

Innovate
UK

RESHIP Project Research Newsletter

Issue 2 | November 2024



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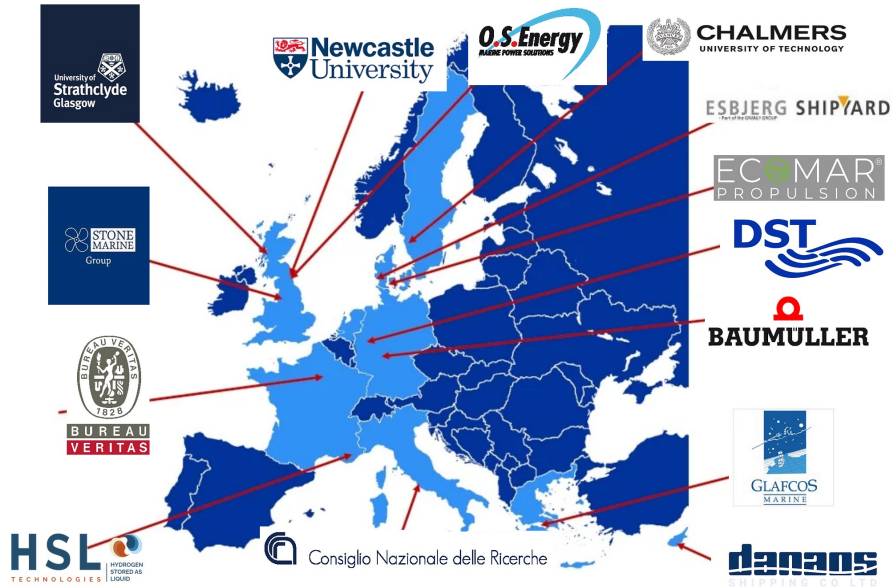
Who we are...

The RESHIP Project

RESHIP brings together a team of world-leading multidisciplinary experts from Universities and Research Center, Shipyards, Industry and Classification Societies including key patent holders from both shipping and hydrogen sectors.

RESHIP consortium is made of 14 partner organisations from 9 European Countries.

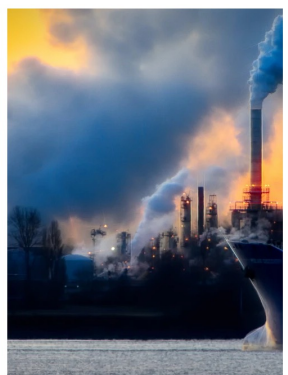
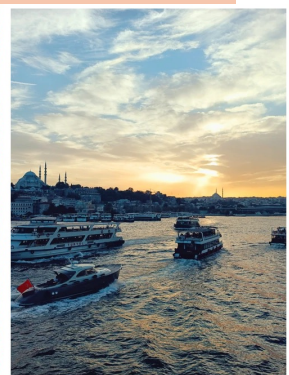
RESHIP Project is coordinated by HYSILABS



Our Research Aims

RESHIP is a three year Project that aims at enhancing energy efficiency performance and at addressing the current challenges for hydrogen usage onboard, including high energy demand, abrupt power spikes, demanding energy storage requirements. The specific and measurable objectives are listed as below.

 <p>PROPELLER</p> <p>Redesign open and ducted propellers with novel bioinspired features, Tubercle Assisted Propulsors (TAPs), using multi-objective design and optimisation methods to be hydrogen compatible and widely applicable to different vessel types.</p>	 <p>ESD</p> <p>Review the currently developed energy saving solutions and identify hydrogen preferred standalone and combined solutions for inland, short-sea and ocean-going shipping for both new builds and retrofits to reduce the energy & storage demand and smooth shaft power.</p>	 <p>OPERATION</p> <p>Investigate operational energy efficiency of developed energy saving solutions during manoeuvring and harsh sea conditions with development in the novel and hydrogen compatible automation and control strategy.</p>	 <p>CARRIER</p> <p>Research novel onboard hydrogen solution with energy efficient liquid inorganic hydrogen carrier HydroSil, to reduce the energy consumption in the process of storage, release and utilisation.</p>
 <p>RECOVERY</p> <p>Develop energy recovery solution with combined heat and power to revalorise the energy output (waste heat) in the release process from the onboard carrier HydroSil.</p>	 <p>WATER</p> <p>Validate the use of river/sea water as a reactant for the carrier at large scale; exploit the fresh water circulation onboard using the output from the fuel cell as the reactant for hydrogen release.</p>	 <p>BALLAST</p> <p>Investigate the impact on ship operation in ballasting and operational propulsion efficiency, due to the weight changes of the hydrogen carrier during release, two times heavier after release.</p>	 <p>DEMONSTRATION</p> <p>Perform prototype development and demonstration using the selected target vessel for a fullscale exploitation to investigate performance at sea.</p>
 <p>IMPACT</p> <p>Research the potential impacts in technical, environmental, economic, safety and regulatory for the applications to marine and inland waterway ships and fleets.</p>	 <p>UPSCALE</p> <p>Develop and standardise the developed technological solution; upscale the technology for high power application; communicate with regulatory bodies for wider uptake.</p>		



RESHIP is moving on!

Updates from RESHIP Coordinator

Daria Matignon

HSL TECHNOLOGIES (HYSILABS)

RESHIP project is moving on despite some challenges that it had to face recently.

Redefining energy efficiency through the two innovative technologies - the core mission of the project - will be soon entering the exciting phase of physical integration.

Our target vessel Fortuna Crane is ready to undergo the retrofitting works and the partners are eager to witness the final demonstration. However, we still some work to be done before that happens.

The tubercule assisted propulsion part of the project is following its initial schedule. The final informed decisions and choices are being made for the propulsion system before it can go into production.

As for the hydrogen power generator integration, it will take some more time than planned but for the good reason of assuring that all safety and security requirements are respected. Innovation surely shifts the lines, but that requires due preparation which may need more time, as in our case (follow WP4 update section for more). We are currently working closely with class and flag societies to find the best way to get the approval to conduct demonstration onboard and thus to push the technologies closer to the market.

All the partners of the consortium are putting their best effort in attaining the objectives of the project. The partners had the opportunity to meet for our extended Steering Committee in June at the premises of DST, which was a great occasion to assist in some experimental trials and get more work done during the workshops.

Recently, we also welcomed a new Danish member of the consortium - ECOMAR Propulsion who joined us to complete the H2PG team. They replace H2Tec who had to leave the project for internal reasons.

The period was also rich in numerous major communication occasions such as Posidonia 2024 in Athens or SMM 2024 in Hamburg.

To sum up, RESHIP project is in the phase of finalizing the design, engineering and integration modalities of the novel technologies before heading into the compelling more tangible phase of production and first testing. We will be sure to keep you posted!



RESHIP is moving on!

Updates from WP leaders

WP1

Daria Matignon

**HSL TECHNOLOGIES
(HYSILABS)**



This WP is dedicated to internal and external Project management. We have had a pretty intense schedule of the management side since our last Newsletter:

- In April we had the Reporting meeting in Brussels in the presence of our then PO Vladimir Cir-Bourg and the Head of Sector, Gabriel Mialocq. Each WP leader presented the achievements, deviations and upcoming tasks. Financial statement have also been submitted by all consortium members. The overall assessment of the European Commission stated that the project has achieved most of its objectives and milestones for the period, with relatively minor deviations.
- In June we were happy to have our extended version of the Steering Committee in person at the premises of DST in Duisburg. The program included a great tour of the DST's facilities, witnessing a part of model tests, presentations of achieved results and ongoing tasks and workshops on the upcoming milestones.
- Our Dutch partner, H2Tec responsible for the power generation sub-system of the hydrogen unit decided to leave the consortium for internal schedules conflict. We are more than happy to welcome our new Danish partner ECOMAR Propulsion onboard of RESHIP. ECOMAR will take over this important role of completing the design and realization of the sub-system.
- The Project's general schedule is currently being subject to discussion with the PO since we have identified a need for budget relocation and potential prolongation on the H2PG side due to out-of-scope permission to onboard procedure. An amendment will be put in place once we have worked out and agreed on all the details.

This WP is dedicated to RESHIP dissemination, communication and exploitation. Since the first Newsletter we have workon on the following tasks:

- On the communication side, we have been working on keeping the Website and our LinkedIn account costantly updated with new posts and news and on promoting RESHIP in public engagement events and media.
- On the dissemination side, we have been active on different dissemination channels. A non-exhaustive list includes: RESHIP presentation in relevant maritime events such as POSIDONIA 2024 and SMM 2024, a Journal paper accepted for publication. Other dissemination activities are in preparation or underway.
- On the exploitation side, we have started a discussion on how to best address all the tasks/activities described in the DEC plan.

WP2

Mario Felli

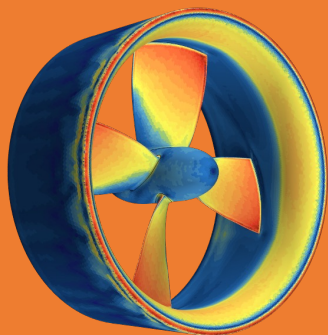
CNR



WP3

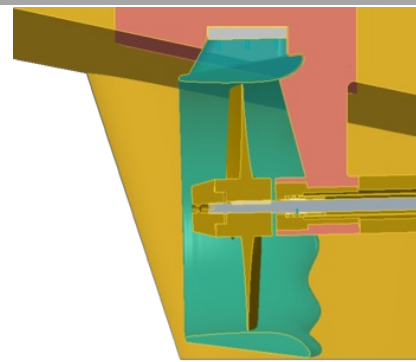
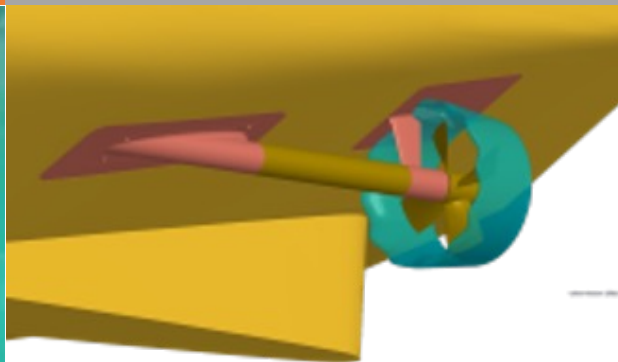
Weichao Shi

**NEWCASTLE
UNIVERSITY**



The WP3 team has been actively engaged in the Tubercle Assisted Propulsion aspect of the project. While NEWCASTLE UNIVERSITY is responsible for the propeller design, CNR has conducted performance tests on the propeller and resistance tests on the ship model in the towing tank facility. CHALMERS has been involved in the numerical optimization of the propeller geometry and is also analyzing the effect of oblique waves on the propeller. DST Germany is studying the impact of the tubercle propeller on inland shipping. Although there have been some challenges with the experimental investigations, the WP3 team remains on schedule.

An important development to note is the modification of the propeller configuration. Initially, the plan was to replace the existing ship propeller with a ducted propeller. However, due to space constraints, installing a duct on the current ship would incur additional costs and reduce the propeller diameter. Additionally, experimental investigations revealed that the tubercle leading edge does not provide significant performance advantages for the propeller. Taking these factors into account, a new propeller is being designed without a duct, but it will retain the tubercle leading edge as originally planned. This change is expected to contribute to the timely completion of the project while maintaining cost control.



Given that that the H2PG is a completely novel unit, class (BV) and flag (DMA) societies are working on a customized procedure which will allow us to perform the demonstration onboard. This new procedure will affect the sourcing and potentially some design solutions for the H2GP. For this reason, the Project's schedule will have to be modified accordingly.

The demonstration is the crucial part of the RESHIP, and it will define its impact. This is why we are currently doing all the necessary estimations, budget-wise and timewise, in order to meet all the requirements of maritime authorities. At this point, we plan to conduct the demonstration by the end of 2025.

On the bright side, HSL Technologies managed to upgrade the design of the hydrogen release unit and exclude the catalyst from the process, which is great news for potential offtakers and for reduction of the environmental impact (which was already low).

With the arrival of ECOMAR, we have been able to pick up and speed up the work on power generation sub-system design. BAUMULLER is on the verge of finishing their work on the power management sub-system with the FAT date set for December 2024. All the partners involved in this workpackage, HSL Technologies, Glafcos Marine, OS Energy, Baumuller, Ecomar Propulsion, DST and Bureau Veritas, are working hard to make it happen!

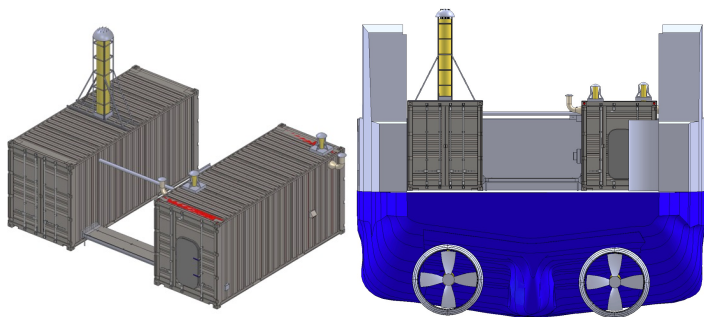
Our next steps include completing the approval for onboarding procedure, manufacturing and assembling the sub-systems into the H2PG and conducting the first trials in the Esjber Shipyard.

WP4

Daria Matignon

**HSL TECHNOLOGIES
(HYSILABS)**





The consortium under WP5 continues to integrate the developed technologies and develop various design drawings always taking under consideration the compliance to rules and regulations. The developed ESD and HydroSil solutions have been incorporated on board under various alternative arrangements especially for the the power containers. Structural and hydrodynamic have been taken into account in order to conclude on a robust industrial solution. The gained experience through the design stage for the retrofit at hand has been already been translated to new buildings however the conclusion of the physical installation is essential for the completion of this task. Final equipment selection is underway, and this will provide the final fine tuning for the execution.

WP6

Martin Nürnberg

OS ENERGY

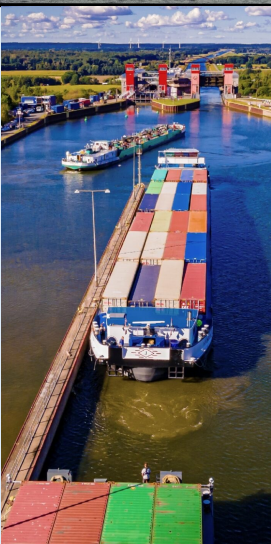
The work team of Wp6 is working on the preparatory activities for the sea trials. Specifically, OS ENERGY has been conducting surveys on the target vessel (i.e. the Fortuna Crane vessel) and reviewed and updated its safety management system documentation with specific focus on the hazardous aspects of hydrogen testing on board.

OS ENERGY has reviewed the propeller design proposals with special consideration for the installation and operational impacts post retrofit. WP loader is currently steering the partners towards the certification of the propeller refit, which is awaiting final drawings to be submitted, and supporting the project lead in the discussion for the wider regulatory aspects concerning the ships operation for the demonstration with the Danish maritime authority.

WP5

Leonidas Drikos

GLAFCOS MARINE



As originally planned, the WP7 team has been following the project implementation over the past few months at a low level. After the classification of the fleets at sea and on inland waterways, including the identification of the associated operating profiles, was completed in the first year of the project, it was now time to await the results of the other work packages. The involved partners are currently preparing the methods and tools for the final tasks 'Assessment of suitability of the developed solutions' and 'Development of technology uptake scenarios and fleet modelling', which are in the starting blocks.

WP7

Benjamin Friedhoff

DST

ECOMAR[®]

PROPULSION

Ecomar Propulsion ApS is a Danish company that specializes in zero emission marine propulsion and energy storage systems.

Founded in 2022, the company forms part of the Ecomar Propulsion group, with headquarters in the UK.

Ecomar Propulsion owns numerous patents and currently owns and operates 3 prototype vessels using clean energy and hydrogen propulsion systems and is a well-known leading SME in developing high technology solutions for decarbonising maritime operations.

In the consortium, Ecomar Propulsion will take over the role of H2Tec who recently left the Project. Our new partner will be working on the hydrogen power generator and will be in charge of its power generation sub-system.

The partners are happy to welcome the new member and continue together the exciting journey of redefining ships' efficiency!

**RESHIP
is glad to
welcome
onboard
Ecomar
Propulsion!**

www.ecomarpropulsion.com



Insights into tubercle propellers

Results from CFD and EFD surveys @ UNEW

Weichao Shi

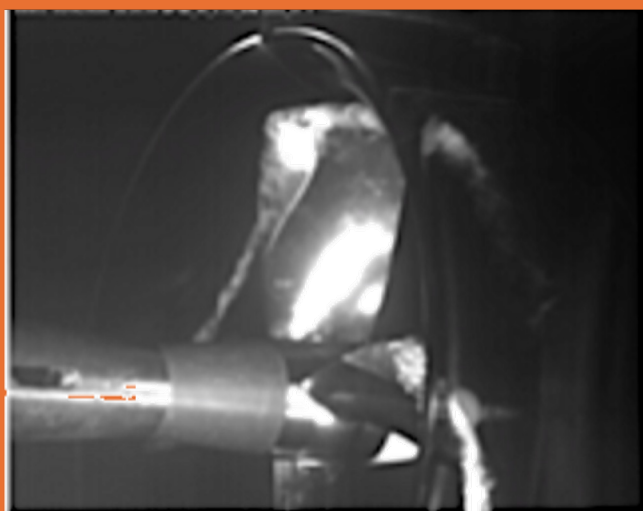
NEWCASTLE UNIVERSITY



A comprehensive numerical and experimental survey has been conducted from NEWCASTLE UNIVERSITY, CNR, CHALMERS and DST to insight into the propulsive performance and the hydrodynamics of tubercle propellers. NEWCASTLE UNIVERSITY continued open-water testing of its newly designed propeller featuring tubercles, in the Emerson cavitation tunnel ([emerson cavitation tunnel](#)).

The experimental campaign aimed to investigate the hydrodynamic forces and cavitation characteristics of the tubercle-assisted propeller with a duct. Two sets of propellers and ducts were designed for the tests: one with a reference propeller and duct, and the other with a propeller and duct incorporating tubercles. The open-water tests were conducted under design pitch conditions to assess the impact of tubercles on the propeller and duct both individually and in combination. The experimental results were promising.

When tubercles were applied solely to the propeller, efficiency improved by up to 4%. However, when tubercles were applied to both the propeller and duct, the efficiency gain was 2%. Notably, tubercles on the duct alone did not significantly affect the propeller's overall performance. Additionally, it was observed that the tubercles significantly reduced sheet cavitation on the propeller blades.





How do tubercle propellers perform?

Towing tank experiments @ CNR

Mario Felli

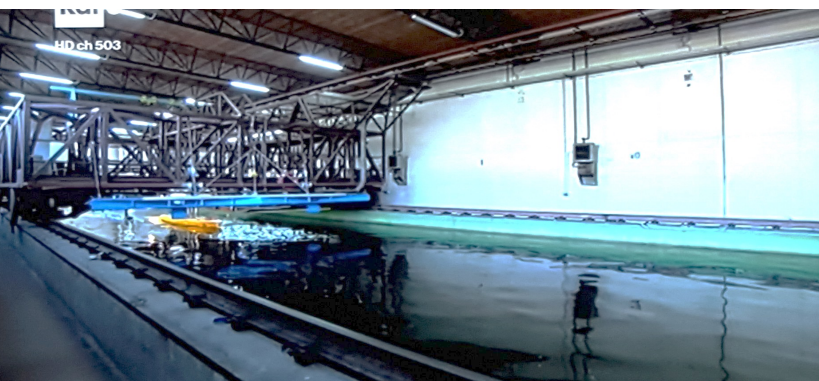
CNR

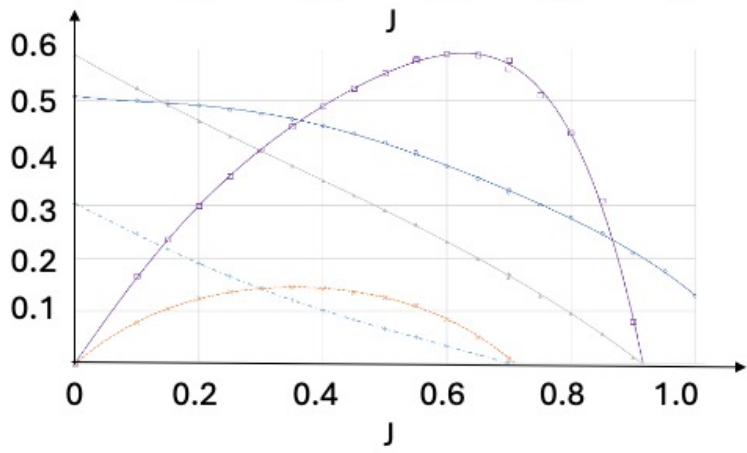
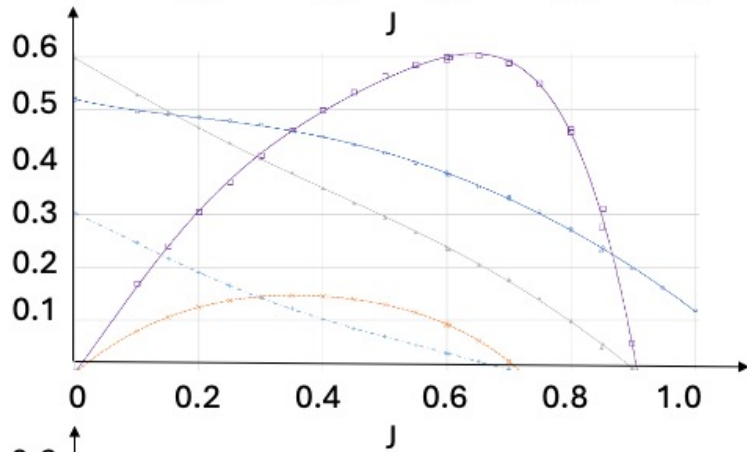
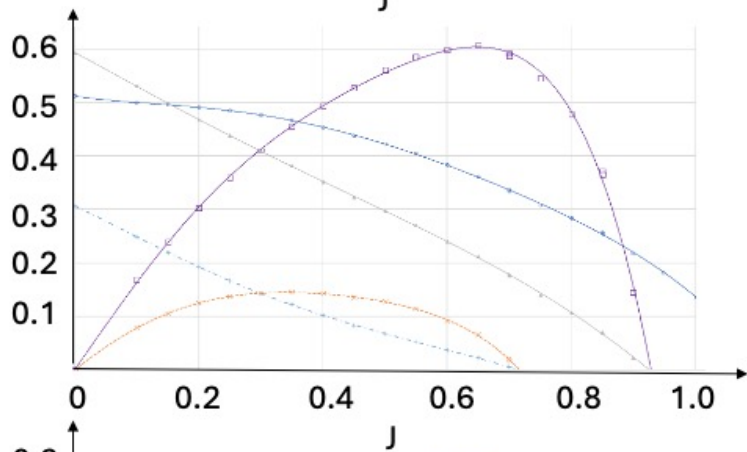
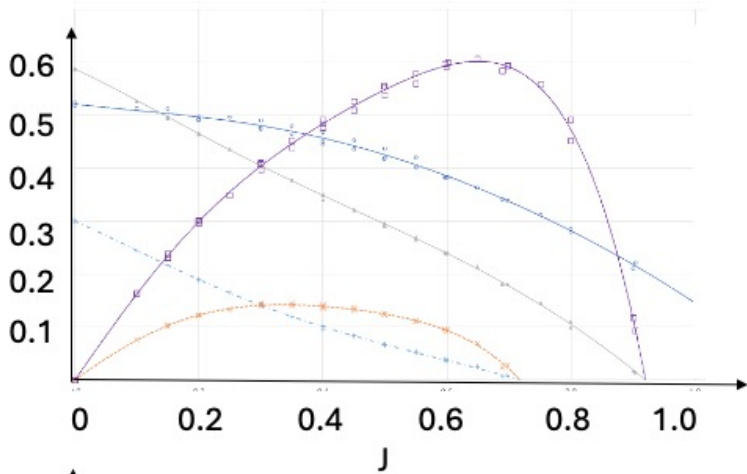
CNR is involved in a comprehensive experimental activity to assess the hydrodynamic, propulsive and acoustic performance of the target vessel before and after retrofit.

Experiments will be conducted in the large towing tank and in the free surface large cavitation channel of CNR using conventional and state of the art techniques. More information about the test facilities can be found at the www.cnr-inm.it.

Test models included a scaled replica of the Fortuna Crane vessel in its original configuration with a conventional propeller and after retrofit with a tubercle ducted propeller. Propeller and hull models were built in 1:7.5 scale ratio. This scale factor corresponds to an overall length of the model of 7090 mm and to a propeller diameter of 233 mm.

Hull model was manufactured in wood. The rotors of the original and tubercle propulsors were made in bronze. The ducts were made in a transparent material (i.e. Polymethyl methacrylate) to allow flow visualizations around the rotor systems.





- 10Kq
- Kt duct
- Kt tot
- Eta duct
- Eta tot

The first part of the experimental activity was conducted last July and August in the large towing tank of CNR-INM (i.e. 470 m long, 13.5 m wide and 6.5 m deep). Tests included open water propeller performance measurements and resistance measurements.

Open water tests involved different combinations of rotor and duct with and without leading edge tubercles (i.e. rotor and duct with tubercles, rotor and duct without tubercles, rotor with tubercles and duct without tubercles, rotor without tubercles and duct with tubercles).

The second part of the experimental program, involving cavitation observation and acoustic tests, will assess the effectiveness of bio-inspired duct and propeller blade designs as noise mitigation measures. Tests will be conducted by end of 2024.

Previous page:

- ship model during resistance tests (top)
- towing tank during tests (bottom-left)
- ship hull before CNC machining (bottom-right)

Current page:

— Results of Open water tests. Configuration without tubercles, configuration with tubercle duct and no-tubercle propeller, configuration with tubercle propeller and no-tubercle duct, configuration without tubercles (from top to bottom)

A new research paper on Tubercle propeller physics

CNR and UNEW researchers have produced a new paper documenting key insights into tubercle propeller physics

The paper *Large Eddy Simulation of a marine propeller with leading edge tubercles* by A. Posa, R. Broglia, W. Shi and M. Felli has been accepted for publication on *Physics of Fluids* and will be published soon!!!

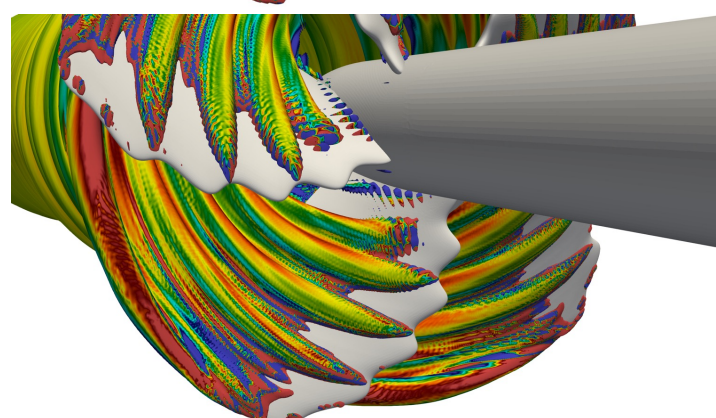
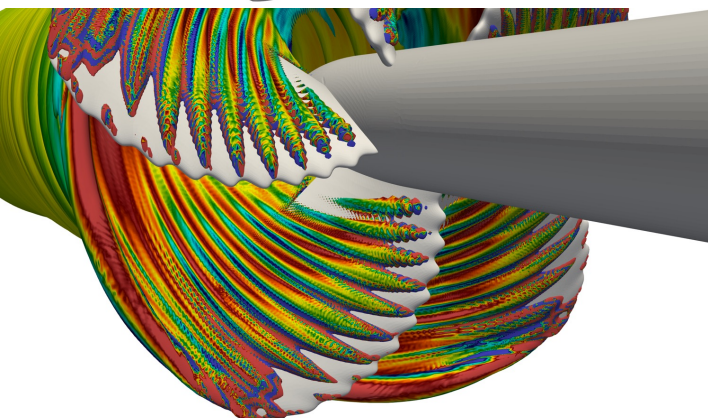
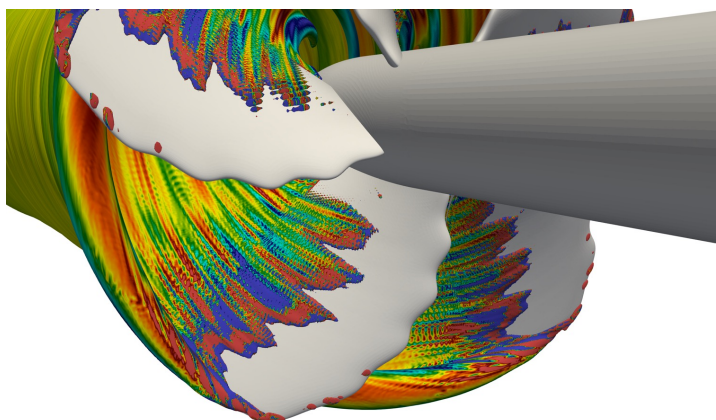
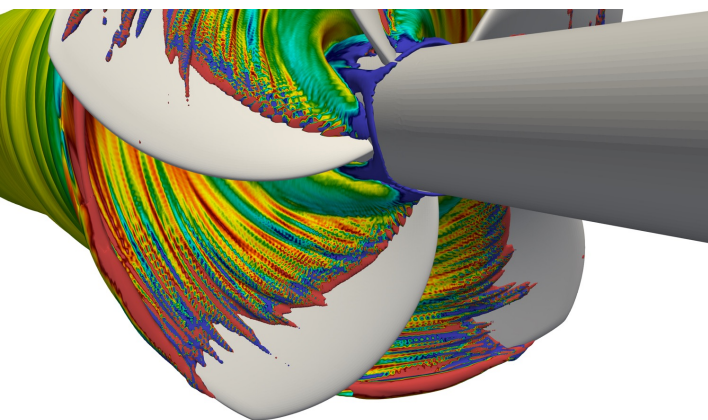
In this new paper, CNR and UNEW researchers present the results of state-of-the-art computational study by Large Eddy Simulations (LES) investigating the underlying physical mechanisms of the effect of leading edge tubercles (LETs) on the hydrodynamic and

propulsive performance of a marine propeller.

Specifically, a comparative analysis was conducted among marine propellers with different leading edge tubercle distributions with a baseline geometry without tubercles.

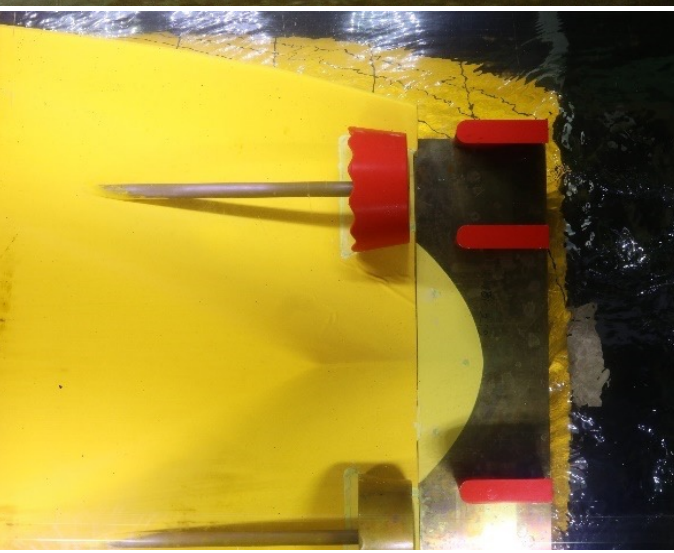
The study reveals a marginal influence of LETs on both performance and wake features.

The paper was chosen to be promoted as an Editor's Pick and will be displayed on the journal's homepage.



Baseline tests for RESHIP's inland vessel completed @ DST!!!

Benjamin Friedhoff
DST



In June 2024 a first extensive model test campaign for the RESHIP inland vessel was completed at DST's large shallow water basin.

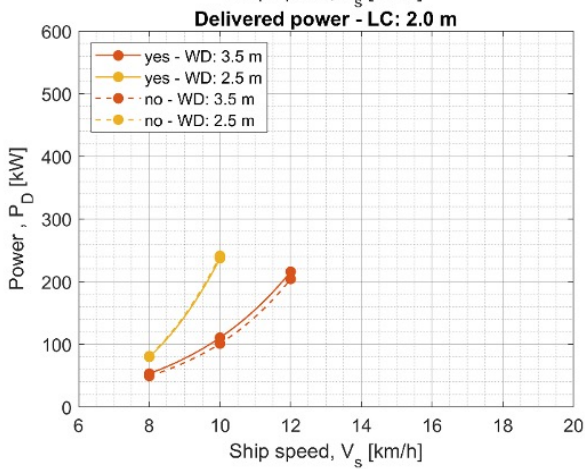
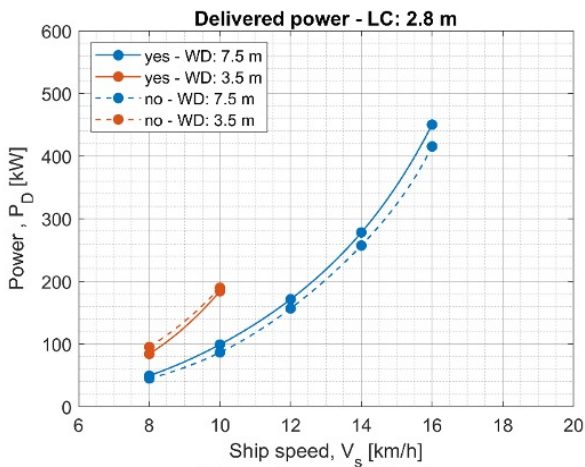
The selected target ship represents a typical vessel operating on western European inland waterways (CEMT V, so-called large Rhine vessel). It measures 110 meters in length and 11.4 meters in breadth, with a frequently used draught of up to 2.8 meters.

The fluctuating boundary conditions on rivers, the confined canals and the specific transportation tasks in inland shipping lead to a wide range of operating conditions. These complexities were addressed in the test matrix. The loading cases were varied, in terms of draught, from almost empty ($T = 1.4$ m) to partial load ($T = 2.0$ m) and a representative high utilisation ($T = 2.8$ m). The water depths cover the range of Rhine, tributaries, and some canals, including both deep and shallow water (specifically $h = 7.5; 3.5; 2.5; 2.0$ m).

Since the requirement for shallow draught in low-water periods limits the propeller diameter of the full-scale ships, 1.6 m for the given twin-screw design, the models of inland ships need to be quite large to limit undesired scale effects. Accordingly, the model was built in scale 1:11 with a total length of 10 m and equipped with four Schilling-type rudders and two ducted propellers.

Some pictures from model tests @ DST's large shallow water basin

T [m] \ h [m]	7.5	3.5	2.5	2
2.8	✓ ($h/T = 2.68$)	✓ ($h/T = 1.25$)		
2.0		✓ ($h/T = 1.75$)	✓ ($h/T = 1.25$)	
1.4			✓ ($h/T = 1.79$)	✓ ($h/T = 1.43$)



Even though the primary objective of this series of experiments was to provide the basis for validating the CFD simulations and the initial values for optimization, it was possible to integrate some initial tests with a tubercle duct in comparison with a conventional 19A duct. Tests were also carried out on the influence of the flow-separation/ventilation-prevention plate. The test campaign included resistance and propulsion tests without rudders, as well as propulsion tests with rudders. The vessel was tested across a range of speeds between 8 and 16 km/h.

Forthcoming tests will focus on open water characteristics of the tubercle duct with DST/Promarin stock propellers to gain a better understanding of the interaction of propeller, duct and the complex inflow in behind condition under more or less extreme shallow water conditions. The most significant energy-saving potential is expected with the systematic hull-form variation and multi-objective optimisation covering a set of representative operating conditions defined by draught, water depth and speed.



RESHIP at SMM 2024, the leading international maritime trade fair

Daria Matignon and Stefan Krahn

HSL TECHNOLOGIES (HYSILABS) and BAUMULLER

SMM (Shipbuilding, Machinery and Marine Technology trade fair)

SMM is the world's leading trade fair and conference event for the maritime industry (<https://www.smm-hamburg.com/>).

SMM 2024 brought together about 40,000 participants from over 120 countries and served as a unique platform for business, the exchange of ideas and cooperation. On the exhibition floor, more than 2,000 companies presented state of the art technologies and services.



RESHIP coordinator **Daria Matignon** from **HYSILABS** and **Stefan Krahn** from **BAUMULLER** gave an interesting talk about RESHIP at the VDMA Booth of SMM 2024 in Hamburg. Particular emphasis was placed on the process of energy transfer from a Liquid Inorganic Hydrogen Carrier (LIHC) hydrogen release unit to the ship via an efficient energy distribution platform.

GLAFCOS promotes RESHIP in POSIDONIA 2024 and SMM 2024

Angeliki Deligianni and Leonidas Dirkos

GLAFCOS MARINE

GLAFCOS MARINE, a longstanding service provider in the maritime industry, proudly presented the latest developments from the RESHIP project at leading international maritime events



At this POSIDONIA 2024, GLAFCOS MARINE Ltd. showcased their innovative solutions for the maritime industry, including robotic platforms for inspection and cleaning, new propellers and rudders for ships, and advanced fuel technologies aimed at enhancing ship efficiency and reducing environmental impact at their front-line stand. Visitors had the opportunity to engage with 3D printed models and video presentations that highlighted the company's achievements and initiatives. One of the key projects highlighted at POSIDONIA 2024 was the RESHIP project.

This initiative, among many others, exemplifies the commitment to advancing maritime technology and sustainability. Through their participation, GLAFCOS MARINE Ltd. successfully communicated their ongoing efforts and successes in driving the maritime industry forward.

We thank all attendees who visited our stand at POSIDONIA 2024 to learn more about GLAFCOS MARINE Ltd.'s innovative solutions and engaged in discussions about the future of maritime technology.



POSIDONIA...the international shipping exhibition

POSIDONIA has long been established as one of the major calendar events of the shipping industry. The international exhibition Posidonia first took place in 1969 and has been taking place every two years ever since. POSIDONIA serves as the platform that brings international shipowners in touch with the latest developments in the shipping industry and offers them direct access to the entire range of shipping products and services available on the international shipping market.



At SMM 2024, GLAFCOS MARINE proudly presented the latest developments from the RESHIP project. Visitors to the event had the opportunity to explore RESHIP project's research at the European Union's stand, where mockups of key components from the project were displayed.

The highlights of this presentation included a model of the innovative TAP blade design for the ship's propeller, as well as a prototype of the container system being developed. These innovations are integral to the RESHIP project, which focuses on improving the efficiency and environmental impact of shipping through advanced engineering and sustainable solutions.

Both mockups sparked significant interest among attendees, showcasing RESHIP project's commitment to contributing to the green transition in maritime transport. As a participant in the RESHIP project, GLAFCOS MARINE's involvement at SMM 2024 further underscores its role in driving innovation within the industry. The event provided a valuable platform for networking and exchanging ideas with industry leaders, professionals, and policymakers, as the global maritime sector continues to evolve towards more sustainable practices.



RESHIP



H₂

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