Pays de la Loire FOR MARINE ENERGY