WIND AVATAR®

DIGITAL TWINS OF FLOATING OFFSHORE WIND TURBINES

PROJECT SUMMARY

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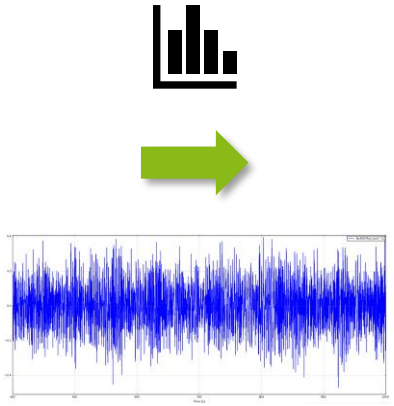
MOTIVATION

- O&M of FOWT assets is limited by the possibility to install monitoring on critical locations (e.g., mooring lines) because of technological or cost issues.
- Digital Twin or Model-based approach ≡ data from optimized sensors locations enriched with physical models.

REAL ASSET

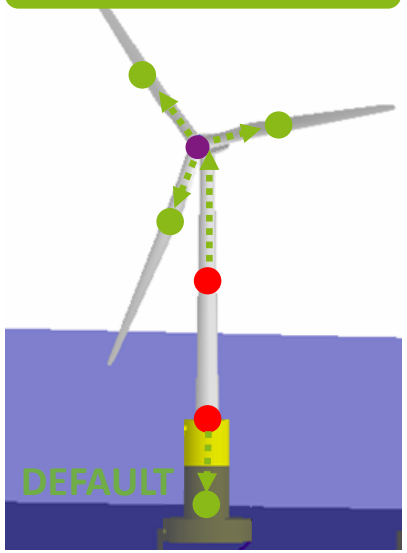
- SCADA
- Motion / Acceleration
- (Env conditions)

Data contain **information** on **operation, loadings and response**



Sensors time serie

DIGITAL ASSET



The physical model **propagates** the information to **other locations & other variables**

KPIs

Consistency between **data & model** is ensured

WPS OBJECTIVES

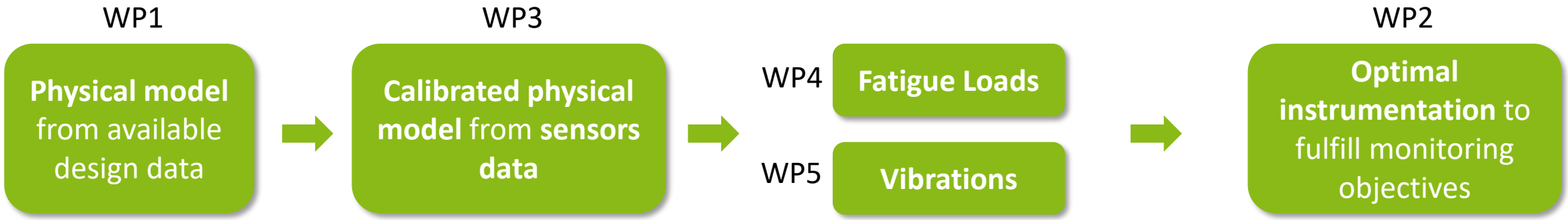
- Case study : generic 15MW wind turbine on a semi-submersible floater
  - Use noise to build a theoretical sensor

- IFPEN Scope
  - WP1: physical model of the FOWT (basis of coupled simulations in operational and parked situations, methods to reconstruct missing data)
  - WP2: find the optimal monitoring configuration that achieves monitoring objectives.
  - WP3: update the physical model to better fit the “as-built” & “as-installed” asset.
  - WP4: estimate fatigue loads in the structural components of the FOWT.
  - WP5: monitor the vibrations signature of the FOWT to detect structural default.

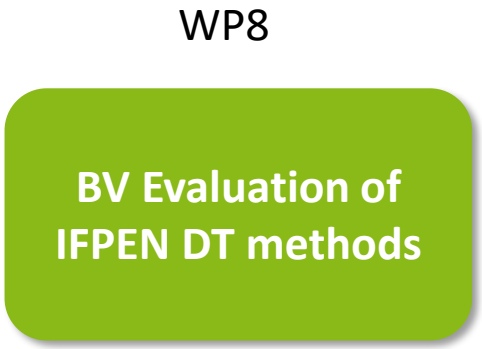
- BV WP8: review of virtual sensor IFPEN methods with BV conversion matrix tool, evaluate benefits for design and O&M.

PROJECT OVERVIEW

- Develop methodologies adapted to FOWT using Digital Twin to improve FOWT assets O&M



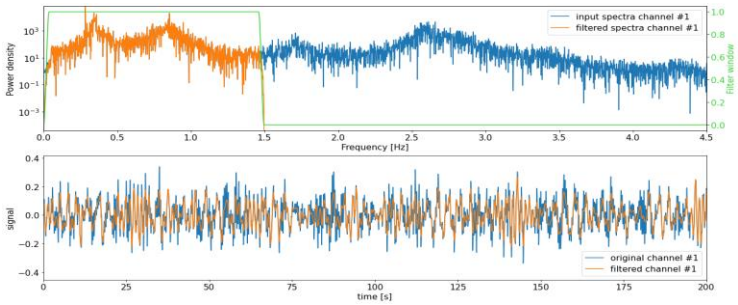
- Ticket 45 k€/year/Sponsor for 2 years
- Kick-off meeting : 29 June 2023 (1.30pm – 5.00pm)



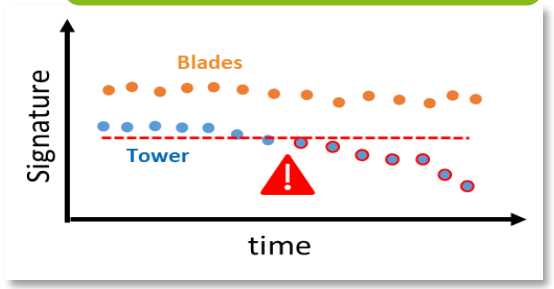
FOCUS ON METHODS

- Operational Modal Analysis allows to fit the model (WP3) and detect structure defects with mode changes (WP5)

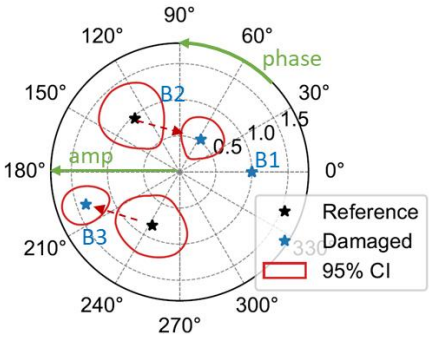
Vibration timeseries



Vibration signature



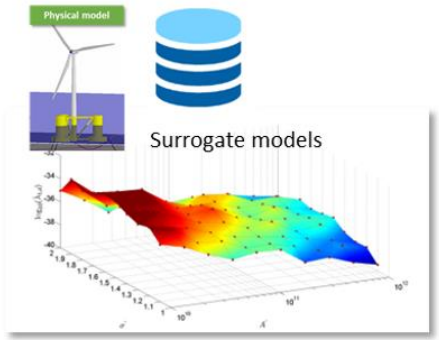
Phase Amplitude diagram



- Surrogate models are used to compute efficiently the fatigue (WP4) from 10 min available data (machine learning, modal expansion)

10 min SCADA statistics

Sensors Raw Data



KPIs

- **Loads**

PROJECT OUTCOMES

- At the end of the project, sponsors will gain a comprehensive view of the methodologies to be used to achieve the required functionalities and associated impacts

Functionalities	Outcomes	CAPEX	OPEX	REVENUE
Optimal monitoring configuration	• Minimization of the instrumentation cost • Achievement of monitoring objectives	X	X	
Fatigue Loads Monitoring	• Estimation of lifetime consumption (predictive maintenance) • Lifetime extension or retrofit • Optimization of new designs (less conservatism)	X X	X	X
Structural Vibrations & Motion Monitoring	• Early Faults Detection (predictive maintenance)		X	
Electrical Production Monitoring	• Production Optimization			X

- Deliverables
  - Technical reports (data, methodologies, results)
  - Presentations & minutes of workshops
  - Surrogate models
  - Access to case-specific executable R&D prototypes