

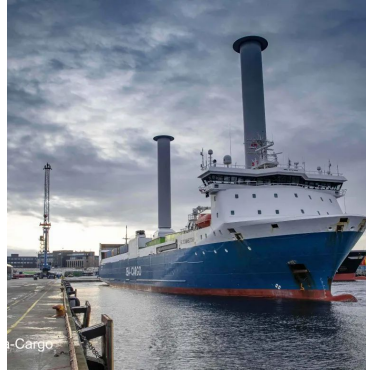


Innovative solutions for design and operation of wind assisted vessels

Blue Week 2021 - online

Reducing carbon footprint with wind

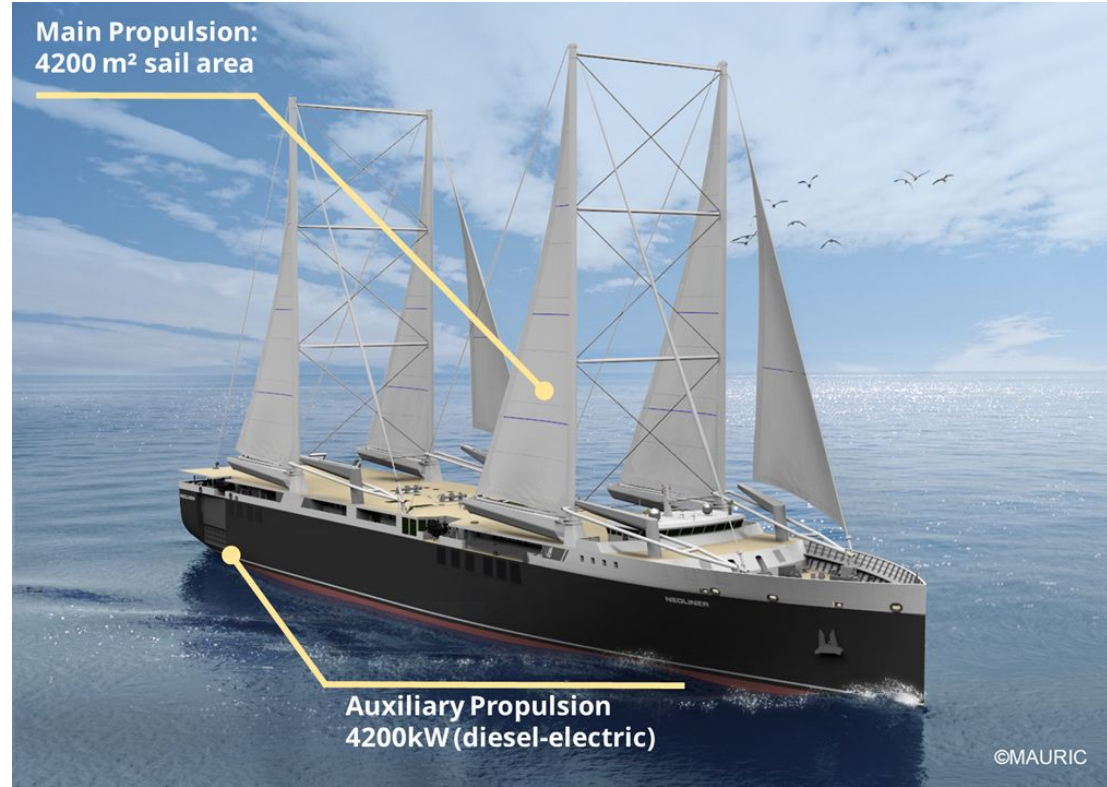
- UN Sustainable Development Goal 13 = take urgent action to combat climate
By 2050 : At least 50% reduction of total annual GHG emissions (requires
reduction per ship)
→ Wind assisted propulsion systems are one solution to this challenging objective



But Shipowners can be reluctant without certainty of performances and behavior of the ship equipped with such systems

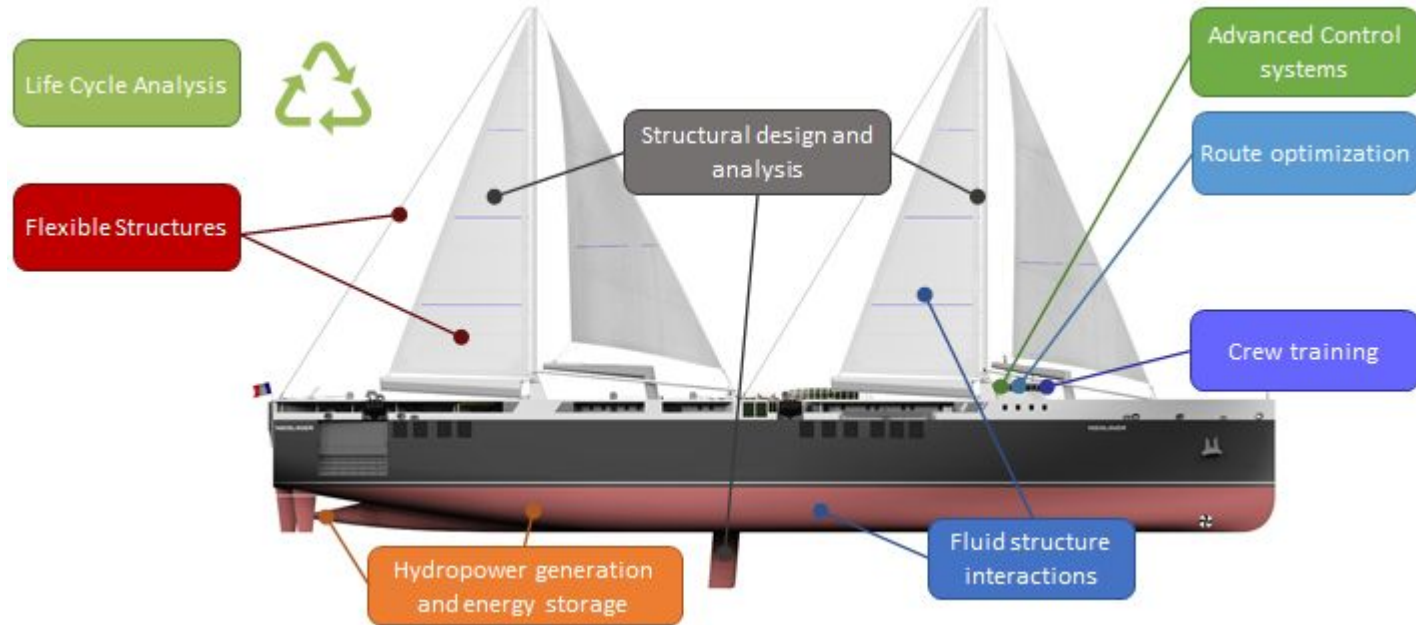
Wind Assisted Vessels

Example of NEOLINER Concept



Wind Assisted Vessels

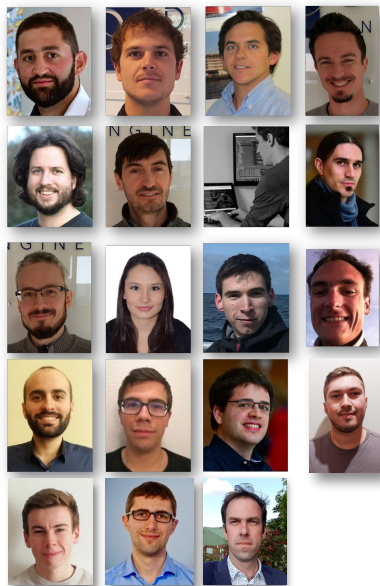
Complex multi-physics Systems



About D-ICE

We are a team of PhDs & Engineers aiming to solve real & complex industrial challenges for Maritime & Energy industries.

D-Team



Main ambitions



Develop & Produce Clean Energy



Reduce Greenhouse emissions



Improve Safety at Sea



Technical & Commercial Partnerships

Multiconsult



Key figures

- Founded in 2015
- Offices in Nantes & Paris (France)
- Turnover about ~950k€ (2020)
- 17+ clients / 46+ projects
- 100% independent

Hydrodynamics. Robotics. Control Systems. Artificial Intelligence. Software Engineering. Ice Mechanics.

Our Products



Next-generation Monitoring,
Control, Navigation &
Decision-support System



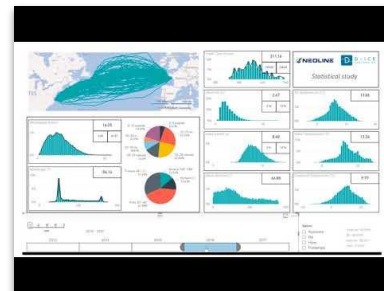
Advanced Framework of modelling
& simulation of offshore systems
and marine operations



Cutting-edge statistical
weather routing



Advanced Control &
Monitoring of Offshore
Wind Turbines



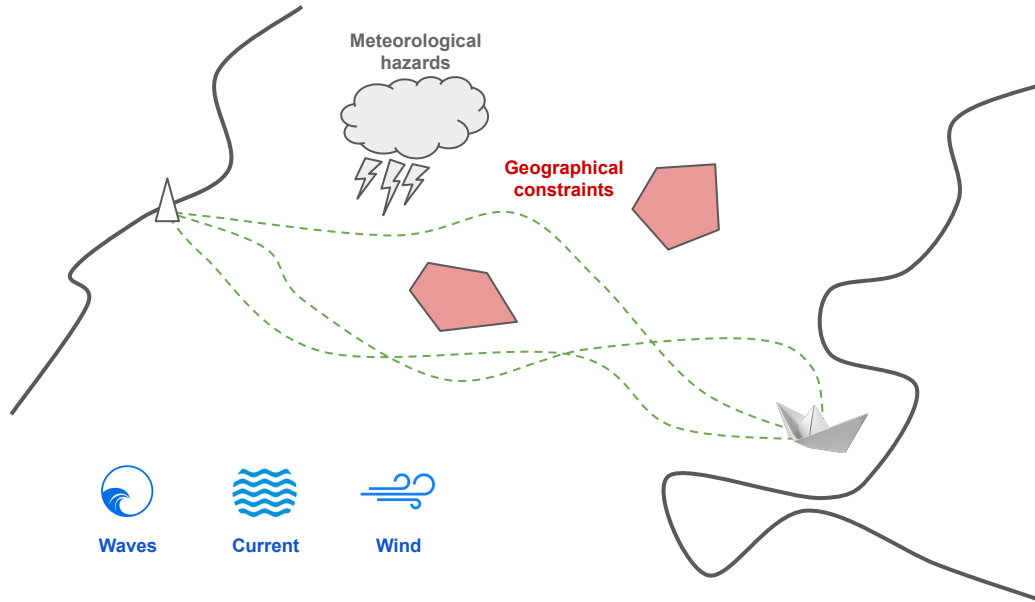
Modelling and simulation of Wind
assisted vessels



Weather routing

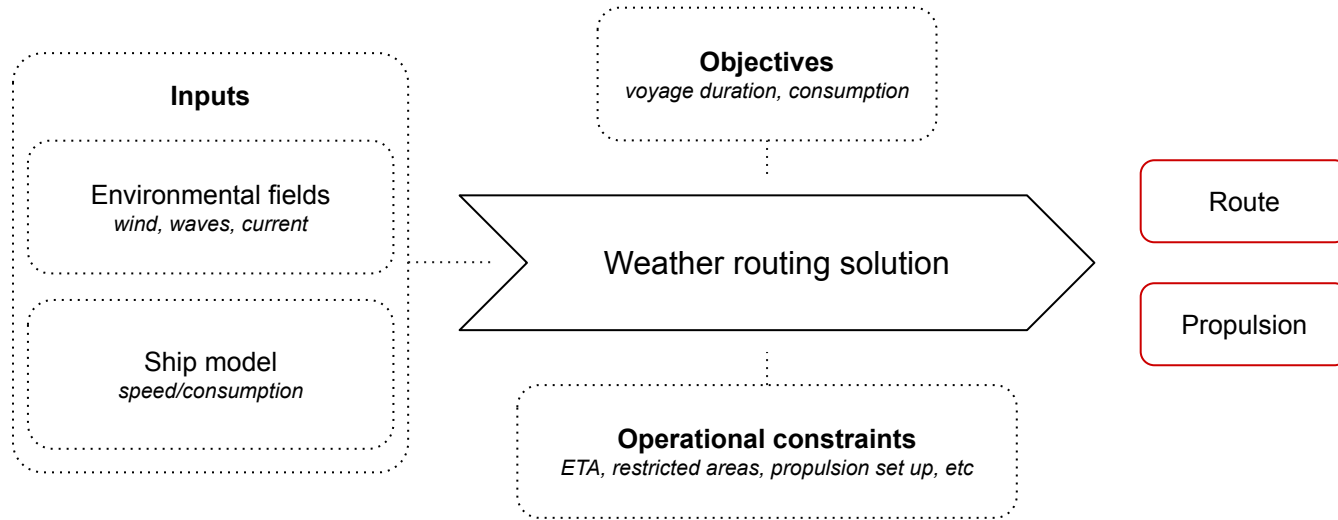
Weather routing - *Generalities*

Problem: Finding the best route or set of routes from a position to another regarding some optimization criterias and constraints



- Various environmental fields which strongly impact ship behaviour
- Many constraints including for safety reasons

Weather routing - Generalities



Few observations:

- two different approaches for weather routing of motor ship or sailing ships
- no off-the-shelf solutions for hybrid propelled vessels
- ships becoming more complex needing various constraints and multi-objective optimizations

Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

- mono and multi-objective optimization
- tailorable and flexible
- sailing, motor, and hybrid ships

What led us compute route optimization **with the same solution** for

- ★ sailing ships



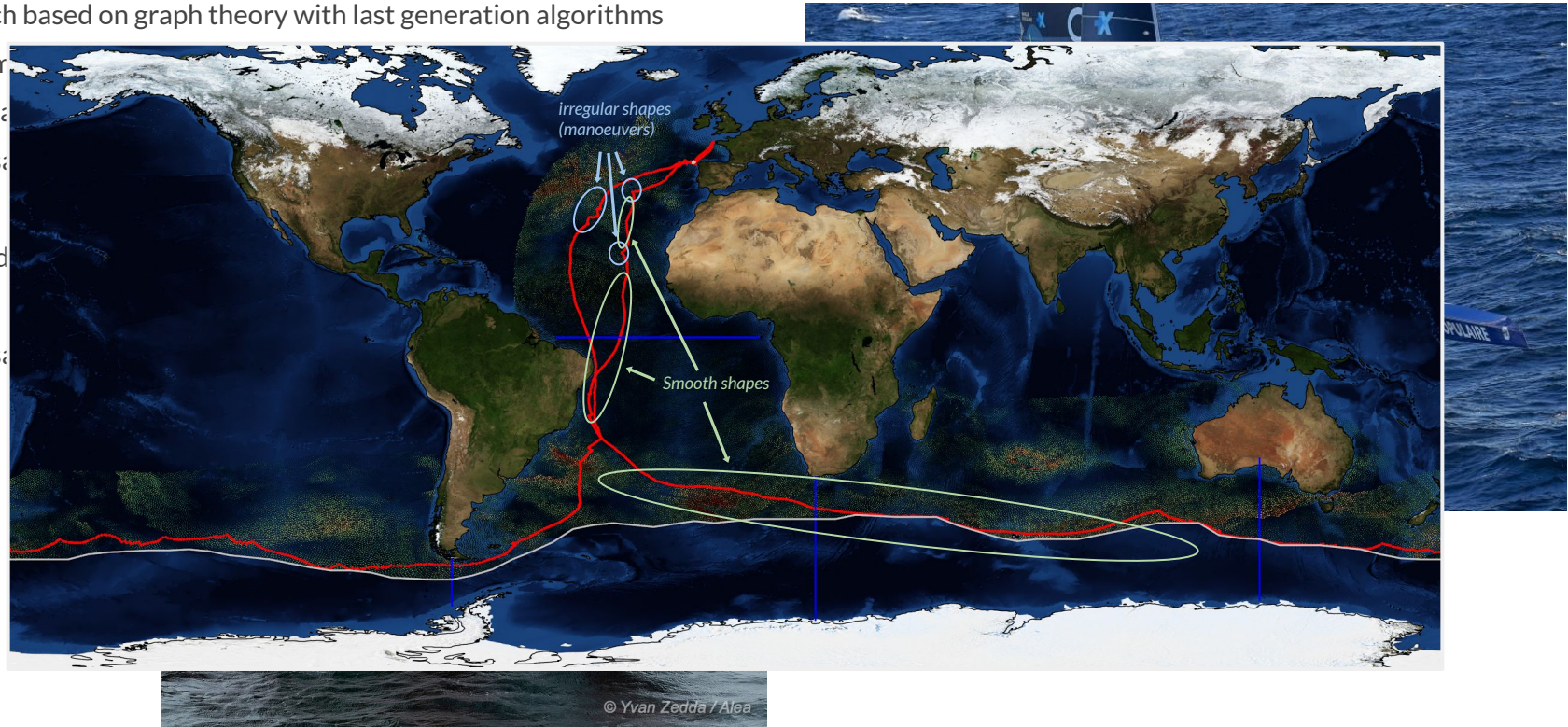
Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

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What led

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Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

- mono and multi-objective optimization
- tailorable and flexible
- sailing, motor, and hybrid ships

What led us compute route optimization **with the same solution** for

- ★ sailing ships
- ★ conventional ships



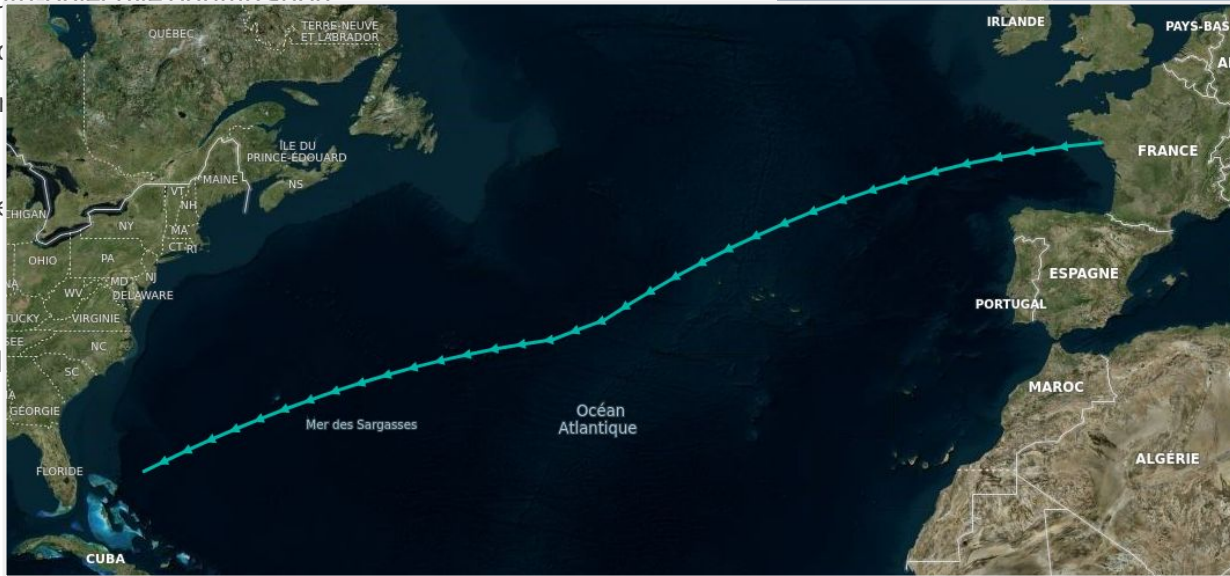
Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

- mono and multi-objective optimization
- tailorable and
- sailing, motor

What led us compute

- ★ sailing ships
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Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

- mono and multi-objective optimization
- tailorable and flexible
- sailing, motor, and hybrid ships

What led us compute route optimization **with the same solution** for

- ★ sailing ships
- ★ conventional ships
- ★ hybrid ships

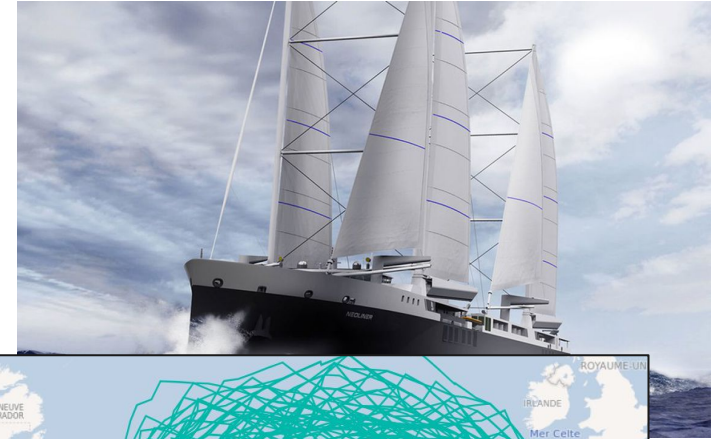


Depending on the operational profile of the hybrid ship, optimal route may be totally different, so the **versatility** of the solution to handle sailing / motor propulsion is **essential**.

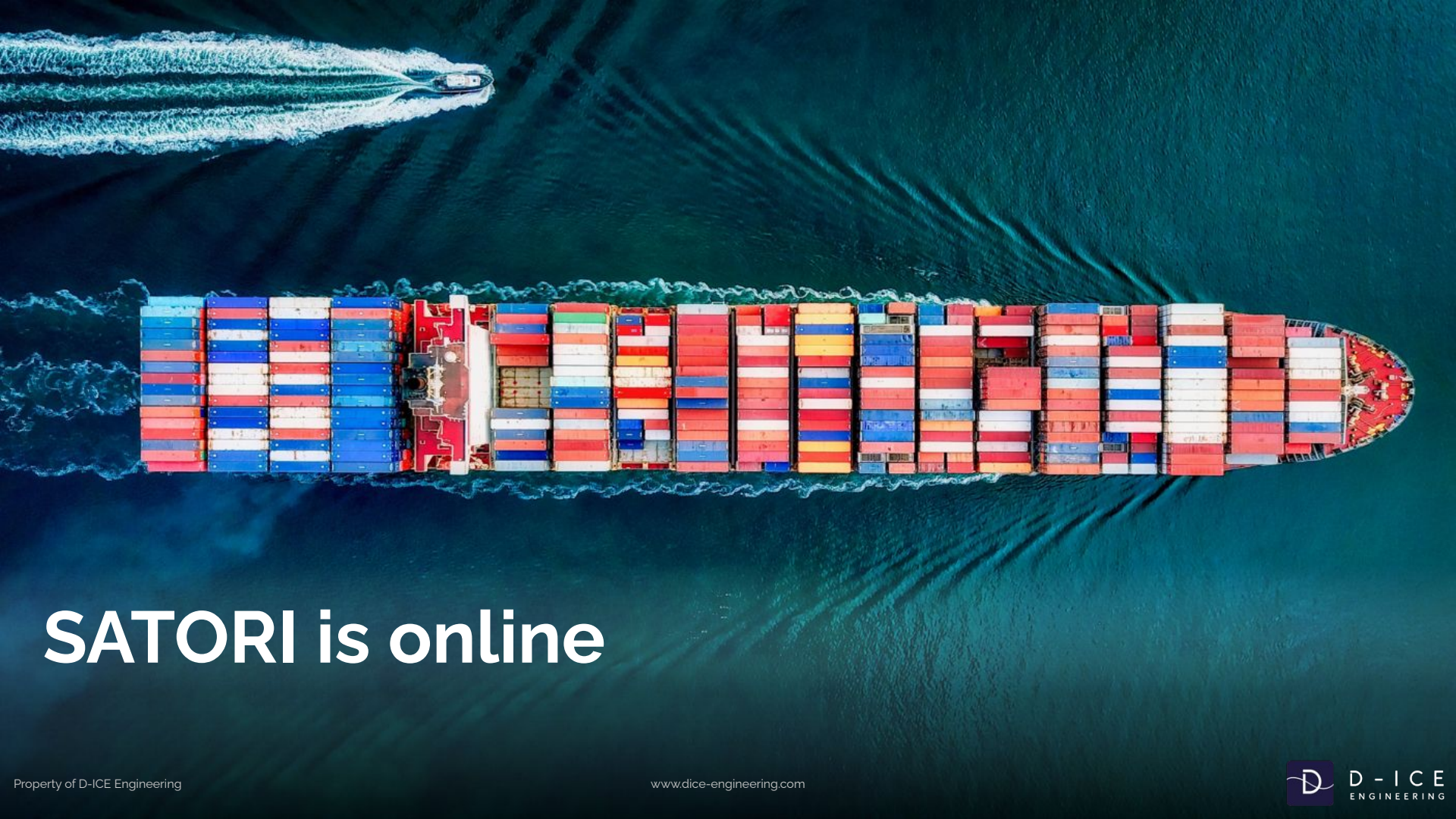
Weather routing - *Solution*

Approach based on graph theory with last generation algorithms

- mono and multi-objective optimization



propulsion is **essential**.

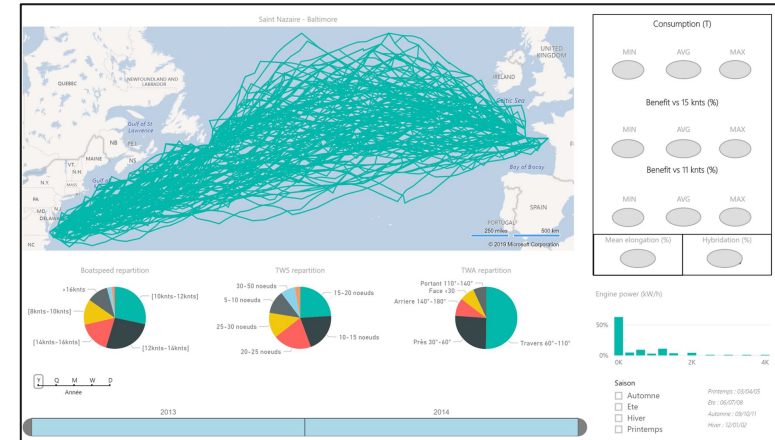


SATORI is online

Propose a solution for **ship owner**, **naval architects**, and **solution developers** to launch statistical weather routing studies by **their own**, online.

From historical weather datas get statistics to:

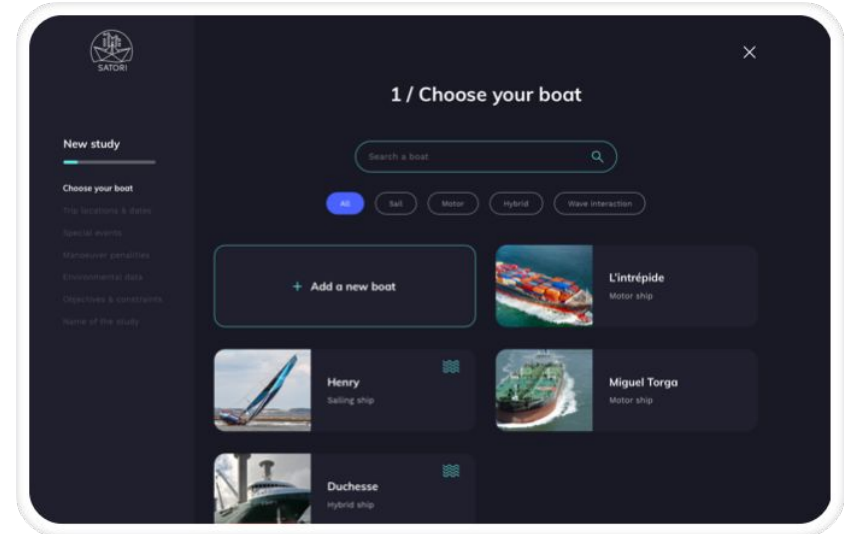
- Evaluate benefits & payback of a wind assist solution
- Validate your ship performances & associated business model
- Optimize your design



Project duration 18 months
Funded through CMEMS User Uptake Program
Market release: November 2020

1. **Define your study** : create an account, upload your ship performance data and submit your calculation

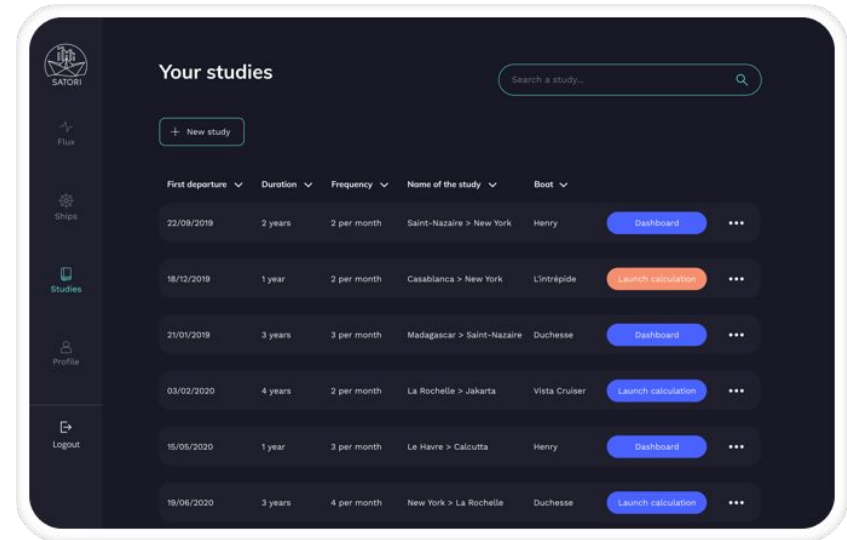
- *mechanical, sailing, or hybrid propulsion*
- *ETA, waypoints, canal*
- *First / Last departure dates and frequency*
- *Manoeuvrer penalties*
- *Polar tables of the ship*
- *Waves speed loss calculation*
- *etc*



Project duration 18 months
Funded through CMEMS User Uptake Program
Market release: November 2020

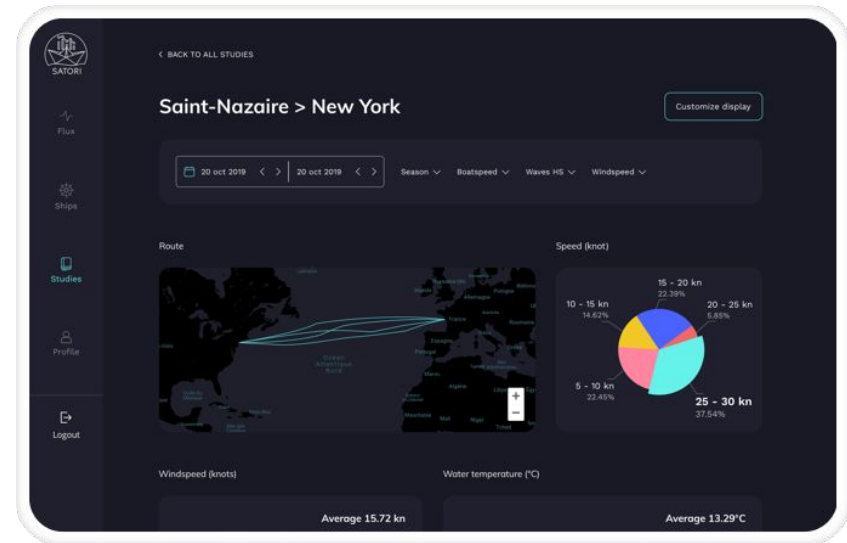
1. **Define your study** : create an account, upload your ship performance data and submit your calculation
2. **SATORI calculates all optimal routes**

- *Automatic cloud computing and notification at the end*



Project duration 18 months
Funded through CMEMS User Uptake Program
Market release: November 2020

1. **Define your study** : create an account, upload your ship performance data and submit your calculation
2. **SATORI calculates all optimal routes**
3. **Create your dashboard** : analyze your results through our dynamic visualization
 - *Online customization*
 - *Various visuals (map, pie chart, bar chart, scatterplots, density map)*
 - *Interactive filtering from visuals selection*
 - *Share functionality*



Project duration 18 months
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From previous studies and discussions, we are convinced that this answers to a real need for

- ship owners
- solution providers
- naval architects

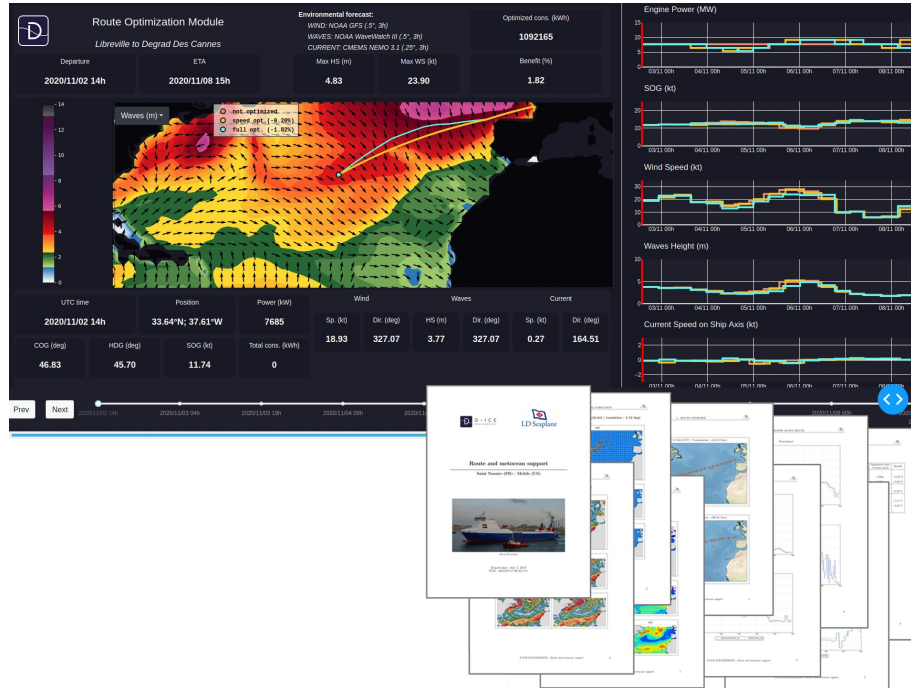
Some references on statistical route optimization



Operations



Operational routing



- Optimization of route and engine power
- integration of tailorable constraints (ETA, navigation area, maximum motions, etc)
- Daily tailorable report & dynamic visualization
- 24/7 assistance
- Wind /waves / current environmental fields

About 5 to 10% of fuels savings expected

- Cutting-edge Navigation System towards **Autonomy** at Sea
- Full Features
 - ECDIS
 - Conning
 - **Weather Routing**
 - DP & Autopilot & Track Control
 - Sails Management
 - Cameras & Docking Sensors Management
 - Situational Awareness
 - Collision Avoidance
- Tailorable & Evolutive system
- User Centered Design (UI/UX)
- Cost Effective, Sea Proven & Type Approved Hardware
- Cutting-edge algorithms powered by AI, nonlinear control, nonlinear optimization & nonlinear filtering
- Strong ongoing R&D (auto-docking, perception based control, etc.)

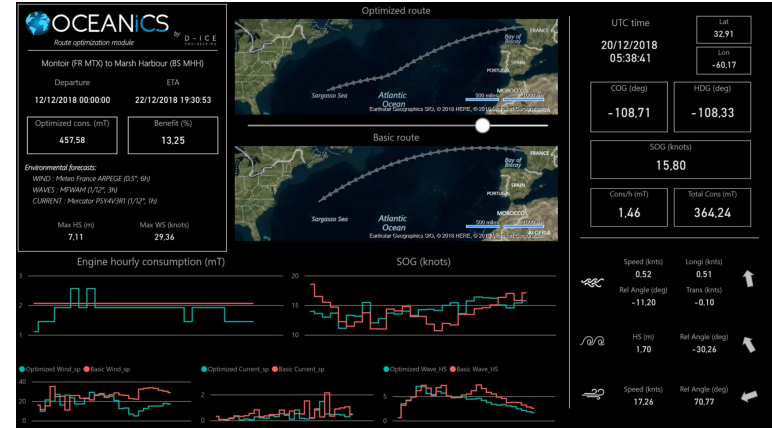


Rewarded Innovation



OCEANiCS routing - *Work in progress*

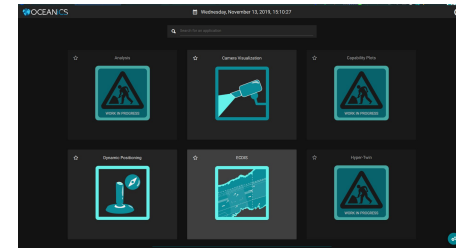
- Embedded solution OCEANiCS routing



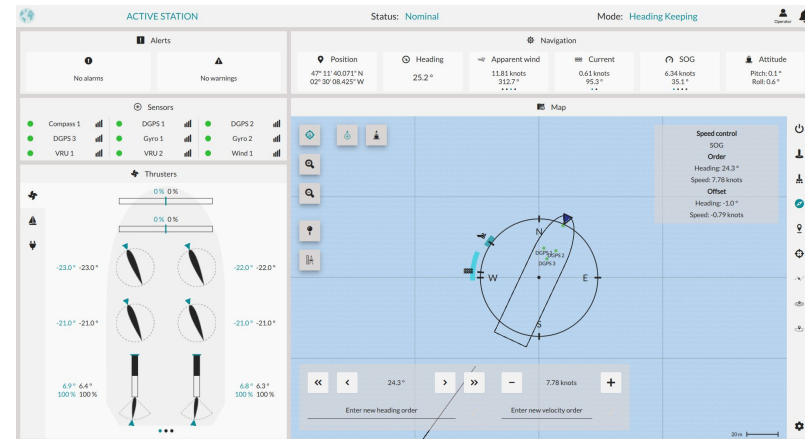
The routing module will be integrated in the OCEANiCS solution, and also be available as a standalone solution.

Additional features :

- performance monitoring system
- ship polar tables update from navigation datas



- Cutting-edge Navigation System towards **Autonomy** at Sea
- Full Features
 - ECDIS
 - Conning
 - Weather Routing
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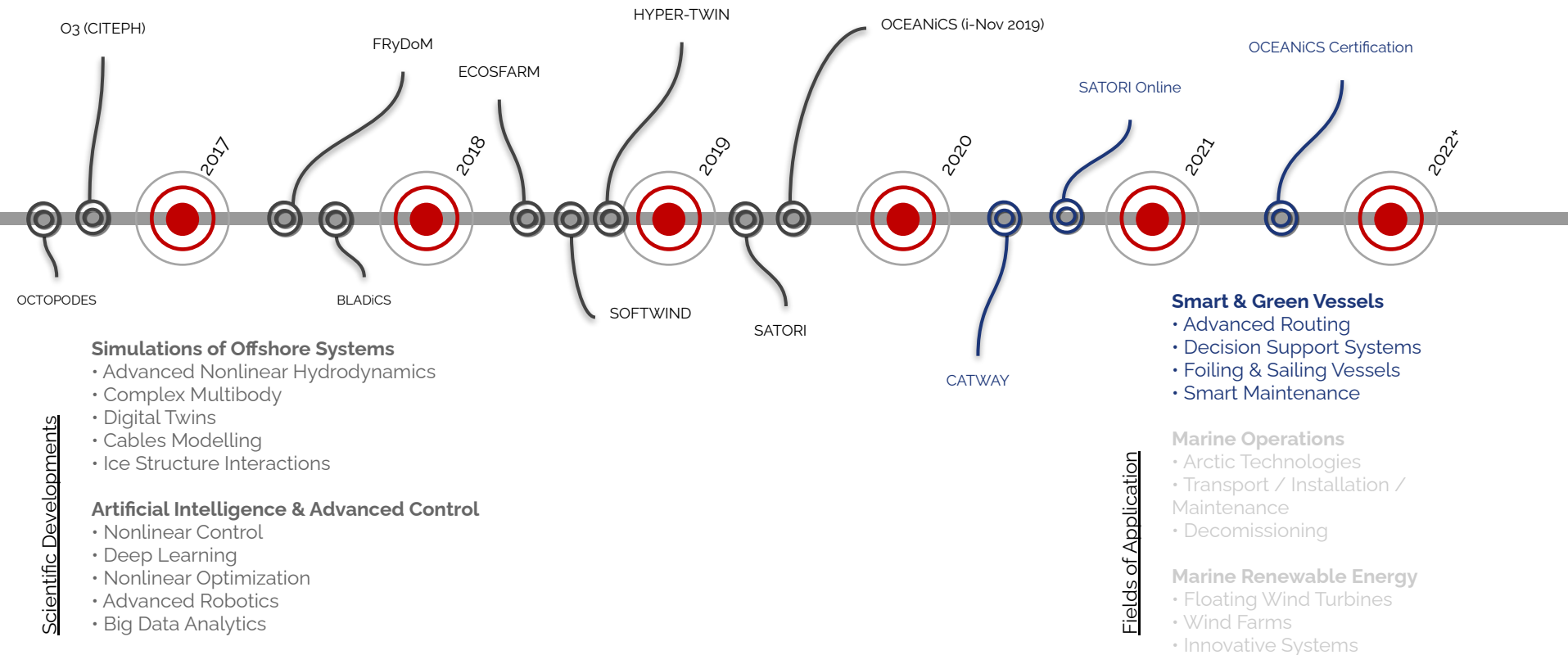
Rewarded Innovation





What's next !

R&D Roadmap



Real Challenges. True Solutions.

Contact us !

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satori@dice-engineering.com

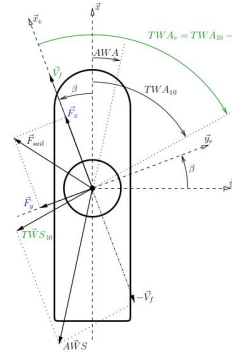
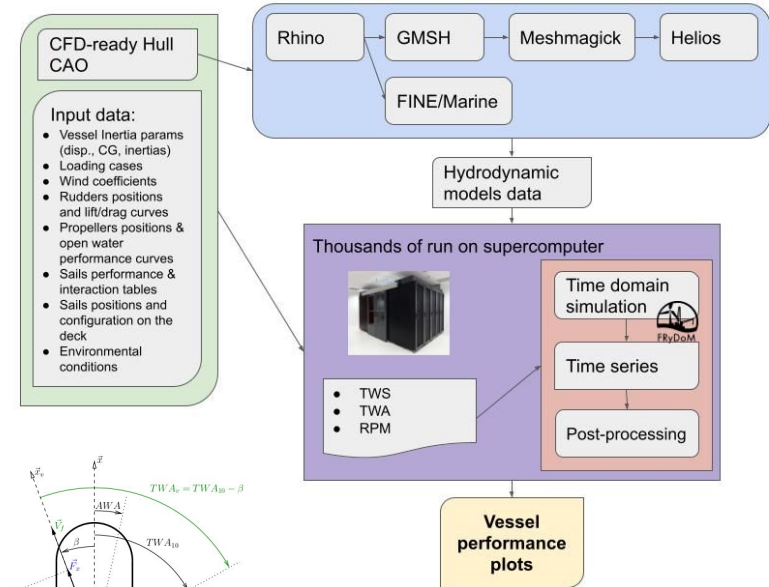
sylvain.faguet@d-ice.fr

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Ship performance plots generation workflow

- **Software used**
 - **(D-)ESPERADO** (static or Dynamic vESsel PERformAnce preDiction prOgram)
 - **FINE/Marine** (CFD)
 - **Helios** (hydrodynamic potential theory)
 - **FRyDoM** (multi-body/multi physics)

- Inputs:
 - Marine environment (wind, wave)
 - Vessel data (CAO model, displacement, draft, COG, inertia data,...)
 - Vessel propulsion & rudder details
 - Vessel aerodynamics polar coefficients



Context

→ Ship emissions reduction: Legal, Environmental and Economical issue

Solutions exists

- optimization of operational costs (weather routing, piloting, ship energy efficiency)
- New propulsions:
 - LNG
 - Wind propulsion
 - Hydrogen
 - Electric
 - Biofuels

Challenges

- Many solutions are still in a development stage and not commercial
- None of the solutions are polyvalent and effective enough for shipping operational constraints
 - **Transition will need hybridization of propulsion and combination of these solutions**