

D.1.1.1 Paimpol-Bréhat Test Site Report

CONFIDENTIAL



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1 Tables, references and acronyms

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- [2] Prefectural decree authorising under the Environmental Code the establishment of a tidal turbine demonstration park in the marine environment, 30/03/2011, transferred to the OPEN-C Foundation on 25/09/2025 under Article R. 187-47 of the Environmental Code
- [3] Order No. 2016/134, Regulatory Order within the Paimpol-Bréhat Park, 16/12/2016
- [4] PI1-ENV-RP-001_Rapport METOC Paimpol-Bréhat V1.1
- [5] Decree No. 86-606 of 14 March 1986 on nautical commissions
- [6] Plan de Coordination Maritime – PAIMPOL-BREHAT
- [7] Maritime Intervention Plan – PAIMPOL-BREHAT
- [8] Electrical Coordination Plan – PI1-ELE-SP-001_Plan-Coordination-Electrique_PAIMPOL
- [9] Technical note of 21 April 2022 on the organisation of search and rescue in and in the immediate vicinity of offshore wind installations

1.5 Acronyms

AIS	Automatic Identification System
ADCP	Doppler current meter
BT	Low Voltage ($U < 1\text{kV}$)
CARD-I	Feed-in Distribution Network Access Contract
CNL	Local Nautical Commission
CROSS	Regional Operational Surveillance and Rescue Centre
CUDPM	Concession for the Use of the Public Maritime Domain
DDTM	Departmental Directorate of Territories and the Sea
DPM	Maritime Public Domain
DRFIP	Regional Directorate of Public Finances
EMR	Marine Renewable Energies
ETM	Metal trace elements
FO	Fiber Optics
HAZID	HAZard Identification
HTA	High Voltage A ($1\text{kV} < U < 50\text{kV}$)
LAT	Lowest Astronomical Tide

MWS	Marine Warranty Surveyor
PDL	Delivery Station
PIM	Maritime Response Plan
PREMAR	Maritime Prefecture
QHSE	Quality, Health, Safety, Environment
ROV	Remotely Operated Vehicle
DPR	Public Distribution Network
SCADA	Supervisory Control and Data Acquisition
SNIA	National Airport Engineering Service
STAC	Civil Aviation Technical Service
VLAN	Virtual Local Area Network
VPN	Virtual Private Network

2 Introduction

2.1 Background

The Paimpol-Bréhat test site is intended to test tidal turbines, which can be connected to the electricity distribution network. The Paimpol-Bréhat site is also intended for research and development activities on system equipment, its environmental impact and its in-service monitoring.

In addition to the collaboration agreement signed between the OPEN-C Foundation ("OPEN-C") and the entity in charge of the on-site demonstrator ("the Company"), this document specifies the framework and requirements of the State services and OPEN-C relating to the hosting, on the Paimpol-Bréhat site, of a demonstrator developed by the Company. He describes:

- The site and its infrastructure
- The regulatory framework and the process for hosting demonstrators on site
- Characterization of the site's environmental conditions
- The regulatory framework and the Parties' commitments in terms of environmental monitoring
- Maritime safety rules to be respected on the site
- The constraints associated with the electrical connection to the Public Distribution Network (PDR)
- Obligations in terms of data sharing/communication via OPEN-C's SCADA system
- Insurance and certification conditions

2.2 Presentation and occupancy of the test site

The Paimpol-Bréhat tidal energy site is located in Brittany, in the Côtes-d'Armor department, in the north-east of the island of Bréhat.

The Paimpol-Bréhat test site, shown in Figure 1 and Figure 2 includes:

- An area at sea on the Public Maritime Domain (DPM), which benefits from the authorisations [1] and [2], and which is located about 8 nautical miles (15km) from the cable's landing beach in Ploubazlanec. The site is located in the Trégor-Goëlo Natura 2000 area. The geographical coordinates of this 0.035 km² experimental area are defined in the Concession for the Use of the Public Maritime Domain (CUDPM) [1] and specified in the Table 1. The depth of the site is between 25 and 42m LAT. The area is not the subject of on-site signage but it is represented on the nautical chart and is delimited by its four georeferenced corners:

Table 1: Geo-referenced coordinates of the sea trial area

WGS84-UTM30 N	Latitude	Longitude
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North	48°54.62'N	002°53.48'W
East	48°54.56'N	002°53.31'W
South	48°54.49'N	002°53.37'W
West	48°54.56'N	002°53.54'W

- A dedicated electricity network, connected to the public electricity distribution network and made up of:
 - | A 15km export cable connected to the Paimpol-Bréhat HV substation under a voltage of 5.5kVac and for a maximum current of 360A. The maximum injection power at the HV substation is limited to 2.5MW.
 - | An HVA substation (20kV), located at 25, rue de Launay Mal Nommé, in Ploubazlanec (22,620) and connected to the public electricity distribution network.
- A secure computer network consisting of:
 - | 12 optical fibers (FO) with a capacity of 1Gb/s digitally connecting the offshore site to the shore substation. The substation will be equipped with a 4G internet connection 30Mbps down / 10 Mbps up.

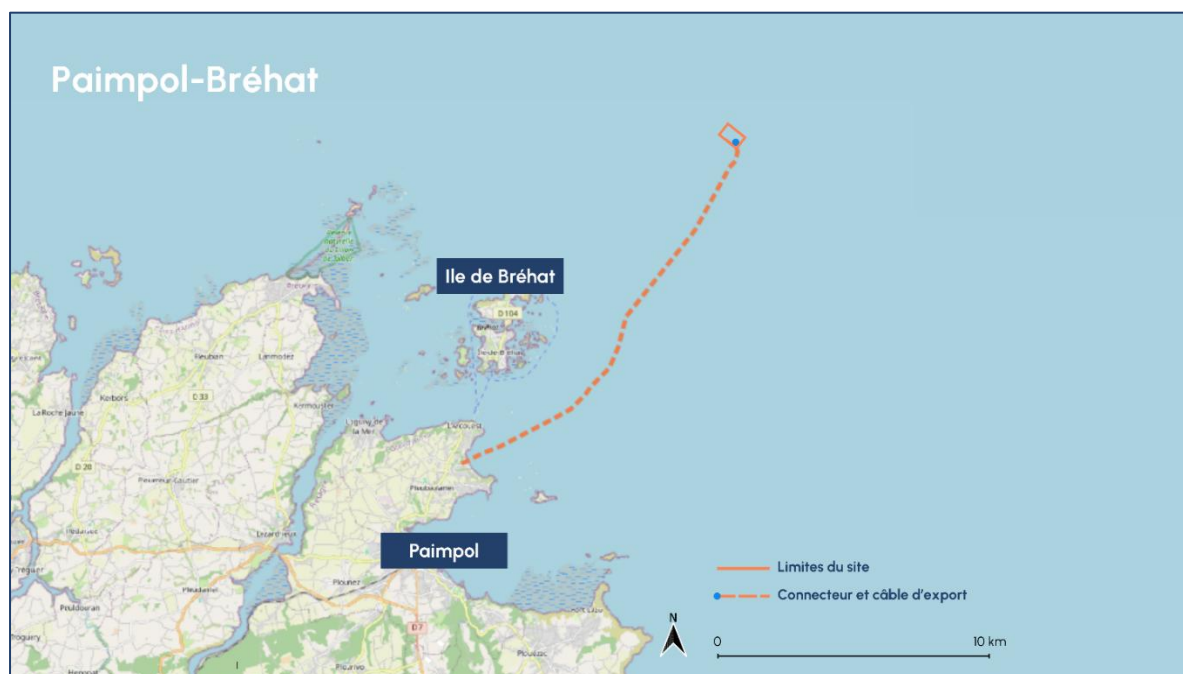


Figure 1: Location of the offshore area of the Paimpol-Bréhat site

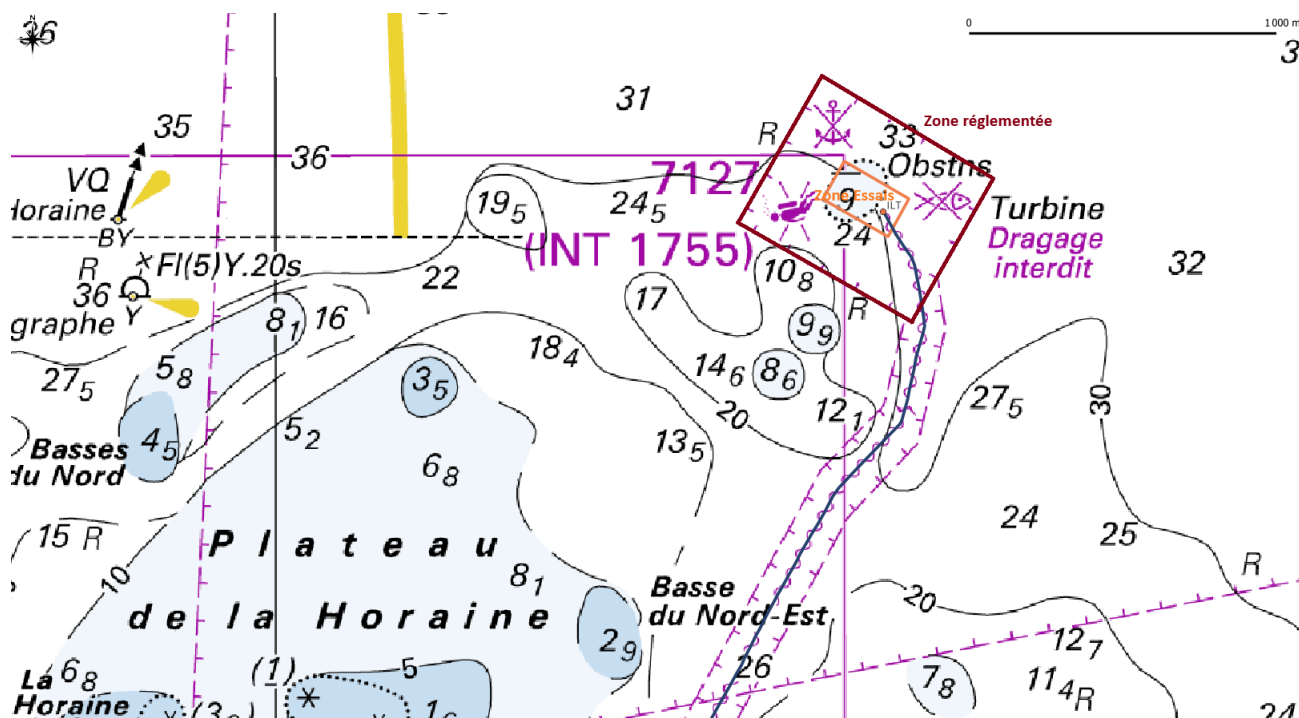


Figure 2: Paimpol-Bréhat sea trial site – Trial area & Restricted area

2.3 Characterization of the site's environmental conditions

The Foundation makes available the meteocean data (wind, wave, current, tide) of the Paimpol-Bréhat test site in the 9.2 Appendix 2 – Metocean Report Summary and in the complete version [4] PI1-ENV-RP-001_Rapport METOC Paimpol-Bréhat V1.1. It presents a meteo-ocean analysis based on a Measure-Correlate-Predict approach, in a consolidated report that simultaneously provides tidal current, wind and swell data. It uses data from more than six months of ADCP measurement campaigns, 38 years of wind measurements on the island of Bréhat (MÉTÉO FRANCE) and 3 years of wave measurements (CEREMA).

The report provides useful statistics for machine design, such as current, wind and wave values for return periods of 2 to 100 years, in different directions.

It also makes it possible to predict the rise of the water and the speed of the currents thanks to a tidal analysis. Graphs such as compass rose and waves, as well as distribution diagrams, are included for the tide and ebb phases.

This document should serve as a basis for the design of the various components of the demonstrator, in particular for the design of subsea elements and associated accessories (cables, anchors, submerged systems, etc.), for the determination of the behaviour of floating systems, and for the determination of systems subjected to hydrodynamic forces.

3 Regulatory framework

3.1 Environmental Approvals and Concessions

The Paimpol-Bréhat test site is the subject of a Seabed Lease for the use of the Public Maritime Domain (DPM) [1] and an environmental authorisation under the Water Act. These decrees set out the conditions for the use of the test site:

- The demonstrators tested: tidal turbine technologies;
- The geographical boundaries (area of 0.035km² mapped via its four georeferenced corners) as well as the route of the export cable and the location of the concrete protective mats;
- Environmental monitoring to be implemented (see section 7);
- The need to rehabilitate the site at the end of each experiment.

The Seabed Lease [1], as well as the environmental authorisation and its amendments, define the responsibility of the test site manager vis-à-vis the demonstrators and the rules for the operation of the site, in particular for the onboarding of new systems that must comply with the business process described below, section 3.2.

3.2 Procedure for the installation of a demonstrator

The Table 2 below is the responsibility matrix that governs the hosting of a demonstrator at the test site, as well as the main associated deliverables.

The conditions of access to the site and the demonstrator during the operation phase are described in the Maritime Coordination Plan [6].

The applications must demonstrate that the project is carried out in accordance with the requirements of the authorisation orders, particularly in terms of environmental impact and safety at sea. They are intended for the State services concerned (DDTM, PREMAR, CROSS, etc.) and for the members of the Local Nautical Commission (CNL), in cases where it is necessary to convene it.

The expected contents of the folders are described in the following sections. Templates prepared by OPEN-C will be provided to the Company.

Table 2: Responsibility matrix related to the hosting of a demonstrator

Phase	Deliverable	Company	OPEN-C	French State services
1. Preparation	Collaboration agreement between OPEN-C and the Company	A	R	I (DDTM, Prémarm)
	O-9 month Demonstrator Dossier at the latest	R*	C	A (DDTM, Prémarm)
	Installation Procedure + HAZID <i>O-4 months</i>	R	A	I (DDTM, Prémarm)
	Works Documentation 3.2.2 <i>O-3 months</i>	R*	C	A (DDTM, Prémarm)
	Decommissioning bond (3.2.4) <i>O-3 months at the latest</i>	R	A	A (DDTM)
	Risk Analysis (HAZID) Exploitation <i>O-3 months</i>	R	C	-
	Maritime Response Plan (MIP) installation and operation, <i>O-2 months</i>	R*	C	A (Prémarm, CROSS Etel)
	Holding of a Local Nautical Commission (CNL), at the discretion of the State Services <i>O-2 months</i>	C	C	R/A (DDTM)
2. Installation	Installation Report	R	A	I (DDTM, Prémarm)
	Commissioning tests	R	A	I (DDTM, Prémarm)
3. Operation	Maritime Intervention Plan (PIM)	R*	C	A (Prémarm)
	Environmental Monitoring Reports	C	R	A (DDTM, Prémarm)
4. Dismantling	Works Documentation	C*	R	A (DDTM, Prémarm)
	Dismantling procedure	R	A	I (DDTM, Prémarm)
	Decommissioning Report	C*	R	A (DDTM, Prémarm)
	Waiver of the decommissioning bond	R	I	A (DDTM)
Legend	Y = Date before transactions *based on a report template provided by OPEN-C R: Responsible - Responsibility for writing the document / carrying out the activity A: Accountable – Approval, Validation C: Consulted – Advice, contribution, review, expertise or opinion I: Informed – Information			

3.2.1 Demonstrator Dossier

The Demonstrator Dossier is a document presenting the project and includes at least the following elements:

- General description of the project, the test program and its objectives;
- Planning with the main milestones for the installation, operation and dismantling of the demonstrator;
- Description of the system as a whole and its specificities, allowing a simple and concise understanding of how the system works, is anchored on the DPM and connected to the Paimpol-Bréhat electricity network. The technical descriptions must in particular make it possible to ensure that there is no impact on the environment other than those presented in the impact study;
- Description of the methods envisaged for the operations (installation, commissioning, operation and maintenance);
- A Natura 2000 impact study, intended to update the impact study related to the test site;
- Environmental monitoring program;
- Preliminary Risk Analysis (HAZID) to identify risks to people, the environment, maritime activities and air traffic. The measures taken to mitigate these risks must be described in the Dossier;
- Insurance plan;
- Description of the methods envisaged for dismantling, including an assessment of its cost.

According to Article 3-1 of the CUDPM, the Demonstrator Dossier is presented to the State services at least 9 months before the start of the planned test campaign and a final version is submitted at least 6 months before the tests. Any significant change in the reception project may result in the updating of the Demonstrator Dossier.

3.2.2 Works Documentation

The Works Documentation is a document presenting the marine installation operations, specific operations or dismantling. It can be used in whole or in part as a support for a possible CNL and it includes at least the following elements:

- General description of the operation, including its timeline and operational limitations;
- List of subcontractors;
- Characteristics of the components handled on site (specifications, plans, certificates, test reports);
- Description of the nautical means used;
- Operating procedures for the various elements making up the demonstrator;
- Description of the commissioning procedure (if relevant);
- QHSE plan;
- Risk analyses;

- Risk prevention plan;
- Insurance.

3.2.3 Local Nautical Commission

A Local Nautical Commission (CNL) may be convened, at the request of the State services, if a specific regulation (restriction of certain uses outside the already regulated area, towing, etc.) should be adopted by the maritime prefect in view of the planned work. In this case, the CNL is responsible for issuing an opinion to inform the decision of the maritime prefect concerning the navigation rules during the operation.

The terms and conditions related to the CNL are framed by legislation [5]. The Works Documentation may be sent (in whole or in part) to the members of the CNL.

3.2.4 Dismantling bond

The complete dismantling of the demonstrator/prototype elements and the restoration of the area are one of the obligations of the concessionaire of the Paimpol-Bréhat site.

The OPEN-C Foundation will have to provide a guarantee with the Caisse des Dépôts et Consignation equal to the cost of the dismantling. The demonstrator/prototype can only be authorised to be installed on the Paimpol-Bréhat site once the receipt of deposit of funds has been sent to the DDTM.

The Company must support the provision of this deposit by a financial transfer of the amount to be deposited with the OPEN-C Foundation, in accordance with the terms and conditions defined in the Hosting Agreement concluded between the Company and the OPEN-C Foundation.

The dismantling deposit may only be deposited and returned once the demonstrator has been completely dismantled and the site has been restored by the Company.

4 Maritime coordination

4.1 Maritime Coordination Plan

The Maritime Coordination Plan or PCM [6] defines the rules for the coordination of maritime activities and the terms and conditions of access to the Paimpol-Bréhat test site, thus ensuring a high level of maritime safety. It determines a common reference system for the various companies working on the test site, on behalf of the site manager or the entities hosted for testing. It is also intended for all parties potentially concerned by the risks associated with the activities taking place within its perimeter and its immediate surroundings.

More specifically, the maritime coordination plan includes the following sections:

- Presentation and occupation of the test site: organization, occupation of the DPM, equipment on site, contacts of entities, etc. ;
- General conditions of access to the test site: general safety rules, navigation safety zones, general terms and conditions of access to the site;
- Special conditions of access for site visits;
- Special conditions of marine operations in the test site;
- Installation or dismantling operations;
- Conduct of search and rescue operations.

In order to prepare for the reception of the demonstrator, the Maritime Coordination Plan for the Paimpol-Bréhat site will be provided by OPEN-C to the Company, in a version reflecting the current state of the site before the arrival of the new demonstrator. It will then be updated during the project in order to integrate the future demonstrator.

4.2 Risk analyses

In order to guarantee the safety of the equipment and demonstrators present on the test site when a new demonstrator is received, the Company is asked to conduct several risk analyses:

- Preliminary risk analysis, such as HAZard IDentification (HAZID), covering all phases of the project's life. This risk analysis will be included in the Demonstrator Dossier (section 4.2).
- Risk analysis of the demonstrator installation procedure. This risk analysis is usually carried out by the maritime operator in charge of the installation, with the participation of OPEN-C and, if applicable, the Marine Warranty Surveyor (MWS). This risk analysis makes it possible to consolidate the installation procedure, as well as the Maritime Intervention Plan (PIM) installation if necessary (section 4.3).
- Risk analysis, HAZID type, dedicated to the operation phase, and based on the detailed design of the demonstrator. This risk analysis makes it possible to consolidate the operational PIM (section 4.3), as well as the safety signal exchange table (section 6.4).

- Risk analysis of the demonstrator dismantling procedure, paid for by the maritime operator in charge of the dismantling, with the participation of OPEN-C and, if applicable, the MWS.

In the event of significant operation and maintenance activity of the demonstrator during the operation phase, OPEN-C reserves the right to ask the Company for a review of the operating procedures and additional risk analyses.

The conduct of these risk analyses is strongly recommended in the form of meetings/workshops, facilitated by an external facilitator and involving the project stakeholders (Company, Organisation, installer, MWS, operator, etc.).

4.3 Maritime Response Plan

The Paimpol-Bréhat Maritime Intervention Plan (PIM) [7] defines the organisation set up by the OPEN-C Foundation in order to react to emergency situations that may arise in and around the Paimpol-Bréhat test site. It determines a common reference framework for the various entities involved in the test site and concerned by the risks associated with the activities taking place on the site.

A PIM specific to the demonstrator is established and implemented by the Company in coherence with the PIM of the Paimpol-Bréhat test site [7], and for each phase of the life of its test project: Installation / Operation / Heavy maintenance / Dismantling.

The work of drafting the PIM by the Company, and the exchanges with the Maritime Prefecture as well as the CROSS Etel must be well anticipated several months in advance, with a view to validation and signature of the PIM by the Maritime Prefecture two weeks before the installation of the demonstrator on the test site.

The expected content of the PIM is inspired by the [9] and recalled below:

- Emergency numbers to reach the operator 24 hours a day, 7 days a week (document header)
- Context of the MIP and project description
- Risk analysis and risk control measures
- Operator's Emergency Management System
- Annexes: risk analyses, list and characteristics of personal and collective protective equipment, means available to the operator to contribute to the management of emergency situations, emergency notification diagram, etc.

4.4 Towing

In the event of a towing of the demonstrator to the test site, the regulatory framework is IMO Resolution [A.765](#) "Guidelines on the Safety of Towed Ships and Other Floating Objects", as well

as IMO Circular [MSC/Circ.884](#) "Guidelines for the Safety of Towing at Sea" taken into account in French law by [Decree No. 2014-330](#) of 13 March 2014.

4.5 Presence of Foundation staff during key operations

When a demonstrator is hosted on site, the presence of representatives of OPEN-C on the construction site or on board during marine operations may be required at several key moments:

- Before installation: visit of the demonstrator on land (e.g. assembly site, dockside, etc.).
- During the installation: presence of one or more representatives of OPEN-C on board the vessels used for the installation.
- Operation:
 - | Occasional presence of representatives of OPEN-C on board the vessels (environmental monitoring, network and electrical infrastructure, R&D projects, etc.). The number of people, equipment, actions on board, and duration of intervention will be adapted to each demonstrator and specified later, and will comply with the operator's rules.
 - | In the event of significant marine operations related to the demonstrator during the operation phase (e.g. heavy maintenance), OPEN-C reserves the right to ask the Company to be present on board the vessel to guarantee the safety of the equipment present on the test site.
- During the dismantling: presence of one or more representatives of OPEN-C on board the vessel used for the dismantling.

4.6 Operation Report

The Foundation wishes to have precise knowledge of the XYZ position of all the structures and equipment implemented by the Company in the context of the installation of the demonstrator (foundations, anchors, anchor lines, cables, connectors, demonstrator, etc.) or operations on it.

It will be up to the Company to implement all means (ROV, USBL sonar, video, metrological means, etc.) to allow a precise re-gluing of the position of the equipment after each intervention (*As Laid*) and at the end of the operation (*As Built*).

The Company will also transmit the *As Built specifications* of the installed equipment performing the bottom-to-surface link (cable and anchorage).

An installation report including these elements will be drawn up by the Company and sent to OPEN-C within one month of installation.

For any significant transaction, an operating report will also be drawn up by the Company and sent to OPEN-C.

A dismantling report will also be requested post-operation to ensure that operations are running smoothly and that all the system and associated equipment are removed.

5 Electrical coordination

5.1 Presentation of electrical infrastructures

The Paimpol-Bréhat electricity network consists of:

- an onshore substation, or "Delivery Substation" (PDL), HVA 20 kVAC connected to the Enedis public distribution network. The delivery station is located at 25, rue de Launay Mal Nommé, in Ploubazlanec (22 620);
- a 15km submarine cable, or "export cable", with an electrical power of 5.5 kV AC and 260 A, equipped with 12 Optical Fibers [FO];
- a *dry-mate* connector at the end of this cable.

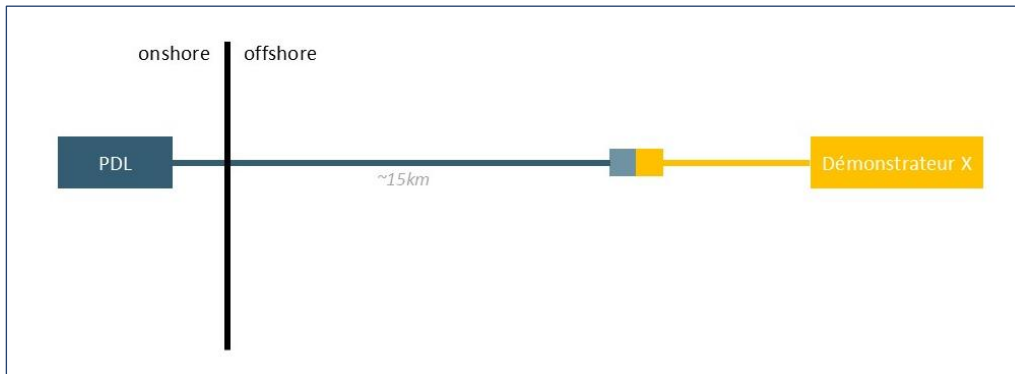


Figure 3: Principle of connection to the Paimpol-Bréhat network

5.2 Single line diagram of the delivery station

The onshore substation is the physical and legal interface between the Paimpol-Bréhat electricity network (private domain) and the Enedis electricity network (public domain). It ensures a role of protection and management of electrical parameters and energy flows between the offshore grid and the distribution network. The simplified single-line diagram of the Paimpol-Bréhat substation is presented in Figure 4.

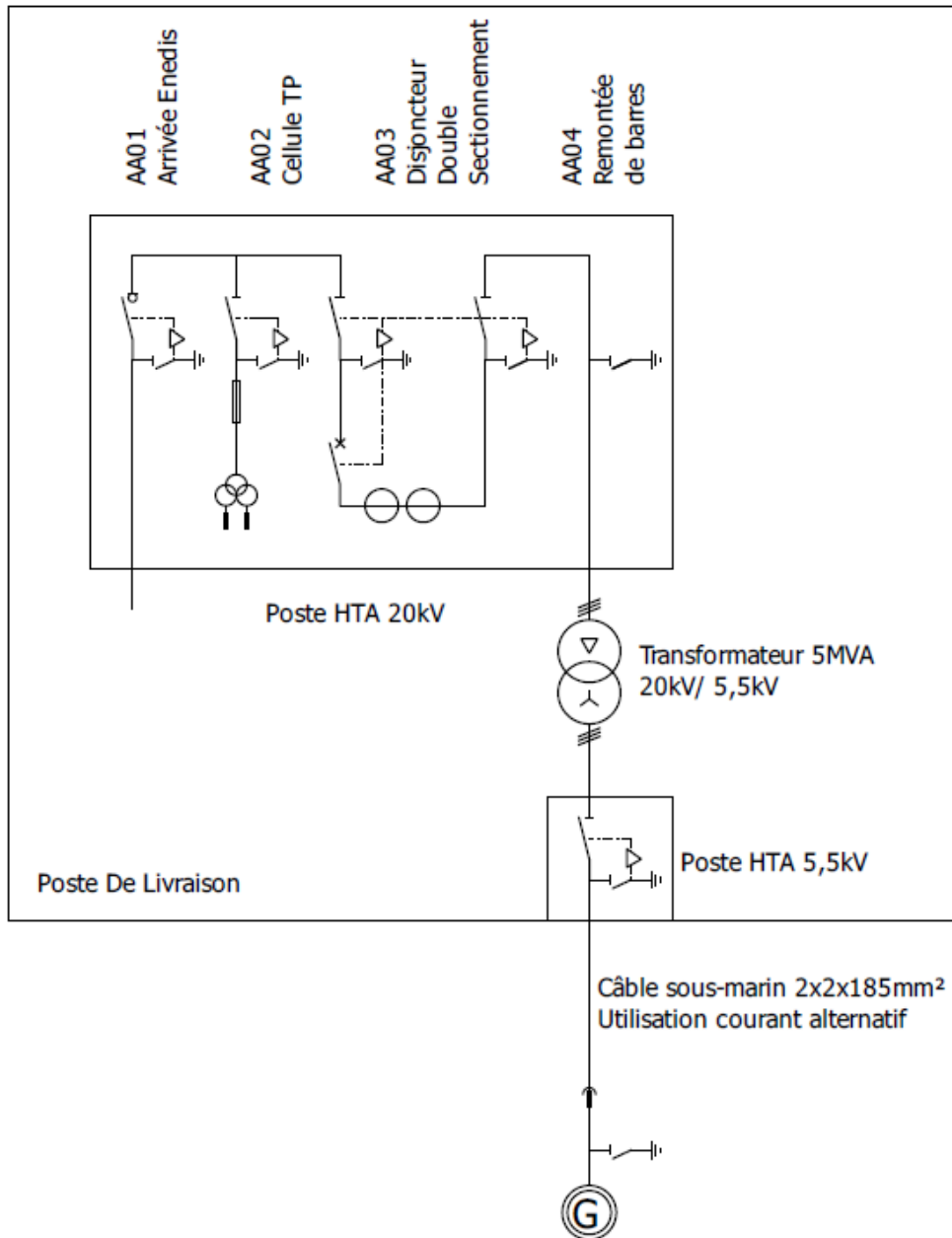


Figure 4 : Projected single-line diagram of the HV network at the Paimpol-Bréhat site

5.3 Electrical coordination plan

The electrical coordination plan or PCE [8] specifies the contractual rules to ensure a high level of electrical safety at the Paimpol-Bréhat test site. The electrical coordination plan covers the following topics:

- Presentation of the electrical infrastructure of the test site.
- Electrical grid operating rules and limits.

- Identification of electrical operating managers within the meaning of the NF C18-510 standard.
- Exchange of electrical and safety operating data.
- Procedures for submarine cable lockout/lockout operations.

In order to prepare for the reception of the demonstrator, the electrical coordination plan for the Paimpol-Bréhat site will be provided by OPEN-C to the Company. It will be updated to integrate the demonstrator or to report on developments.

5.4 Electrical Studies

OPEN-C, and its possible electrical operations manager, operates the Paimpol-Bréhat electricity network. As a result, it is the sole interlocutor of Enedis and undertakes to take the necessary steps to update the agreements and/or contracts (connection agreement, CARD-I, operating agreement, etc.) according to the needs of the demonstrator and the evolution of the test site.

The connection of the demonstrator requires OPEN-C to carry out, at a minimum, the following studies:

- A connection study, allowing the network to be modelled with the demonstrator.
- A declaration to Enedis of the electrical characteristics of the demonstrator and the expected state of the Paimpol-Bréhat network (resumption of the study, disruptive customer sheets, etc.). In the case of a resumption of the study, it consists of the declaration of the demonstrator and the verification of compatibility with the Enedis network. It leads to the updating of the connection agreement, the CARD-I and the operating agreement.
- An update of the selectivity study of the Paimpol-Bréhat network, allowing the definition and adjustment of the protection equipment of the Paimpol-Bréhat network and the demonstrator (calculation of short-circuit currents, decoupling protections, etc.).
- A reactive power regulation study, in order to ensure compliance with the requirements of the public distribution network (Enedis) in terms of injected/absorbed reactive power, or to provide for the implementation of the necessary regulation or compensation means if necessary.
- A study of the voltage plane, making it possible to verify that the HVA voltages of the demonstrator are in accordance with the operating ranges of the equipment and to determine any adjustments to be made.

The Company undertakes to provide OPEN-C with the data from the demonstrator necessary for the proper performance of these studies, in particular the data requested in the collection sheets that will be used for the resumption of the study carried out by Enedis, if applicable.

The Foundation undertakes to provide the Company with the network data necessary for the sizing of the demonstrator, according to the needs expressed by the Company. In particular, the sizing studies carried out by the Company may include:

- A selectivity study on the demonstrator side, allowing the definition and adjustment of protective equipment respecting the principles of selectivity (calculation of short-circuit currents, decoupling protections, etc.) at the prototype level, and the results of which will feed into the selectivity study at the test site;
- A pre-harmonic study (*optional*), prior to the resumption of the study carried out by Enedis, to anticipate the analysis of the harmonics generated by the installation (consumption or production), to verify compliance with the thresholds (regulatory limits, energy code) and to propose means of action if necessary (anti-harmonic filter, converter regulation, etc.).

5.5 Electrical and optical testing

The commissioning of the Paimpol-Bréhat submarine electrical network, after connection work, cable handling or major HV electrical work, is subject to the completion of electrical and optical tests in accordance with a protocol validated between the Company and OPEN-C, in the presence of the Company and OPEN-C, demonstrating the electrical integrity of the work. Performing electrical and optical tests before, during, and after offshore operations is therefore essential to ensure the integrity of the network, or to be able to take corrective actions quickly in the event of a fault.

The tests recommended by OPEN-C are listed in the Table 3, and follow the standards and recommendations in force (e.g. IEC 63026:2019).

Table 3: Electrical and optical tests

Type of test	Checks carried out	Description
Electric	Breakdown tests or Insulation stiffness test at 2U0	The insulation stiffness test according to IEC 60502-2:2014 (Clause 20.3.1-c) or IEC 63026:2019 (Clause 13.3) is performed by the use of TBF (Very Low Frequency) sinusoidal voltage sources to verify the implementation of the cable and its accessories (also known as breakdown tests). For installations that have already been in operation, lower voltages and/or shorter durations (2 U0) are permitted.
Optics	OTDR / 1550nm Reflectometry Measurement	Measurement by reflectometry makes it possible to characterize the different fiber sections and all the events present on the optical link.

The Company will be required to provide the following:

- The results of the FAT following the exit of its dynamic cable from the factory in order to attest to the integrity of the cable to be installed;
- The anticipated test plan for the offshore operations of installation, connection or maintenance of the Company's dynamic cable, including at least the tests of the Table 3;
- The results of these tests in the form of a report including the results and calibration certificates of the equipment. Especially for optical tests, the results will be presented in the form of a table, indicating for each fiber: its length (km), the measured attenuation (dB), and the deviation from the attenuation at the initial state. The report will also specify the parameters of the test: wavelength (nm), refractive index, pulse (μ s) and duration (s). The source files of the OTDRs as well as the files in .pdf format will be provided to OPEN-C.

The realization of electrical and/or optical qualification tests (tan delta, resistance, capacitance,...) and intermediate tests to validate the critical phases of operation is strongly recommended by OPEN-C.

As part of these tests, OPEN-C undertakes to:

- Provide the results of electrical and optical tests of the Paimpol-Bréhat network previously carried out by OPEN-C and corresponding to the initial state before the works;
- Take the necessary steps to consign the Paimpol-Bréhat submarine network and provide a certificate of consignment to allow the associated work and tests to be carried out;
- Provide access to the onshore substation in order to be able to connect the necessary test equipment;
- At the end of the installation of the demonstrator, OPEN-C will be able to carry out a power-up test for 24 hours with the system's nominal operating voltage.

5.6 Protection of the Paimpol-Bréhat network

OPEN-C asks the Company testing a demonstrator on the Paimpol-Bréhat site to guarantee that the connector at the interface between OPEN-C's cable and the Company's cable does not suffer damage during the life of the project, in order to guarantee the proper functioning of the Paimpol-Bréhat electricity network.

In addition, OPEN-C asks the Company to guarantee a sufficient length of cable to be able to reassemble the connector at the interface between the parties, in the event of a defect or damage rendering the electrical network inoperable.

6 Information system

The sections below will be progressively completed in line with the evolution of the site architecture.

6.1 Optical network

TBD

6.2 Communication

TBD

6.3 SCADA System

TBD

6.4 Data exchange

TBD

7 Environmental impact monitoring

7.1 Environmental monitoring

Within the framework of the Seabed Lease for the use of the Public Maritime Domain [1] and the Environmental authorisation under the Water Act [2], the prototypes tested must demonstrate the absence of any new environmental impact and carry out follow-up measures to ensure this. These follow-up measures will be determined on a case-by-case basis for each demonstrator, in particular with regard to the updating of the Natura 2000 impact study which will be presented in the Demonstrator Dossier.

For information purposes, the measures currently in force are those defined in the amending prefectural decree of 18/04/2019 :

- Before the tidal turbine is installed,
 - | Description of the substrate and benthic support (fauna and flora) on the surface of the land and around the tidal turbine (area potentially affected by the variation of currents),
 - | Initial state noise
- During the tidal turbine operation phase,
 - | Description of the substrate and benthic support (fauna and flora) on the surface of the land and around the tidal turbine (area potentially affected by the variation of currents),
 - | Water temperature measurement,
 - | Water velocity in the vicinity of the tidal turbine (determine the area of influence of the tidal turbine in maximum operation),
 - | Carrying out an acoustic study in order to characterize and evaluate, during normal operation, the sound footprint of the tidal turbine, with evaluation of the impacts on the species and determination of the zones (distances) of effects
- At the end of the test phase, and after (within 2 months) the removal of the tidal turbine,
 - | Description of the substrate and benthic support (fauna and flora) on the surface of the land and around the tidal turbine (area potentially affected by the variation of currents)

Environmental monitoring is managed by the OPEN-C, in close coordination with the Company. The report on the follow-up measures, accompanied by all the elements of assessment (comparative initial/operating/post-removal state) must be sent to the Prefect of the Côtes d'Armor within 3 months of the removal of the demonstrator.

The Company will also implement any follow-up it deems necessary.

The Company undertakes to comply with the regulatory requirements defined in terms of environmental monitoring and undertakes to facilitate the implementation of monitoring, in particular through the sharing of data (videos, sensors, etc.) or by facilitating the installation of environmental sensors.

OPEN-C is committed to facilitating the environmental monitoring offered by the Company, in particular through the development of dedicated research projects.

7.2 The Environmental Monitoring Committee

An Environmental Monitoring Committee for the test site has been set up by the State services. Chaired by the Prefect of the Côtes d'Armor or his representative, it is currently composed of representatives of:

- State services (DDTM, DREAL, Maritime Prefecture, ARS, OFB)
- Local authorities (Guingamp-Paimpol Agglomération)
- of sea fishing and shellfish farming (CDPEM, Regional Committee for Shellfish Farming in Northern Brittany)
- Trégor-Goëlo Natura 2000 Steering Committee
- Expert scientific bodies (CEREMA, SHOM, Ifremer, CNRS, France Energies Marines, Océanopolis, UBO, Ademe, MNHN, etc.).

The Monitoring Committee is informed and consulted on the evolution of the installations, the maintenance methods, the constraints induced by the presence and operation of the demonstrators, the environmental impacts that would come to light over time as well as the dismantling measures.

As this is an experimental site, the representatives and services of the State will be informed of the results obtained and the technical and environmental data collected.

7.3 A test site in a Natura 2000 area

The test site is located within two Natura 2000 areas: the Special Area of Conservation (SAC) No. FR5300010 "Trégor-Goëlo" and the Special Protection Area (SPA) No. FR5310070 "Trégor-Goëlo" (Figure 5).

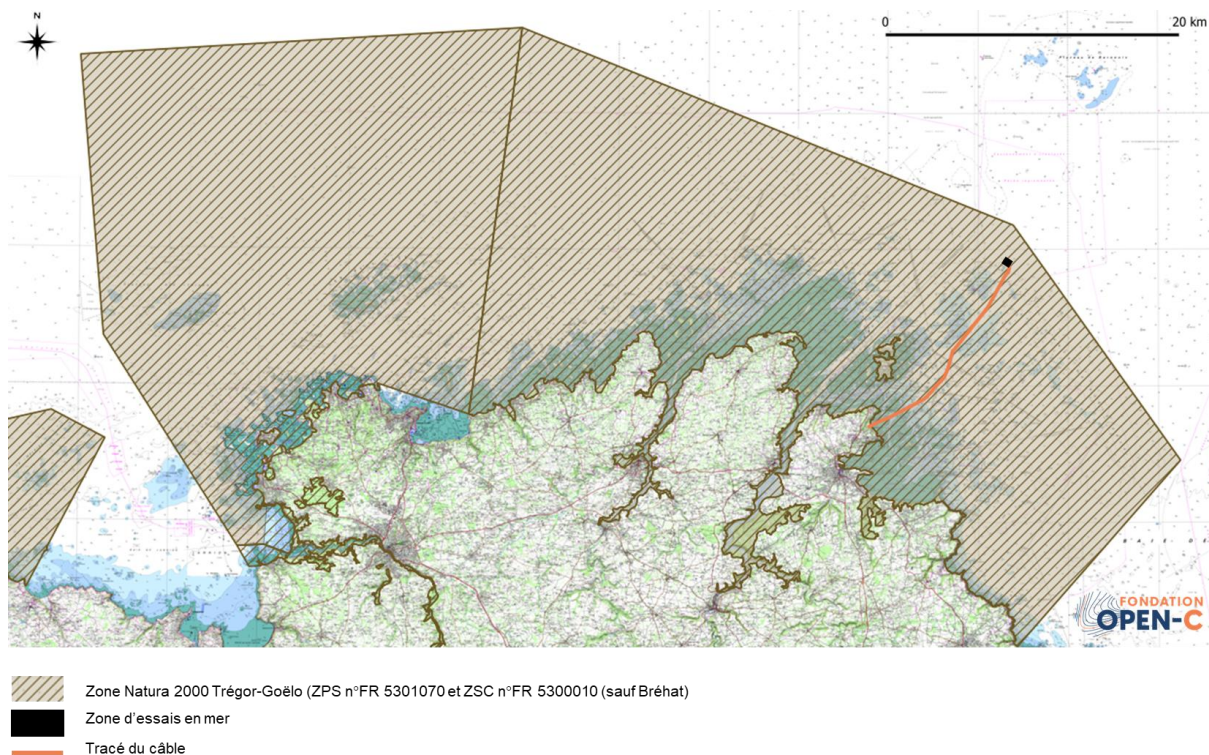


Figure 5: Map showing the location of the test site and its connection within the "Trégor-Goëlo" Natura 2000 areas

The Demonstration Dossier will include an assessment of the Natura 2000 impacts which will make it possible to define the possible need for additional prescriptions to the monitoring already implemented.

8 Insurance and certification

8.1 Insurance

8.1.1 OPEN-C and Company Insurance

The responsibilities and commitments relating to the insurance coverage of the Company and OPEN-C are set out in the Collaboration Agreement signed between the Company and OPEN-C.

The Company's insurance certificates required by the agreement are provided to OPEN-C prior to the installation of the demonstrator on site. In the event of a substantial update of the insurance contracts, the Company must communicate the updated insurance certificates to OPEN-C.

8.1.2 Subcontracting companies

A copy of the insurance certificate of the companies acting as subcontractors of the Company may be requested by OPEN-C. These certificates will be required in particular for subcontractors involved in the execution of offshore works.

8.1.3 Marine Warranty Surveyor

The intervention of a Marine Warranty Surveyor (MWS) may be required by the Company's insurance, as is commonly the practice in order to reduce the risks inherent in marine operations. In this case, the name of the company, and the point of contact within the company chosen to perform these MWS services will be transmitted to OPEN-C.

The Foundation also strongly recommends the intervention of an MWS to ensure that the subcontracted activities are carried out according to standards and good practices.

8.2 Certification

The Company undertakes to have the design of the demonstrator reviewed by a third party, such as a certification office. A copy of the certificate issued by the third party must be provided to OPEN-C before the deployment of the demonstrator on the Paimpol-Bréhat site.

The certificate provided will be at least of the "Approval in Principle" or "Statement of Feasibility" type. The review may initially be limited to the methodological basis of the project ("design basis"), without independent calculations by the third party.

The purpose of this review is to ensure that the design of the demonstrator is carried out in accordance with the norms and standards in force and in a manner that minimizes risks. It will cover at least the following elements (if applicable to the demonstrator):

- General arrangement drawings
- Hydrodynamics
- Stability
- Anchoring
- Structure, corrosion
- Electricity (single-line, load balance)
- Ballast

Beyond this approval in principle, it is recommended that the Company obtain a certificate for the detailed design review and manufacturing monitoring of the demonstrator before its installation on the test site. Where applicable, the Company will provide OPEN-C with the third party's certificates/attestations. In the absence of these certificates/attestations, the specific documents and methodologies that demonstrate the integrity of the demonstrator for the duration of the tests will be included in the work file detailed in section 3.2.2.

8.3 Extension of the trials

In the case of an extension of the Lifetime Extension beyond the initial Design Life, the Company shall provide OPEN-C with third-party certifications; or the specific documents and methodologies that demonstrate the total integrity of the demonstrator (turbine, anchor, cable, etc.) for the new test duration. The Foundation will carry out a technical review with a view to validating this request for an extension of the trials.

9 Appendices

9.1 Appendix 1: Terms and conditions of access to the Paimpol-Bréhat site for major operations related to demonstrators

Deadline	Document	Company	Open6c	State services
O – 6 months	Maritime coordination plan	I	R/A	I
O – 4 months	Operation Procedure + HAZID	R	A	I
O – 3 months	Works Documentation, used (in whole or in part) to compile the file that will be sent to the members of the CNL	R*	C	A
O – 2 months for signature at O-15days	Maritime Response Plan (MIP)	C	R	A
O – 2 months	Holding of a Local Nautical Commission (CNL), at the discretion of the State Services	C	C	R/A
O – 1 month	Risk Prevention Plan	R*	A	-
O – 72h	Point Go/NoGo	R	A	-
O – 48h	Site Access Request	R*	A	-
Legend: Y = Date before operation *based on a report template provided by OPEN-C R: Responsible - Responsibility for writing the document / carrying out the activity A: Accountable – Approval, Validation C: Consulted – Advice, contribution, review, expertise or opinion I: Informed – Information				

9.2 Appendix 2: Metocean Report Summary

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1 Bathymetry

High resolution bathymetric survey was performed on 1st of May 2012 by IXSurvey using a R2Sonic Multibeam Echosounder (MBES) to accurately map the seafloor. The depths are included between 41.87 m and 25.89 m in reference to Z.H (Zero Hydrographique). The water depth increases to the north and the east. Erosional channels are observed on the entire area, principally oriented north / west and north. The deepest erosional channel crosses the area from north/northwest to south/southeast, shows a maximum 25 m width and a maximum slope failure of 5 meters. Secondly, smaller oriented east-west are observed. In the southwest, some rocky outcrops are observed up to -26 meters deep.

In the west of the area, the bathymetry shows the presence of few rocky plateaus, at -36 m deep.

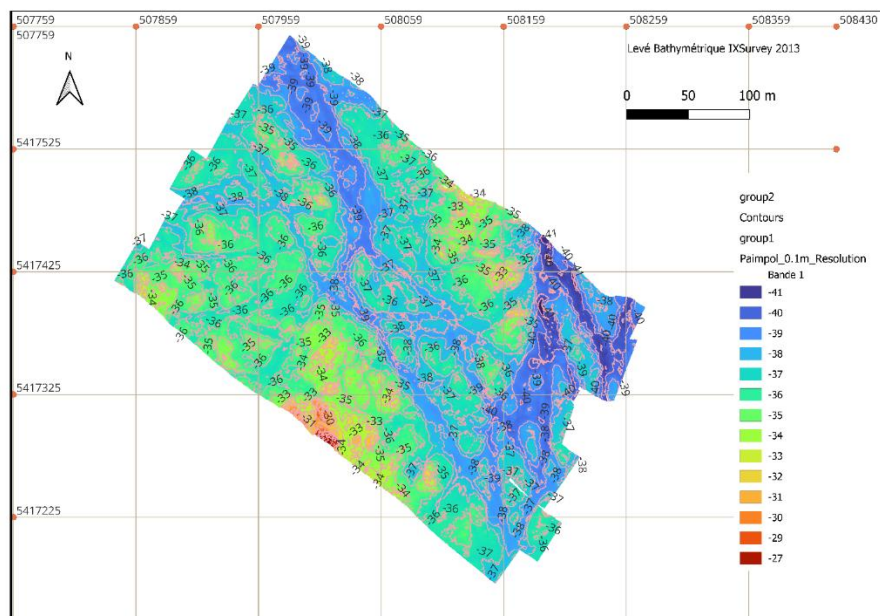


Figure 6: Paimpol BREHAT TEST SITE BATHYMETRY (EPSG 2154 – UTM30)

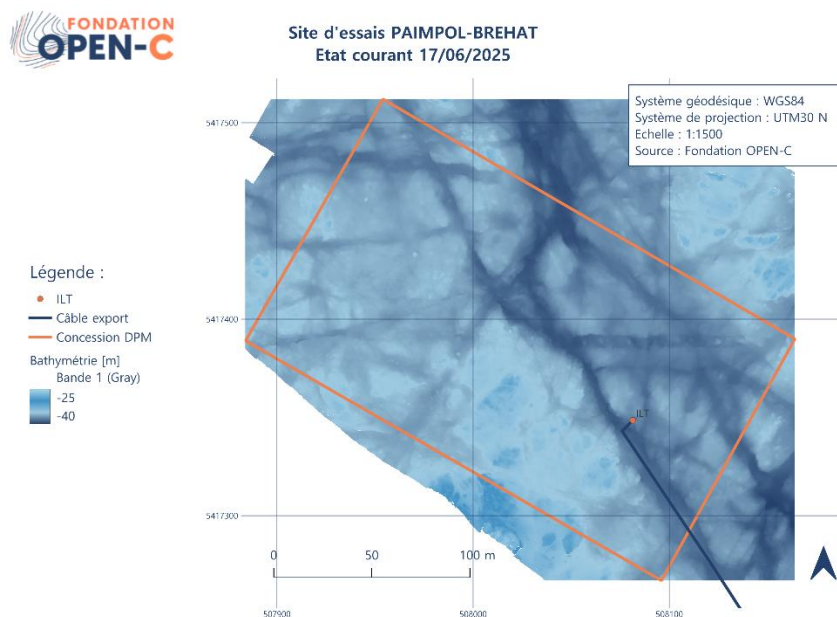


Figure 7: Current status of Paimpol Brehat test site: site location, cable and ILT location

2 Water level

2.1 Water level provided by SHOM in nearest harbour

The harbour of Saint-Quay-Portrieux is a harbour close to Paimpol-Brehat test site which is equipped with a tidal gauge that belongs to the National numerical tidal gauge network RONIM (Réseau d'Observation du Niveau de la Mer) managed by the SHOM.

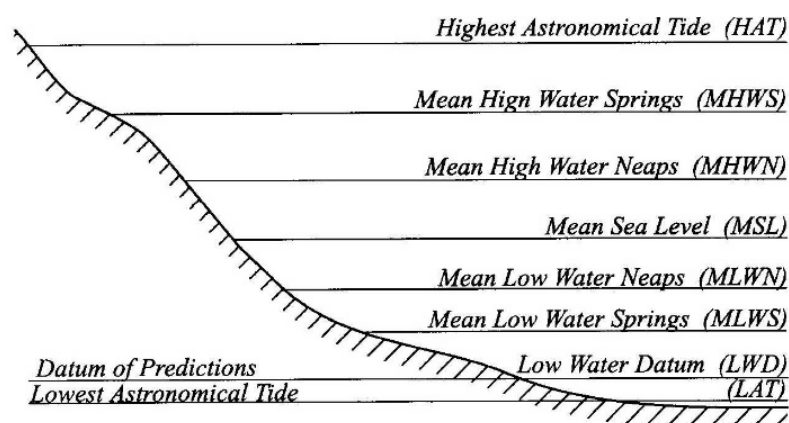


Figure 8: SCHEME of water level definition and acronyms

The following table provides the water level (Chart Datum) determined by the SHOM for “St Quay Portrieux” harbour: (ZH = -5.908 m par rapport à la RF N.R.K3V3-45a IGN69).

Saint Quay Portrieux (48.6475°N, 2.818056°O)				
HAT	12.62			12.39
MHWS	11.45		9.90	
MHWN	8.80	4.65		
MSL	6.46			
MLWN	4.15			

MLWS	1.55			
LAT	0.23			

Table 1: Water levels and tidal ranges [m] against C.D in St Quay Portrieux. Source: SHOM RAM 2022

4 Current measurements varying with depth

4.1 Current measurements

4.1.1 Presentation of measurement campaign

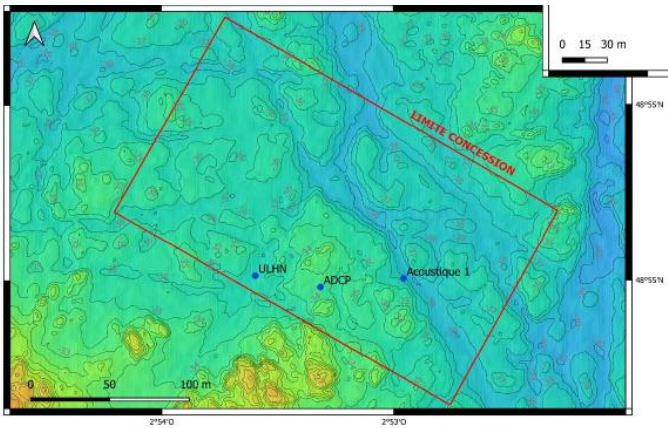
Station	ADCP TIGER	
Date	19/09/2022 – 27/03/2023	
Duration	189 days	
Sensor / Instrument	Nortek Signature 500	
Latitude	48.90896333	
Longitude	-2.89062821	
Local depth		
Sampling Frequency	1 Hz : mean on 10 min Turbulence : 2 Hz (30 min every 2 hours)	
Measurement Frequency	Burst mode: 2Hz during 10 minutes every 20 minutes.	

Table 2: characteristics of CURRENT Measurements parameters and ADCP Location

The 10-min averaged data of ADCP measurement are filtered according to the quality criteria and results of the tidal height measured by the ADCP from pressure and depth-averaged velocity are presented below.

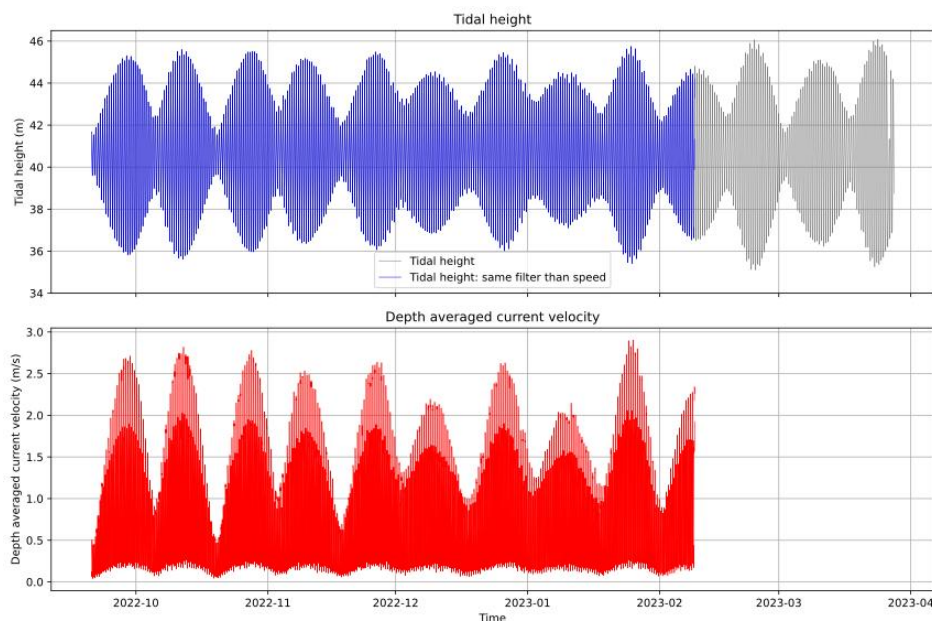


Figure 9: Tidal Height and depth averaged velocity measured by ADCP campaign from tiger project

The maximum and minimum velocities observed during the measurement campaign are presented in Table 3.

Date	Depth averaged velocity (m/s)	Tidal height (m)	Tidal range (m) - (Tidal coefficient)
2023/01/24 16:45	2.897 m/s	41.92 m	11.98 m - (coef 105)
2023/01/25 17:25	2.905 m/s	40.11 m	11.83 m - (coef 101)
2022/09/20 19:55	0.038 m/s	39.78 m	7.77 m - (coef 28)

Table 3: Maximum and minimum velocities during measurement campaign

The current rose from ADCP measurement and the mean vertical profile is presented on Figure 10.

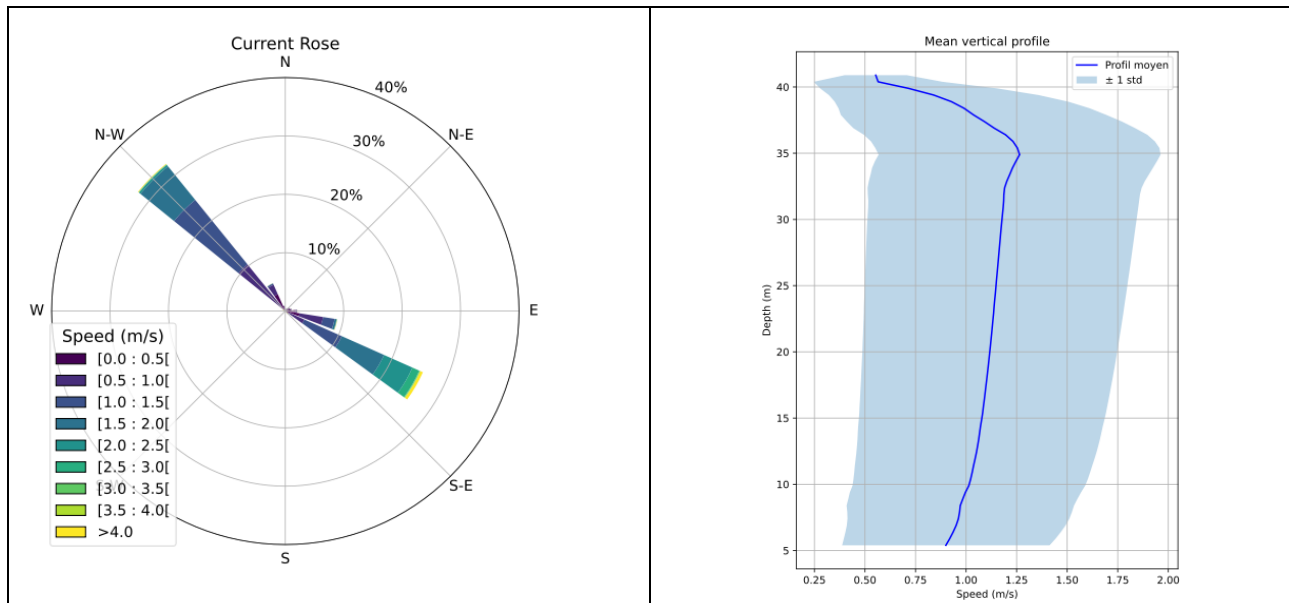


Figure 10: Current rose from adcp campaign in tiger project (LEFT) and Mean vertical profile (RIGHT)

Velocity measurements shows a macrotidal environment with tidal ranges reaching 11.98 m in the measurement dataset and depth averaged tidal current velocity reaches 2.9 m/s. Tides are semi-diurnal and asymmetric: peak flood in South-East direction show higher velocities than peak ebb towards North-West. The mean velocity profile shows an inflection point at 35.4 m corresponding to the minimum of tidal height.

4.2 Harmonic analysis on measurements data

Harmonic analysis is performed on water elevation and velocity. Coefficients are provided in Appendix 7.1 and 7.2 (for velocity at 5.39 m above sea bottom).

4.2.1 Water elevation signal reconstruction

The harmonic analysis constituents are then used to generate the water elevation signal on a typical year, in this case 2023. The minimum of the depth reconstructed is 35.61m (35.41 m measured) and the maximum 45.88 m (45.75 m measured).

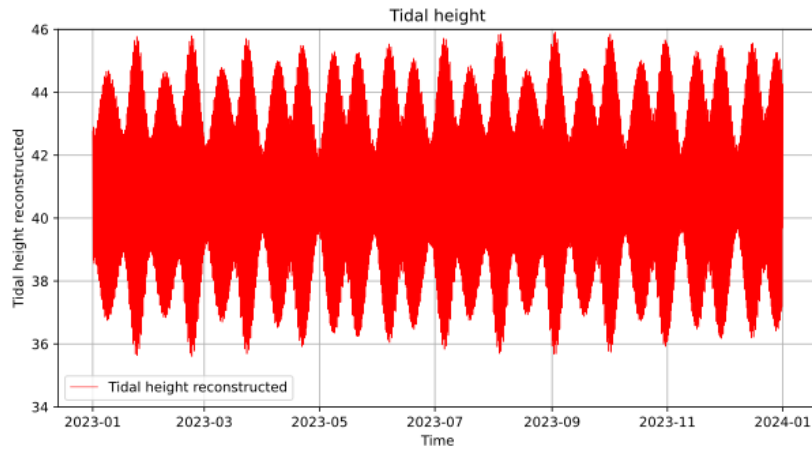


Figure 11: Water elevation for a typical year (2023)

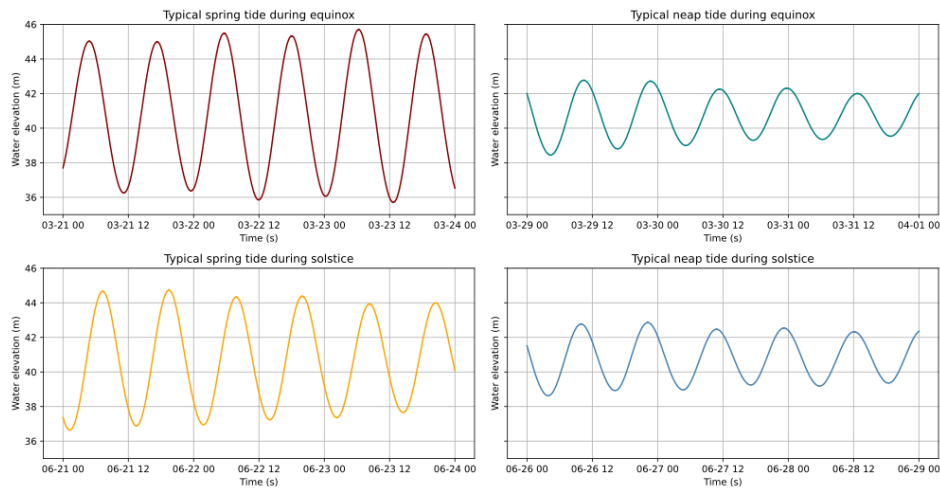


Figure 12: water elevation for typical tidal cycles: equinox vs solstice from reconstructed signal in 2023

4.2.2 Typical year (2023) reconstruction of velocity distribution for all heights above sea bottom

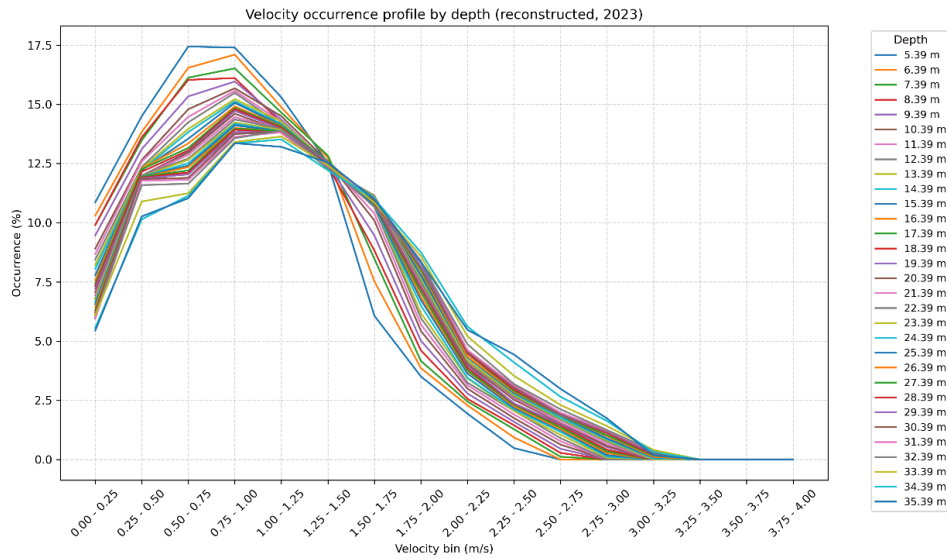


Figure 13: velocity distribution reconstructed from harmonic analysis for a typical year (2023) at all heights above sea bottom

4.3 Turbulence analysis

The Turbulent Intensity (TI) quantifies the relative magnitude of turbulent fluctuations compared to the mean flow, according to:

$$TI = \frac{\sqrt{\overline{u'^2} + \overline{v'^2}}}{\bar{U}}$$

Where u' and v' are the instantaneous fluctuations from the mean eastward $\bar{u}$ and northward $\bar{v}$ velocity components, and $\bar{U} = \sqrt{\bar{u}^2 + \bar{v}^2}$ is the mean horizontal current speed.

For each time segment (burst), TI was calculated at every vertical bin (depth cell). The **vertical profile of mean TI** is presented, together with its variability. The shaded envelope (± 1 standard deviation, σ) illustrates the inter-burst variability at each depth.

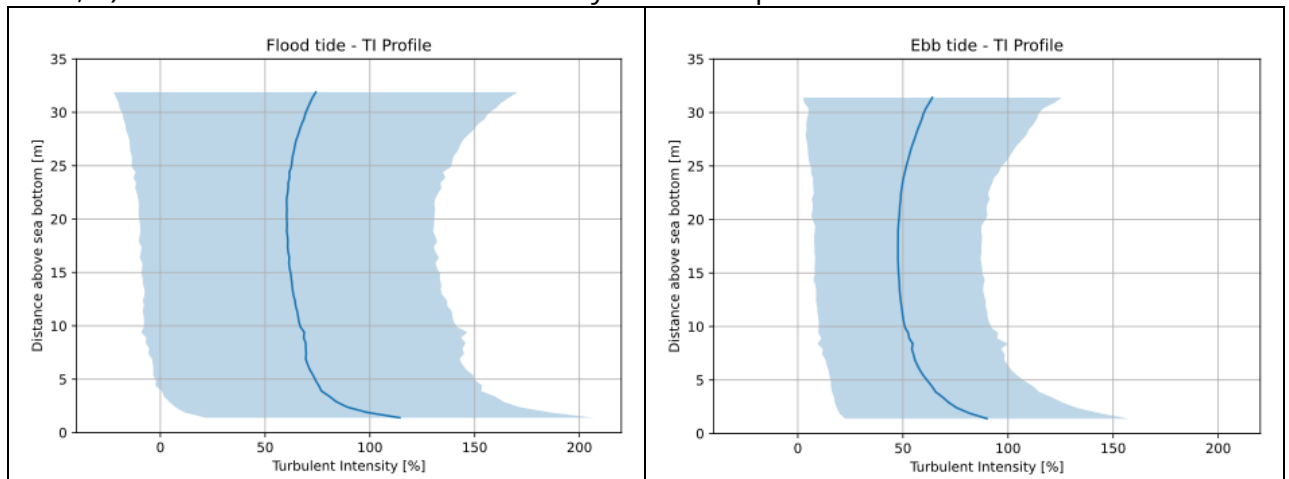


Figure 14: Turbulence Intensity mean profile (+/- 1 standard deviation) for flood and ebb tide

For each burst (10 min period), a column-averaged TI was computed by averaging the TI values over the water column (valid vertical bins):

$$TI_{col} = \frac{1}{N} \sum_{i=1}^N TI_i$$

where N is the number of valid vertical bins in the burst, and TI_i is the TI at bin i .

A scatter plot of TI_{col} as a function of the mean horizontal velocity is presented on Figure 15. Each point corresponds to a burst, and color shading indicates the local density of points (number of bursts sharing similar TI and velocity).

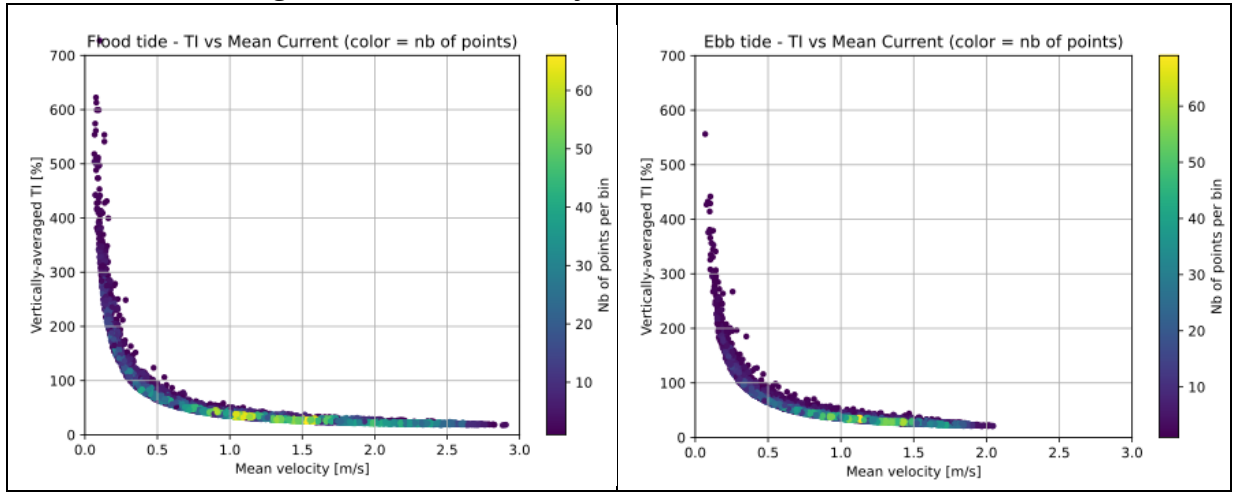


Figure 15: vertically averaged turbulence intensity versus mean velocity (coloured by number of points)

Turbulent Kinetic Energy (TKE) presented on Figure 16 provides a measure of the total energy contained in velocity fluctuations:

$$TKE = \frac{1}{2} (\overline{u'^2} + \overline{v'^2} + \overline{w'^2})$$

where w' is the deviation from the mean vertical velocity $\bar{w}$. The mean TKE profile was calculated as the average over all bursts, with a shaded envelope showing $\pm 1 \sigma$ (standard deviation) at each depth.

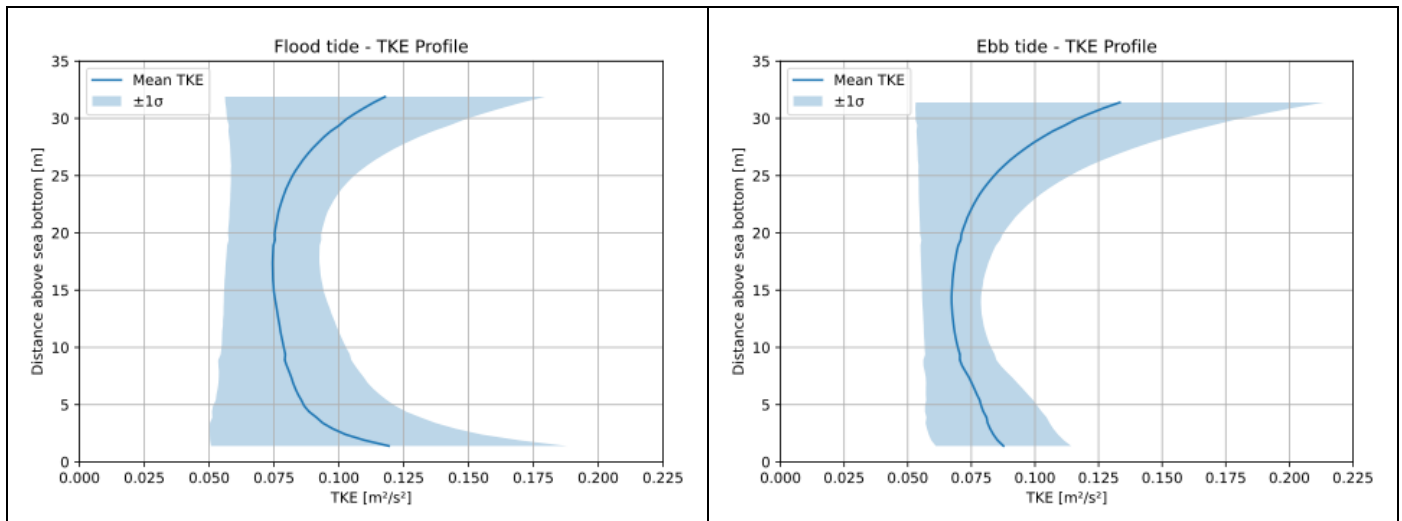


Figure 16: Turbulent kinetic energy profile for flood and ebb

5 Current model: mean velocity

5.1 Numerical model MARS2D (from IFREMER)

Water levels, surges and currents are computed by MARS 2D (Model for Applications at Regional Scale) hydrodynamic model, based on the shallow water equations and developed at IFREMER.

5.2 Comparison of measured and modelled mean velocities

Raw velocities from ADCP measurement campaigns are compared to numerical model MARS2D

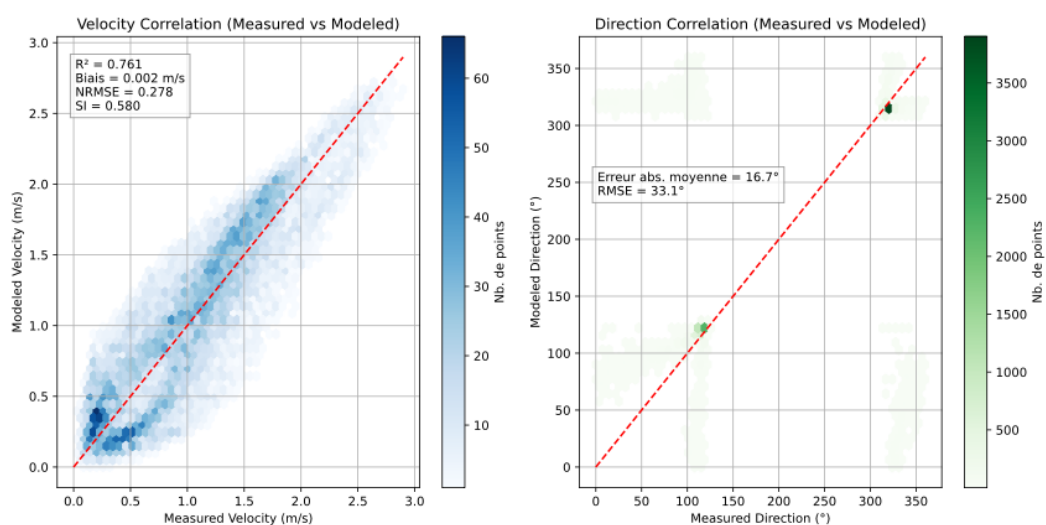


Figure 17: Correlation model / Measure on mean velocity and mean direction on the water column

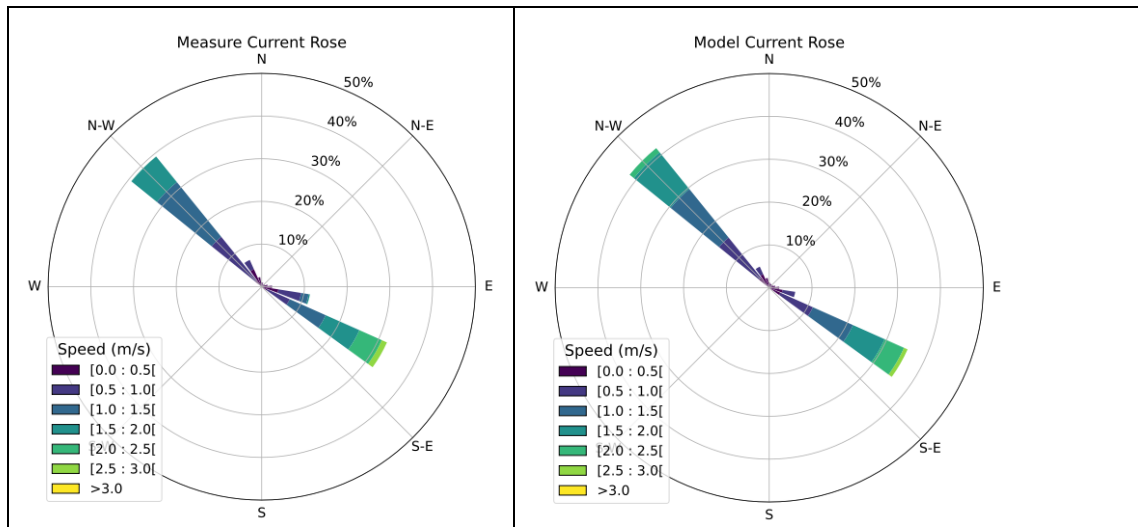


Figure 18: Current roses of measured current (left TIGER campaign – mean on 15 min) and model MARS2D

Results show that the asymmetry of the flow is less represented in the model. For ebb tides, velocity magnitudes are higher than for ADCP measurements and conversely for flow tides. This can be related to several hypothesis; the 2D models does not represent local accelerations, friction phenomenas and tidal asymmetry are note exactly reproduced of velocity peaks are occurring on a short time period and are smoothed in the model.

6 Waves

6.1 Wave measurements and model

Wave conditions were measured 13 km North of Paimpol-Brehat site by Cerema between July 2016 and January 2021. Waves are measured with a directional Datawell MkIII Waverider buoys. The buoy is referred in Cerema Candhis network by 02204_BREHAT_N (Kergadallan, 2024). A sea-states hindcast database identified as Resource Code, developed by Ifremer (Accensi Mickael, 2022) is used as numerical model database. A comparison between Resource Code database and in-situ measurements was performed for the Period 2016-2021. The buoy located 13 km North of Paimpol Bréhat test site is identified as “02204_BREHAT_N” Buoy in the Cerema CANDHIS network. The significant wave height correlation between measurements and the hourly hindcast data is 0.976.

6.2 Statistics operational

Operational statistics are presented in this section. The relative and cumulative frequency of H_s is presented on Figure 19, along with Weibull fit. The scatter diagram is also presented.

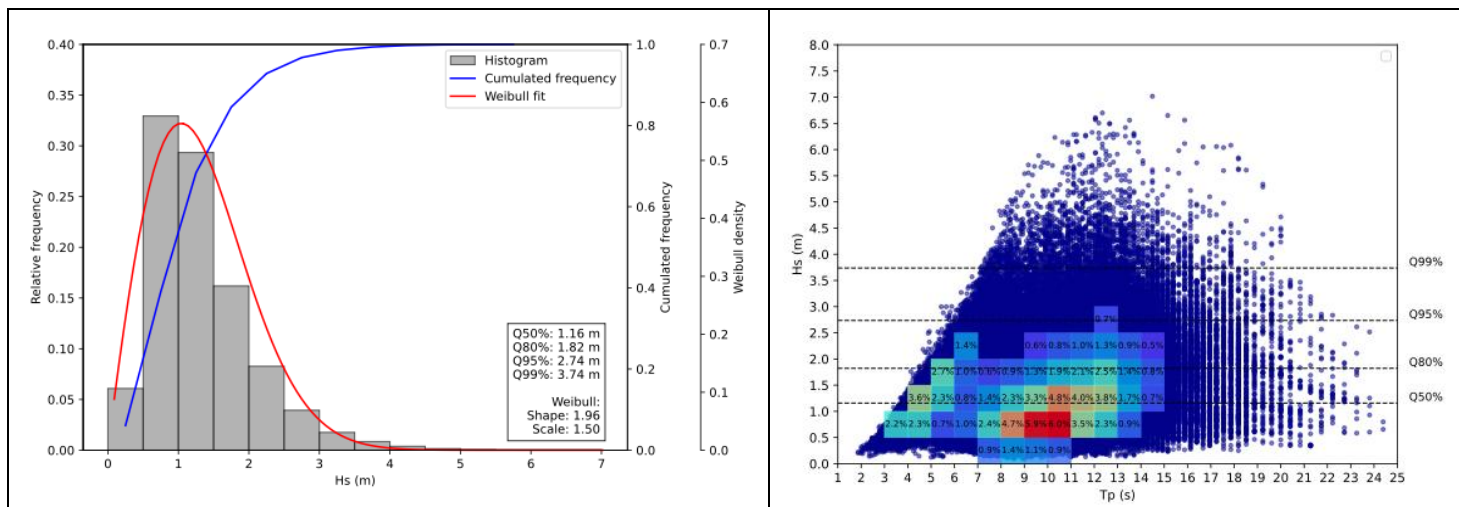


Figure 19: Left: Frequency of Hs, Right: Scatter diagram

The Figure below shows the annual wave height rose (%) distributed in angular sectors of 15°. Around 80% of the sea states in Paimpol-Brehat are characterized by a mean direction included in the intervals $[285^\circ \pm 7.5^\circ$ and $315^\circ \pm 7.5^\circ]$. The highest waves are also coming from the WNW sector.

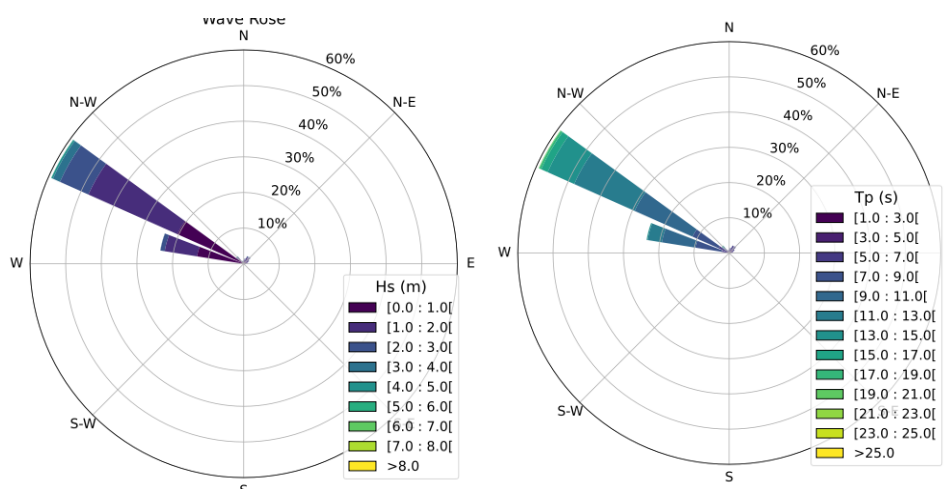


Figure 20: Significant Wave HEIGHT Rose DISTRIBUTION (Resource code, 1994-2020). Convention: "WAVES are coming from"

6.3 Extreme waves

Extreme waves are computed with the toolbox from Resource Code (Raillard Nicolas, 2023), based on Peak Over Threshold (POT) method and generalized Pareto distribution. It is performed for all directional sector and is not performed for different sectors since 86 % of waves are coming from WNW sector and waves with $H_s > 5$ m are coming from this sector as well.

Return period (years)	H_s (m)	Lower 95% CI	Upper 95% CI
1	5.29	5.09	5.47
2	5.77	5.53	6.01
5	6.32	6.01	6.63
10	6.69	6.30	7.08
25	7.12	6.61	7.68
50	7.41	6.81	8.09
100	7.67	6.97	8.47

Table 7: Return periods of h_s for all directions on Paimpol-Bréhat

7 Appendix

7.1 Harmonic analysis on water elevation

The harmonic analysis is performed on ADCP measurements of water elevation, after filtering described in previous sections. The duration of the analysed signal is 176 days. Analysed tidal constituents including the amplitude and phase of all constituents leads to the fact that 98.6% of the total variance is captured by the constituents.

Constituent	Amplitude (m/s)	Amplitude_CI (m/s)	Phase (°)	Phase_CI (°)	Prediction Error	SNR
M2	3.15	0.02	140.98	0.43	81.82	69277.09
S2	1.26	0.02	212.61	1.07	13.01	11011.89
N2	0.62	0.02	112.19	2.17	3.18	2687.82
K2	0.37	0.02	211.44	3.65	1.12	946.47
MU2	0.20	0.02	129.71	6.72	0.33	279.52

L2	0.11	0.02	148.67	11.71	0.11	91.99
SSA	0.10	0.03	136.96	17.17	0.08	45.25
K1	0.09	0.00	94.49	2.10	0.07	2870.19
O1	0.08	0.00	314.70	2.51	0.05	1994.31
MSF	0.07	0.03	252.25	23.97	0.04	22.22
M4	0.07	0.00	242.71	2.15	0.04	2737.21
MS4	0.07	0.00	325.48	2.18	0.04	2647.32
MSN2	0.05	0.02	358.98	24.80	0.02	20.52
EPS2	0.05	0.02	93.13	28.06	0.02	16.03
MF	0.04	0.03	226.87	41.39	0.01	7.37
MM	0.04	0.03	259.85	44.73	0.01	6.29
Q1	0.03	0.00	251.75	6.60	0.01	289.47
P1	0.03	0.00	74.79	7.56	0.01	220.51
ETA2	0.02	0.02	268.49	54.99	0.00	4.17
MKS2	0.02	0.02	233.75	56.92	0.00	3.89
MN4	0.02	0.00	205.50	6.62	0.00	287.27
2MS6	0.02	0.00	201.64	2.67	0.00	1775.91
M3	0.02	0.00	101.71	4.11	0.00	745.27
MK4	0.02	0.00	322.81	7.28	0.00	237.73
M6	0.02	0.00	128.86	3.53	0.00	1013.15
S4	0.01	0.00	70.14	10.44	0.00	115.63
MK3	0.01	0.00	198.85	6.77	0.00	275.41
SN4	0.01	0.00	324.80	11.63	0.00	93.30
NO1	0.01	0.00	113.03	17.03	0.00	43.47
SK4	0.01	0.00	75.79	16.13	0.00	48.51
2MN6	0.01	0.00	84.83	7.00	0.00	257.12
2SM6	0.01	0.00	280.46	7.39	0.00	230.86
OO1	0.01	0.00	196.20	26.48	0.00	18.00
SK3	0.01	0.00	253.63	12.63	0.00	79.09

TAU1	0.01	0.00	126.57	27.53	0.00	16.65
SO3	0.01	0.00	163.35	14.05	0.00	63.87
2MK6	0.01	0.00	199.97	9.16	0.00	150.21
PHI1	0.01	0.00	311.34	33.77	0.00	11.06
MSK6	0.01	0.00	280.38	11.02	0.00	103.74
M8	0.00	0.00	338.98	4.33	0.00	672.74
MO3	0.00	0.00	96.94	18.87	0.00	35.41
2Q1	0.00	0.00	219.06	42.63	0.00	6.94
SO1	0.00	0.00	286.24	43.59	0.00	6.63
ALP1	0.00	0.00	140.79	51.27	0.00	4.80
J1	0.00	0.00	140.26	64.67	0.00	3.02
BET1	0.00	0.00	304.17	84.17	0.00	1.78
UPS1	0.00	0.00	176.84	299.82	0.00	0.14
2MK5	0.00	0.00	281.43	53.95	0.00	4.33
2SK5	0.00	0.00	220.32	54.42	0.00	4.26
3MK7	0.00	0.00	257.12	37.16	0.00	9.14

Table 78: Harmonic analysis constituents

7.2 Harmonic analysis on 10-min velocity at 5.39 m above sea bottom

The harmonic analysis is performed for velocities on the first cell of ADCP Measurement, located at 5.39 m above the sea bottom and 142 days of data. Analysed tidal leads to the fact that 91.4% of the total variance is captured by the constituents for velocities.

Constituent	Amplitude (Lsmaj, m/s)	Half small axis (Lsmin, m/s)	Heading (theta, °)	Phase (g, °)	SNR
M2	1.33	0.02	146.49	3.09	62484.10
S2	0.51	0.01	146.10	308.67	9190.10
N2	0.26	0.00	146.43	189.42	2296.81
M4	0.13	0.02	162.32	179.62	4552.23

MS4	0.10	0.01	162.72	140.01	2582.40
MSF	0.07	0.00	24.04	308.03	679.02
MN4	0.05	0.01	158.80	357.33	778.77
2MS6	0.05	-0.01	147.89	189.70	736.53
M6	0.05	0.00	150.61	244.56	674.30
L2	0.03	0.00	147.09	154.65	34.13
MU2	0.03	-0.01	145.74	77.79	31.80
MM	0.03	0.00	29.88	179.46	101.37
2MN6	0.02	0.00	151.60	73.11	181.94
K1	0.02	0.00	146.27	175.37	232.41
M3	0.02	0.00	147.23	26.19	119.07
S4	0.02	0.00	156.86	87.81	67.79
SN4	0.01	0.00	153.22	343.31	61.78
O1	0.01	0.00	144.46	140.94	101.62
2SM6	0.01	0.00	140.83	125.53	46.83
M8	0.01	0.00	0.78	248.43	45.48
MK3	0.01	0.00	154.40	30.06	31.66
SK3	0.01	0.00	149.89	331.67	26.51
Q1	0.01	0.00	145.16	303.82	18.73
NO1	0.00	0.00	17.46	75.04	4.30
ETA2	0.00	0.00	150.87	187.90	0.58
EPS2	0.00	0.00	150.41	234.46	0.22
OO1	0.00	0.00	149.64	178.79	5.70
J1	0.00	0.00	178.25	9.78	2.32
2Q1	0.00	0.00	146.31	212.94	1.37
UPS1	0.00	0.00	135.14	21.43	2.00
2SK5	0.00	0.00	137.18	65.89	0.89
MO3	0.00	0.00	1.41	158.70	1.08
ALP1	0.00	0.00	39.84	352.17	0.82

3MK7	0.00	0.00	169.41	253.19	0.52
2MK5	0.00	0.00	134.73	302.73	0.32

Table 89: Harmonic analysis constituents for velocity magnitude at 5.39 m above sea bottom

8 Bibliographie

Accensi Mickael, A. G. M. F. M. C. ., 2022. *RESOURCECODE - Resource Characterization to Reduce the Cost of Energy through Coordinated Data Enterprise. Database user manual. WP3| Database development..* [En ligne]

Available at: <https://doi.org/10.131>

Kergadallan, X., 2024. *CANDHIS*. [En ligne]

Available at: <https://doc.cerema.fr/Default/doc/SYRACUSE/601420/candhis-analyse-2024-des-etats-de-mer-tome-1-mer-du-nord-manche-et-atlantique>

Pineau-Guillou, L., 2013. PREVIMER. Validation des modèles hydrodynamiques 2D des côtes de la Manche et de l'Atlantique.. Ref. ODE/DYNECO/PHYSED/2013-05.

Ifremer.(<https://archimer.ifremer.fr/doc/00157/26800/>).

PREVIMER, 2013. *ODE/DYNECO/PHYSED/2013-05 version 1.0, June 2013. 2D hydrodynamic model Validation at English Channel and Atlantic Ocean coastlines.* [En ligne]

Available at:

http://www.previmer.org/content/download/7384/39384/file/2013_06_05_rap_valid_modeles_PREVIMER_L1-MARS2D.pdf

PREVIMER, Raillard Nicolas, e. a., 2023. *RESOURCECODE: A Python package for statistical analysis of sea-state hindcast data. Journal of Open Source Software, 8(83), 4366.* [En ligne]

Available at: <https://doi.org/10.21105/joss.04366>.