TIGER
TIDAL STREAM INDUSTRY ENERGISER

Project Overview
Journée du GdR EOL-EMR

25 nov. 2021 – Paris, France

Grégory Pinon (en tant que présentateur) avec
Unicaen: Sylvain Guillou, Philippe Mercier, Jérôme Thiébot, Nasteho Djama Dirieh, Kabir Shariff
UBS : Mouncef Sedrati, Méha Mardi Alaoui, Glen Bulot, Evelyne Goubert
ULHN : Damien Leduc, Melanie Vah, Marc-Amaury Dufour, Camille Choma Bex, Armelle Jarno, François marin, Moucef El Kettani

EUROPEAN UNION

Interreg
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Content

- What is TIGER?
- What is tidal stream?
- What are the TIGER objectives?
- Who are the Partners?
- TIGER Development sites
- Academic updates

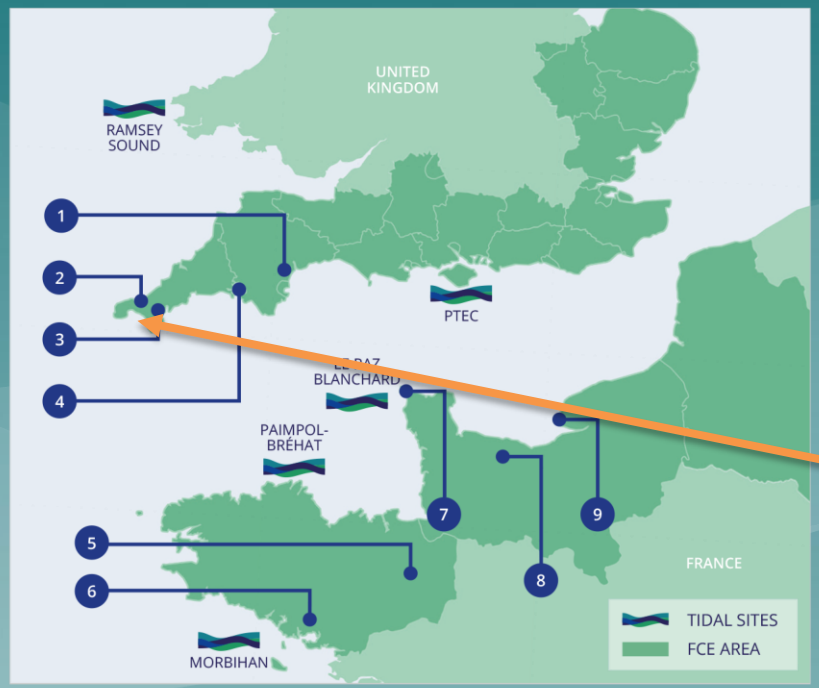
What is TIGER?

TIGER = **T**idal Stream **I**ndustry Ener**G**is**ER**

TIGER is a **€45.4m** (€29.9m ERDF), 4-year project, with 18 partners, approved 2 Jul 2019.

Funded through the Interreg France Channel (Manche) England programme, it is a collaborative cross border project

What is TIGER?



PARTNERS OUTSIDE THE FCE AREA

EMEC · ORBITAL MARINE POWER · QED Naval Limited · MANCHESTER 1824 The University of Manchester · SEENEOH TIDAL TEST SITE · Minesto

CATAPULT Offshore Renewable Energy

1 University of Exeter
2 CATAPULT Offshore Renewable Energy
3 Cambrian Offshore
4 University of Plymouth
5a Bretagne Développement Innovation
6a Université Bretagne Sud – ubs
7a HydroQuest Smart power solutions
8 Université Caen Normandie
9 Université Le Havre Normandie
5b EDF
6b morbihan énergies
7b Normandie Hydroliennes Partnership: SIMEC ATLANTIS ENERGY · NORMANDIE Agence de développement · ÉFINOR

CORNWALL

ORE Catapult
Chi Gallos
Hayle Marine Renewables Business Park
North Quay
Hayle

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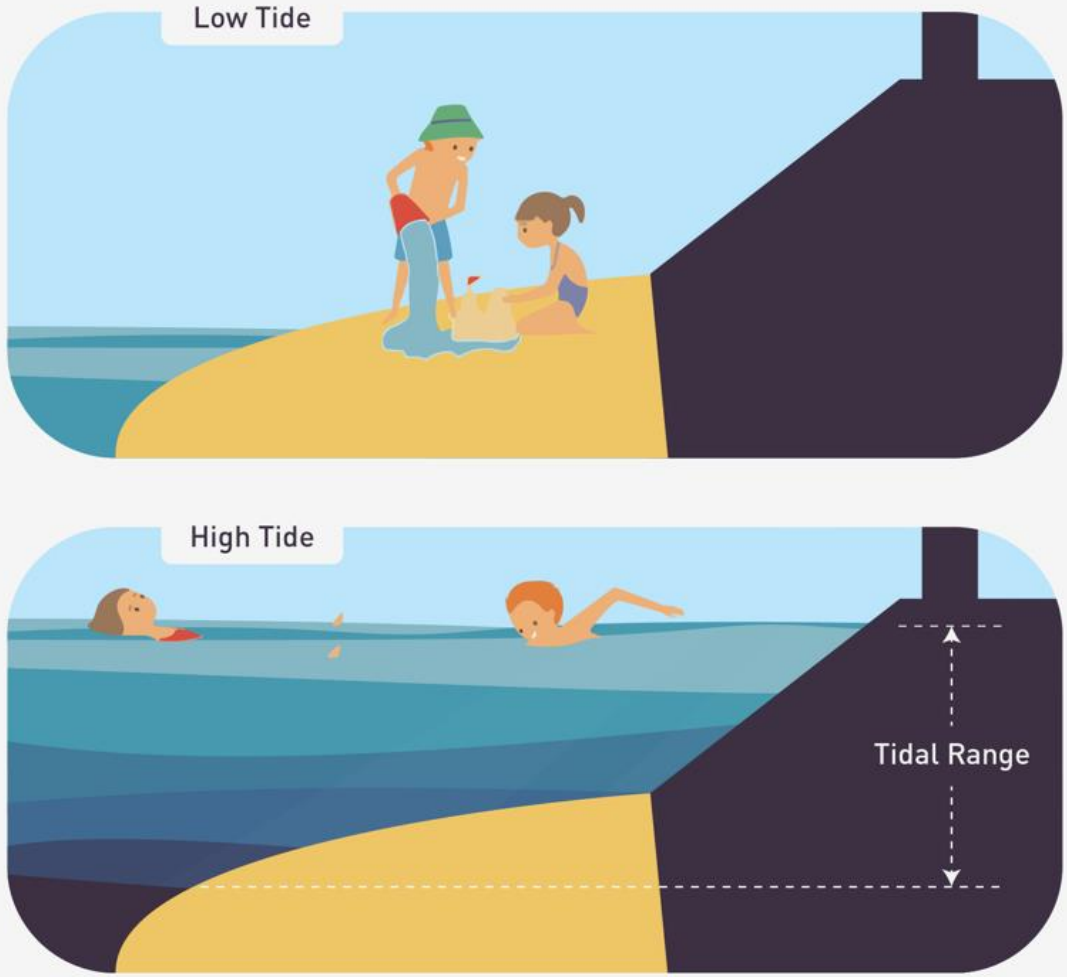
The Tides

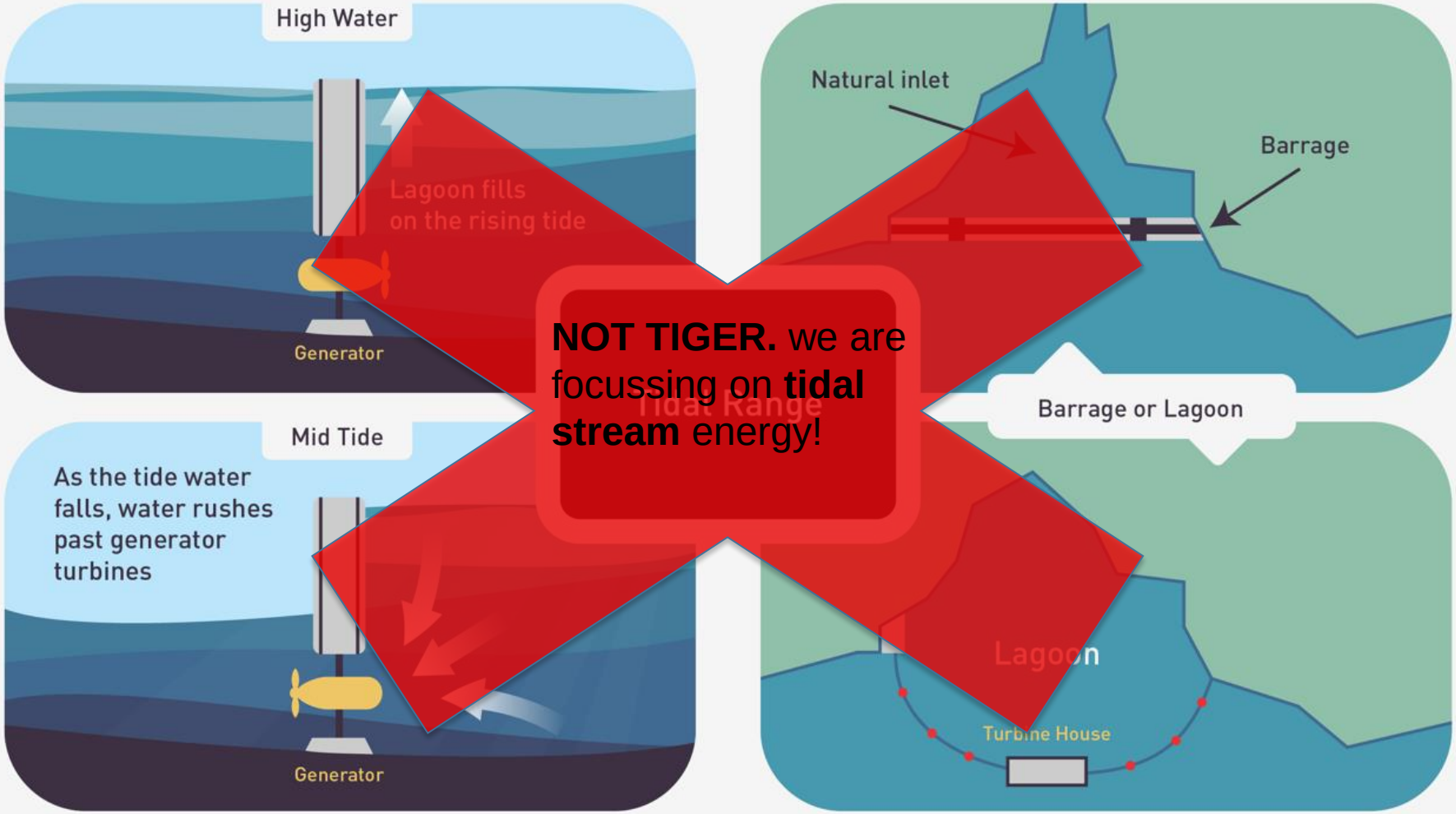
There is a low tide twice a day

There is a high tide twice a day

The difference in height between the low tide and high tide is called the tidal range



Credit: Power of the Ocean PowerPoint - Marine Energy Wales



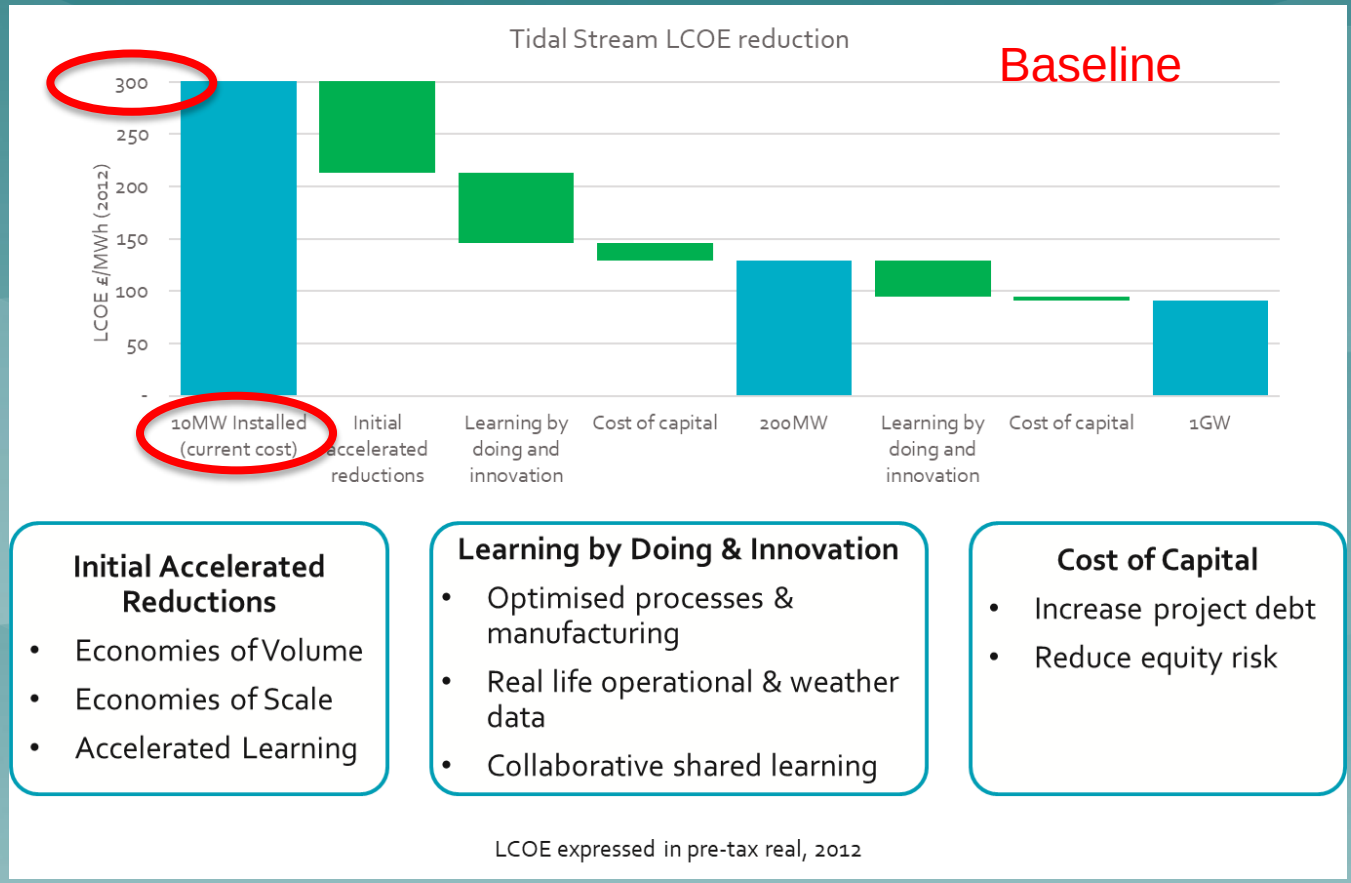
Credit: Power of the Ocean PowerPoint - Marine Energy Wales

Credit: Power of the Ocean PowerPoint - Marine Energy Wales

Other concepts also exist such as mid water column devices and tidal Kites

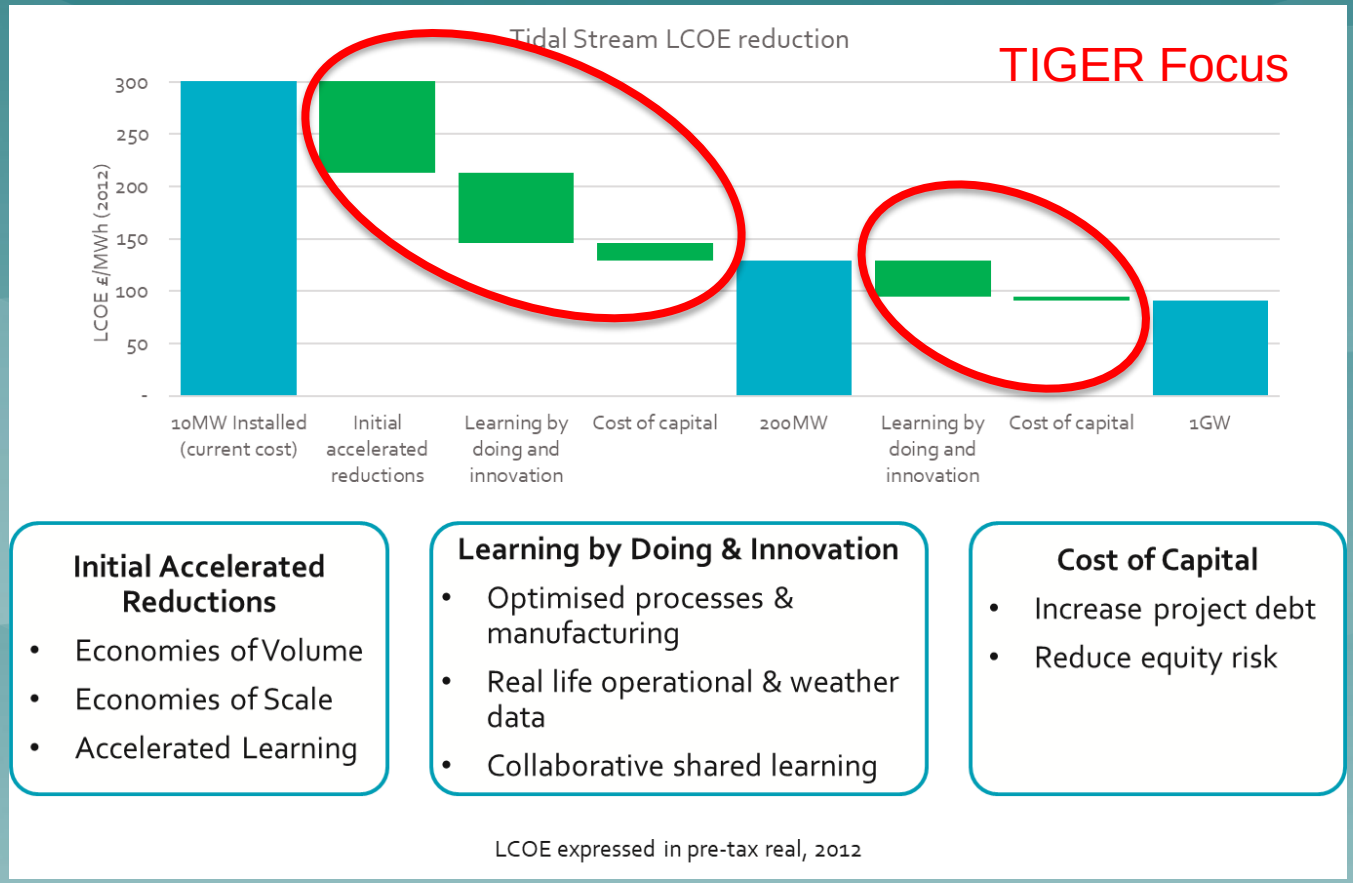
Credit: Power of the Ocean PowerPoint - Marine Energy Wales

What is TIGER about?



OREC 2018 Wave & Tidal cost reduction pathway report

What is TIGER about?



OREC 2018 Wave & Tidal cost reduction pathway report

How will TIGER do this

Underpinned with tidal Technology Developer collaboration & knowledge sharing

WP1 – Tidal energy site development and deployment

The **learning by doing** activities & data collection

- Ramsey Sound
- Paimpol Brehat
- Morbihan Gulf
- Raz Blanchard
- PTEC

WP2 – sector and technology development

Systems, component & process **development & Innovation**. Work together with supply chain companies to innovate and improve and form supply chain clusters with know how in tidal stream

WP3 –Cost reduction analysis

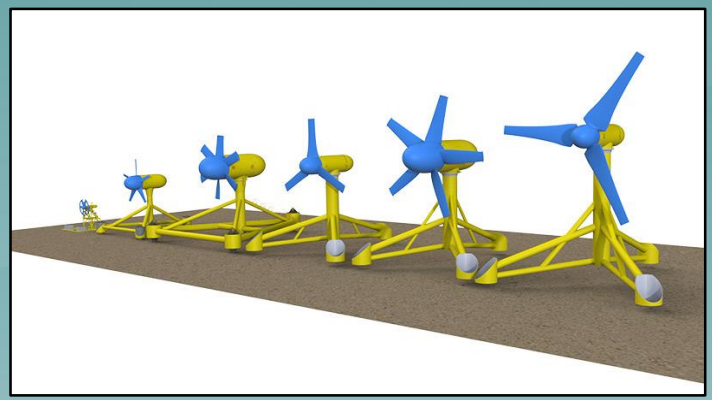
This is where all the data and learnings are pulled together to form evidence case for policy support to root the tidal stream industry in the EU.

WP1 TIGER Development site – Morbihan Gulf

Sabella & Energies 56 have formed MHE56 to consent and install 2x D08 250kW turbines in the Morbihan Gulf.

sabella ride the tide

56énergies



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WP1 TIGER Development site – **Paimpol Brehat**

Minesto will design and install a new variation of their DG100 Tidal kite at the EDF/SEENEOH tidal demonstration site

EDF SEENEOH TIDAL TEST SITE Minesto

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WP1 TIGER Development site – **Ramsey Sound**

Cambrian Offshore will repurpose the Ramsey Sound demonstration site and install a different tidal device

CAMBRIAN OFFSHORE
AR Y MÔR CAMBRIAN

WP1 TIGER Development site – PTEC

QED Naval will work to bring PTEC back out of hibernation and develop a commercial array off the Isle of Wight.

QEDNaval

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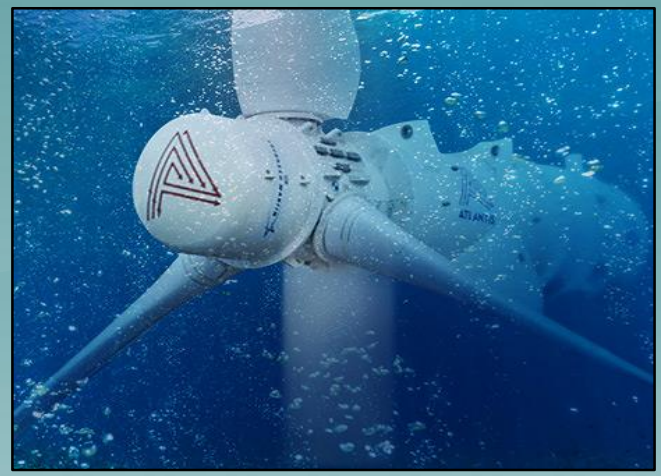
WP1 TIGER Development site – **Raz Blanchard**

SIMEC & AD Normandie have formed Normandie Hydroliennes to consent and develop a commercial array.

SIMEC ATLANTIS ENERGY

NORMANDIE AGENCE DE DÉVELOPPEMENT



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WP1 TIGER Development site – **Raz Blanchard**

HydroQuest will secure consent and develop a 10MW commercial array.

HydroQuest
Smart power solutions

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Orbital Marine Power

Through WP T2: LCOE analysis of potential innovations to identify high and medium LCOE impact areas of innovation.

priority areas will be worked into detailed R&D work packages involving identifying suitable partners and external expertise for each.

Feed into a basis of design for future devices

ORBITAL
MARINE POWER

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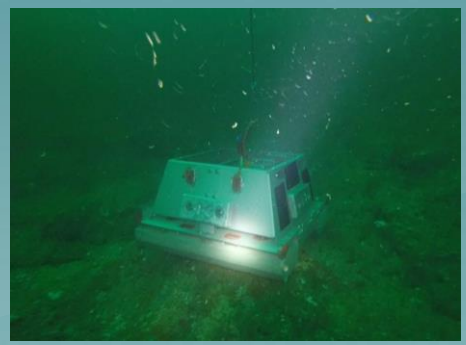
Dr. H. Hafidi Alaoui, Dr. D. Leduc & Prof. M. El Ketani

NDT testing on blade materials - WP 1.2.3

=> Successful deployment of the structure last June

Manufacturing of others samples (coupons) and to be bounded for new deployment.



Recovery of the first samples (coupons) and deployment of the new ones to be performed in Sept/Oct. 2021.
Taking into account weather window, divers and boat availability…

Assessment of the recovered coupons to be analysed soon afterwards.

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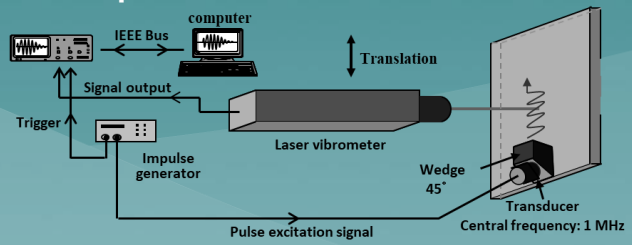
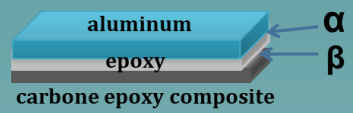
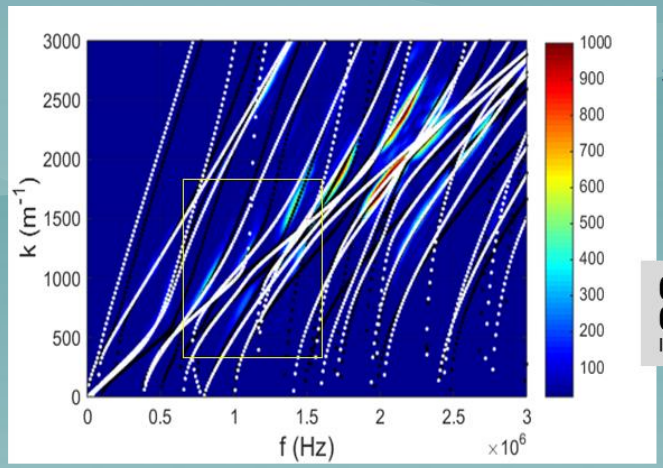
- **Comparison of the ageing of non-recyclable thermoset composites and recyclamine-based recyclable thermoplastic composites**

Example of an ultrasonic method for determining bonding quality:





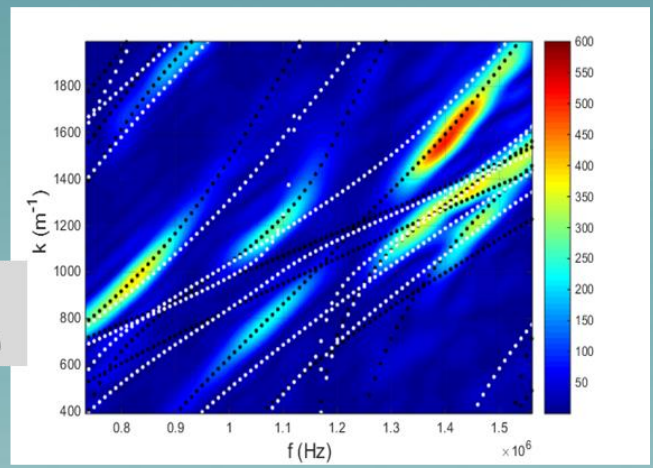
- Ultrasonic guided Lamb waves
- Data: normal displacements as function of time
- Space-Time FFT: experimental dispersion curves



Sample: $Al_{DSi}E_{100}C_{RA}$

zoom

(•) α=1 β=10⁻³
(○) α=10⁻⁵ β=1
Interphases model (FEM, Comsol)



Enable to detect on which side the delamination is (here on the composite side)

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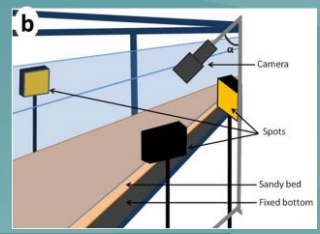
Dr. M. Vah, Dr. A. Jarno & Prof. F. Marin

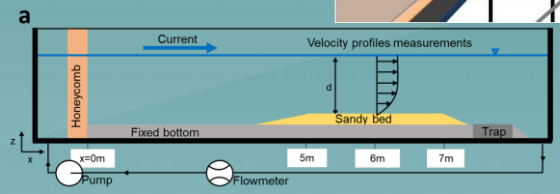
Hydro-sedim aspects on export cables

Development of an image correlation technique to estimate the bedload threshold shear stress (paper submitted, under revision)

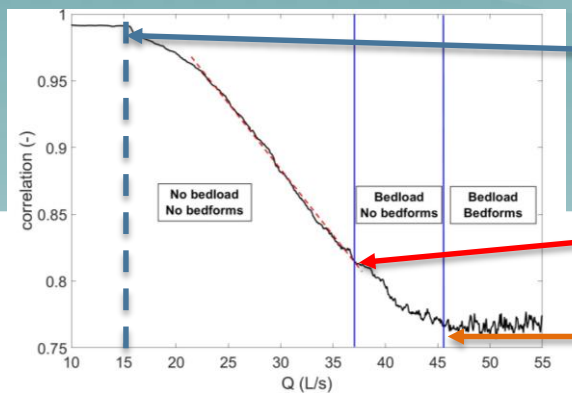
(*used to estimate bed load transport in semi-empirical laws, based on the excess of shear stress*)

- Based on a series of tests performed in a flume with homogeneous sediments with sands in the range 320 and 2700 µm (fine sand to pebbles)
- Robustness of the technique is shown
- Advantages: direct method, little human interference, very little fluctuation in the estimation
- Comparison with visual methods and bedload extrapolation methods





Interpretation of the three thresholds exhibited in the correlation curve in terms of transport



- Beginning of sporadic movement of grains (when decorrelation begins)
- Continuous long distance motion: bedload transport
- Formation of bedforms

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Dr. M. Vah, Dr. A. Jarno & Prof. F. Marin

Hydro-sedim aspects on export cables

Application of the method to bimodal sediment mixture (tests ok – data processing and analysis: under progress)

-> Several bimodal mixtures with diameter ratios D1/D2 in the range 3 to 8 were tested - The proportion of the two species was also varied (25-75, 50-50, 75-25)

-> The method is validated for bimodal mixtures. It can give the threshold of motion of the two populations of grains composing the mixtures.

Measurements of bedload transport for 30 mn just above the sediment threshold for the bigger sediments (general movement criterion)

-> For transport analysis, need to estimate the transport of the two sands (under progress) to calculate hiding coefficients and compare to the literature

- Search for a method that can be applied: not possible by sieving
- (too little sediment transported) nor by laser granulometry
- (too many sediments, fine sand to pebbles are used)
- Use of a flatbed scanner (just bought and installed)
- First tests with narrowly graded unimodal sieved sands to compare
- with the sieving method

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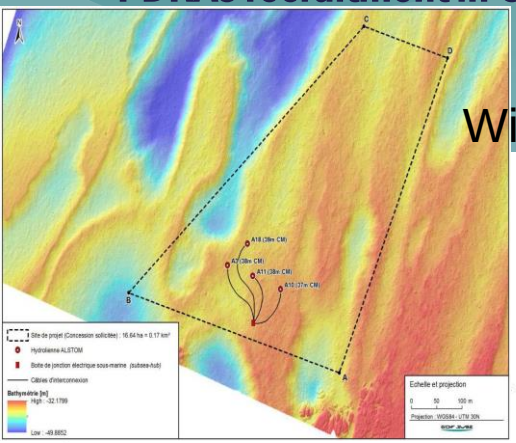
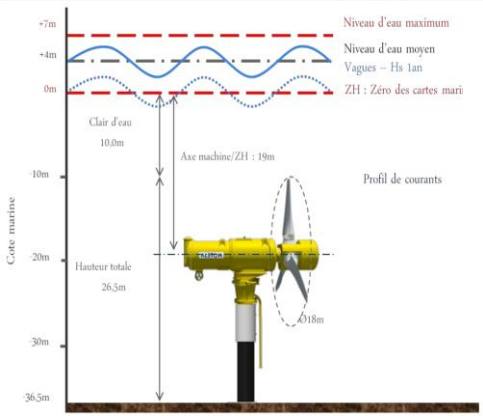
Resource Assessment and modelling – WP 1.7.2

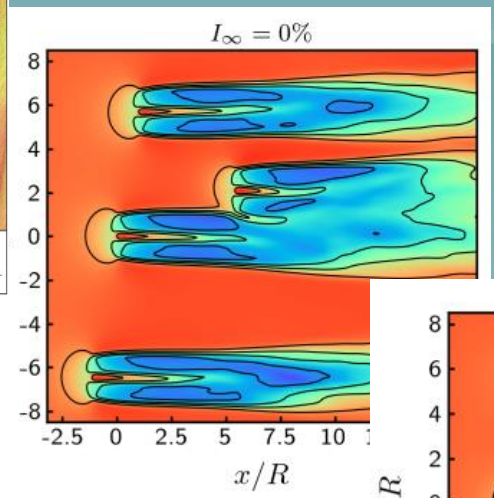
ULHN - Numerically reproduce and analyse different farm configurations for optimisation and turbine reliability

- **Use of Dorothy, the Vortex Particle Method code, use of a lifting line**
- **Account of ambient turbulence, upstream generated turbulence, array optimisation**
- **PDRAs recruitment in Oct. 2021 (Camille Choma Bex and Marc-Amaury Dufour)**

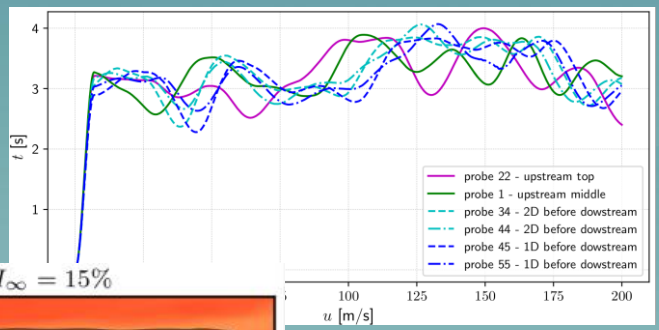


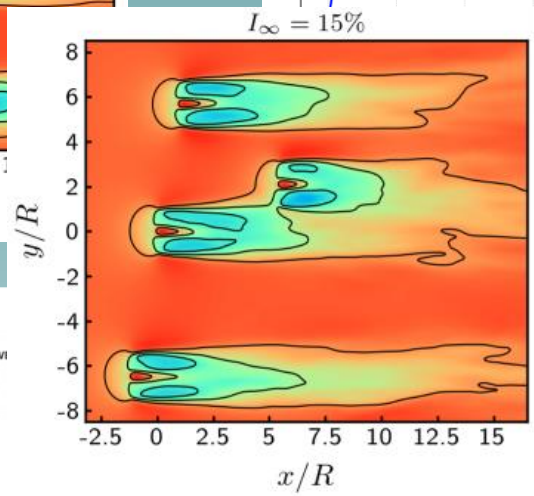


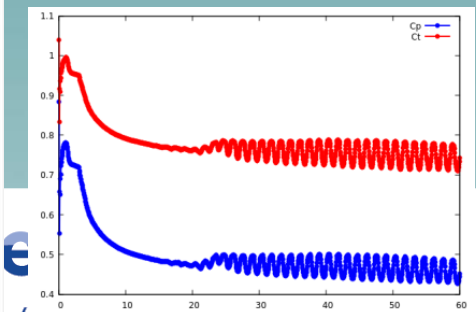
Without ambient turb. & with



Fluctuating velocity upstream
Fluctuating load







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Morbihan Data Center

=> New Data Center Sheets

Two new documents have been added to the Morbihan Data Center library.

The first is a report on the **characterisation of the acoustic footprint** of the Gulf of Morbihan and the second on the **global sedimentary context** of the Gulf of Morbihan and the TIGER project site

Sheets will be published on the **TIGER web page** of the UBS and the **MHE56** web site

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Morbihan Site Survey

=> New UAV site survey

A new DEM realized from September UAV site survey is under progress.

The comparison between 2020 and 2021 UAV surveys will provide differential DEMs of the site (morphological evolution) and eelgrass herbarium evolution along the landing zone the GM site.

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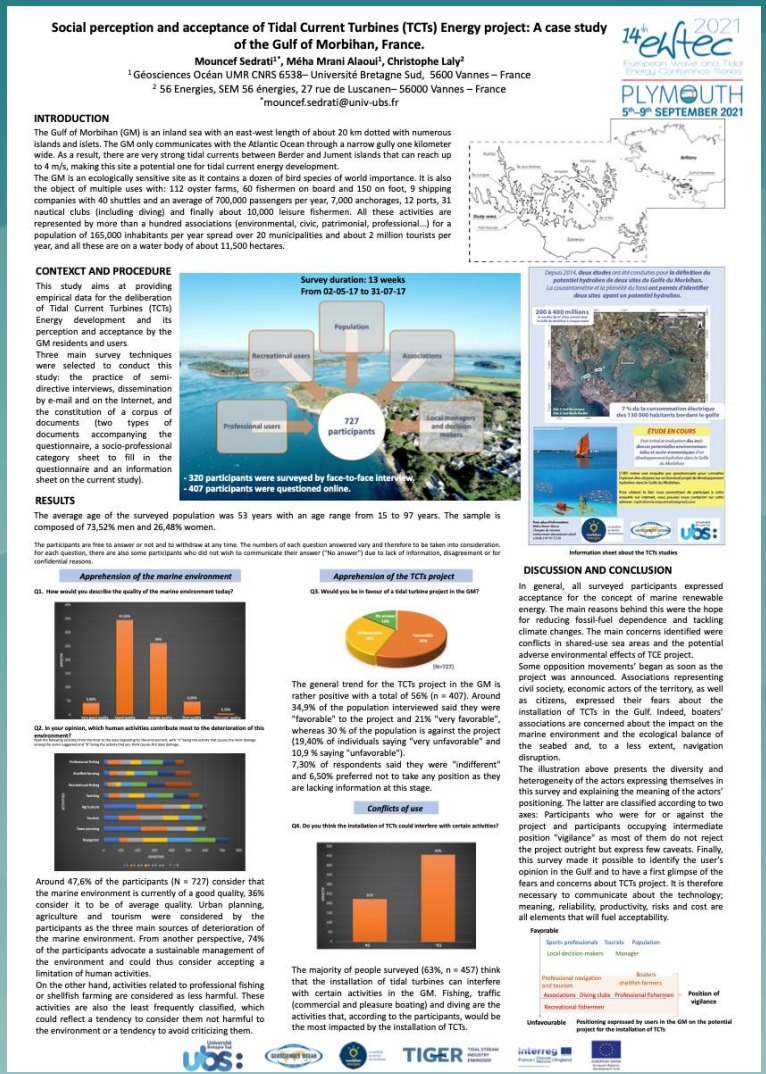
Dissemination

Participation in EWTEC 2021

Plymouth – UK. 21-24 September

Social perception and acceptance of Tidal Current Turbines (TCTs) Energy project: A case study of Morbihan, France

Winner for the best Poster Presentation



Social perception and acceptance of Tidal Current Turbines (TCTs) Energy project: A case study of the Gulf of Morbihan, France.

Mouncef Sedrati[1*], Méha Mrani Alaoui[1], Christophe Laly[2]

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[2] 56 Energies, SEM 56 énergies, 27 rue de Luscanen– 56000 Vannes – France

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14th ewtec 2021 European Wave and Tidal Energy Conference Series — PLYMOUTH 5th–9th SEPTEMBER 2021

INTRODUCTION

The Gulf of Morbihan (GM) is an inland sea with an east-west length of about 20 km dotted with numerous islands and islets. The GM only communicates with the Atlantic Ocean through a narrow gully one kilometer wide. As a result, there are very strong tidal currents between Berder and Jument islands that can reach up to 4 m/s, making this site a potential one for tidal current energy development.

The GM is an ecologically sensitive site as it contains a dozen of bird species of world importance. It is also the object of multiple uses with: 112 oyster farms, 60 fishermen on board and 150 on foot, 9 shipping companies with 40 shuttles and an average of 700,000 passengers per year, 7,000 anchorages, 12 ports, 31 nautical clubs (including diving) and finally about 10,000 leisure fishermen. All these activities are represented by more than a hundred associations (environmental, civic, patrimonial, professional…) for a population of 165,000 inhabitants per year spread over 20 municipalities and about 2 million tourists per year, and all these are on a water body of about 11,500 hectares.

CONTEXT AND PROCEDURE

This study aims at providing empirical data for the deliberation of Tidal Current Turbines (TCTs) Energy development and its perception and acceptance by the GM residents and users.

Three main survey techniques were selected to conduct this study: the practice of semi-directive interviews, dissemination by e-mail and on the Internet, and the constitution of a corpus of documents (two types of documents accompanying the questionnaire, a socio-professional category sheet to fill in the questionnaire and an information sheet on the current study).

Survey duration: 13 weeks
From 02-05-17 to 31-07-17

Population
Recreational users
Associations
Professional users
727 participants
Local managers and decision makers

- 320 participants were surveyed by face-to-face interview.
- 407 participants were questioned online.

Information sheet about the TCTs studies

RESULTS

The average age of the surveyed population was 53 years with an age range from 15 to 97 years. The sample is composed of 73,52% men and 26,48% women.

The participants are free to answer or not and to withdraw at any time. The numbers of each question answered vary and therefore to be taken into consideration. For each question, there are also some participants who did not wish to communicate their answer ("No answer") due to lack of information, disagreement or for confidential reasons.

Apprehension of the marine environment

Q1. How would you describe the quality of the marine environment today?

Q2. In your opinion, which human activities contribute most to the deterioration of this environment?

Around 47,6% of the participants (N = 727) consider that the marine environment is currently of a good quality, 36% consider it to be of average quality. Urban planning, agriculture and tourism were considered by the participants as the three main sources of deterioration of the marine environment. From another perspective, 74% of the participants advocate a sustainable management of the environment and could thus consider accepting a limitation of human activities.

On the other hand, activities related to professional fishing or shellfish farming are considered as less harmful. These activities are also the least frequently classified, which could reflect a tendency to consider them not harmful to the environment or a tendency to avoid criticizing them.

Apprehension of the TCTs project

Q3. Would you be in favour of a tidal turbine project in the GM?

The general trend for the TCTs project in the GM is rather positive with a total of 56% (n = 407). Around 34,9% of the population interviewed said they were "favorable" to the project and 21% "very favorable", whereas 30 % of the population is against the project (19,40% of individuals saying "very unfavorable" and 10,9 % saying "unfavorable").

7,30% of respondents said they were "indifferent" and 6,50% preferred not to take any position as they are lacking information at this stage.

Conflicts of use

Q4. Do you think the installation of TCTs could interfere with certain activities?

The majority of people surveyed (63%, n = 457) think that the installation of tidal turbines can interfere with certain activities in the GM. Fishing, traffic (commercial and pleasure boating) and diving are the activities that, according to the participants, would be the most impacted by the installation of TCTs.

DISCUSSION AND CONCLUSION

In general, all surveyed participants expressed acceptance for the concept of marine renewable energy. The main reasons behind this were the hope for reducing fossil-fuel dependence and tackling climate changes. The main concerns identified were conflicts in shared-use sea areas and the potential adverse environmental effects of TCE project.

Some opposition movements' began as soon as the project was announced. Associations representing civil society, economic actors of the territory, as well as citizens, expressed their fears about the installation of TCTs in the Gulf. Indeed, boaters' associations are concerned about the impact on the marine environment and the ecological balance of the seabed and, to a less extent, navigation disruption.

The illustration above presents the diversity and heterogeneity of the actors expressing themselves in this survey and explaining the meaning of the actors' positioning. The latter are classified according to two axes: Participants who were for or against the project and participants occupying intermediate position "vigilance" as most of them do not reject the project outright but express few caveats. Finally, this survey made it possible to identify the user's opinion in the Gulf and to have a first glimpse of the fears and concerns about TCTs project. It is therefore necessary to communicate about the technology; meaning, reliability, productivity, risks and cost are all elements that will fuel acceptability.

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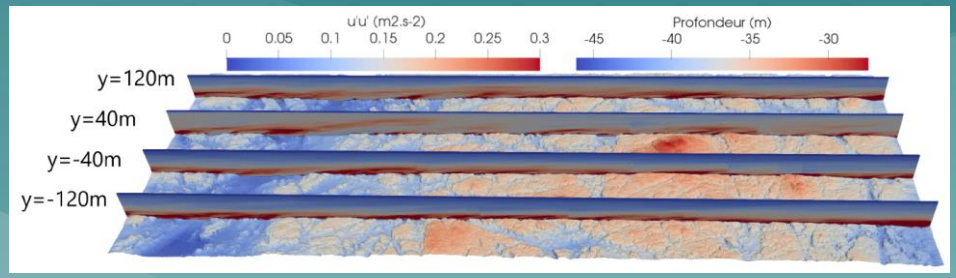
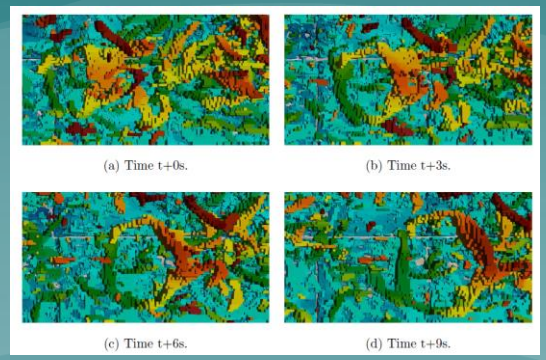
Tidal resource modelling and turbines' installation assessment (T1.7)

Flow and turbulence in tidal sites: LES Simulations

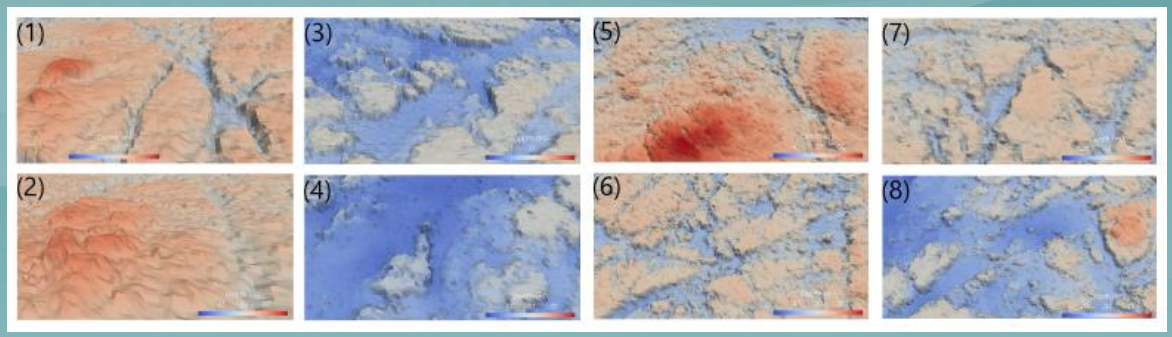
- Effect of the bottom and the tidal conditions in Raz Blanchard





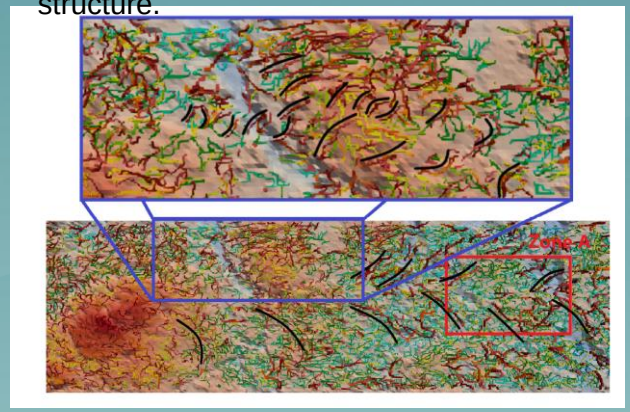
The formation of a large coherent flow structure.

- Identification of some source of large eddies



Bathymetry details prone to generating turbulence

Mercier P., Guillou S. (2021), The impact of the seabed morphology on turbulence generation in a strong tidal stream, Physics of Fluids, 33, 055125 (2021);



Predictor-corrector visualisation of vortex trails. The black lines highlight the vortices within the trails.

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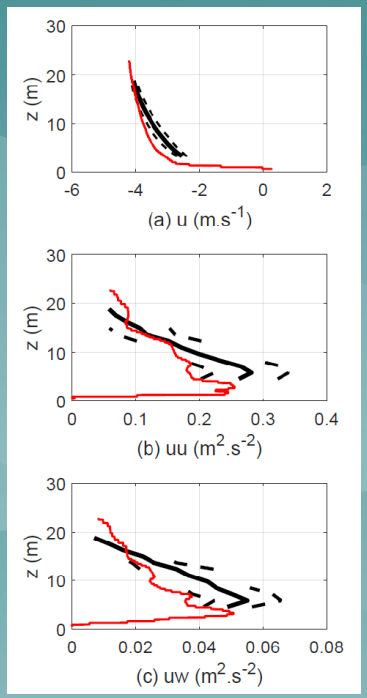
Tidal resource modelling and turbines' installation assessment (T1.7)

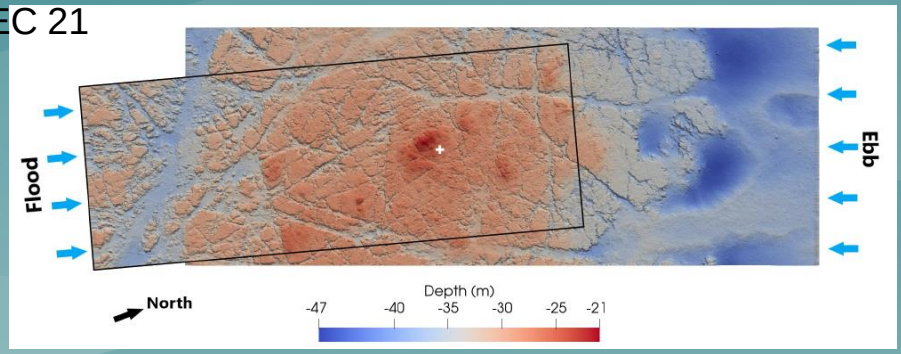
Flow and turbulence in tidal sites: LES Simulations

- Effect of the bottom and the tidal conditions

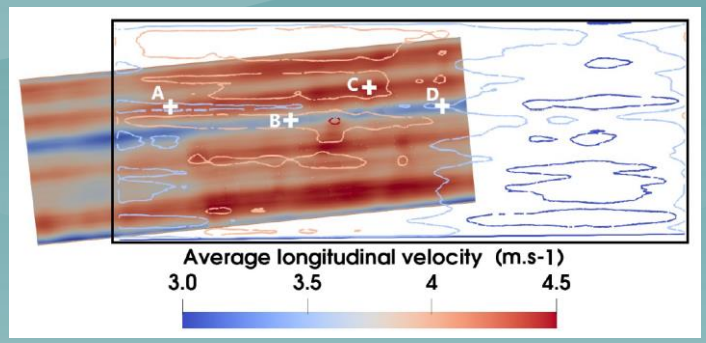


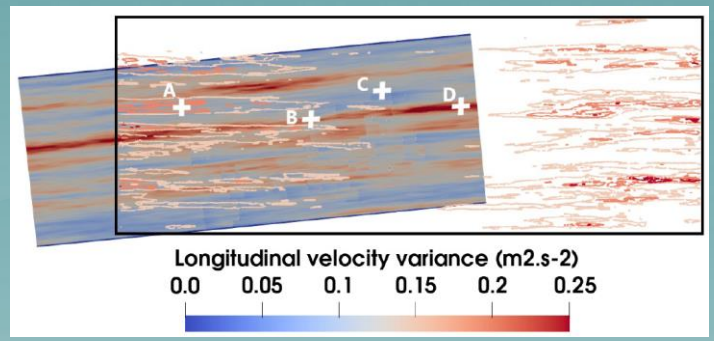
Comparison of the Reynolds stresses derived from ADCP measurements and simulation data.

Mercier P., Guillou S., Thiébot J., Poizot E., Flood/ebb variability of turbulence characteristics in the Raz Blanchard: an analysis by large-eddy simulation, EWTEC 21



Flood and ebb simulation domains.





Average longitudinal velocity and velocity variance at a 15 m depth for flood (iso-surfaces) and ebb (iso-contours).

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Tidal resource modelling and turbines' installation assessment (T1.7)

Flow and turbulence in tidal sites: LES Simulations

- Application at Paimpol-Bréhat site (in preparation, data provided by SEENEOH)

Sharp details of the bathymetry at the Paimpol-Bréhat site.

- Application at the Golfe of Morbbihan (in prepation with UBS)

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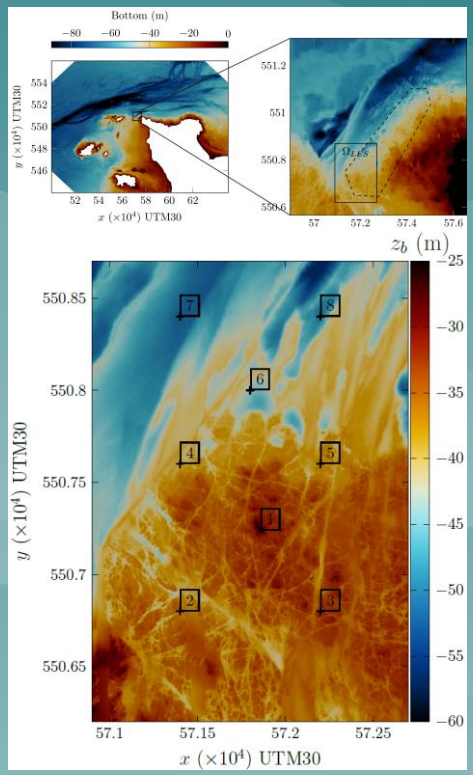
Tidal resource modelling and turbines' installation assessment (T1.7)

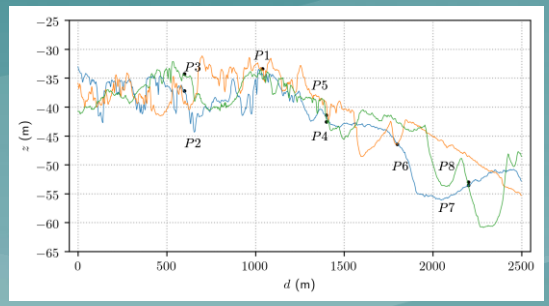
Flow and turbulence in tidal sites: LES Simulations

- Extraction of turbulence characteristics at different locations

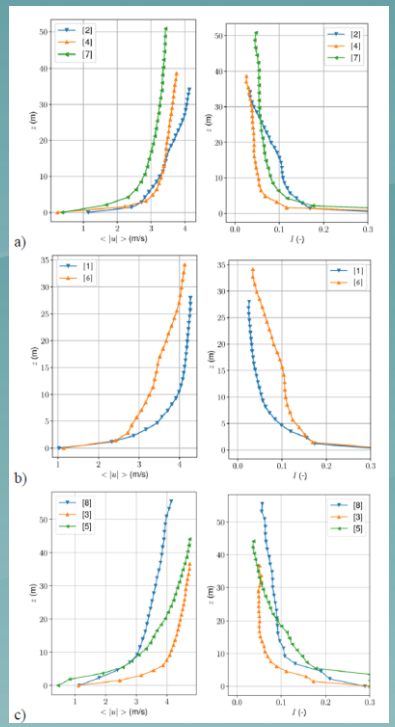


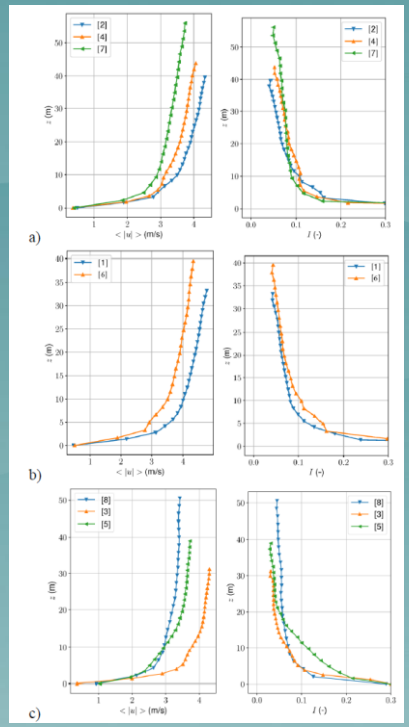
Seabed elevation (with respect to the mean sea level) and domain decomposition: Top left) Entre domain Ω; top right) location of Ω_{LES} domain and zone retained for the TEC pilot farm area; bottom) bathymetry in Ω_{LES} with the locations of numerical probes.

Guillou S., Bourgoin A., Thiébot J., Ata R., On the spatial variability of the flow characteristics at a Tidal energy site: Case of the Raz Blanchard, EWTEC 21.



South–North bathymetric profiles passing by the points P1 to P8. P3, P5 and P8 are on green curve. P2, P4 and P7 are on blue curve. P1 and P6 are on orange curve.





Profiles of velocity magnitude and turbulence intensity at Flood (Left) and ebb (Right) peak at several locations

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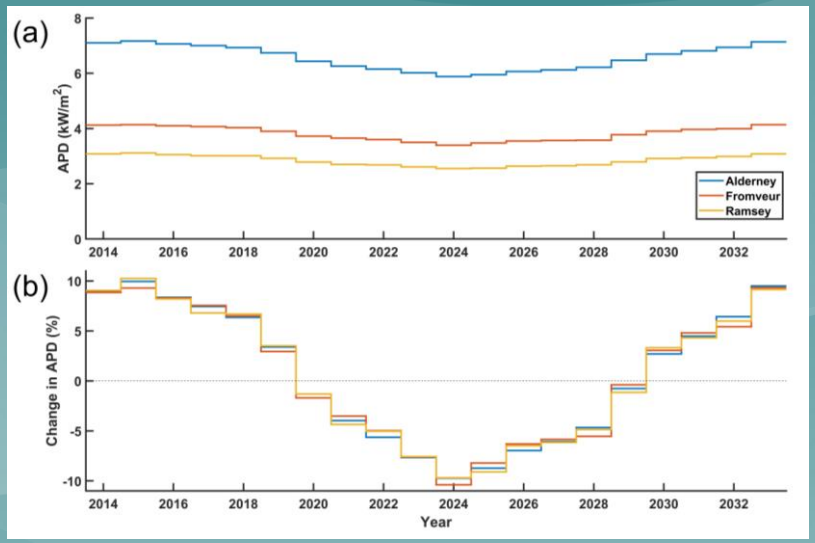
Tidal resource modelling and turbines' installation assessment (T1.7)

REGIONAL MODELLING and ENERGY ASSESSMENT

- Inter-annual variability of the resource. Raz Blanchard, Ramsey Sound, Fromveur Strait) (U.CAEN, U. Plymouth) (publication submitted)



(a) Evolution of the Annual Power Density (APD) over the 2014-2033 period; (b) Change in APD (with respect to the mean value)

Thiébot J., Coles, D., et al., On the inter-annual variability of the tidal resource in north-western Europe. Applied Ocean Research, (submitted)

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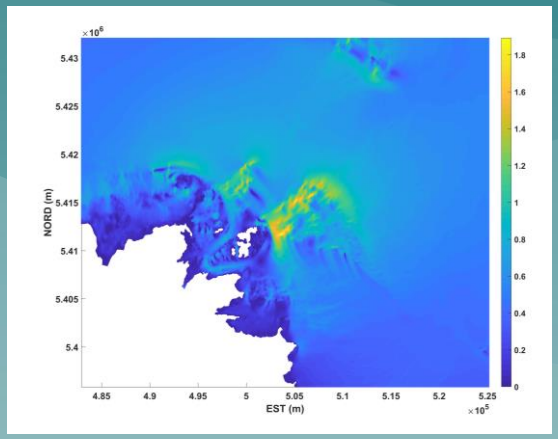
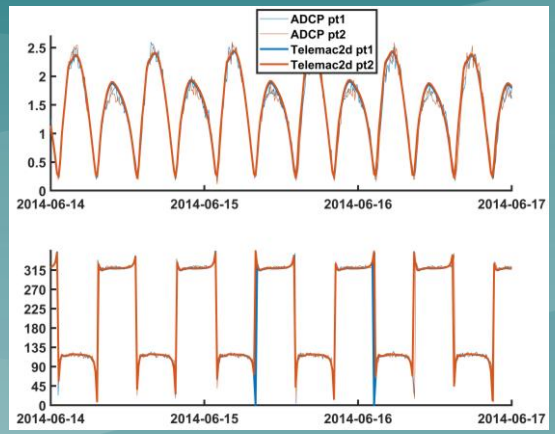
Tidal resource modelling and turbines' installation assessment (T1.7)

REGIONAL MODELLING and ENERGY ASSESSMENT

- Modeling of Paimpol Bréhat with TELEMAC (in progress, data provided by SEENEOH)





Resource assessment in Paimpol Bréhat

Rms error < 0.14 m/s with Telemac2D

Rms error < 0.20 m/s with Telemac3D

- Application at the Golfe of Morbbihan (in preparation with UBS)

- Collaboration with UMAN : extraction of data from the Telemac3D model of the Raz Blanchard
- Collaboration with ORE Catapult : Telema2D simulations and extraction of data in the Raz Blanchard

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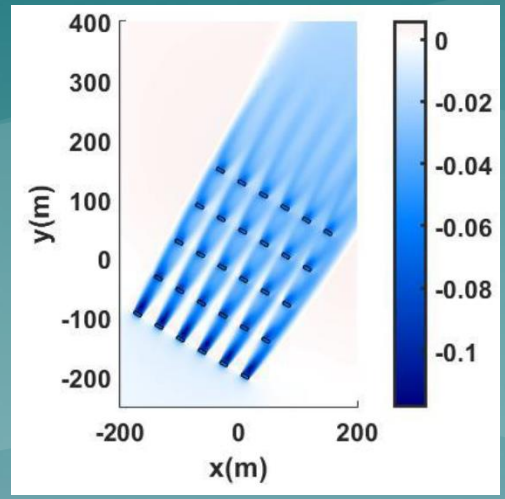
Farm layout and optimisation (Performance assessment) (T3.2)

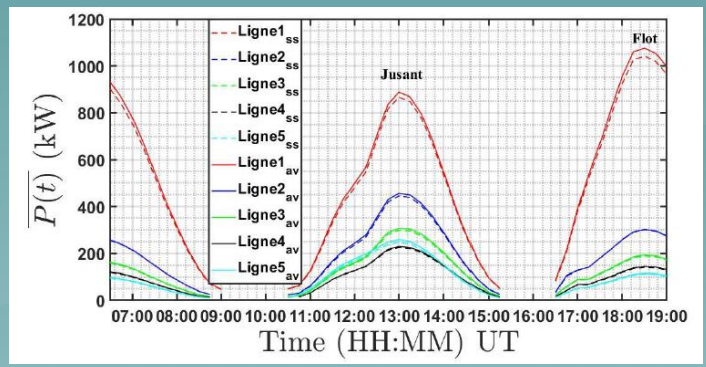
PERFORMANCE OF A TIDAL FARM LAYOUT

- Analysis of the flow in a tidal farm by regional numerical modelling
- Analysis of the farm and blockage effects.
  - PhD of Dirieh funded by Normandy region

METHODOLOGY:

- Use of simplified modellings to take into account the turbines in a farm
- Use of the regional code TELEMAC, and CFD code for local modelling
- Comparison with local modelling (Uman, ULH)





Article in writing:

Dirieh N. D., Thiébot J., Guillou S.S, Guillou N., Blockage corrections for tidal turbines - Application to an array of turbines in the Alderney Race

Blockage effect in Actuator Disk tidal turbine modelling (Dirieh et al., JH2020). Right: velocity difference with and without blockage effet in a tidal farm in the Raz Blanchard. Left: Tidal farm power with blockage effet (---) and without (____).

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Academics Update

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Collaboration & knowledge sharing

TIGER welcomes the opportunity to collaborate with other like-minded projects and associations.

If you would like to discuss possible opportunities, please get in touch.

Thank You

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