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Final measurement campaign at La Jument lighthouse to optimise the design of offshore wind turbines

France Energies Marines is coordinating two collaborative R&D projects aimed at better understanding and predicting breaking waves in order to optimise the design of offshore wind turbines. Originality of these projects: using offshore structures as experimental devices at scale 1 and carrying out measurements directly in the field. The fourth and final data acquisition campaign at La Jument lighthouse has just begun.

Left: Member of the scientific team at the La Jument lighthouse gallery level (© France Energies Marines) - Right: Giant breaking wave (© Air Vide et Eau Production)

Better forecasting of breaking waves to optimise the design of offshore wind turbines

During storms, wind turbines are subjected to high wave amplitudes, which are taken into account in the stability calculations during the design phase. Among these waves, breakers are a particular danger because of the extreme loads they can induce on the superstructures. In order to refine the design of offshore wind turbines and ensure their resistance to storm events, it is important to collect information on the occurrence and characteristics of breakers and the loads they generate. It is with this objective in mind that France Energies Marines is leading the DIME and DIMPACT collaborative R&D projects that focus on the creation of breaking waves offshore observatories.

An unprecedented experiment at sea

The DIME project, initiated in 2017, includes an unprecedented experiment carried out near the Ushant island, with the support of Cerema, Phares et Balises, Sécurité civile, Ifremer, Shom and Helmholtz-Zentrum Geesthacht. The principle: to use La Jument lighthouse, located in an area representative of the bathymetry of the areas where floating wind turbines are installed, as an experimental device on a scale of 1 and to carry out measurements directly in the field. A current profiler located at the foot of the building and a wave buoy anchored 2 km to the west provide in-situ information on waves and surrounding currents. Accelerometers quantify the movements of the building and three pressure sensors installed on its façade determine the forces exerted by the waves. State-of-the-art equipment has also been installed at the top of the lighthouse: a stereoscopic camera system allows the three-dimensional shape of the waves to be reconstructed, and a radar allows the wave field to be mapped on a larger scale. A measurement campaign has been conducted every winter since December 2017. The fourth and final campaign has just begun.

▶ The approach in video: **https://www.youtube.com/watch?v=kpVcGLJKLHU**

A breaking wave of more than 24 m recorded

During the second winter measurement campaign, a giant 24.6 m high breaking wave (ridge to trough) was observed in three dimensions using a stereo-video camera system. It was also possible to correlate it with the acceleration of the structure: a world first! A scientific article was published on the subject in the very selective peer-reviewed journal Philosophical Transactions of the Royal Society A. At the end of the final measurement campaign that has just begun, a major analysis of the data collected will contribute to significantly improving the predictability of high amplitude breaking waves. Following these methodological developments, the DIMPACT project, initiated in 2020, will conduct a new experiment at sea, this time on a floating wind turbine, in this case Unitech Zefyros, deployed off the Norwegian coast.

- Scientific article online: **https://royalsocietypublishing.org/doi/10.1098/rsta.2019.0008**

A scientifically and technically rich context

The DIME and DIMPACT projects receive funding from the members and partners of France Energies Marines, which, as an Institute for Energy Transition, benefits from French State aid managed by the National Research Agency under the Investments for the Future programme. The experimentation conducted on La Jument lighthouse has specifically received support from the Filière Mer du Crédit Agricole. Coordinated and scientifically leaded by France Energies Marines, these projects bring together a total of 27 academic and private partners with complementary skills and contributions, guaranteeing high-quality scientific work.

- Projet DIME (ANR-10-IEED-0006-14): **www.france-energies-marines.org/en/projects/dime**
- Projet DIMPACT ANR-10-IEED-06-34): **www.france-energies-marines.org/en/projects/dimpact**

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DIME project partners

Duration: 42 months (2017-2021) | **Budget:** €1,664 k

DIMPACT project partners

Duration: 40 months (2020-2024) | **Budget:** €2,600 k