MONUSEN

~ MONtenegrin center for Underwater SEnsor Networks ~

DELIVERABLE D5.8

PROCEEDINGS OF EMRA 3

Project Acronym:	**MONUSEN**	
Grant Agreement number:	**101060395**	
Project title:	**MONtenegrin center for Underwater SEnsor Networks**	
Funding:	**Horizon Europe - Widening participation and strengthening the European Research Area**	
Call:	**HORIZON-WIDERA-2021-ACCESS-02-01, Twinning Western Balkans Special**	
Type of action:	**HORIZON EUROPE - Coordination and Support Action**	
Start date of project:	**1st June 2022**	
Duration:	**36 months**	
Project website:	**http://monusen.ucg.ac.me/**	
Delivery date:	**24th July 2024**	
Version:	**1.0**	
Lead participant	**CNR**	
Dissemination level:		
PU	**Public**	**x**
SEN	**Sensitive, only for members of the consortium (including the Commission Services)**	

Funded by the European Union

DELIVERABLE DATA SHEET

Project Acronym:	**MONUSEN**
Grant Agreement number:	**101060395**
Project title:	**MONtenegrin center for Underwater SEnsor Networks**
Funding:	**Horizon Europe - Widening participation and strengthening the European Research Area**
Call:	**HORIZON-WIDERA-2021-ACCESS-02-01, The Twinning Western Balkans**
Type of action:	**HORIZON EUROPE Coordination and Support Action**
Start date of project:	**1st June 2022**
Duration:	**36 months**
Project website:	**http://monusen.ucg.ac.me/**

Deliverable number:	**D5.8**				
Deliverable title:	**Proceedings of EMRA 3**				
Work package:	**WP5: Broad networking events**				
Type:	R	**Delivery date**	**24th July 2024**	**Version:**	**1.0**
Lead participant:	**National Research Council of Italy (CNR)**				
Dissemination level:					
PU	**Public**				**X**
SEN	**Sensitive, only for members of the consortium (including the Commission Services)**				

Version log			
Revision no.	**Date**	**Author (Partner)**	**Change**
1	23th July 2024	CNR	
2	24th July 2024	UoM	Document compression

Deliverable summary

This deliverable includes the Proceedings of EMRA 2024, the Tenth Anniversary Edition of the Workshop on EU-funded Marine Robotics and Applications, held in Arenzano, Italy, from May 27 to 29, 2024. After a short summary including basic information about the Workshop, the introduction talk and the main slide of each presentation are reported. Overall workshop information and extended proceedings, including all presentations, are available in EMRA 2024 website @ https://emra-24.marinerobotics.eu/

Funded by the European Union

MONUSEN ~ MONtenegrin center for Underwater SEnsor Networks ~

Proceedings of
EMRA 2024
10th Anniversary Edition

Workshop on
EU-funded Marine Robotics and Applications

Short Version

Arenzano, Italy, May 27th-29th, 2024

About EMRA 2024

Following the success of previous EMRA workshops (CNR-Rome 2014, IST-Lisbon 2015, NCL-Newcastle 2016, VICOROB-Girona 2017, UL-Limerick 2018, IFREMER-Toulon 2019, Univ. Pisa-online 2021, NOC-Southampton 2022, and UNIZG-FER-Sibenik 2023), in the Tenth Anniversary of the first edition held in CNR headquarters in Rome, the Institute of marine engineering of the Italian National Research Council (INM-CNR) organised the Workshop on EU-funded Marine Robotics and Applications in Arenzano, Italy, from 27th to 29th May 2024.

Organised under EU projects MONUSEN, MAELSTROM, UWIN-LABUST, SeaTecHub, FAITH, and DIH InnovaMARE, EMRA 2024 brought together a diverse range of speakers, from ongoing H2020-H-Europe projects, industry, end users and stakeholders. The interdisciplinary event provided an excellent opportunity for networking and cross-fertilisation of ideas in marine robotics, enabling technologies and applications.

In a single track conference programme over two days, 25 project presentations were organised in four sessions, focusing respectively on “Enhancing marine robotics R&I in the European regions”, “HORIZON 2020 Projects”, “Horizon Projects”, and “Enlarging the area of marine robotics R&I”.

An opening keynote session focused on R&I needs of 6 stakeholders representing offshore industry, water management companies, yachting and marinas clusters, public administration and university spin-offs, while a closing round table about “Bridging research and innovation funding with regional funding in the area of marine research and engineering in Europe” had as panellists representatives of EC WIDERA and EISMEA, Regione Veneto - AG Interreg Italy-Croatia, and Regione Emilia-Romagna.

The Workshop, which was an event for the European Maritime Day in My Country, was attended by 86 persons from research (32%), academis (26%), industry (19%), public authorities (8%), NGOs, chambers of commerce, and others. More than 36% of the registered persons were female.

Organising Committee

Co-Chairs Massimo Caccia, CNR - Institute of marine engineering, Italy Marco Bibuli, CNR - Institute of marine engineering, Italy **Members** Nikola Miskovic, UNIZG-FER, Croatia Fausto Ferreia, UNIZG-FER, Croatia Riccardo Costanzi, ISME-UNIPI, Italy Alessandro Ridolfi, ISME-UNIFI, Italy	Jan Obderbecke, IFREMER, France Edin Omerdic, University of Limerick, Ireland Pere Ridao, University of Girona, Spain Marc Carreras, University of Girona, Spain Jeff Neasham, University of Newcastle, UK Antonio Pascoal, IST-ISR, Portugal Maaten Furlong, NOC, United Kingdom Igor Radusinovic, University of Montenegro, Montenegro Antonio Vasilijevic, NTNU, Norway Ioannis Kyriakides, CMMI, Cyprus
Organised with the support of the projects MONUSEN, MAELSTROM, UWIN-LABUST, SeaTecHub, Faith, DIH InnovaMARE	

Workshop Programme and a short summary of the presentations are reported in the following.
Further information, including all the presentations, are available at https://emra-24.marinerobotics.eu/

EMRA 2024 Programme

Day 1 : May 27th, Monday	
19:30-23:00	**MONUSEN & MAELSTROM WELCOME RECEPTION & Registration**

Day 2: May 28th, Tuesday	
8:00 - 8:50	**REGISTRATION**
8:50 - 9:00	**WELCOME - Massimo Caccia (CNR-INM)**
9:00 - 10:30	**KEYNOTE SESSION - STAKEHOLDERS NEEDS - Chair: Nikola Miskovic (University of Zagreb)**
	Offshore industry - Saipem (Marco Novello) Water management - IRETI (Andrea Serafini) University spin-off - H2O Robotics (Vladimir Djapic) Public administration - ARPAL (Federico Gaino) Yachting & marinas - NAVIGO (Pietro Angelini) University spin-off - Iqua Robotics (Joseta Roca) Open discussion
10:30 - 11:00	**SeaTecHub COFFEE BREAK**
11:00 - 12:45	**SESSION 1: Enhancing marine robotics R&I in the European regions - Chair: Marco Bibuli (CNR-INM)**
	MONUSEN - Montenegrin Centre for Underwater Sensor Networks Igor Radusinovic (University of Montenegro) SeaTecHub - Croatia-Cyprus Excellence Hub on Eco-Innovative Technologies for Healthy and Productive seas - Ioannis Kyriakides (CMMI) DIH InnovaMARE. Mateo Ivanac (Croatian Chamber of Economy) AMIS - Advanced monitoring systems and digital twins for coastal safety and resilience. Roberta Ferretti (CNR-INM) Blue Point - Blue circular economy of marine plastics. Matheus Santos (University of Limerick) PLOME - Platform for Long lasting Observation of Marine Ecosystems. Tali Hurtos (Iqua Robotics)

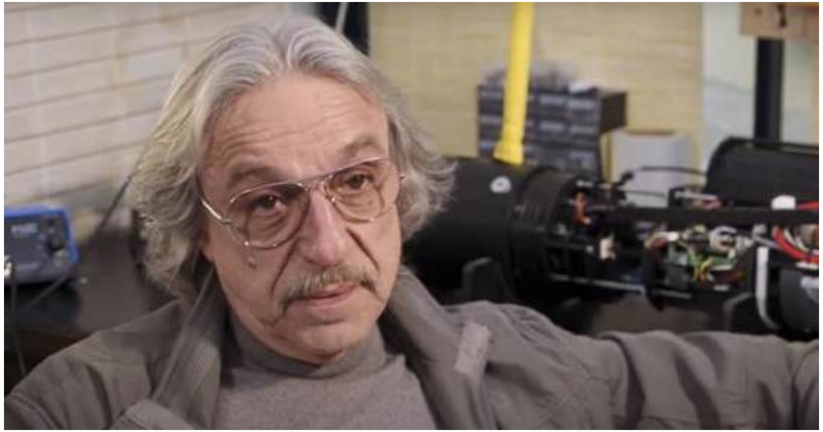
	UWIN-LABUST - ERA Chair in Internet of Underwater Things at LABUST. Roee Diamant (University of Zagreb)
12:45 - 14:15	**SeaTecHub LUNCH**
14:15 - 15:30	**SESSION 2: HORIZON 2020 Projects - Chair: Igor Radusinovic (University of Montenegro)**
	MAELSTROM - Smart technology for Marine Litter SusTainable RemOval and Management. Pierre-Helie Herve (Tecnalia) RAMONES - Radioactivity Monitoring in Ocean Ecosystems. David Cabecinhas (IST-ISR) Mission Atlantic - Towards the sustainable development of the Atlantic Ocean - Ralf Bachmayer (MARUM University of Bremen) Eurofleets+ - An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities. Jan Opderbecke (IFREMER) RAPID - Risk-Aware Autonomous Port Inspection Drones. Matheus Santos (University of Limerick)
15:30 - 16:00	**FAITH COFFEE BREAK**
16:00 - 17:45	**SESSION 3: Horizon Projects - Chair: Ioannis Kyriakides (CMMI)**
	FAITH - Fostering Artificial Intelligence Trust for Humans towards the optimization of trustworthiness through large-scale pilots in critical domains. Rafael Company, Mark Tanner (Fundacion Valencia Port) Trident - Jose Miguel Almeida (INES TEC) NERITES - Jorg Hermsdorf (Laser Zentrum Hannover) Diver Sea - Integrated Observation, Mapping, Monitoring and Prediction for Functional Biodiversity of Coastal Seas. Lucrezia Bernacchi (University of Porto) Aquarius - Aqua Research Infrastructure Services for the health and protection of our unique, oceans, seas and freshwater ecosystems. Simo Cusi (EMSO ERIC) COREU - Marco Novello (SAIPEM) TRIQUETRA- David Nguyen (CSEM)
19:30 - 23:00	**MONUSEN & MAELSTROM INFORMAL DINNER**

Day 3 : May 29th, Wednesday	
8:30 - 9:00	**REGISTRATION**
9:00-10:30	**SESSION 4: Enlarging the area of marine robotics R&I - Chair: Mateo Ivanac (Croatian Chamber of Economy)**
	MIR Erasmus Mundus. David Cabecinhas (IST-ISR) METRICS - Metrological Evaluation and Testing of Robots in International Competitions. Alessandro Faggiani (CMRE) UNDINA - UNderwater robotics with multi-moDal communIcation and Network-Aided positioning system. Antonio Vasilijevic (NTNU) uBlueTec - Fausto Ferreira (University of Zagreb) EOREA - The European Ocean Research and Education Alliance. Elena Paifelman (CNR-INM) S3-MasBBE - Tiziana De Nittis (Regione Emilia-Romagna)
10:30 - 11:00	**DIH InnovaMARE COFFEE BREAK**
11:00 - 12:30	**ROUND TABLE - Bridging research and innovation funding with regional funding in the area of marine research and engineering in Europe - Chair: Adeline Kroll (European Commission)**
	Introductory Talk: The European Research and Innovation Spreading Excellence and Widening Participation under Horizon 2020 and Horizon Europe. Adeline Kroll (EC) Panelists: ● Francesco Matteucci (EC - EISMEA) ● Angelo Mason (Regione Veneto - AG Interreg Italy-Croatia) ● Tiziana De Nittis (Regione Emilia-Romagna) Open discussion

EMRA 2024 Presentations Summary

Workshop on
EU-funded Marine Robotics and Applications

Remembering: Ric & Pino



EMRA 2024 co-organising projects

MONUSEN
– MONtenegrin center for Underwater SEnsor Networks –

MAELSTROM

UWIN~LABUST

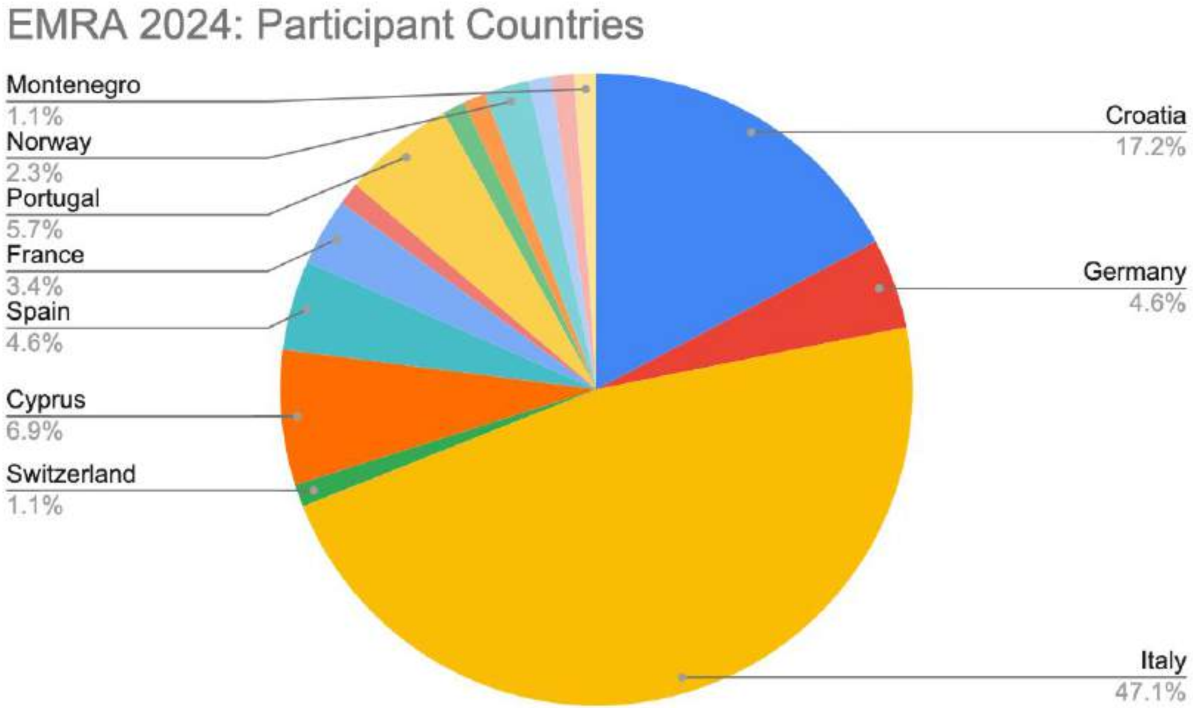
SeaTechHub

fAIth
Trustworthy

Interreg
Co-funded by the European Union
Italy – Croatia
DIH InnovaMare

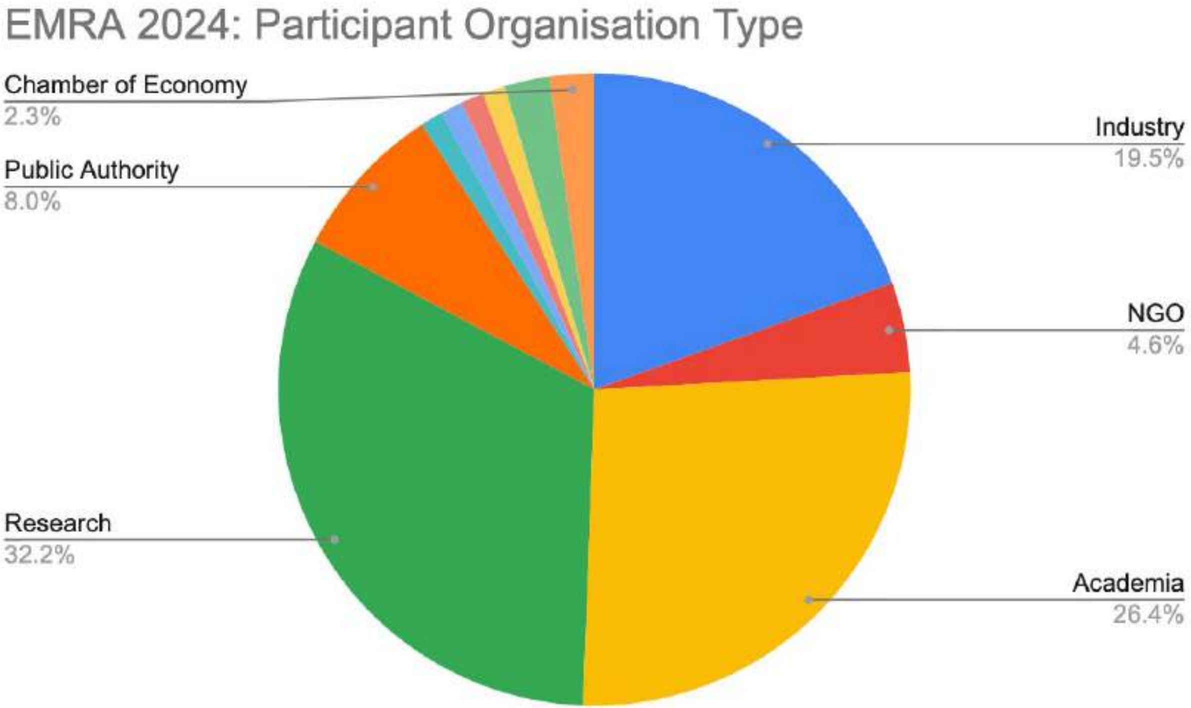
EMRA 2024 numbers

86 registered people



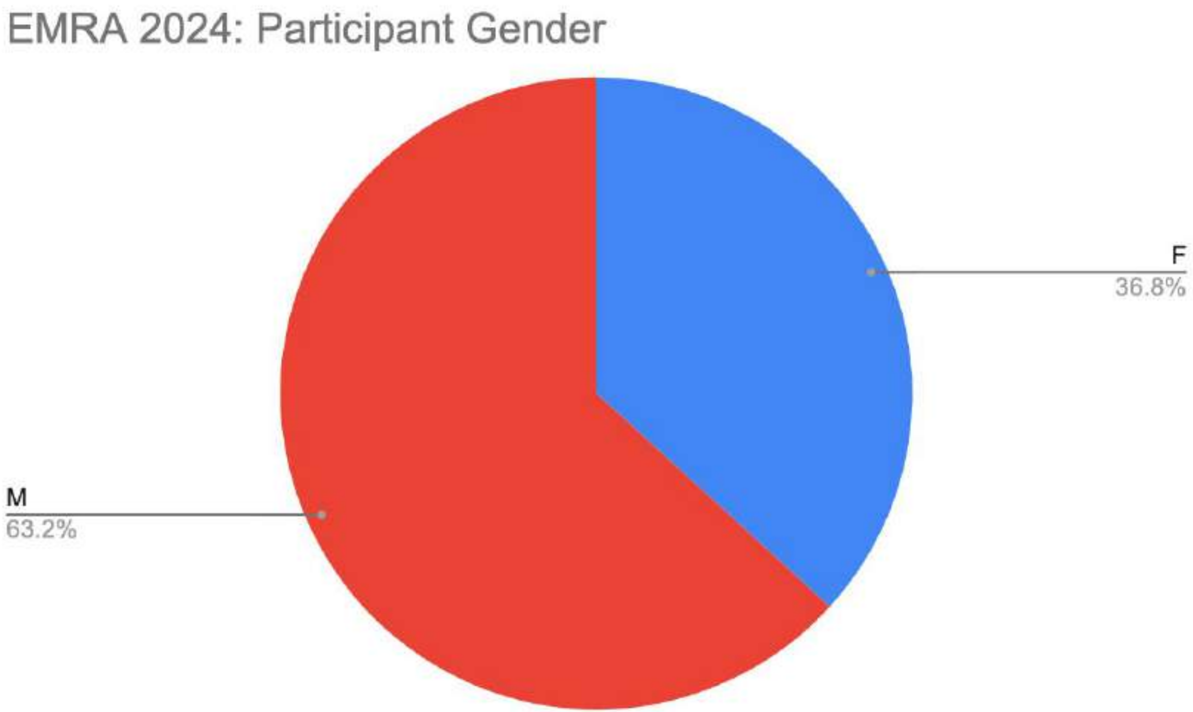
EMRA 2024 numbers

86 registered people



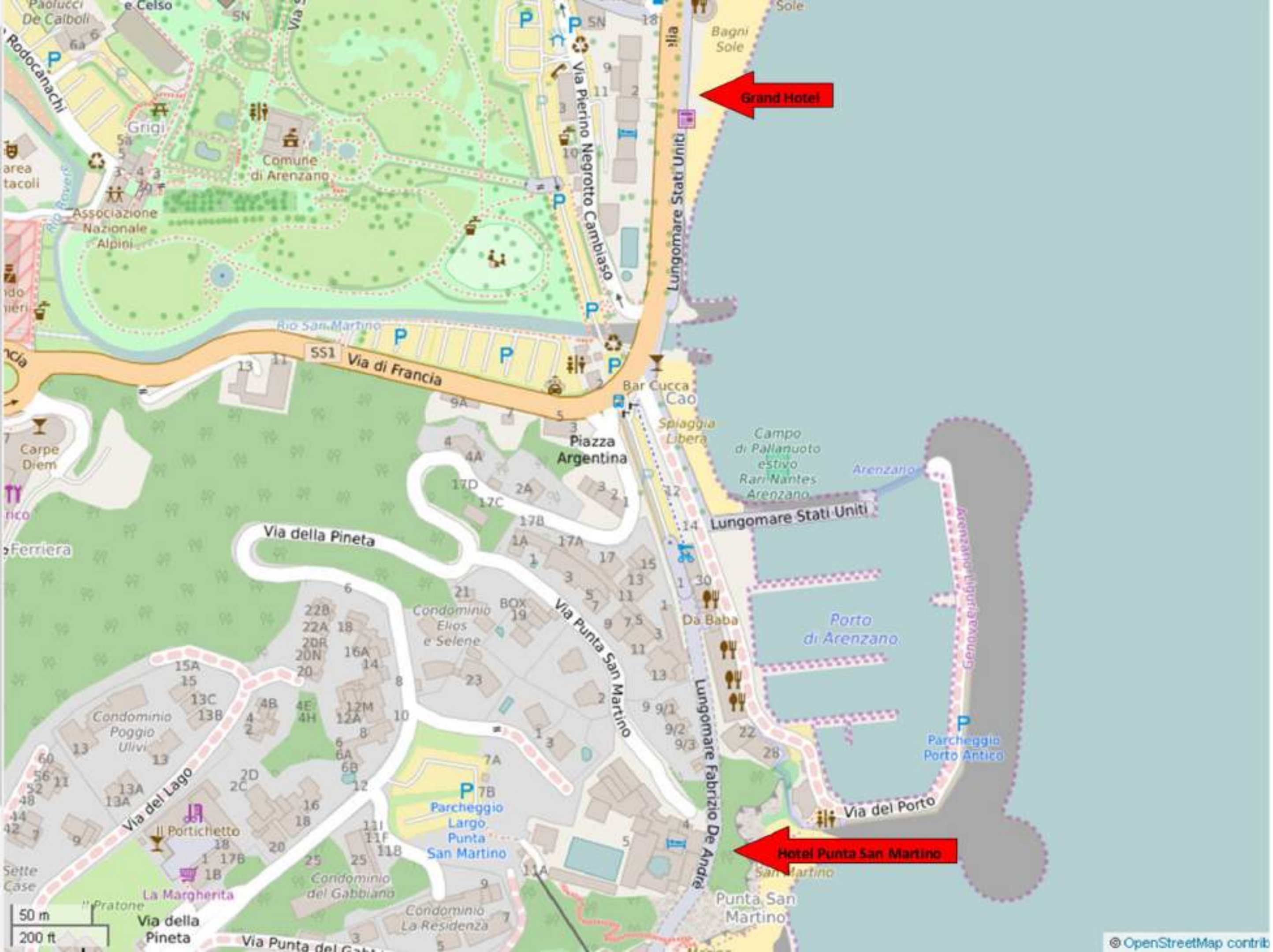
EMRA 2024 numbers

86 registered people



EMRA 2024 is an event for the European Maritime Day In My Country

Events for the **European Maritime Day In My Country 2024** will take place all over Europe **from 1 April until 31 October 2024.**



Dinner

Meet @ 18:45

In front of this hotel

Hotel Punta San Martino

Saipem SpA

Research and Innovation needs

Marco Novello

marco.novello@saipem.com

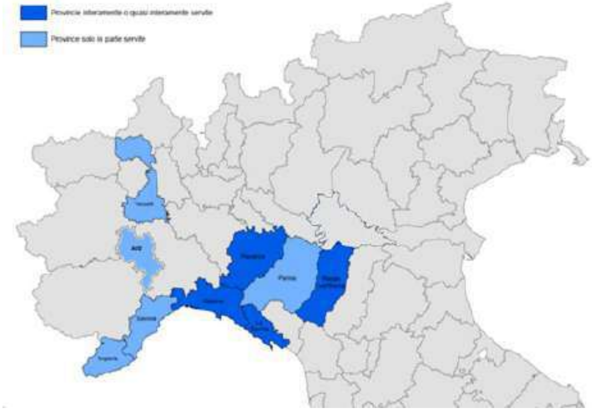
Research and Innovation needs

Andrea Serafini

andrea.serafini@ireti.it

Ireti Spa (Gruppo Iren company)

Iren is a multy-utility company operating mainly in the north of Italy in the field of energy (gas and electricity) and water treatment and distribution.
Ireti is the company of Iren Group involved in the the integrated water service (captation, treatment and distribution of drinkable water, collection, treatment and discharge of waste water)



andrea.serafini@ireti.it

Main sectors of interest regarding marine robotics research for Ireti activity in Genova district are related to:

- **Management of 7 big dams with related artificial reservoir**

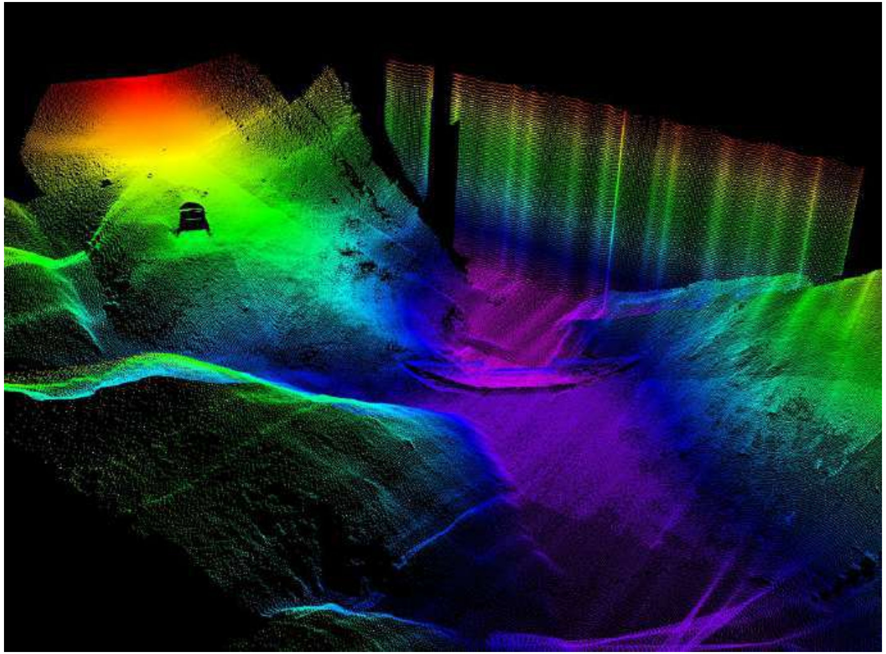
(Brugneto, Valnoci, Busalletta, Lungo, Lavezze, Badana and Lavagnina dams)

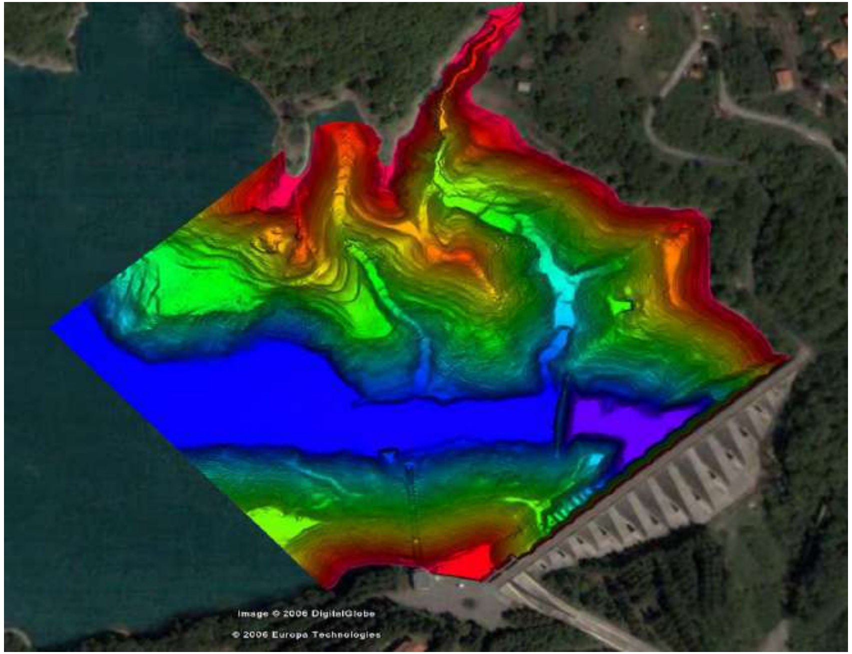
- **Management of several submarine outfalls and related breakwater**

(Arenzano, Voltri, Pegli, Sestri Ponente, DAC, Darsena, Puntavagno, Sturla, Quinto, Sori, Recco, Camogli, Santa Margherita, Chiavari, Lavagna, Sestri Levante submarine outfalls)

Big dams and related artificial reservoir

Purpose of the activity: monitoring the silting and deep outlet conditions





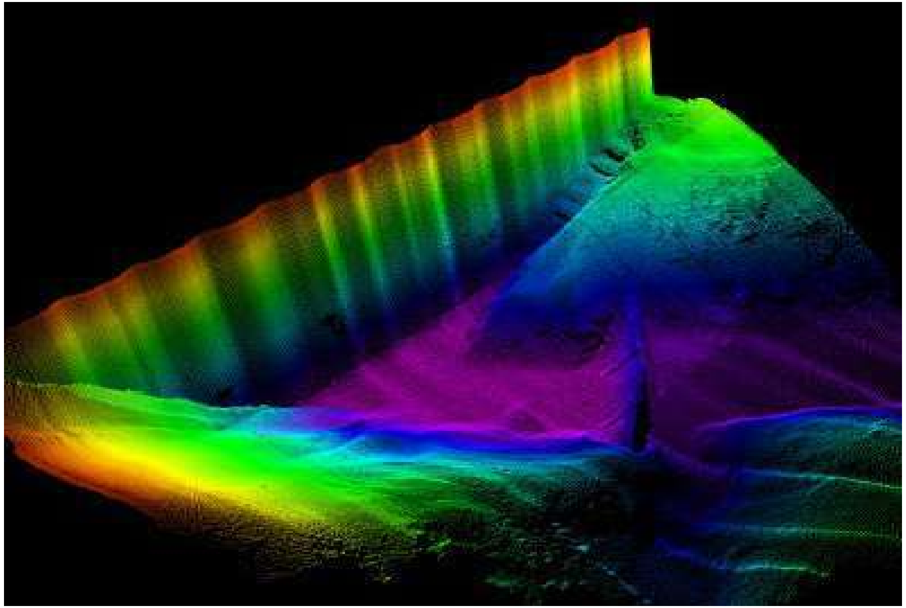
Brugneto dam multy beam echo sounder survey

andrea.serafini@ireti.it

Dams needs related

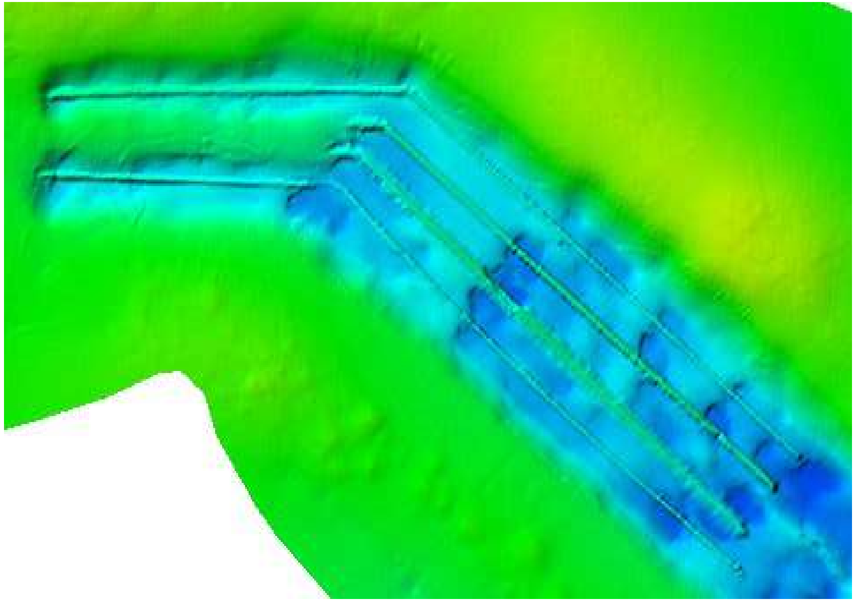
- monitoring the silting level of the reservoirs with Multy Beams Echo Sounder (MEBS) and Sub Bottom Profiler (SBP), every 10 years

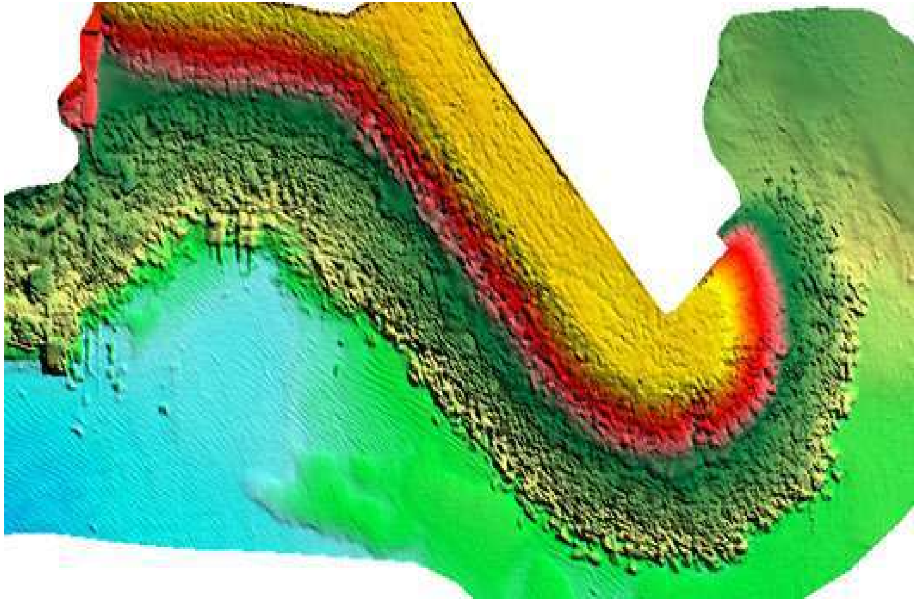
- verify deep outlet conditions with Multy Beams Echo Sounder (MEBS) and ROV's video inspection



Underwater discharge pipeline of treated waste-water

Purpose of the activity: seabed survey for engineering and monitoring existing submarine outfalls and related breakwaters



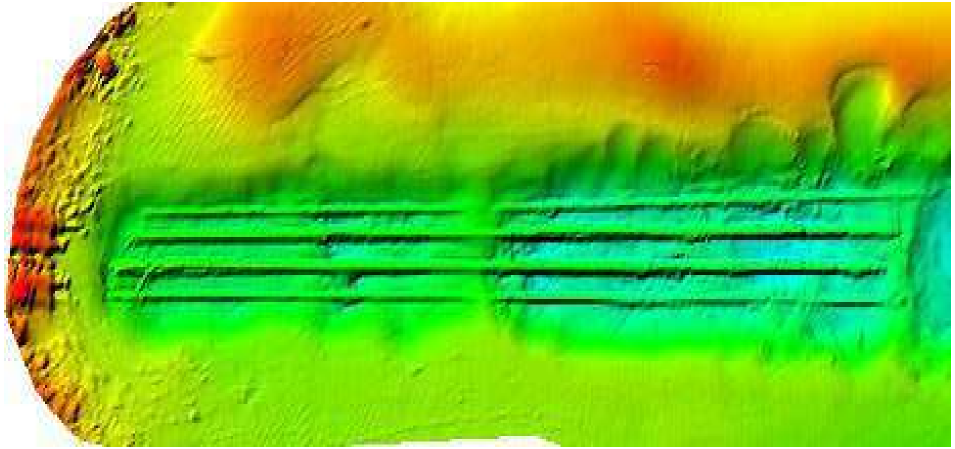


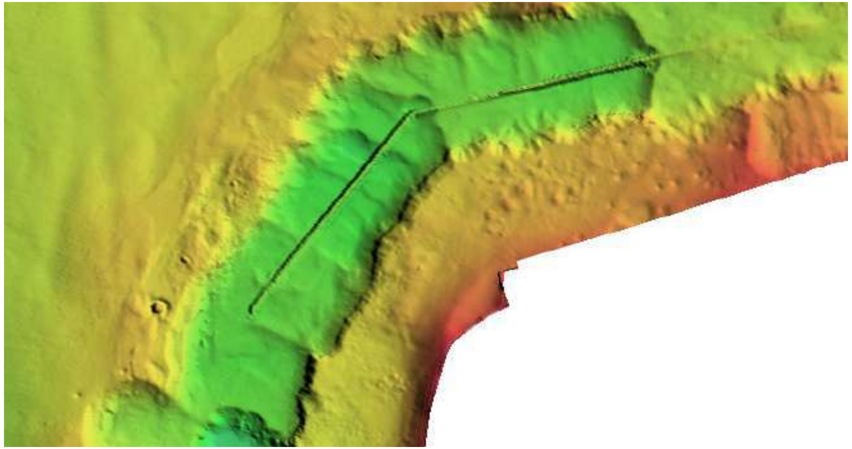
Underwater pipe lines needs related

New pipelines:

- Engineering phase: survey of the seabed with Multy Beams Echo Sounder (MEBS), Side Scan Sonar (SSS) and Sub Bottom Profiler (SBP)

- Construction phase: monitoring works progress with Multy Beams Echo Sounder (MEBS)

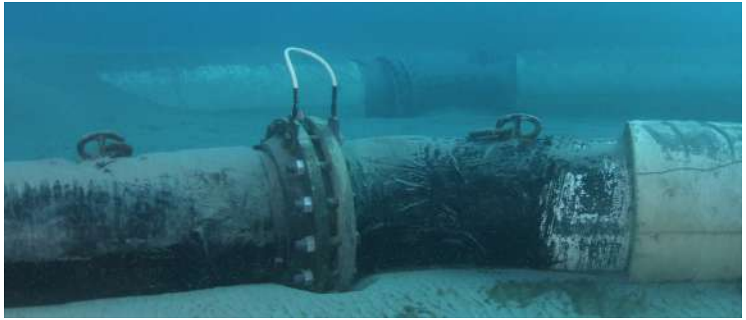


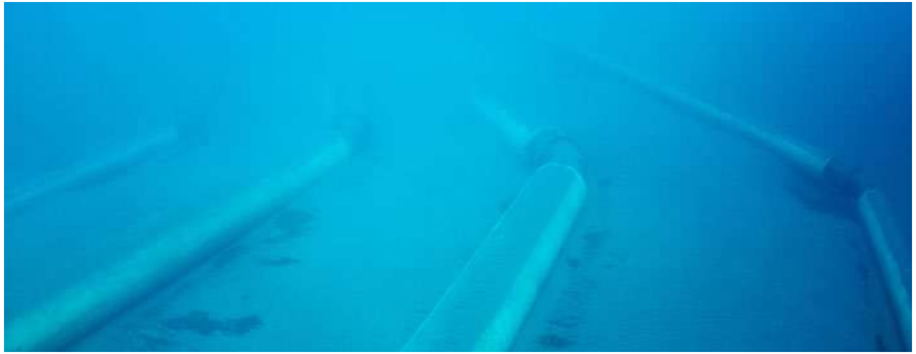


Underwater pipe lines needs related

Existing pipelines:

- Monitoring the conditions of the pipeline with video inspection (with ROV and Air Diver), every 2 years





Mid term needs related to submarine pipeline:

Availability of video system to survey <u>inside the pipeline</u> to verify the internal condition of the outfalls after years of operation.

Our submarine outfalls are tipically 1.000m long and reach the depth of 30-35m below sea level, with a diameter of 300/500mm for the diffuser section and 700/1.200mm for the pipeline

Thanks for your attention

H2O ROBOTICS

Research and Innovation needs

EMRA'24 - Arenzano, Italy
May 27-29, 2024

Vladimir Djapic, CEO
vladimir@h2o-robotics.com
H2O Robotics

Institution/Company name

Founded in 2017. - Zagreb, Croatia

Spin-off from

University of Zagreb - UNIZG

Faculty of Electrical Engineering and Computing - FER

Laboratory for Underwater Systems and Technologies – LABUST

Result of more than 15 years of experience in marine systems and technologies

UNIVERSITAS STUDIORUM ZAGRABIENSIS MDCLXIX

FER

LABUST
LABORATORY FOR UNDERWATER SYSTEMS AND TECHNOLOGIES

- Research and Development – 30 + Projects
- Education – Navigation, guidance and control of Autonomous Marine Vehicles
- Cooperation with students, experts, researchers and scientists

vladimir@h2o-robotics.com

Main sectors of interest regarding robotics research

- Maritime robotics for environmental monitoring and pollution detection
- Internet of Underwater Things (IoUT) for expanded data collection and remote access
- Autonomous Surface / Underwater / Aerial Vehicles (AxVs) for wider measurement area coverage
- Use of open-source, low-cost components for hardware and software (e.g., Raspberry Pi, Grafana, ThingsBoard, MQTT)
- Emphasis on energy efficiency and renewable energy sources for long-term autonomy
- e-Mobility

vladimir@h2o-robotics.com

Short term needs (next 3 years)

- One significant short-term need is the development of **advanced autonomous navigation, docking, and obstacle avoidance** systems for maritime robots, including Unmanned Surface Vehicles (USVs), Autonomous Underwater Vehicles (AUVs), and aerial drones.
- This need is driven by the increasing demand for maritime robots in various industries, such as offshore oil and gas, marine research, and environmental monitoring, where they must operate in **complex and dynamic environments**.
- The goal is to achieve **reliable and safe autonomous operation, reducing the need for human intervention** and the risk of accidents.
- To address this need, research and innovation efforts should focus on:

  1) Improving **sensor fusion and perception algorithms** to enable robots to better understand and react to their surroundings.

  2) Developing **adaptive and learning-based navigation algorithms** that can handle unexpected situations and environmental changes.

  3) Enhancing **communication and cooperation** between multiple robots to enable efficient and coordinated operations.
- With focused research and development, significant advancements in autonomous navigation and obstacle avoidance for maritime robots can be achieved within the next three years.

vladimir@h2o-robotics.com

Mid term needs (next 6 years)

- One crucial mid-term need is the development of **advanced human-robot collaboration and intuitive interfaces** for maritime robotic systems, ensuring seamless integration with human operators and enhancing the overall efficiency and safety of operations.
- This need is driven by the **growing complexity of maritime missions and the increasing number of robots** involved, which necessitate effective communication, coordination, and collaboration between humans and robots.
- The goal is to create intuitive and adaptive interfaces that enable human operators to easily **deploy, understand, monitor, and control maritime robotic systems**, as well as to develop algorithms and strategies for effective human-robot teaming.
- To address this need, research and innovation efforts should focus on:

  1) Developing novel approaches for **human-robot interaction**, such as **natural language processing, gesture recognition, and haptic feedback**, to enable more intuitive and immersive interfaces.

  2) Investigating **human factors, systems engineering, and ergonomics** in the design of maritime robotic systems, ensuring that they are well-suited for human operators and can minimize fatigue and stress.

  3) Exploring algorithms and strategies for **human-robot teaming**, such as **task allocation, role switching, and shared situation awareness**, to enable effective and adaptive collaboration in various maritime scenarios.
- With focused research and development, significant advancements in human-robot collaboration and intuitive interfaces for maritime robotic systems can be achieved within the next six years.

vladimir@h2o-robotics.com

Long term needs (next 10 years)

- One important long-term need is the development of **highly energy-efficient and environmentally friendly maritime robotic systems**, which can significantly reduce the carbon footprint and ecological impact of maritime operations.
- This need is driven by the increasing global awareness of **climate change and environmental degradation**, as well as the growing demand for sustainable and eco-friendly solutions in various industries, including the maritime sector.
- The goal is to create maritime robotic systems that are not only highly efficient and effective in their tasks but also **minimize their energy consumption and environmental impact**, contributing to the overall sustainability of maritime operations.
- To address this need, research and innovation efforts should focus on:

  1) Developing novel **energy-harvesting and storage technologies**, such as solar, wind, and wave energy converters, as well as advanced batteries and capacitors, to enable maritime robots to operate for extended periods with minimal or no external energy input.

  2) Investigating **bio-inspired designs and materials for maritime robots**, which can not only improve their performance and energy efficiency but also reduce their ecological impact by mimicking the properties and behaviors of marine organisms.

  3) Exploring strategies and algorithms for energy-aware and environmentally conscious navigation, planning, and control of maritime robotic systems, which can **dynamically adapt to the environment and optimize their energy consumption and ecological impact**.
- With focused research and development, significant advancements in energy-efficient and environmentally friendly maritime robotic systems can be achieved within the next ten years, paving the way for a more sustainable and eco-friendly future in the maritime sector.

What about cooperation with other research institutions? Does the privileged link with the “mother” research institution affect cooperation with others?

- H2O Robotics, as a spin-off from the Laboratory for Underwater Systems and Technologies (LABUST), maintains a strong and privileged link with its "mother" research institution, **which is beneficial for both parties in terms of knowledge exchange, access to resources, and collaboration opportunities.**
- However, this privileged link does not affect or hinder cooperation with other research institutions, as **H2O Robotics is committed to fostering a culture of openness, collaboration, and mutual learning in the field of maritime robotics**.
- Examples of successful spin-offs from other maritime robotics research university laboratories, such as the **recent win of a team from the Zagreb Faculty of Electrical Engineering and Computing (FER)** in an international robotics competition, demonstrate the potential and value of such collaborations.
- To further enhance cooperation with other research institutions, H2O Robotics (and other companies) can:

  1) Actively **seek and engage in joint research projects, consortia, and networks** with other leading institutions in the field of maritime robotics, both at the national and international level.

  2) Participate in and contribute to relevant **conferences, workshops, and forums**, which can provide opportunities for networking, knowledge exchange, and collaboration.

  3) Offer **internships, research visits, and exchange programs** for students and researchers from other institutions, which can help to build relationships, foster talent, and stimulate innovation.
- By embracing and promoting cooperation with other research institutions, H2O Robotics can not only enrich and broaden its own capabilities and expertise but also **contribute to the overall advancement and impact of maritime robotics research and innovation**.

vladimir@h2o-robotics.com

Which cooperation mechanisms (research proposals, direct contracts, research agreements, …) do you propose (see as most suitable) for short, medium and long term research and innovation?

- Short-term (1-3 years): **Research proposals and direct contracts** are the most suitable cooperation mechanisms for addressing immediate needs and fostering collaboration between institutions. **Give something to someone, usually you will get something back**.
- Mid-term (4-6 years): **Research agreements and consortia** can be established to tackle more complex and long-term challenges, such as the development of advanced IoUT technologies and their integration with existing systems. **EXPAND THE PIE**.
- Long-term (7-10 years): **Transatlantic cooperation and strategic partnerships** should be pursued to address global challenges and expand the pie of maritime robotics research and innovation. This can be facilitated by mechanisms such as the **Office of Naval Research (ONR) and ONR Global**.
- **"A lot of funding has been provided to companies and institutions exploring space, but we have oceans around us that we have not explored." - Vladimir Djapic, TEUTA project**
- **"With climate change and rising ocean temperatures, improving and extending the observation of these environments is critical." - Gabriele Pieri, NAUTILOS project**
- The **ocean is so vast and complex that a collaborative and global approach** is needed to address its challenges and harness its potential.
- Smart sensors and IoUT technologies can significantly improve our understanding and protection of the oceans, but more work is needed to ensure their **widespread adoption and impact**.
- Cooperation mechanisms such as research proposals, direct contracts, research agreements, and strategic partnerships can facilitate collaboration and innovation in the field of maritime robotics and address short, mid, and long-term needs.

vladimir@h2o-robotics.com

Final Message

- In conclusion, the deployment of autonomous robotic maritime systems with high-level artificial intelligence holds immense potential for revolutionizing **transportation, search and rescue, and environmental monitoring**. By leveraging advanced sensor suites, HD mapping, and remote driving capabilities, these systems can navigate complex waterways safely and efficiently, reducing traffic congestion and carbon emissions in coastal and urban areas.
- However, the development and implementation of these systems also raise **ethical and environmental considerations**. Ensuring the security and privacy of data transmitted between boats and dispatch centers is paramount, as is the responsible use of AI to prevent unintended consequences or misuse. Additionally, the maritime industry must prioritize the environmental impact of these systems, such as minimizing noise pollution and protecting marine life, while also promoting the use of clean energy sources like electric propulsion.
- As we move forward in the era of autonomous maritime systems, **it is crucial to foster collaboration between academia, industry, and government to address the technical, regulatory, and ethical challenges that lie ahead**. By doing so, we can unlock the full potential of these systems and create a more connected, sustainable, and efficient future for maritime transportation and beyond.

Thank you!

Vladimir Djapic

H2O Robotics

vladimir@h2o-robotics.com

h2o-robotics.com

Research and Innovation needs

Federico Gaino

federico.gaino@arpal.liguria.it

ARPAL

- The Regional Agency for Environment Protection of Liguria Region is the govern reference body in charge of monitoring the regional environment and of controlling the potential pollution sources.

- It is operational since 1 January 1998 in support of the Region, Provinces, Municipalities for the protection of environment, biodiversity, water resources and soil, and for the prevention and promotion of collective health and safety.

https://www.arpal.liguria.it/

ARPAL: main activities

Environmental monitoring and control activities

Many compartments

Laboratory

ARPAL: sampling tools and methods








ARPAL: sampling tools and methods

federico.gaino@arpal.liguria.it

Main sectors of interest regarding robotics research

✓ **Risk reduction for operators**

✓ **Improve the reproducibility of underwater measurements and runs**

✓ **Optimization of human resources deployment (after screening with drones)**

✓ Autonomous recognition of organisms

✓ Error reduction

✓ Time/money saving

Short term needs (3 years?)

Development of autonomous sampling systems

Deep water automatic samplers

AUV capable of recognizing different types of seabed and their populations

Mid term needs (6 years?)

Autonomous sampling systems and measurement of the chemical-physical parameters of the water column that can carry out periodic campaigns over long distances.

AUV capable of carrying out the same routes over time

AUV capable of recognizing and measuring organisms (recognizing the “same” organism)

Long term needs (10 years)

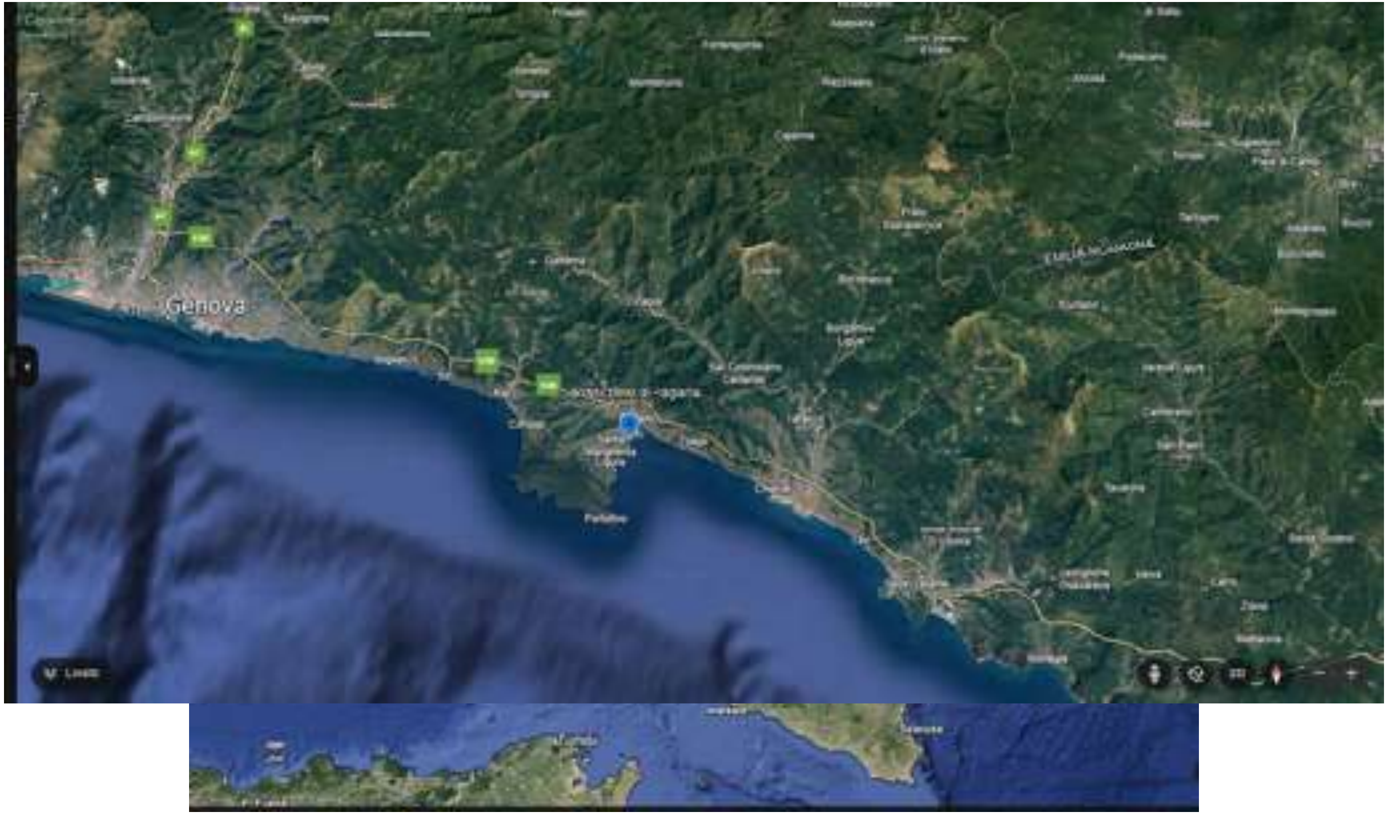
Integrated systems of monitoring stations and multiple autonomous vehicles, interconnected with each other and recording continuous data

Success research and innovation story

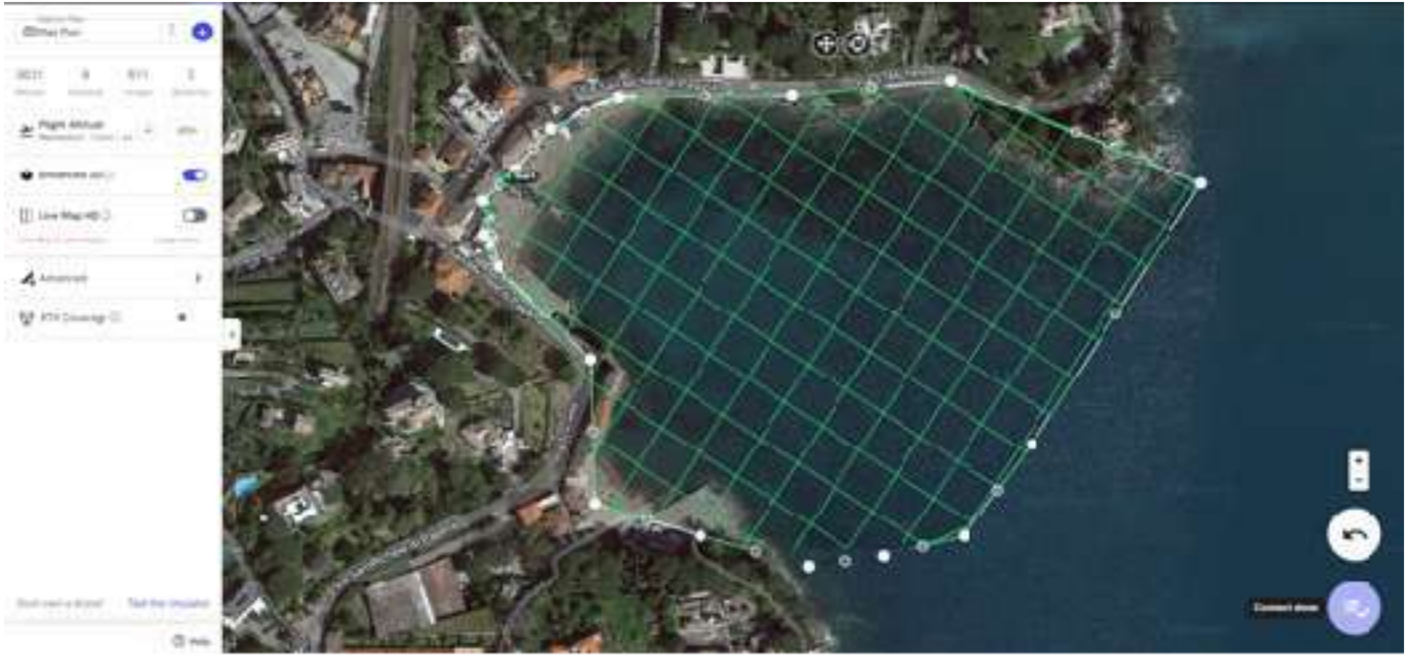
2019: ARPAL STARTED USING DRONES

Success research and innovation story

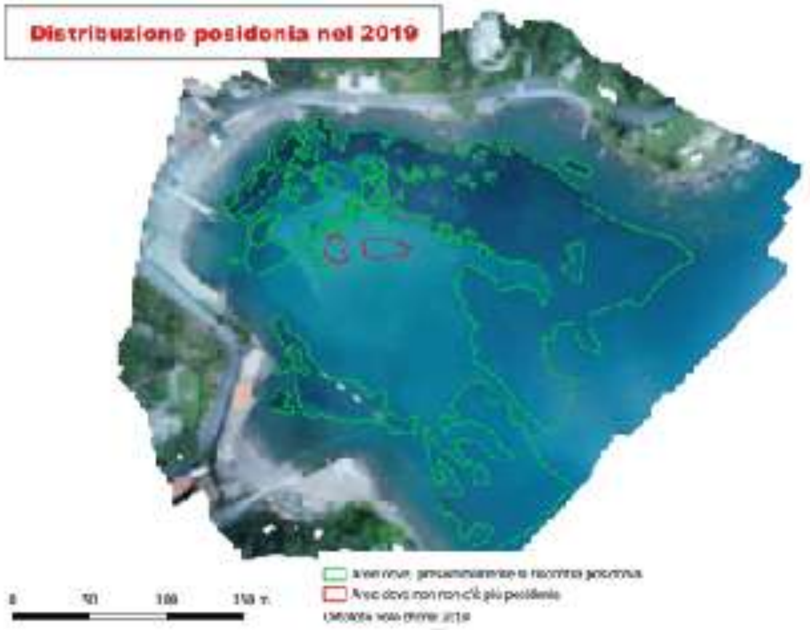
San Michele di Pagana *Posidonia oceanica* meadow

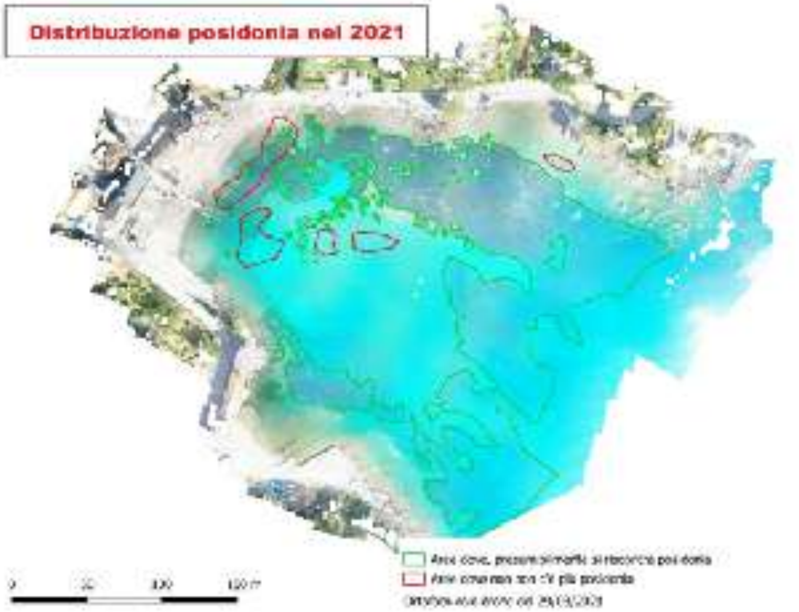


San Michele flight plan



Results


Distribuzione posidonia nel 2019


Distribuzione posidonia nel 2021

experimental activity with the University of Pisa

UNIVERSITÀ DI PISA

Experimental activity with the University of Pisa

Proposed cooperation mechanisms

European projects?

Legal aspects

Current laws limit or do not allow the use of autonomous vehicles at sea, this aspect should be resolved to allow the effective use of new technologies in ordinary activities

Thanks for the attention

federico.gaino@arpal.liguria.it


NAVIGO
INNOVAZIONE E SVILUPPO DELLA NAUTICA

About NAVIGO

NAVIGO è il più grande network di imprese nautiche in Italia e ricopre una posizione di rilievo in Europa e nel mondo.

Nato nel 2007 come uno dei centri servizi pionieristici per la nautica da diporto in Toscana, NAVIGO si è evoluto in un punto di riferimento e di riferimento chiave per l'industria nautica. Il successo dell'organizzazione può essere attribuito ad una profonda conoscenza del settore e ad un team di partner e dipendenti flessibili e competenti.

Navigo gestisce il Distretto Tecnologico Regionale (Rete Penta) che riunisce più di 300 aziende associate.

NAVIGO in Numbers

Navigo coordina ogni anno una media di 1.200 incontri Business-to-Business, 300 incontri Research-to-Business e 180 incontri Financial-to-Business, promuovendo un'ampia collaborazione e networking.

Il fatturato annuo delle società collegate a Navigo ammonta a circa **3.5 miliardi di euro (risultati al 31 dicembre 2023)**

Dimostrando un impegno per lo sviluppo del business, Navigo ha gestito un totale di 30 milioni di euro di fondi pubblici dedicati alle imprese e ha guadagnato 15 milioni di euro in servizi.

Navigo è attivamente impegnata nel progresso tecnologico, supervisionando lo sviluppo di 50 servizi digitali e partecipando a 50 progetti di ricerca e sviluppo.

A livello internazionale, Navigo estende il suo impatto attraverso il coordinamento di 20 progetti UE.

L'organizzazione beneficia una notevole visibilità nel settore organizzando tre importanti eventi : YARE, VYR e WSA, fornendo piattaforme preziose per mostrare innovazioni e facilitare le connessioni di settore.

NAVIGO in Numbers

I contatti di ben 11000 imprese e 4800 capitani nel nostro database!

Di seguito alcuni dei nostri importanti consociati:

AZIMUT YACHTS

Benetti ITALIAN EXCELLENCE SINCE 1873

SANLORENZO

OVERMARINE GROUP

BAGLIETTO 1854

CODECASA SHIPYARDS SINCE 1825

ROSSINAVI The Luxury of Experience

THE ITALIAN SEA GROUP

PICCHIOTTI

ADMIRAL

PERINI NAVI

TECNOMAR

NCA REFIT

NAVIGO Network

La nostra rete comprende diversi importanti cluster di innovazione e ricerca sia a livello nazionale che regionale, come: Cluster Nazionale Trasporti, Cluster Blue Italian Growth (BIG), Polo Magona, Navicelli Pisa, ARTES 4.0

YACHTING WEST MED CLUSTERS

DISTRETTO TECNOLOGICO PER LA NAUTICA E LA PORTUALITÀ TOSCANA

ARTES 4.0 Industry 4.0 Competence Center on Advanced Robotics and enabling digital TEchnologies & Systems

BIG Blue Italian Growth Technology Cluster

Cluster Trasporti

NAVIGO
INNOVAZIONE E SVILUPPO DELLA NAUTICA

Formazione

TRUE YACHTING TRAINING

ARTERI ACADEMY

ITS Istituto Tecnico Superiore
ISYL ITALIAN SUPER YACHT LIFE

GIOYA®
HIGHER EDUCATION INSTITUTION

PESA II

34.99m | Maiora | Next Yacht Group

Semi-Displacement or Planing Motor Yachts

WRAITH

37m | AB Yachts | Next Yacht Group

Semi-Displacement or Planing Motor Yachts


FRANCESCA II
41.2m | Baglietto S.p.A. |

JIMMY

49.8m | Tankoa Yachts SpA |

MULTIPLE

39.2m | Overmarine Group | Alberto Mancini

OREOS

40.8m | Benetti | RWD | Bonetti / Kozerski Architecture

ALUNYA

49.9m | Azimut|Benetti Group | P.L.A.N.A Design | RWD

ETERNITY

49.9m | Overmarine Group | P.L.A.N.A Design | Alberto Mancini

THIS IS IT
43.5m | Tecnomar - The Italian Sea Group

ALCHEMY

65.7m | Rossinavi | Vitruvius Yachts | Team for Design - Enrico Gobbi

BENETTI OASIS DECK™: *an* INNOVATIVE AFT DECK CONCEPT *that* PLACES YOU *at* ONE *with the* SEA

Sanlorenzo 50 steel

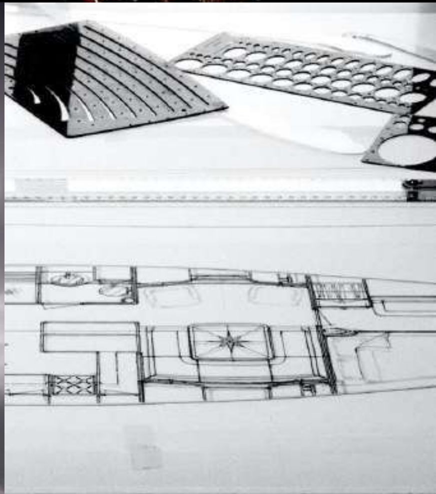



NAVIGO









Nautical Observatory Livorno

SOME NUMBERS ON THE RESEARCH SAMPLE

Our sample is made up of companies in the **Yachting industry**, characterized by companies that work in the shipbuilding industry, obviously including suppliers of goods and services. We have deliberately omitted to consider the wider pool of companies that still fall within the maritime economy, primarily those operating in the navigation sector, but also those that do so in a non-unique and indirect way (for example catering, hospitality, real estate , insurance, etc…) so as to have a more accurate picture of the performance of the main sector of the blue economy.

SOME NUMBERS ON THE RESEARCH SAMPLE

Going into detail, the choice was to consider primarily the companies in the shipbuilding sector understood in a broad sense, i.e. with the inclusion of shipyard suppliers, and subsequently a part of the companies in the logistics sector filtered through their proximity to the world of shipbuilding.

The data that emerges is obviously conservative and aims to identify, among the many companies that operate tangentially with the sector, a representative core of businesses that really moves this economic context, both in terms of turnover and employment.

Numeri delle provincie di Livorno e Grosseto

According to this model, the numbers of companies in the "sector" are as follows:

Livorno: around **1300 companies**

Grosseto: around **650 companies**

Of these 1950 companies, 450 are "hybrid" logistics companies. Overall they employ around 8,000 people and have an aggregate turnover of around 1.5 billion euros.

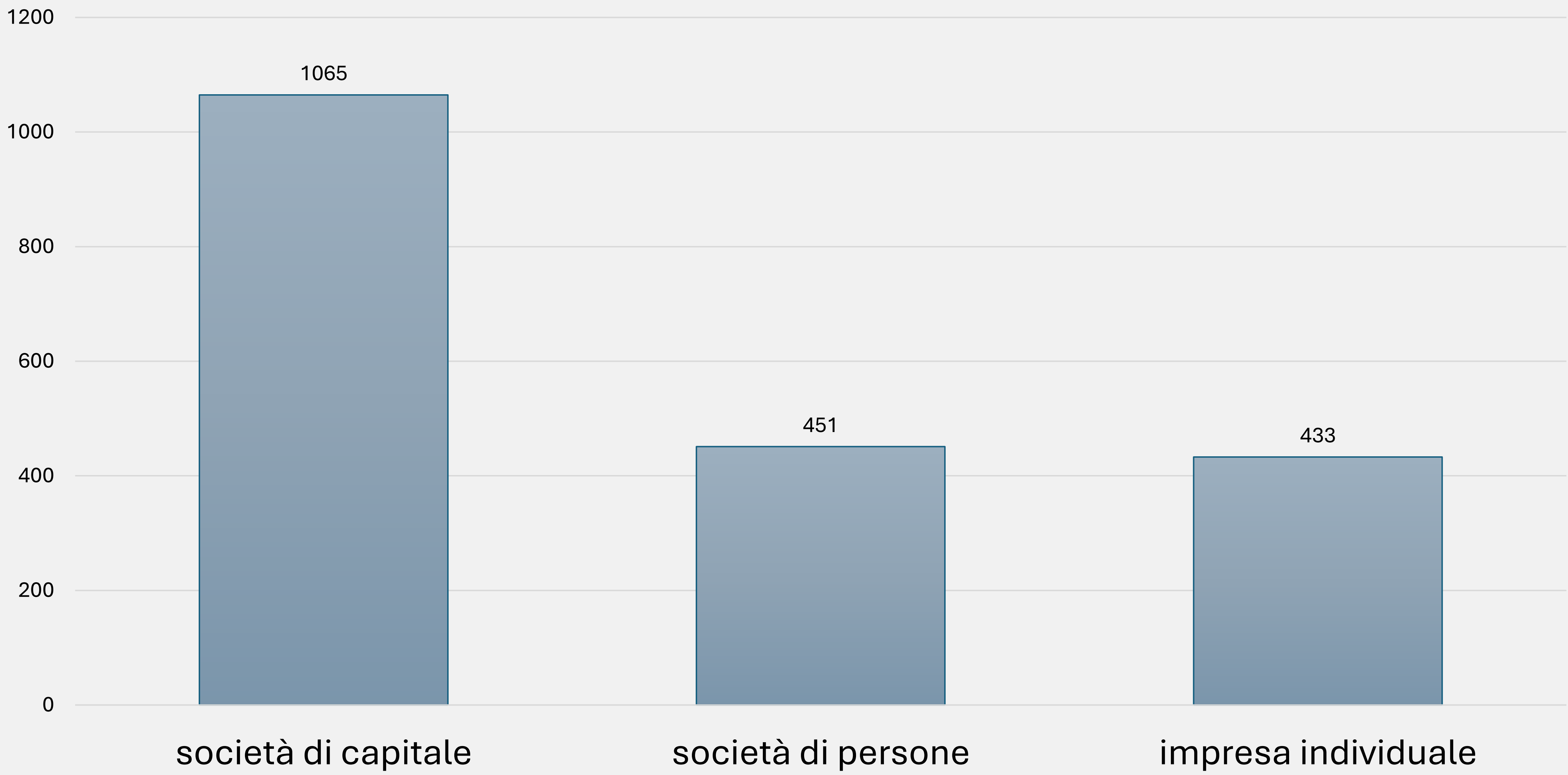
The Tuscany sample selected with the same parameters, approximately **5,400 companies**, employs approximately **25,000 people** and produces 6 billion euros in revenues.

THE VARIABLES THAT REMAIN OPEN

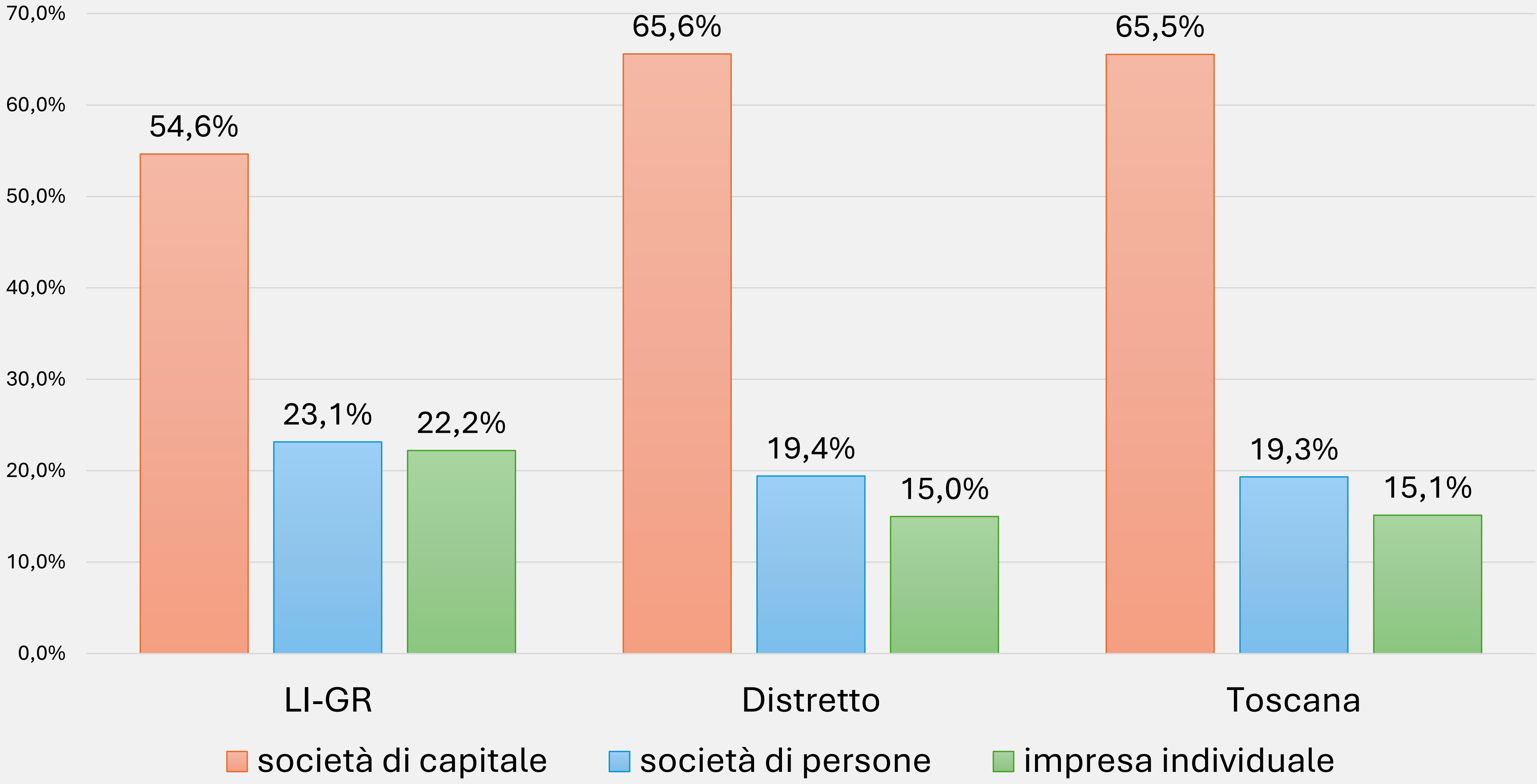
However, some variables remain in the selection of the sample. The data we have today make it complicated to determine the share of turnover and employees that truly pertains to a specific geographical area, especially when there are companies that operate in the entire Ligurian-Tuscan district and beyond.

Even determining, mainly in the case of large companies, what share of the turnover accrued in activities related to the nautical context is not simple.

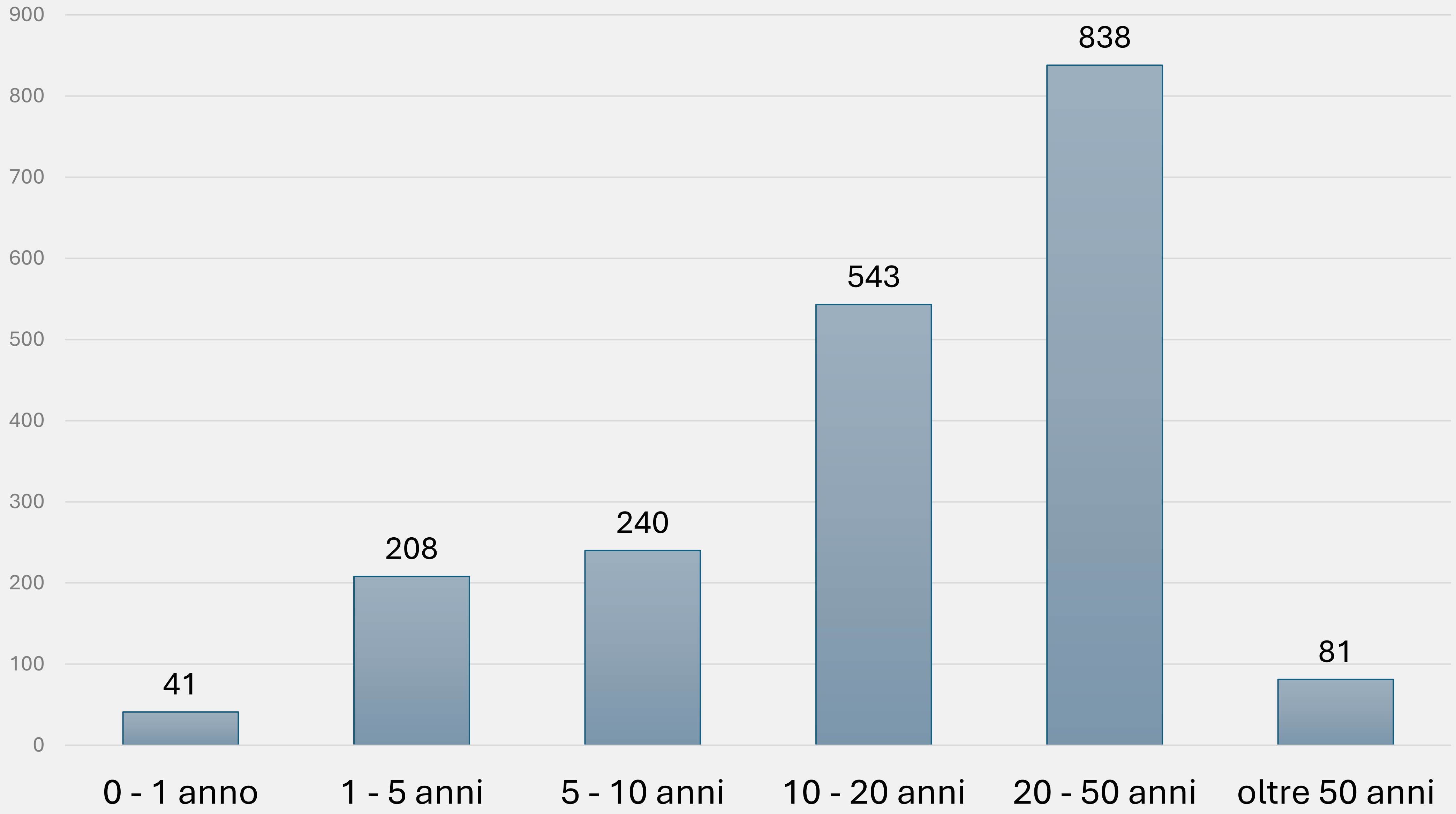
Enterprises by legal form Livorno and Grosseto – 1950 Companies



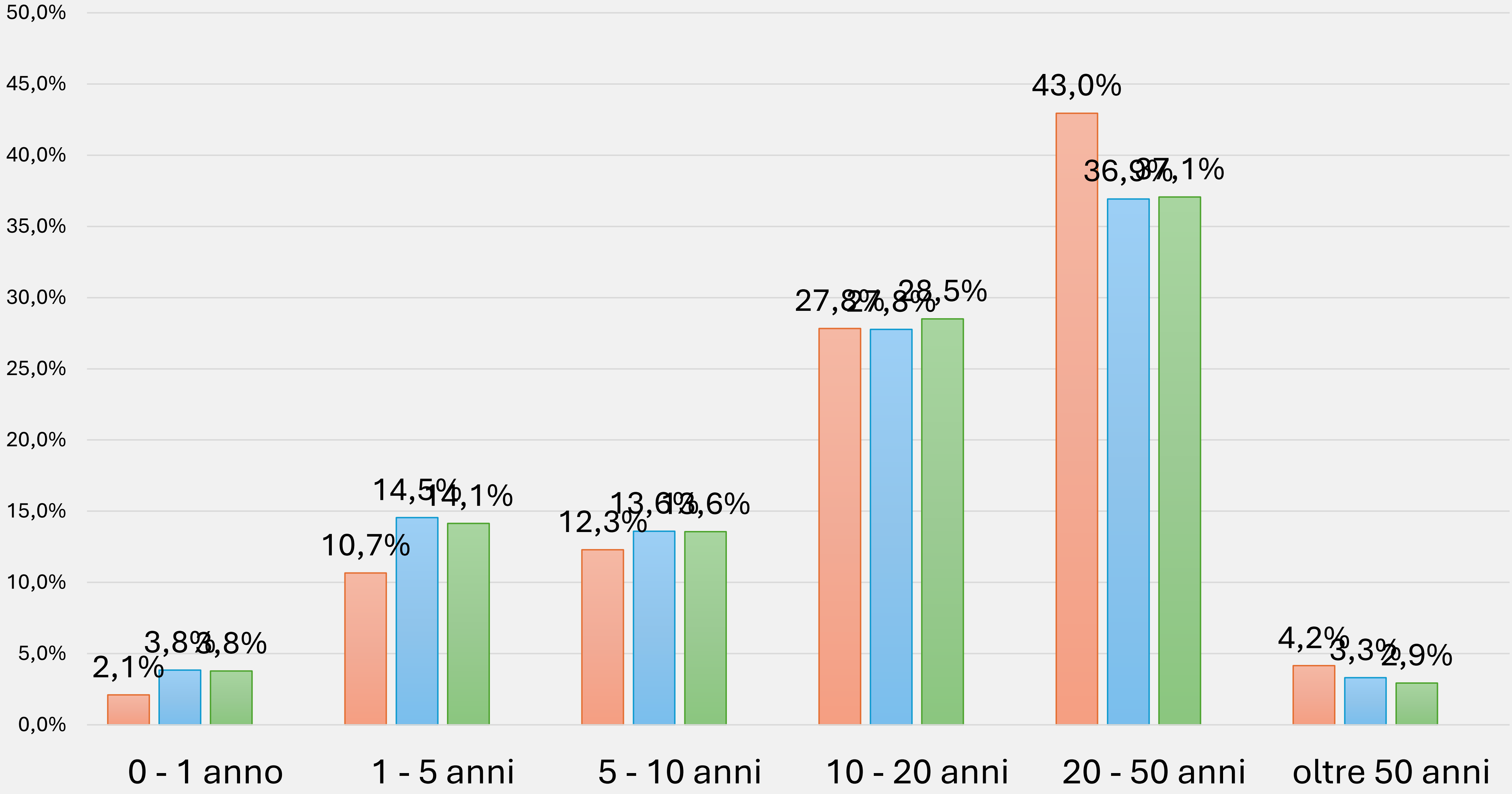
Enterprises by nature comparison LI-GR/District/Tuscany



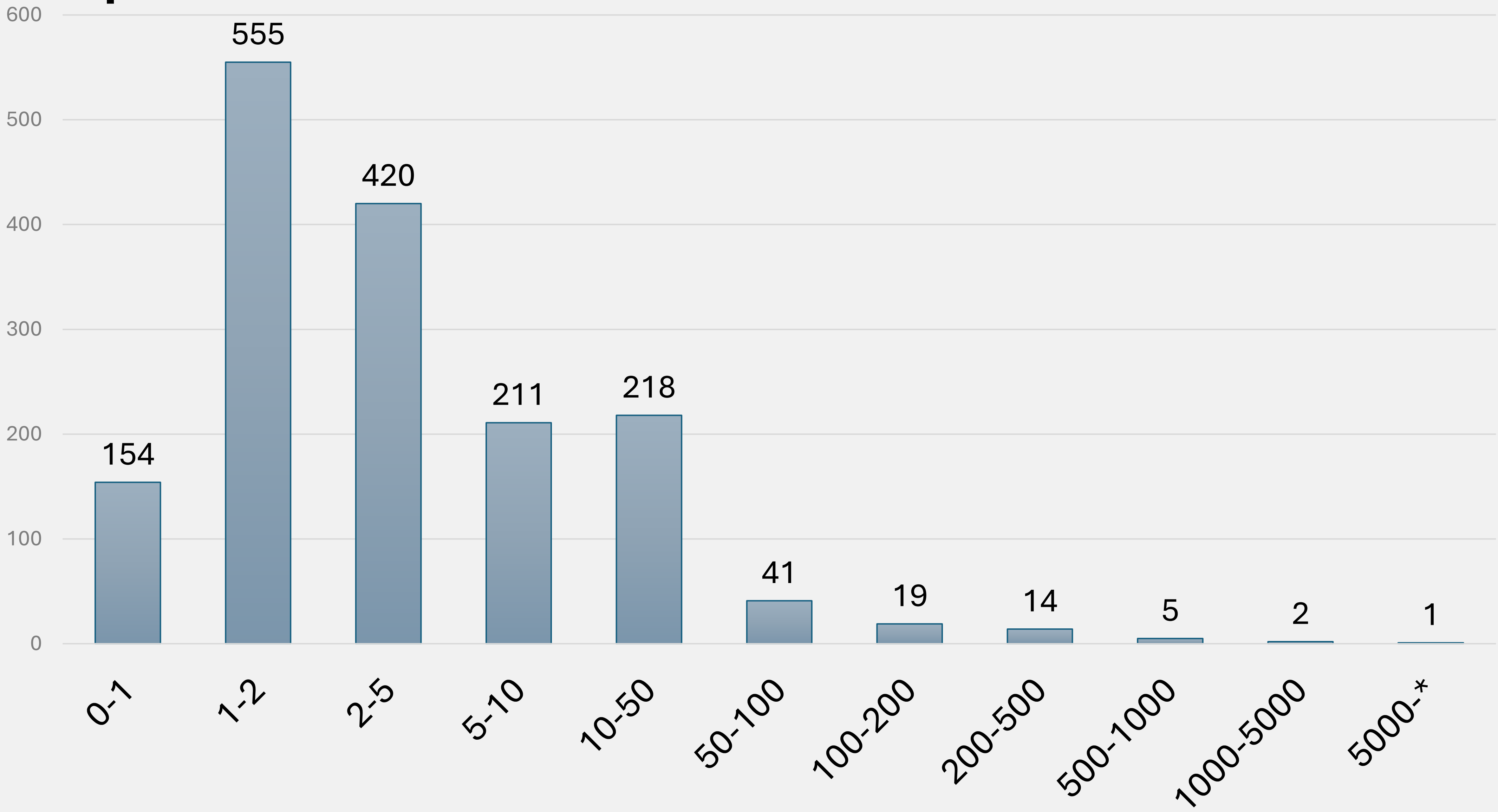
Enterprises by age Livorno and Grosseto – 1950 Companies



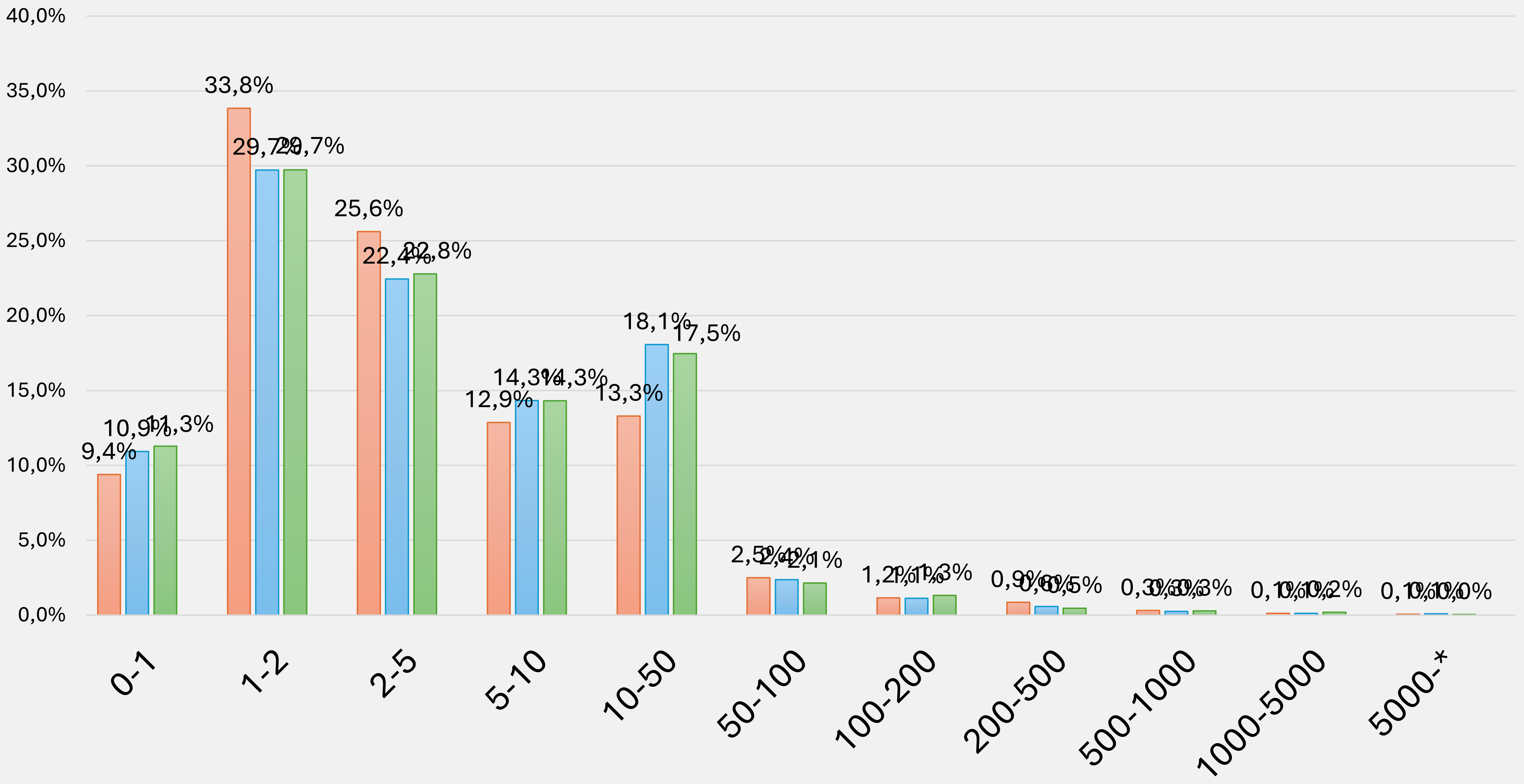
Enterprises by age comparison LI-GR/District/Tuscany percentage



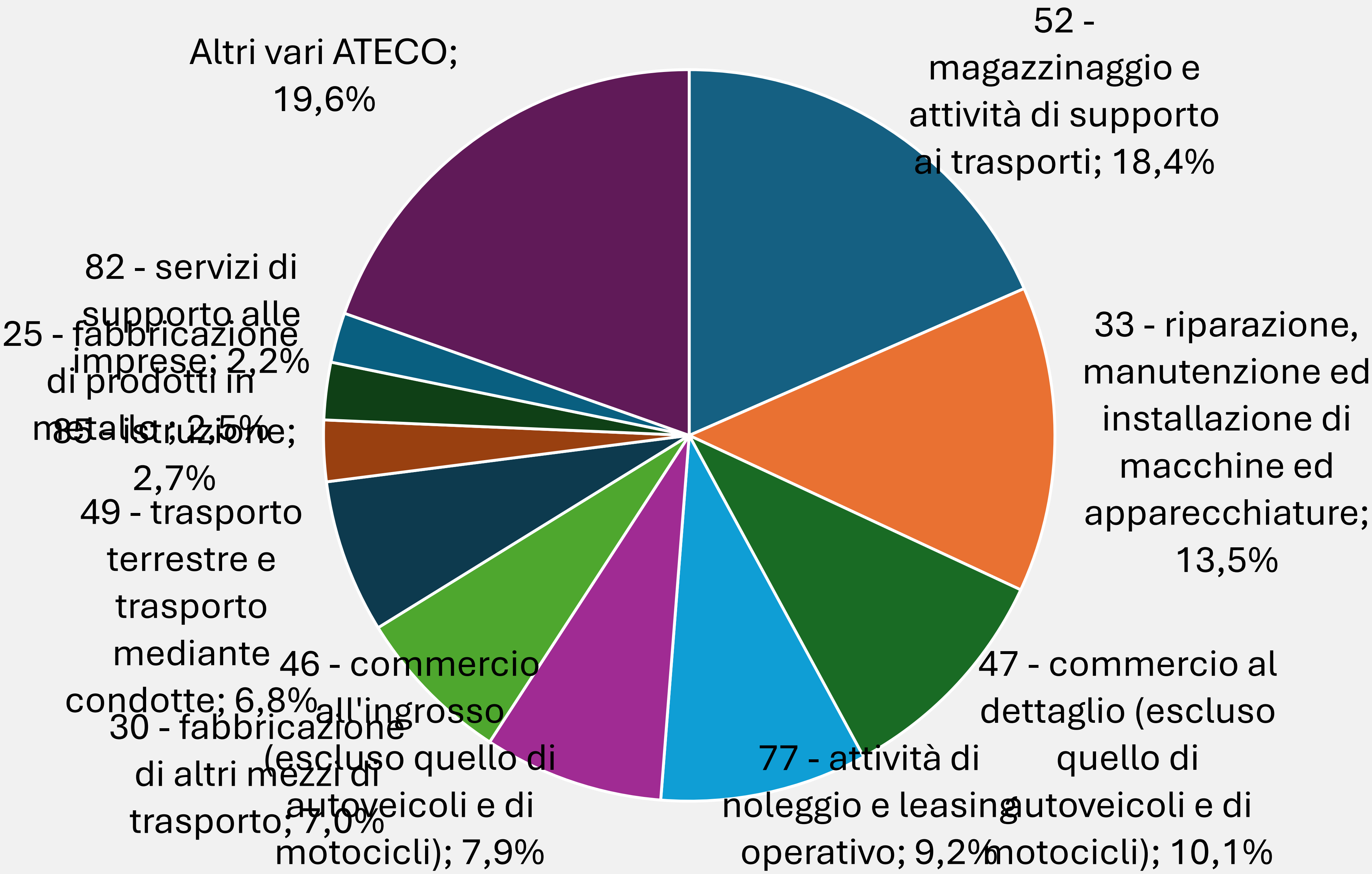
Enterprises by number of employees Livorno and Grosseto – 1950 Companies



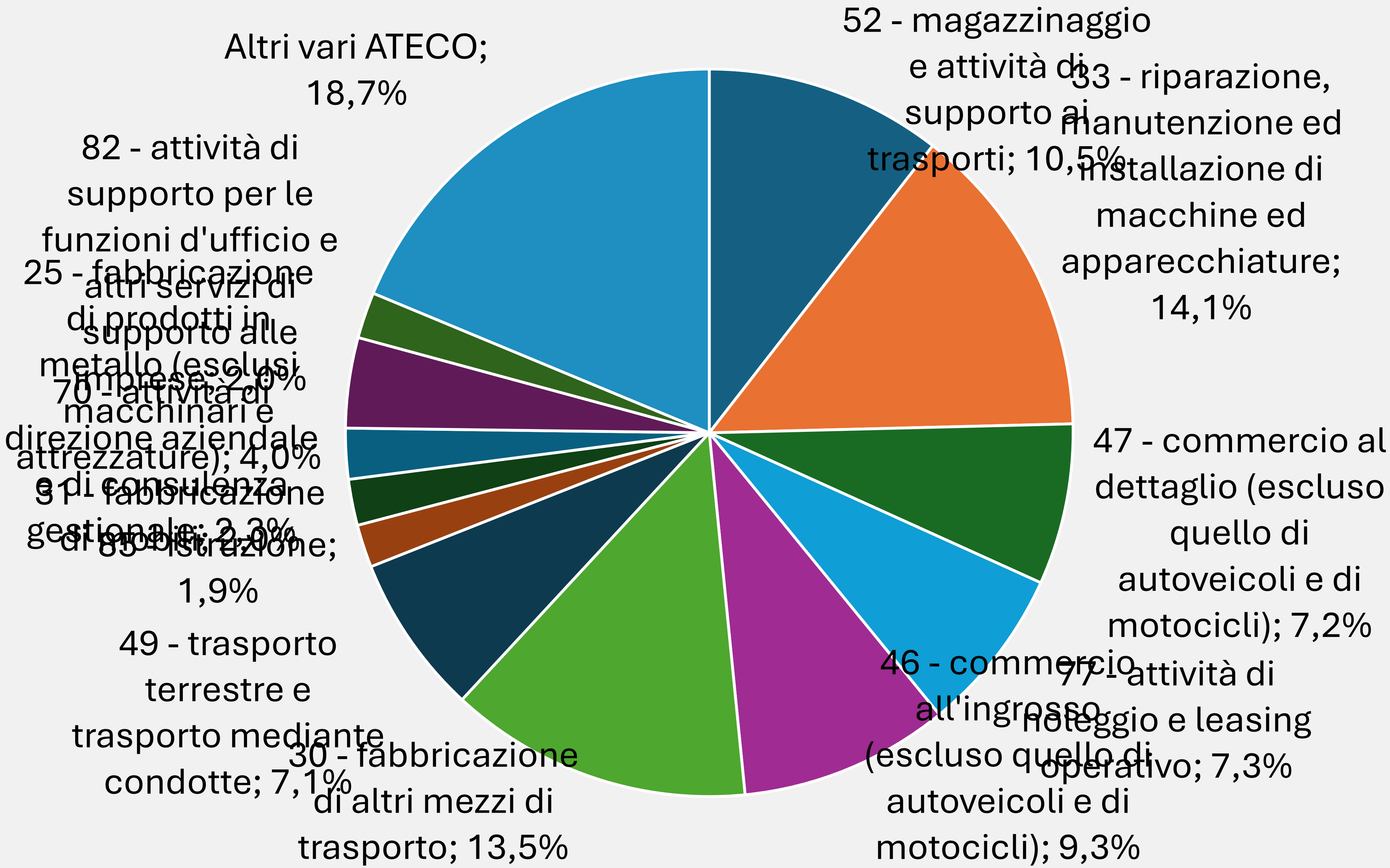
Comparison by number of employees LI-GR/District/Tuscany percentage



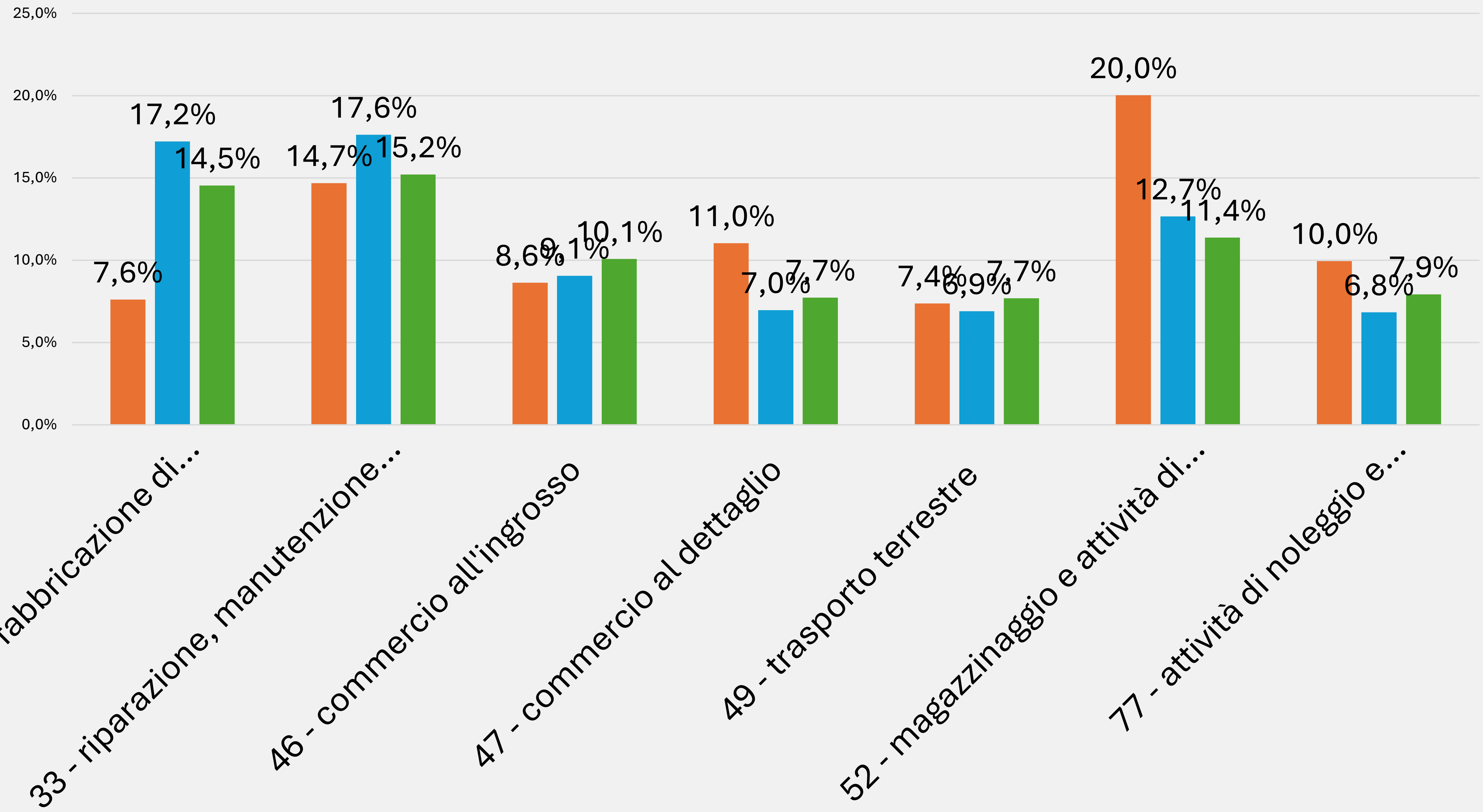
Division by ATECO code Livorno and Grosseto – 1950 Companies



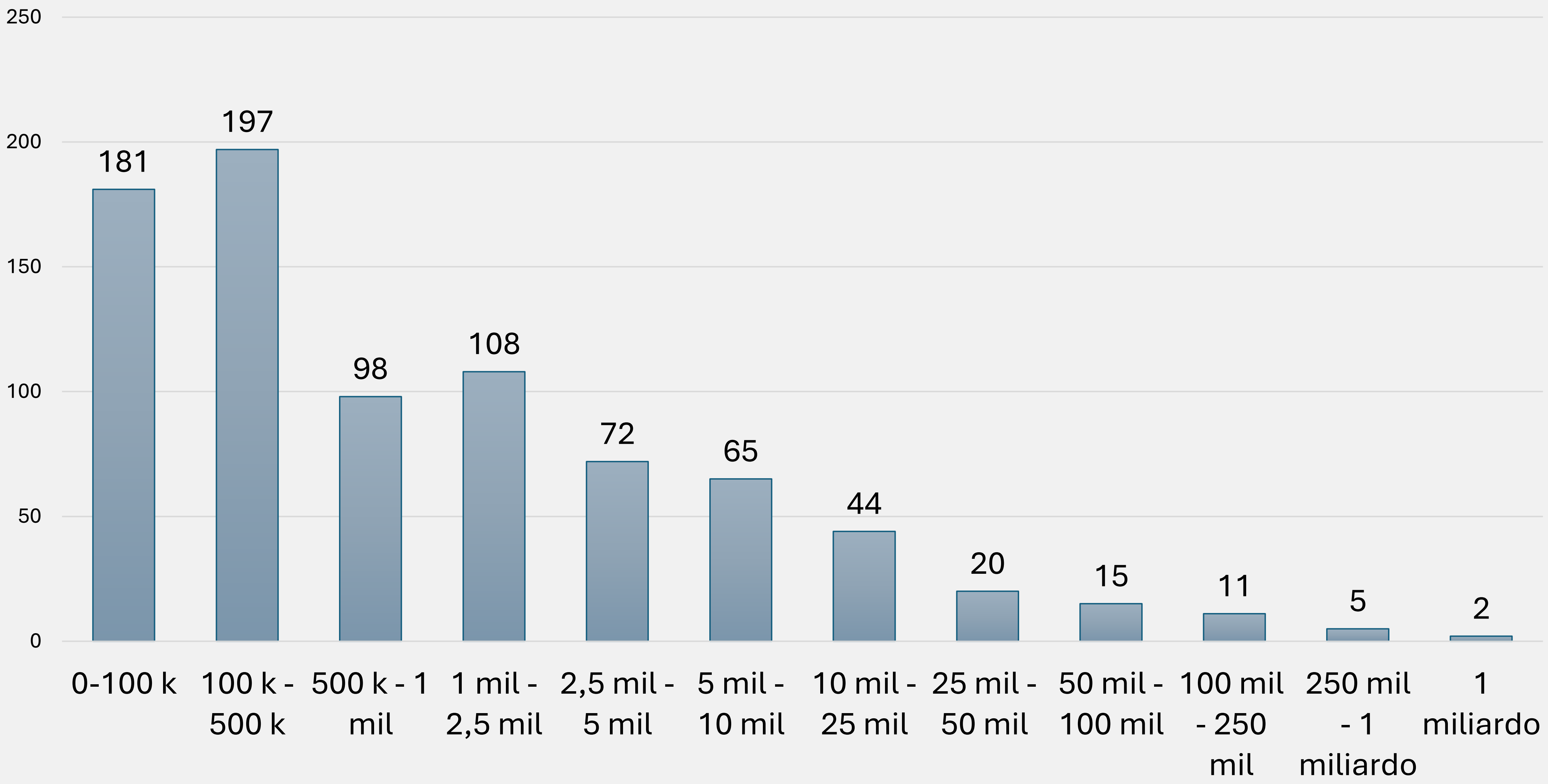
Division by ATECO code Tuscany



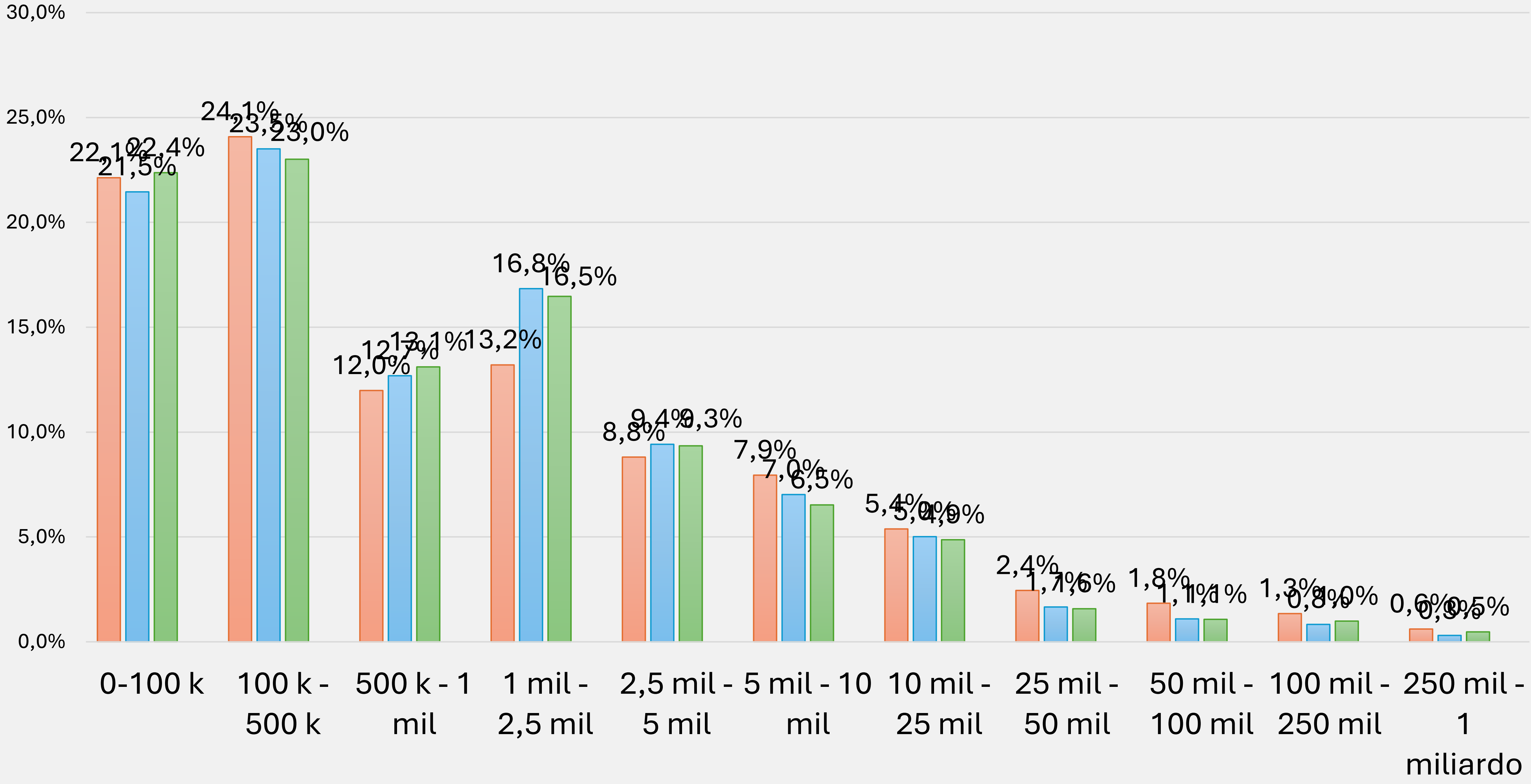
Comparison by significant ATECO codes LI-GR/Distretto/Toscana



Enterprises by revenues Livorno and Grosseto – 1950 Companies

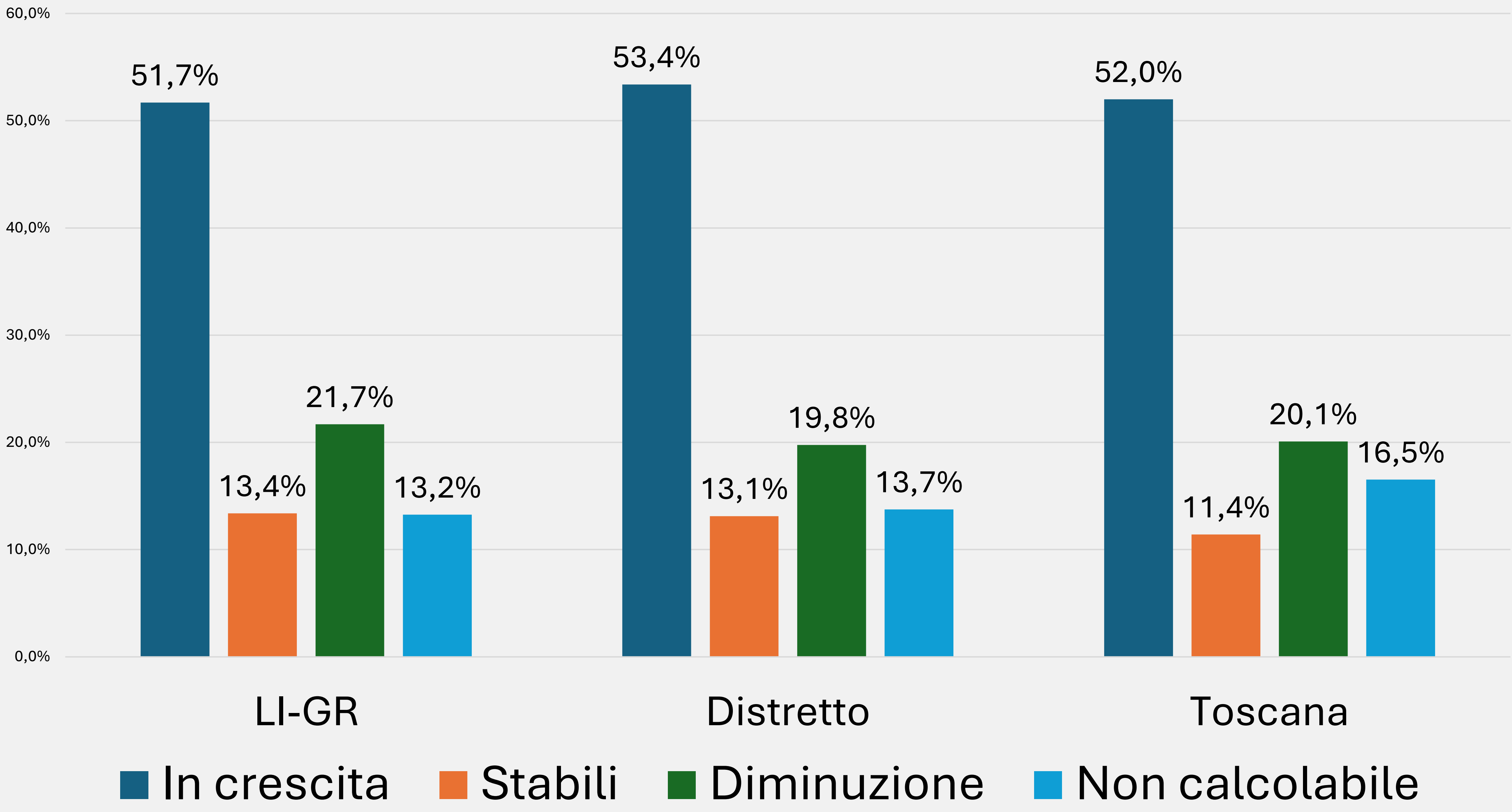


Enterprises by revenues comparison LI-GR/District/Tuscany*

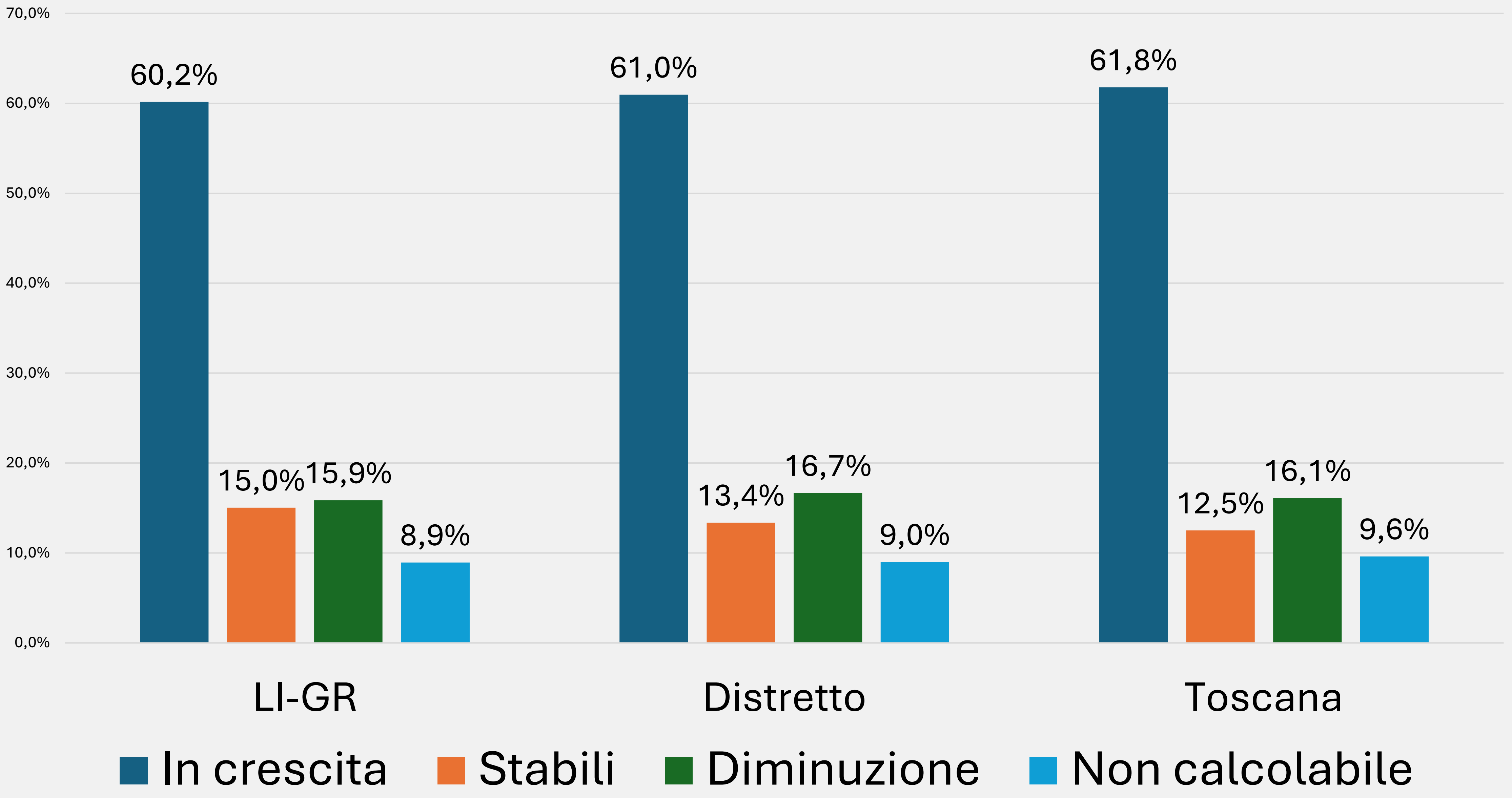


Circa il 50% delle imprese non è tenuta alla presentazione dei bilanci

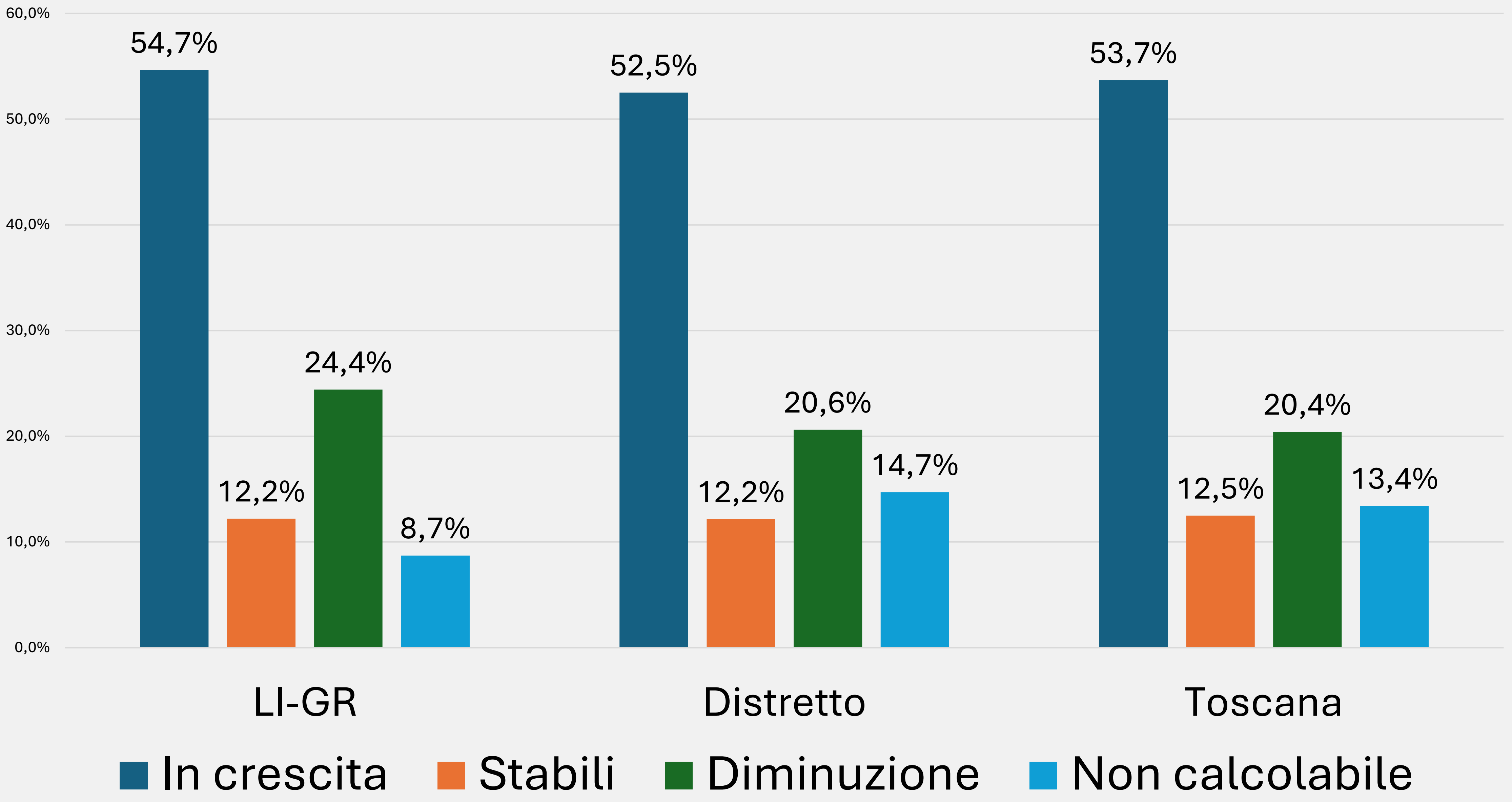
Trend revenues comparison LI-GR/District/Tuscany



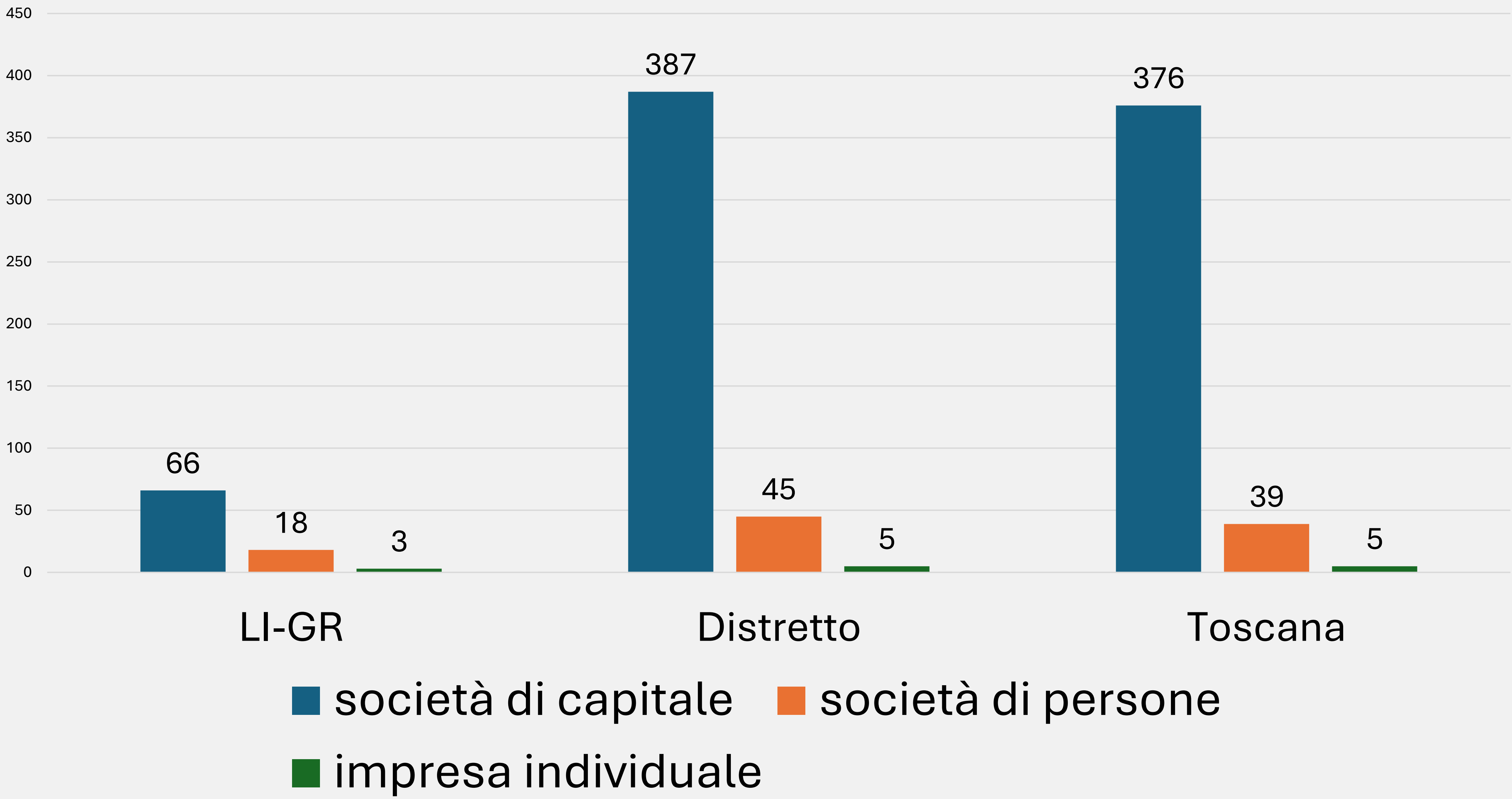
Trend revenues LOGISTICS LI-GR/District/Tuscany



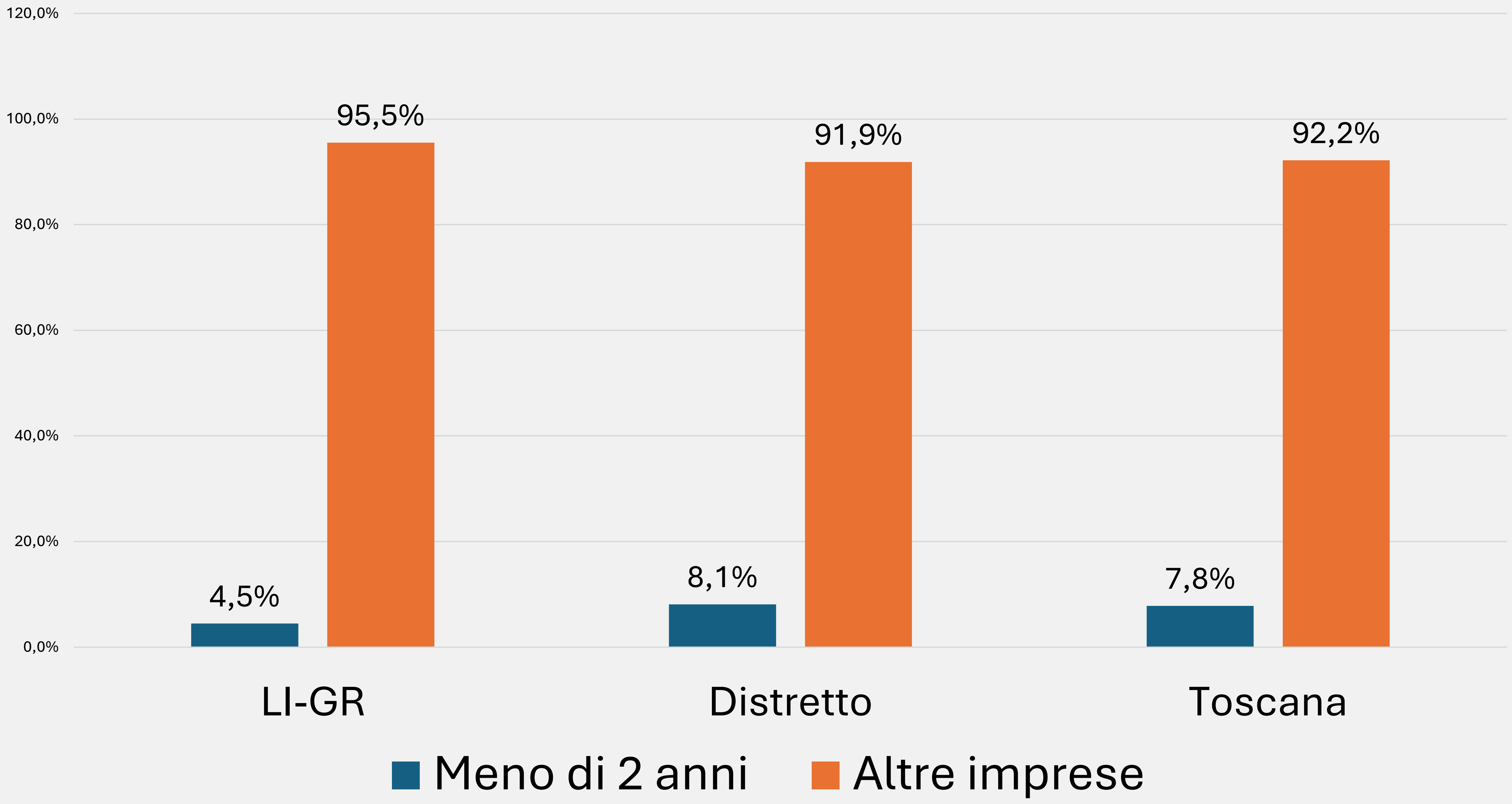
Trend revenues Shipyards LI-GR/District/Tuscany



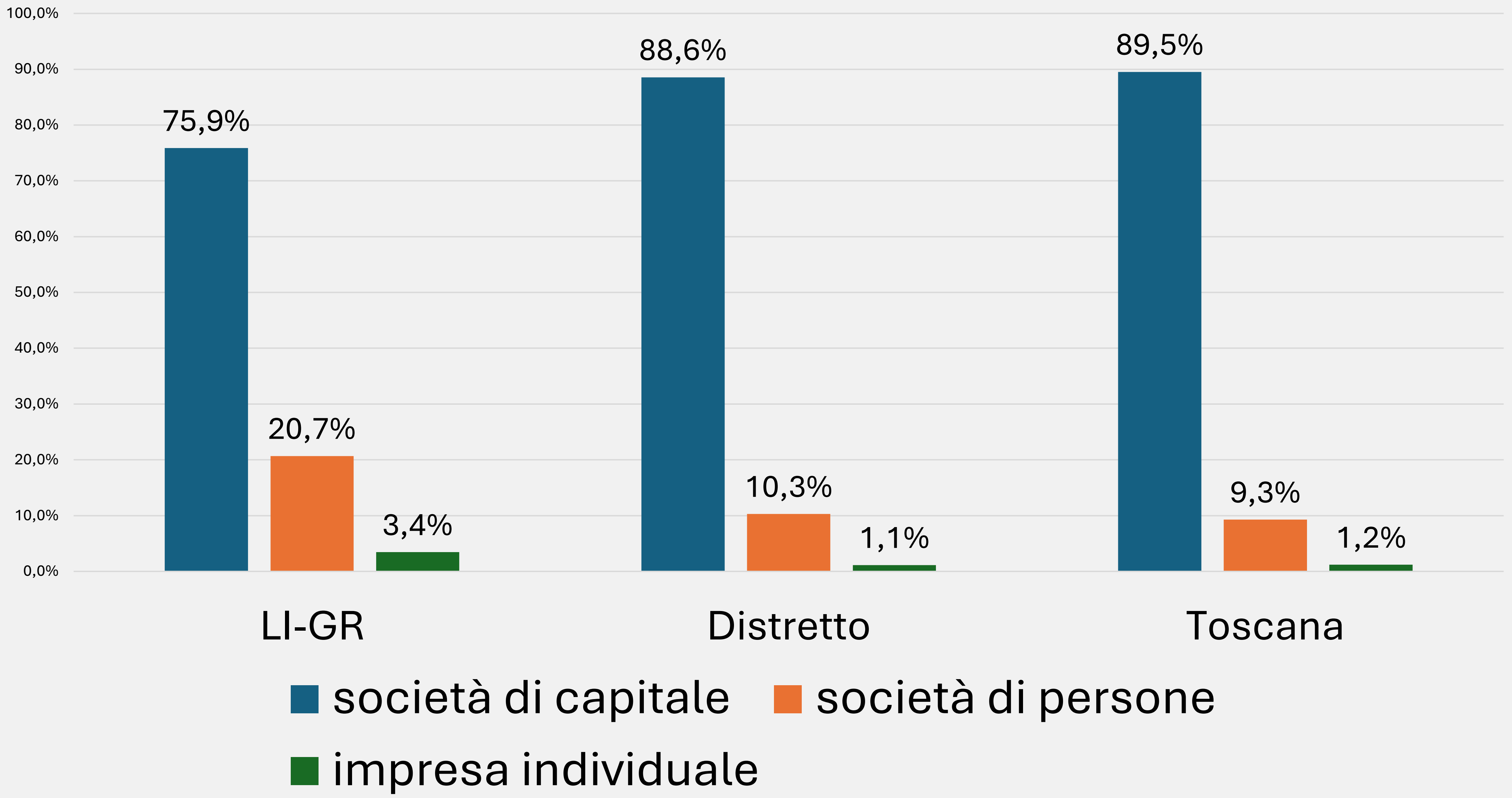
Enterprises max 2 years comparison LI-GR/District/Tuscany



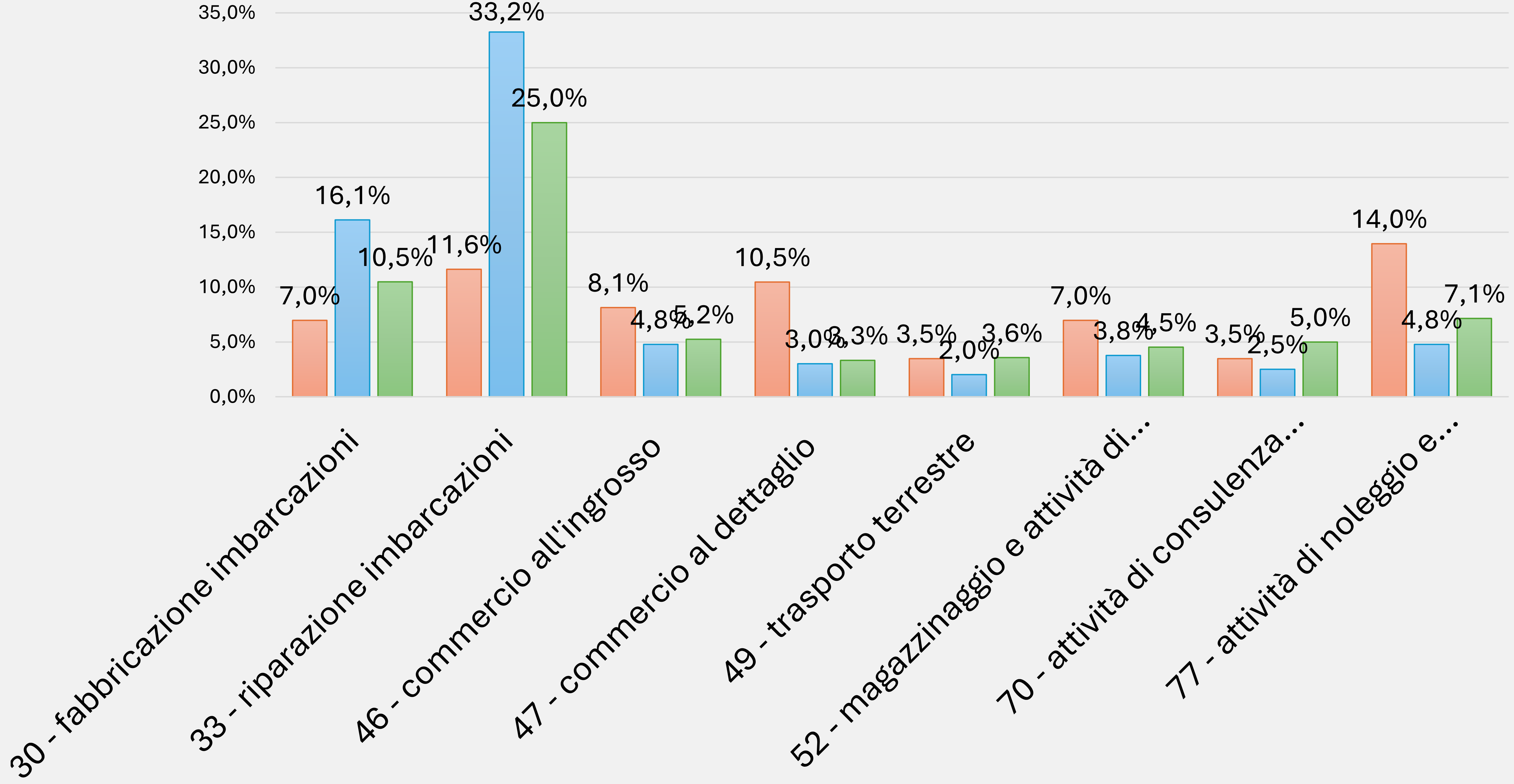
Enterprises max 2 years on totals comparison LI-GR/District/Tuscany



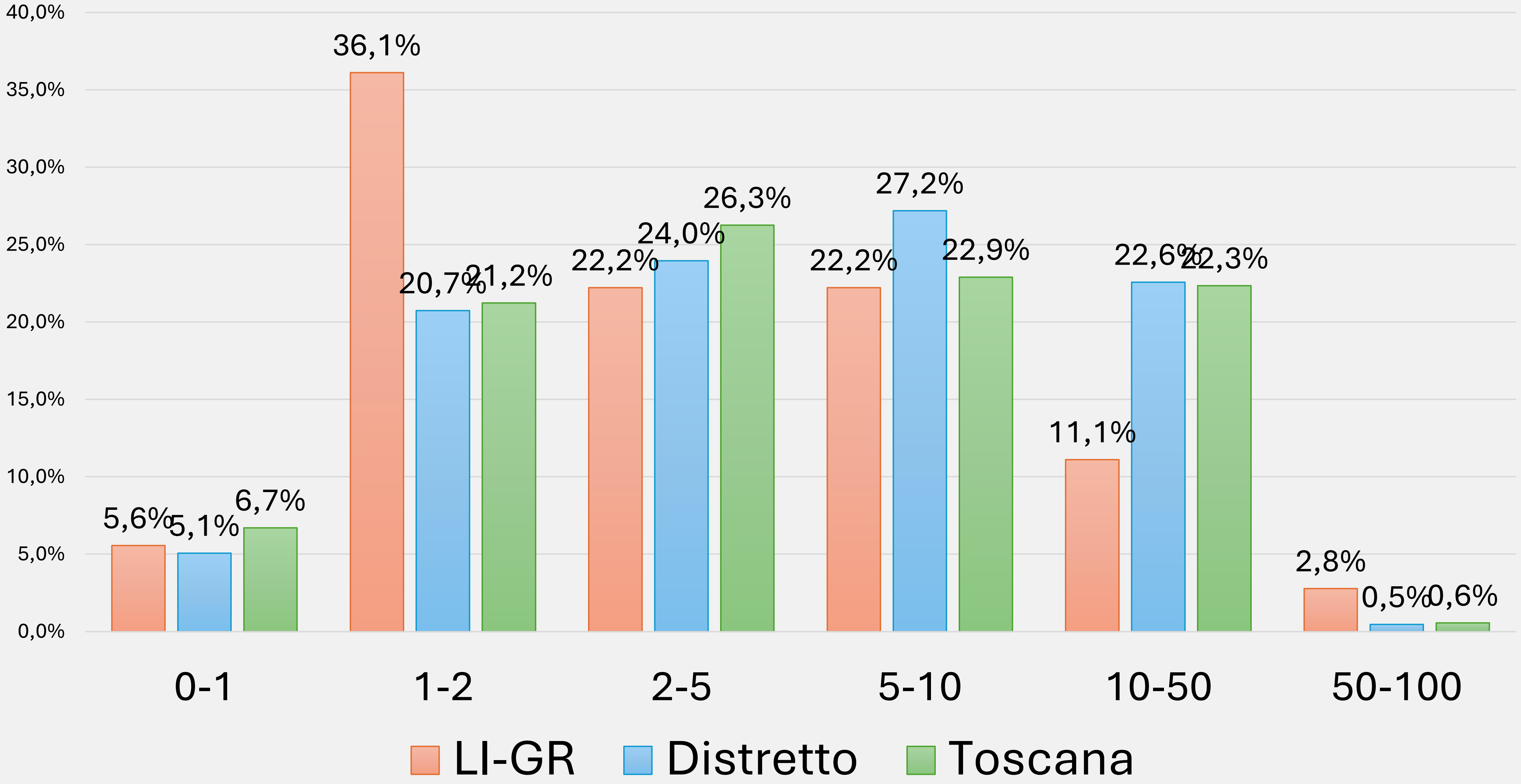
Enterprises 2 years by legal form comparison LI-GR/District/Tuscany



Enterprises max 2 years by ATECO code comparison LI-GR/District/Tuscany

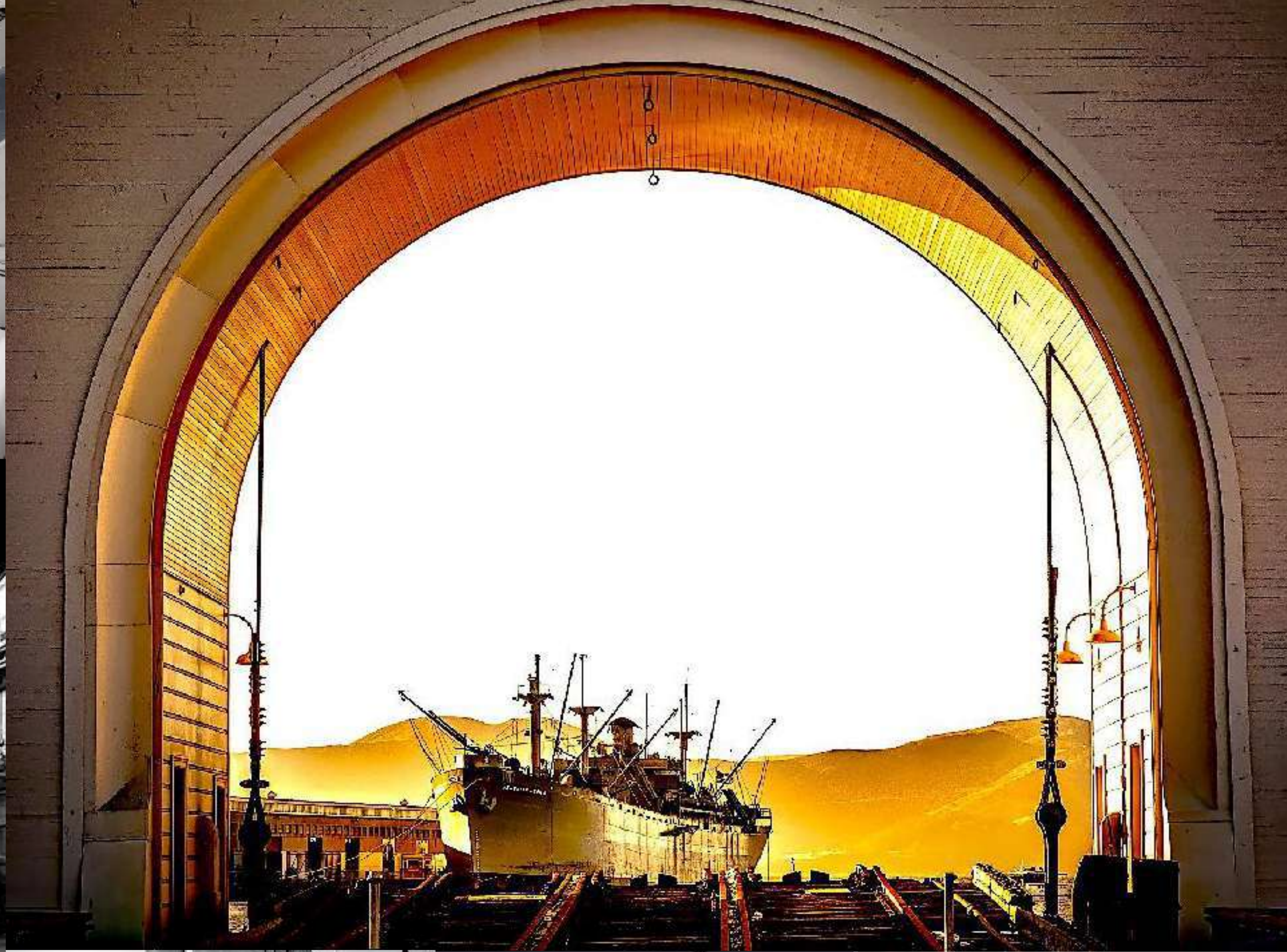


Enterprises max 2 years by employees comparison LI-GR/District/Tuscany

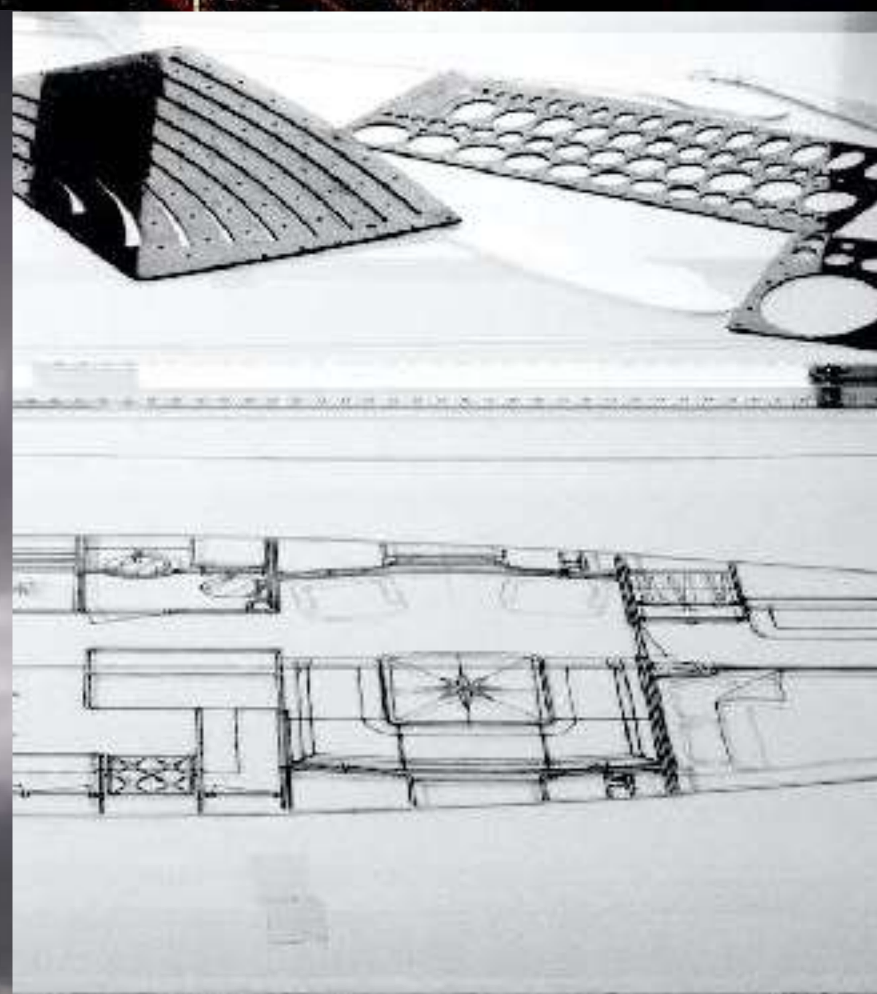


NAVIGO

La più estesa rete di aziende di nautica della Toscana ed una delle principali d’Europa.



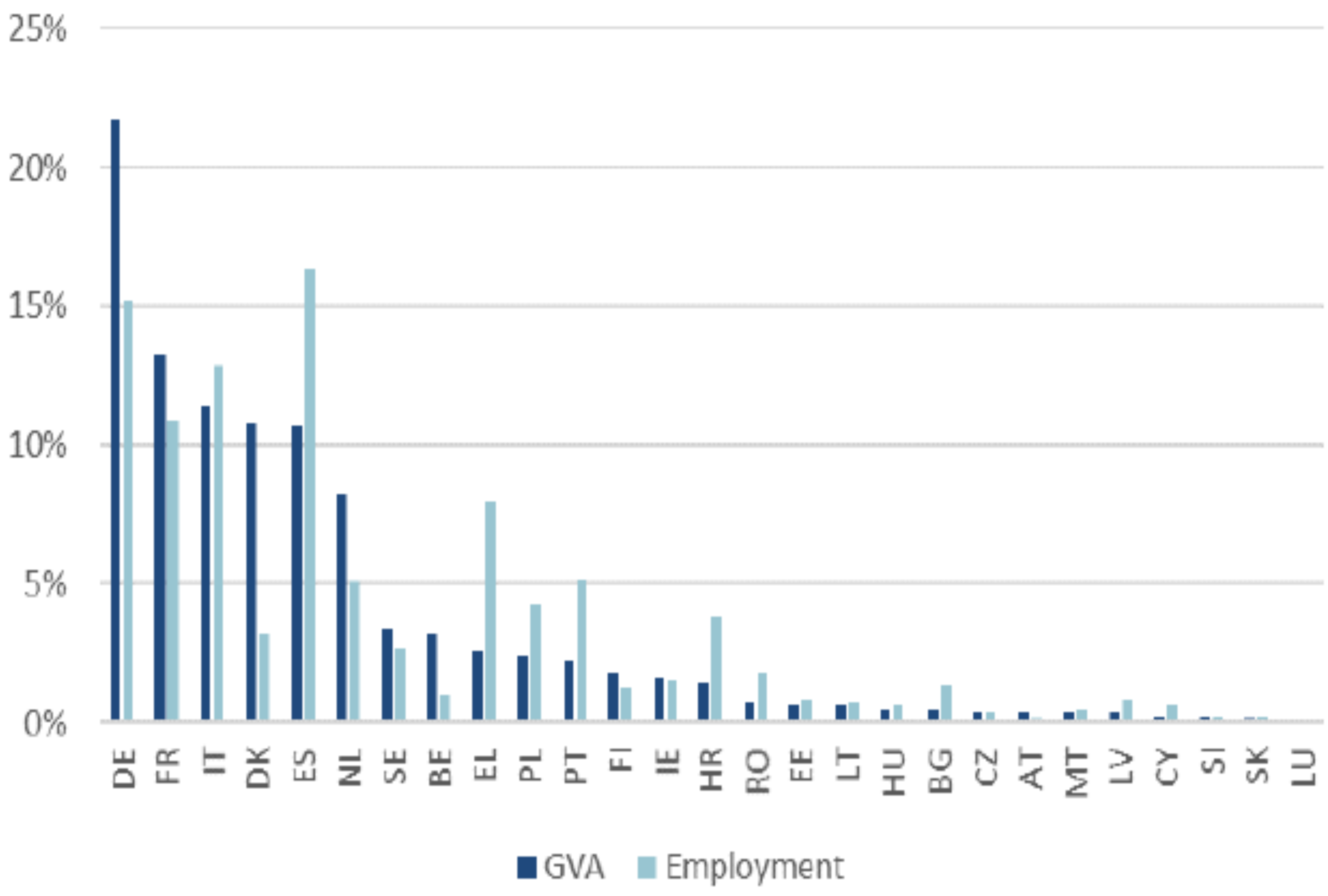
NAVIGO



Scenario Nazionale & Internazionale

Figure 1.4 National contribution to the EU Blue Economy, percentage (EU28 = 100%) in terms of employment and GVA

L'apporto italiano alla blue economy europea in termini del valore aggiunto lordo la posiziona al terzo posto, tuttavia in termini di occupazione si guadagna la seconda posizione superando la Francia. (Anno di riferimento 2020)



Source: Own calculations based on Eurostat (SBS) and DCF data

The EU BLUE ECONOMY REPORT 2023

LE IMPRESE IN ITALIA

Anno di riferimento dati: 2022

DINAMICA DEL TESSUTO IMPRENDITORIALE

228.190 LE IMPRESE DELLA ECONOMIA DEL MARE → **3,8%** L'INCIDENZA SUL TOTALE ECONOMIA

VARIAZIONI 2022/2019	Valori assoluti	Variazione %
Economia del Mare	+9.616	+4,4%
Totale economia	-72.695	-1,2%

	NUMEROSITA' (valori assoluti e incidenza %)		VARIAZIONE 2022/2019 (valori assoluti e variazione %)	
Servizi di alloggio e ristorazione	109.121	47,8%	+7.717	+7,6%
Attività sportive e ricreative	34.363	15,1%	+840	+2,5%
Filiera ittica	33.242	14,6%	-493	-1,5%
Filiera della cantieristica	28.583	12,5%	-181	-0,6%
Movimentazione di merci e passeggeri via mare	12.512	5,5%	+462	+3,8%
Ricerca, regolamentazione e tutela ambientale	9.864	4,3%	+1.314	+15,4%
Industria delle estrazioni marine	505	0,2%	-43	-7,9%
TOTALE	228.190	100,0%	+9.616	+4,4%

Fonte: Centro Studi delle Camere di commercio Guglielmo Tagliacarne - Unioncamere - OsserMare

VALORE AGGIUNTO DEI COMPARTI

(in miliardi di €. Tra parentesi, variazione % 2021/2020)

Ricerca, regolamentazione e tutela ambientale	15,0 (+0,4%)
Servizi di alloggio e ristorazione	13,3 (+22,1%)
Movimentazione di merci e passeggeri via mare	10,4 (+5,1%)
Filiera della cantieristica	7,7 (+11,7%)
Attività sportive e ricreative	2,7 (+5,4%)
Filiera ittica	2,6 (+8,0%)
Industria delle estrazioni marine	0,8 (+69,8%)

VALORE AGGIUNTO DELLE ECONOMIE LOCALI

Prime 5 province per valore assoluto *(in miliardi di €)*

Roma	10,1
Napoli	3,7
Genova	3,3
Milano	2,4
Venezia	2,1

Prime 5 province per incidenza % sul totale economia provinciale

Trieste	15,0%
Livorno	14,2%
La Spezia	13,3%
Genova	12,0%
Vibo Valentia	11,1%

Fonte: Centro Studi delle Camere di commercio Guglielmo Tagliacarne - Unioncamere - OsserMare

COMMERCIO ESTERO

Anno di riferimento dati: 2022

PESO PERCENTUALE SUI FLUSSI COMMERCIALI NAZIONALI

EXPORT 1,6%

1,3% IMPORT

FLUSSI COMMERCIALI DELL'ECONOMIA DEL MARE

Valore Export: 10.288 mln di €

Valore Import: 8.416 mln di €

Saldo commerciale

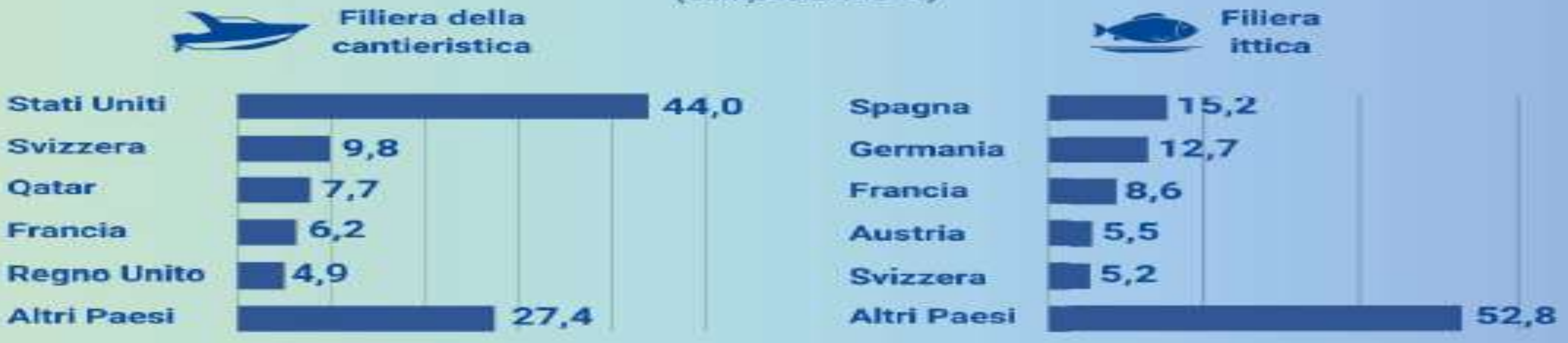
+1.872 mln di €

SETTORI DELL'EXPORT

	Vale circa (mln di €)	Saldo commerciale (mln di €)	Variazione % 2022/2021	
			Export	Import
Filiera della cantieristica	9.355	+8.304	+40,7	-58,6
Filiera ittica	933	-6.432	+11,2	+12,7

PRINCIPALI MERCATI DI SBOCCO

(composizione %)



Fonte: elaborazioni Centro Studi delle Camere di commercio Guglielmo Tagliacarne - Unioncamere - OsserMare su dati Istat

LA BLUE ECONOMY A LIVELLO EUROPEO *
IL CONTRIBUTO DELL'ITALIA

* Tutti i dati si riferiscono all'UE-27

L'ASCESA DELL'ECONOMIA BLU NELL'UNIONE EUROPEA

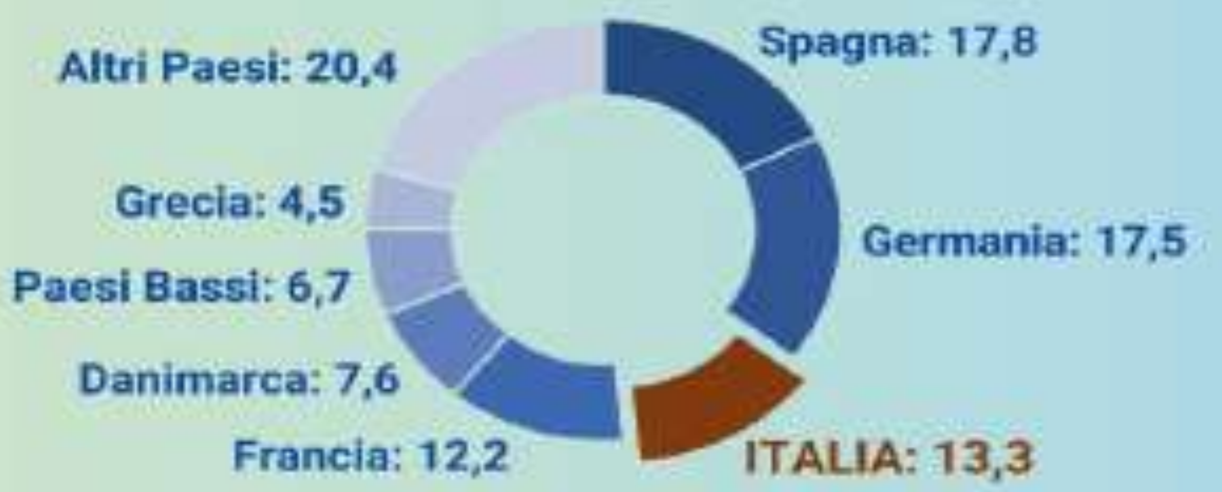
(2019, variazione % rispetto al 2009)

VALORE AGGIUNTO LORDO	UTILE LORDO	OCCUPATI
184 Mld di €	73 Mld di €	4,5 mln
+20%	+22%	+0,5%

VALORE AGGIUNTO PER PAESE

OCCUPAZIONE PER PAESE

(2019, composizione %)



Cantieristica navale e riparazioni	3° posto	19%
Risorse marine non biologiche	3° posto	16%
Trasporto marittimo	3° posto	14%
Turismo costiero	3° posto	13%
Risorse biologiche marine	4° posto	14%
Attività portuali	5° posto	8%

Fonte: The EU Blue Economy Report, 2022

FORZA MOLTIPLICATIVA

Anno di riferimento dati: 2021

1 EURO PRODOTTO DALLA BLUE ECONOMY NE ATTIVA ALTRI 1,7 SUL RESTO DELL'ECONOMIA

Valore aggiunto prodotto: 52,4 Mld di €

Valore aggiunto attivato: 90,3 Mld di €

8,9% *Incidenza sul totale economia nazionale*

MOLTIPLICATORE PER COMPARTI

Movimentazione di merci e passeggeri via mare	2,7 €
Filiera della cantieristica	2,5 €
Attività sportive e ricreative	2,1 €
Filiera ittica	1,9 €
Servizi di alloggio e ristorazione	1,9 €
Industria delle estrazioni marine	1,1 €
Ricerca, regolamentazione e tutela ambientale	0,5 €

Fig. 1.1 ~~~ **Industria italiana della nautica, andamento del fatturato globale 2000-2022**

valori in miliardi di euro

Fonte: elaborazione Confindustria Nautica

Fig. 2.10 ~~~ **Evoluzione 2010 - 2022 del contributo della nautica al PIL**

valori in miliardi di euro, variazioni percentuali annuali

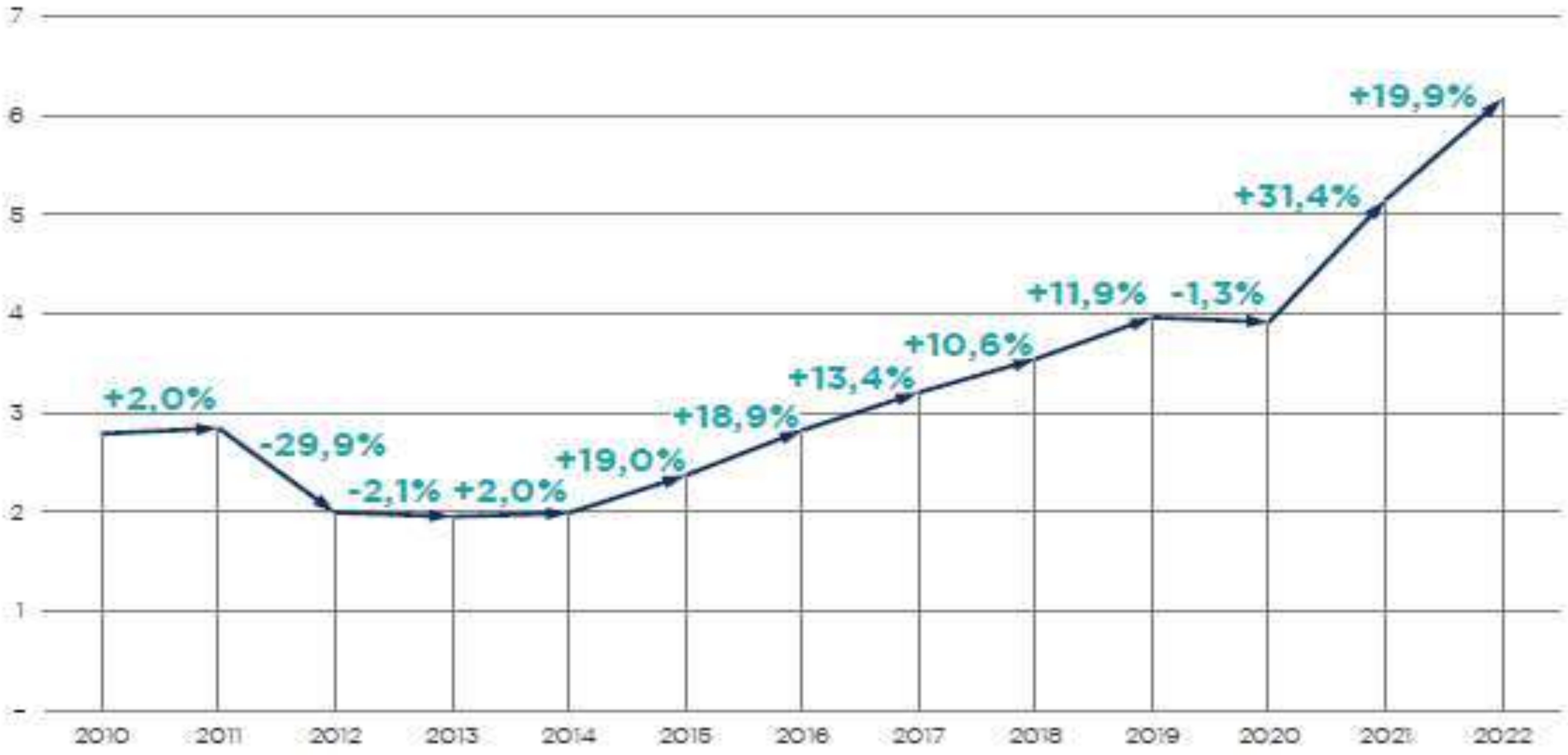


Fig. 2.11 ~~~ **Peso del contributo al PIL della nautica rispetto al PIL nazionale 2010 - 2022**

valori ‰

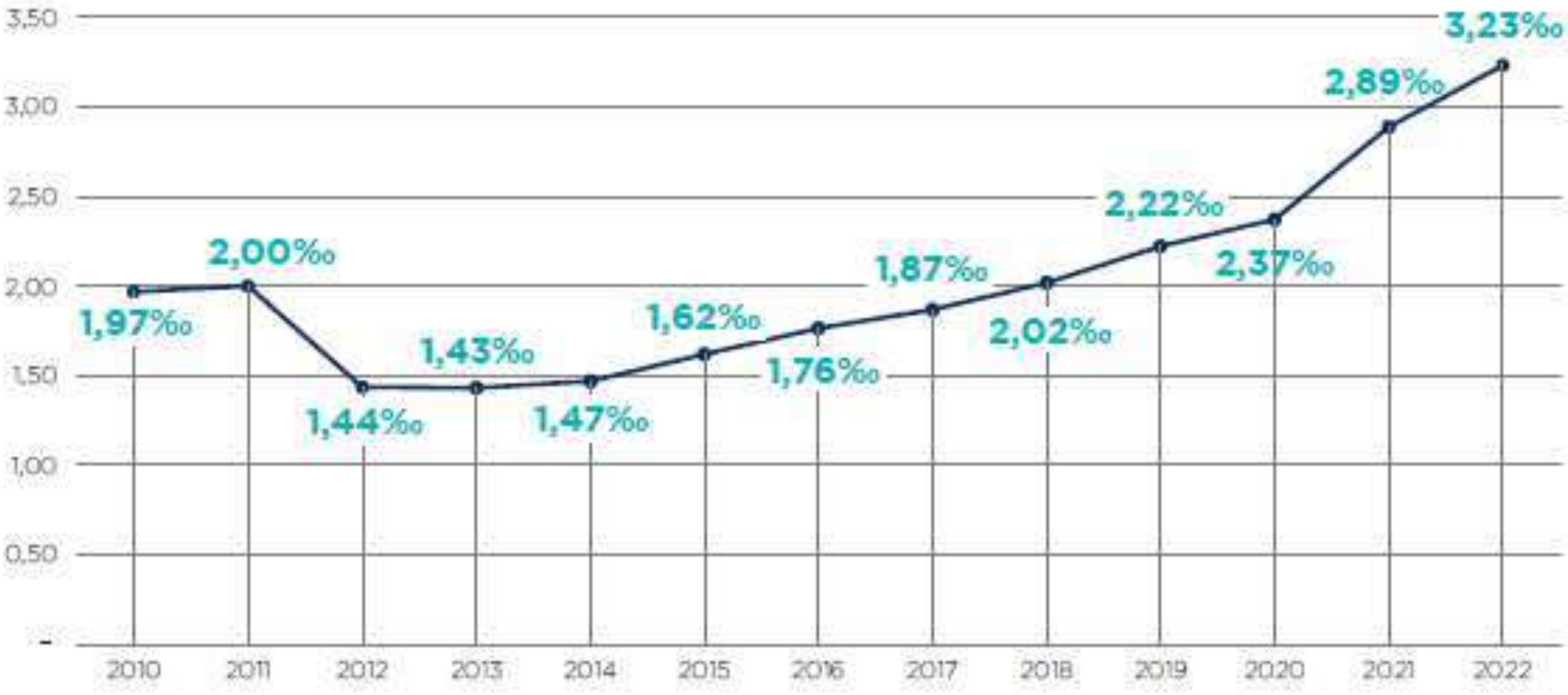
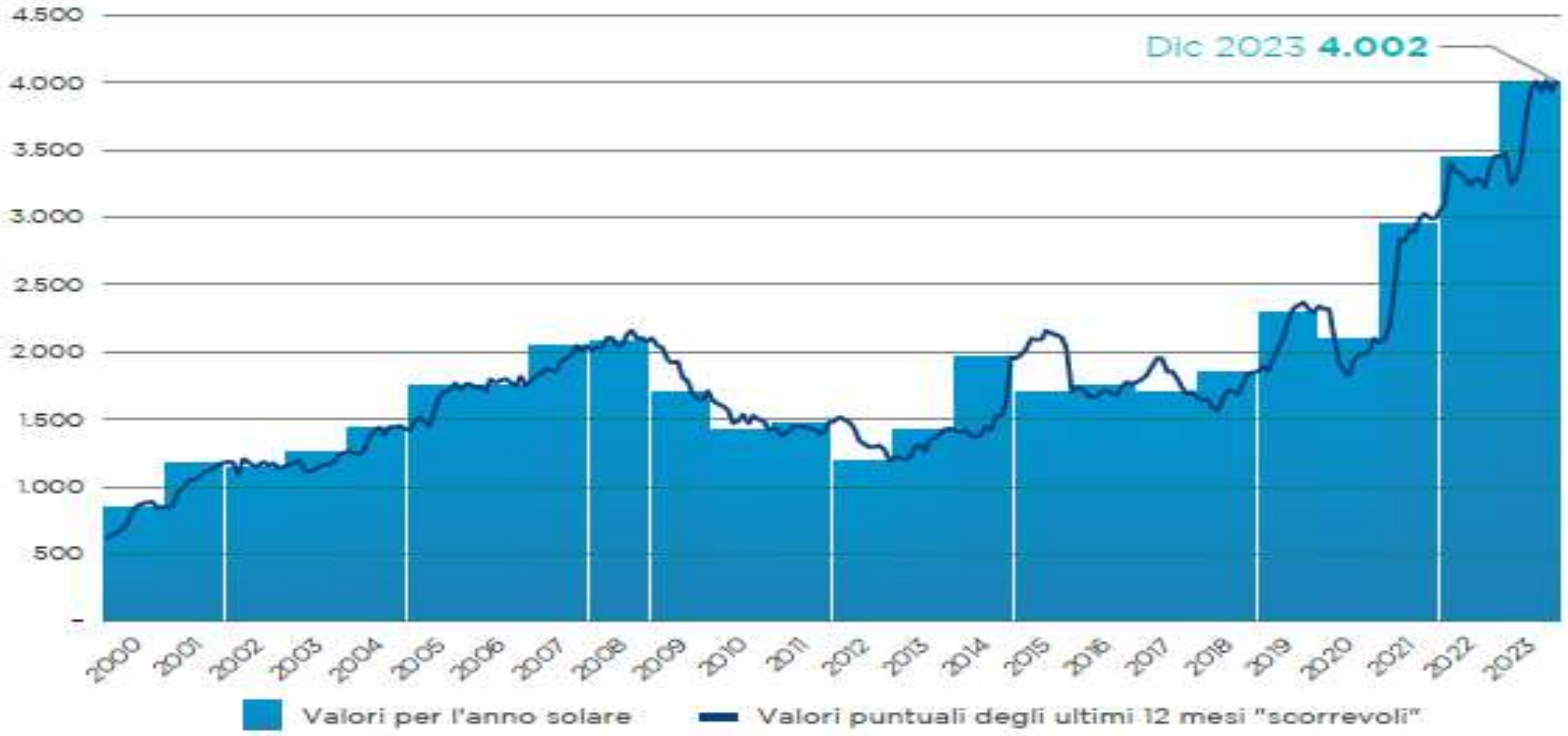


Fig. 1.1 ~~~ **Export italiano di imbarcazioni da diporto e sportive**

ultimi 12 mesi "scorrevoli"; milioni di euro; aggiornato a dicembre 2023



Fonte: elaborazione Fondazione Edison su dati Istat

Tab. 2.3 ~~~ L'impatto del settore nautico sul mercato del lavoro

anno 2022

Sottosettori	Dipendenti	Addetti esterni	di cui: Addetti esterni in esclusiva	% Addetti in esclusiva su totale addetti esterni	Dipendenti + addetti esterni	Numero medio mesi di utilizzo addetti esterni	% di utilizzo per più di 11 mesi all'anno	% di utilizzo per più di 6 mesi all'anno
Nuove unità da diporto	13.730	2.430	670	28%	16.160	9	63%	88%
Refit, riparazione e rimessaggio	3.340	780	220	28%	4.120	8	35%	82%
Accessori	8.240	250	80	32%	8.490	9	67%	82%
Motori	760	60	60	100%	820	12	89%	93%
Totale addetti	**26.070**	**3.520**	**1.030**	**32%**	**29.590**	**9**	**58%**	**86%**

Tab. 2.4 ~~~ Addetti equivalenti ed effettivi

anno 2022

Sottosettori	Dipendenti	Addetti equivalenti	Addetti effettivi
Nuove unità da diporto	13.730	1.820	15.550
Refit, riparazione e rimessaggio	3.340	520	3.860
Accessori	8.240	190	8.430
Motori	760	60	820
Totale addetti	**26.070**	**2.590**	**28.660**

Tab. 2.5 ~~~ Variazioni % forza lavoro

anno 2022 su 2021

Sottosettori	Dipendenti	Addetti esterni	Addetti esterni in esclusiva	Addetti equivalenti	Addetti effettivi
Nuove unità da diporto	+5,2%	+10,0%	+4,7%	+9,6%	+5,7%
Refit, riparazione e rimessaggio	+2,8%	+14,7%	+4,8%	+15,6%	+4,3%
Accessori	+18,6%	+4,2%	0	+5,6%	+18,2%
Motori	+1,3%	0	0	0	+1,2%
Totale	**+8,6%**	**+10,3%**	**+4,0%**	**+10,2%**	**+8,8%**

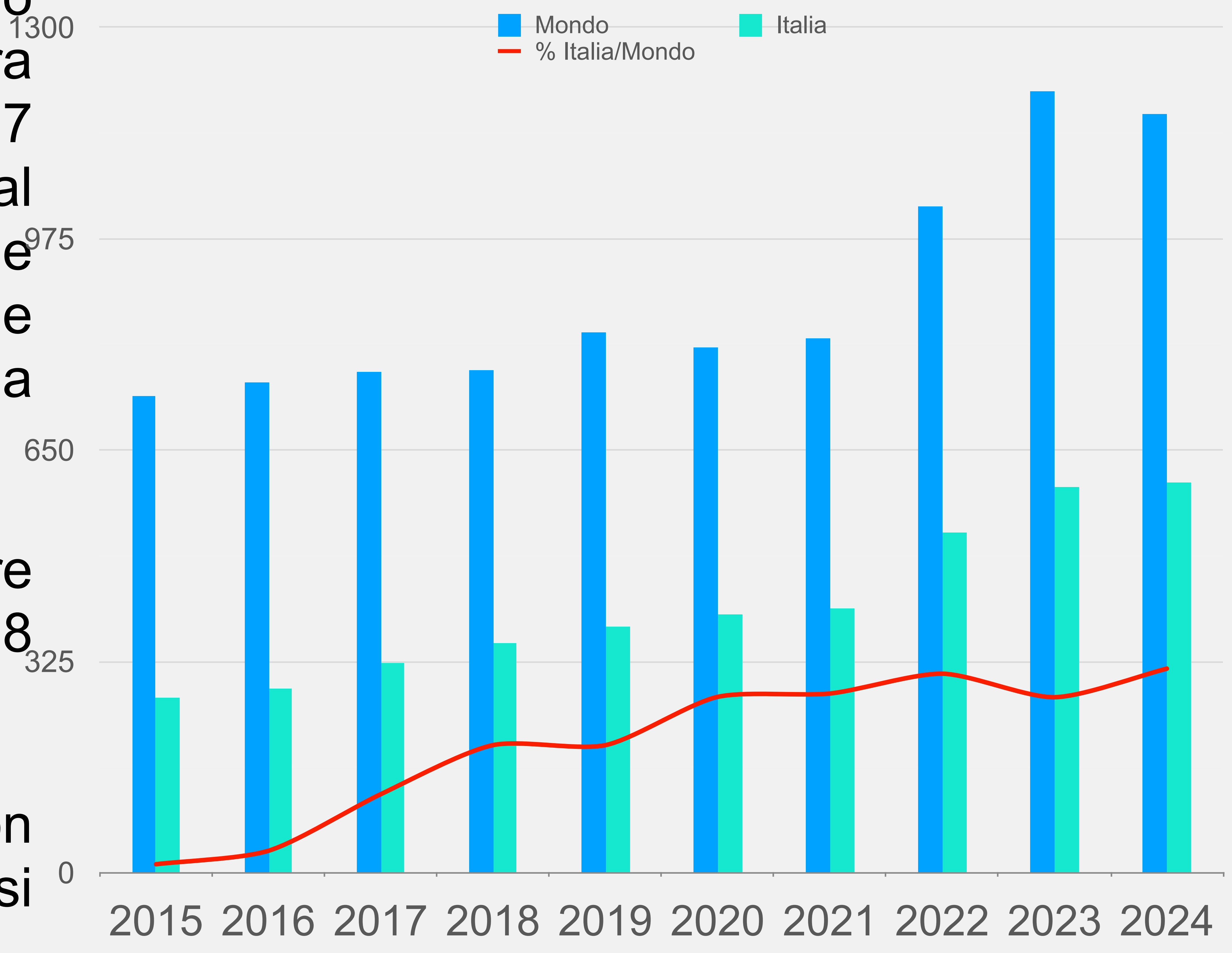
Andamento di mercato di superyachts sopra i 24 metri – Boat International

Andamento di mercato di superyachts sopra i 24 metri – Focus anno 2024

Il grafico di cui alla slide precedente evidenzia che il settore della nautica italiana cresce nonostante un lieve decremento dell'order book mondiale. Su 1166 ordini delle imbarcazioni, ben 600 saranno realizzati in Italia, vale a dire il 51,4 % della produzione mondiale. Tra 600 progetti, 233 riguardano il segmento 24-30 metri, mentre 377 sono 30+ metri (su 695 nel mondo) e vede la percentuale crescere al 54,2% della produzione mondiale. Sarebbe utile evidenziare che circa il 65% della produzione nazionale e circa il 35% mondiale vengono realizzati nel distretto nautico che va da La Spezia fino a Livorno e trova il suo cuore pulsante a Viareggio.

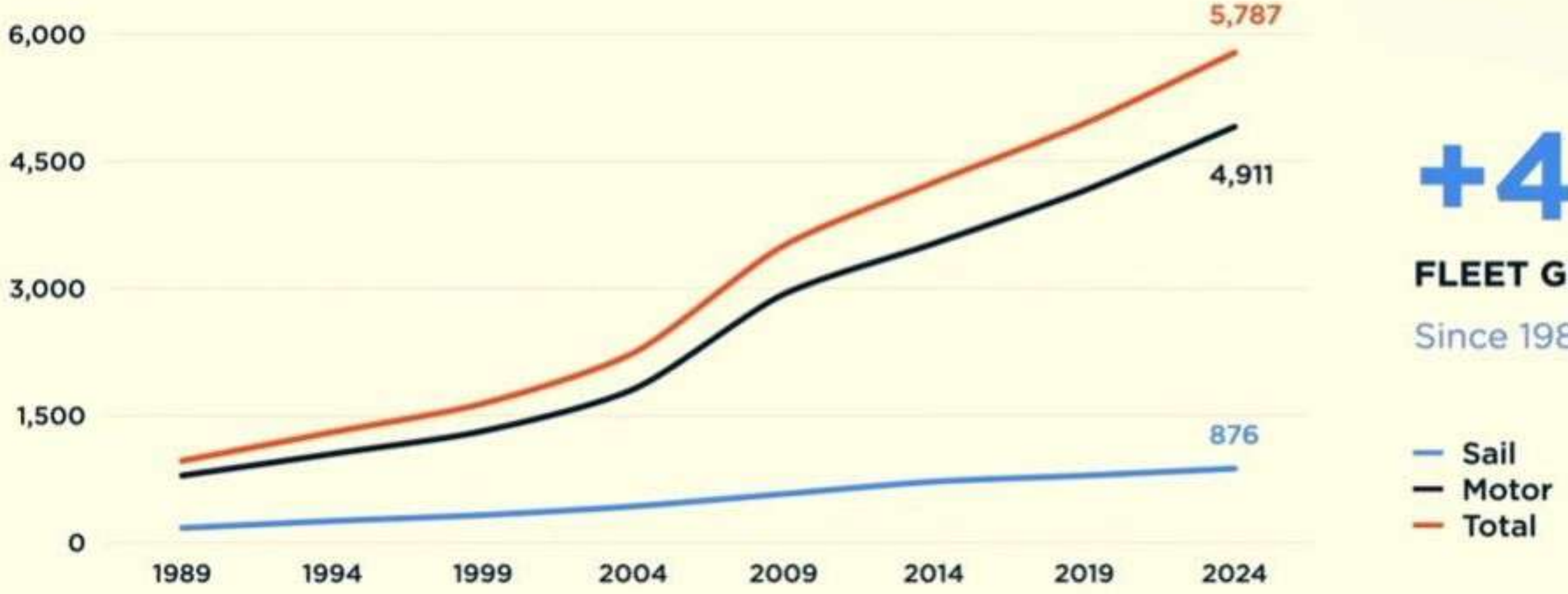
A livello di lunghezza complessiva degli ordini, il podio vede sempre l'Italia sul gradino più alto con 22.468 metri, seguita da Turchia (5.838 metri), Paesi Bassi (4.959 metri) e Regno Unito (2.419 metri).

L'Italia risulta prima anche nel ranking basato su gross tonnage con 220.068 GT, seguita dalla Germania (86.903 GT) e dai Paesi Bassi (86.376 GT).



SUPERYACHT TIMES

Fleet development 30m+



+499%

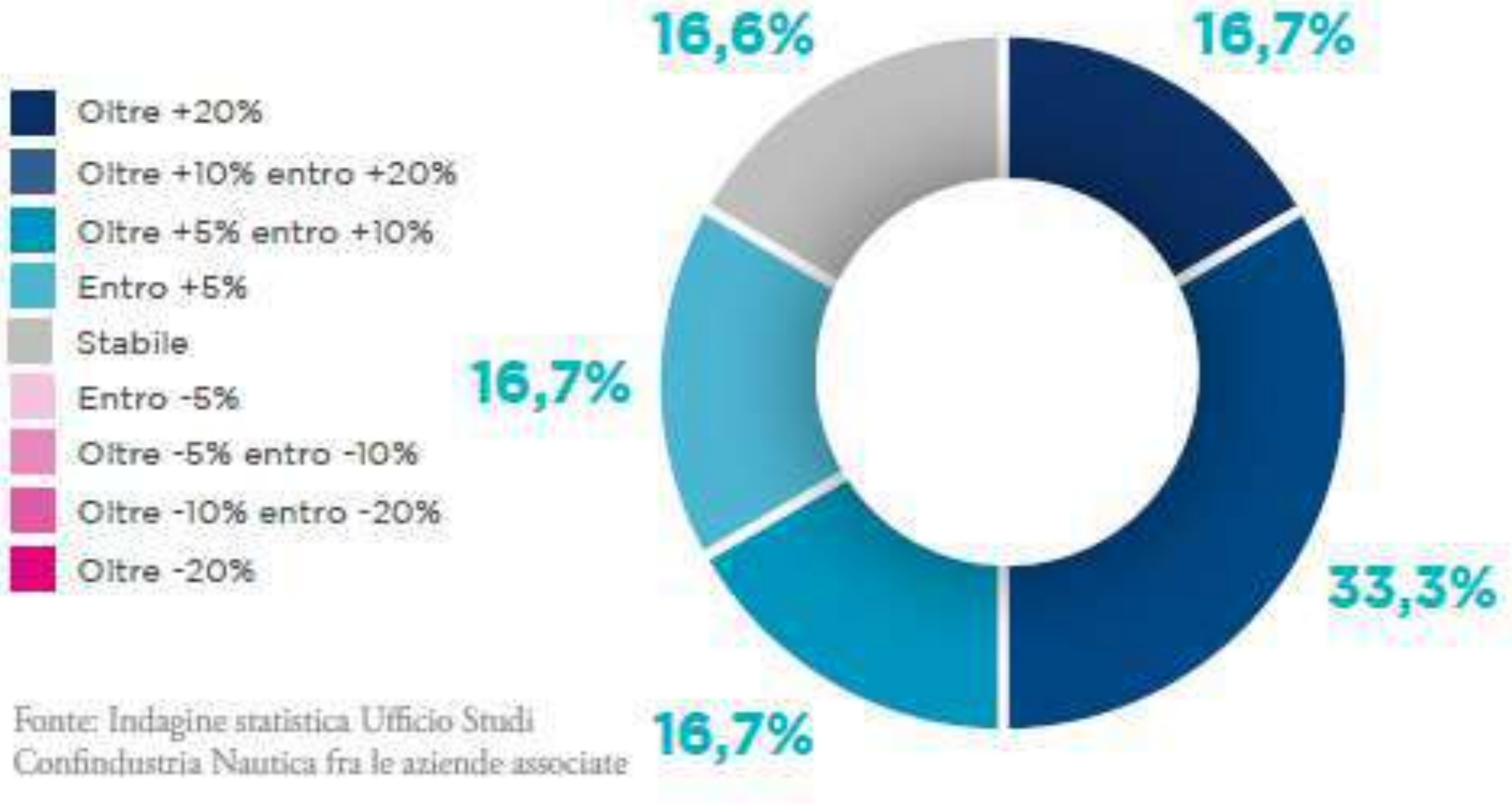
FLEET GROWTH

Since 1989

SY/T

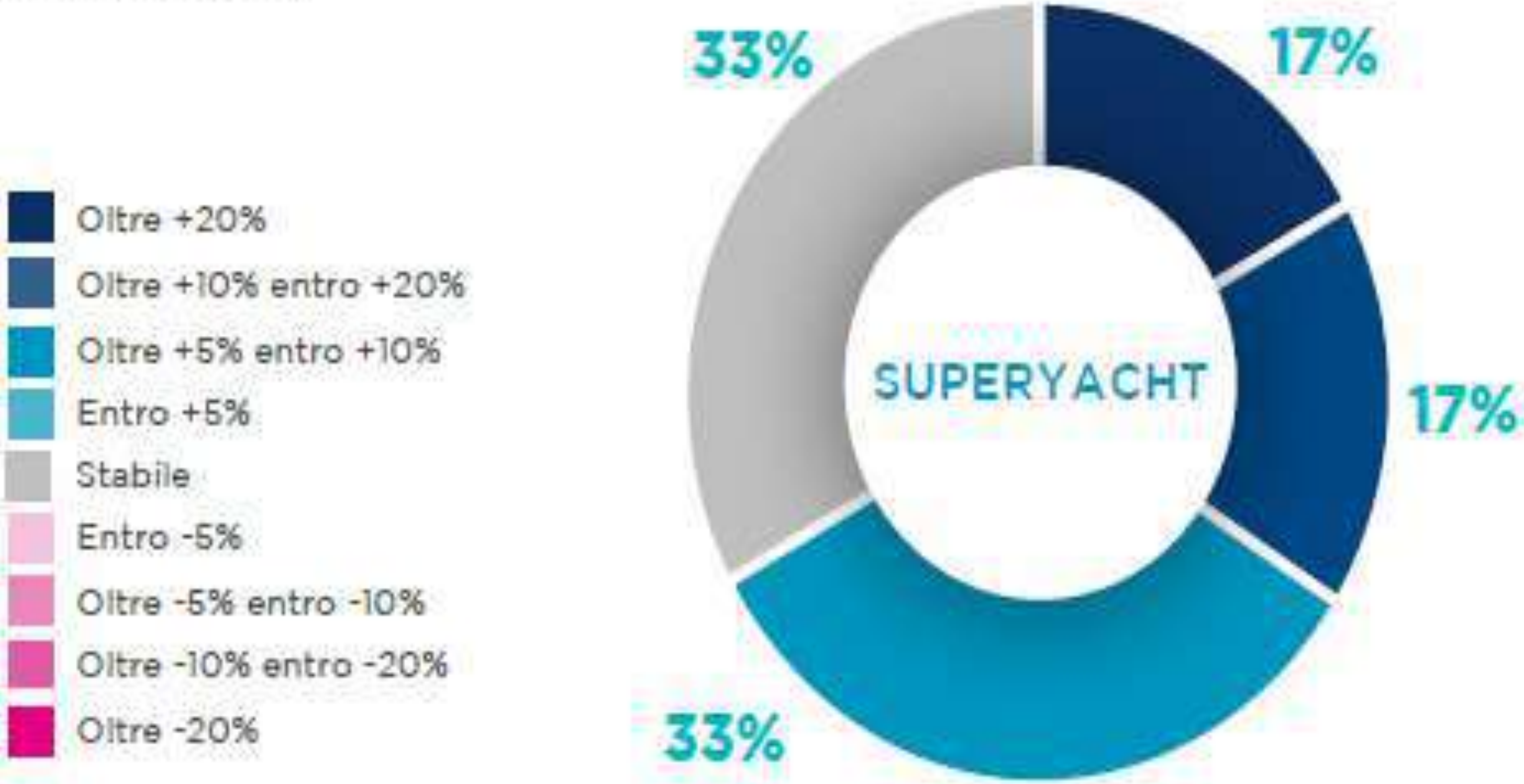
Analisi dei sentiment: 2023/2024
fatturati e ordini stabili e in crescita!

Superyacht
Aspettative di fatturato per l'anno 2024 rispetto al 2023
valori percentuali



Fonte: Indagine statistica Ufficio Studi Confindustria Nautica fra le aziende associate

Variazione del portafoglio ordini a febbraio 2024 rispetto a febbraio 2023
valori percentuali



REFIT

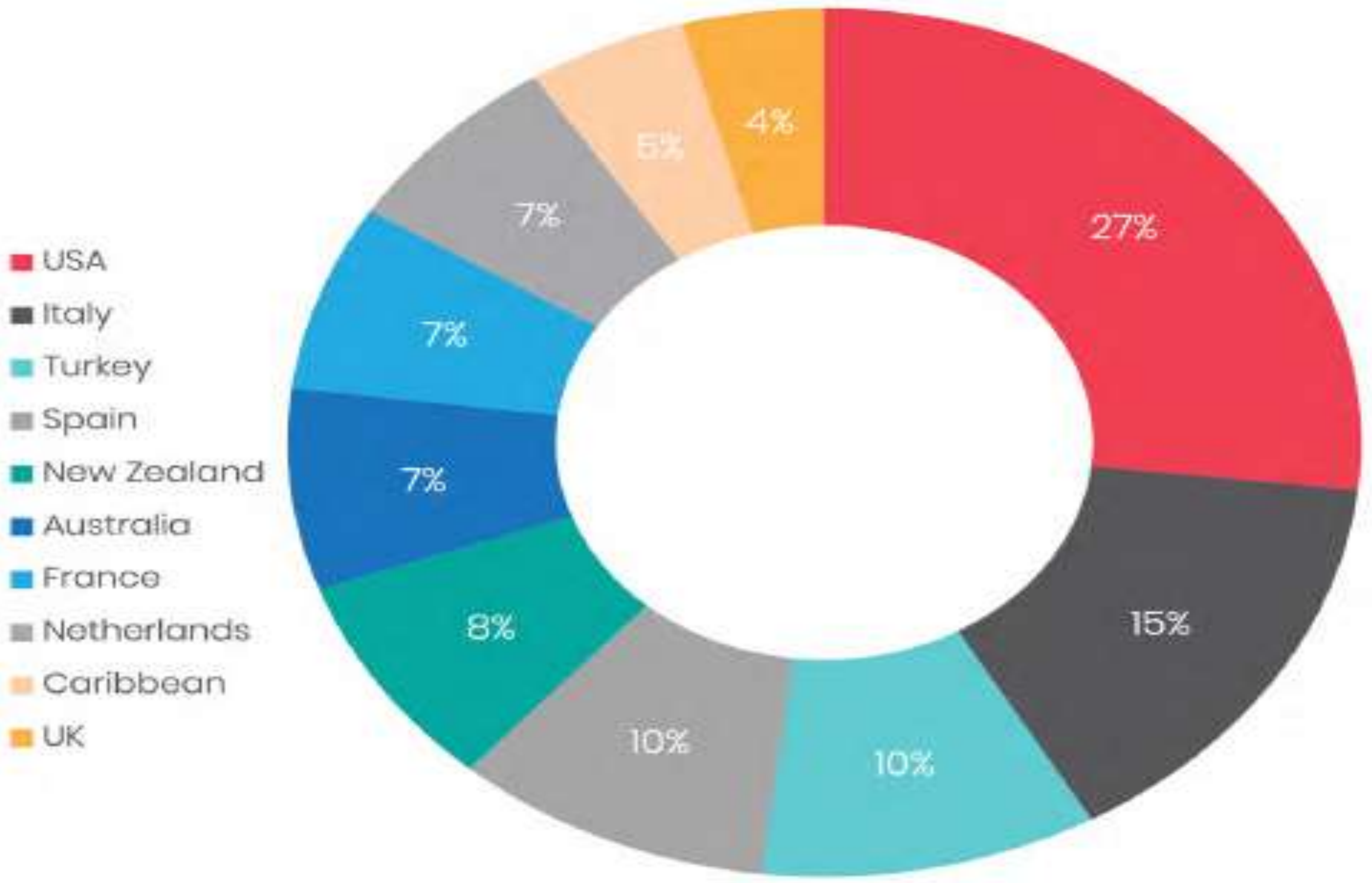
Tab. 3.6 ~~~ **Refit, riparazione e rimessaggio**
anno 2022

	Valori in €	Valori %
Produzione nazionale	420.730.000	100%
su imbarcazioni nazionali (a)	195.210.000	46%
su imbarcazioni estere (b)	225.520.000	54%
di cui su imbarcazioni UE	*106.780.000*	*47%*
di cui su imbarcazioni extra UE	*118.740.000*	*53%*
Fatturato globale	420.730.000	100%

Tab. 3.7 ~~~ **Refit, riparazione e rimessaggio, andamento 2010 - 2022**
valori in euro

Anno	Produzione nazionale su imbarcazioni italiane (a)	Produzione nazionale su imbarcazioni estere (b)	Produzione nazionale (a+b)
2010	127.090.000	45.390.000	172.480.000
2011	128.690.000	50.370.000	179.060.000
2012	112.900.000	47.660.000	160.560.000
2013	96.030.000	42.400.000	138.430.000
2014	98.050.000	43.100.000	141.150.000
2015	105.550.000	101.600.000	207.150.000
2016	107.660.000	104.650.000	212.310.000
2017	112.500.000	108.310.000	220.810.000
2018	113.310.000	130.000.000	243.310.000
2019	125.250.000	157.330.000	282.580.000
2020	126.970.000	147.380.000	274.350.000
2021	169.470.000	187.770.000	357.240.000
2022	195.210.000	225.520.000	420.730.000
Variaz. % 2022-2021	+15,19%	+20,10%	+17,77%

Top 10 countries with the largest quantity of yards offering refit

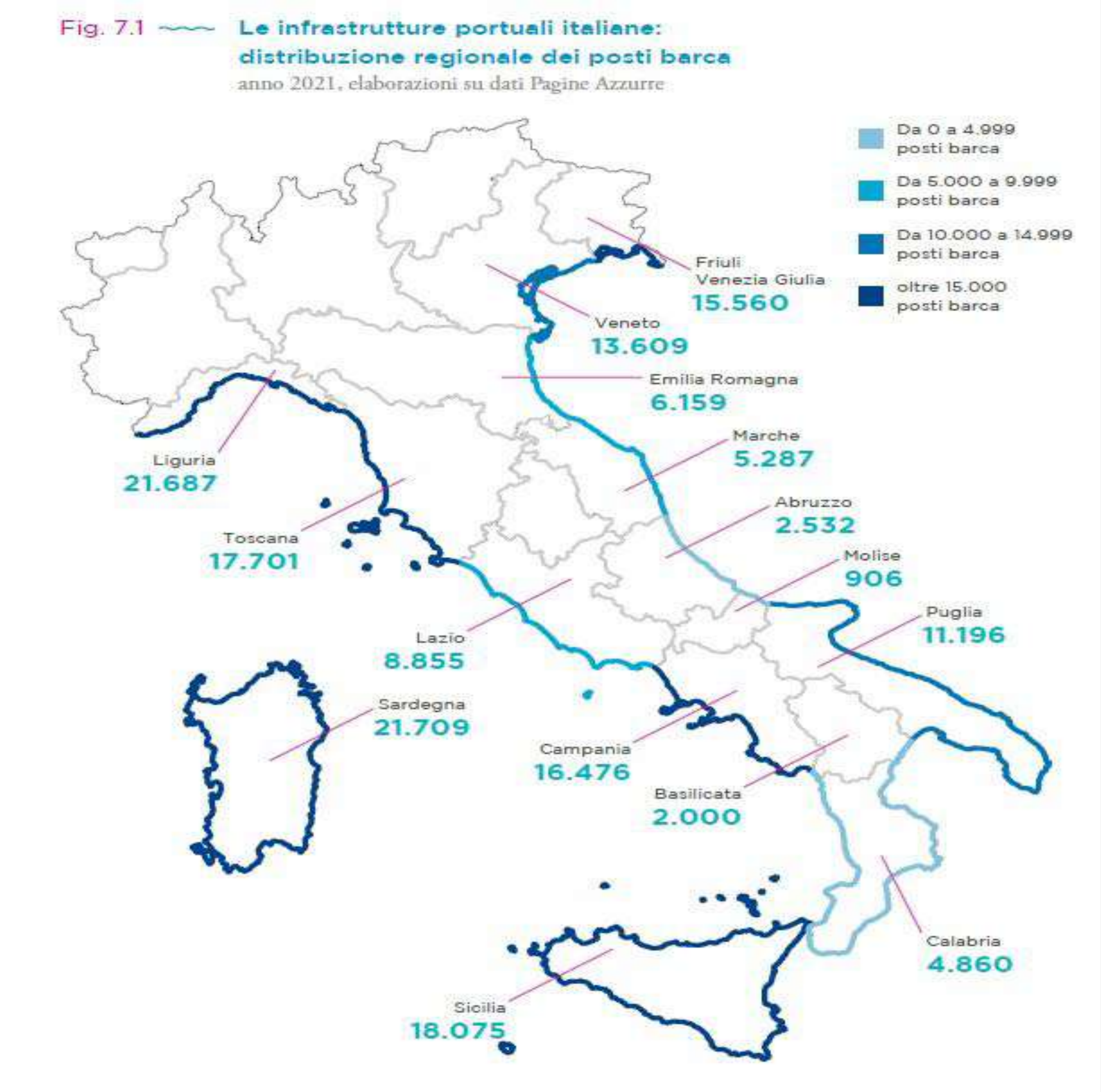


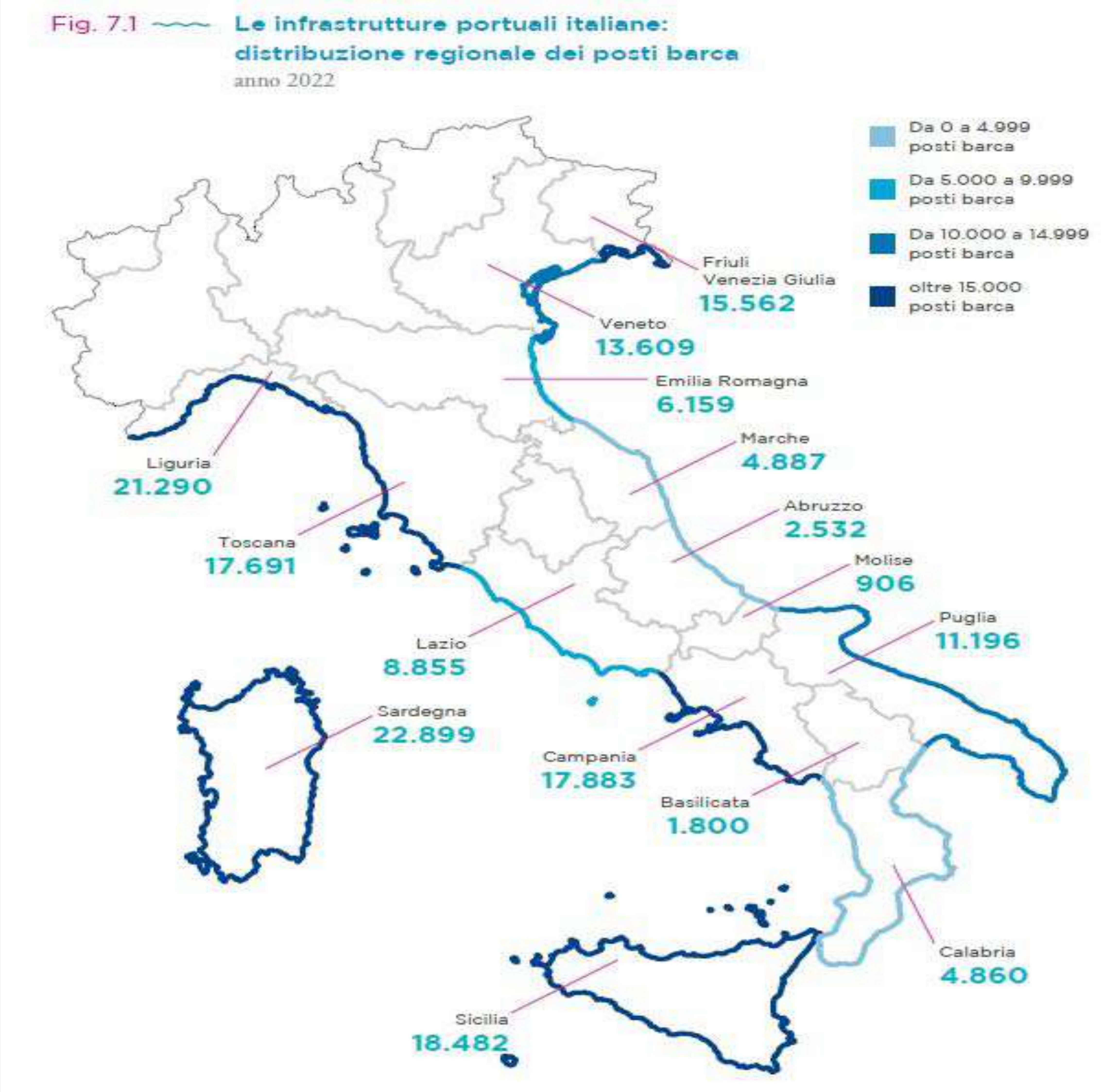
Estimated Refit Projections

	2022	2025
30-40m	2588	2693
40-60m	1188	1266
60-90m	283	325
90m+	78	92
Total	**4137**	**4376**

Variazioni posti barca 2021 vs 2022

Interessante notare lo sviluppo verificatosi nelle regioni Sardegna (+1190 posti barca) e Campania (+1490 posti barca)!





NAVIGO

La più estesa rete di aziende di nautica della Toscana
ed una delle principali d’Europa.

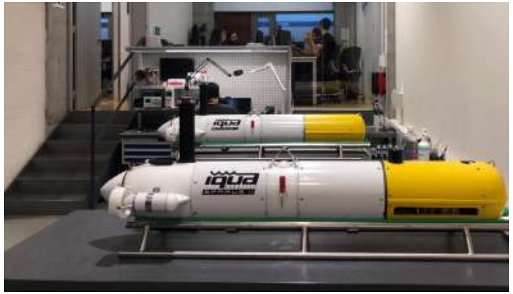
EMRA '24 - Arenzano, Italy
May 27-29, 2024

Research and Innovation needs

IQUA robotics

Innovative technologies

for **exploring**, **mapping** and **inspecting** the underwater environment

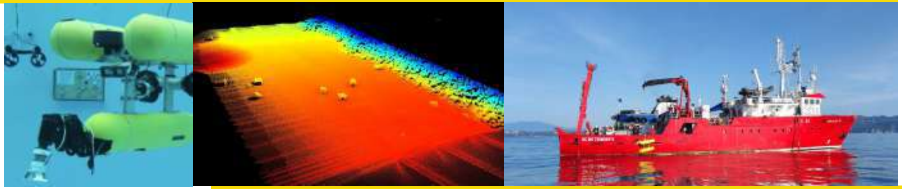


Spin off from the: Universitat de Girona

IQUA robotics

Main sectors of interest regarding robotics research

Research



Commercial

Security

Short term needs

Classic mapping with intelligent behaviours

Image courtesy of:

GEOMAR

Mid term needs

New uses of “classic” technologies for new emerging markets

Long term needs

Permanent deployment & Autonomous Intervention

Proposed cooperation mechanisms

Short term

In-house innovation
Research contracts

Mid term

In-house innovation
Innovation project proposals (TRL5-7)

Long term

R&D project proposals (TRL3-5)

What about cooperation with other research institutions?

Robotics research institutions (mother institution UdG)

Scientific research institutions

Other disciplines research institutions

Clients	Project partners	Facility suppliers	Technology suppliers

EMRA '24 - Arenzano, Italy
May 27-29, 2024

Thanks! See you at the coffee break! :)

MONUSEN
– MONtenegrin center for Underwater SEnsor Networks –

MONtenegrin center for Underwater SEnsor Networks (MONUSEN)

Prof. Igor Radusinovic

Funded by the European Union
ETFUCG
FER
Faculty of Electrical Engineering and Computing
INM
Newcastle University

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101060395.

MONUSEN

~ MONtenegrin center for Underwater SEnsor Networks ~

Project overview

Title: MONtenegrin center for Underwater SEnsor Networks (**MONUSEN**)

Call: HORIZON-WIDERA-2021-ACCESS-02-01, The Twinning Western Balkans

Budget: 1.443.196€

EU contribution: 1.131.346€

Start: 01.06.2022.

Duration: 36 months

Coordinator: Faculty of Electrical Engineering, University of Montenegro (UoM)

Partners: Consiglio Nazionale Delle Ricerche – CNR-INM (IT)

Faculty of engineering and computing, University of Zagreb (CRO)

Newcastle University (UK) – Associated partner

Specific Project Objectives

I. To increase the scientific excellence and innovation capacity of UoM within **three strategic research domains** related to underwater sensor networks (USNs)**:**
   I. Communication protocols and security
   II. USN data processing
   III. Mobile USNs

II. To create a framework for **sustainable collaboration between UoM and the leading partners** through **joint research actions**;

III. To significantly increase UoM **scientific involvement, innovation potential, and broad visibility**.

IV. To strengthen the **research management capacities** of UoM.

Know-how exchange

The overall approach towards reaching excellence in the above-define SRDs at UoM is based on the following measures for research know-how exchange:

- **Staff exchanges** - UoM research staff visiting partner institutions.
- **Expert visits** from the leading partner institutions to UoM - transfer of the highest quality theoretical knowledge in the USN field;
- **Trainings** - work with USN equipment; hands-on experience and practical knowledge transfer.

Funded by the European Union

Know-how exchange



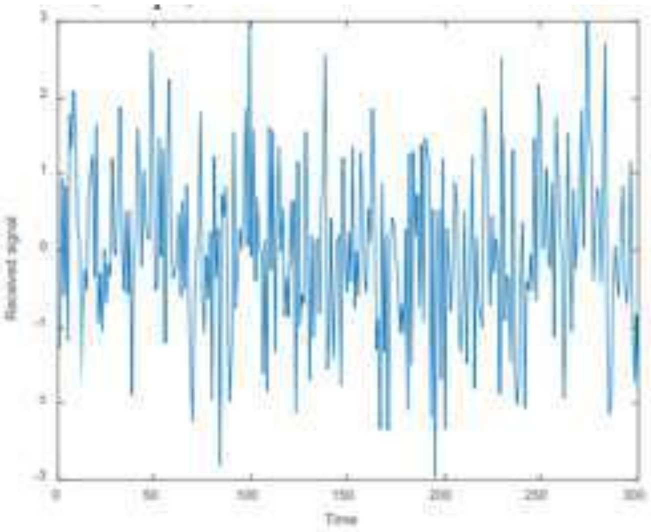



Funded by the European Union

Joint research actions

Chaos-based acoustic signal modulation techniques

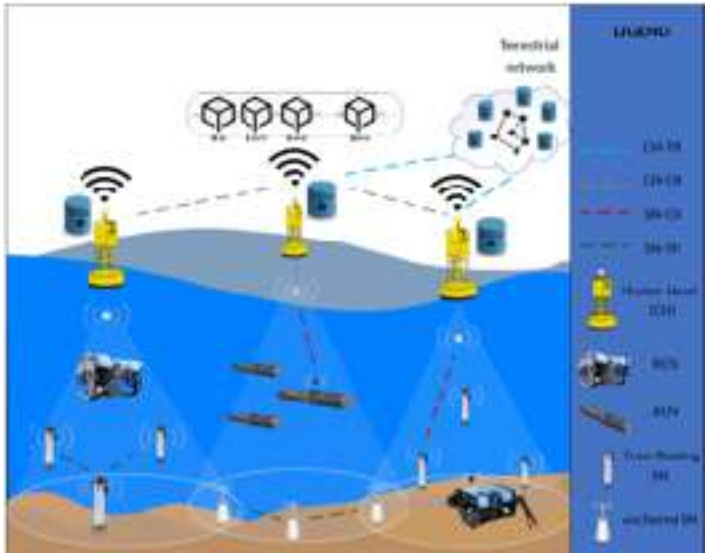
- UoM and UNEW researchers designed waveform patterns based on chaotic signals, which not only **tolerates low signal-to-noise ratio and severe multipath but also improves communication security**.
- The proposed waveforms exhibit a **noise-like spectrum**, making them less detectable for eavesdroppers.
- They are also **less disruptive to marine life** than more deterministic signals.
- **Successful field trials** were conducted **in the North Sea**, reinforcing the system's viability for operational use.



1. https://zenodo.org/records/10850770
2. https://zenodo.org/records/10215214
3. https://zenodo.org/records/7747509

Funded by the European Union

Joint research actions



Security in underwater sensor networks

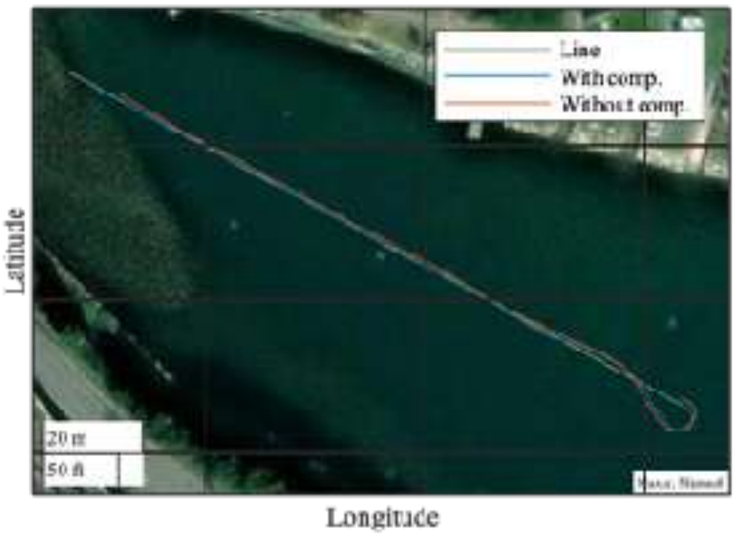
- Focused on providing efficient means of **authentication and key-exchange** in clustered UASNs with mobile sensor nodes.
- In this scenario, the need for **lightweight and fast authentication** is particularly pronounced because nodes frequently switch between surface gateways due to mobility.
- In the proposed network architecture surface gateways form a **blockchain network** to maintain network information and provide distributed certificate authority services for sensor nodes.
- The implementation of a blockchain network **eliminates the need for reauthentication in case of cross-cluster mobility**. It also provides protection against replay attacks.
- Sea trials conducted in Kumbor, Montenegro, during BTS 2023.

1. S. Tomović, B. Krivokapić, D. Nadj, I. Radusinović: "BEKMP: A Blockchain-Enabled Key Management Protocol for Underwater Acoustic Sensor Networks" has been accepted for publication in IEEE *Access*
2. https://zenodo.org/records/7747513

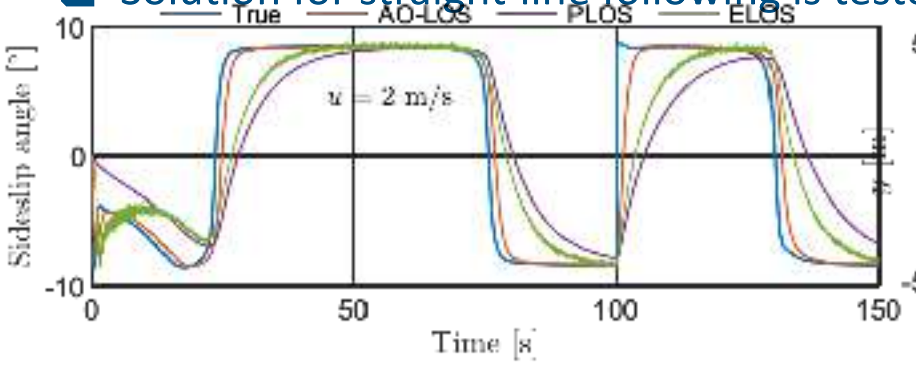
Joint research actions

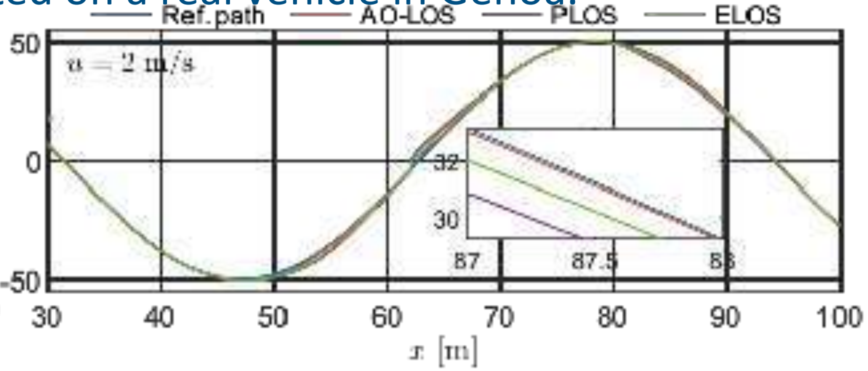
Path following of single USV

- Adaptive observer-based Line-of-Sight (LOS) guidance laws for straight-line and curved path following of underactuated USVs with sideslip compensation have been proposed.
- The sideslip angle is treated as an unknown system state and is estimated along with the path following errors using an adaptive Kalman-like observer.
- **Features:** stronger stability properties, faster convergence and smaller path following errors compared to the existing methods.
- Solution for straight-line following is tested on a real vehicle in Genoa.



https://zenodo.org/records/11124790





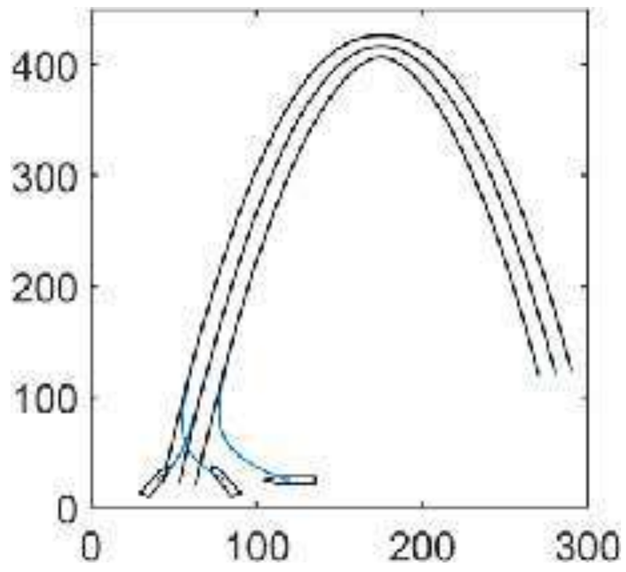
1) https://zenodo.org/records/7747458
2) https://zenodo.org/records/10850785
3) https://zenodo.org/records/10850577

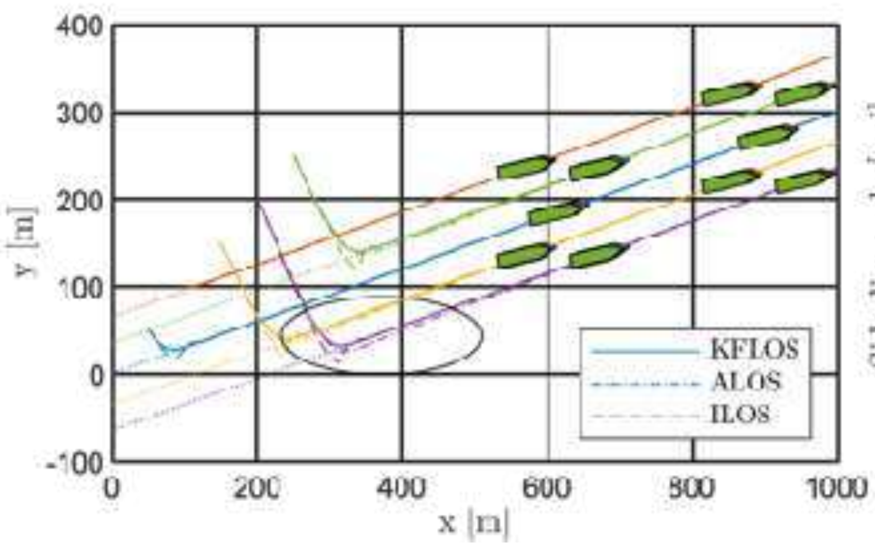
Funded by the European Union

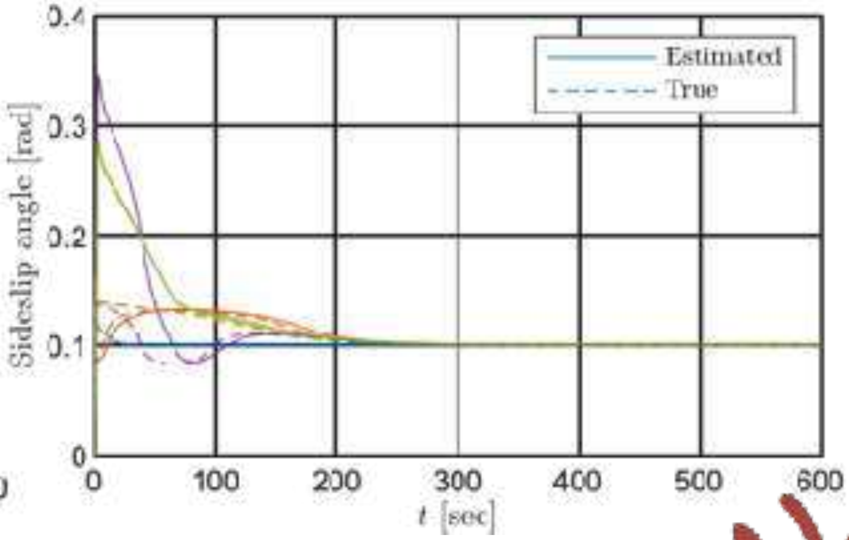
Cooperative path following of multiple USVs

- The control objective is to force a group of USVs to follow a set of parameterized paths while maintaining the desired formation pattern.
- The cooperative guidance law for straight-line formation path-following in presence of ocean currents is proposed.
- The references paths are synchronized using the distributed observer, while the observer-based LOS guidance laws and nonlinear velocity laws are proposed to minimize the cross-track errors and compensate for the sideslip.
- Preliminary results for curved path following are also obtained.

Joint research actions







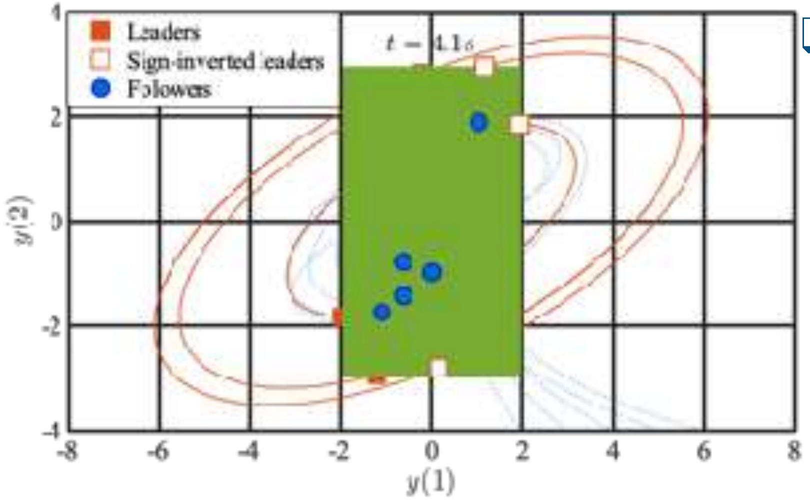
https://zenodo.org/records/10850793

Funded by the European Union

Joint research actions

Cooperative control of unmanned vehicles

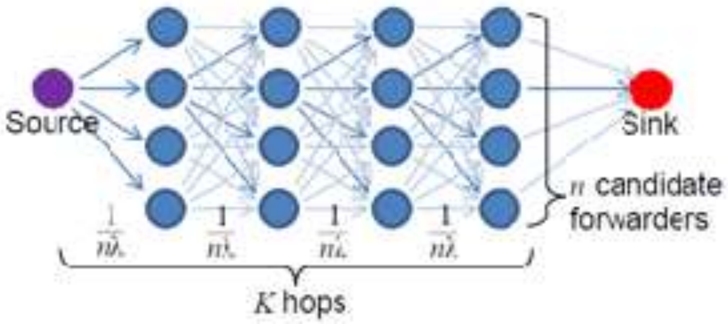
- Several **distributed control protocols** have been devised to address **various cooperative control problems** in USNs consisting of AUVs and/or unmanned USVs organized in a **leader-follower** manner.
- For instance, **bipartite output containment control is addressed,** where the main task of the leader vehicles is to **detect hazardous areas** and generate the proper trajectories to **steer away the followers to a safe region**.
- The proposed protocol ensures that the **outputs of the follower vehicles converge to the convex hull generated by the leader vehicles' trajectories and their symmetric counterparts**.
- The unique feature of the proposed protocol is that controllers embedded in the **followers do not share internal information**.



1) https://zenodo.org/records/8226549
2) https://zenodo.org/records/11264739

Funded by the European Union

Joint research actions



Communication protocols for event-driven UASNs

Objective: provide a solution to the joint control problem of how to optimally set the system parameters of the sleep-wake scheduling protocol and the anycast packet-forwarding protocol to **maximize the network lifetime**, subject to a **constraint on the expected end to end packet-delivery delay**.

- Focus on **asynchronous sleep-wake scheduling** protocols - the sleep-wake schedule at each node is independent of that of other nodes.
  - **Advantages:** A synchronization procedure or a secondary low-power receiver is not required.
  - **Challenges:** Nodes lack awareness of each other's schedules, causing potential delays as nodes wait for their next-hop neighbors to wake up before transmission.
- NMV3 acoustic modem simulator developed by the Newcastle University team to facilitate network protocol verification – allows integration of hardware nodes within the simulation environment.
- The developed solutions will undergo verification through sea trials to ensure real-world applicability and effectiveness.

1. https://zenodo.org/records/10850812
2. https://zenodo.org/records/10850803
3. https://zenodo.org/records/10215194

Funded by the European Union

Broad Networking Events

- MONUSEN project places a significant emphasis on strengthening links with industry and USN end-users.
- **EMRA (EU-funded marine robotics and applications) workshop** will be organized each year by one of the project leading partners and serve as a meeting place for researchers, marine research stakeholders, and industry.
  - EMRA 2022 was co-organized from 15 to 16 June 2022 in Southampton, UK.
    - 26 speakers from ongoing FP7/Horizon Europe projects, industry, marine robotics end-users, and stakeholders.
    - 150 participants from six countries and diverse sectors, such as marine robotics, oceanography, offshore renewables, oil and gas, satellite communication, and the blue economy
  - EMRA 2023 was co-organized from 20 to 21 June 2023 at Šibenik, Croatia.
    - 16 EU project presentations,
    - 5 company presentations
    - 2 round tables with policy makers
    - 100 participants.
  - EMRA 2024 has been co-organized from 28 to 29 May 2024 in Arenzano, Italy.
    - 5 companies and 1 public administration
    - 23 project presentations
    - roundtable regarding the EC Research and Innovation funding instruments.

Broad Networking Events

Three summer schools have been organized during the project's lifespan:

- 25/09 – 02/10/2022, Biograd, Croatia
- 24/09 – 01/10/2023, Kumbor, Montenegro
- 02/06 -08/06/2024, Kotor, Montenegro

MONUSEN

~ MONtenegrin center for
Underwater SEnsor Networks ~

Thank you!
Questions?

www.monusen.ucg.ac.me

CROATIA-CYPRUS EXCELLENCE HUB

on Eco-Innovative Technologies for Healthy and Productive Seas

Funded by the European Union under grant agreement No. 101087162.

SeaTecHub

CROATIA-CYPRUS EXCELLENCE HUB ON ECO-INNOVATIVE TECHNOLOGIES FOR HEALTHY AND PRODUCTIVE SEAS

Consortium

Total project cost: € 4,999,580.00

Total project funding: € 4,999,580.00

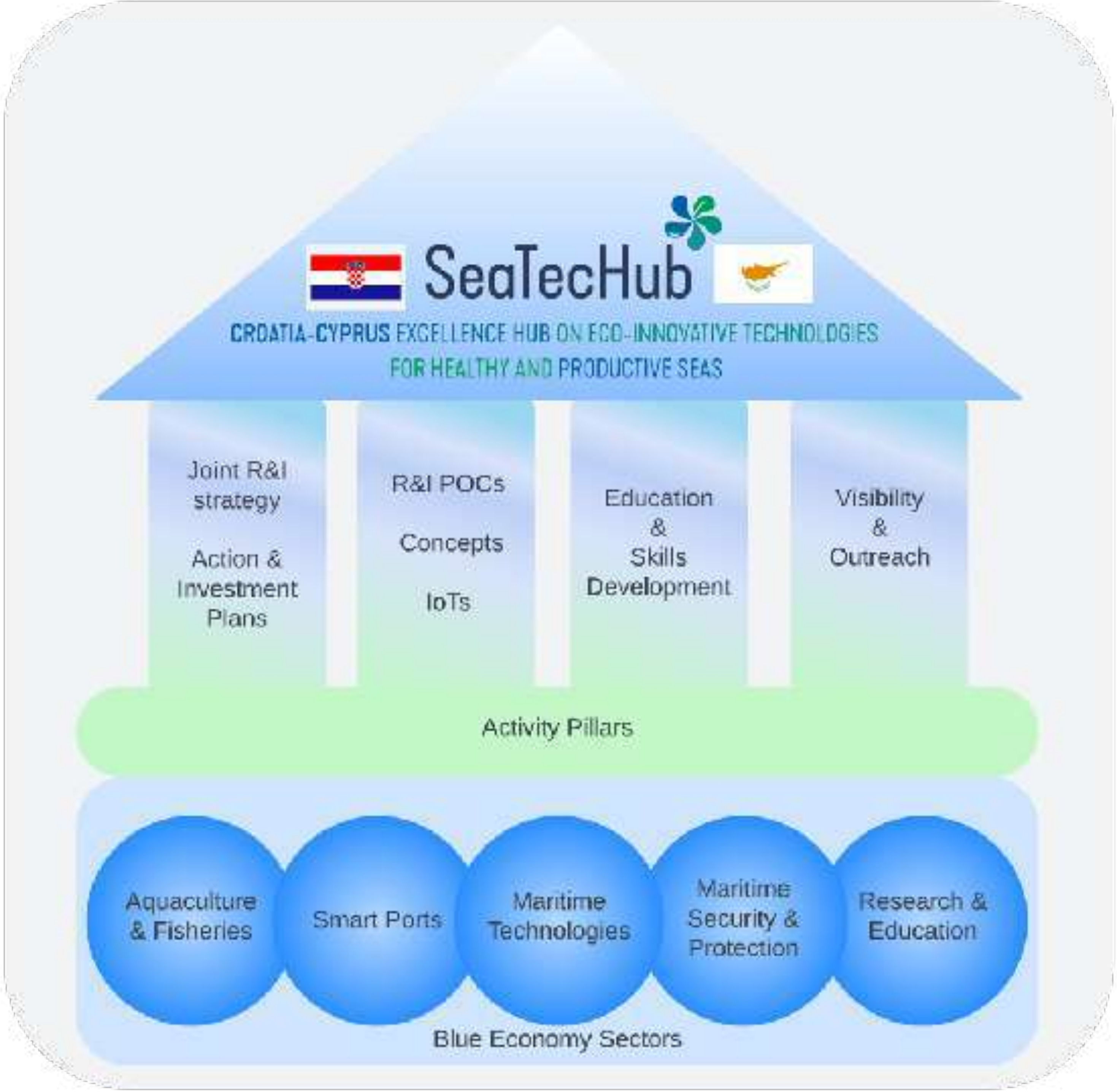
Duration: 01/06/2023 – 31/05/2027

Project Coordinator: Dr Ioannis Kyriakides

Funded by the European Union

Funded by the European Union under grant agreement No. 101087162.

Horizon Europe Excellence Hubs


SeaTechHub
CROATIA-CYPRUS EXCELLENCE HUB ON ECO-INNOVATIVE TECHNOLOGIES
FOR HEALTHY AND PRODUCTIVE SEAS
Joint R&I strategy
Action & Investment Plans
R&I POCs
Concepts
IoTs
Education & Skills Development
Visibility & Outreach
Activity Pillars
Aquaculture & Fisheries
Smart Ports
Maritime Technologies
Maritime Security & Protection
Research & Education
Blue Economy Sectors

Overview

- Strengthen the research and innovation ecosystems of Croatia and Cyprus
- Cross-border, inter-sectorial collaboration
- Common Strategy
- Common Action and Investment Plans
- Co-developing value-adding chains
- Joint research and innovation work
- Mutual learning and skill development
- Knowledge transfer and stronger links between quadruple helix stakeholders
- Citizen engagement
- Staff exchanges, conferences, workshops, innovation training sessions

Objectives

1. Facilitate long-term cross-border and inter-sectoral collaboration to advance eco-innovative technologies for healthy and productive seas within Croatian and Cypriot innovation ecosystems.

✓ Develop a Joint R&I Strategy:

- Align with the Green Deal and Digital transition objectives.
- Align with regional and national smart specialization strategies.

✓ Create Action and Investment Plans:

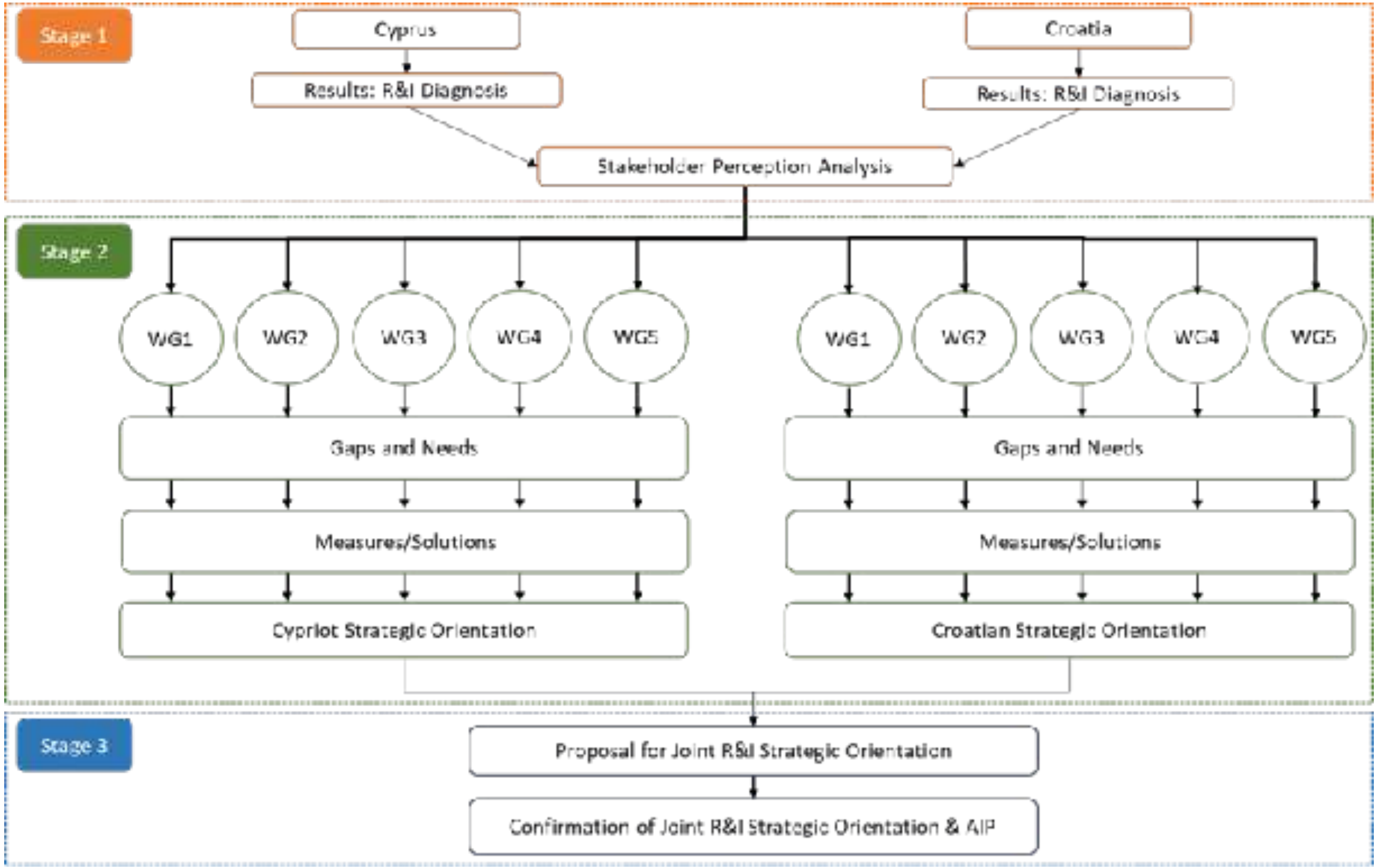
- Develop plans for implementing the strategy.
- Ensure plans extend beyond the project's duration.
- Leverage national, regional, and European funds.
- Attract private (venture) capital for funding.

Digital Blockchain-Based Platform

✓ SeaTecHub :

- Design and establish the SeaTecHub platform.
- Utilize emerging digital technologies for effective strategy delivery.
- Facilitate collaboration and innovation in the maritime sector.

Strategy Development Process



Joint AIP methodology process

Diagnosis - Assess needs and gaps in five sectors across both countries, enriched by stakeholder input.

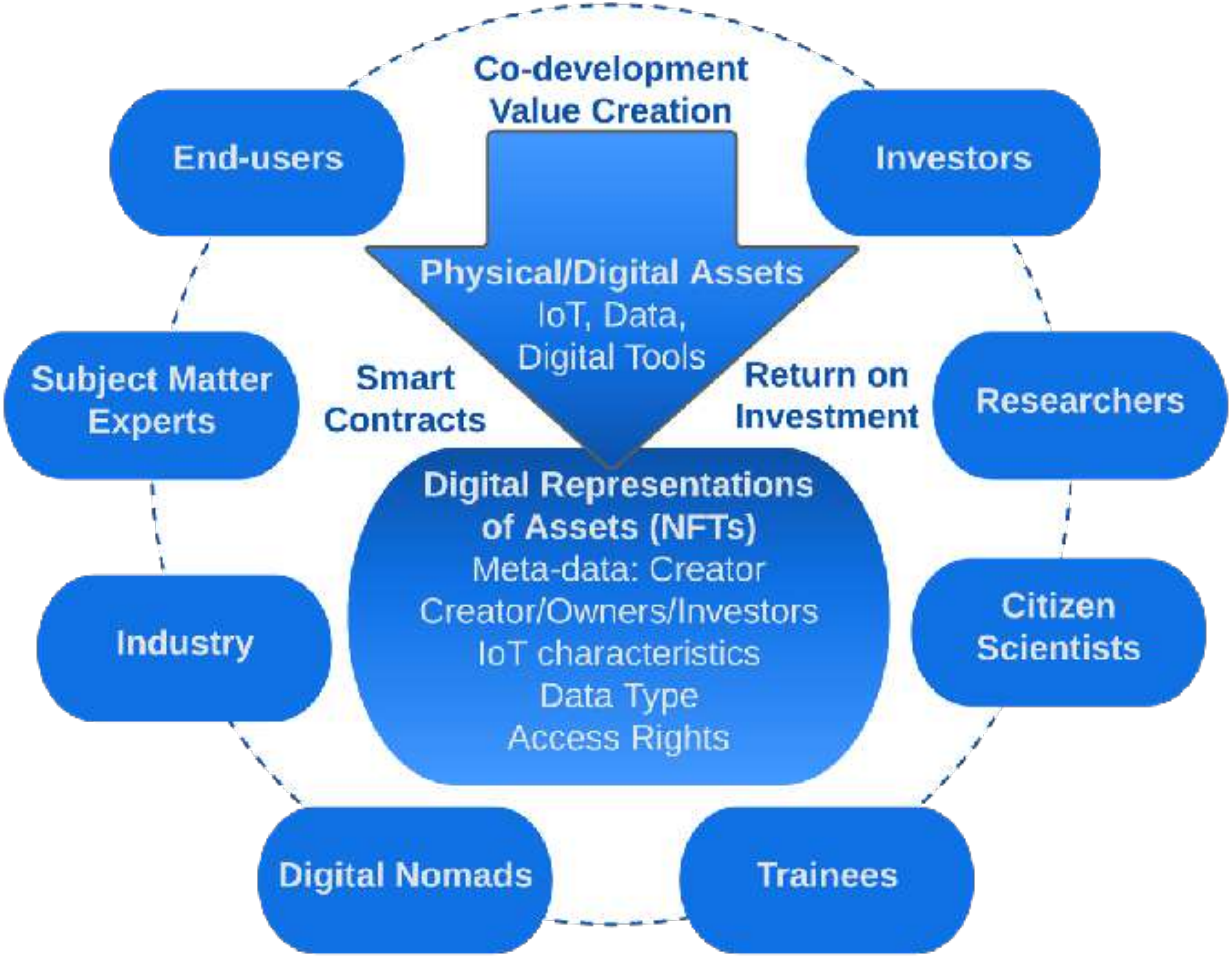
Questionnaire - Deepen insights into sector-specific needs and gaps.

Focus groups – Validate, supplement, and prioritize the needs and gaps.

Joint action and investment plan draft – Formulate a draft based on priority needs for both countries.

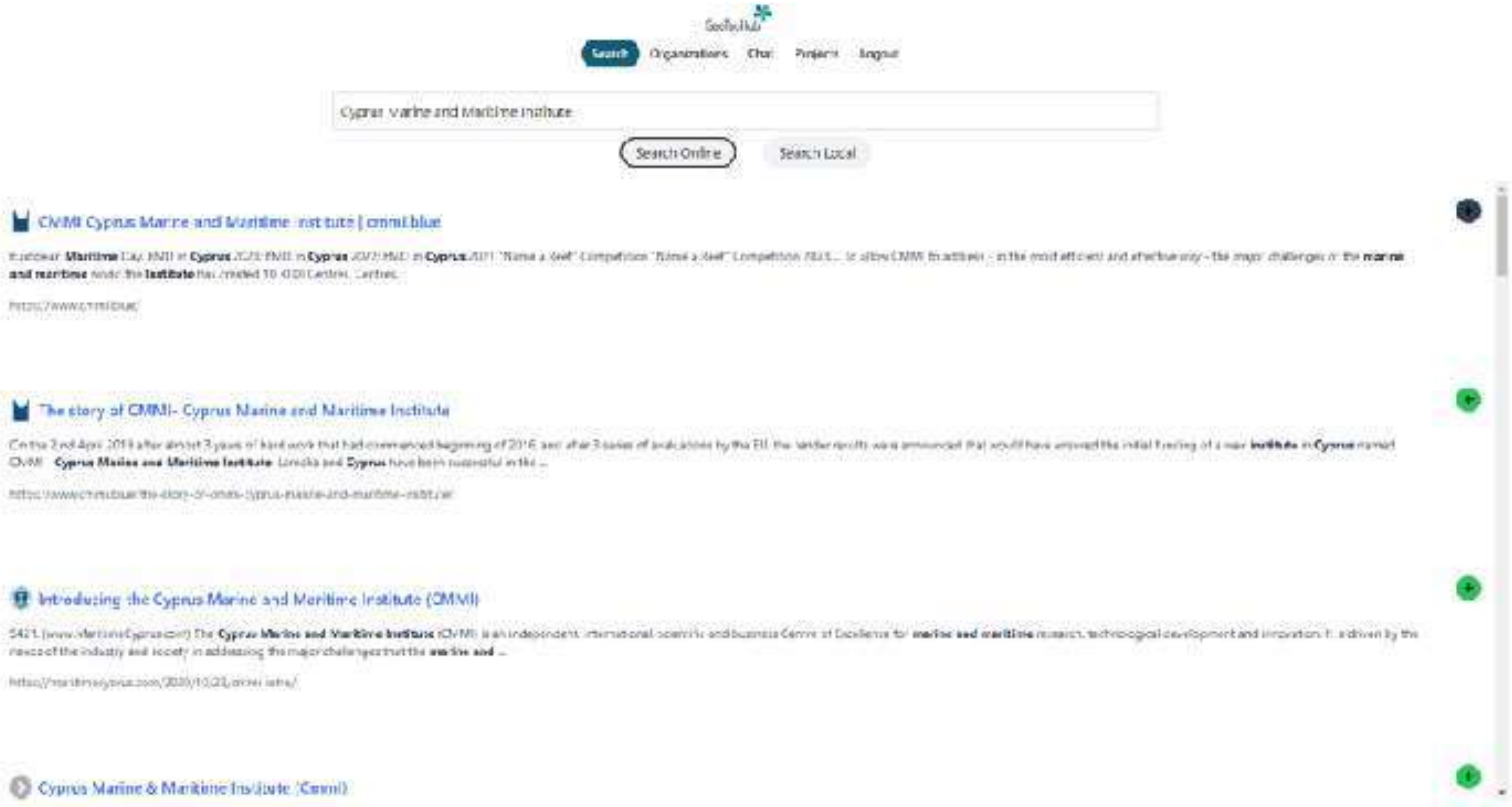
Ex post evaluation - Have the Evaluation Committee review the draft Joint Action and Investment Plan.

Joint action and investment plan – Develop and periodically update the first version of the plan.

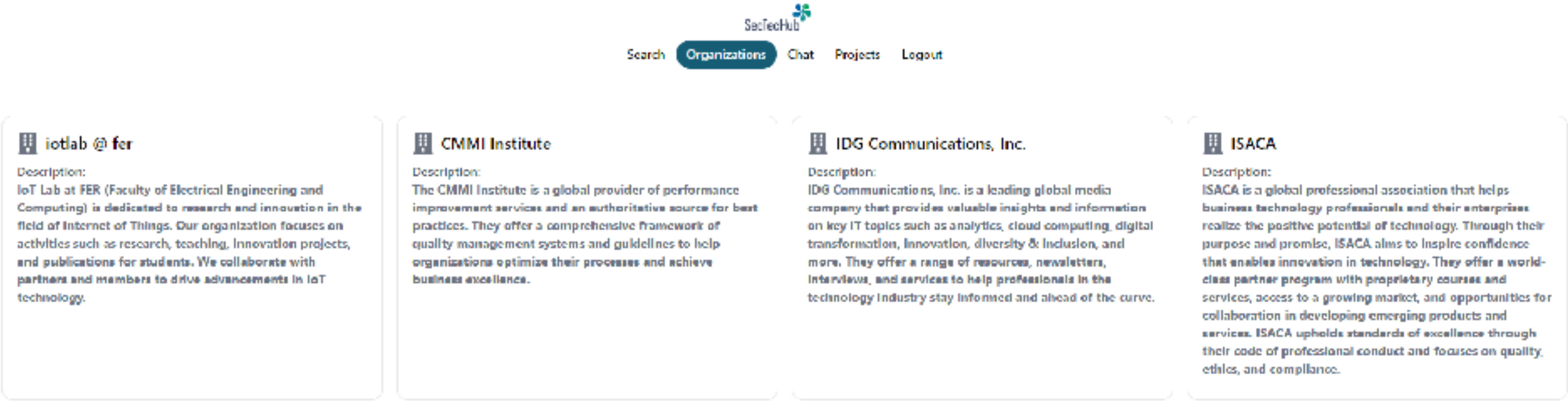

Co-development
Value Creation
End-users
Investors
Physical/Digital Assets
IoT, Data,
Digital Tools
Subject Matter
Experts
Smart
Contracts
Return on
Investment
Researchers
Digital Representations
of Assets (NFTs)
Meta-data: Creator
Creator/Owners/Investors
IoT characteristics
Data Type
Access Rights
Industry
Citizen
Scientists
Digital Nomads
Trainees

Digital Blockchain-Based Platform

Digital Blockchain-Based Platform

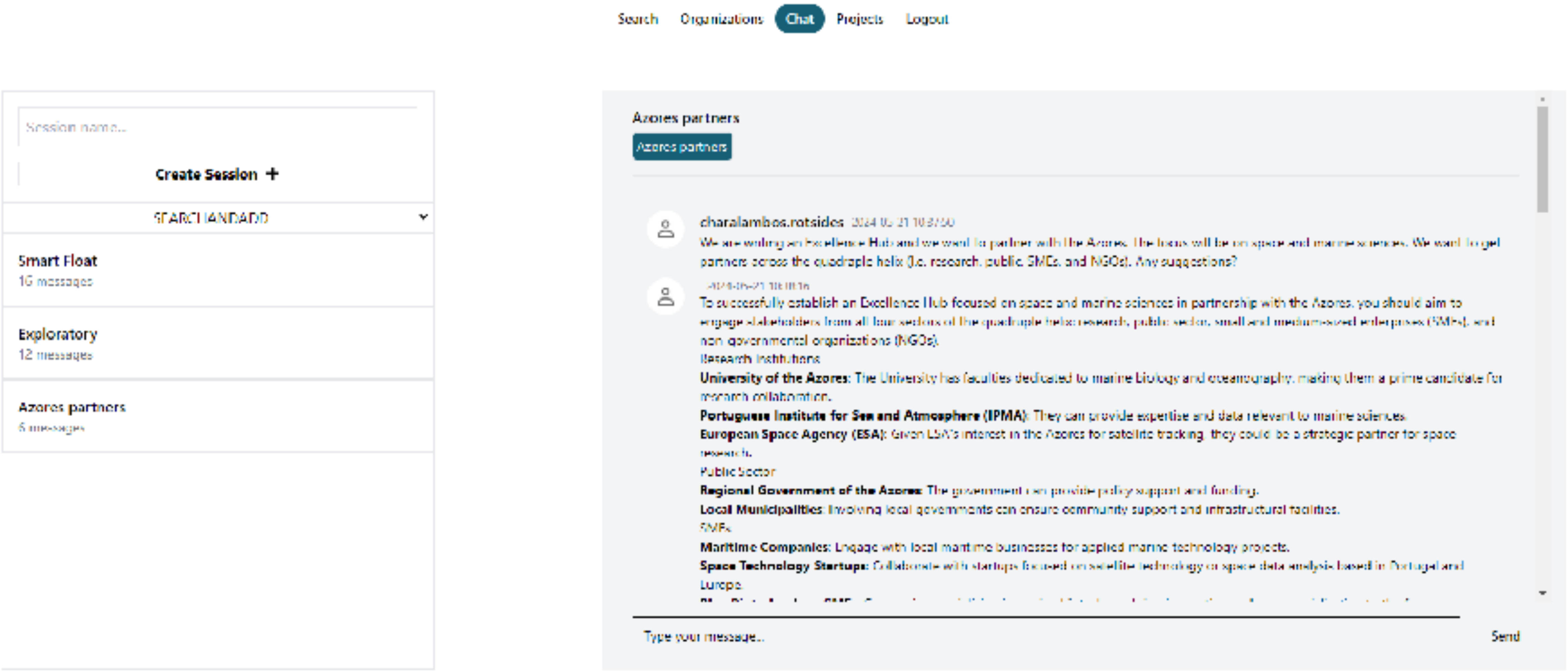


Digital Blockchain-Based Platform

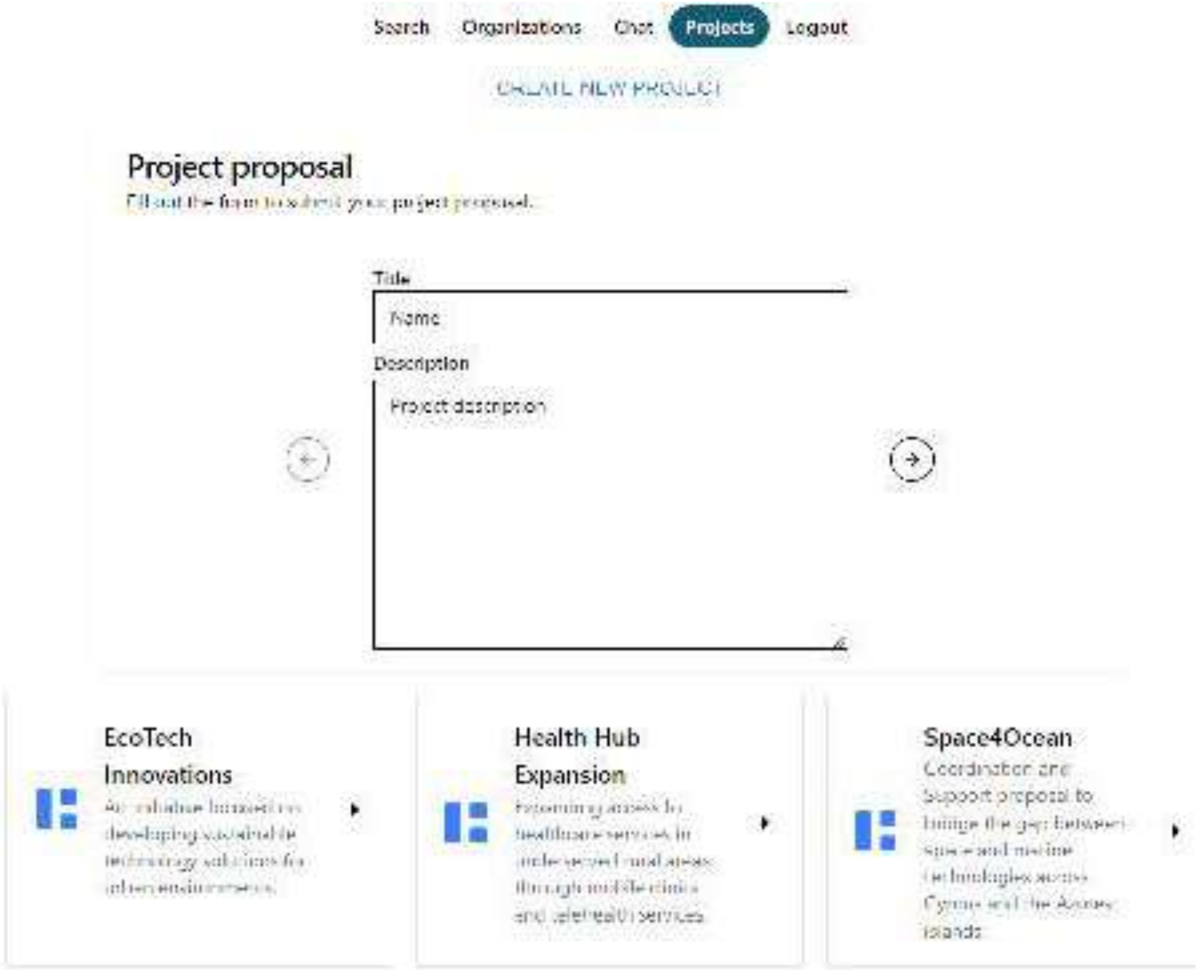


Digital Blockchain-Based Platform

SeaTecHub
CROATIA-CYPRUS EXCELLENCE HUB ON ECO-INNOVATIVE TECHNOLOGIES FOR HEALTHY AND PRODUCTIVE SEAS



Digital Blockchain-Based Platform



Objectives

2. Perform joint research work within SeaTecHub focus sectors to bridge knowledge gaps, strengthen quadruple helix connections, and validate strategy and action and investment plans.

✓ Develop a Proof-of-Concept Marine Spatial Planning (MSP) Tool:

- Create a prototype MSP tool for improved spatial planning in the maritime sector.
- Enhance sustainable resource utilization and ecosystem preservation.

✓ Create Proof-of-Concept Maritime Internet of Things (IoTs):

- Develop IoT solutions tailored for maritime applications.
- Enable data-driven decision-making and innovation in the maritime industry.

✓ Utilize R&I Work for Pilot and Demonstrator Pre-Planning:

- Employ research and innovation findings to plan pilot projects and technology demonstrations.
- Identify technologies and practices with market potential.
- Enhance the practical implementation of eco-innovative solutions in the maritime sector.

Objectives

3. Implement mutual learning and skills development measures within Croatian and Cypriot ecosystems.

✓ Science & Technology (S&T) and Ocean Literacy Knowledge Transfer:

- Provide expert visits for theoretical knowledge sharing.
- Offer tutorials for hands-on experience.
- Enhance S&T and ocean literacy in the ecosystem.

✓ Market Positioning of Research Results:

- Enable the successful placement of research outcomes in the market.
- Provide innovation training in areas like R&I management, entrepreneurship, and technology transfer.

✓ Quadruple Helix Stakeholder Strengthening:

- Foster stronger connections within the quadruple helix framework.
- Facilitate mutual staff exchange to enhance collaboration and knowledge sharing.

✓ Citizen Engagement Activities:

- Organize activities aimed at engaging a broad audience.
- Promote public understanding and participation in marine innovation and sustainability efforts.

Objectives

4. Elevate the visibility of Croatian-Cypriot innovation ecosystems through strategic measures, including networking, knowledge sharing, and experience transfer events.

✓ Industry and Policy Outreach:

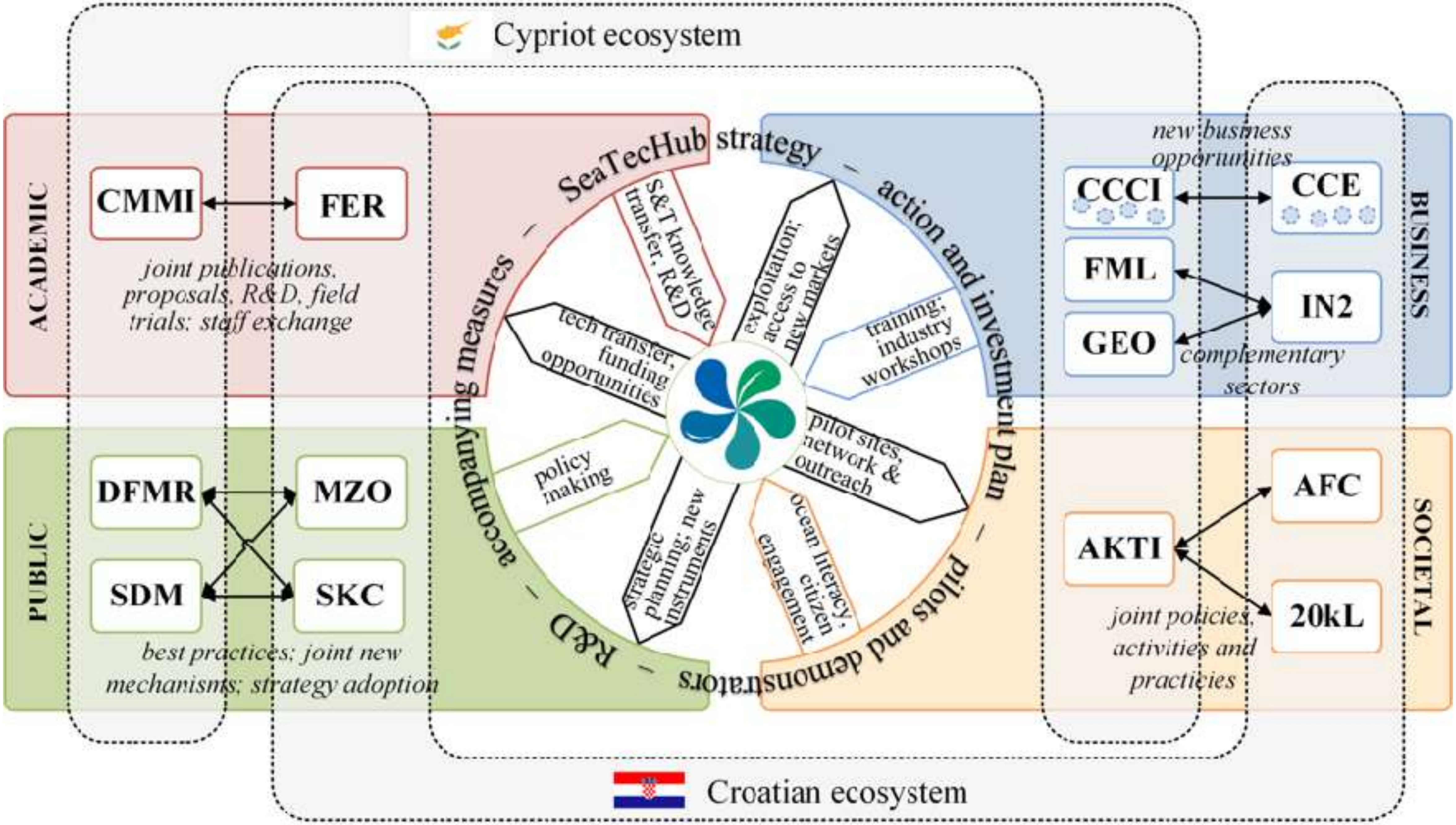
- Organize research-industry workshops, such as "EU-funded projects in marine robotics and applications workshop - EMRA."
- Host round tables and participate in industrial fairs and meetings.
- Organize a high-profile industry fair to connect with key industry players and policymakers.

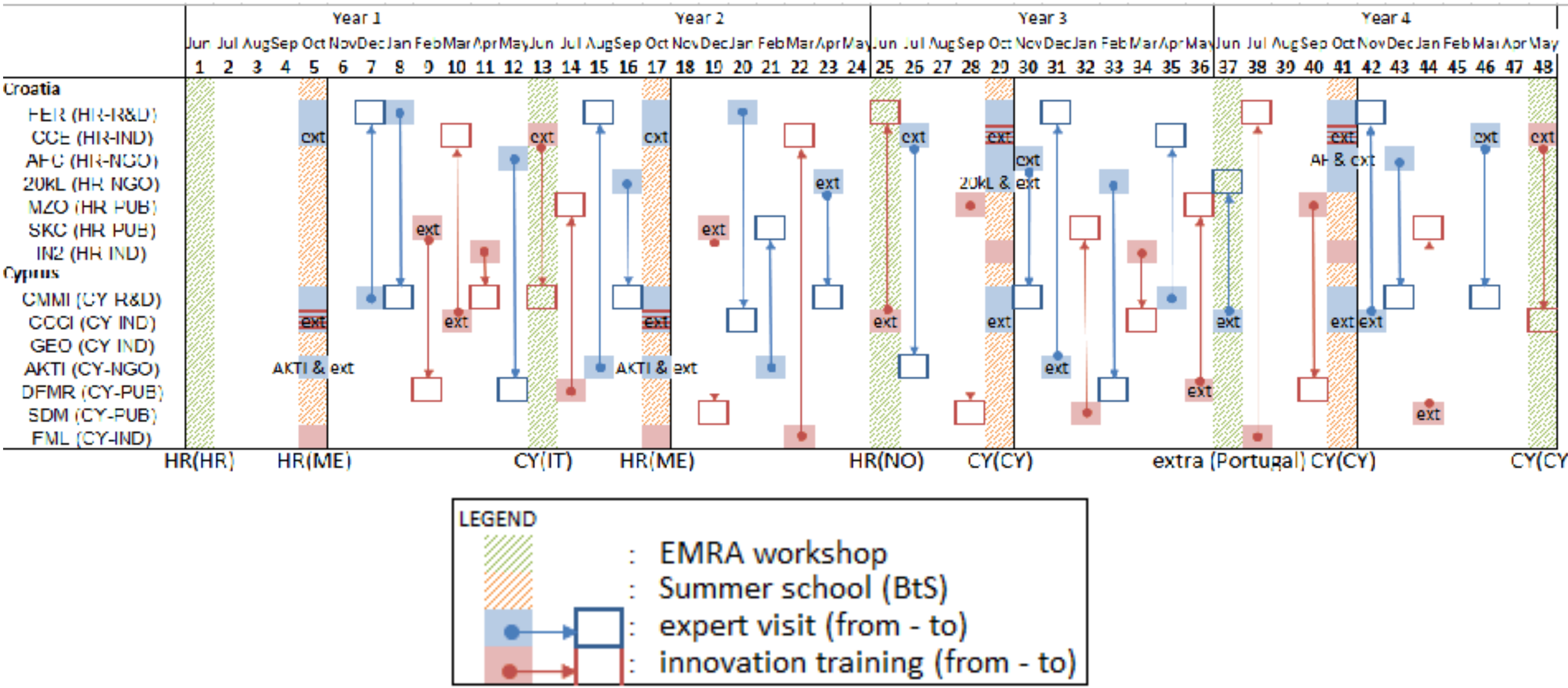
✓ End-User Engagement:

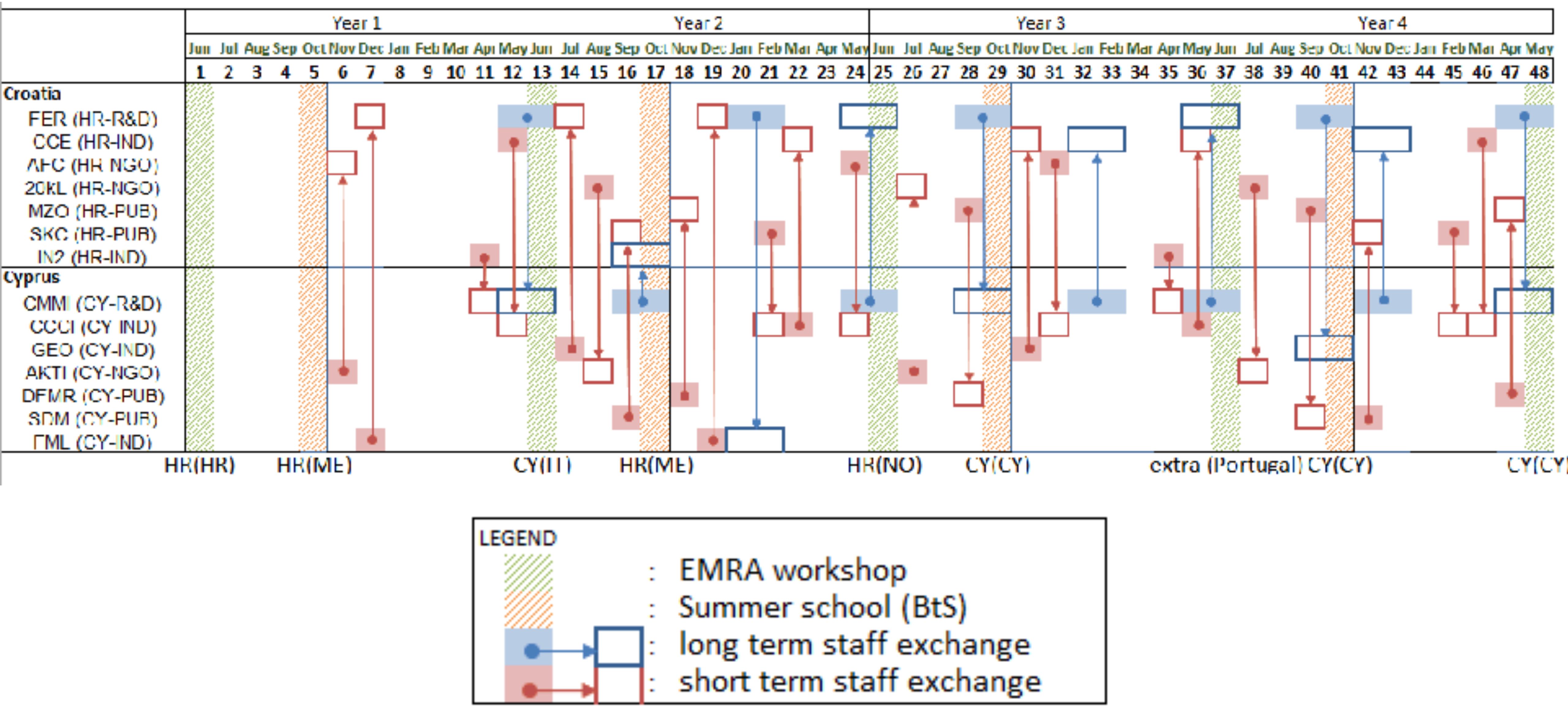
- Reach out to end-users in various fields, including marine biology, marine archaeology, oceanography, and marine security (navies, coast guards, search and rescue units).
- Collaboratively organize summer schools, exemplified by "Breaking the Surface – BtS Summer School."

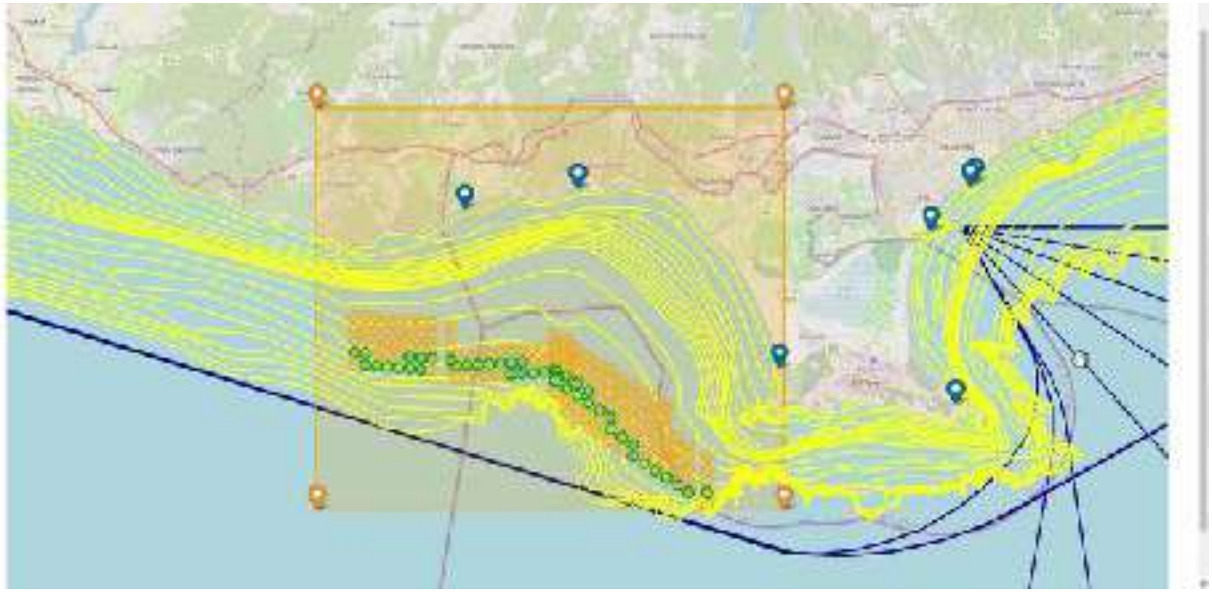
✓ Strengthen Scientific Community Links:

- Foster stronger ties with the scientific community by jointly organizing a high-profile scientific conference.
- Facilitate knowledge exchange and collaboration among researchers and academics in the maritime sector.


Cypriot ecosystem
Croatian ecosystem
ACADEMIC
CMMI
FER
joint publications, proposals, R&D, field trials; staff exchange
PUBLIC
DFMR
MZO
SDM
SKC
best practices; joint new mechanisms; strategy adoption
BUSINESS
new business opportunities
CCCI
CCE
FML
IN2
GEO
complementary sectors
SOCIETAL
AFC
AKTI
20kL
joint policies, activities and practicies
SeaTecHub strategy – action and investment plan – pilots and demonstrators – R&D – accompanying measures –
S&T knowledge transfer, R&D
exploitation; access to new markets
training; industry workshops
pilot sites, network & outreach
ocean literacy; citizen engagement
strategic planning; new instruments
policy making
tech transfer, funding opportunities


Year 1
Year 2
Year 3
Year 4
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Croatia
FER (HR-R&D)
CCE (HR-IND)
AFC (HR-NGO)
20kL (HR-NGO)
MZO (HR-PUB)
SKC (HR-PUB)
IN2 (HR-IND)
Cyprus
CMMI (CY-R&D)
CCCI (CY-IND)
GEO (CY-IND)
AKTI (CY-NGO)
DFMR (CY-PUB)
SDM (CY-PUB)
FML (CY-IND)
ext
AKTI & ext
20kL & ext
AF & ext
HR(HR)
HR(ME)
CY(IT)
HR(ME)
HR(NO)
CY(CY)
extra (Portugal)
CY(CY)
CY(CY
LEGEND
: EMRA workshop
: Summer school (BtS)
: expert visit (from - to)
: innovation training (from - to)


Year 1
Year 2
Year 3
Year 4
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
Croatia
FER (HR-R&D)
CCE (HR-IND)
AFC (HR-NGO)
20kL (HR-NGO)
MZO (HR-PUB)
SKC (HR-PUB)
IN2 (HR-IND)
Cyprus
CMMI (CY-R&D)
CCCI (CY-IND)
GEO (CY-IND)
AKTI (CY-NGO)
DFMR (CY-PUB)
SDM (CY-PUB)
EML (CY-IND)
HR(HR)
HR(ME)
CY(IT)
HR(ME)
HR(NO)
CY(CY)
extra (Portugal)
CY(CY)
CY(CY)
LEGEND
: EMRA workshop
: Summer school (BtS)
: long term staff exchange
: short term staff exchange



Raising visibility and outreach

- ✓ **Participated in the EMRA 2023 workshop on marine robotics and applications, in Croatia.**

- ✓ **Partic … the Surface … egro.**

Raising visibility and outreach

- ✓ Published press releases.

- ✓ Participated in two **clustering events:**

- For the **'OS-Aqua' project** held in Cyprus, SeaTecHub contributed insights to WG1 (Aquaculture and Fisheries) through stakeholder interactions and knowledge exchange

- For the **BCTHubs project** held through Zoom, which aims to establish hubs in Malta, Greece, and Bulgaria as well as other future participating countries to provide cutting-edge scientific and innovative solutions and products in areas of sustainable Blue Economy and Culture.

Raising visibility and outreach

✓ Participated as co-organisers at Beach and Seabed Cleaning event in Limassol, Cyprus, an initiative of the Fameline Holding Group. During the event, the CMMI's ROV technology was used for the seabed cleaning.

Raising visibility and outreach

- ✓ Organized a pivotal event in Cyprus to inform, engage, and explore opportunities within the SeaTecHub project, with dignitaries and stakeholders among Cyprus.

- ✓ Organized the first “Kids Think Blue” event within the framework of the SeaTecHub project. This groundbreaking initiative is aimed at fostering awareness about the marine environment and ocean literacy among children and youth.

Hosted by the **AKTI Project and Research Centre**, the event was a collaborative effort that included, among other organisations and associations, the **Cyprus Marine and Maritime Institute (CMMI).**

Raising visibility and outreach

✓ Organized the first “Blue Café”, in Zadar. The target audience was a group of university students. Thematology: Exploring the sea - who, how and WHY.

✓ More “Blue Cafes” and “Kids Think Blue” activities are planned already.

✓ 20kL & SeaTecHub as co-organizers of EMSEA conference for the 11th European Marine Science Educators Association Conference in Zadar - the week before BTS

SeaTecHub

CROATIA-CYPRUS EXCELLENCE HUB ON ECO-INNOVATIVE TECHNOLOGIES FOR HEALTHY AND PRODUCTIVE SEAS

https://www.seatechub.eu/

info@cmmi.blue

Ioannis Kyriakides (PC)
ioannis.kyriakides@cmmi.blue

Funded by the European Union

Funded by the European Union under the Horizon Europe Program, Grant No: 101087162

SeaTecHub

CROATIA-CYPRUS EXCELLENCE HUB ON ECO-INNOVATIVE TECHNOLOGIES FOR HEALTHY AND PRODUCTIVE SEAS

THANK YOU

DIH Innovamare

EMRA, 28.5.2024.

Interreg Co-funded by the European Union

Italy – Croatia

DIH InnovaMare

Cross-border digital innovation Hub for innovative marine technology

Digital Innovation Hub (DIH) InnovaMare

- project financed by the Interreg Italy - Croatia 2021-2027 cross-border cooperation program
- aimed at **expanding the cross-border innovation ecosystem** (the DIH) established as part of the InnovaMare strategic project
- Duration: from February 2024 to June 2026 (**30 months**)
- Budget: **1.602.726,40 €**

Partners:

- Croatian Chamber of Economy (CCE) (Croatia) – Lead partner;
- Apulia Regional Agency for Technology and Innovation (ARTI) – Italy
- University of Zadar (UNIZD) – Croatia
- Wireless and More SRL (W&M) – Italy
- Ruđer Bošković Institute (RBI) – Croatia
- National Research Council of Italy (CNR) – Italy
- Šibenik Knin County (SKC) – Croatia
- Regional Union of the Chambers of Commerce of Veneto Region

Associated Partners:

- University of Padua (Italy)
- HAMAG-BICRO – Croatian Agency for Small Business, Innovation and Investment (Croatia)
- Port System Authority of the Northern Adriatic Sea – Ports of Venice and Chioggia (Italy)
- Veneto Innovazione SpA (Italy)

Interreg Co-funded by the European Union

Italy – Croatia

DIH InnovaMare

The general objective

- become a **leader at a cross-border and community level** in strengthening research capabilities
- **promoting technology transfer** for the development of innovative **marine technologies**, which will enable digital and green **transformation for a sustainable blue economy in the Adriatic Sea**

Specific objectives

- **Strengthening innovation capabilities** and promoting technology transfer processes in marine technologies in the blue economy sectors;
- **Developing a pilot program** for the cross-border mobility of researchers to strengthen collaboration among quadruple helix actors in marine technologies and the blue economy at a cross-border level;
- **Implementing joint pilot actions** and developing new marine technologies for the needs of emerging markets, such as monitoring and preventing marine pollution as a basis for a sustainable blue economy;
- Developing **new innovative solutions** to respond to the challenges of the blue economy.

Main activities

- Development **of innovation capabilities** for the implementation of marine technologies, through the creation of specific educational modules;
  - **mapping and sharing of examples of good cooperation** practices between the private and scientific sectors in the field of research applied to the marine technologies market;
  - organization of **focus groups aimed at enhancing collaboration** between technology companies and blue economy sectors and promoting green and digital transformation;
- **Strengthening collaboration between the private and scientific sectors** and the innovative network for the development of new marine technologies for a sustainable blue economy, thanks to:
  - the mapping of **young researchers** at a cross-border level, who will receive specific training modules;
  - organization of **study visits** to universities and public research institutes;
  - participation in **science fairs**.

Interreg Co-funded by the European Union

Italy – Croatia

DIH InnovaMare

Main activities

- **Implementation of three pilot actions** in the field of underwater archaeology, underwater wireless networks and biodiversity monitoring;
- **Co-creation of new concepts of innovative solutions, projects**, new opportunities and funding schemes through open calls, idea competitions and co-creation workshops.

Interreg
Co-funded by the European Union
Italy – Croatia
DIH InnovaMare

Croatian Chamber of Economy (CCE) (Croatia) – Lead partner

Rooseveltov trg 2, 10000 Zagreb, Croatia

Mateo Ivanac
mivanac@hgk.hr

AMIS

Advanced coastal risk Monitoring systems and dIgital twinS for coastal safety and resilience

Systèmes evoluès de surveillance et jumeaux numeriques pour la sécurité et la résilience côtier

Sistemi Avanzati di Monitoraggio e gemelli dIgitali per la Sicurezza e resilienza della costa

Roberta Ferretti (CNR-INM)

Regione Toscana

CULLETTIVITÀ DI CORSICA
COLLECTIVITÉ DE CORSE

REGIONE LIGURIA

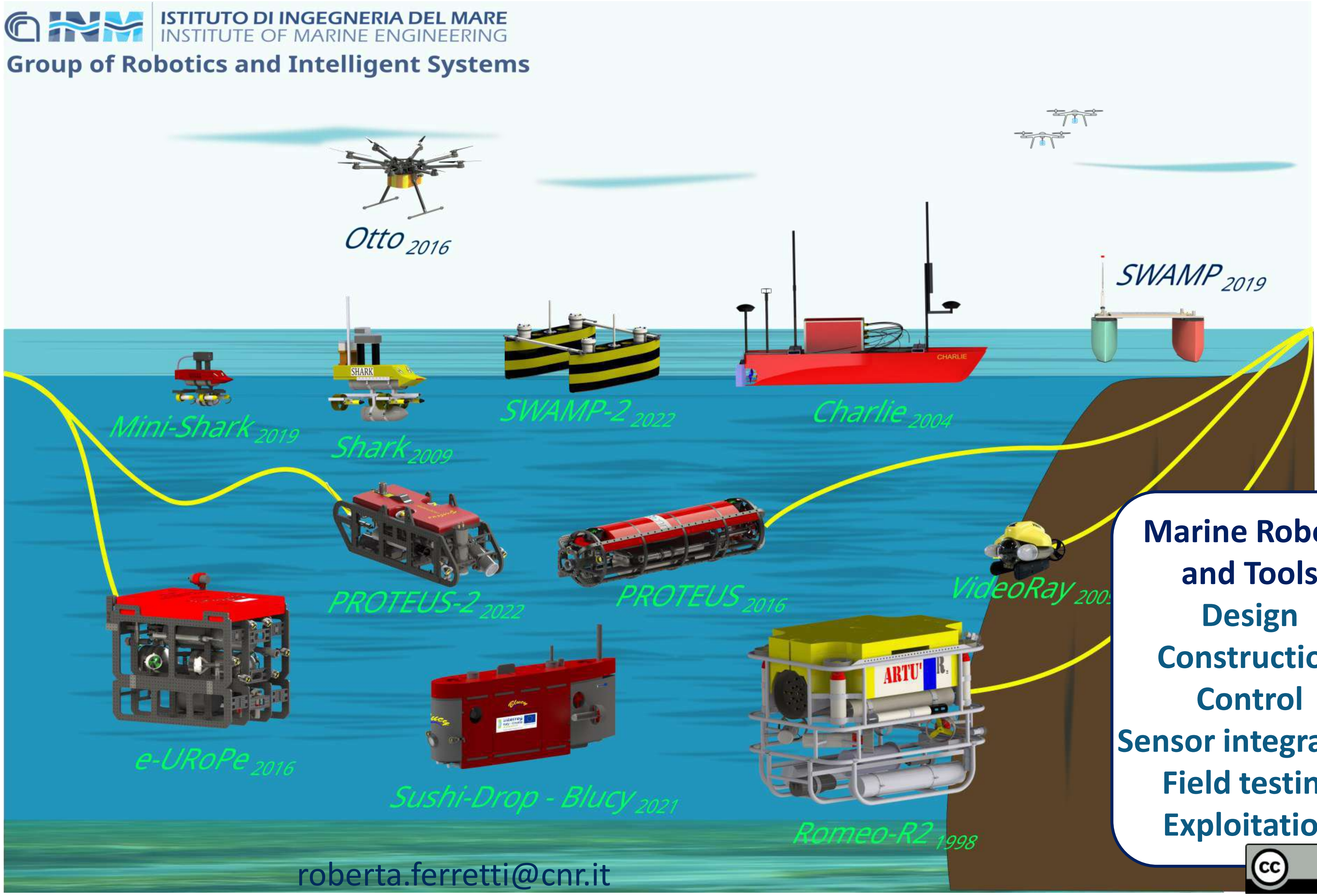
RÉGION SUD PROVENCE ALPES CÔTE D'AZUR

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

Marine robotics @ CNR-INM Genoa: the fleet

INstitute of Marine engineering – National Research Council

Roma (Headquarter)
Roma – ARTOV
Genoa
Palermo



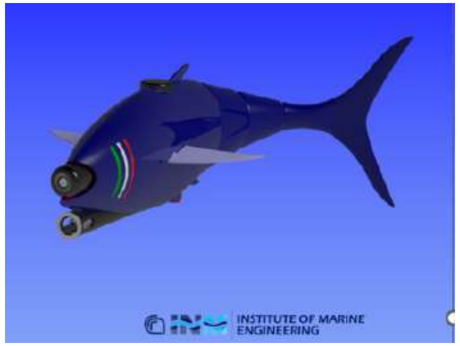
Marine Robots and Tools
Design
Construction
Control
Sensor integration
Field testing
Exploitation

roberta.ferretti@cnr.it

Marine robotics @ CNR-INM Genoa: state of the art

AI: Machine learning and learning by imitation

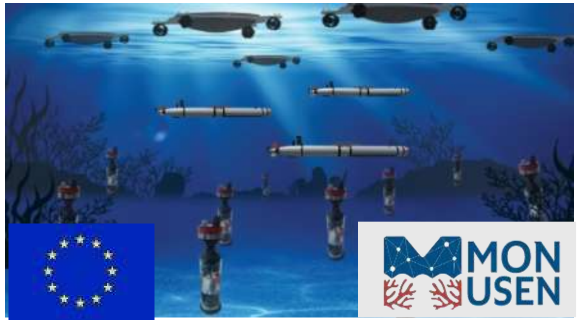
Bio-inspired marine robotics PERSICO



Lagoon environmental monitoring

Artica and Antartica missions

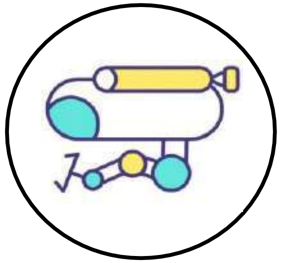
Autonomous sensor networks



Coastal tourism, Marina and harbour monitoring

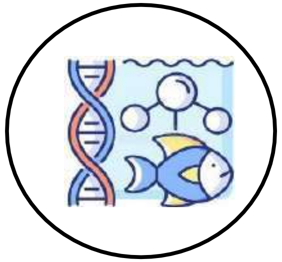
roberta.ferretti@cnr.it

The NEW paradigm in marine robotics @ CNR-INM Genoa: data-centric vision



ROBOTICS RESEARCH

MARINE ENGINEERING INNOVATION



MARINE SCIENCE APPLICATIONS

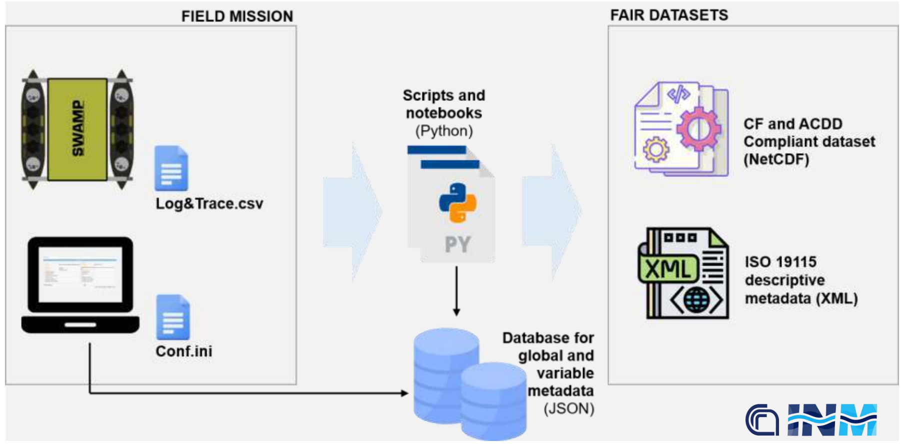
INTER-DISCIPLINARITY

MULTIPLE END-USERS

DATA-CENTERED VISION

A new way of thinking to our research activities from a **data perspective**

Motta, Aracri, Ferretti et al., *A framework for FAIR robotic dataset*, Scientific Data 2023



Findable

Accessible

Interoperable

Reusable

roberta.ferretti@cnr.it

Interreg
Cofinanziato dall'Unione europea
Cofinancé par l'Union européenne
Marittimo–IT FR–Maritime

AMIS - *Advanced coastal risk Monitoring systems and dIgital twinS for coastal safety and resilience.*

Funding program: Interreg Italy-France Maritime 2021-2027
Cross-border program co-financed by the European Fund for Regional Development (FESR), within the European Territorial Cooperation (CTE) objective of the EU Cohesion Policy 2021 - 2027

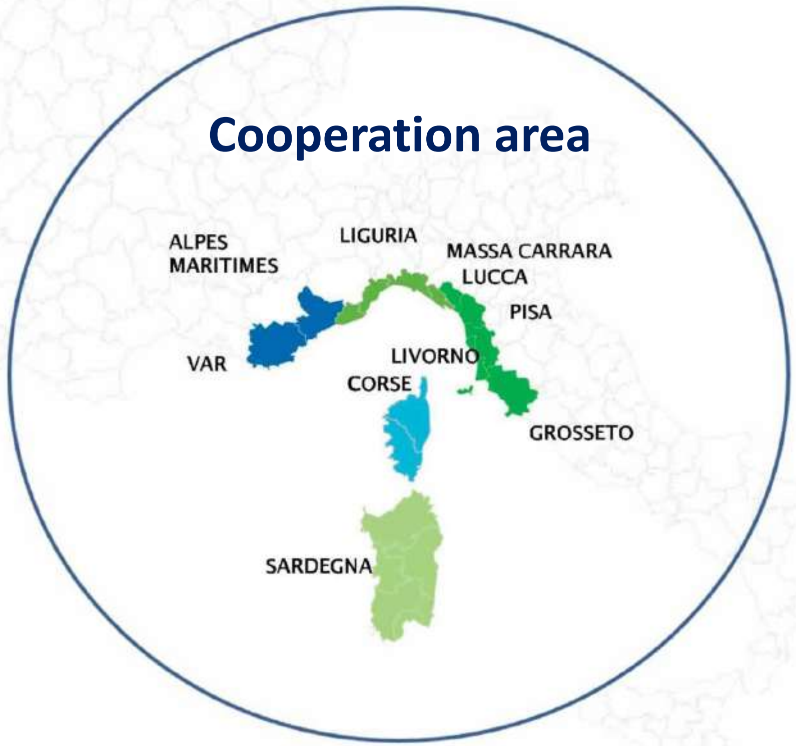
Priority 2 "A resilient and resource-efficient cross-border area"

SPECIFIC OBJECTIVE 2.4) Promote **adaptation to climate change,** disaster **risk prevention** and resilience, considering ecosystemic approaches


(credits: Brandini, LAMMA)

AMIS - Simple innovative project

Duration: **30 months** (1 March 2024 – 31 August 2026)
Financial size: **1.9** million euros



Interreg IT – FR Maritime 2021-2027: AMIS in a nutshell

Cross border & interdisciplinary cooperation

- **LAMMA Consortium**
- National Research Council (CNR-INM)
- University of Genoa (UniGE–DISTAV)
- French Geological Service (BRGM)
- CPIE

Multiplatform Coastal Monitoring

Technology & ICT
Robotics (marine&aerial)
video surveillance
remote sensing
Earth and marine sciences
advanced models risk prediction
Pilot Site Implementation
-high coast and active cliffs
-sandy and low coast
-river mouth area

Expected results

- ✓ Operational **protocols** and Innovative **multiplatform technologies** for coastal monitoring
- ✓ **Digital twins** of the pilot areas and **atlas of risks**
- ✓ Guidelines for **risk communication**

Capitalization from Interreg IT – FR (2014-20)

- MAREGOT
- MATRAC-ACP

Public Authority (partner & end-users)

- District Basin Authority of the Northern Apennines (ABDAS)
- Autonomous Region of Sardinia -General Directorate of Civil Protection (RAS)
- Region of Liguria - Territorial Planning Sector (RL)

roberta.ferretti@cnr.it

AMIS - Project work plan

WP1
Digital twins for coastal risk analysis in relation to climate change

WP2
Advanced technologies for coastal monitoring

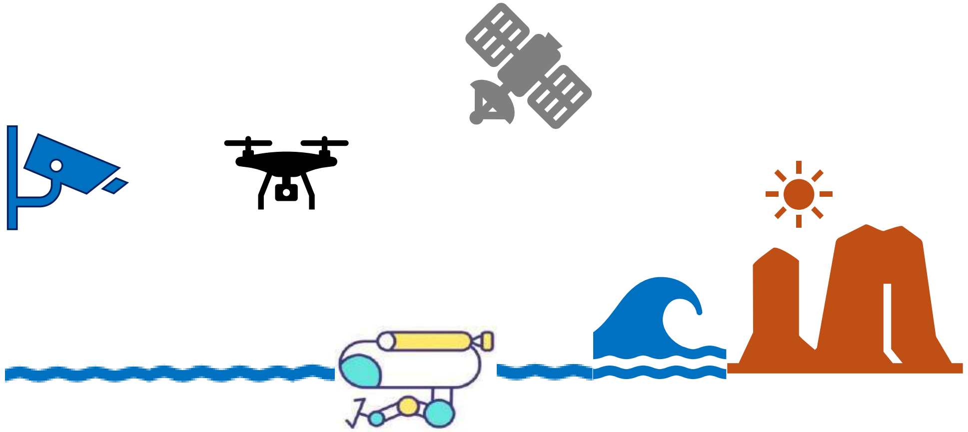
WP3
Integrated coastal monitoring and risk mapping

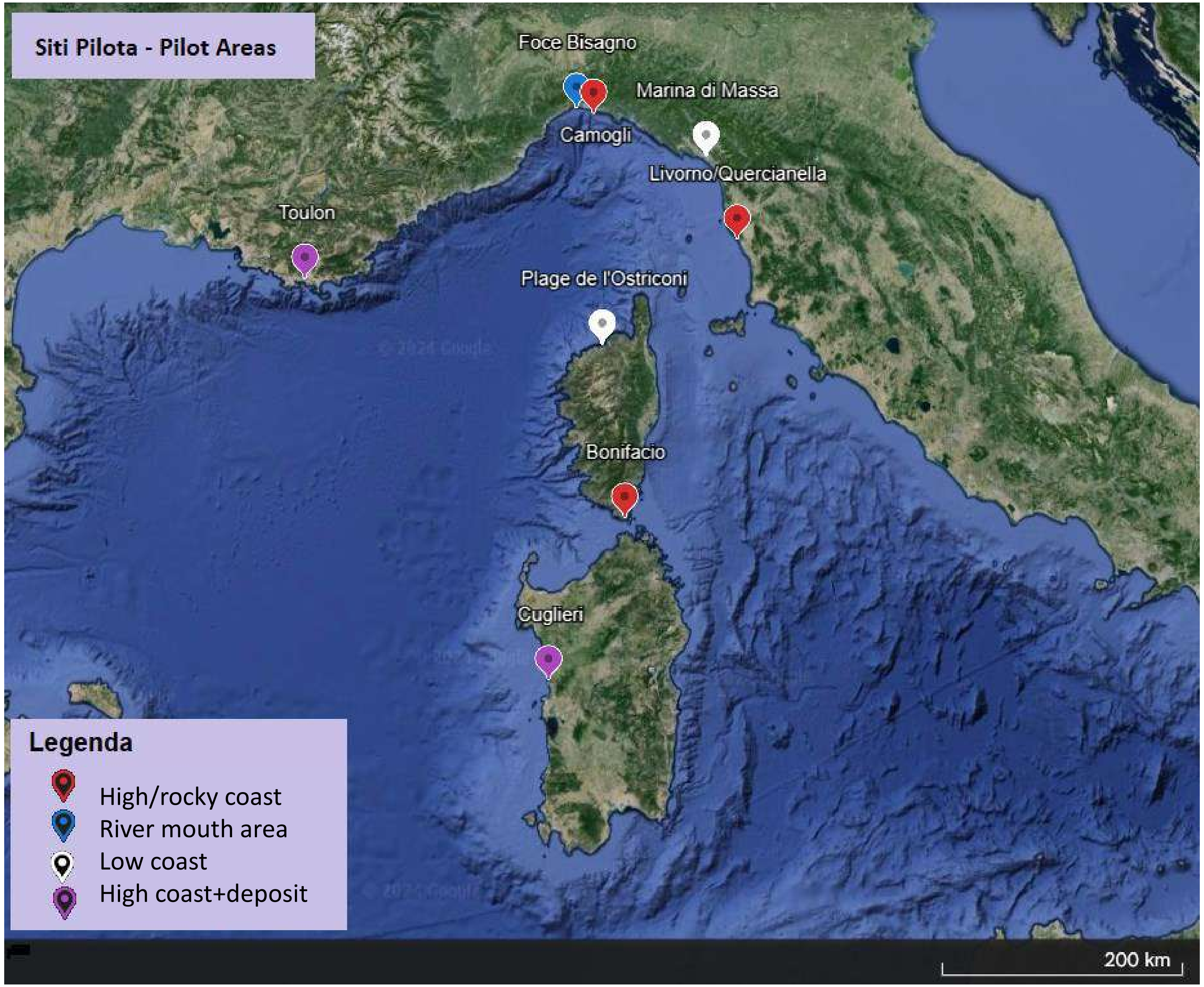
PROTEZIONE CIVILE
Regione Autonoma della Sardegna

roberta.ferretti@cnr.it

Pilot areas

- Pilot areas distributed across the **Program area** and representative of **different types of coast** (high coast and active reefs; low coast; river mouth area)
- Different **observation methodologies** (marine robot and aerial drones; video surveillance; remote sensing) based on the **type of coast**
- **CNR** engaged in cross-border activities across the entire program area

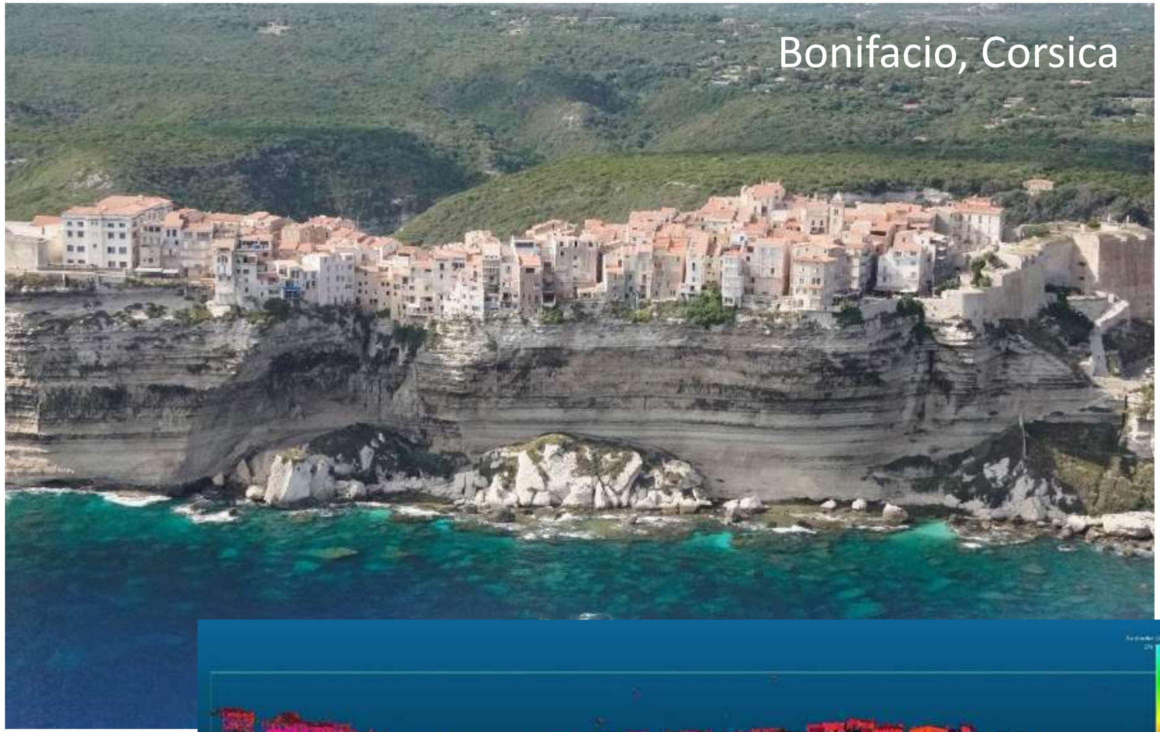


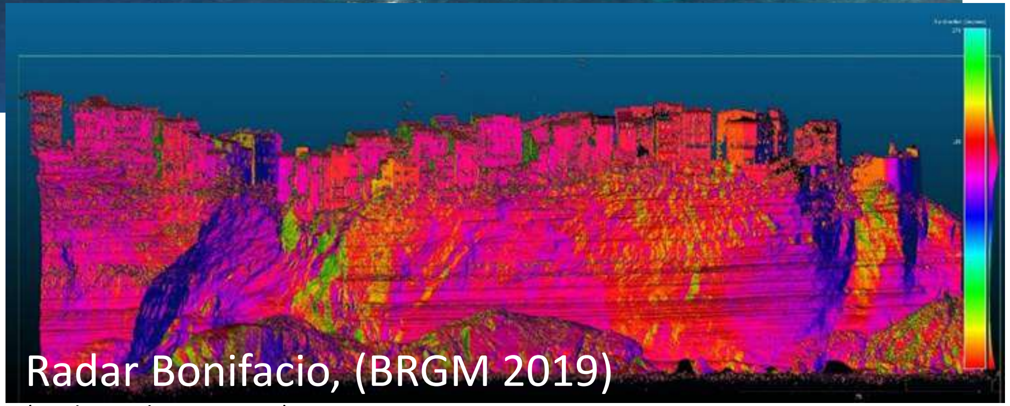


roberta.ferretti@cnr.it

AMIS pilot areas - types of coasts and associated risks

High and rocky coast - risk of landslides and erosion




Radar Bonifacio, (BRGM 2019)

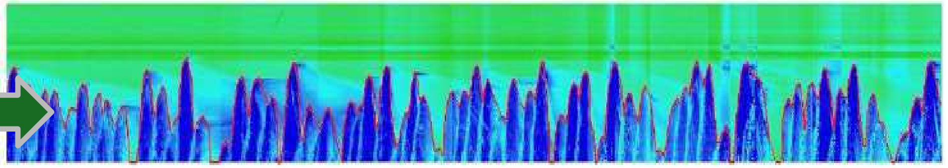
(credits: Balouin, BRGM)

Low and sandy coast - risk of storm surges and erosion

Impact of waves on the coast

23/01/2021 10:00

Integration with video monitoring systems



Enhance-ment of the sea

Time

(credits: Brandini, LAMMA)

roberta.ferretti@cnr.it

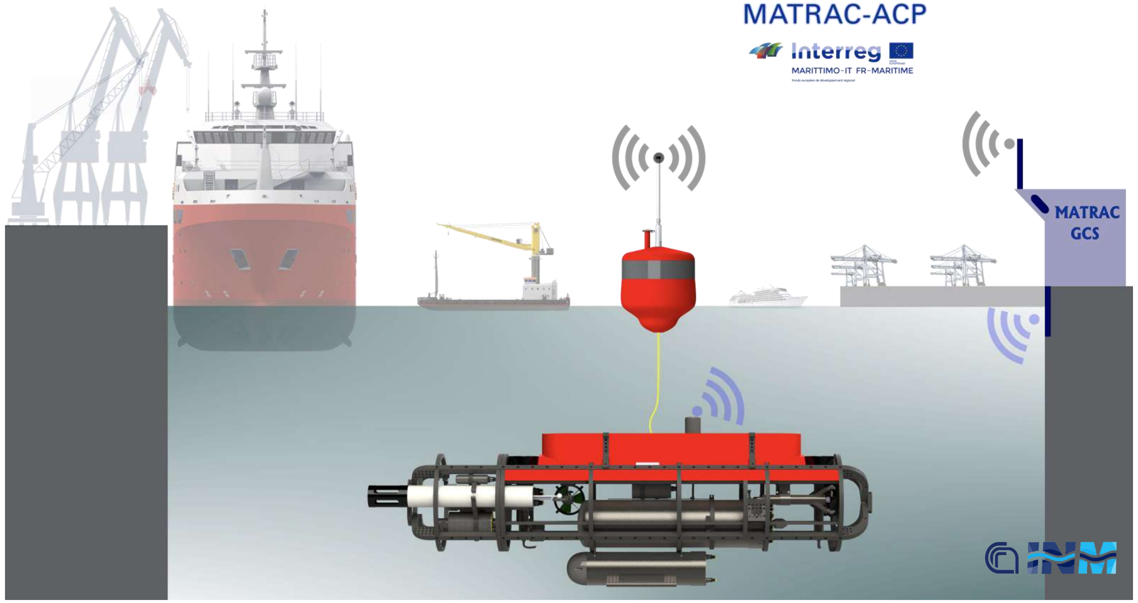
AMIS - The role of innovative robotic technologies

Bridging the gap between **available technologies** and their use by **public authorities** responsible for managing and planning activities on the territory.

Use a combinations of **aerial and marine drones** to outline the **morphology** of emerged and submerged cliffs for coastal monitoring

Camogli, Liguria
(credits: Brandini, LAMMA)

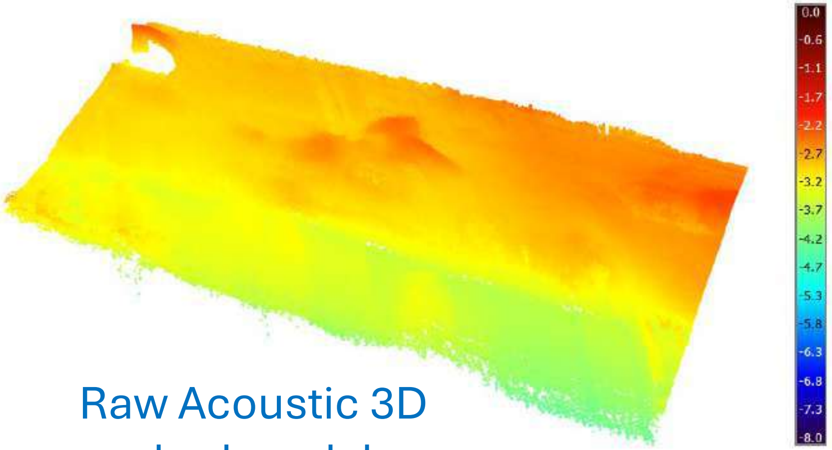
Capitalization of Interreg IT – FR Maritime 2014-20: **MATRAC-ACP** (P.I. Caccia M. - CNR INM)



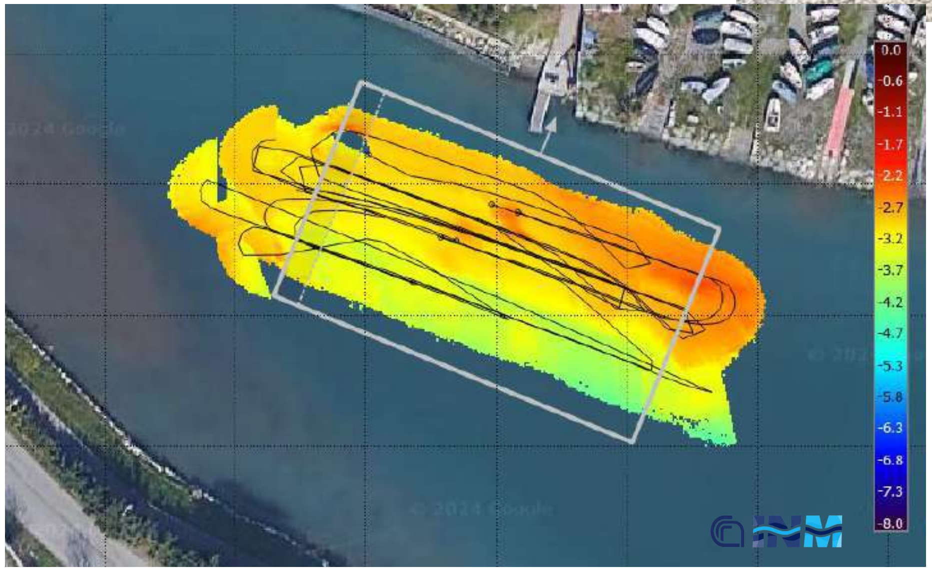
The **MBES** MATRAC-ACP kit will be made available for adaptation and use in AMIS

roberta.ferretti@cnr.it

AMIS - Preliminary test towards ASV_MBES kit



Raw Acoustic 3D seabed model



Port area of Genova Prà (March - April 2024)

SWAMP ASV with MBES, GNSS+RTK, AHRS, DVL

Team: 2 people

roberta.ferretti@cnr.it

AMIS – Key outcomes and benefits

Operational Protocols

Shared **guidelines** and **best practices** for effective coastal monitoring

Innovative Monitoring

Integrated **multiplatform technologies** in pilot sites

Risk Communication

Harmonized procedures for raising **public risk awareness,** using **gamification** and **citizen science** methods

Digital Twins and Risk Atlas

Creating **virtual coasts models** linked to cross-border coastal **risks atlas** to support decision-making and planning

Practical tools ensuring advanced data representation, adopted by public administrations involved in **coastal management** procedure**, planning** activities and **civil protection**, especially during **emergency** situations

roberta.ferretti@cnr.it

(credits: Brandini, LAMMA)

Thank you!

Cross-border cooperation: a value to be defended

Géosciences pour une Terre durable
brgm

PROTEZIONE CIVILE
Regione Autonoma della Sardegna

Università di Genova

AMIS

REGIONE LIGURIA

Autorità di Bacino Distrettuale dell'Appennino Settentrionale

CONSORZIO LaMMA

Interreg
Cofinanziato dall'Unione europea
Cofinancé par l'Union européenne
Marittimo-IT FR-Maritime

roberta.ferretti@cnr.it

Interreg Atlantic Area

Co-funded by the European Union

Blue Point

BLUE CIRCULAR ECONOMY OF MARINE PLASTICS 2023/2026

Contents

About BluePoint

BLUEPOINT project is an initiative to address the problem of marine plastic waste through sustainable and circular solutions.

- 4 years starting 2023
- 13 Partners
- €3.3 Million

Partners

Gipuzkoako Foru Aldundia
Diputación Foral de Gipuzkoa

mik

CENTRO PARA A VALORIZAÇÃO DE RESÍDUOS

I CLEAN MY SEA

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

Ollscoil Teicneolaíochta an Atlantaigh
Atlantic Technological University

DECATHLON

ECONOMÍA SOCIAL
ASATA ASTURIAS

SODERCAN
Sociedad para el Desarrollo Regional de Cantabria

ESTIA
INSTITUTE OF TECHNOLOGY
une école CCI BAYONNE PAYS BASQUE

South East BIC

Laboratório da Paisagem
2014-2024

Principado de Asturias

AIMS

Multi-stakeholder ecosystem

- Intercooperation
- Innovation
- Entrepreneurship
- Internationalization

WORK PACKAGES & LEAD INSTITUTES

WP1
Research, focus and prospections of blue economy circularity based on plastic recycling

WP2
Analysis and diagnosis of sustainable new opportunities of blue economy bu[illegible] models

WP3
Blue and green economy awareness raising actions to involve the demand side in the new value chain

WP4
Technical pilots to boost blue and green economy and near market analysis

WP5
Blue and green economy entrepreneurship support and boosting

WP6
Transfer system to support new sustainable blue business models development

APPROACH

- Create marketable solutions within the marine plastic value chain boosting the entrepreneurship activity
- Develop technology solutions that cover needs within the marine plastic value chain

APPROACH

From the technology research developed in WP1, technology pilots will be developed in WP4 that will be subsequently assisted to accelerate the development of real marketable solutions (WP5).

Pilot 1

Prototype marine plastic drone detection system

Pilot 2

Development of an efficient boat for plastic fishing

Pilot 3

Development of a prototype for plastic selection

Pilot 4&5

Development of new products based on recycled marine plastic

IMPACT

From WP4 and WP5

- Creation of real marketable solutions within the marine plastic value chain
- Creation of novel companies/start-ups focused on the marine plastic value chain (either at the technology or business level)

Interreg Atlantic Area

Co-funded by the European Union

Blue Point

EMRA '24 - Arenzano, Italy
May 27-29, 2024

PLOME

latform for Long-lasting Observation of Marine Ecosystems

The PLOME project

Intelligent solution for **spatio-temporal seafloor observations**, capable of studying ecosystem dynamics in a more persistent, systematic, and comprehensive manner.

Total budget: 1.5M €
NextGenerationEU Spain

Universitat de Girona

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

UIB Universitat de les Illes Balears

POLITÉCNICA

Institut de Ciències del Mar

CSIC

iqua ROBOTICS

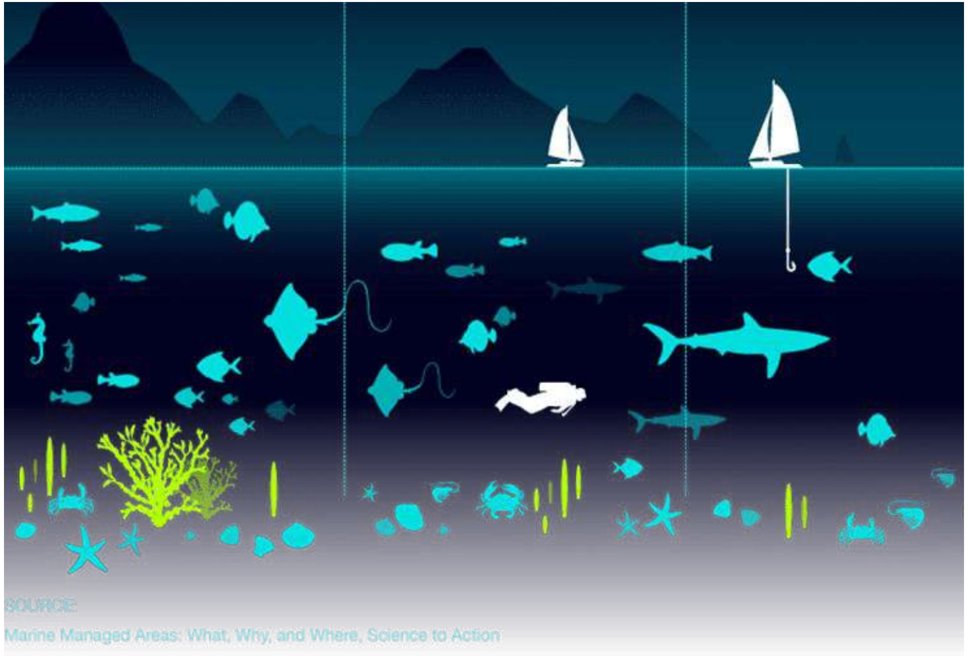
MINISTERIO DE CIENCIA E INNOVACIÓN

Financiado por la Unión Europea NextGenerationEU

Plan de Recuperación, Transformación y Resiliencia

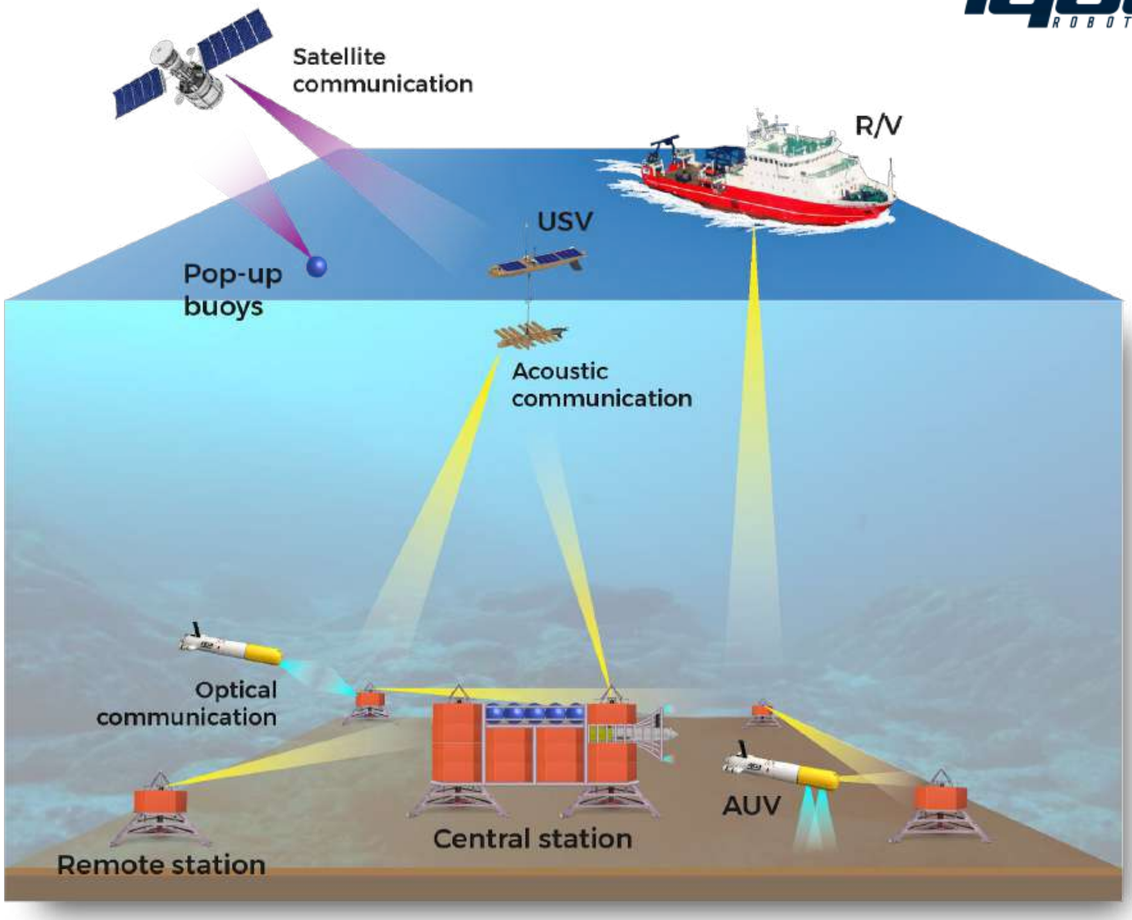
AGENCIA ESTATAL DE INVESTIGACIÓN

Ref. PLEC2021-007525/AEI/10.13039/501100011033

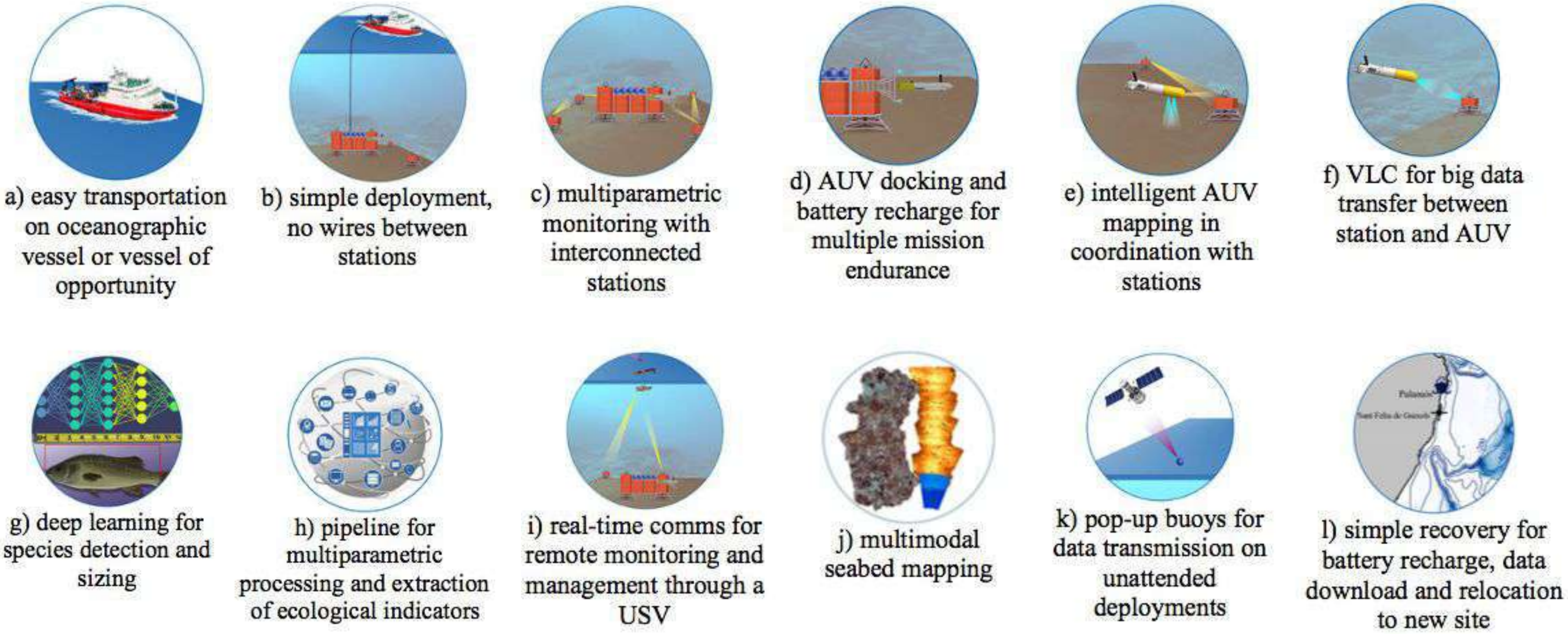


The concept

"PLOME proposes a **spatially adaptive modular platform** of independent and wirelessly connected **benthic stations and autonomous underwater vehicles** (AUVs) for **monitoring and mapping marine ecosystems** over **long-lasting periods** with near real-time **supervision**."

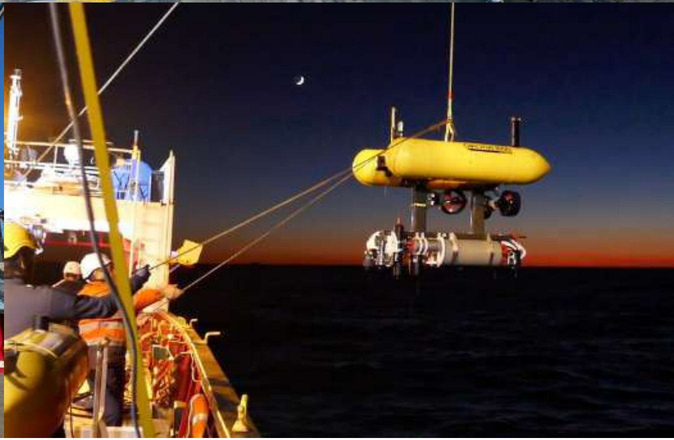


Key proposal aspects



Experimental validation campaigns

- Coastal environment
- Deep marine protected area
- Long deployment in the OBSEA cabled observatory.

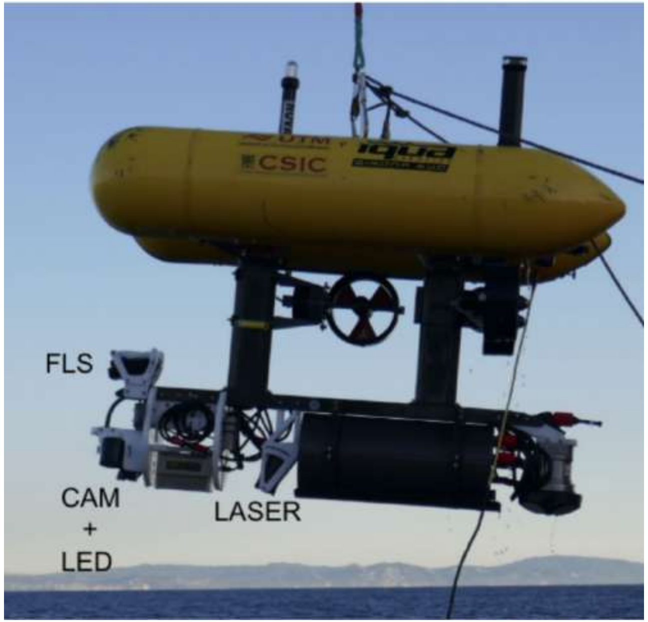


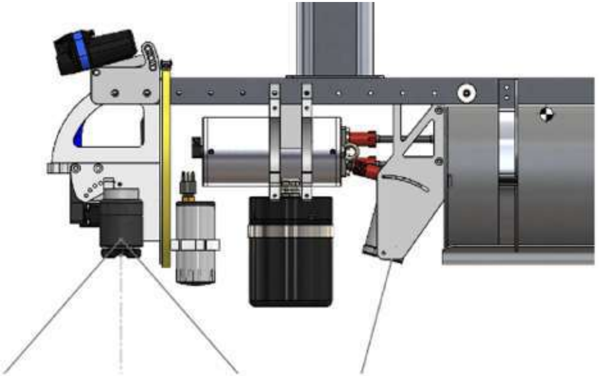
IQUA Robotics role

AUV mapping:

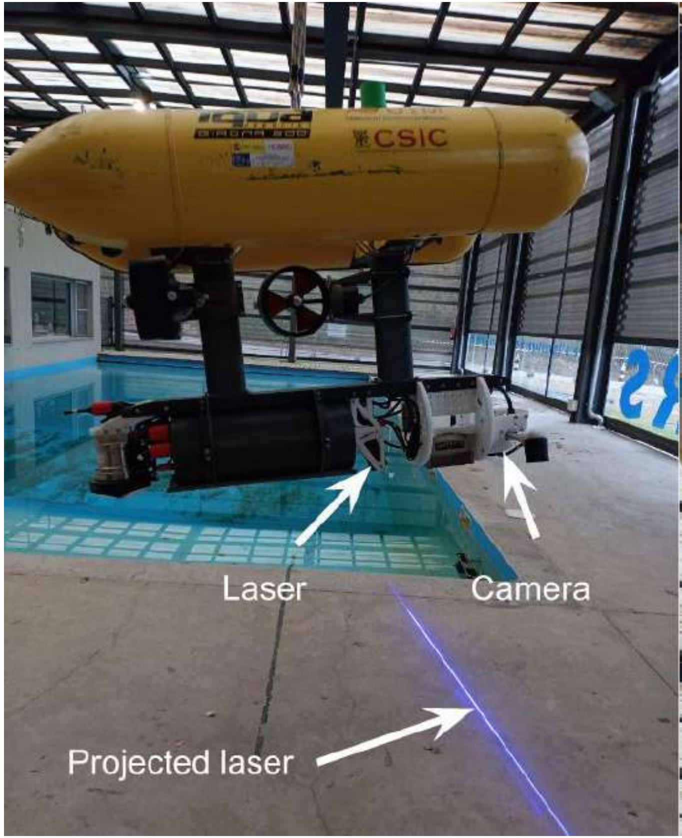
- Multimodal mapping payload:
    - Laser-camera system
    - Forward-looking sonar
    - Optical camera

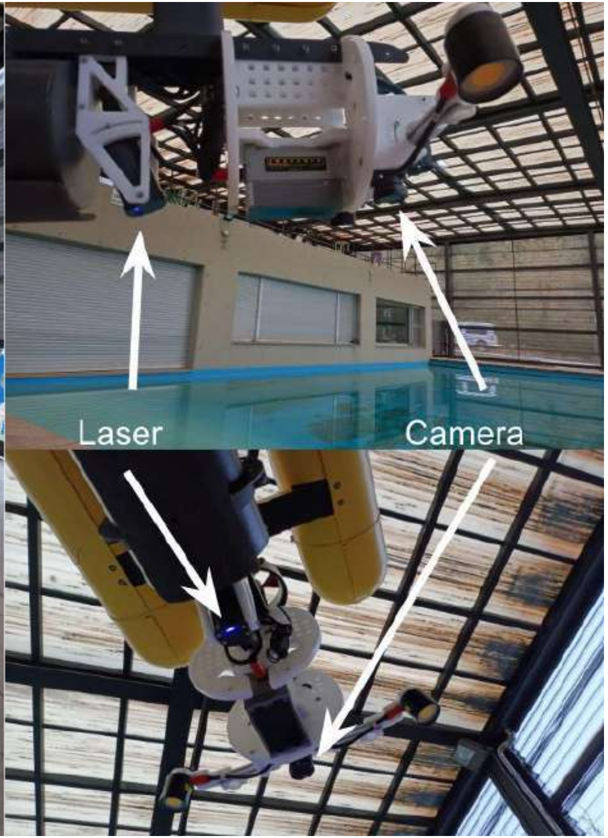
- Quick map processing for mission evaluation and transmission to lander stations / surface.
    - Micro-bathymetry
    - Acoustic mosaic
    - Optic mosaic

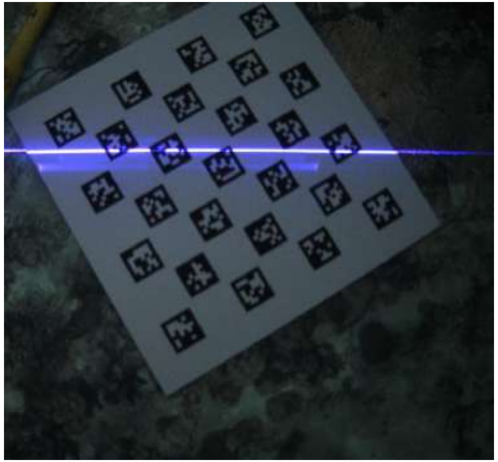


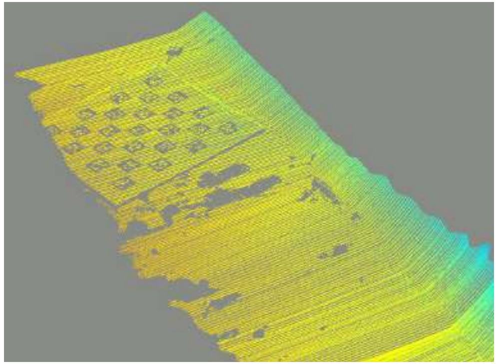


Laser-camera system

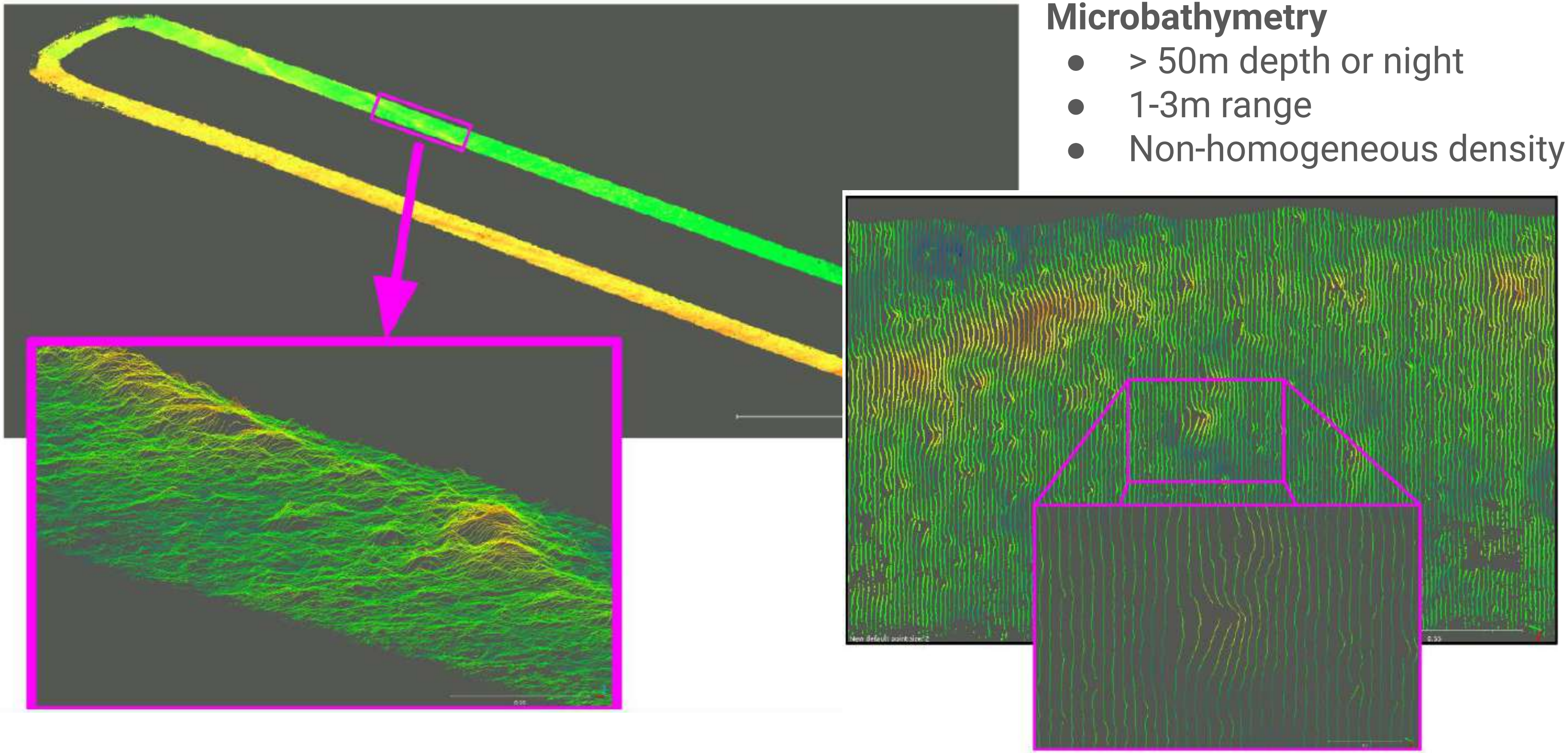








Laser-camera system

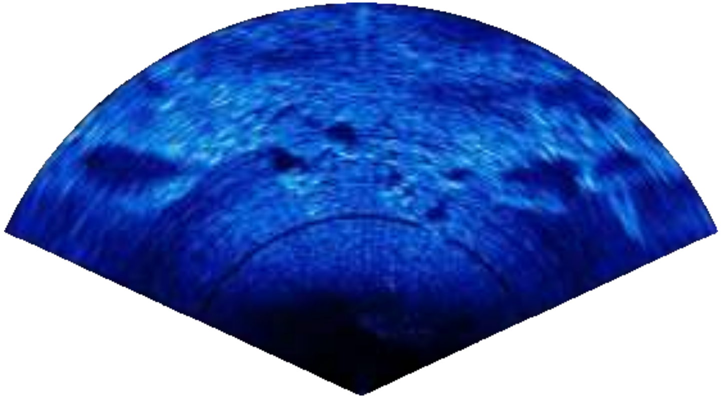


Microbathymetry

- > 50m depth or night
- 1-3m range
- Non-homogeneous density

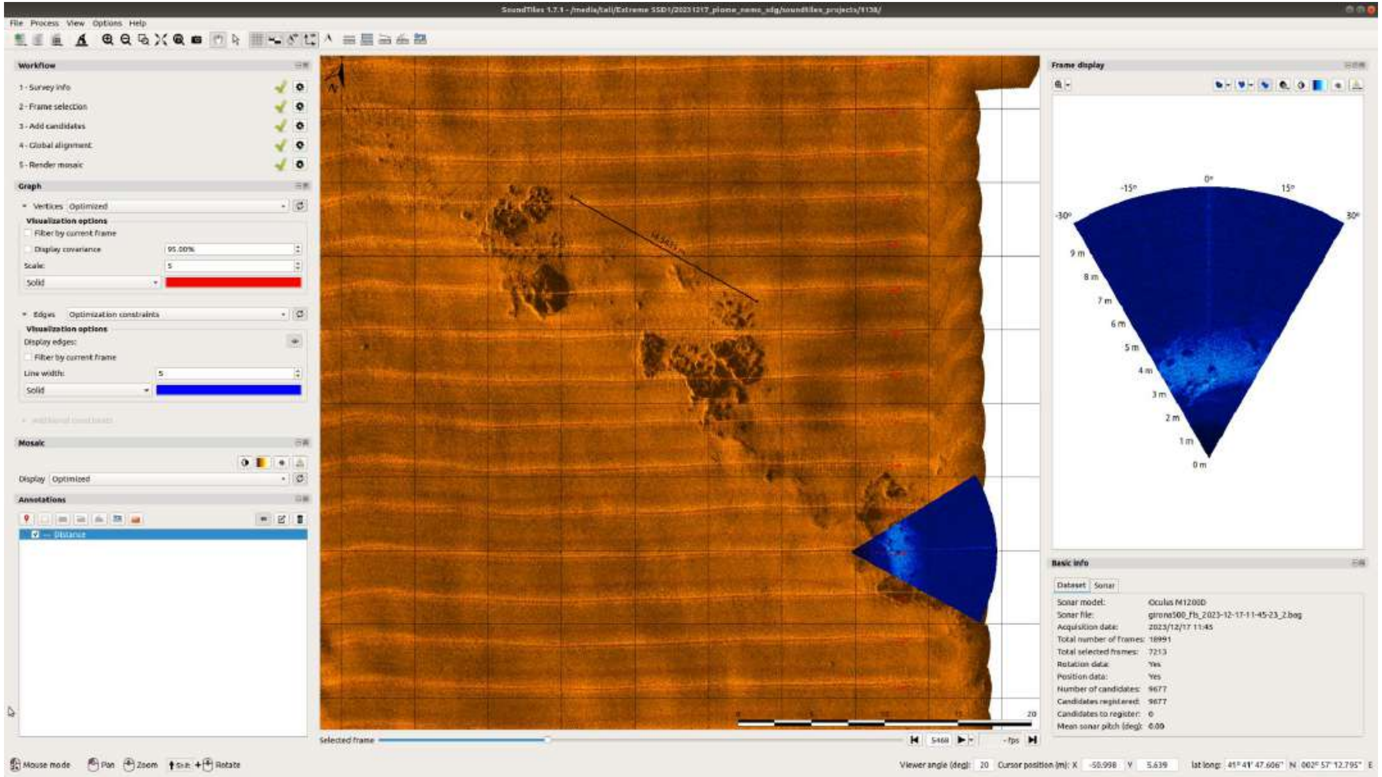
Acoustic mapping

- Mapping regardless of water visibility
- Less invasive
- Range/resolution depending on mounted FLS



Acoustic mapping: processing

- **SoundTiles** post-processing software
- Mosaicing even without positioning information.
- Increases SNR with respect to individual images.

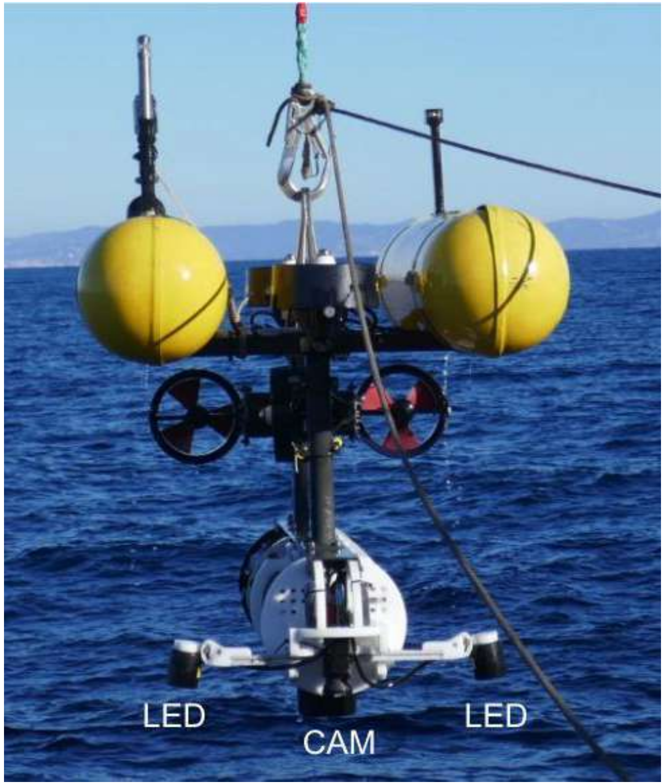


Acoustic mapping: on-board processing

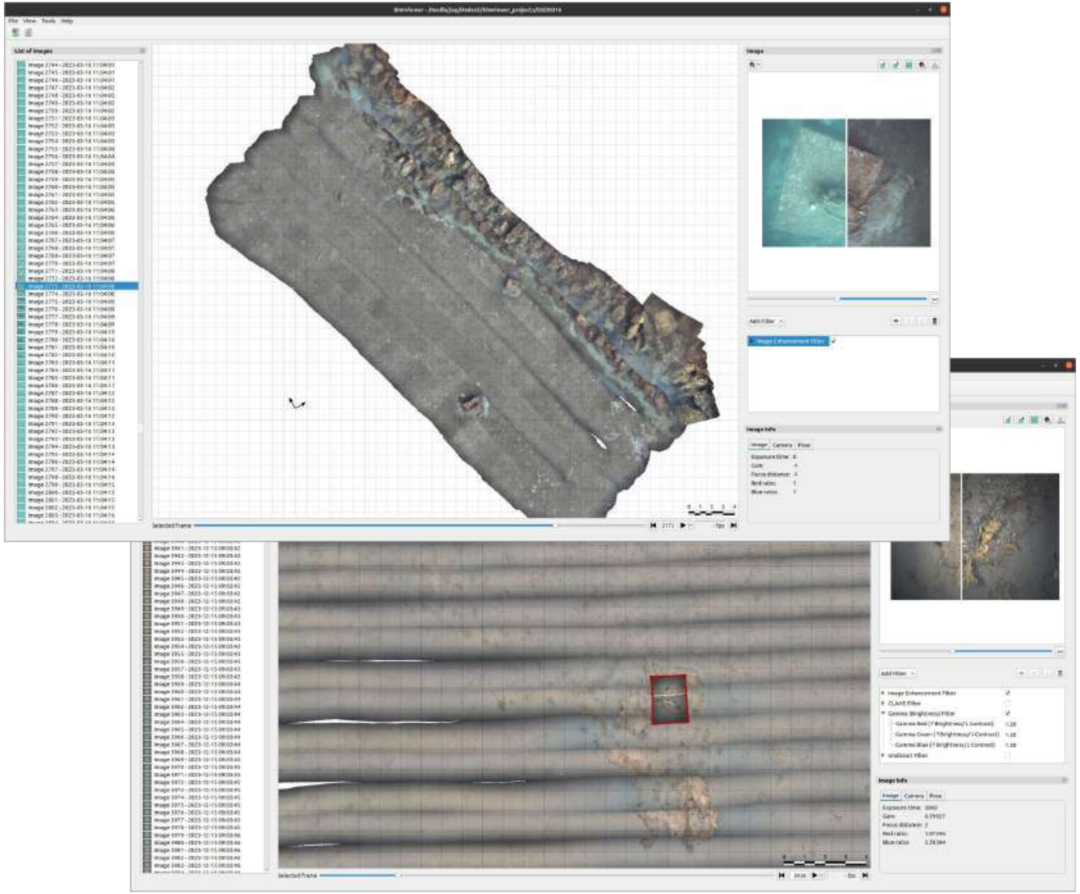
- Adapted pipeline to generate mosaic on-board using positioning information.
- Not real-time, but available once the vehicle emerges.

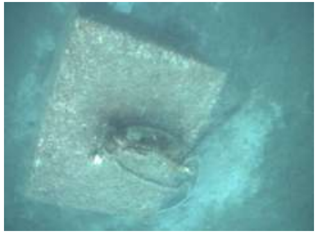
Data courtesy of Norbit

Optical mapping



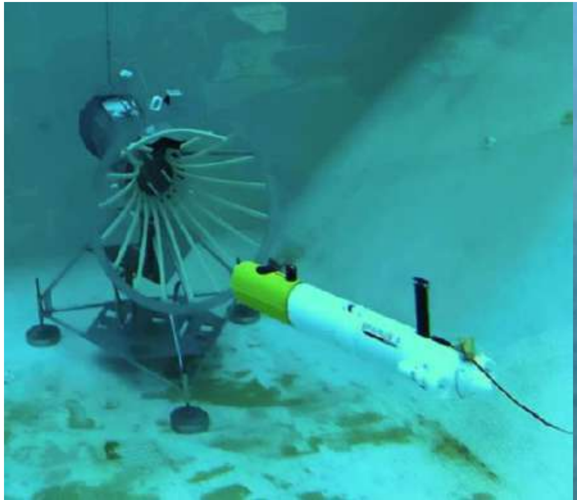
Optical mapping: processing

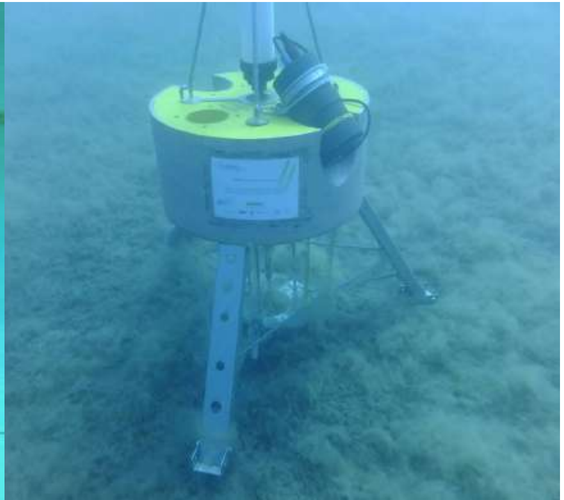




What's next?

- Long deployment campaign (2 weeks).
- Remote data transmission
- Pipeline for ecological indicators





EMRA '24 - Arenzano, Italy
May 27-29, 2024

Thank you!

Project Presentation

EMRA’24

Arenzano, Italy

May 27-29, 2024

Funded by the European Union

Goals

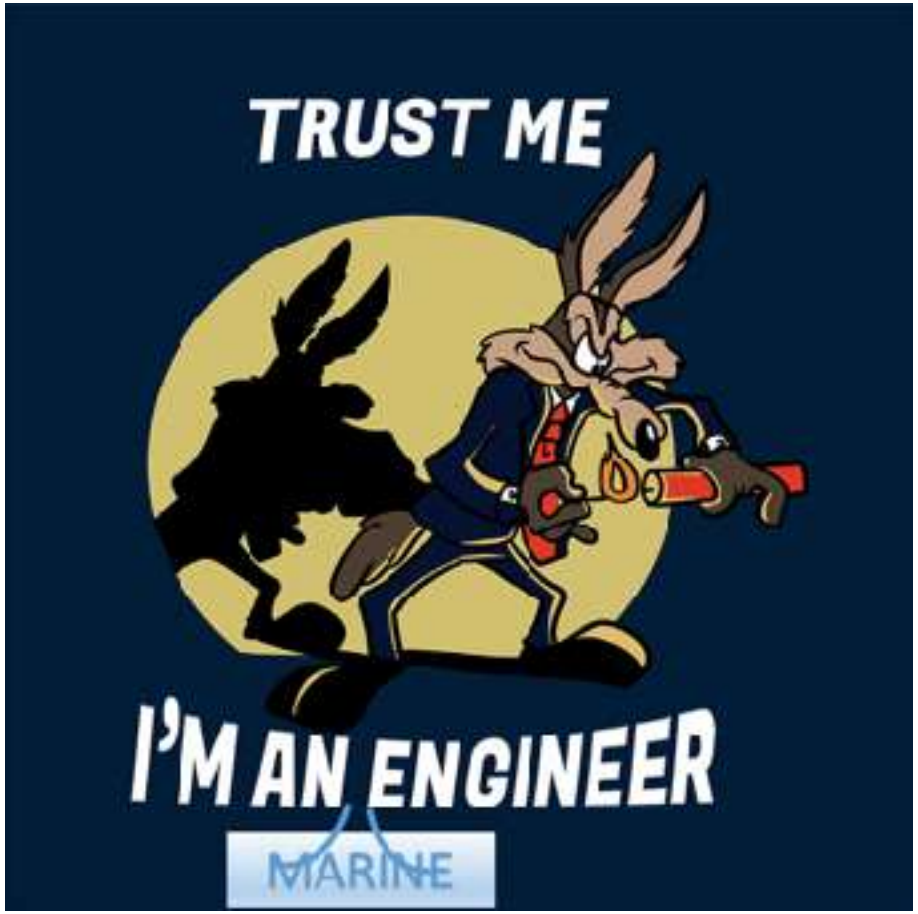
- Vision

Becoming a world leading group in the development of underwater acoustics technologies by being unique in the synergy of underwater acoustics with marine robotics, maintaining sustainable foundation for expertise gained, and performing research leading to high impact outcomes.

- Research (sensor communication, acoustic signal processing, collaborative autonomy)
    - Staying up-to-date with the research
    - Identify needs and knowledge gaps through links to the industry, policy makers, and end users
    - Steering the research activity towards fields involving both underwater acoustics and marine robotics
    - Encourage innovation in research through an open minded environment and idea sharing
    - Avoid heuristics, focus on optimized approaches
    - Focus on marine sciences, environmental protection, blue economy, and standatilization of technologies
    - Expose research outcomes: academic community and general public

Main KPIs

- 50 external researchers visiting
- 140 visiting students
- 20 Journal publications
- 30 conference publications
- 4 Postdocs, 6 PhD
- 20 Grant submissions, 5 accepeted
- 2 spinoffs, 2 patents, 4 buisness models



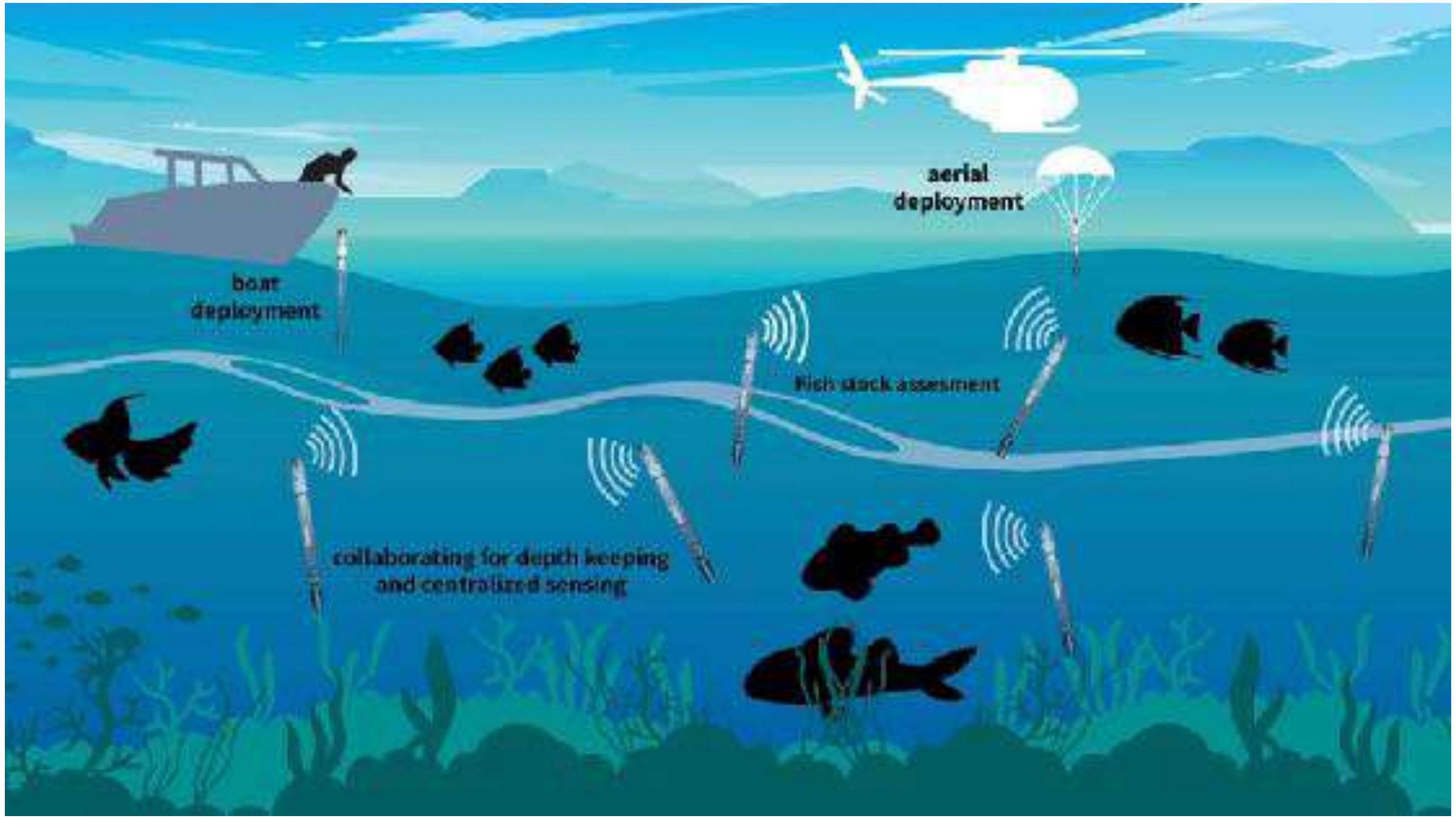
UWIN Core Team

- ERA-Chair holder
- Group leader (TBD)
- Technology Transfer Officer (TBD)
- 1 postdoc
- 3 PhD students
- 2 MSc students
- 1 BSc

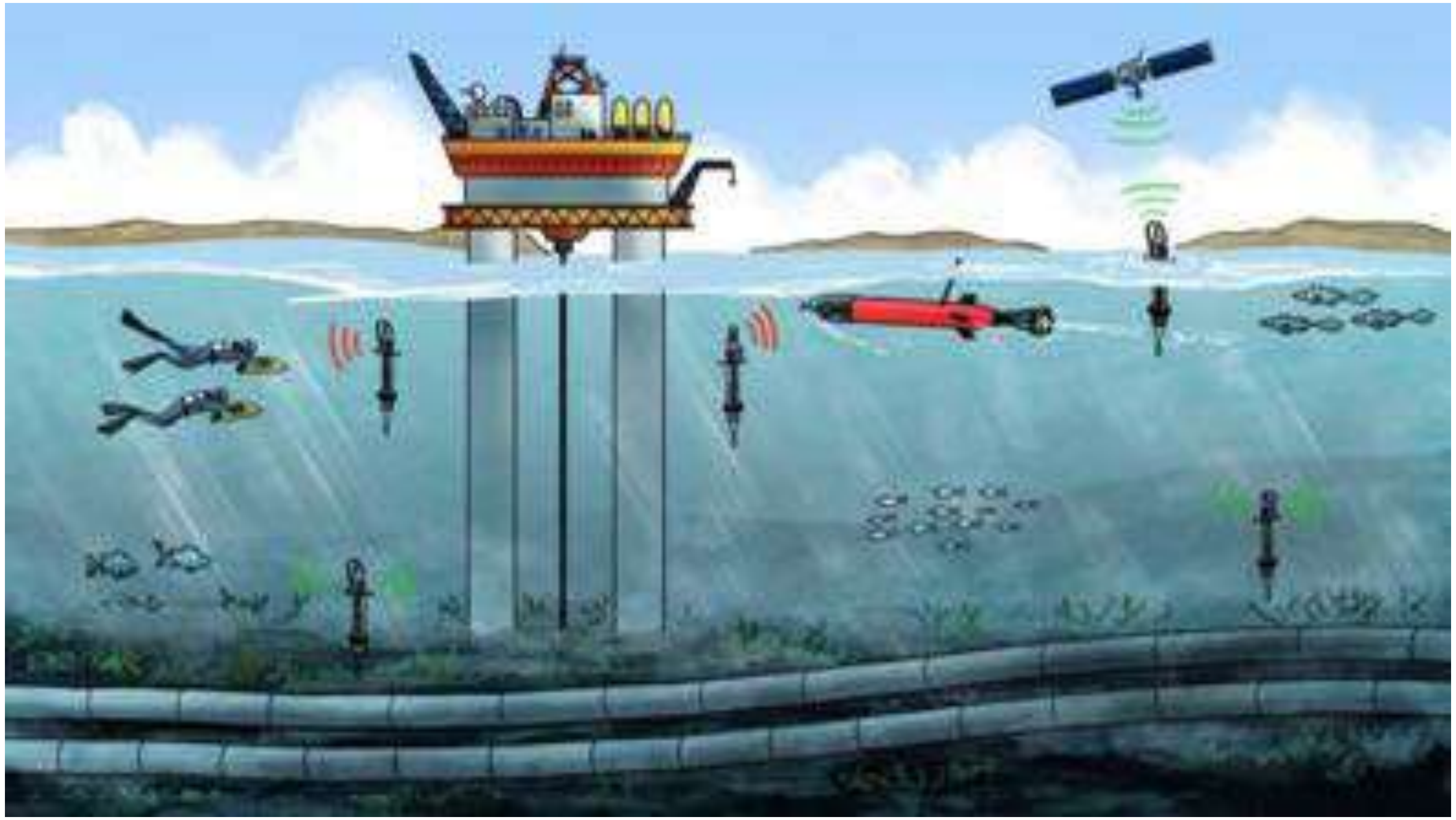
Still searching for good candidates for postdocs and PhD students

UWIN Main Projects

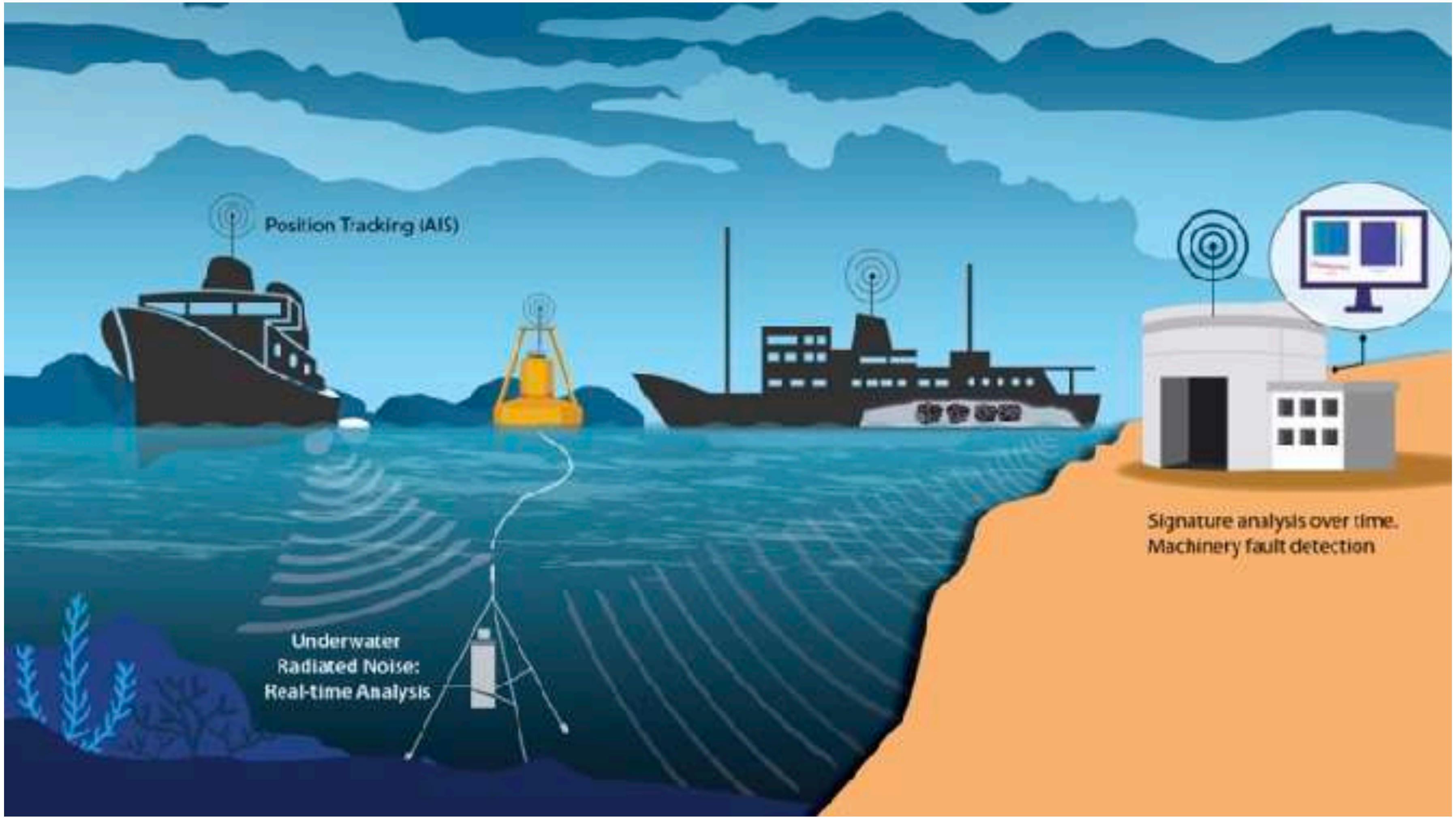
SOUND: Technology for Sustainable Fishing



Grottos: Energy Harvesting for IoUT

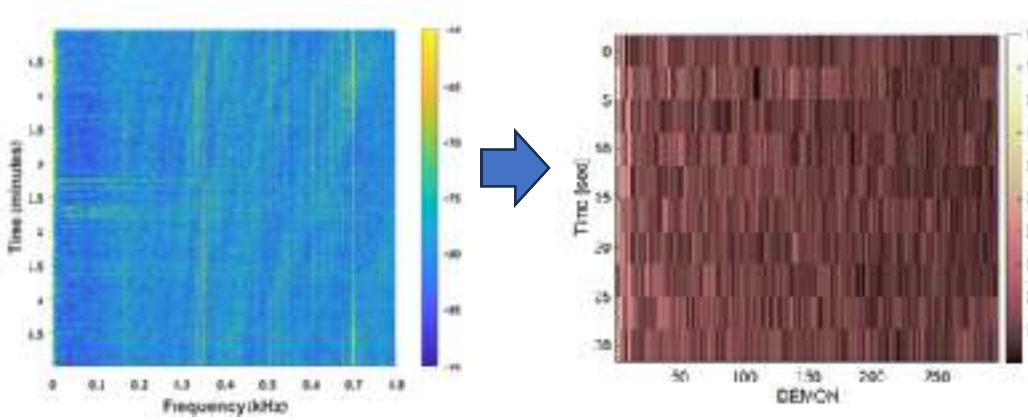


Shipping Noise

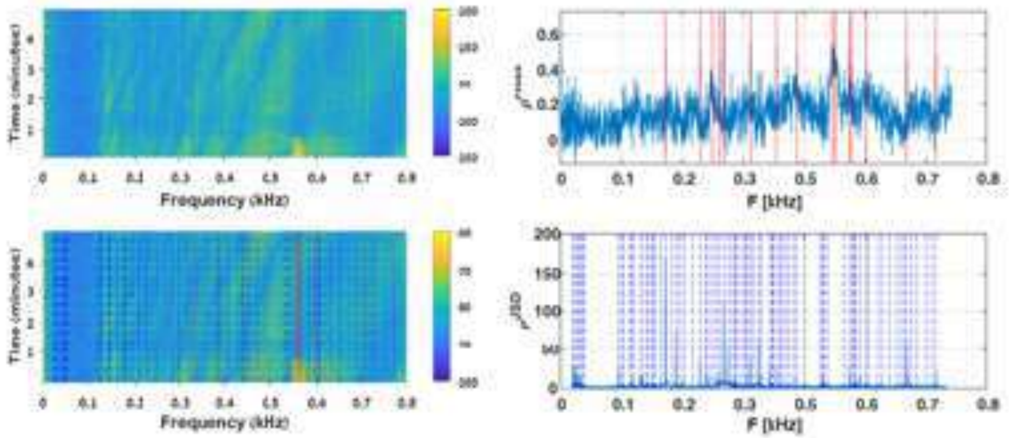


Shipping Noise Projects

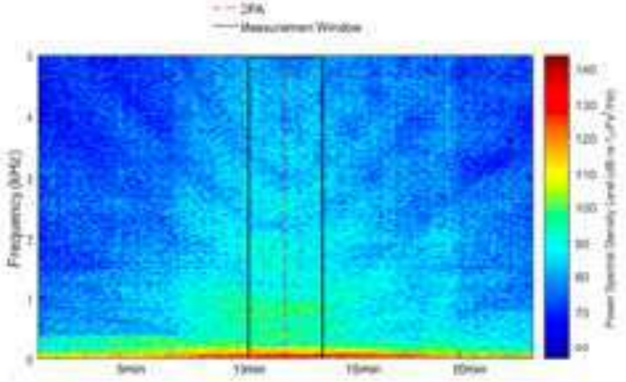
Shipping Noise Detection



Shipping Identification



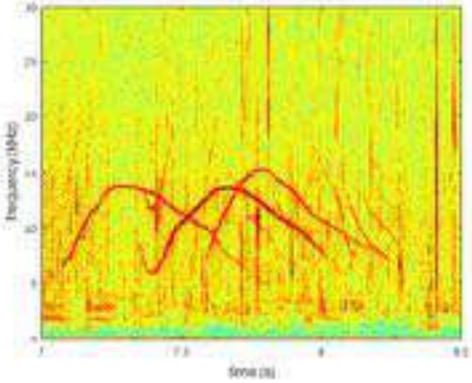
Dictionary of Shipping Noise

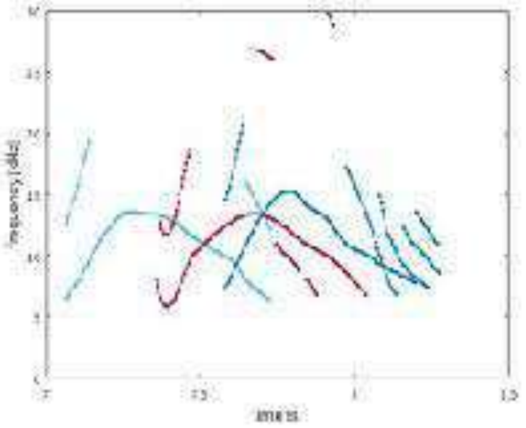


UWIN~LABUST

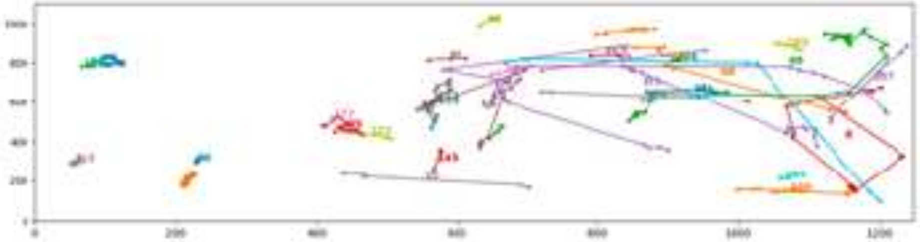
Shipping Noise Projects Cont.

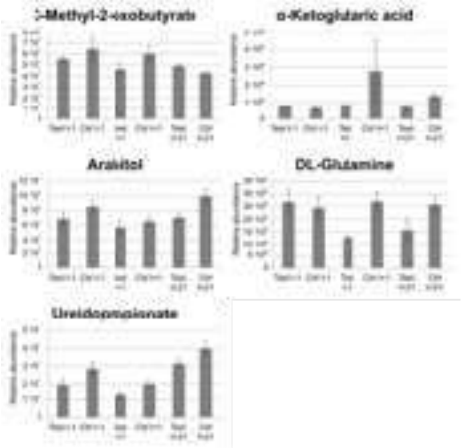
Impact on Dolphins

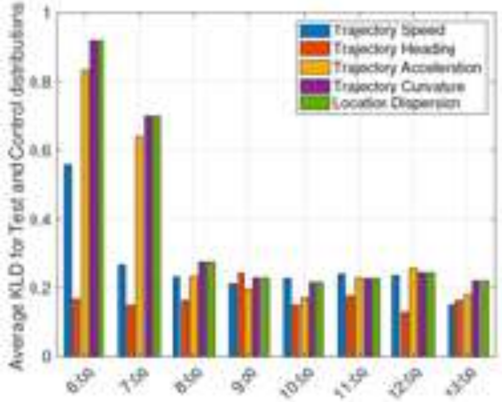




Impact on Fish







Additional Projects

- Fish size estimation using a single camera
- Doppler shift estimation from acoustic signals
- Sediment characterization by inverse propagation
- Cyber security of underwater acoustic communications
- Sperm whale vocalization: detection and localization

Peer Review Papers (Accepted / Presented)

- Journal:

1. António J. Oliveira, Bruno M. Ferreira, Nuno A. Cruz, and Roee Diamant, “Probabilistic Positioning of a Mooring Cable in Sonar Images for in-situ Calibration of Marine Sensors”, IEEE Transactions on Mobile Computing, Jan. 2024
2. Murad Tukan , Eli Biton, Roee Diamant, “An Efficient Drifters Deployment Strategy to Evaluate Water Current Velocity Fields”, IEEE Journal of Ocean Engineering, Jan. 2024.
3. Rebeca Chinicz , Roee Diamant “A Statistical Evaluation of the Connection Between Underwater Optical and Acoustic Images”, Remote Sensing, Jan. 2024
4. Roee Diamant, Alberto Testolin, Ilan Shachar , Ori Galili, Aviad Scheinin, “Impact of shipping underwater radiated noise on the behavior of dolphins”, Springer Nature Scientific Reports, March 2024
5. Guy Gubnitky and Roee Diamant, “Automatic Detection of Sperm Whales’ Echolocation Clicks”, IEEE Transactions on Audio, Speech and Language Processing
6. Talmon Alexandri and Roee Diamant, “Detection and Characterization of Ship Underwater Radiated Narrowband Noise ”, Elsevier Computer Networks, May, 2024
7. Tamir Mishali , Paolo Casari, and Roee Diamant, “Interception of bio-mimicking underwater acoustic communications signals ”, IEEE Internet of Things Journal, May, 202

- Conference:

1. Fausto Ferreira, Roee Diamant, Ilan Shachar, Alexia Badi, Nikola Mišković, Danny Morick, “Preliminary study on the impact of acoustic emissions on fish”, IEEE Oceans, Limerick, June 2023
2. Roee Diamant, Paolo Casari, Francesco Ardizzon, Stefano Tomasin, Thomas Corner, Benjamin Sherlock, Jeff Neasham, “A Key Agreement Algorithm for Securing Underwater Acoustic Communications”, IEEE Oceans, Singapore, April 2024
3. Anja Babić, Martin Oreč, Nikola Mišković, Roee Diamant, “SOUND: A swarm of low-cost floaters for sustainable fishing”, IEEE Oceans, Singapore, April 2024
4. Roee Diamant, "Impacts of shipping noise on Dolphin vocalizations", OceansNoise, Barcelona, Spain, May 2023
5. Roee Diamant, "Secrete key generation from channel characterizations", Oceans'24, Singapore, April, 2024
6. Anja Babić, "SOUND: autonomous floaters for sustainable fishing", Oceans'24, Singapore, April 202

Other Initiatives

Tesla Technological Museum: Zagreb
University of Haifa: Israel

Grant Submission

- NATO SPS: vessel and diver detection
- EU ATN Network: Marine observations
- EU Horizen: Noise monitoring
- EU Horizen: Shipping noise impacts
- AgroCroatia: acoustic monitoring for oyster farms

Conference Organization

Strategy Development

2nd October 2023

To:
Her Excellency, Vesela Mrđen Korać, Ambassador of Croatia to Israel
His Excellency Gary Koren, Ambassador of Israel to Croatia
Mr Eliaz Luf, Head of International Relations Division, Israel's Ministry of Innovation, Science and Technology
Mr Staša Skenžić, Head of Unit for International Cooperation, Croatian Ministry of Science and Education

Joint Students

- U. Zagreb / U. Haifa: 2 PhD
- FER / Bosnia: 1 MSc.
- FER / France: 2 BSc.
- Erasmus: 2 Phd

UWIN~LABUST

Funded by the European Union

Faculty of Electrical Engineering and Computing

We are actively looking for PhD and postdocs:

- Machine learning
- Signal and image processing
- Sensor fusion
- Communication and networking
- Sensor development

Options for research in Israel and Croatia
Great stipends!

You are welcome to visit us:

tecnalia

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

SEABEDCLEANER
Robotic Platform For Underwater Operations

Usecase: Removing Marine plastics and litter from the seabed

Pierre-Elie HERVE
R&D Engineer
Pierre-elie.herve@tecnalia.com

2024

RAMONES

RAMONES – Radioactivity Monitoring in Ocean Ecosystems

David Cabecinhas (IST/ISR)
on behalf of RAMONES consortium

EMRA 2024, Arenzano, Italy – May 28th, 2024

Receives funding from European Union under Horizon 2020 FET Proactive Programme via grant agreement No. 101017808

RAMONES – Radioactivity Monitoring in Ocean Ecosystems

RAMONES

Partners

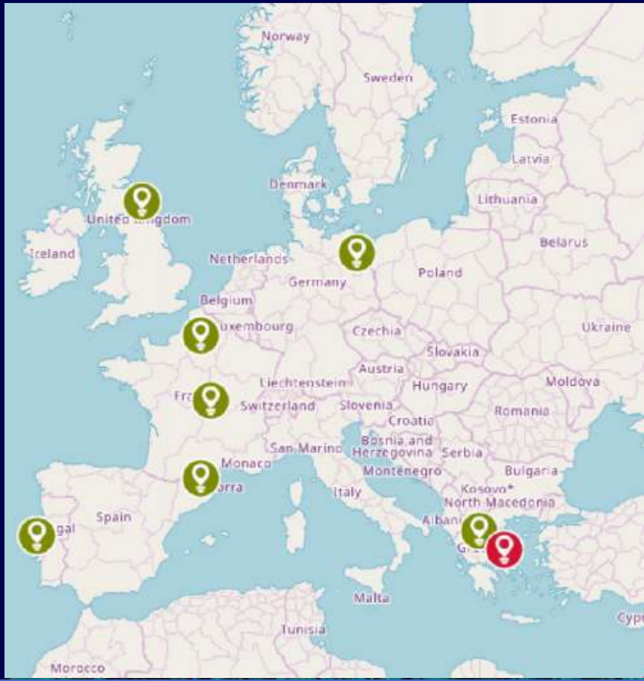
- National and Kapodistrian University of Athens
- Instituto Superior Técnico
- EvoLogics GmbH
- Ecole Normale Supérieure de Paris
- National Technical University of Athens
- Ploa Technology Consultants, S.L.
- University of Durham
- Université Clermont Auvergne

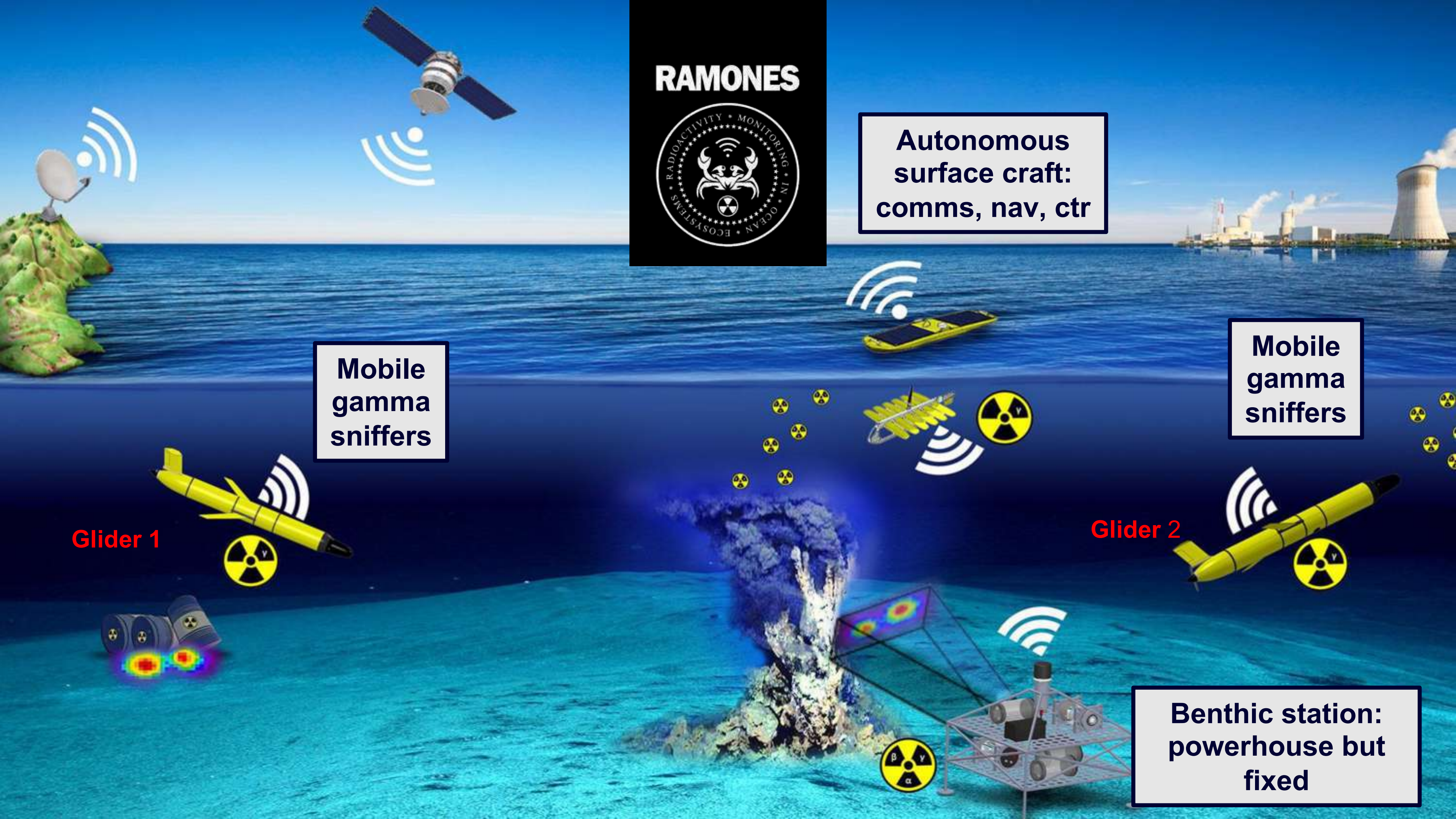
Three pillars of Excellence, R&D, and Innovation

NOVEL RADIOACTIVITY INSTRUMENTS

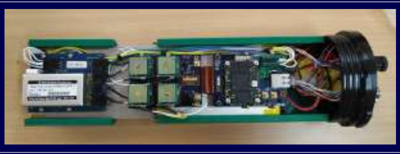
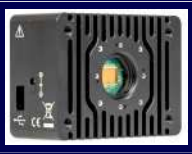
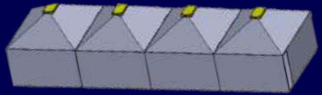
NOVEL MARINE ROBOTICS

NOVEL AI METHODS & ENVIRONMENTAL MODELLING




RAMONES
RADIOACTIVITY MONITORING IN OCEAN ECOSYSTEMS
Autonomous surface craft: comms, nav, ctr
Mobile gamma sniffers
Mobile gamma sniffers
Glider 1
Glider 2
Benthic station: powerhouse but fixed

Radiation Measurement Instruments

	M18	M36
γ-Sniffer Gamma Spectrometer for autonomous vehicles		
SUGI Submarine Gamma Imager		
CHERI Cherenkov Imager	 	 
αSPECT Underwater Alpha Spectrometer		 
GASPAR Gamma Spectrometer for Marine Radioactivity Studies		

RAMONES

Key technological challenges

– **Glider platforms**

- Long endurance and low power
- Technologically limited
- Slow internal update rate

– **Communications**

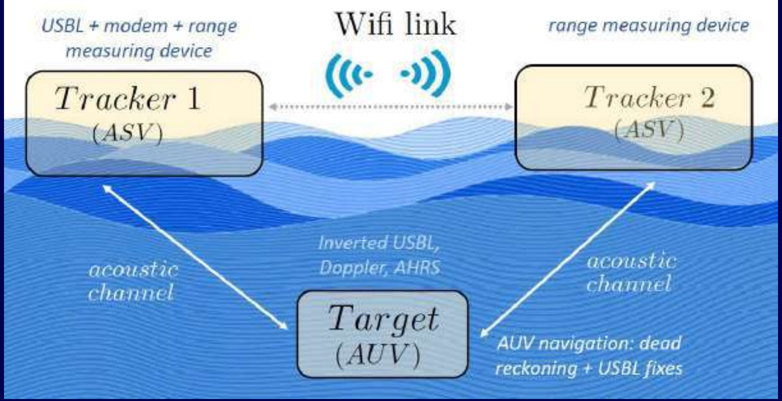
- Only acoustic communications
- Interference, shadow zones, low bandwidth

– **Radiological survey and mapping**

- Unconventional measurements (stochastic)
- Enormous volume
- Multiple collaborative vehicles

Adaptive Motion Planning and Cooperative Control

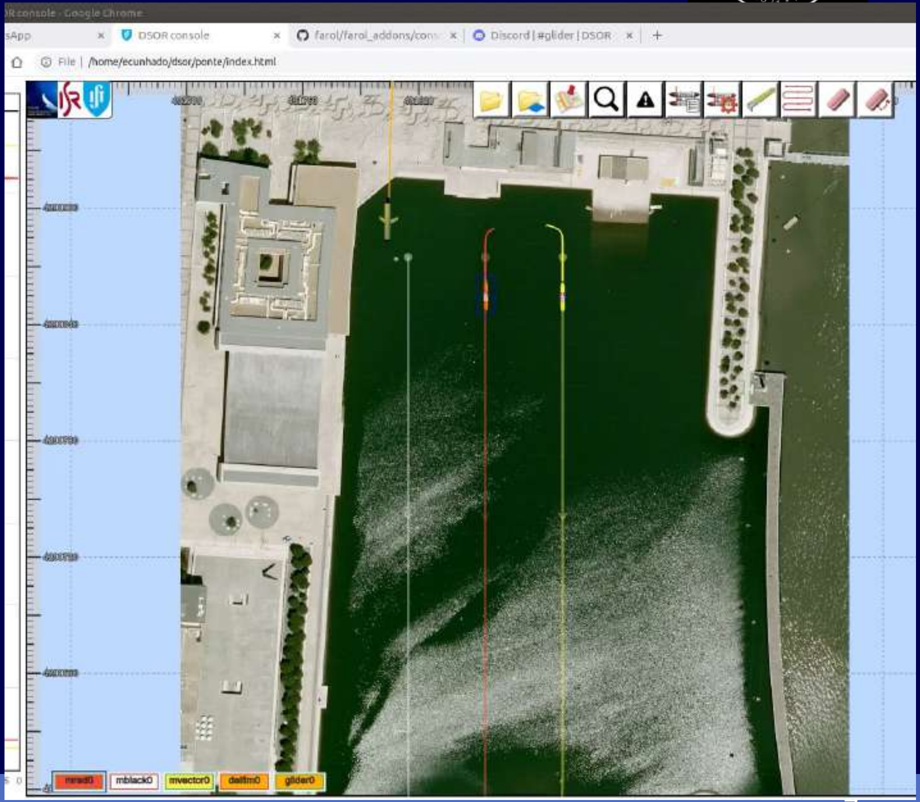
Cooperative Control / Simultaneous Target Localization and Pursuit (SLAP)



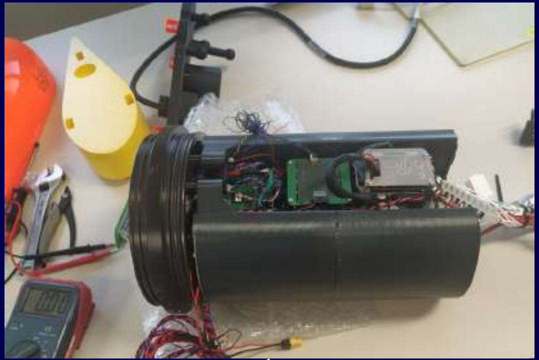
System Integration with Robotic Vehicles

Glider Backseat driver

- Gliders are typically autonomous
- After mission definition and launch the operate completely autonomously
- Only high-level mission commands can be sent though Iridium satellite link
- **RAMONES** will make use of the **novel backseat driver** functionality to change mission parameters on-the-fly
- BSD is custom software and is **not generally available**

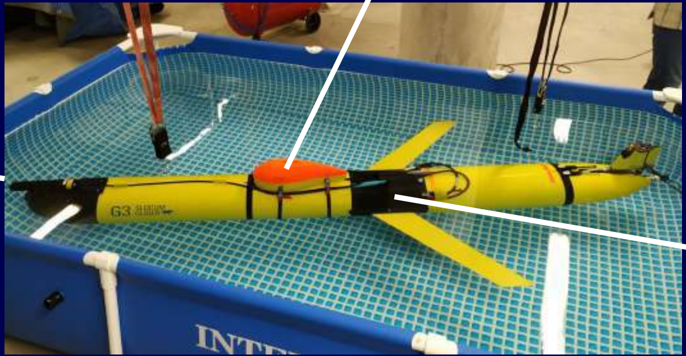


Underwater autonomous glider



USBL/Modem payload

γ-Sniffer payload



Control module

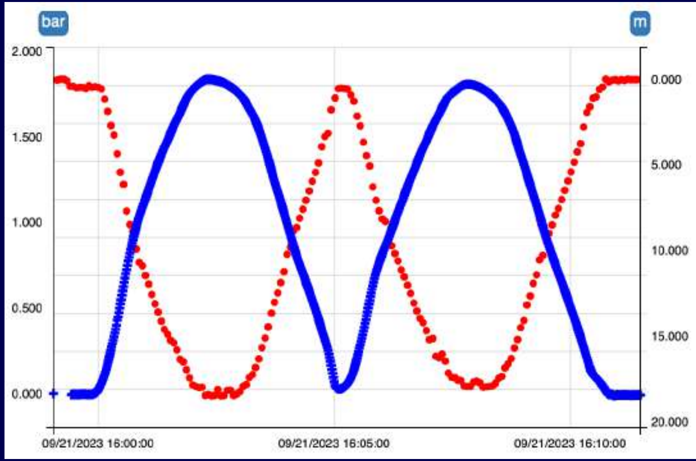
RAMONES

System Integration with Robotic Vehicles
First integrated system field test

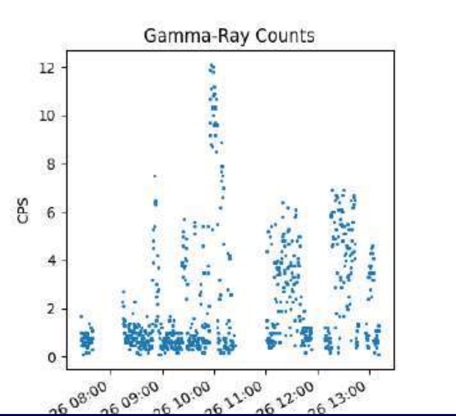
Glider extension bay, USBL modem, and gamma sniffer (Castelo de Bode, Portugal)

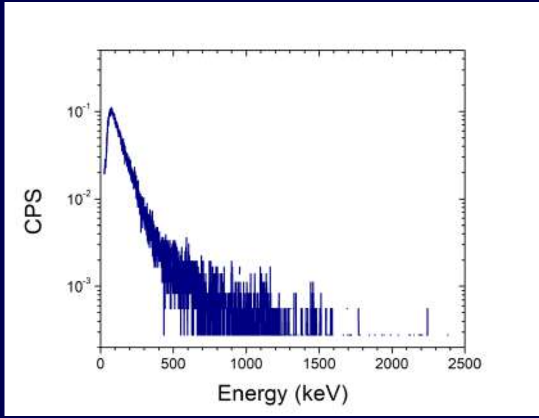
System Integration with Robotic Vehicles
First integrated system field test

Field tested instruments and integration code



Internal glider measurements of depth and pressure, C. de Bode, Portugal





Radiation data gathered though ROS code, Milos, Greece

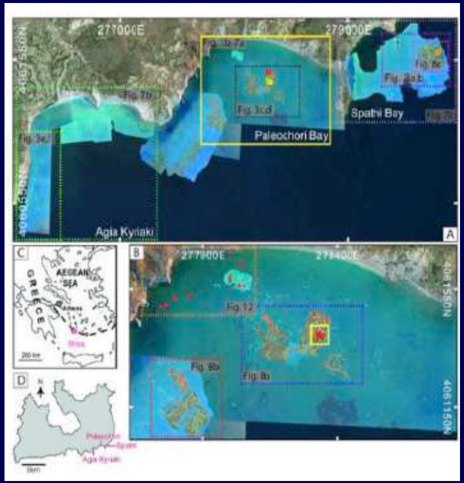
System Integration with Robotic Vehicles
Canarias – ROC-SIANI

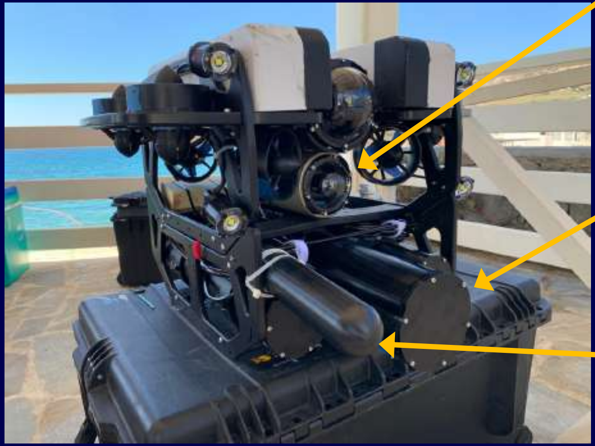
RAMONES

RADIOACTIVITY • MONITORING • IN • OCEAN • ECOSYSTEMS

Field tests – Milos (GR) 2023

RAMONES





CHERI UV

SUGI + Benthic control

γ-Sniffer

ROV "*METIS*" (NKUA / NTUA)

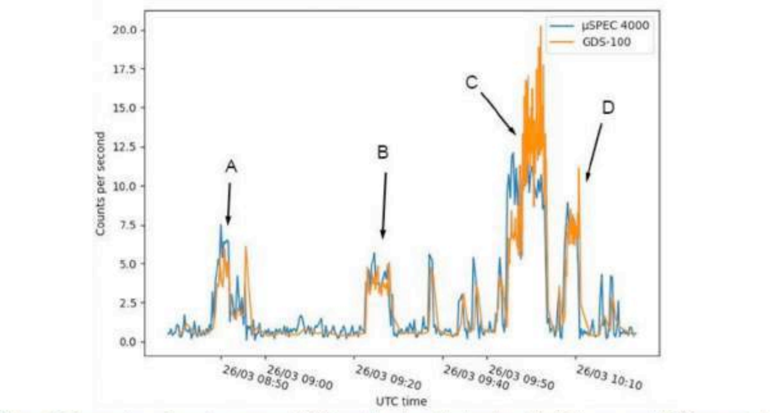


Figure 26 Comparison of counts-per-second (CPS) readings from the baseline (γSniffer) sensor with CPS computed based on events registered by SUGI for Paleochori

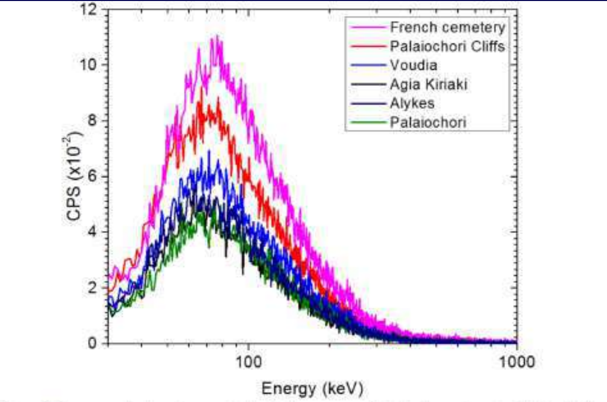


Figure 25 Time-normalized spectra acquired by in situ measurements in shallow waters using the handheld γSniffers. The Compton interaction of the gamma rays in water is dominant. Note, the x-axis is in log scale.

Field tests – Kolumbo (GR) June 2023

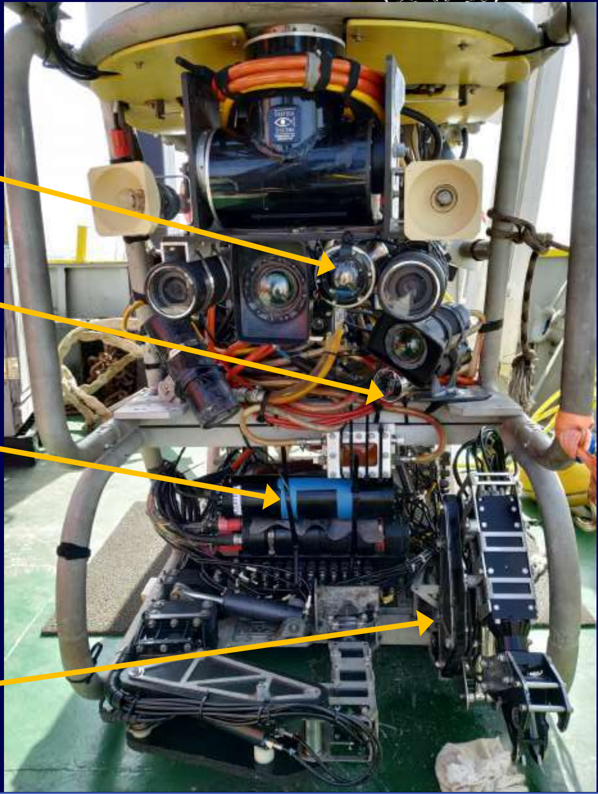
RAMONES

CHERI UV

CTD

SUGI + Benthic control

γ-Sniffer



Field tests – Kolumbo (GR) October 2023

RAMONES

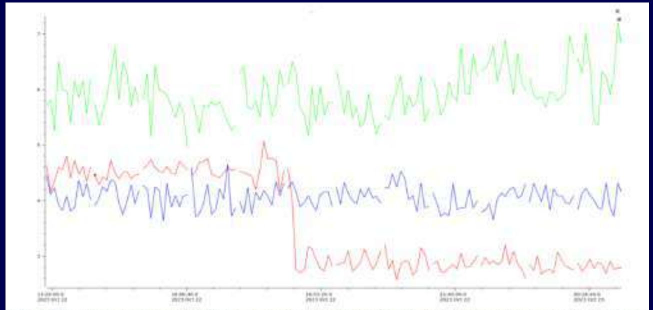


Figure 45 Extended-time monitoring of radioactivity in the Kolumbo caldera captured simultaneously using three γSniffers placed at different depths

Benthic lab control module

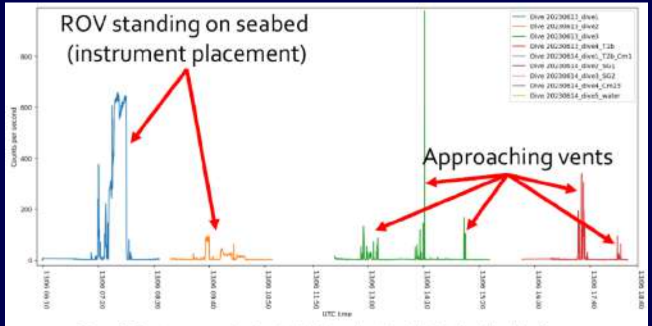


Figure 41 Counts per second vs time for the data collected of the first four dives (day 1)

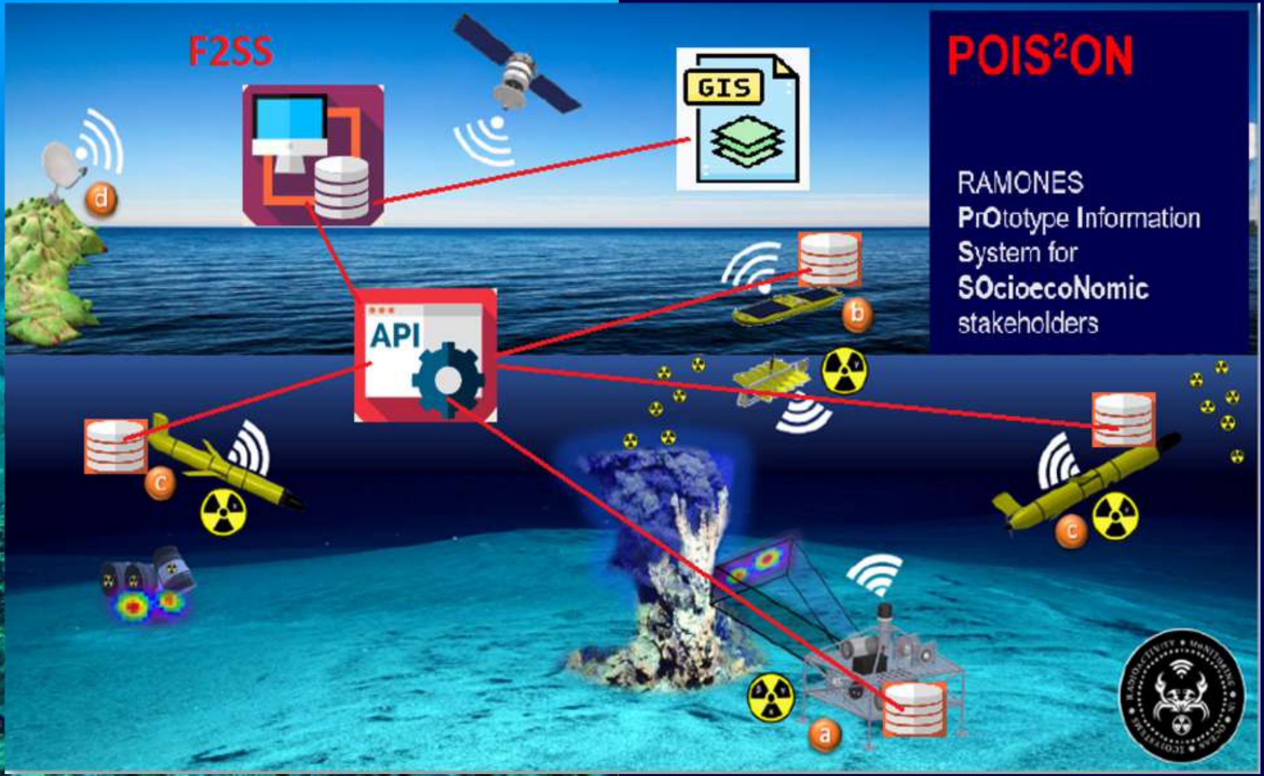
Technological innovations

- ✓ Novel instrument for gamma spectroscopy in the marine environment (γ-Sniffer)
- ✓ Novel instrument for gamma radiation imaging in the marine environment (SUGI)
- ✓ Novel imager for u/w Cherenkov radiation (CHERI UV)
- ✓ Novel acoustic and radioactivity payload for autonomous underwater gliders (γ-Sniffer + USBL/Modem + AUG)

- POIS2ON – PrOtotype Information System for SOcioecoNomic stakeholders
- AI-based methods for Radioactivity Hotspot Detection, Recognition, and Monitoring
- Multi-modal Data Analytics and Environmental Modelling

POIS²ON

RAMONES

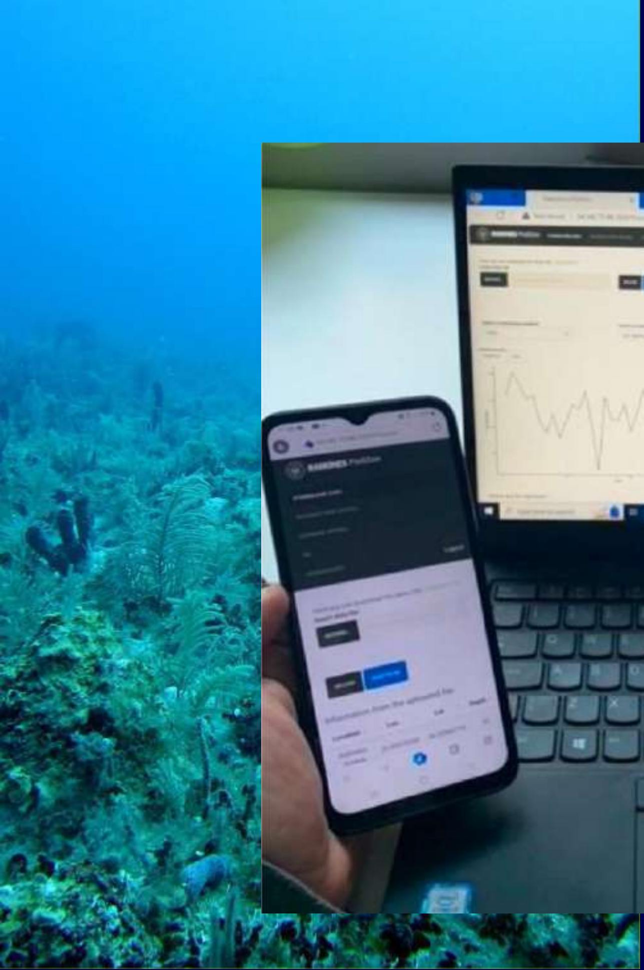


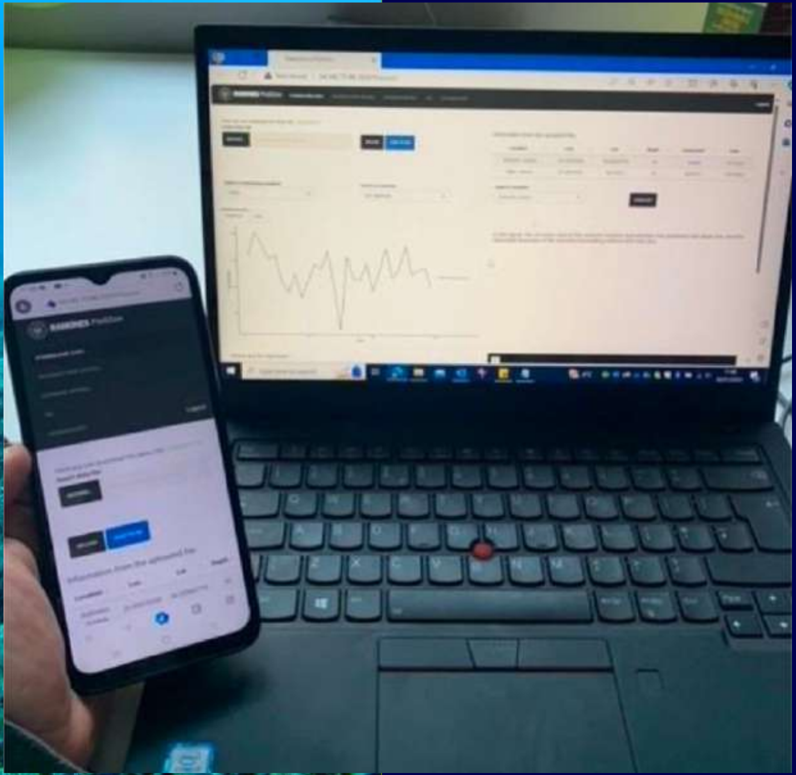
RAMONES
Pr**O**totype **I**nformation **S**ystem for
SOcioeco**N**omic stakeholders

A true **EI** solution and initiative

POIS^{2}ON

RAMONES





RAMONES
Pr**O**totype **I**nformation **S**ystem for **SOcioecoNomic** stakeholders

A true **EI** solution and initiative

THE JOINT ENVIRONMENTAL INTELLIGENCE

WATCHPLANT

RADIOACTIVITY • MONITORING IN • OCEAN • ECOSYSTEMS

SMART LAGOON

I-Seed

Towards New Frontiers for Distributed Environmental Monitoring Based on an Ecosystem of Plant Seed-Like Soft Robots

A coalition formed under the umbrella of EIC

- ✓ ReSET
- ✓ WatchPlant
- ✓ SmartLagoon
- ✓ i-Seed
- ✓ RAMONES

RAMONES

RAMONES – Radioactivity Monitoring in Ocean Ecosystems

David Cabecinhas (IST/ISR)
on behalf of RAMONES consortium

EMRA 2024, Arenzano, Italy – May 28th, 2024

Receives funding from European Union under Horizon 2020 FET Proactive Programme via grant agreement No. 101017808

EMRA'24
Arenzano, Italy
May 27-29, 2024

Towards the sustainable development of the Atlantic Ocean

Ralf Bachmayer
rbachmayer@marum.de
Werner Siemens Innovation Center for Deepsea Environmental Monitoring
MARUM - Center for Marine Environmental Sciences
University of Bremen
Germany

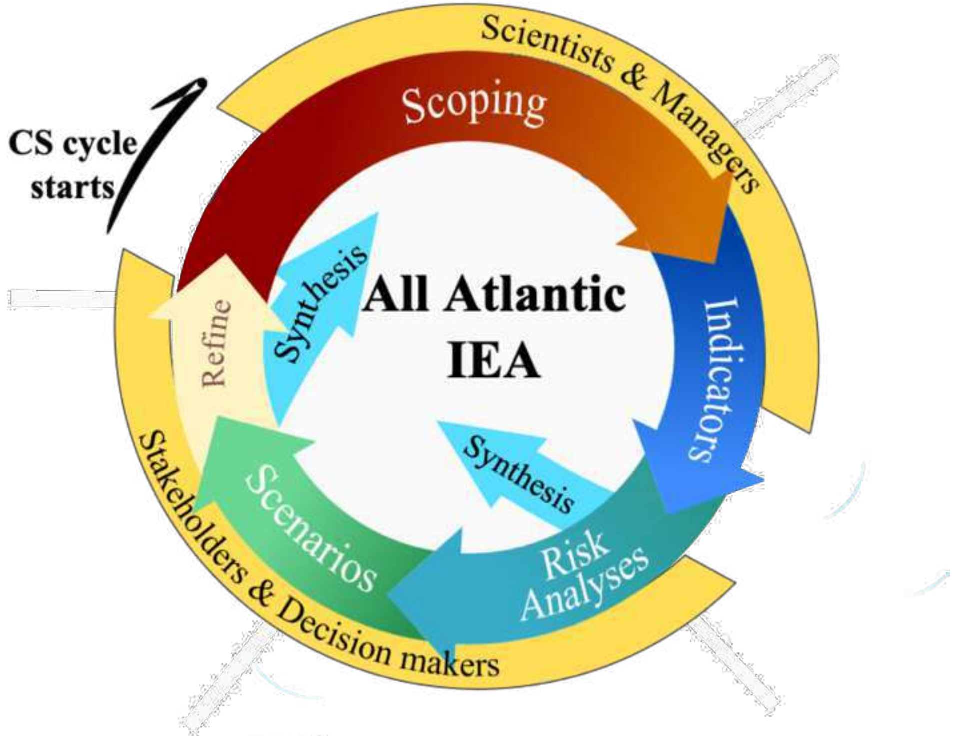
Integrated Marine Ecosystem Assessment

- Integrate knowledge for a systemic approach to the management of Atlantic Ocean ecosystems

- MISSION ATLANTIC develops and systematically applies Integrated Ecosystem Assessments (IEAs).

- IEAs enable identification of ecosystem components most at risk from natural hazards and the consequences of human activities.

The project employs all available information on those sources, the pressures they impose, and the ecosystem components are affected, to identify the most important risk factors influencing sustainable development.

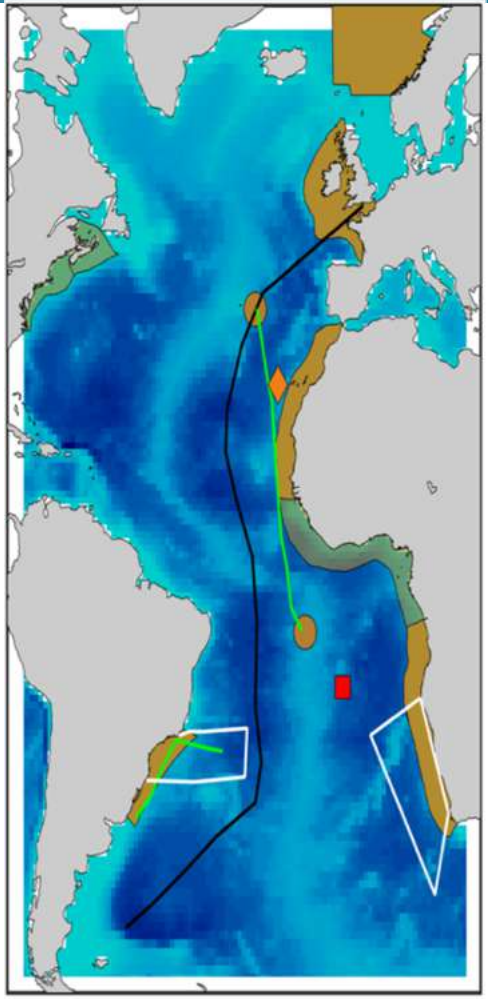


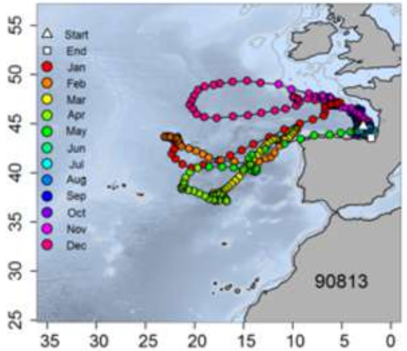
MISSION ATLANTIC

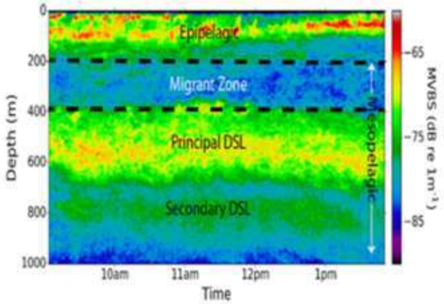
New data and technologies

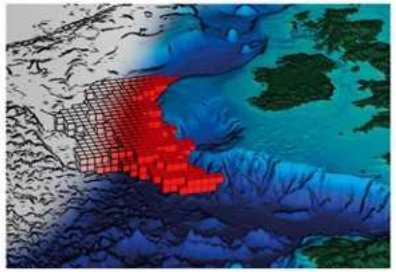
EMRA'24
Arenzano, Italy
May 27-29, 2024

- 7 Case Studies for the IEA cycle + All Atlantic synthesis
- Data are collected across those regions
- New technologies for marine automation developed for effective data acquisition, storage and analyses (7 technology demonstrators)









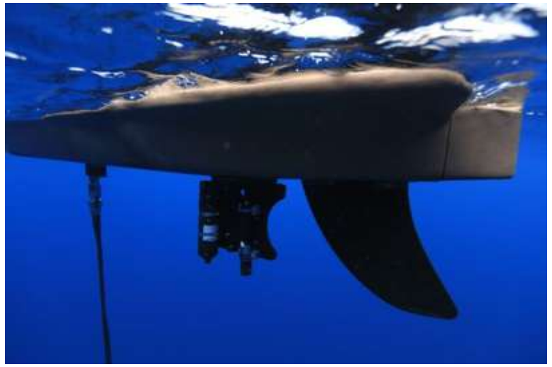
Field campaigns Waveglider

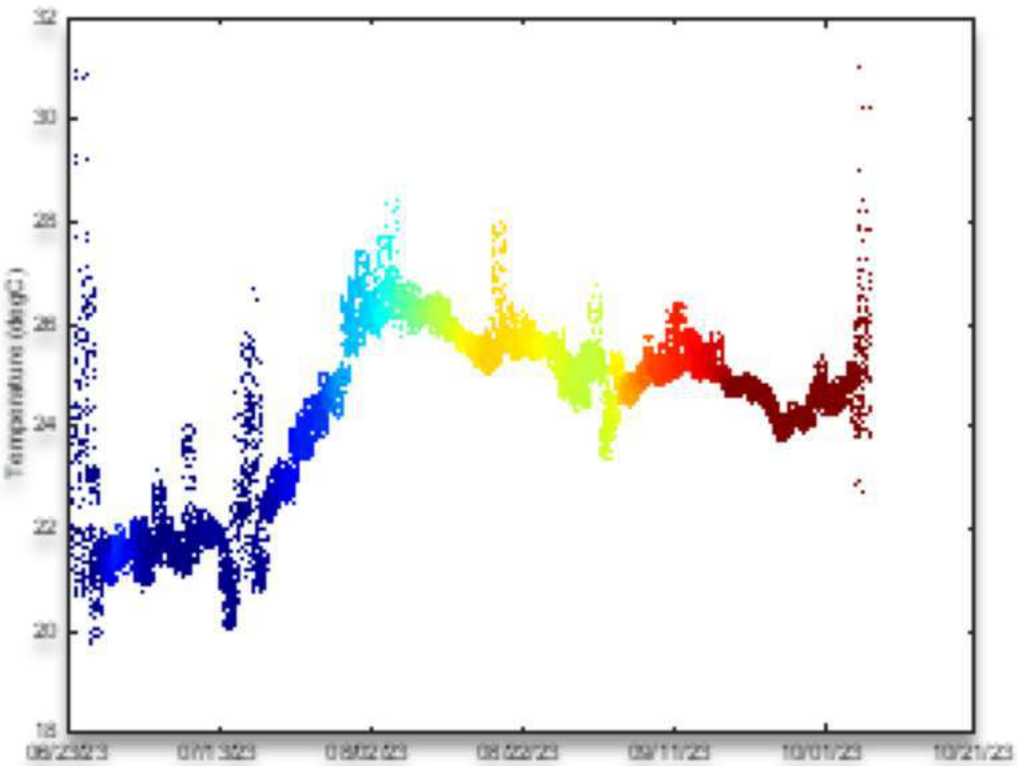
Deployment June 26 2023 Horta, Azores

Detection of problem July 15, return and holidng position for two weeks

Relaunch August 7th

Recovery Gran Canaria October 7th

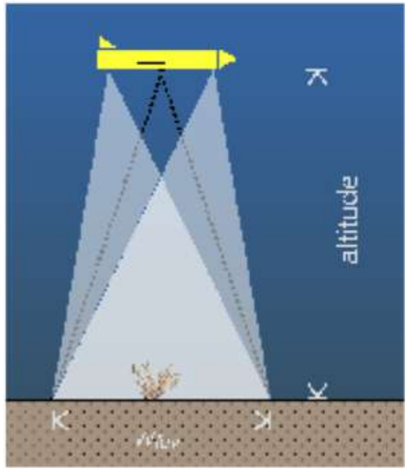


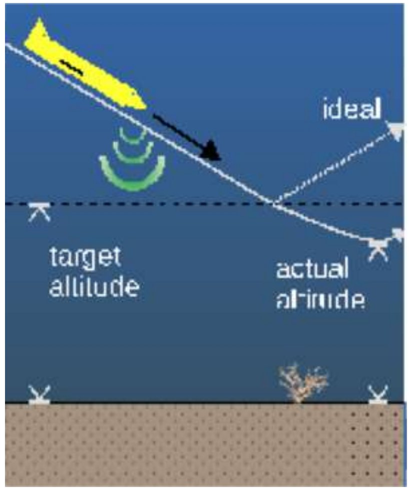


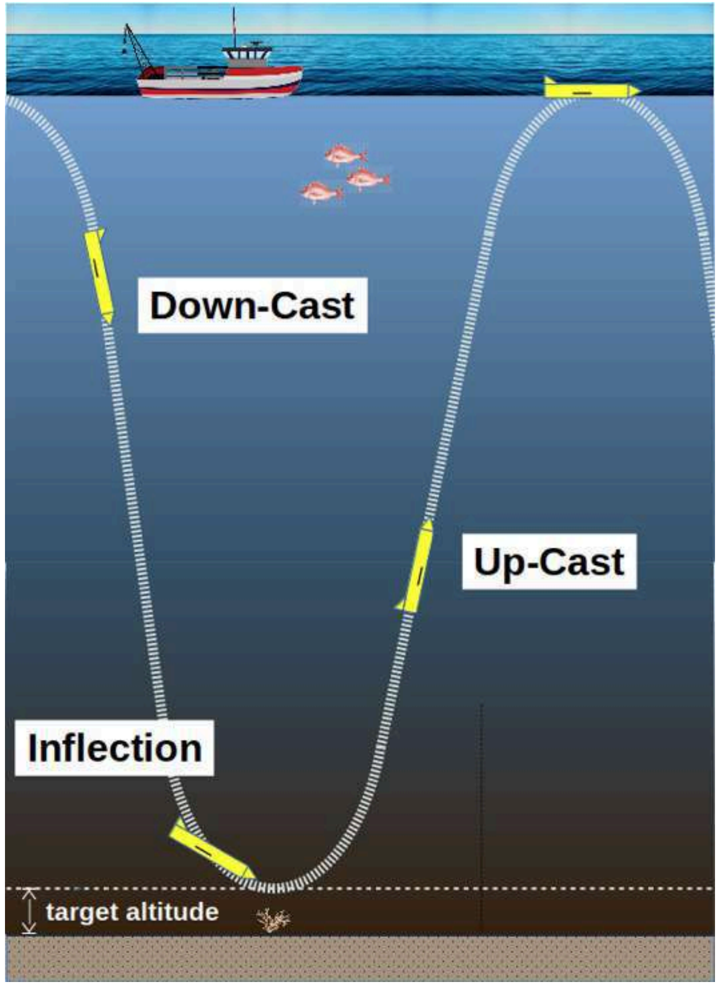
Long-Endurance Optical Seafloor Imaging using Underwater Gliders – Idea and Concept

EMRA'24
Arenzano, Italy
May 27-29, 2024

- Motivation:
  - Large scale, low cost collection and classification of seafloor images for seafloor (ecosystem) classification
- Leverage:
  - widely used infrastructure, i.e. Slocum gliders
  - Long endurance
  - Standardized payload modules and access ports
- Concept:
  - Stand-alone seafloor imaging payload including Camera, Lights, Control and Acquisition
  - Camera system activation at deep inflection





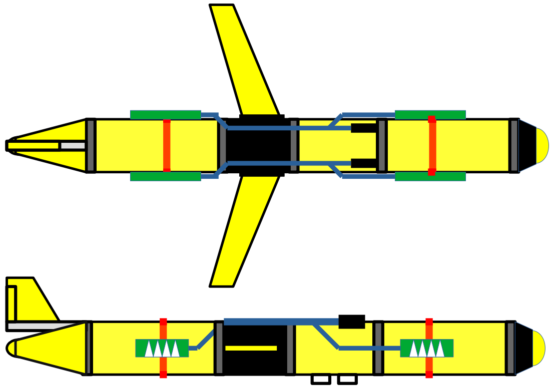


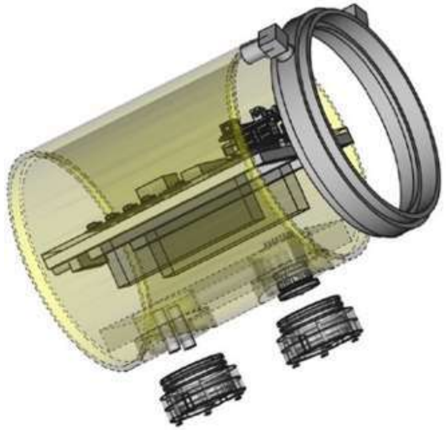
D. Gregorek, A. Tibebu, E. Caudet, C. Barrera, R. Bachmayer. "Long-Endurance Optical Seafloor Imaging Using Underwater Gliders: Concept, Development and Initial Trials" IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2023.

Imaging Payload - Technical Specifications

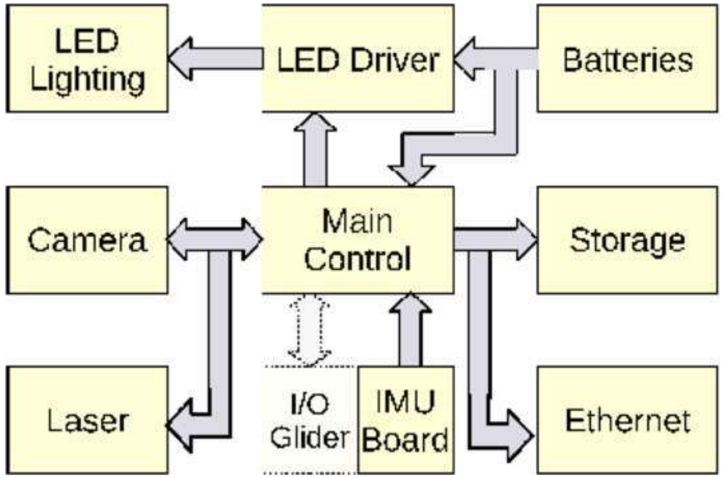
EMRA'24
Arenzano, Italy
May 27-29, 2024

- 1000 m standardize SLOCUM glider pressure housing with custom view ports
- Downward looking low-light camera
  - Up to 1.1” sensor size
- External LED lighting modules
- Attitude sensor / IMU



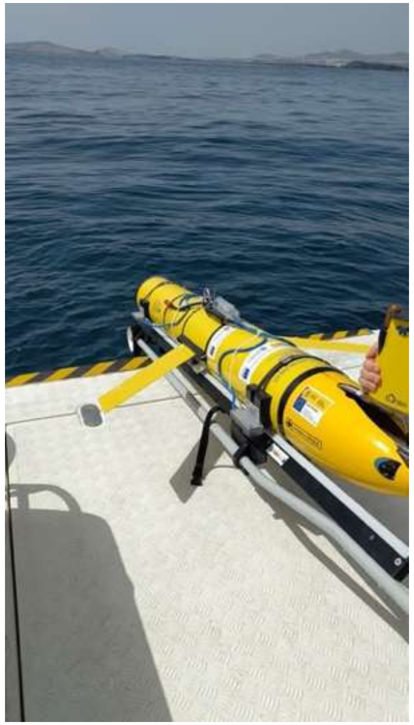


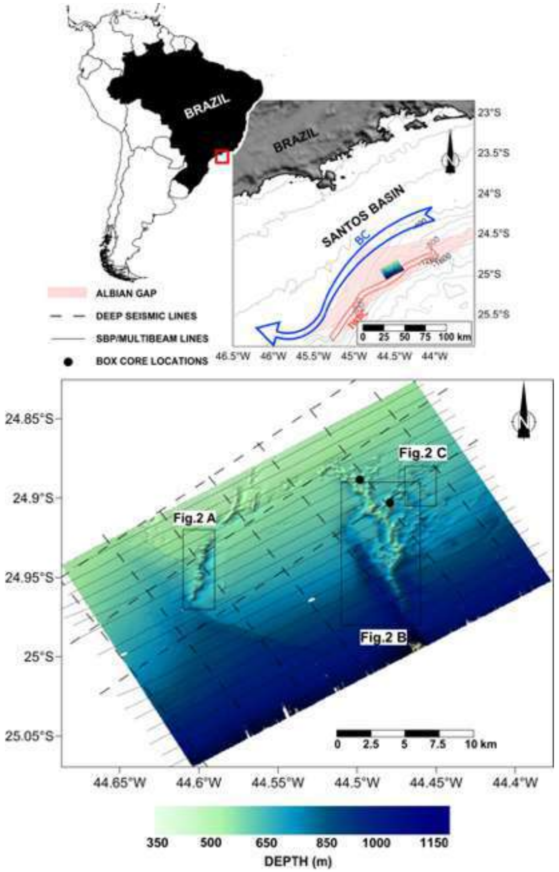
- Heterogenous on-board computer
  - Microcontroller + SBC
- Laser module
  - Photogrammetry Range finding
- Adaptive sampling based on IMU (inflection) and laser range finder (altitude)



Field campaigns - Underwater Glider

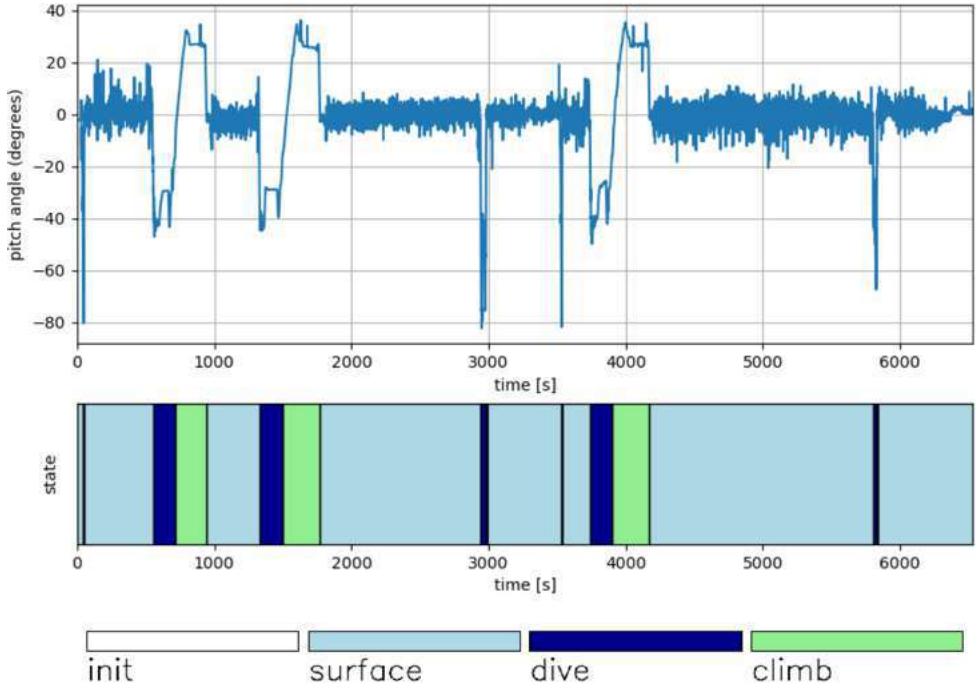
- 2022/23
  - System Test, Melenara Bay, Telde, Canary Islands (PLOCAN) < 50 m depth
- April 2024
  - Full system deployment >100 m
  - Acoustic altimeter issues
- June 2024
  - Deep deployment < 1000 m
- Sept/Oct 2024
  - Operation on Alpha Crucis Carbonate Ridge (Brazil)





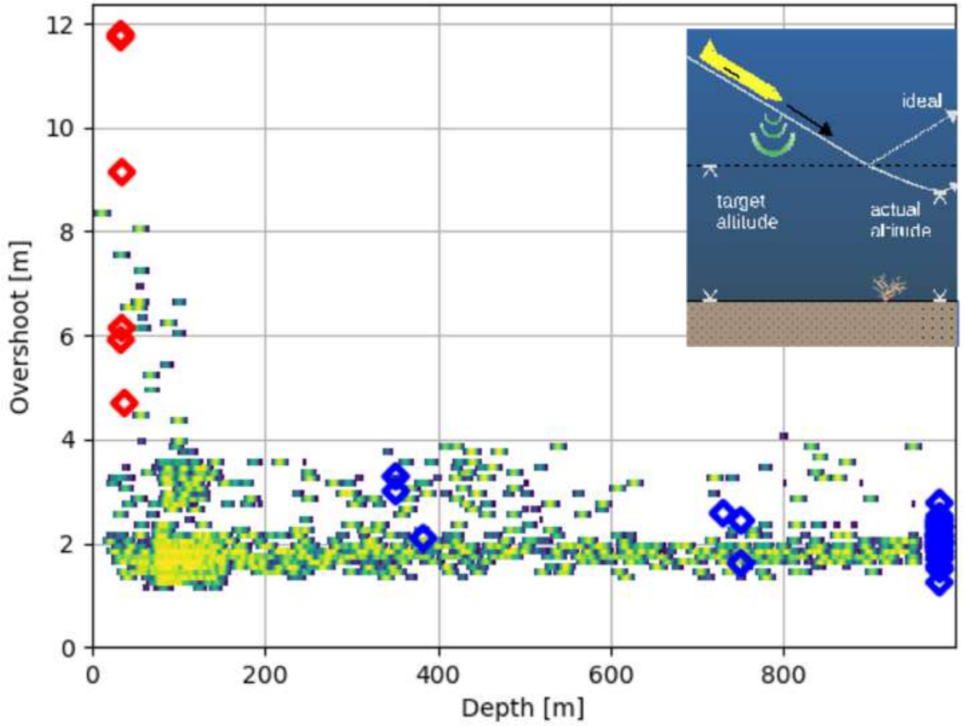
Maly, M., Schattner, U., Lobo, F.J. et al. The Alpha Crucis Carbonate Ridge (ACCR): Discovery of a giant ring-shaped carbonate complex on the SW Atlantic margin. Sci Rep 9, 18697 (2019). https://doi.org/10.1038/s41598-019-55226-3

Imaging Module Control



Measured pitch angle θ by payload IMU during deployments and estimation of glider state. The sharp spikes stem from the launch & recovery of the glider.

- Main imaging system only active during low point inflection
- Wake-up through in IMU -> altitude and water quality measurement -> image acquisition

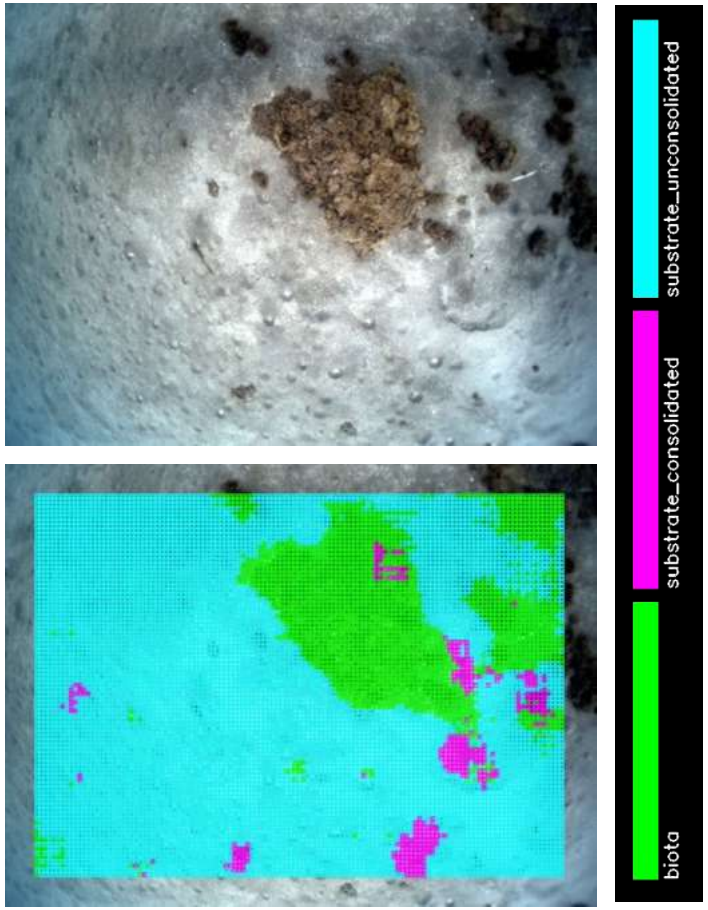


Overshoot vs. maximum dive depth. The blue diamond markers represent our measurements with a baseline Slocum G3, the red markers with the extended G3 carrying the imaging system.

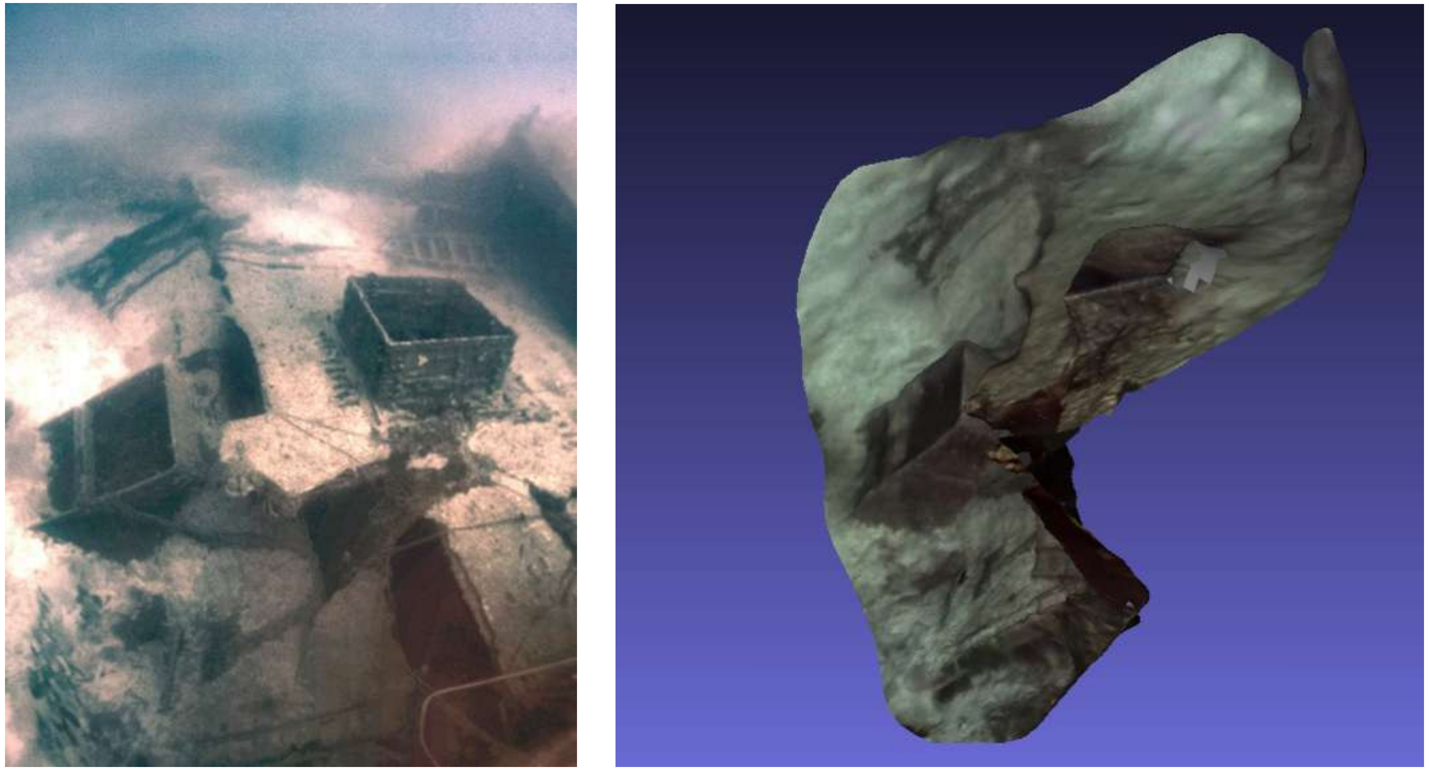
- Glider overshoots during seafloor approach Overshoot varies between dives ≈5 m safety margin needed

Image Post-Processing examples

EMRA'24
Arenzano, Italy
May 27-29, 2024

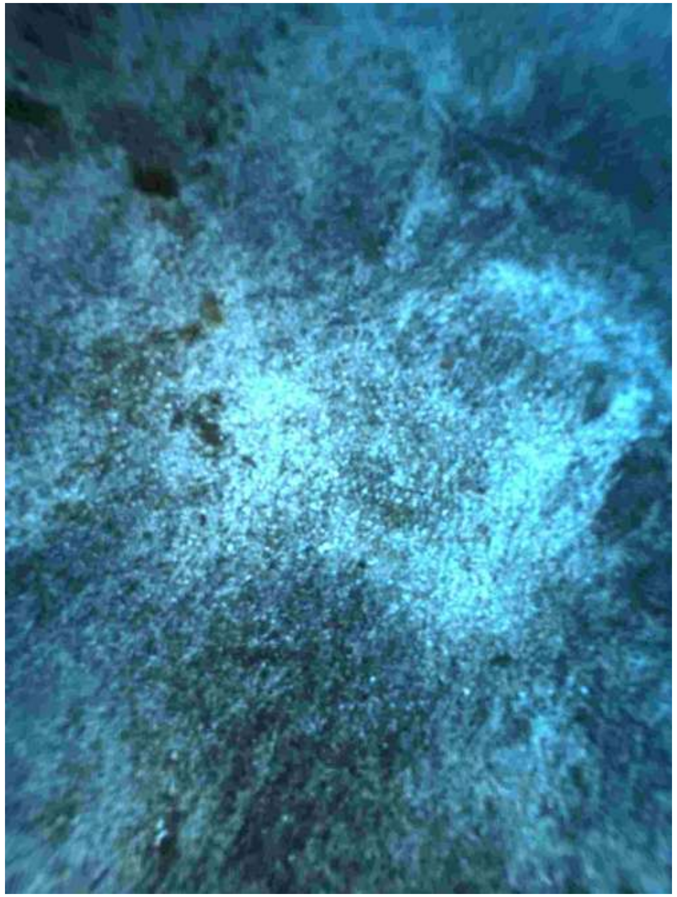


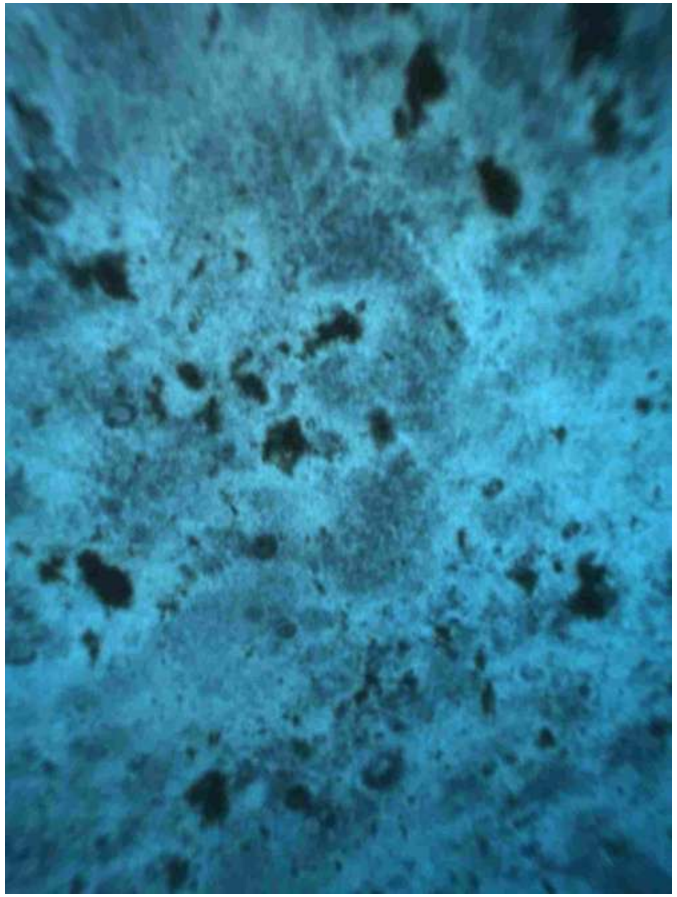
Seafloor classification: 73.9% accuracy using BENTHOZ- 2015 dataset



Sample image from potential ship wreck at Melenara Bay and 3D reconstruction. Single overflight with underwater glider.

Sample images from Melenara Bay seafloor





Results & Outlook

Achievements

- Working imaging and lighting module
- Standalone system (including power) for Slocum class gliders, so far deplyed on G2 and G3 gliders
- In vehicle charging of module and data download
- Independent waterquality (optical) and altitude detection for adaptive sampling
- Post-processing of images and synchronization with glider data

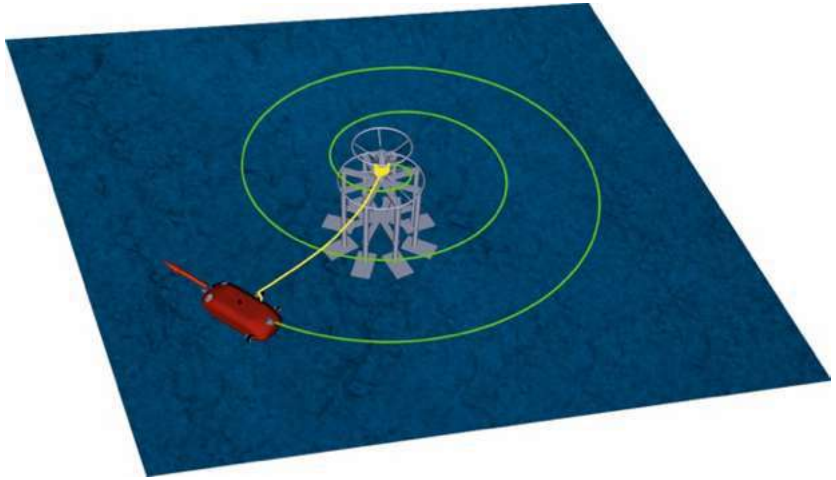
To do's

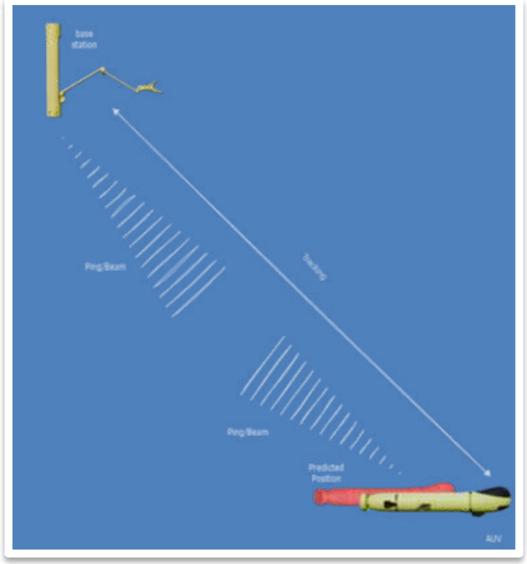
- On-board ultra low power processing for auto-classification of images
- Power consumption can be further reduced
- Streamlining of wiring and lighting modules
- …

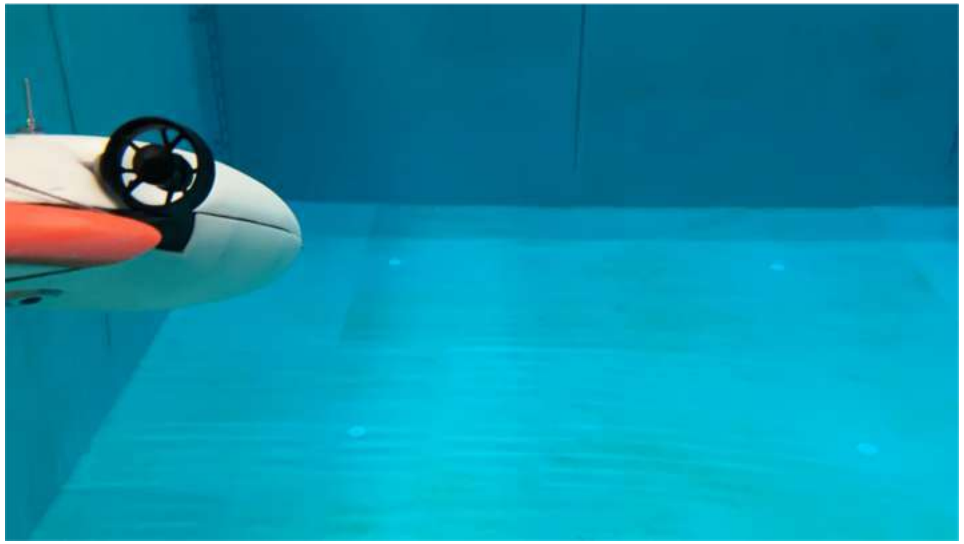
Other system developments at MARUM University of Bremen

EMRA'24
Arenzano, Italy
May 27-29, 2024

- Hybrid Deep-Sea Observatory for long-term monitoring (<3000 m, <2000 m^2)
- Deep Hybrid glider (<3000 m)
- Autonomous gas detection and sampling
- In-situ Sensing (such as Raman, in-situ microscope)
- Extra-terrestrial under-ice exploration







The Underwater Glider Project is conducted at MARUM by

- Daniel Gregorek e-mail: dgregorek@marum.de
- Ralf Bachmayer e-mail: rbachmayer@marum.de

and supported at PLOCAN by

- Eduardo Caudet and Carlos Barrera

Mission Atlantic contacts:

Project Coordinator
Patrizio Mariani
Email: pat@aqua.dtu.dk

AORA – Belem Panel Chair
Michael St. John
Email: mstjo@aqua.dtu.dk

Management Team
Elliot J Brown
Maria Kruger-Johnsen
Ivo Grigorov
Email: missionatlantic@aqua.dtu.dk

The Project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant agreement No. 862428

www.missionatlantic.eu
/missionatlantic
www.allatlanticocean.com
/allatlantico

Jan Opderbecke
IFREMER

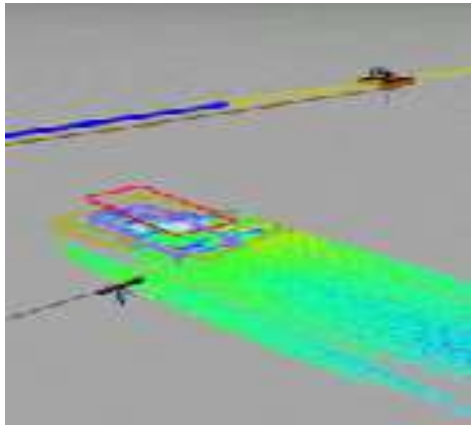
Eurofleets+ Task 3.3

JRA: Cooperative USV & AUV navigation

Task background & objectives

1. Why use cooperative AUV-USV operations ?
2. Design choices and use cases for AUV-USV operations
3. Deep-sea positioning strategies
4. Deep-sea positioning performance analysis



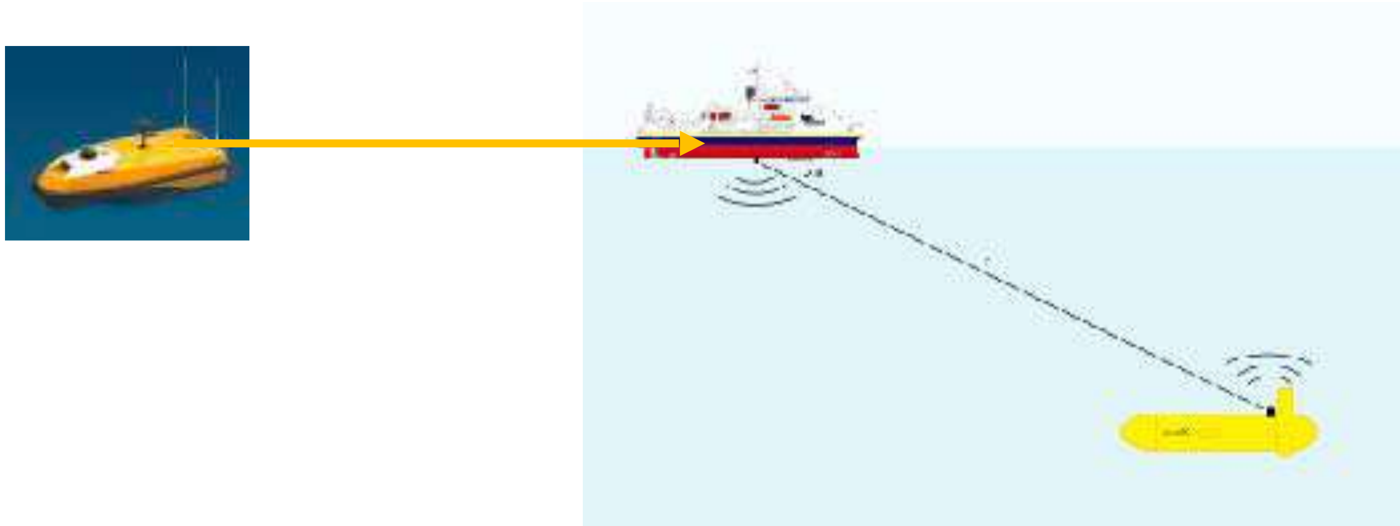
JRA : Cooperative USV & AUV navigation


Ifremer’s 6000m AUV ulyX on Pourquoi Pas ?

1. Purpose of cooperative AUV-USV operations ?

- AUV nav & scientific data need acoustic positioning
- Sea-floor LBL-transponders are a time-consuming solution
- Research vessel are still used for this purpose

Will the use of an additional vehicle (the USV) solve the dilemma ?



2. Cooperative USV & AUV navigation – Design choices

USV characteristics (endurance, size…) & deployment conditions depend on positioning solution.

The task objective is to examine a USV use case in regards of the AUV positioning requirement.

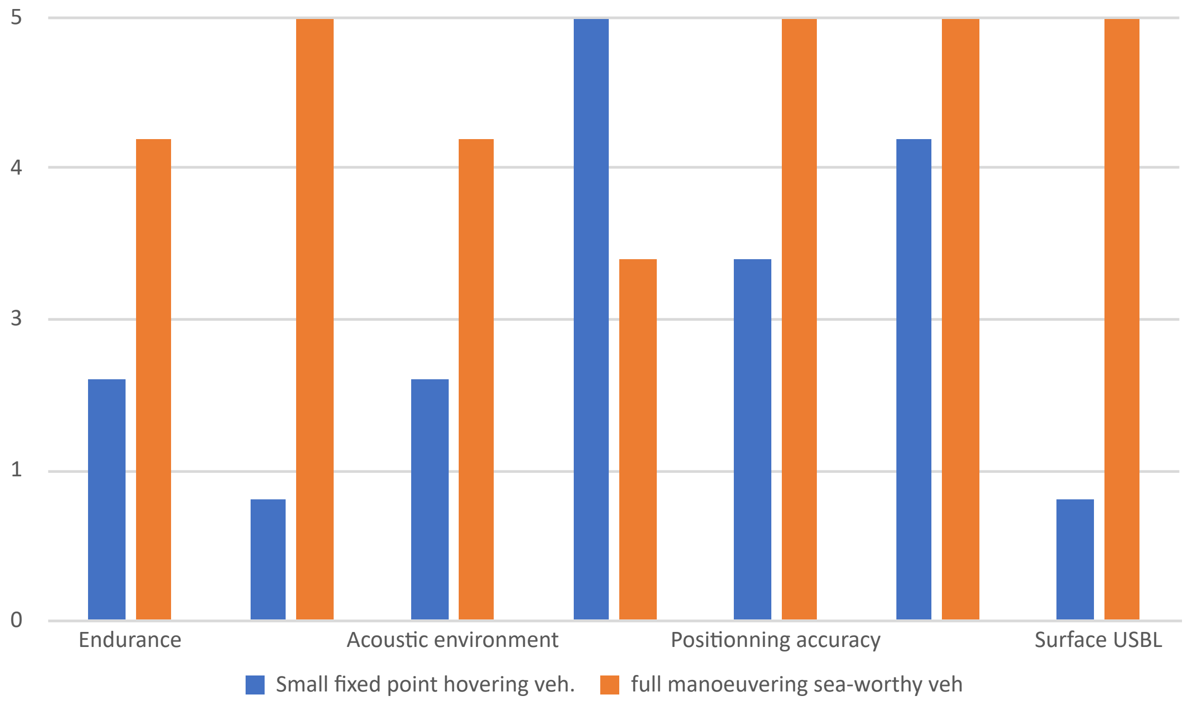
Defining a USV solution

Small fixed point vehicle (a) vs **Fast seaworthy vehicle (a)**

- surface LBL
- "virtual mooring" centered in survey area
- Small footprint on ship (space& crew)
- Battery powered, few hours
- Low impact

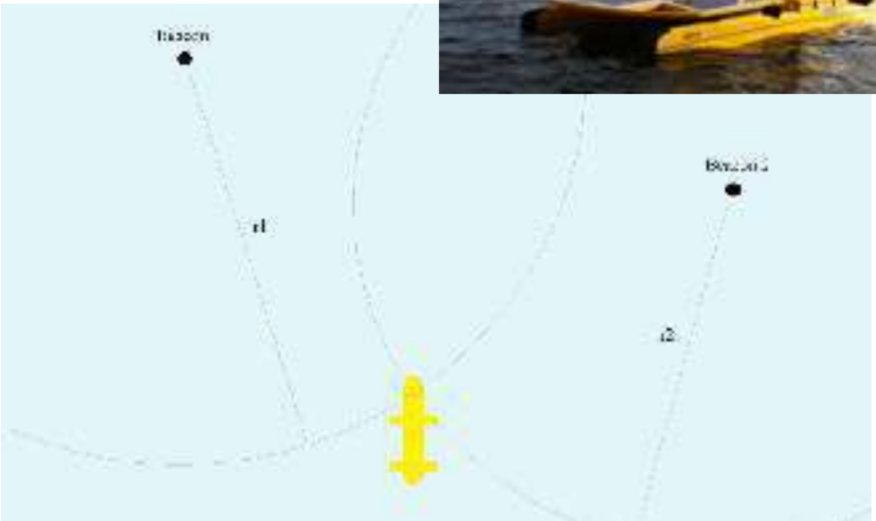
- surface USBL
- Follows AUV
- Larger footprint on ship (space& crew)
- Diesel engine, mutli-dive endurance
- Major equipment

USV design criteria

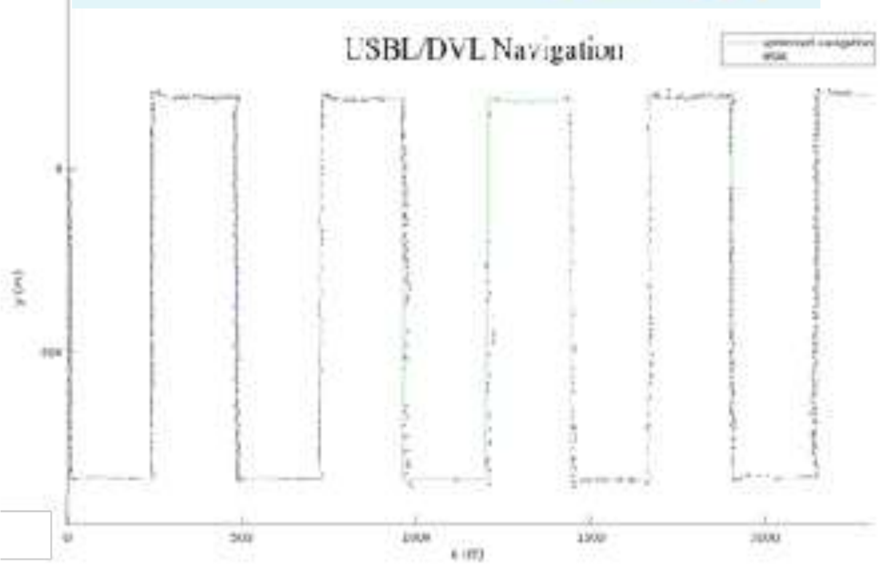


3. Cooperative USV & AUV navigation – positioning strategies

Evaluation on real data : USBL or surface-borne LBL

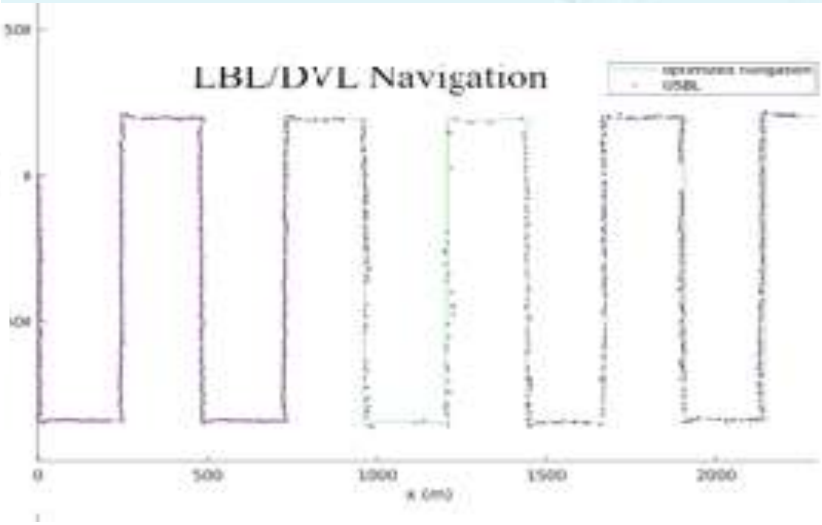


USBL and LBL to be implemented on USV



$$\begin{pmatrix}\Delta\hat{\Theta}\\ \Delta\hat{c}_{imu}\\ \hat{s}\end{pmatrix} = \underset{\Delta\Theta,\Delta c_{imu},s}{\operatorname{argmin}} \left(E_{range} + E_{depth} + E_{prior}\right)$$

$$E_{range} = \sum_{i=1}^{N} \left(\frac{rBL_i - r_{imu,i}}{\sigma_{BL}}\right)^2$$



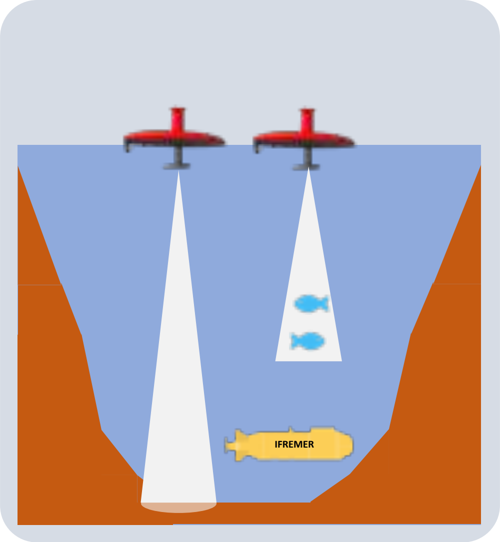
AUV/USV for deep-sea AUV positioning : range-only vs USBL

Main conclusions

- Range measurements from a single transponder (USV) allow to obtain global accuracy of the observed AUV path at the same level of performance as a series of USBL positioning.
- Range-meter “virtual long baseline” provides accurate vehicle path observation at the cost of a longer and complex of trajectory. Deep positionning needs wider geometric extent and travel, not suitable for a USV in fixed position.
- Range-meter position observation is especially suitable for lawn-mower type missions, much less on rectilinear long distance transects.
- Whenever the support vessel “real estate” allows use of a larger USV, the concept based on USBL positioning will be more versatile and have advantages especially in exploration type AUV missions requiring the USV to follow the AUV path.

Cooperative USV & AUV navigation – ongoing work

- Continued evaluation with surface-borne LBL
- USV experiment with USBL
- By-product : navigation post-processing software, new agorithms
- Perspective : Project SEMNA : real world trials with **IFREMER** AUV and **EXAIL** USV on blue-water research vessel



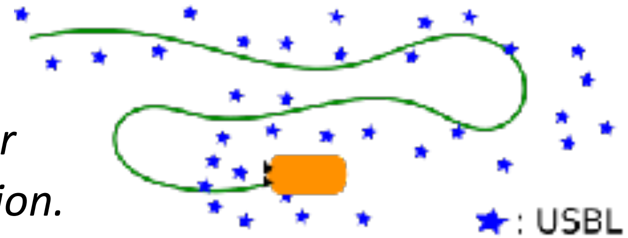
Navigation - applications

Real-Time

Hybrid dead-reckoning navigation:

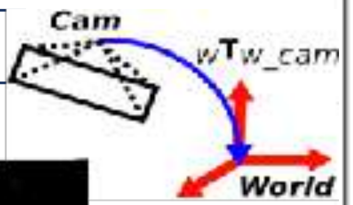
INS + DVL + Depth (+ USBL)

Ensure safe navigation for data acquisition.



Optical navigation :

Stereo Camera + INS + Depth



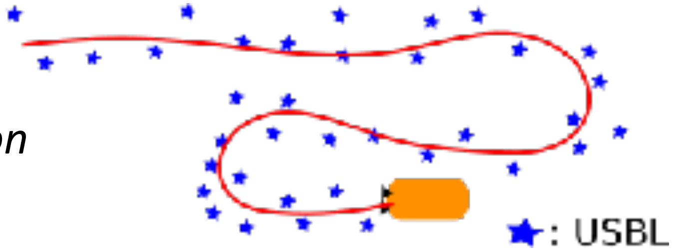
Highly accurate local navigation (e.g. for online 3D mapping).

Post-Processing

Maximum A Posteriori Estimate:

INS + DVL + Depth + USBL

Recover highly accurate navigation (e.g. for mapping).



Offline Photogrammetry:

Video / Still Camera(s) (+ nav)

Highly accurate 3D reconstruction, scaled from navigation sensors.

Navigation - algorithms

Real-Time	Post-Processing
Dead-reckoning navigation: *INS + DVL + Depth (+ USBL)* *Kalman Filter based* Accuracy: - Robustness: +	Maximum A Posteriori Estimate: *INS + DVL + Depth + USBL* *Nonlinear Least Squares Optimization* Accuracy: ++ Robustness: ++
Optical navigation: Stereo Camera + INS + Depth *Visual SLAM based* Accuracy: ++ Robustness: -	Offline Photogrammetry: *Video / Still Camera(s) (+ nav)* *Full Bundle Adjustment Optimization* Accuracy: +++ Robustness: ++

Navigation - algorithms

Real-Time	Post-Processing
Dead-reckoning navigation: INS + DVL + Depth (+ USBL) *Kalman Filter based* Accuracy: - Robustness: +	Maximum A Posteriori Estimate: INS + DVL + Depth + USBL *Nonlinear Least Squares Optimization* Accuracy: ++ Robustness: ++
Optical navigation: Stereo Camera + INS + Depth (+USBL) *Visual SLAM based* Accuracy: ++ Robustness: -	Offline Photogrammetry: Video / Still Camera(s) (+ nav) *Full Bundle Adjustment Optimization* Accuracy: +++ Robustness: ++

Thanks for your attention !

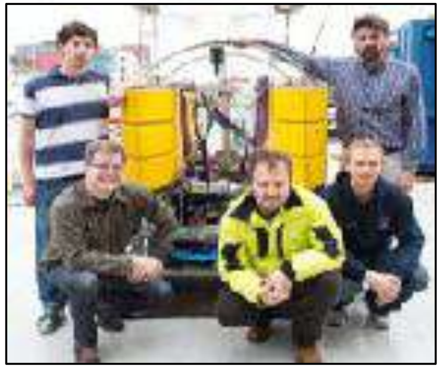
Centre for Robotics & Intelligent Systems

CRIS Centre for Robotics & Intelligent Systems

Science Foundation Ireland For what's next

MaREI Marine Renewable Energy Ireland

ENTERPRISE IRELAND where innovation means business



rapid

RISK-AWARE AUTONOMOUS PORT INSPECTION DRONES

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

CRIS
Centre for Robotics & Intelligent Systems

CONTENTS

- About RAPID
- Aim & Objectives
- Approach
- Final Demo

rapid

About RAPID

The EU-funded RAPID project combine and extend drone technology to deliver a fully automated and safety-assured maintenance inspection service for bridges, ship hull surveys, and more. Specifically, the service combine self-sailing unmanned surface vehicles with autonomous unmanned aerial systems.

rapid

PARTNERS

AIMS

The aim is to reduce the time and cost of structural condition monitoring of maritime transport infrastructures such as material-handling equipment, cargo and passenger ships, and bridges. RAPID's new system will also facilitate the prioritisation of safer transport infrastructure.

AIMS


CRIS
Centre for Robotics & Intelligent Systems
Offshore survey Dec 2022, RV Tom Crean.


CRIS
Centre for Robotics & Intelligent Systems

rapid

THANK YOU FOR YOUR ATTENTION

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

CRIS
Centre for Robotics & Intelligent Systems

Fostering Artificial Intelligence Trust for Humans towards the optimization of trustworthiness through large-scale pilots in critical domains

Workshop on EU-funded Marine Robotics and Applications

EMRA 2024, 28th May, Arenzano, Italy

Rafael Company: Director of Safety and Security
Mark Tanner: Project Manager of Innovation & Port Cluster development

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Directorate-General for Communications Networks, Content and Technology. Neither the European Union nor the granting authority can be held responsible for them.

Who we are

The **Port Authority of Valencia**,
which trades under the name of **Valenciaport**,
is the public body responsible
for running and managing
three state-owned ports,
Valencia, Sagunto and Gandia.

What we do

The Port Authority of Valencia
is part of the State-owned Ports Body, the umbrella organisation for Spanish ports.
The **PAV** is responsible for developing the global strategy for the three ports it manages, including

- Sales promotion and marketing
- Infrastructure planning and public land management
- The quality of port and logistics services
- Technological developments
- Environmental sustainability
- Research, Innovation and Knowledge Management

valenciaport

valenciaport
Autoridad Portuaria de Valencia

FUNDACIÓN VALENCIAPORT

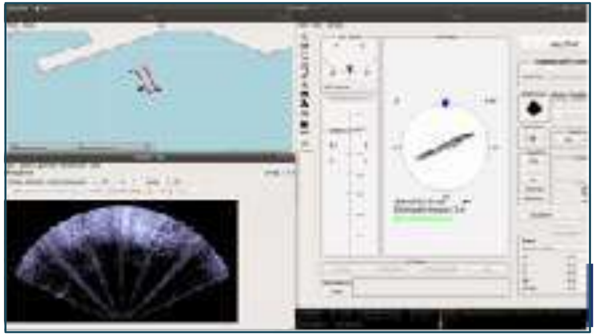

valenciaport
valenciaport
Autoridad Portuaria de Valencia
FUNDACIÓN
VALENCIAPORT

Smartports? Ports of the Future? What else?

Artificial intelligence plays **a key role in the ongoing digital transformation** and has triggered a global competition for tech leadership

END-TO-END DATA INTEGRATION AND STANDARDISATION

					
Marine	**Underwater**	**Tethered**	**Self charged**	**Aerial**	**Tw AI**
Use of marine drones equipped with sensors for the acquisition of bathymetry (Project INTESA).	Use of underwater drones equipped with sensors for the scan of the submerged part of vessels and queys and for the bathymetry (Project SMAUG & UNDERSEC)	Use of tethered drones for the surveillance and security of port areas (Project PASSPORT)	Use of self charged drones for surveillance, inspection and security of port areas (Project PASSPORT)	Use of aerial drones for 5G connection for offshore sensors (Project 5G)	AI trustworthiness: ethical, reliable, and designed to benefit and do no harm to individuals and society (Project FAITH)



Funded by the European Union

Marine Robotics (Port Surveillance)

Improved underwater detection & control capabilities to protect maritime areas & sea harbors

https://smaug-horizon.eu/

https://www.undersec-project.eu/

Project FAITH

Fostering Artificial Intelligence Trust for Humans towards the optimization of trustworthiness through large-scale pilots in critical domains

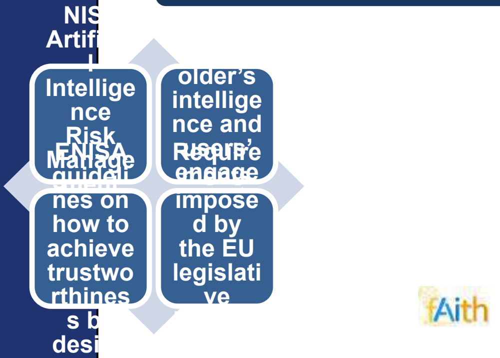
https://faith-ec-project.eu/

Funded by the European Union

Overall objective

To adopt a **human-centric, trustworthiness assessment framework** (FAITH AI_TAF) which enables the testing/measuring/optimization of **risks associated with AI trustworthiness in critical domains.**

FAITH AI_TAF components



FAITH AI_TAF validation

Phase 1. Generic threats of trustworthiness

Phase 2. Domain-specific threats and risks of trustworthiness

Seven (7) Large Scale Pilot (LSP) activities

- active ageing
- industry
- healthcare
- robotics
- education
- media
- transportation

FAITH AI_TAF cross-fertilization

Consortium

- **Total:** 18 partners.
- **Technical Innovation & Benefits Realisation** (FORTH, ATC, ICCS, CNR).
- **Research and development** (trustilio BV, KUL, SINTEF, UoS, BRIDG).
- **User needs and piloting** (FH, EA, MERMEC, APRA, Veas, UNIPI, PAGNI, AOA, VFP).

Funded by the European Union

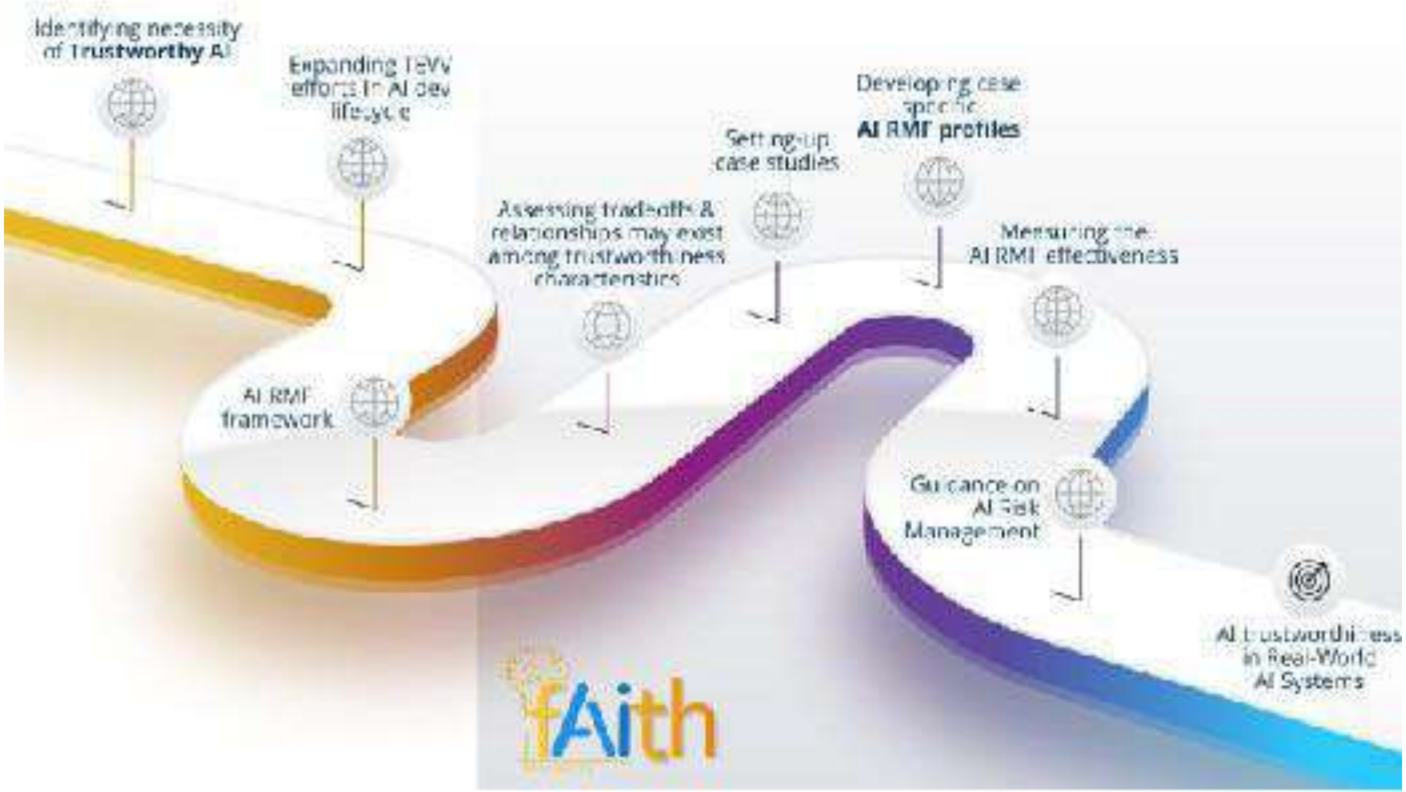
Trustworthy AI (TwAI)

- Development & deployment of an AI system that is: ethical, reliable, & designed to benefit and do no harm to individuals and society.

- Concept gaining attention as AI technologies become more & more present in our daily lives.

- Throughout the lifecycle of an AI system.

FAITH trustworthiness roadmap



TEVV: Test, Evaluation, Validation, and Verification
RMF: Risk Management Framework

Funded by the European Union

TRUSTWORTHINESS through LSPs

- **LSP1:** AI-based assistance to characterize disinformation in the news and claims.
  - **Domain:** Media
- **LSP2:** Use of AI for safer and sustainable public transit.
  - **Domain:** Transport
- **LSP3:** AI tools to constantly monitor student progress, to provide targeted feedback and assess the student's mastery.
  - **Domain:** Education
- **LSP4:** AI driven maintenance of port infrastructure on data from underwater drones.
  - **Domain:** Robotic/Drones
- **LSP5:** Hybrid AI models for wastewater treatment.
  - **Domain:** Industrial Processes
- **LSP6:** Use of AI for the reporting of medical images in radiology workflows.
  - **Domain:** Healthcare domain
- **LSP7:** Use of AI for Active Ageing solutions.
  - **Domain:** Active ageing domain

Funded by the European Union

TRUSTWORTHINESS through LSPs

- **LSP1:** AI-based assistance to characterize disinformation in the news and claims.
  - **Domain:** **Media**
- **LSP2:** Use of AI for safer and sustainable public transit.
  - **Domain:** **Transport**
- **LSP3:** AI tools to constantly monitor student progress, to provide targeted feedback and assess the student's mastery.
  - **Domain:** **Education**
- **LSP4:** AI driven maintenance of port infrastructure on data from underwater drones.
  - **Domain:** **Robotic/Drones**
- **LSP5:** Hybrid AI models for wastewater treatment.
  - **Domain:** **Industrial Processes**
- **LSP6:** Use of AI for the reporting of medical images in radiology workflows.
  - **Domain:** **Healthcare domain**
- **LSP7:** Use of AI for Active Ageing solutions.
  - **Domain:** **Active ageing domain**

Funded by the European Union

LSP4:

AI driven maintenance of port infrastructure on data from Autonomous Underwater Drones

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Directorate-General for Communications Networks, Content and Technology. Neither the European Union nor the granting authority can be held responsible for them.

Port needs

- Use new tech. to optimise operations (IA, UAVs, 5G…)
- Safety & security monitoring (intruders, smuggling, hull inspections, …)
- Support infrastructure monitoring
- Water quality campaigns and monitoring
- Bathymetry analysis + geopositioning sunken objects

SAFE & EASY WAY

Funded by the European Union

LSP4 – Scenarios

Scenario 1 - Bathymetry Analysis

Scenario 2 - Detection of Sunken Objects

Scenario 3 - Inspection of Underwater Infrastructure

Scenario 4 - On-Demand Inspection of Ship Hull

(quays, piers, vessels’ hulls, pipelines, etc.)

Funded by the European Union

Objectives

Trustworthy AI-driven Autonomous Underwater Vehicles (AUVs) for inspection and maintenance of port infrastructures

- Automatic Target Recognition
- Autonomous Coverage

- Support infrastructure monitoring for maintenance
- Bathymetry analysis

FEELHIPPO AUV

Weight: about 35 kg
Hull material: Plexiglass
Maximum depth: 30 m
Maximum speed: 2 knots
Length: [illegible] mm
Energy: 825 Wh
Battery Life: 4 hr
Controlled DOFs: 5

GPS

U-blox 7P precision Global Positioning System

AHRS

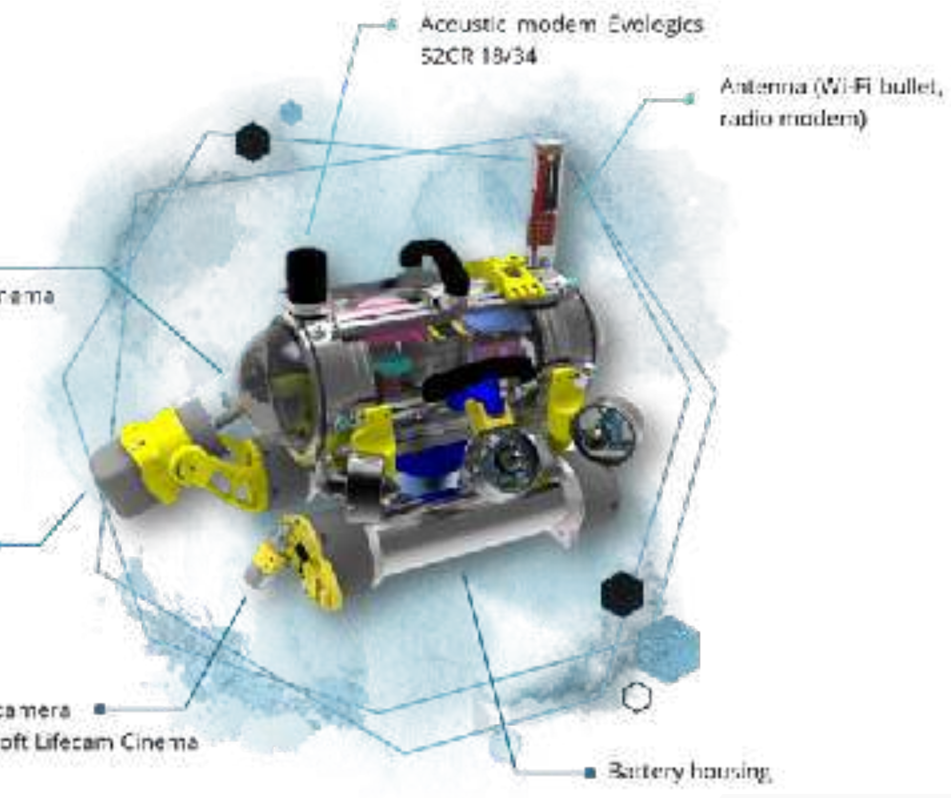
Orientus Advanced Navigation Attitude Heading Reference System

FOG

KVH DSP 1760 single-axis high precision Fiber Optic Gyroscope

DVL

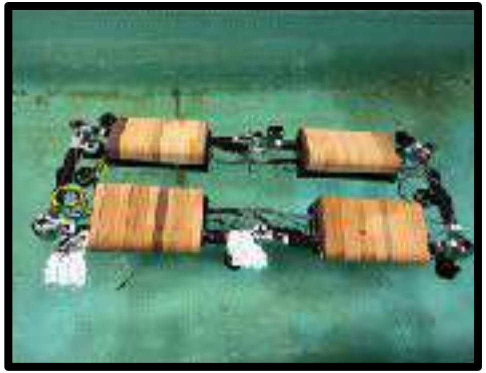
Nortek DVL1000 DVL, measuring linear velocity and acting as depth sensor



RUVIFIST R-AUV

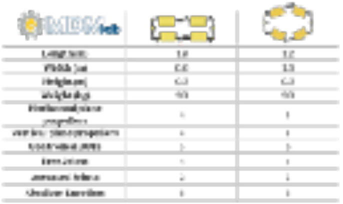
Reconfigurable **U**nderwater **V**ehicle for **I**nspection, **F**ree floating **I**ntervention and **S**urvey **T**asks

Thanks to two actuated joints, the vehicle can autonomously change its shape, switching between two extreme configurations



Survey Configuration

- Hydrodynamic efficiency
- 4 Thrusters along surge direction



Hovering Configuration

- 6 DOFs
- High maneuverability

RUVIFIST R-AUV – 3D scanning sensor

3D Multibeam Scanning Sonar:

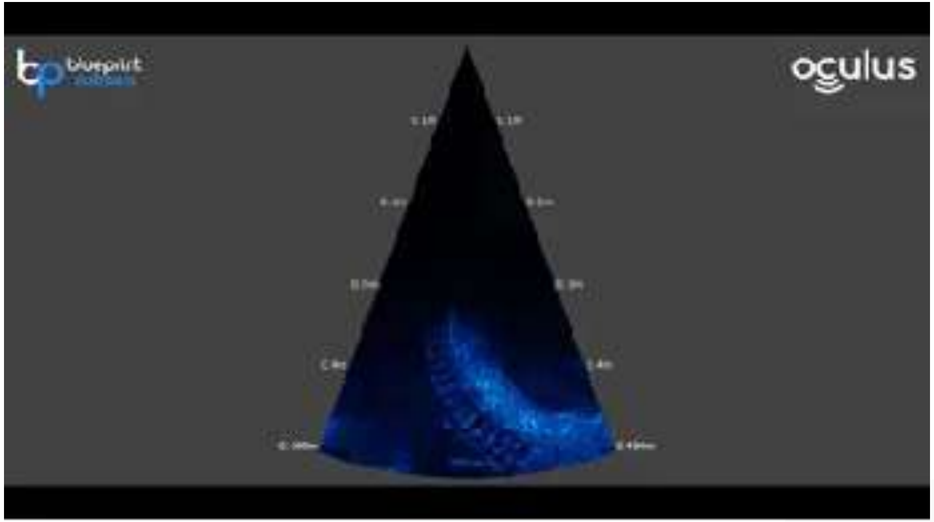
- creates high resolution imagery of underwater areas, **structures**, and **objects of interest**
- even in **low to zero visibility** conditions

High-resolution Forward Looking Sensor

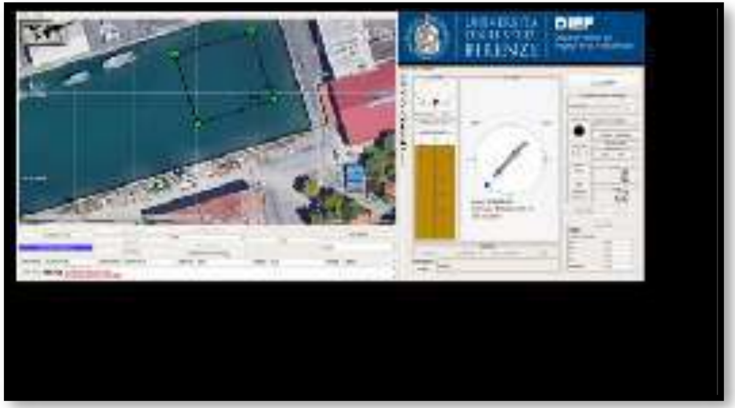
Utilizing the highest frequency in its class, the M3000D is perfect for **identifying targets** and **close range navigation**, as well as **detailed inspections** with the highest resolution of any 2D imaging sonar

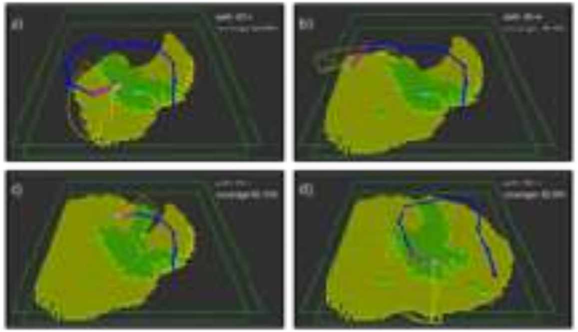
M3000D Multibeam Acoustic Specs

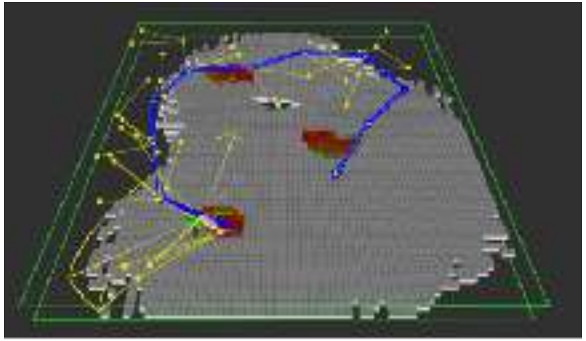
Frequency	1.2MHz (LF) / 3.0MHz (HF)
Range (max)	30m (LF) / 5m (HF)
Range (min)	0.1m
Range Resolution	2.5mm (LF) / 2.5mm (HF)
Update Rate (max)	40Hz
Horizontal Aperture	130° (LF) / 40° (HF)
Vertical Aperture	20° (LF) / 20° (HF)
Number of Beams	512
Angular Resolution	0.6° (LF) / 0.25° (HF)
Beam Separation	0.25° (LF) / 0.16° (HF)

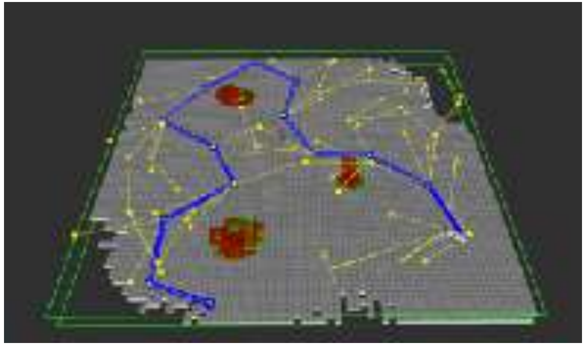


Perception-aware path planning



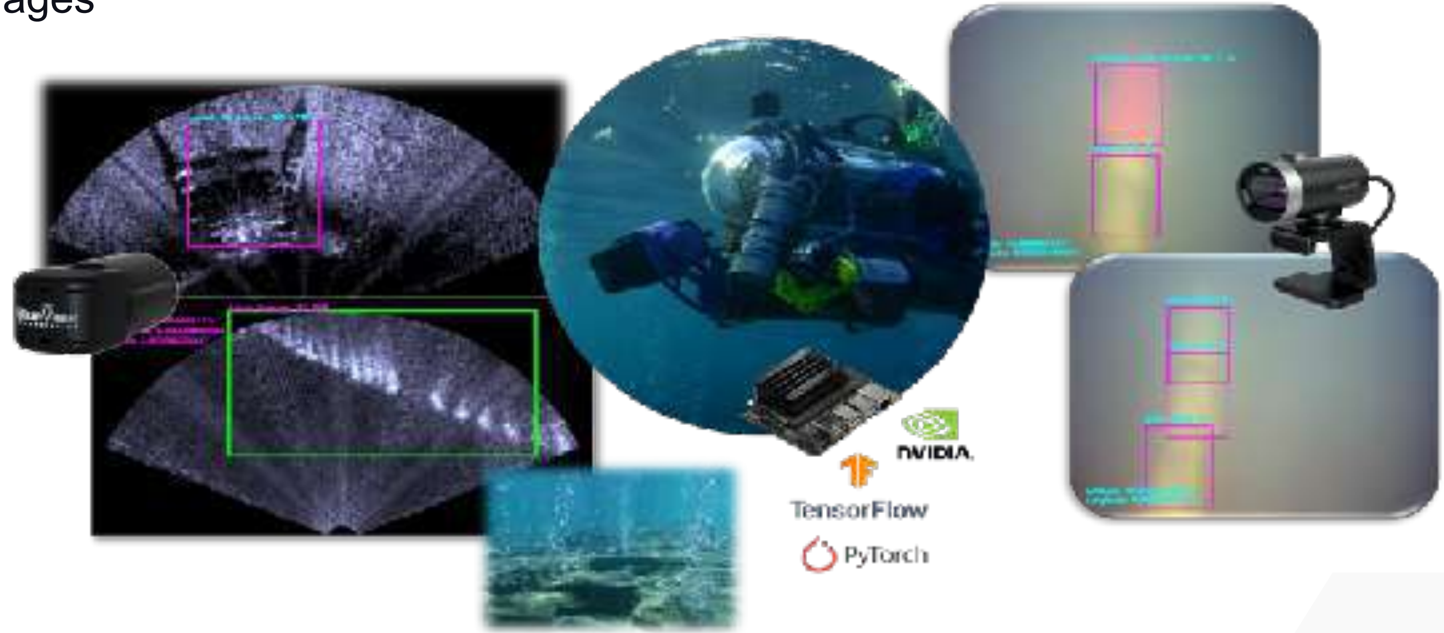






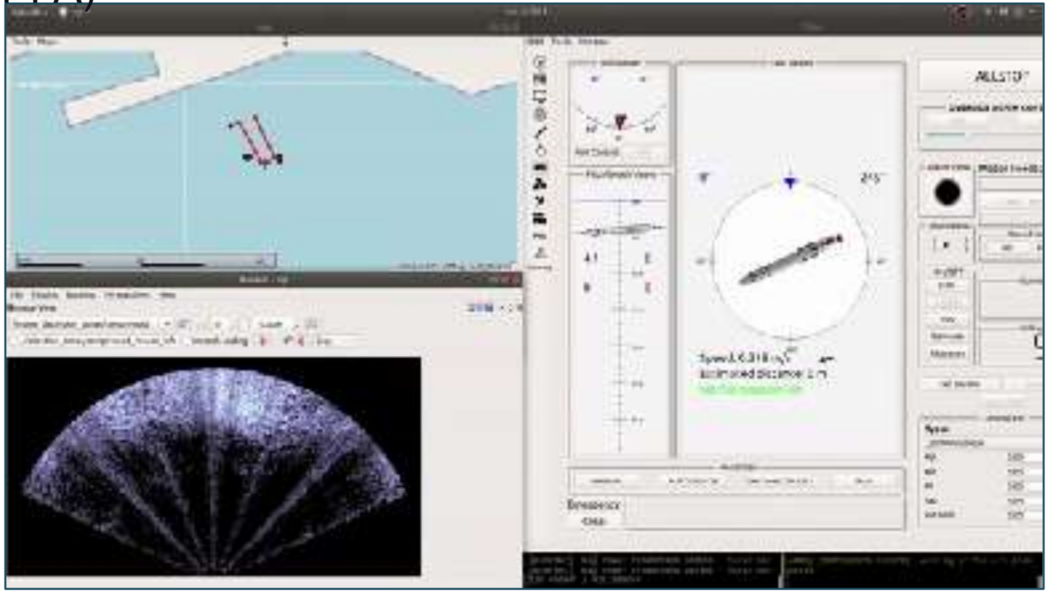
AI-driven methods: automatic target recognition

CNN models to **inspect port infrastructure by automatically recognizing and geo-locating objects of interest** located in port areas with FLS and optical images



AI-driven methods: automatic target recognition

Cluster the CNN model predictions in semantic world representation with Probabilistic Multiple Hypothesis Anchoring (PMHA) or Probabilistic Particle Filter Anchoring (PPFA)



LSP4 – For each mission

1) Remote control of UAVs (maritime and/or underwater):
- **Acquisition of data** of the port's infrastructures

2) Analysis of the data and images acquired:
- **State** of infrastructures
- Seriousness of **damages**
- Assign a **level of priority** of maintenance works

3) Analysis of data and images acquired:
- Determine the **presence of dangerous situation** that can result in a **blocked problem** for the specific infrastructure

Fostering Artificial Intelligence Trust for Humans towards the optimization of trustworthiness through large-scale pilots in critical domains

Thank You

Workshop on EU-funded Marine Robotics and Applications

EMRA 2024, 28th May
Arenzano, Italy

Rafael Company: **rcompany@fundacion.valenciaport.com**
Mark Tanner: **mtanner@fundacion.valenciaport.com**

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Directorate-General for Communications Networks, Content and Technology. Neither the European Union nor the granting authority can be held responsible for them.

TRIDENT

Funded by the European Union

TRIDENT – Technology based impact assessment tool foR sustaInable, transparent Deep sEa miNing exploraTion and exploitation: A project overview

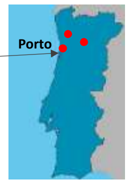
PRESENTERS: José Miguel Almeida / Betina C. Neves

DATE: 27th to 29th May 2024.

EVENT: Workshop EMRA 24

INESCTEC

INESC TEC



- **R&D non-profit research and technology interface institution**
- Researchers from multiple universities in northern Portugal
  - University of Porto
  - **Porto Polytechnic Institute - ISEP**
  - Univ. Minho
  - UTAD
- ~900 researchers (~300 PhDs) dedicated to R&D and advanced consulting
- ~29M€ total activity (2023)

CRAS Robotics and Autonomous Systems

CRIIS Robotics in Industry and Intelligent Systems

CITE Innovation, Technology and Entrepreneurship

CESE Enterprise Systems Engineering

CEGI Industrial Engineering and Management

CAP Applied Photonics

CTM Telecom. and Multimedia

C-BER Biomedical Engineering

CPES Power and Energy Systems

CSIG Information Systems and Computer Graphics

LIAAD Artificial Intelligence and Decision Support

CRACS Advanced Computing Systems

HASLab High-Assurance Software

CENTRE FOR ROBOTICS & AUTONOMOUS SYSTEMS

- Some figures
  - ~85 researchers
  - 25 projects
  - 4.3 M€ turnover (2023)
- Multiple funding sources
  - HE, H2020, P2020, FCT
  - Industry (direct contracts)
- Wide spectrum of TRL levels
- Robotics and Autonomous Systems
  - **Aerial, land and water robotics**
  - Navigation and control
  - Perception and awareness
  - Mapping and real time perception
  - Cooperative robotics
  - Innovative robotic solutions
  - **Long term autonomy**

INESCTEC

ROBOTICS & AUTONOMOUS SYSTEMS LABORATORY

- More than 1000 m^2 of lab space
  - Large indoor space robot testing
- Two test tanks
  - 10 x 6 x 5 m
  - Underwater vision-based ground-truth system
- Hyperbaric chamber
  - 750 bar (7500 m)
  - 400 bar (4000 m)
- Production facilities
  - CNC, 3D printing etc.





R/V MAR PROFUNDO & HARBOUR INFRASTRUCTURES

- Coastal research and technology development vessel
- Catamaran, ~20 m length
- A-frame 1.5 ton and 700 kg crane
- On board lab
- Capacity for 9 researchers
- Ocean operations, tailored for missions up to 60 nautical miles

- Lab space at Harbour
- 2 labs

HUB AZUL LEIXÕES (HAL)

HUB AZUL

INESCTEC

TRIDENT
Funded by the European Union
Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation

TRIDENT
FIGURES & CONSORTIUM

Horizon Europe project

(Total Budget 16 M€,
EU contribution 11.8 M€,
25 partners, 10 countries)

Coordinated by INESC TEC

Start: Jan 2023

End: December 2027

Final demonstration at Tropic Seamount in 2027

https://deepseatrident.eu/

International Organizations

Companies

Research and Technology Organizations

Associations

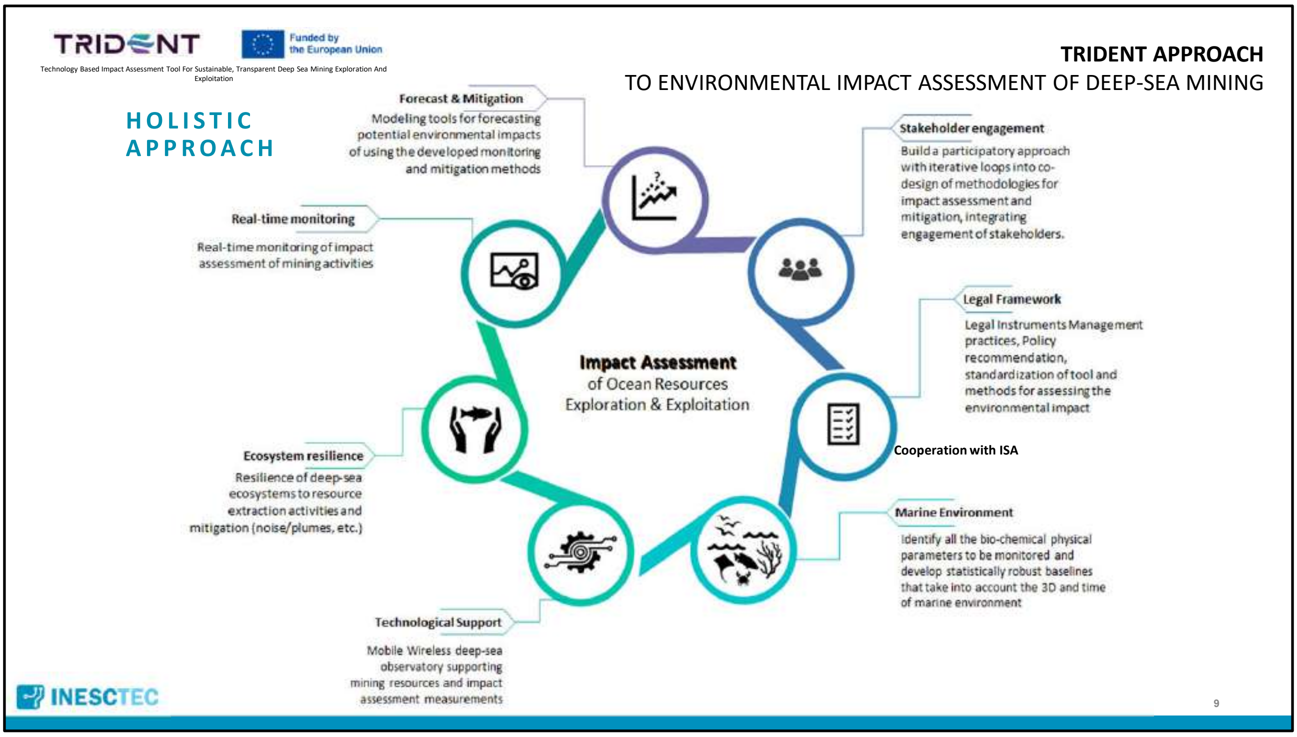
Governmental Organizations

INESCTEC

THE PROBLEM

- **Remote** and **deep** locations
- **Three main types of deep-sea deposits**:
    - **Polymetallic Massive Sulphides (PMS)** – three-dimensional, diameter up to 300 m and 100 m ore body depth, at 1500-5000 m water depths, hydrothermally inactive deposits but can be close to active hydrothermal sites, requires open cast mining
    - **Cobalt-rich ferromanganese crusts (CFC)** - form two-dimensional deposits, a few 10's cm thick and covering 10's to 100's km^2, mainly inactive seamounts and aseismic ridges, at 1500-4000 m depths
    - **Polymetallic nodules (PMN)** - two-dimensional deposits, a few cm's thick and covering 10,000's km^2, 4000-5000 m deep, sediment-covered ocean floor.
- And **each seafloor mineral deposit** has its **own unique** mix of **environmental conditions** and **potential impacts varying across different length scales**.
- There are **different approaches to deep-sea mining; mining technologies are in development stages;** their **potential environmental impacts are still unknown**.
- Environmental impacts are expected to **occur mainly on the seabed and in the water column**
- **Plumes** are the most **far-reaching** of the potential impacts.

INESCTEC

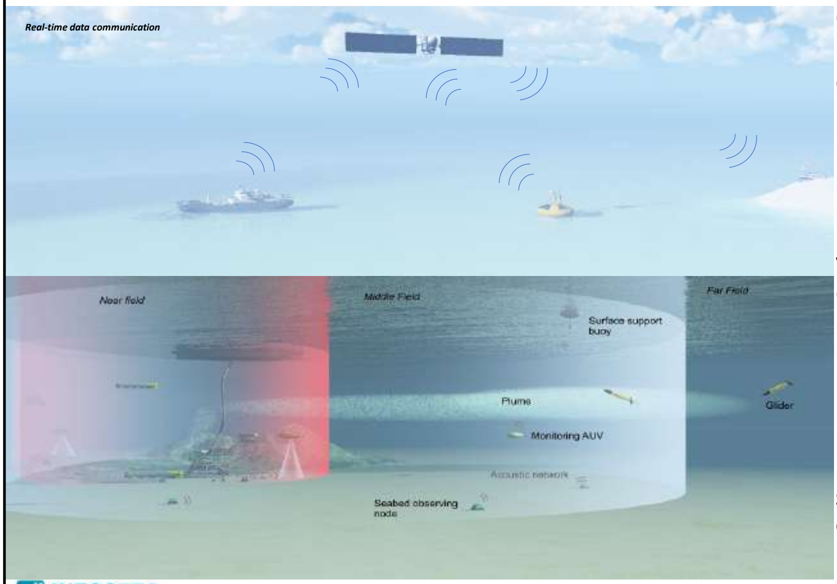

TRIDENT
Funded by the European Union
Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation
TRIDENT APPROACH
TO ENVIRONMENTAL IMPACT ASSESSMENT OF DEEP-SEA MINING
HOLISTIC APPROACH
Forecast & Mitigation
Modeling tools for forecasting potential environmental impacts of using the developed monitoring and mitigation methods
Stakeholder engagement
Build a participatory approach with iterative loops into co-design of methodologies for impact assessment and mitigation, integrating engagement of stakeholders.
Real-time monitoring
Real-time monitoring of impact assessment of mining activities
Legal Framework
Legal Instruments Management practices, Policy recommendation, standardization of tool and methods for assessing the environmental impact
Impact Assessment
of Ocean Resources Exploration & Exploitation
Cooperation with ISA
Ecosystem resilience
Resilience of deep-sea ecosystems to resource extraction activities and mitigation (noise/plumes, etc.)
Marine Environment
Identify all the bio-chemical physical parameters to be monitored and develop statistically robust baselines that take into account the 3D and time of marine environment
Technological Support
Mobile Wireless deep-sea observatory supporting mining resources and impact assessment measurements
INESCTEC
9

TRIDENT

Funded by the European Union

Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation

TRIDENT - PROPOSED CONCEPT



Comprehensive solution Environmental Impact Assessment Monitoring System

dependable, **transparent**, and **cost-effective**

Independent of contractors

Ensuring the Integrity and inviolability of monitoring data

Increase the **autonomy** and **permanence** of the monitoring systems. **Reduce** the **need for support vessels and humans on-site**

Covering **near, middle and far fields**

Incorporating **advanced sensing technology** in **mobile/transportable deep-sea observatories** and **mobile platforms** (long-range AUVs and gliders)

Near Real-time data for remote control centres

Integrating **baseline data, forecasting models and near real-time data** in an intuitive **Traffic Light System** that helps operators and regulators to **quickly** identify **potentially harmful situations**

Has low environmental impact

INESCTEC

INNOVATIVE TECHNOLOGIES

Technologies being developed for the impact assessment system:

- **Advanced sensing systems for** Deep-Sea impact assessment monitoring:
  new biogeochemical sensors, optical Dust Trap, noise sensors and Low power smart data logger
- **Real-time Black-box** for the mining machine
  Near field sensors, independent localisation and communication to surface interface
- **Dynamic Infrastructure for underwater Positioning and Communications**
- Dynamic Infrastructure for the **support of seabed monitoring nodes**
  Energy and Data transfer
- **Collaborative plume tracking and Adaptive Sampling Strategies for Mobile Platforms**
- Development of the **Environmental Management visualisation system** and an **Early Warning 'Traffic Light system'**–integrating real-time data and model forecast
- Incorporating **advanced sensing technology in mobile/transportable deep-sea observatories**

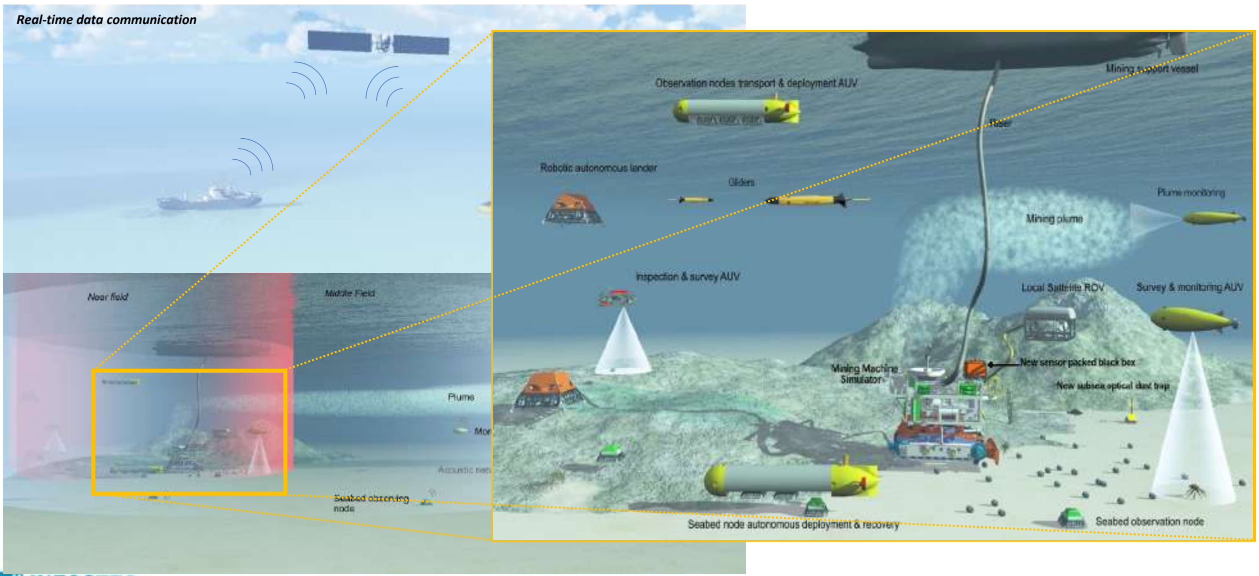
INESCTEC

TRIDENT

Funded by the European Union

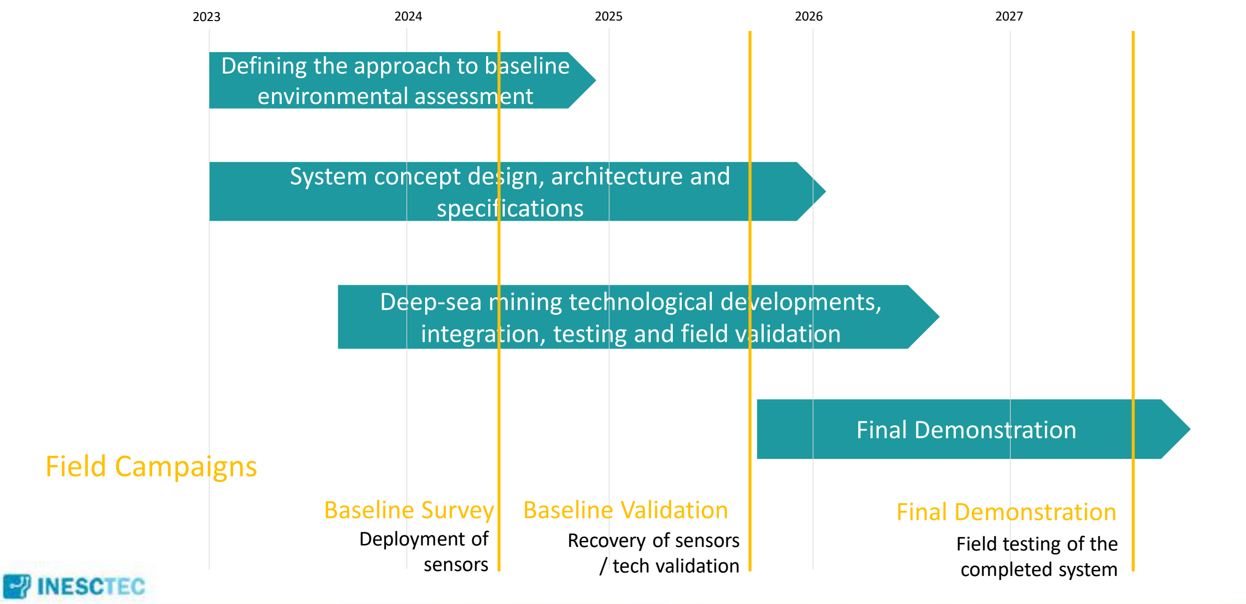
Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation

TRIDENT - PROPOSED CONCEPT



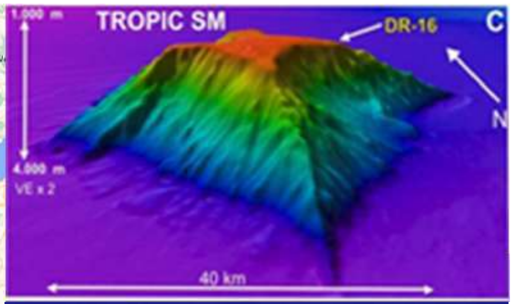
INESCTEC

TRIDENT PROJECT TIMELINE



TRIDENT
Funded by the European Union
Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation

Pilot Site - TROPIC SEAMOUNT



1)

2)

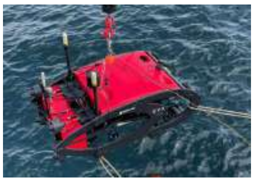
1) Marino, E., et al. (2017). Strategic and rare elements in Cretaceous-Cenozoic cobalt-rich ferromanganese crusts from seamounts in the Canary Island Seamount Province (northeastern tropical Atlantic). Ore Geology Reviews, 87, 41-61.
2) Ramiro-Sánchez, Berta, et al. "Characterization and mapping of a deep-sea sponge ground on the Tropic Seamount (Northeast Tropical Atlantic): Implications for spatial management in the high seas." *Frontiers in Marine Science* 6 (2019): 278.

INESCTEC

TRIDENT

Funded by the European Union

Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation



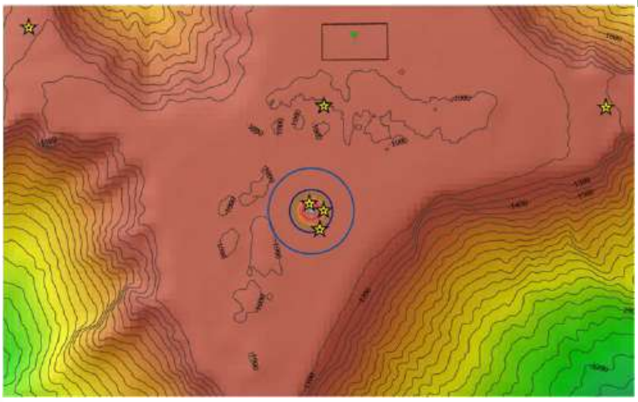
FIRST MISSION
BASELINE SURVEY

Landers

Mooring

Blue circle 1 km diameter

Dark blue 500 m diameter



Research Vessel: Mário Ruivo PT

JUN 2024 – 20 DAY MISSION

- **Deploy 6 Multi-sensor MonSta Landers** for a one year long mission
- Use **EVA AUV/HROV to support** lander deployment**, high resolution survey** and carry several sensors
- **2 SEAEXPLORER Gliders** to take measures on the water column: dissolved oxygen, turbidity and noise
- **Moored** equipment during the expedition to measure **water column parameters**
- **EGIM** module sitting on the seafloor during the expedition to measure conductivity, temperature, turbidity, and dissolved oxygen
- Other classic methods: **Hydrophones, Box corer and/or multi core, CTDs,** Niskin bottles to collect **water samples, Spectroradiometer,** plankton **Multinet**

INESCTEC

1) Marino, E., et al. (2017). Strategic and rare elements in Cretaceous-Cenozoic cobalt-rich ferromanganese crusts from seamounts in the Canary Island Seamount Province (northeastern tropical Atlantic). Ore Geology Reviews, 87, 41-61.
2) Ramiro-Sánchez, Berta, et al. "Characterization and mapping of a deep-sea sponge ground on the Tropic Seamount (Northeast Tropical Atlantic): Implications for spatial management in the high seas." *Frontiers in Marine Science* 6 (2019): 278.

TRIDENT

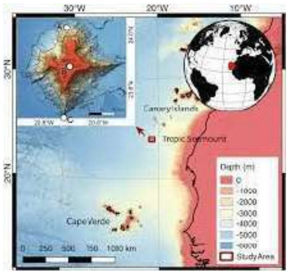
Technology Based Impact Assessment Tool For Sustainable, Transparent Deep Sea Mining Exploration And Exploitation

Funded by the European Union

2027 FINAL MISSION AT THE DEMONSTRATION SITE: TROPIC SEAMOUNT

3 RESEARCH VESSELS:

- Celtic Explorer IE
- RSS James Cook / RSS Discovery UK
- Sarmiento de Gamboa ES
- Mário Ruivo PT (optional)



INESCTEC

Thank you for your attention!

TRIDENT

Funded by
the European Union

José Almeida
Jose.m.almeida@inesctec.pt

info@deepseatrident.eu · www.deepseatrident.eu

INESCTEC

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

This project has recieved funding from the Euopean Union´s Horizon Europe research and innovation program under grant agreement No 101132575.

NERITES
MONITORING UNDERWATER HERITAGE

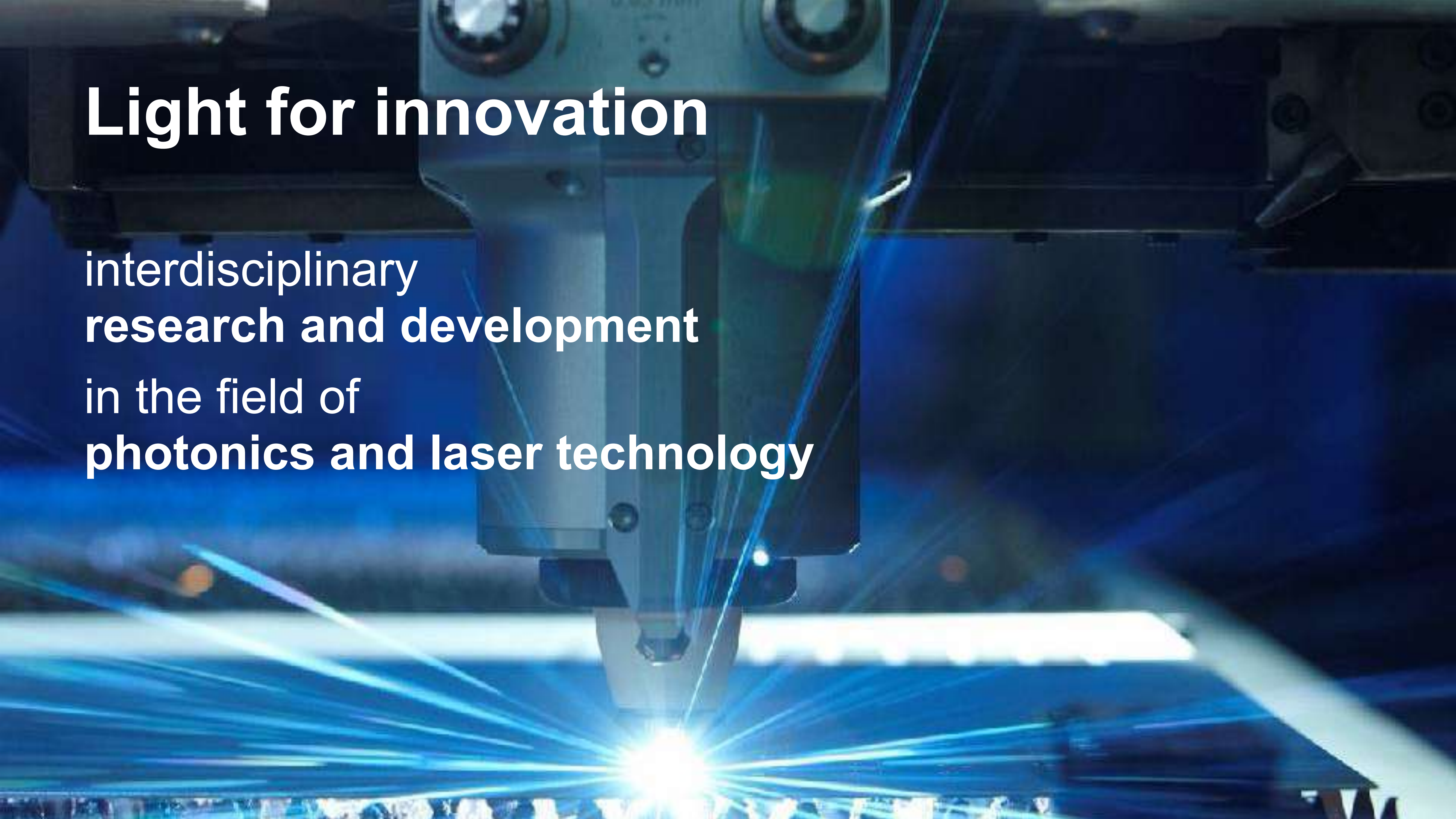
Horizon Europe – Project: NERITES

EMRA 2024

Funded by the European Union

Agenda

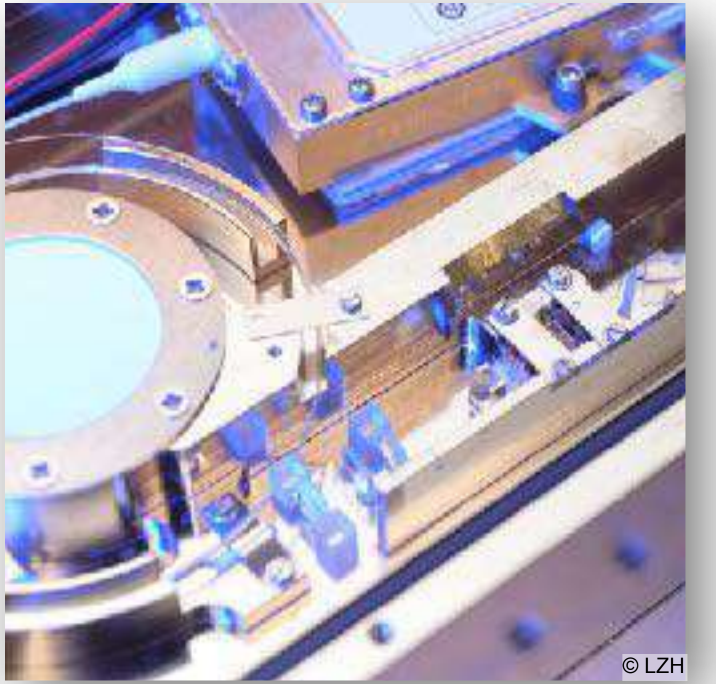
- Laser Zentrum Hannover e.V.
- Group Under Water Technology
- EU-Project NERITES

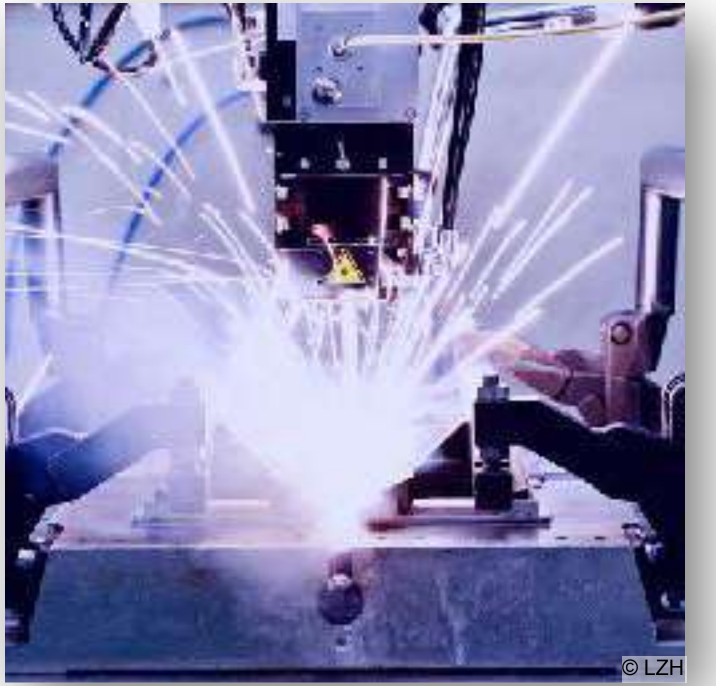


Light for innovation

interdisciplinary
research and development
in the field of
photonics and laser technology

Development along the entire value chain





Optics and components — Laser — Processes and applications

Underwater Technology Group

NERITES
MONITORING UNDERWATER HERITAGE

Material processing under water

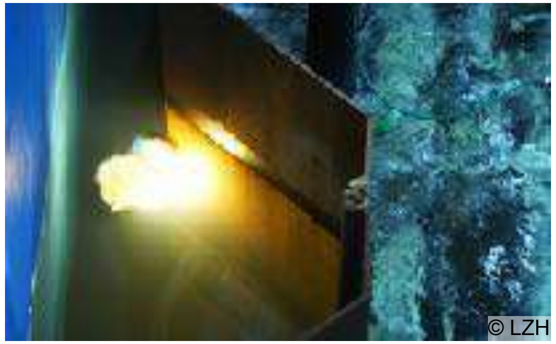
- Laser beam cutting
- Laser beam welding
- Laser cladding, additiv processes
- Defuse of unexploded ordnance (UXO)

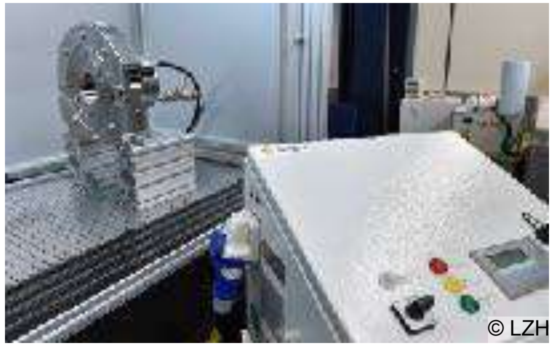
Underwater Measuring technology

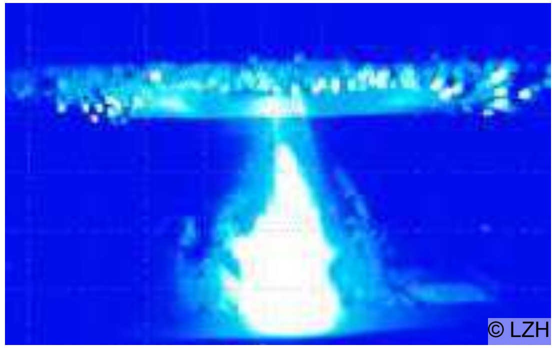
- LIBS (Laser induced breakdown spectroscopy)
- Hydrogen analyses during welding

Shipping

- Cleaning biofouling from ship hulls
- Treatment of water pollution







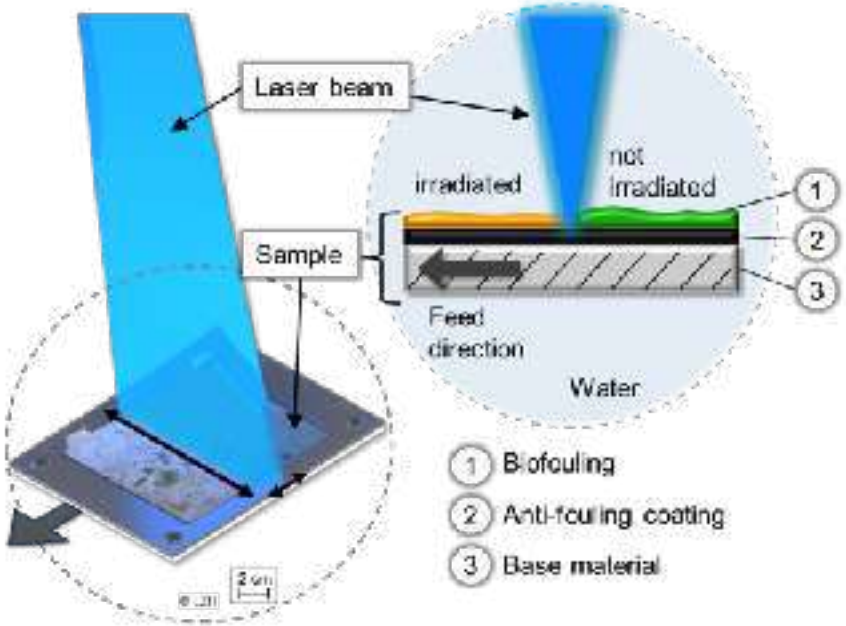
FoulLas

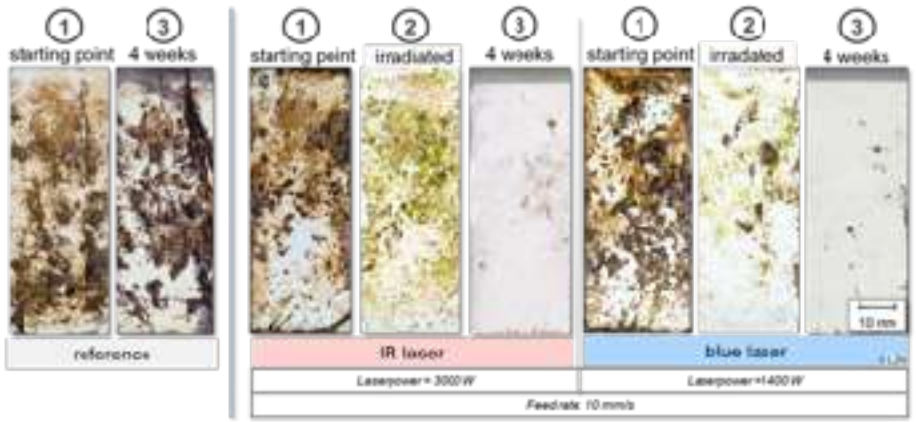
Challenge

- Fouling on maritime surfaces
  - » Accelerated corrosion
  - » Increased flow resistance
  - » Spread of invasive species

Contact-free cleaning process

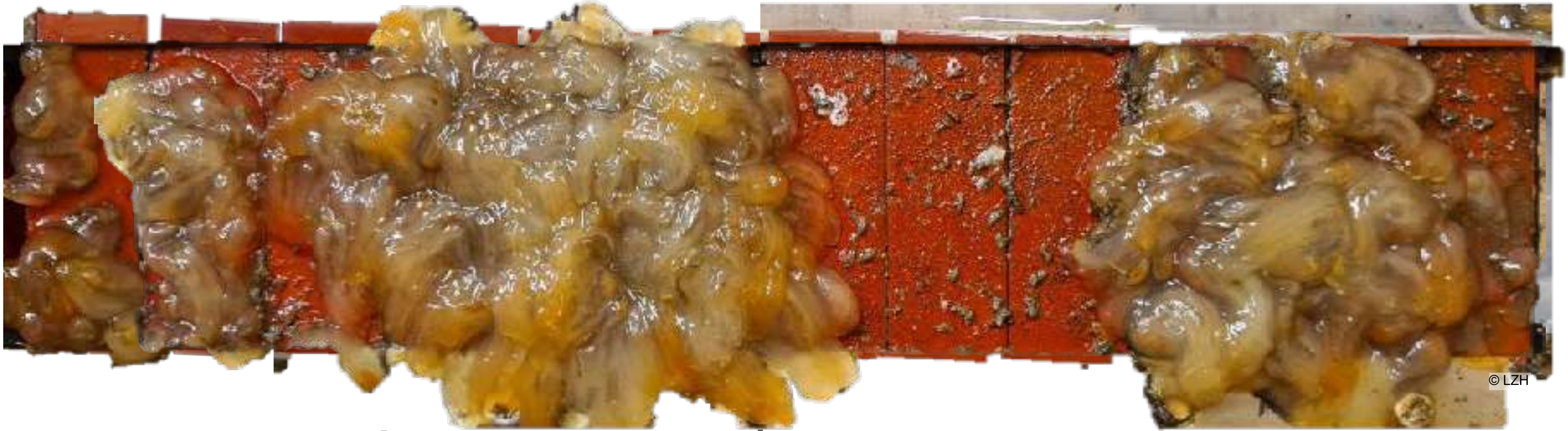
- Lethal damage of the biofouling by laser radiation
- Rectangular spot shape with uniform surface intensity for high surface outputs
- The coating system has to remain undamaged





FoulLas - Cleaning effect

1 Initial state of the biofouling
2 Cleaning effect (radiation)
3 Condition after irradiation (cultured again for 2 weeks)



120 mm/s	200 mm/s	14,71 mm/s	Reference
Laser power = 1400 W			

10 mm

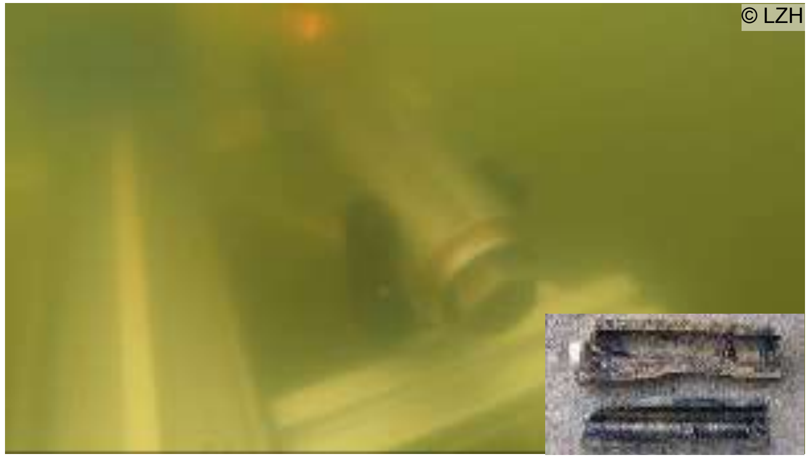
UnLowDet

Challenge

- About 1.6 million metric tons of unexploded ordnances (UXO) in the North and Baltic Sea
- Decades of on going corrosion lead to dissolution of toxic chemicals
- Detonations pose an ever-present danger
- Neutralization by
  - » Explosion (conventional)
  - » Low order detonation

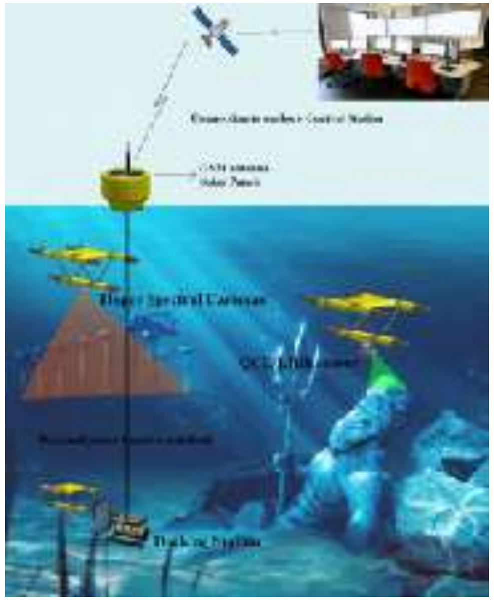
Laser technique for precise weakening of the UOXs under water

- Very small mechanical impact
- Energy input can be adjusted precisely
- Successful studies in atmosphere



Horizon Europe – Projekt: NERITES

Systematic autonomous remote surveying of underwater cultural heritage monuments and artefacts using non-destructive, cost-effective and transportable digital solutions

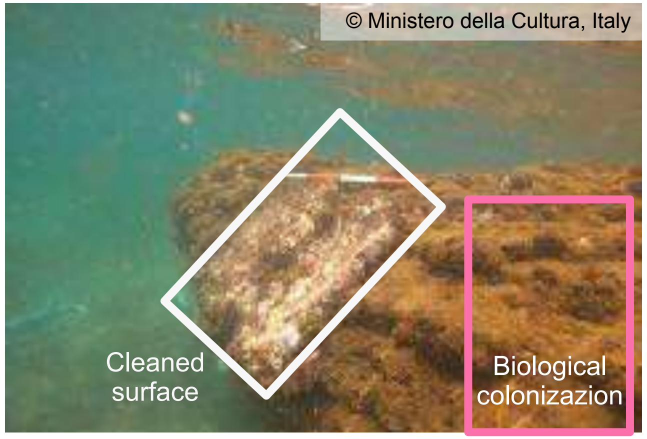


Goal: Providing monitoring solutions for underwater cultural heritage sites with autonomous and robust methods for monitoring chemical, environmental and geophysical indicators

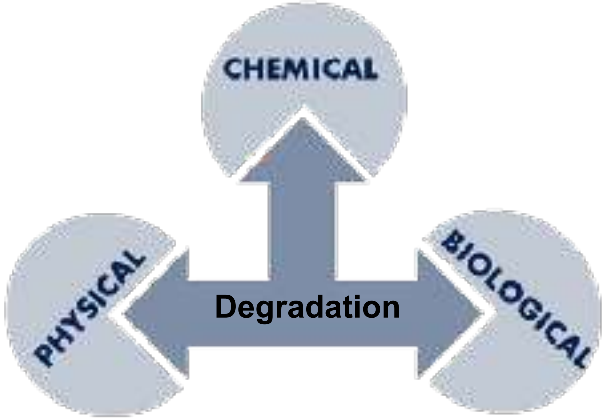
- Call: Advanced technologies for remote monitoring of heritage monuments and artefacts
- Project partners: LZH (Koordinator), ESI, RSE, UULM, ATLANTIS, CERTH, GT, CNR, UNICAL, IHU, ALPES, KORSEAI, MIC
- Project duration: 01.01.2024 – 31.12.2026

Motivation

Internal material components interacting with **the environment can trigger chemical reactions**, leading to deterioration. This degradation can cause significant damage or even complete destruction by transforming the material.



Natural events like **erosion, earthquakes**, or human actions like theft or **mishandling** can cause degradation. This can lead to serious consequences like fractures, breakages, cracks, and even total destruction.



Biodegradation, caused by micro and macroorganisms, involves living organisms chemically or physically altering materials, potentially damaging valuable cultural heritage through colonization and destruction.

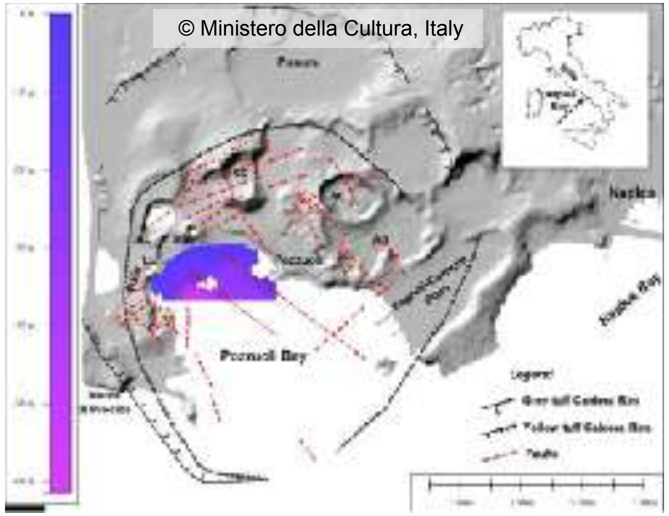
Demo Sites

NERITES
MONITORING UNDERWATER HERITAGE

Baiae (Italy)

2 old villas

- mosaics
- Ceramics and statues



Fourni (Greece)

58 wrecks identified

- 23 % of wrecks in Greece
- Largest concentration in Mediterranean

Partners and Objectives

Underwater Cultural Heritage (UCH)

Establishment and application of NERITES monitoring scheme to underwater monuments.

- Provide the demo site
- Expertise on the underwater survey monuments
- Provide the diving team for sampling
- Develop a protocol for characterizing and identifying degradation parameters

Partners and Objectives

Sensor technology

Novel, non-destructive, low-cost digital sensing devices and techniques

- Development of LIBS underwater sensor
- Development of QCL sensor
- Advanced photogrammetry for hyperspectral visual evidence

Partners and Objectives

NERITES
MONITORING UNDERWATER HERITAGE

Platform

Transportable autonomous underwater remote multi-sensing platform

- AUV-platform carry LIBS, QCL sensor, hyperspectral sensor and photogrammetry to the heritage
- AUV platform be able to maneuver to the heritages (online mission planning)
- AUV, docking station, buoy and control centre (onshore) will be design

Partners and Objectives

NERITES
MONITORING UNDERWATER HERITAGE

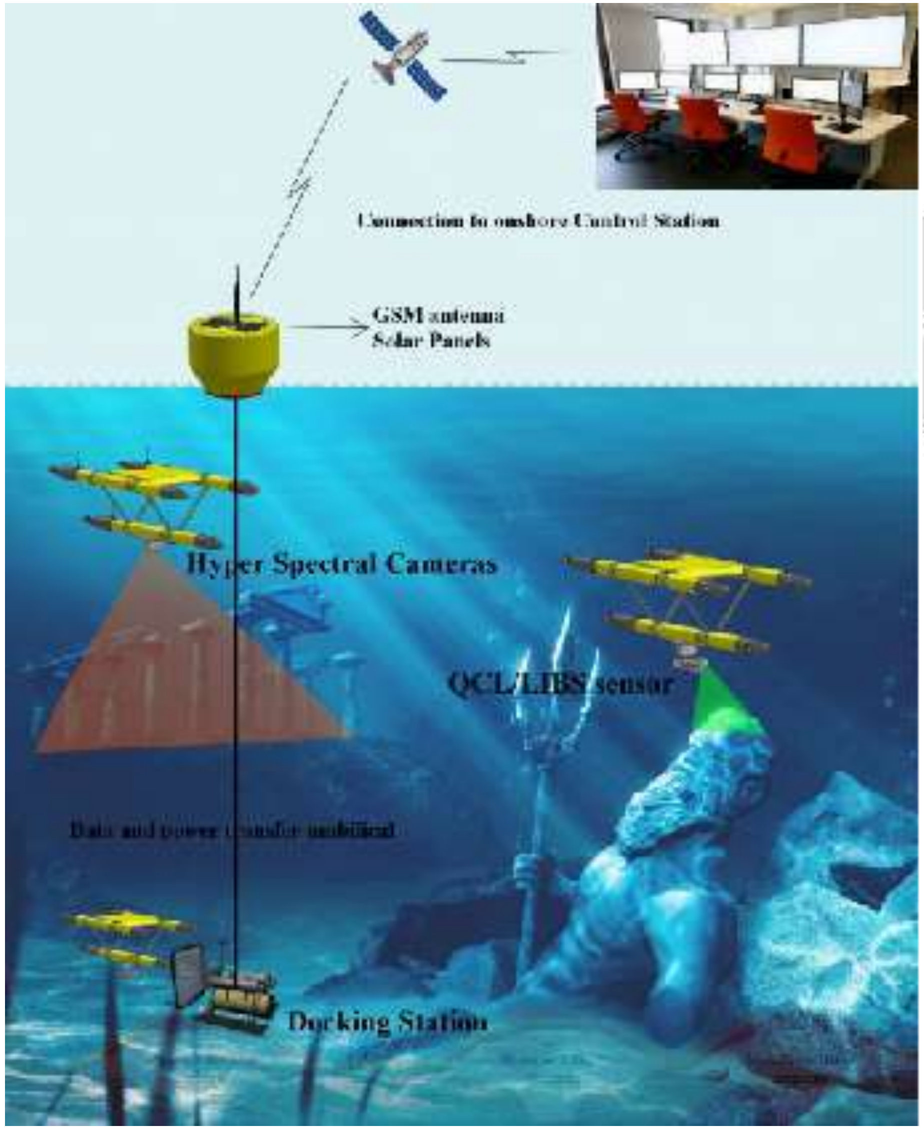
Software

Innovate UCH sites state-of-preservation and degradation assessment protocols utilizing the autonomous underwater sensing platform.
Utilize advanced AI techniques to:

- » Characterize the organic surface and biological colonization
- » Image identification and classification of underwater geomorphology and physical parameter
- » Correlation of evaluation of the results from a chemistry/biology lab
- » Identify alarming conditions

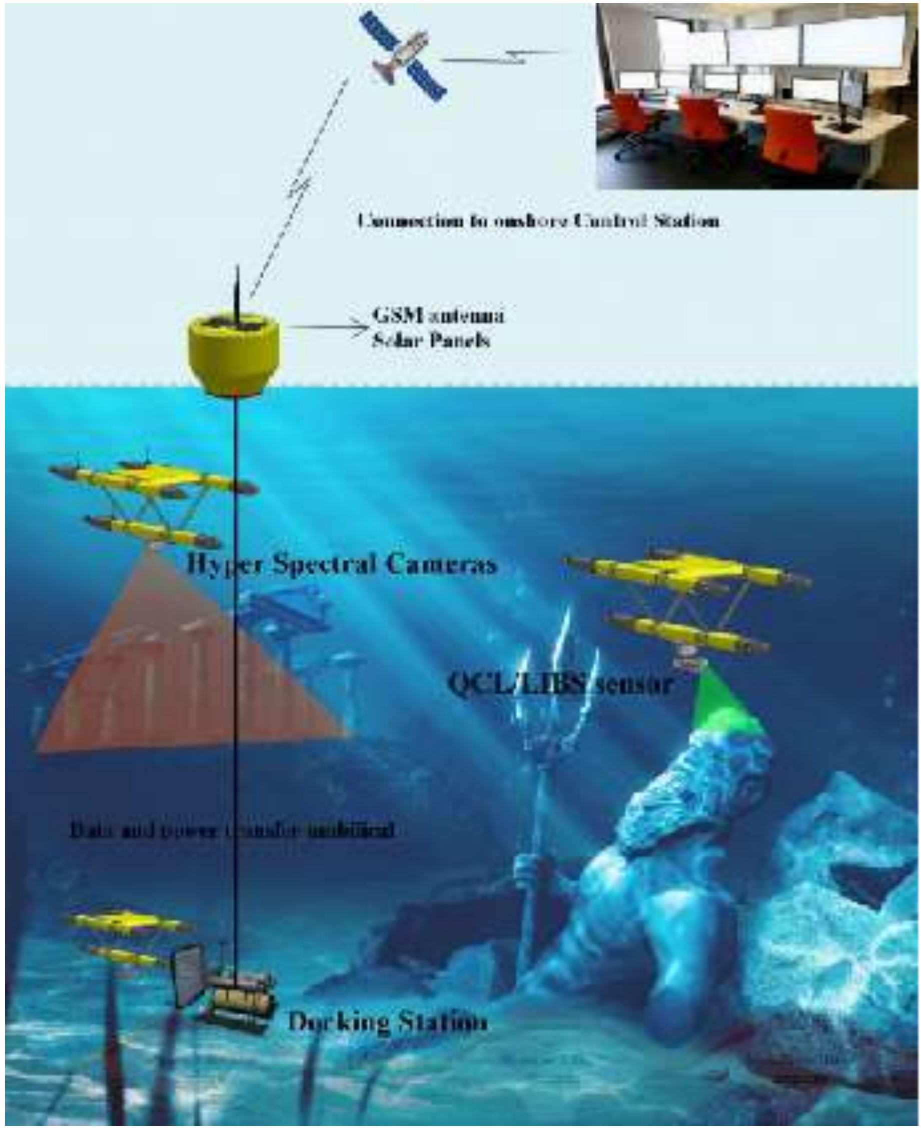
Nerites at a Glance

NERITES
MONITORING UNDERWATER HERITAGE



Nerites at a Glance

Underwater Cultural Heritage



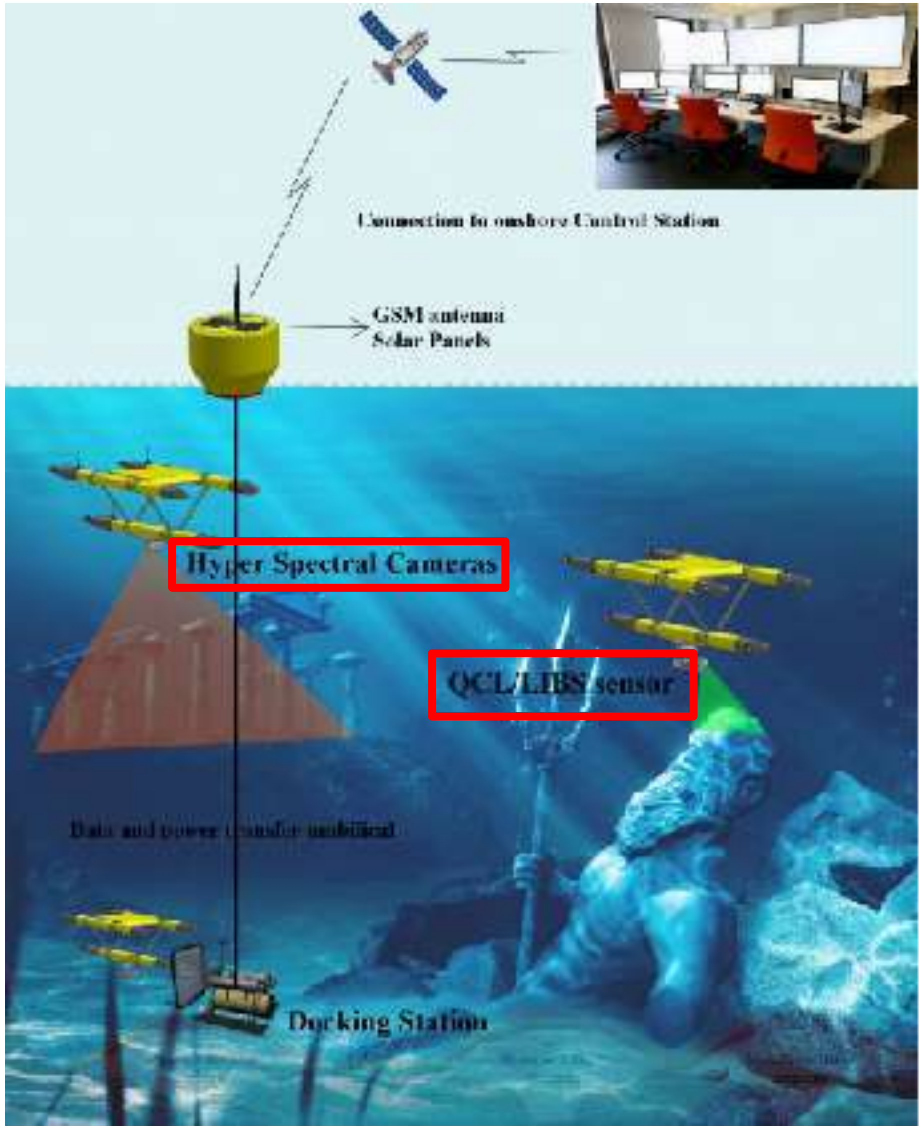
Ceramics

Ship wrecks

Mosaics

Nerites at a Glance

Senor technology



Ceramics

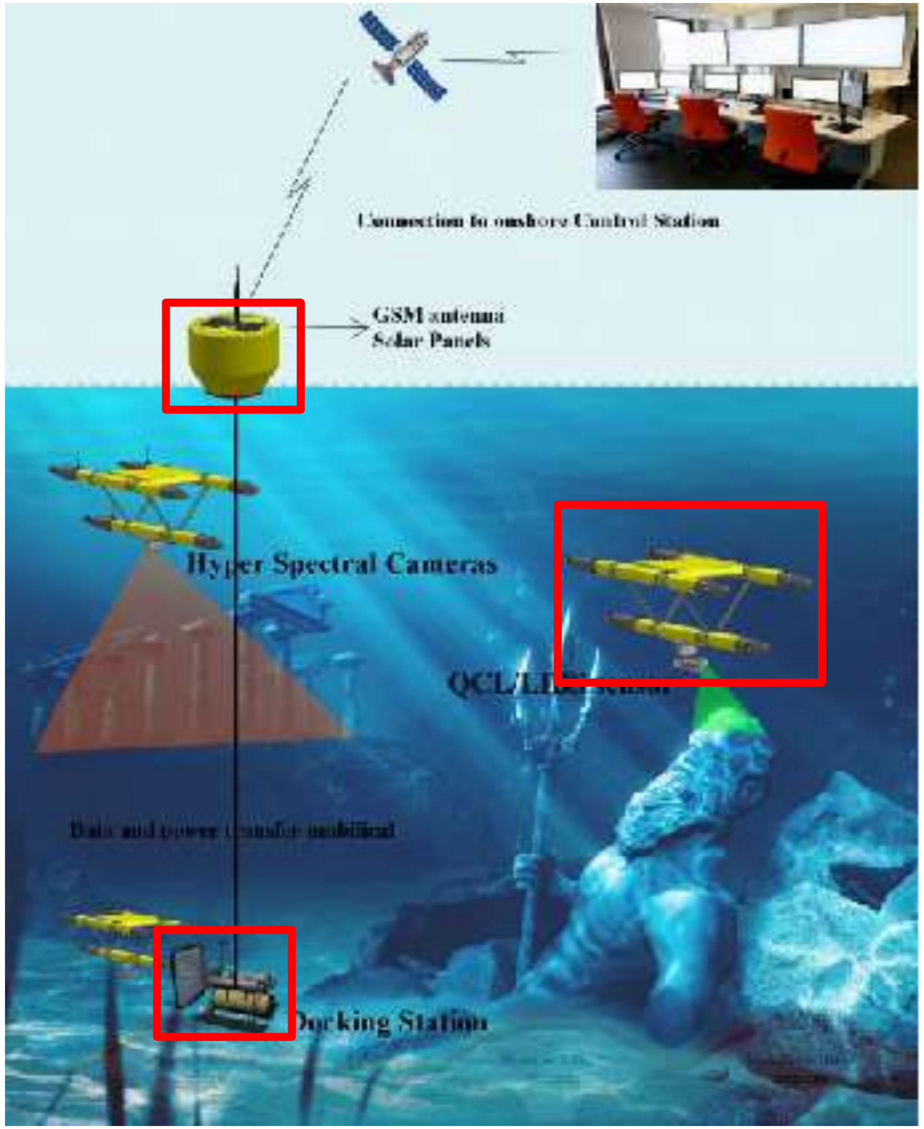
Ship wrecks

Mosaics

Nerites at a Glance

NERITES
MONITORING UNDERWATER HERITAGE

Platform



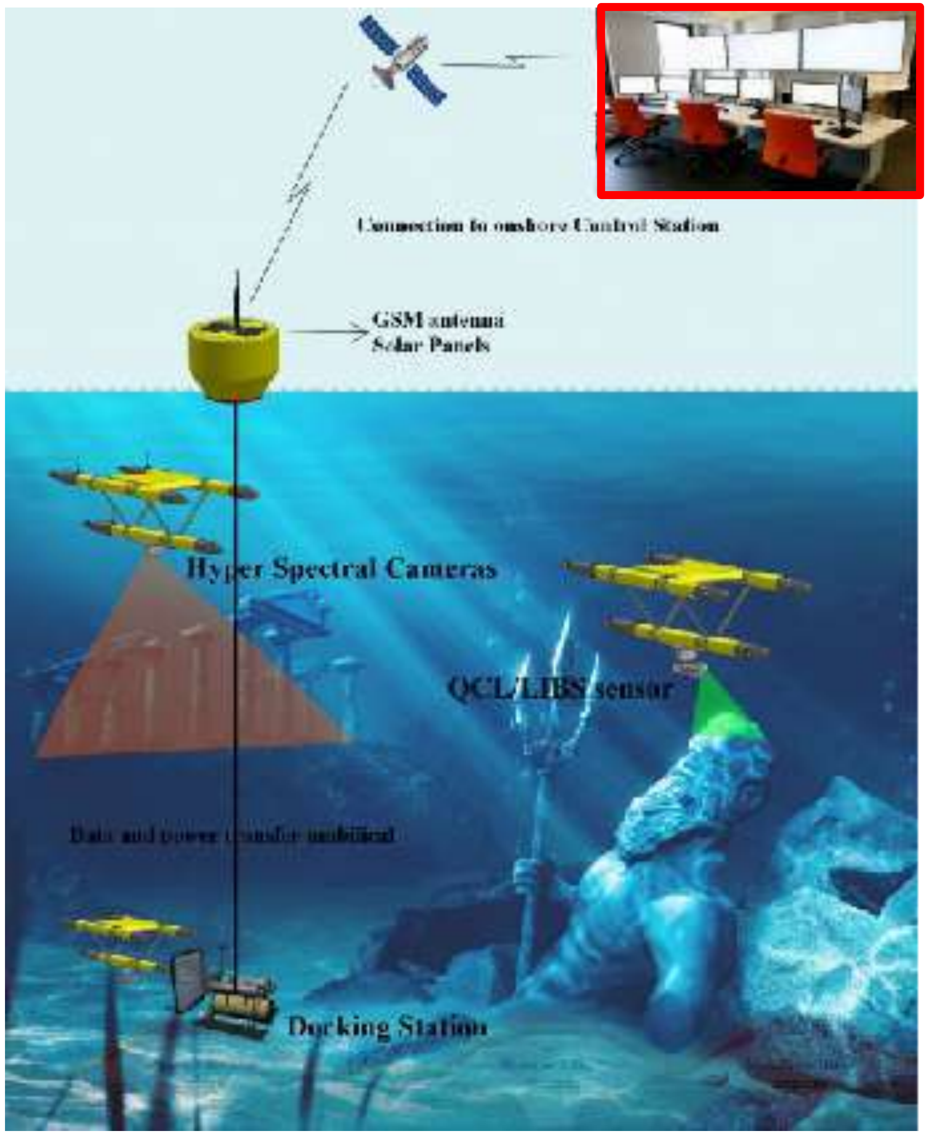
Ceramics

Ship wrecks

Mosaics

Nerites at a Glance

Software



Ceramics

Ship wrecks

Mosaics

Website and Social Media

NERITES
MONITORING UNDERWATER HERITAGE

We are open for further under water projects.
Please contact

Jörg Hermsdorf

j.hermsdorf@lzh.de

NERITES

This project has recieved funding from the Euopean Union´s Horizon Europe research and innovation program under grant agreement No 101132575.

NERITES
MONITORING UNDERWATER HERITAGE

Thank you for your attention.

Funded by the European Union

DiverSea

Integrated Observation, Mapping, Monitoring and Prediction for Functional BioDiversity of Coastal Seas

Lucrezia Bernacchi, Renato Mendes and João Borges de Sousa

University of Porto

Funded by the European Union

LSTS

U.PORTO

FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

- Overview
- Challenges
- Ambition
- Approach
- Field case studies

DiverSea

Funded by the European Union

Overview

Programme

Horizon Europe (HORIZON-CL6-2022-BIODIV-01-01)

Duration:

48 months (September 2023 – August 2027)

Coordinator:

Norwegian University of Science and Technology (NTNU)

Consortium:

19 partners – 14 countries

Challenges

A coastal ecosystem heavly exploited:

- Decline in marine species abundance
- Decline in marine species diversity
- Habitat degradation

?

Biodiversity dynamics

Essential ecosystem goods and services (EGS)

Map
Physical, chemical and biological systems and their interactions

Monitor
Them to detect changement

Predict
And plan for their response to change

Funded by the European Union

Ambition

Novel marine long-term observation and monitoring technology at a pan European scale

- Analyze marine biodiversity dynamics
- Analyze its connection to EGS in European coastal seas
- Facilitate the development of policy action plans

Conventional techniques

Emerging techniques

Discipline specific

Transdisciplinary framework

DiverSea

Funded by the European Union

Approach

Development of molecular monitoring approaches

Field technology integration

Field case studies

Data integration, processing and exploitation

Biodiversity Services Dashboard

Improvement molecular analyses for biodiversity assessment

- New DNA-based identification approach: DNA-marks
- Improving eDNA-eRNA inference and developing indicators

Funded by the European Union

Approach

- Development of molecular monitoring approaches
- Field technology integration
- Field case studies
- Data integration, processing and exploitation
- Biodiversity Services Dashboard

Improvement EOVs & EBVs collection

Integration of a variety of distinct observing platforms:

Nanochemical sensor

Imaging system

Autonomous systems

- Proof-of-concept framework to help non robotic domain experts
- New statistics-based decision-aiding models
- Water column and passive sampling sensors integration

DiverSea

Funded by the European Union

Approach

- **Development of molecular monitoring approaches**
- **Field technology integration**
- **Field case studies**
- **Data integration, processing and exploitation**
- **Biodiversity Services Dashboard**

Comprehensive mapping of important EU marine habitats

Datasets from a wide variety of primary data collection techniques :

- Molecular approaches
- Autonomous vehicles
- Citizen science
- Satellite remote sensing

Funded by the European Union

Approach

Development of molecular monitoring approaches

Field technology integration

Field case studies

Data integration, processing and exploitation

Biodiversity Services Dashboard

DiverSea Data Set

- Data integration (existing dataset, case studies dataset, observational networks)
- Data harmonization
- Data standardization

Predictive Scenario Building

- Model ecosystem dynamics

(machine learning, classical methods)

- Key Indicator variables

(ecosystem state - ecosystem health)

Funded by the European Union

Approach

Development of molecular monitoring approaches

Field technology integration

Field case studies

Data integration, processing and exploitation

Biodiversity Services Dashboard

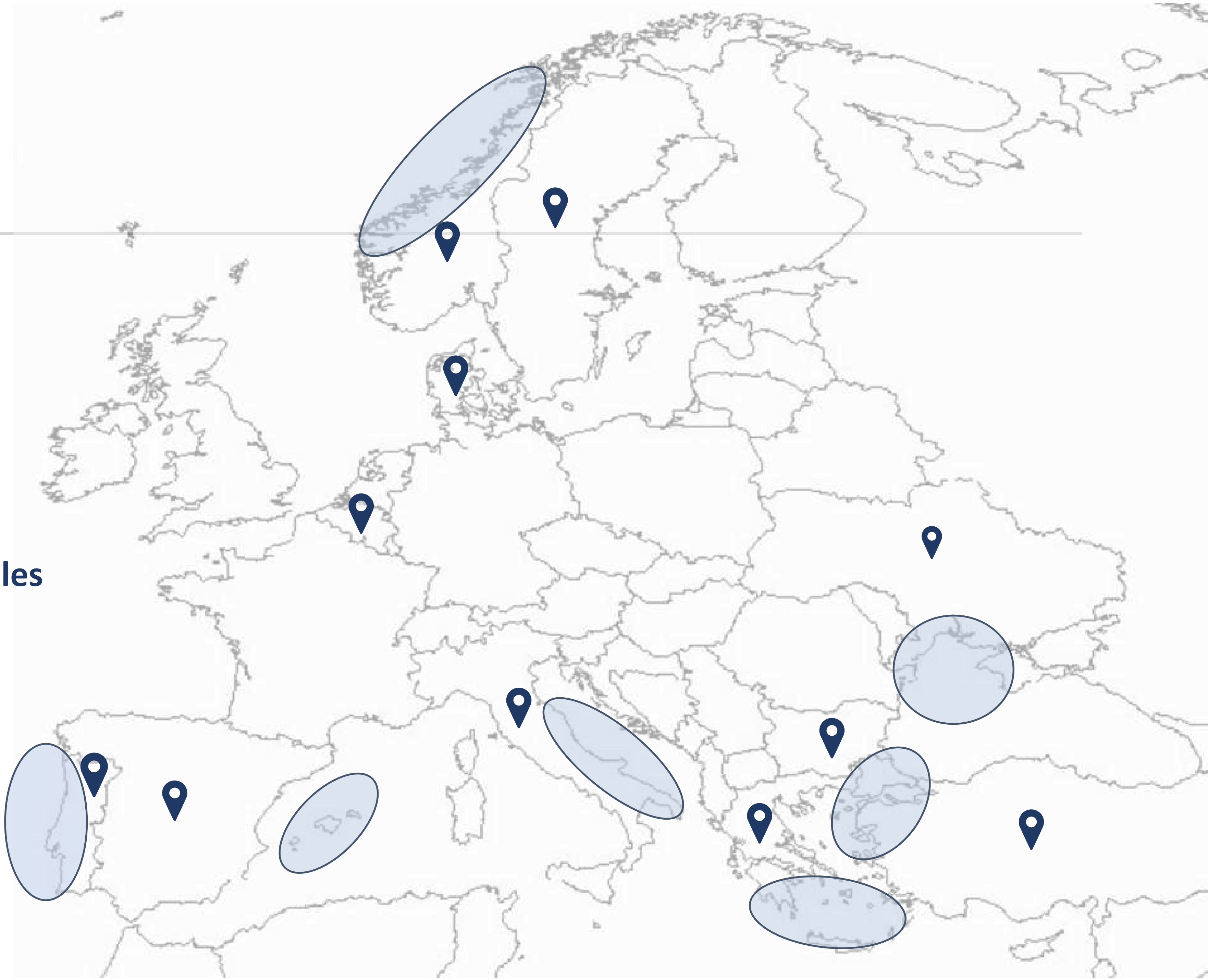
Interactive platform for scientific outcomes communication

- **Integration** of marine biodiversity knowledge and data
- Visualization of key socio-environmental **indicators**
- Examination and comparison of the **impact** of different scenario

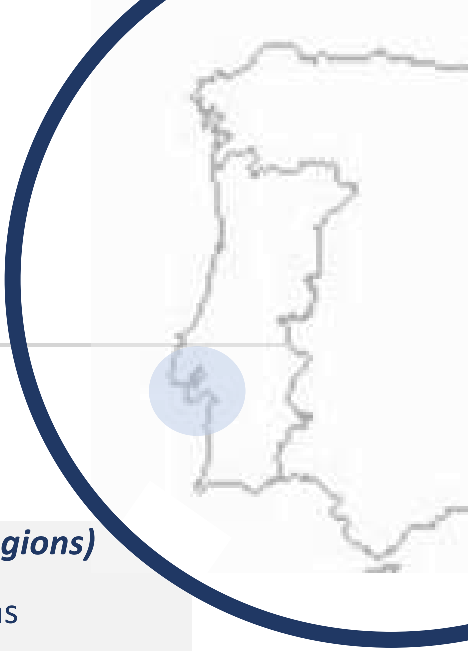
Funded by the European Union

Field case studies

- ❖ Atlantic Coast
- ❖ Norwegian Coast
- ❖ Northwestern Black Sea
- ❖ Greek Site
- ❖ Aegean Sea and Dardanelles
- ❖ Adriatic Sea
- ❖ Balearic Islands

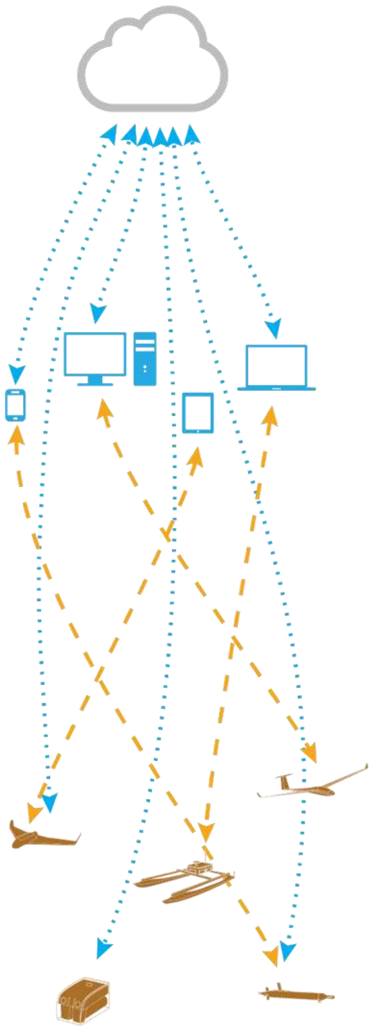


Atlantic Coast



Professor Luiz Saldanha Marine Park

Evaluation and mapping of the sea bottom habitat of the Natura2000 network park



Ripples
Communications hub for data dissemination and situation awareness

Neptus
World Representation
Planning
Simulation
Execution
Analysis

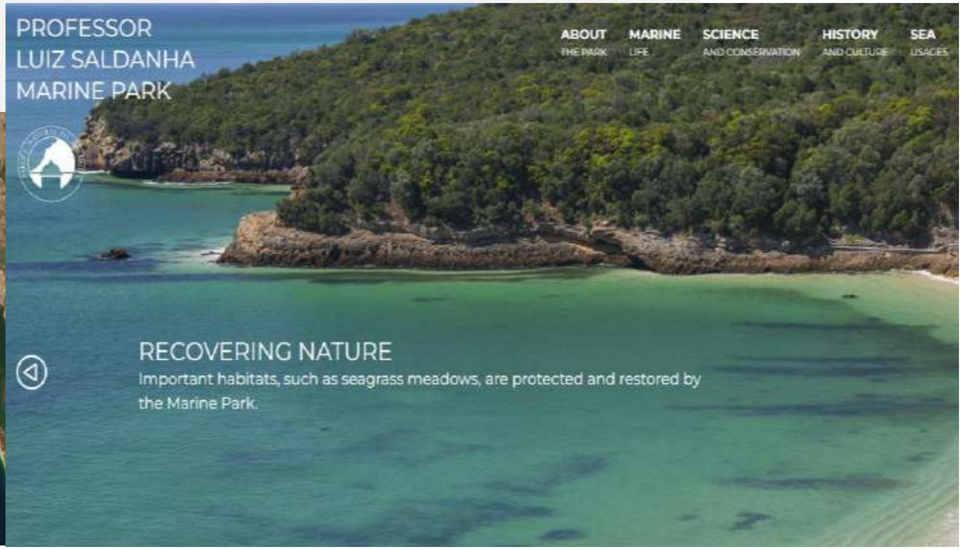
IMC
Inter-Module Communication protocol

DUNE
Uniform Navigational Environment
On-board Software

AUVs (Deeper regions)
- Side-Scan
- Multi-beam
- Video cameras
- CTD
- Chlorophyll sensor
- eDNA sampler prototype

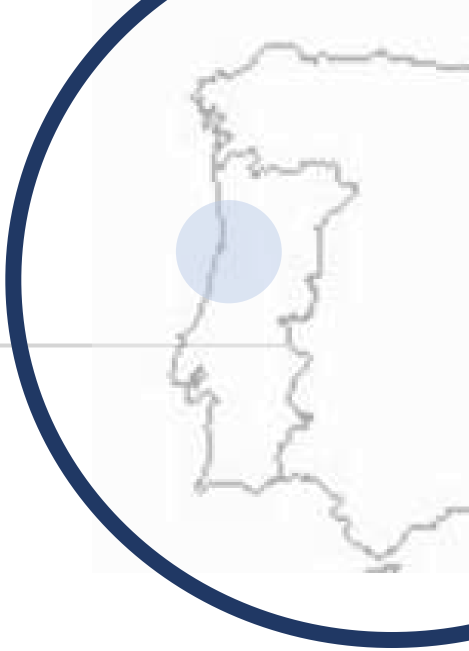
UAVs (Intertidial regions)
- Video cameras
- Hyperspectral cameras
- IR cameras

ASVs (Shallow regions)
- Video cameras
- eDNA sampler prototype

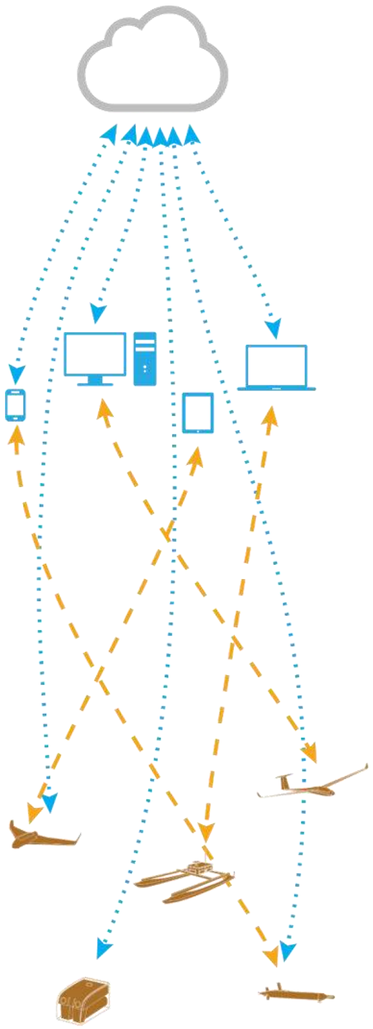


Atlantic Coast

Porto Canyon Upwelling Filament



Track and survey an upwelling frontal system originating from a stable coastal upwelling in the summer seasons



Ripples

Communications hub for data dissemination and situation awareness

Neptus

World Representation
Planning
Simulation
Execution
Analysis

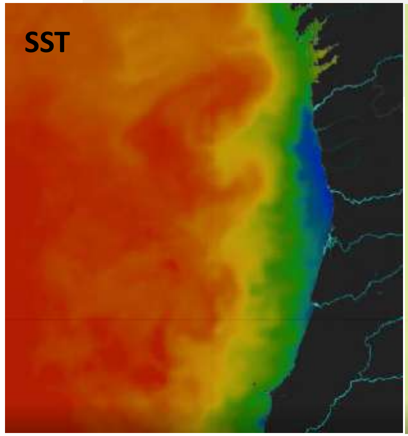
IMC

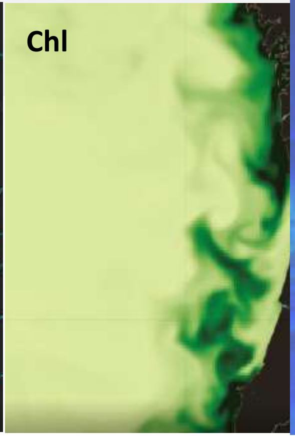
Inter-Module Communication protocol

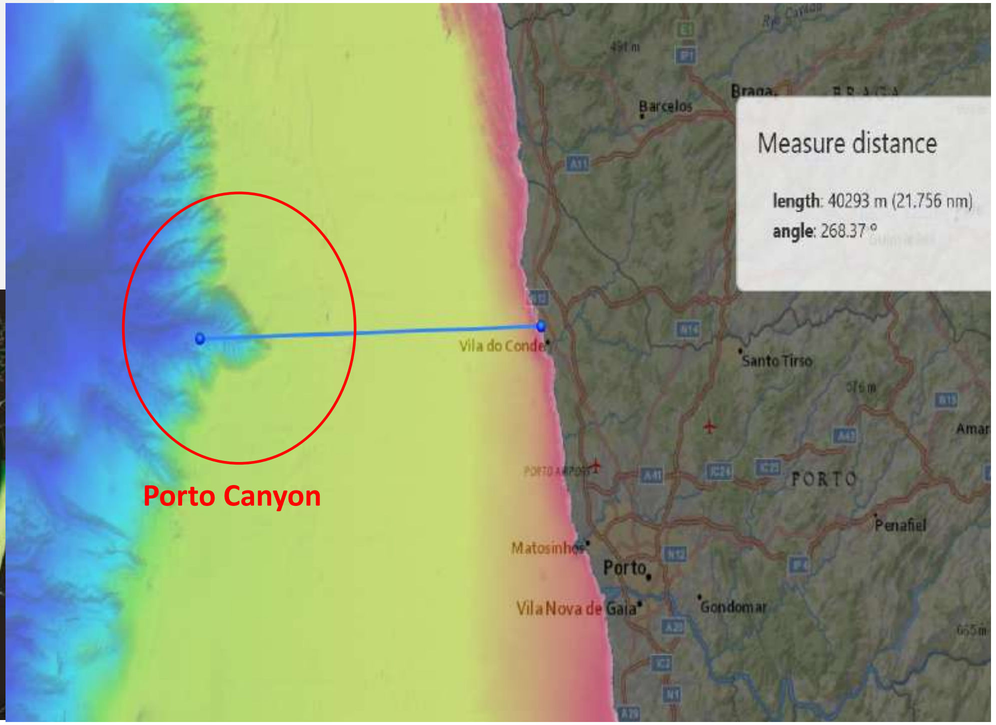
DUNE

Uniform Navigational Environment On-board Software

Multiple autonomous systems remotely controlled by a shore base







Norwegian Coast

Trondheim Fjord & Skagerak Area

Sensor fusion techniques for the estimation of the functional role of distinct pelagic communities and their interactions & Seabed biodiversity mapping

Sensors

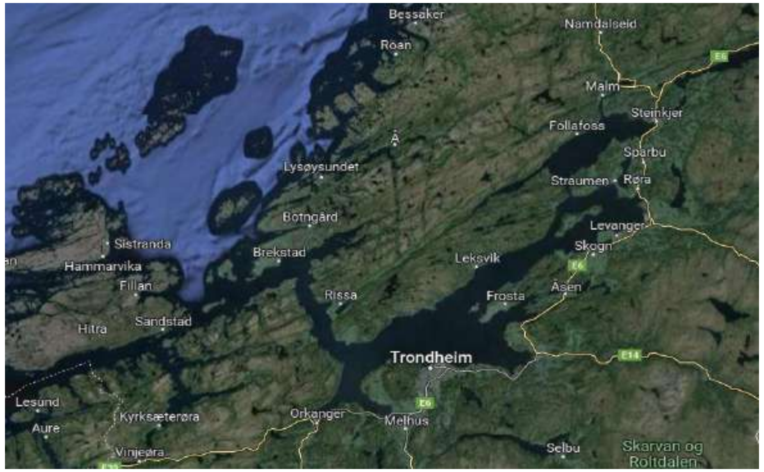
- Optical
- Imaging
- Acoustic

Satellites

- Multi
- Hyperspectral

AUV

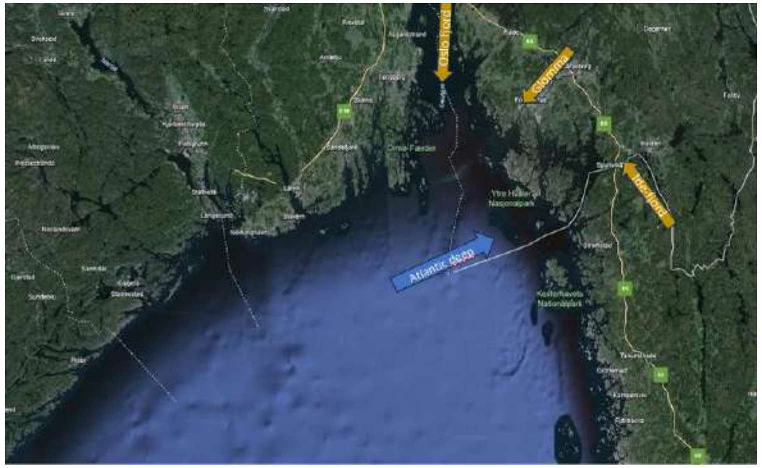
- Side Scan Sonar
- Photogrammetry
- CTD
- Cameras



NTNU Laboratories

(AUR-lab, OceanLab, UAVlab, SmallSat Lab)

- Instruments
- Observational plaforms



Field case studies

Adriatic Sea

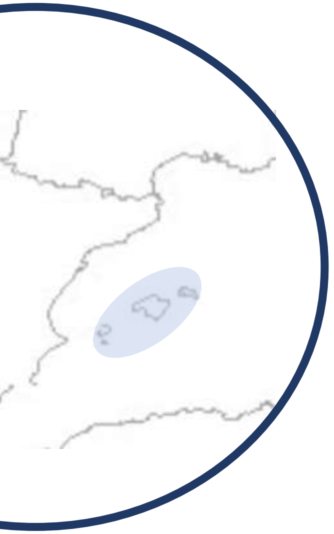
Mapping and characterization of habitats in Marche and Apulia regions

- Historical data
- Unmanned aerial and underwater vehicles
- Snorkeling and Scuba diving

HVA & Dardanelles

Observing Posidonia oceanica meadows and Hydrothermal vent

- Remote sensing data
- Water samples
- Scuba diving
- Drones



Balearic Islands

Quantification of cetacean species and habitats

- Passive acoustic monitoring
- Sighting surveys
- Molecular techniques

Northwestern Black Sea

Mapping biological diversity and invasive species:

- Traditional eDNA:eRNA methods
- ROV methods

Overall

- DiverSEA will constribute to improve and build an integrated and sustainable **coastal observation** system at European level
- DiverSEA will increase Europe's **ability to quickly respond** to the rapid changes in climatic human-induces processes
- And to respond throw **new policies** and management guidelines to evolving stakeholder and end-user requirements

Funded by the European Union

Thank you !

Funded by
the European Union

LSTS

U.PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

AQUARIUS

Aqua Research Infrastructure Services

for the health and protection of our unique ocean, seas and freshwater systems

AQUARIUS

Simo Cusi – EMSO ERIC (simo.cusi@emso-eu.org)

Funded by
the European Union

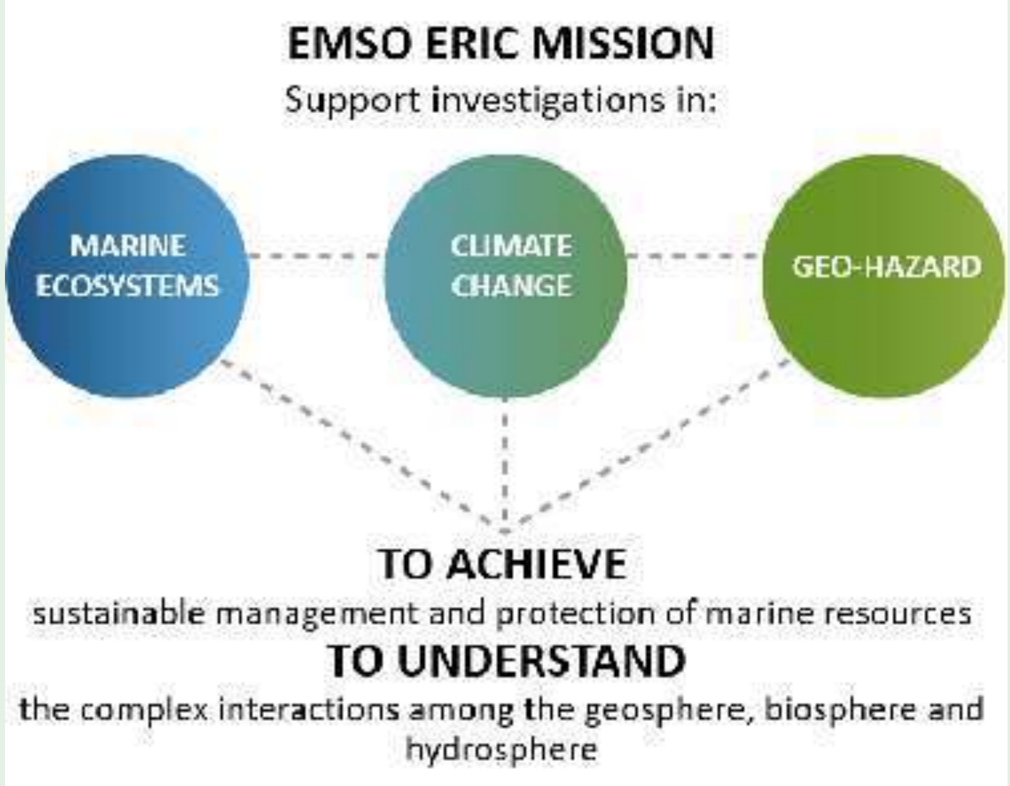
AQUARIUS has received funding from the European Union's Horizon Europe Framework Programme for Research and Innovation under grant agreement No 101130915. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

simo.cusi@emso-eu.org

About EMSO ERIC

Who we are?

- European Multidisciplinary Seafloor and Water Column Observatory
- European Research Infrastructure Consortium with autonomous legal status
- Participated by 8 countries (France, Greece, Ireland, Italy, Norway, Portugal, Romania and Spain)
- Central Management Office in Rome, IT
- Participation in 14 European Projects



EMRA’24, Arenzano, May 27-29 2024

simo.cusi@emso-eu.org

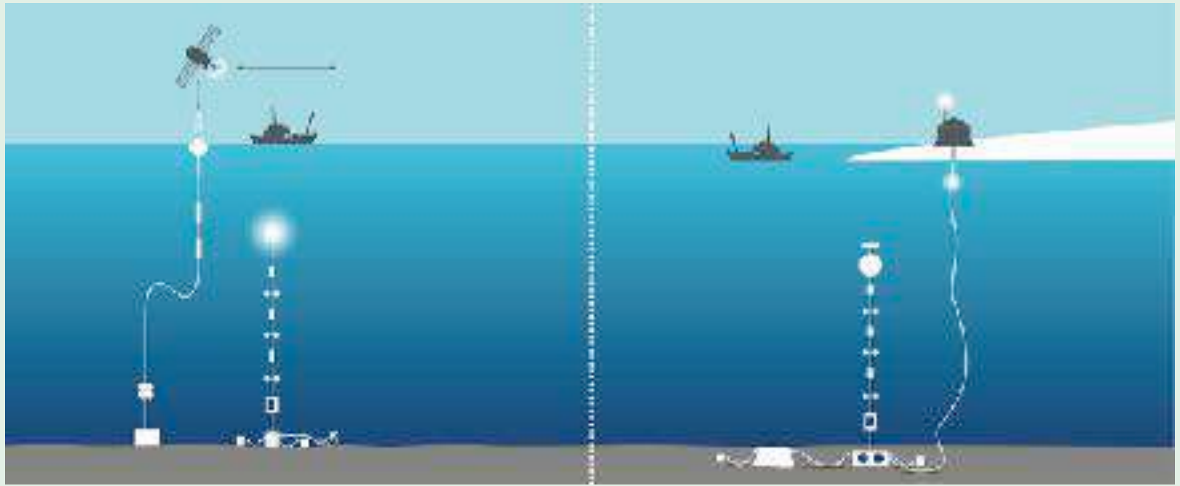
AQUARIUS

About EMSO ERIC

emso ERIC

EMSO Sites

- 14 sites
  - 3 cabled in shallow water for testing
  - 11 deep ocean sites (2 cabled)
  - Institutions running the sites participate in some projects as affiliated entities to EMSO ERIC



simo.cusi@emso-eu.org

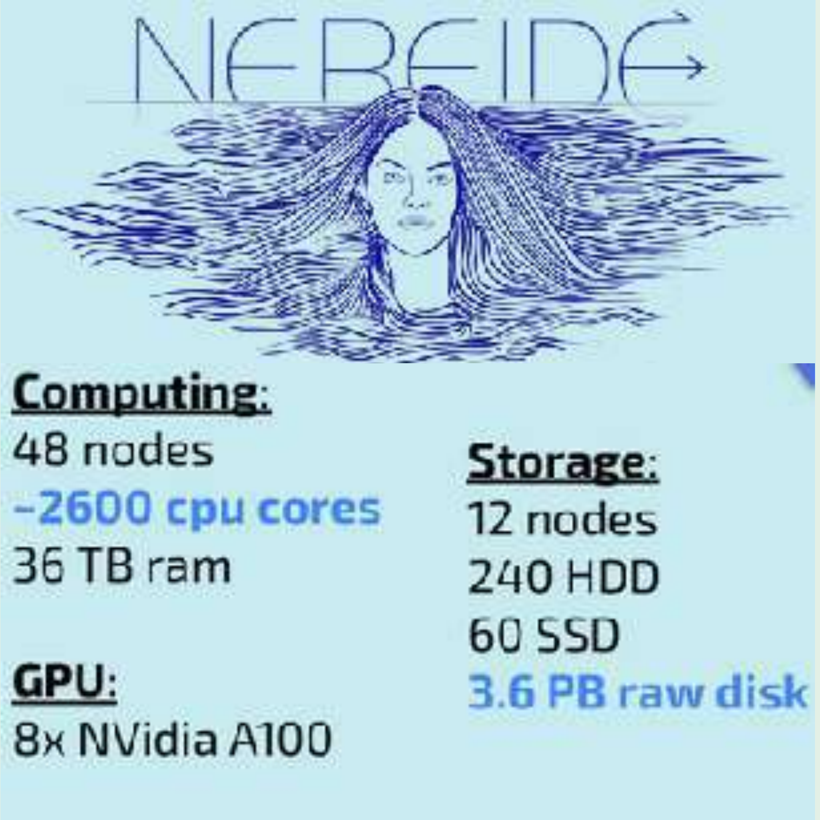
AQUARIUS

About EMSO ERIC

emso ERIC

EMSO Services

- **Data**
  - Federated ERDDAP Server
  - Data Portal with plotting tools
  - Long time-series
  - Multidisciplinary
  - Harmonized
  - Quality controlled



simo.cusi@emso-eu.org

About EMSO ERIC

EMSO Services

- **Physical Access**
  - Access to EMSO sites for testing technologies, scientific experiments, new methodologies, etc.
  - Open to Universities, Research Institutes, SMEs and Large Industries
  - Continuous availability through calls every 2 months
  - Peer Reviewed proposals
  - 15k€ funding per project for travel, adaptations and operations; aside of facility support for logistics, training, etc

simo.cusi@emso-eu.org

About EMSO ERIC

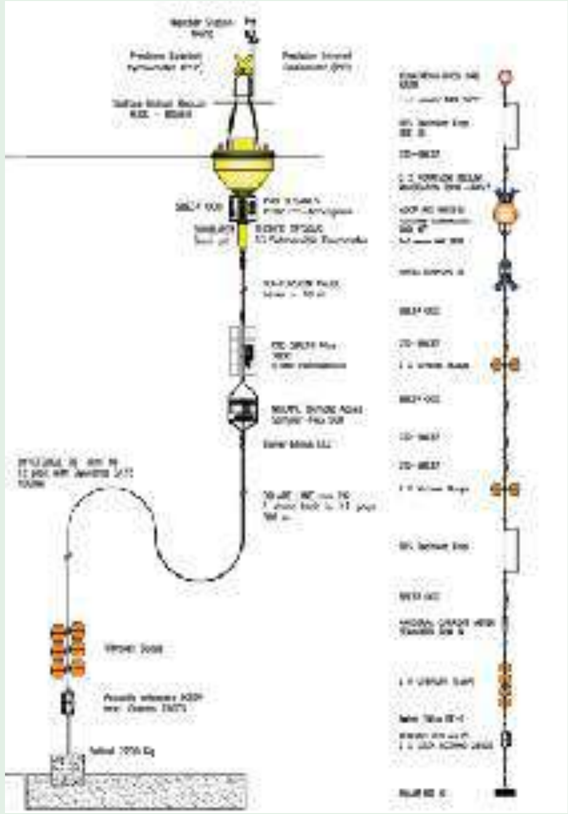
Possible collaborations

What we can provide, gateway to EMSO observatories

- Long timeseries data
- Physical Access
- European Projects

What would be interesting for us

- Resident AUVs for:
  - Maintenance
  - sensor inter-calibration
  - measurements around the fixed-point observatories
  - data mule
  - energy provision to seafloor observatories



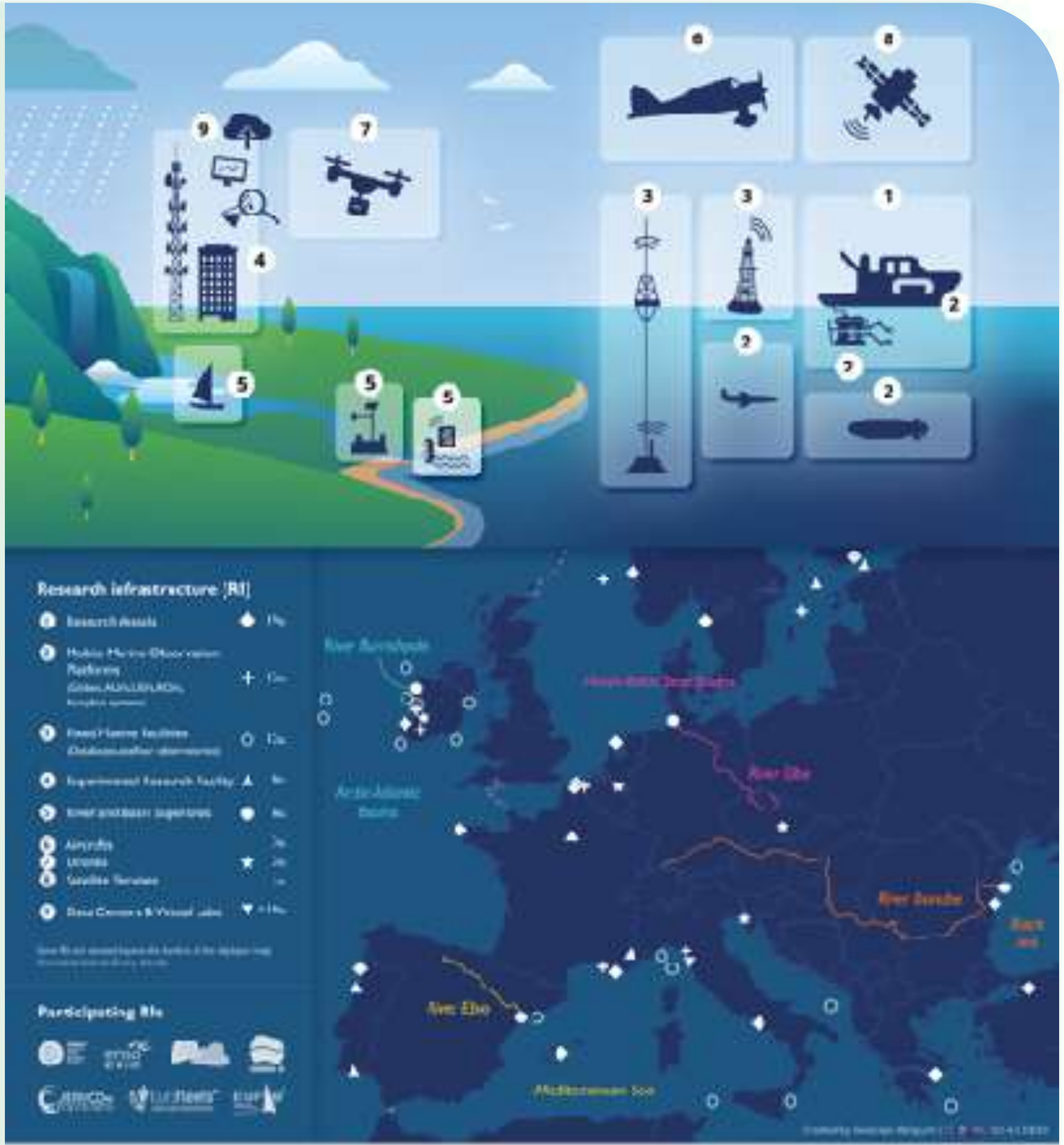
simo.cusi@emso-eu.org

About AQUARIUS

AQUARIUS will **provide access to a comprehensive and diverse suite of integrated research infrastructures** to address challenges & explore opportunities for the sustainability of our marine & freshwater ecosystems.

Horizon Europe

- **4 years starting March 2024**
- **45 Partners (18 nations)**
- **€14.5 Million**



simo.cusi@emso-eu.org

45 partners, 18 nations

simo.cusi@emso-eu.org

AQUARIUS Aim

To provide **free & supported access to a comprehensive & diverse suite of 57 integrated research infrastructures** to address challenges & explore opportunities for the long-term sustainability of our marine & freshwater ecosystems.

©HCMR

©SLU

©CNR

©Wieter Boone

©VITO

simo.cusi@emso-eu.org

AQUARIUS objectives

- Provide single-point access to a **curated catalogue** of 57 diverse marine & freshwater research infrastructure services.
- Design, develop, & manage **2 Transnational Access Funding Calls,** providing free & supported access for selected projects to the research infrastructure.
- Deliver **scientific & technical training** to apply for & use the research infrastructures
- Ensure **advanced data management** to make data **FAIR** (Findable, Accessible, Interoperable, & Reproducible), according to open, global standards.
- Maximise **impact** ensuring that AQUARIUS & the projects it supports deliver to the goals of **the Mission ‘Restore our Ocean & Waters by 2030.**

simo.cusi@emso-eu.org

AQUARIUS

Thematic & Geographical Scope

Thematic scope is informed by the Mission’s objectives

Geographic scope corresponds to the Mission Lighthouse regions

To protect & restore marine & freshwater ecosystems & biodiversity

To make the sustainable blue economy carbon-neutral & circular

To prevent & eliminate pollution of our ocean, seas & waters

Mission Lighthouses: spaces of transformation to pilot, demonstrate, develop & deploy the Mission activities across the EU.

simo.cusi@emso-eu.org

Approach

AQUARIUS will provide single-point access to a curated catalogue of **57 research infrastructure** services

- Categorised by type & location (Mission Lighthouse)
- Modalities of access
- Technical specifications of infrastructure
- User requirements, training

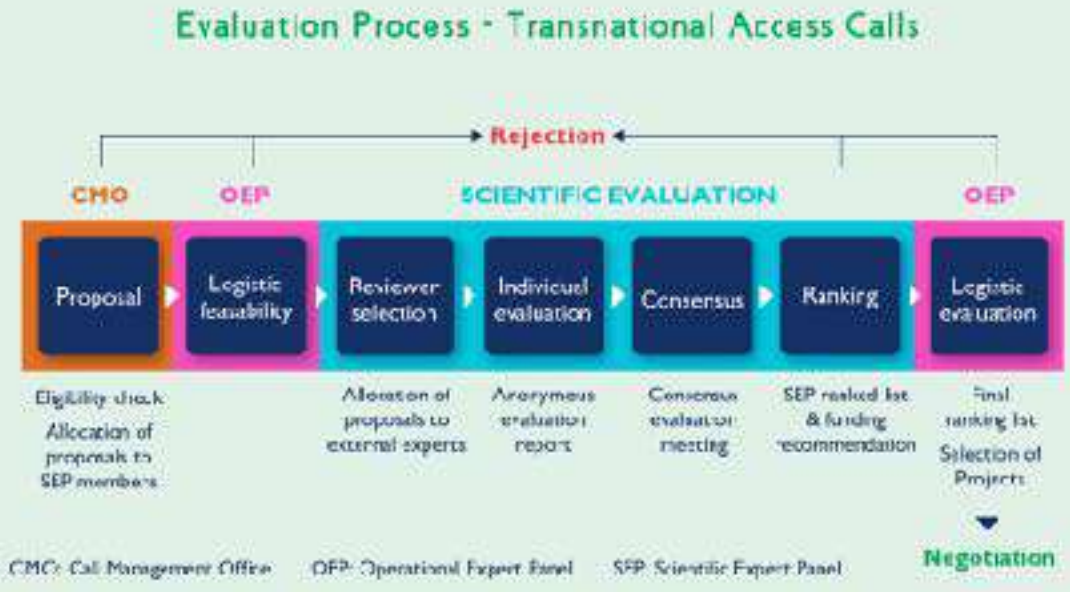
By providing access to this range & diversity of research infrastructures **AQUARIUS** enables a more holistic approach to research & innovation that **contributes to healthy and sustainable marine and freshwater ecosystems.**

aquarius-ri.eu/ri-catalogue

simo.cusi@emso-eu.org

AQUARIUS

Approach



- AQUARIUS will launch two transnational access funding calls for research and innovation project proposals via a dedicated and user-friendly platform.
- Proposals must demonstrate how they will integrate multiple infrastructures and contribute to the defined Mission Ocean challenges.
- Calls are open to scientists from research and academia, from industry, and from citizen science groups, according to the defined eligibility criteria.

Call 1 – Open: 11 November 2024 – 20 January 2025
Call 2 – Open: 02 September 2025 – 28 October 2025

aquarius-ri.eu/access

simo.cusi@emso-eu.org

Technical Training

Provide scientific & technical training for call applicants, selected projects & next-generation marine scientists.

- Use of AQUARIUS calls access platform
- Technical & scientific support to use the research infrastructures
- Data management & stewardship
- Virtual access & analytics
- Floating University & Marine Internships for early career marine scientists

©VLIZ

©Ifremer

©Marine Institute

©OGS

aquarius-ri.eu/training

simo.cusi@emso-eu.org

AQUARIUS

Open Science, Open Data

AQUARIUS will implement best practices in open science & open data making all data FAIR

- Mandatory open data strategy for selected projects
- Scientific teams will be invited to make use of the Blue-Cloud Virtual Research Environment
- All metadata & data will become part of the leading European & global data infrastructures

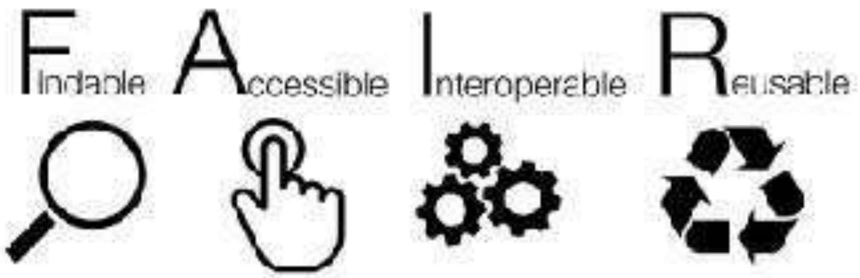
Copernicus Marine Service

EMODnet

EU MISSIONS RESTORE OUR OCEAN & WATERS

EDITOInfra European Digital Twin Ocean

eosc Blue-Cloud2026



IODE

EurOBIS European Ocean Biodiversity Information System

SeaDataNet

GEOSS

aquarius-ri.eu/impact

simo.cusi@emso-eu.org

Centre for Robotics & Intelligent Systems CRIS (University of Limerick) – Matheus Santos - matheus.santos@ul.ie

Established in **2000**, **CRIS – Centre for Robotics & Intelligent Systems** is the research centre focused on the application and development of **marine** and **aerial** robotics.

25+ researchers, internship students, visiting professors and industry placements.

In the last 20 years our focus has been on developing smart, industrial relevant robotics technologies, including:

- Unmanned Aerial and Surface Vehicles (**UAVs/USVs**),
- Remotely Operated Vehicles (**ROVs**),
- Sensor development,
- Marine platforms,
- Control systems featuring ultra high precision 3D dynamic positioning and motion with transparent ocean augmented reality displays.

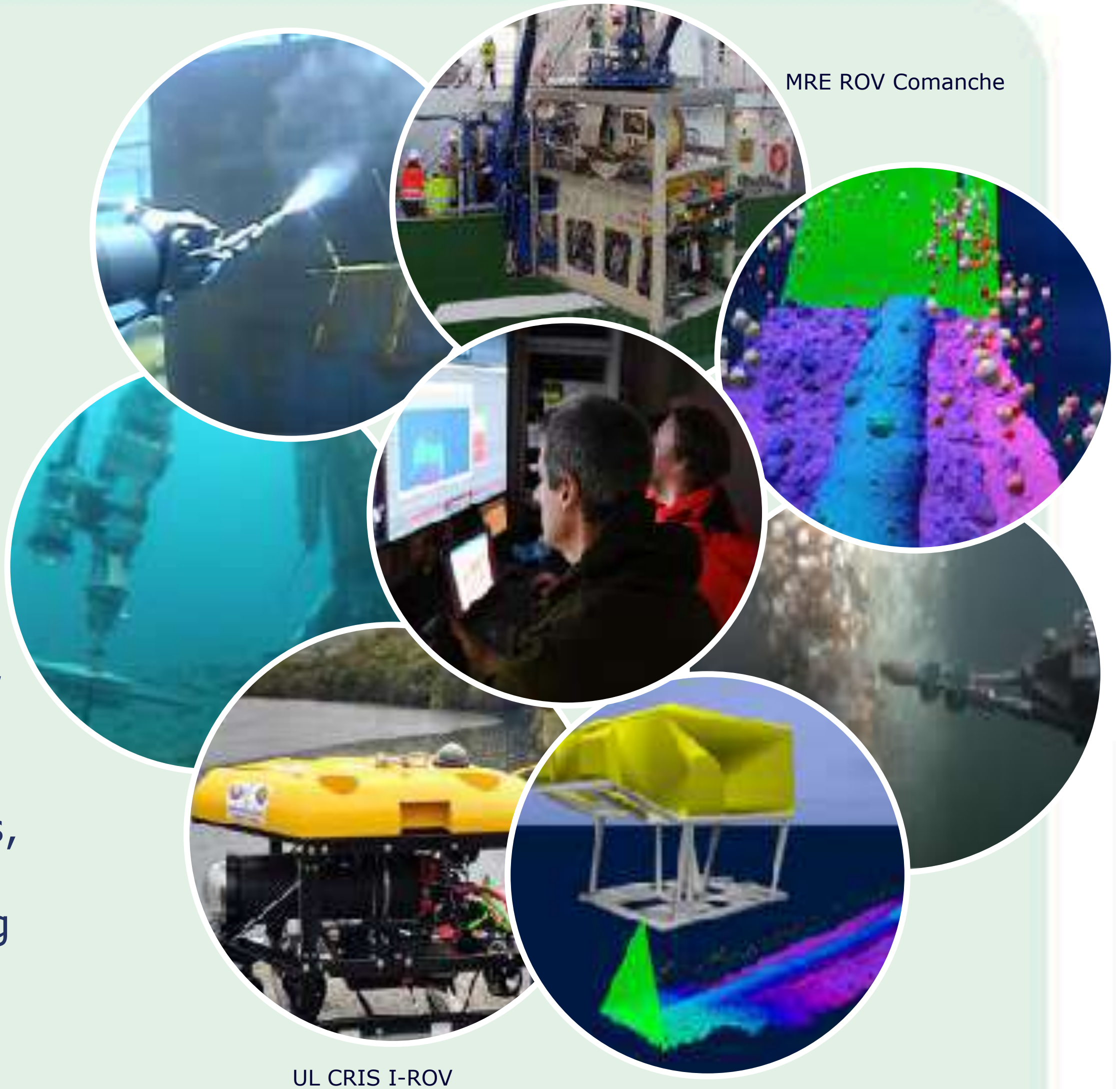
simo.cusi@emso-eu.org

Centre for Robotics & Intelligent Systems CRIS (University of Limerick) – Matheus Santos - matheus.santos@ul.ie

OUR INFRASTRUCTURE & EQUIPMENT

- **CGT 50 Fix-Wing Drone** - the low fuel consumption enables a safe endurance of 6 hours.
- **Drones:** DJI M300, DJI M600, Mavic Pro, UL Octocopter.
- **USV- Blueboat.**
- **MRE-ROV, 2000m** light work-class intervention ROV including LARS and TMS.
- **I-ROV, 300m** light inspection-class ROV.
- Multiple high-resolution sonar systems: Reason, BlueView and Tritech, CODA 3D sonar, …
- Small scale ROVs: **BlueROV, VideoRay.**
- **Manipulators and cleaning tools** (Flexible cleaning fins, Water Jetting /Cavitation)
- Laser Line Scan systems, including 3 UHD subsea imaging cameras and strobe lights.
- LiDARs, thermal cameras, infrared cameras, …

MRE ROV Comanche



UL CRIS I-ROV

simo.cusi@emso-eu.org

EMSO ERIC facilities in AQUARIUS

Marine Institute

Atlantic-Arctic: Protect and restore aquatic ecosystems

Smartbay cabled observatory and buoy

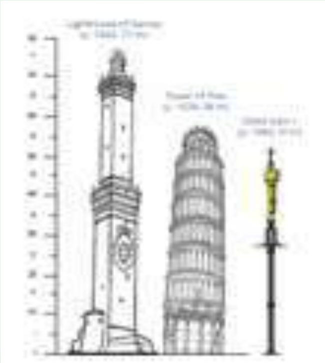
- A fiber optic data and 400v power cable
- High speed comms via 4 pairs of optical fibers
- Sub-sea observatory hosts 23 science ports:
  - 4 optical
  - 18 electrical (serial or ethernet)
  - 1 coaxial
- 1.5km offshore, 25m depth.

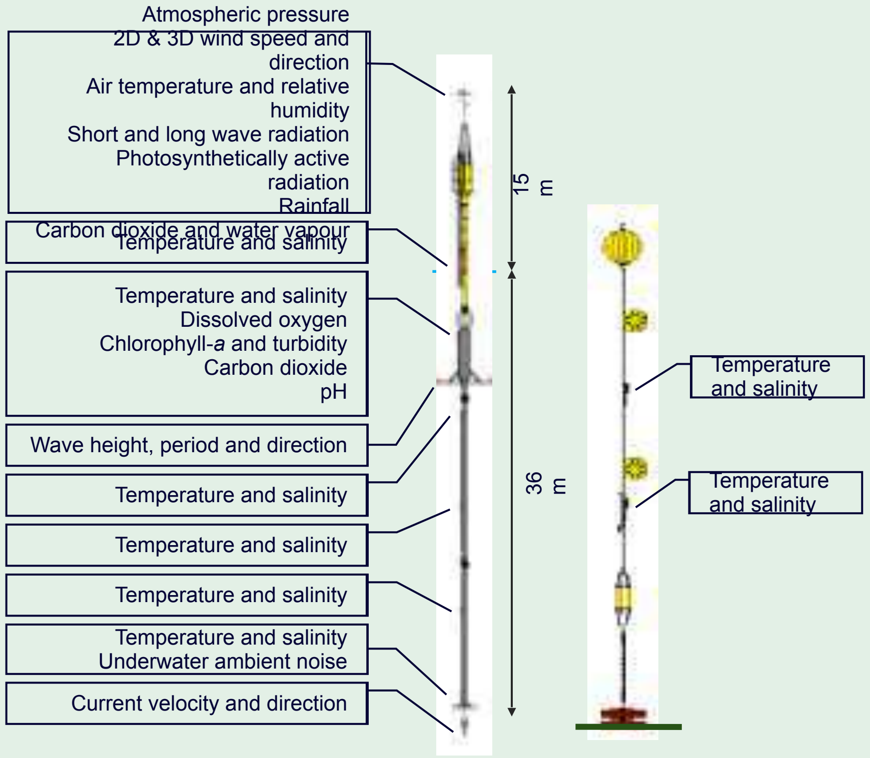
simo.cusi@emso-eu.org

EMSO ERIC facilities in AQUARIUS

Mediterranean: Prevent and eliminate pollution

Western Mediterranean Sea W1M3A





simo.cusi@emso-eu.org

AQUARIUS

EMSO ERIC facilities in AQUARIUS

OGS National Institute of Oceanography and Applied Geophysics

Mediterranean: Prevent and eliminate pollution

South Adriatic Sea E2M3A

Longest time series in the open Adriatic Sea data from 2006 to 2023

Physics

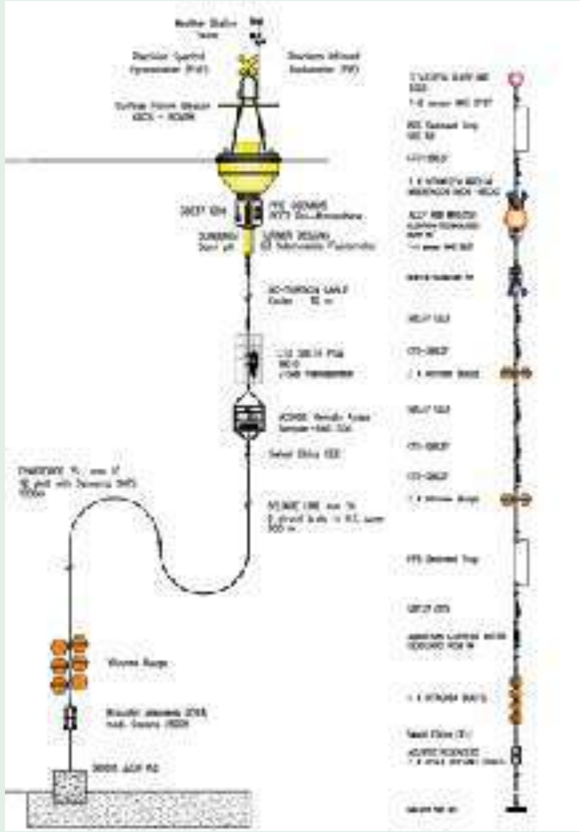
Air – Sea Interaction
Circulation and thermohaline variability
Detection of Mesoscale Eddies
Detection of dense water cascading
Long-term Trends

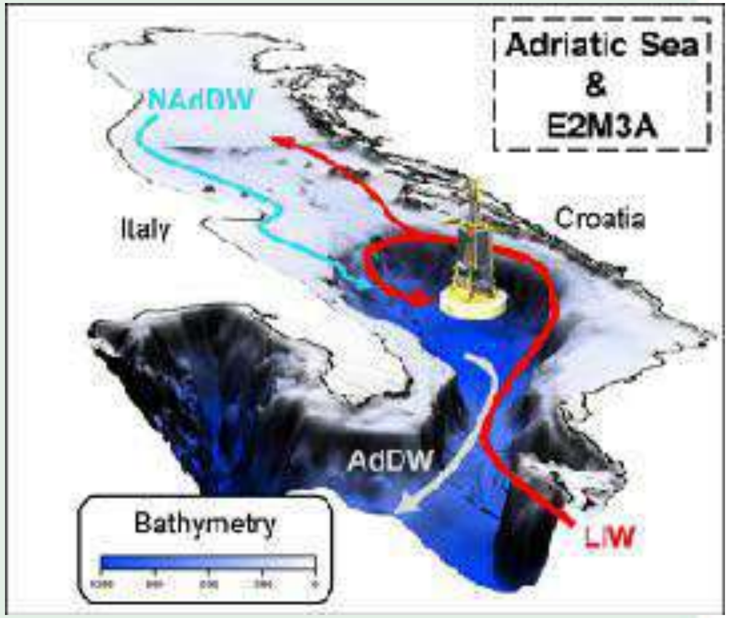
Biological

Zooplankton Diel vertical migration

Biogeochemistry

Downward particulate fluxes
Ocean acidification

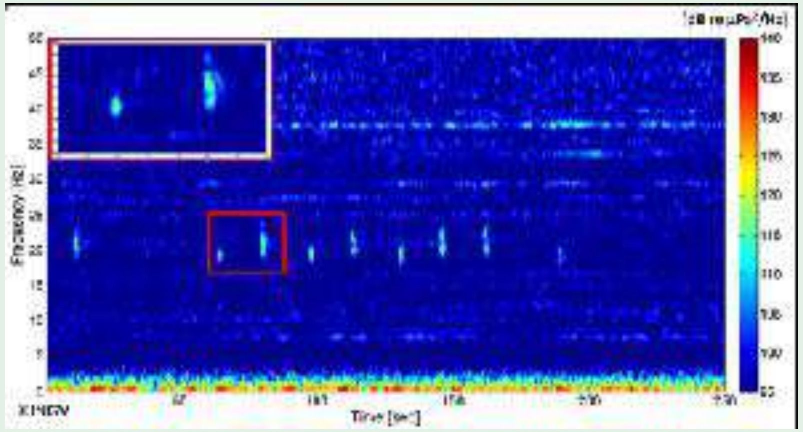


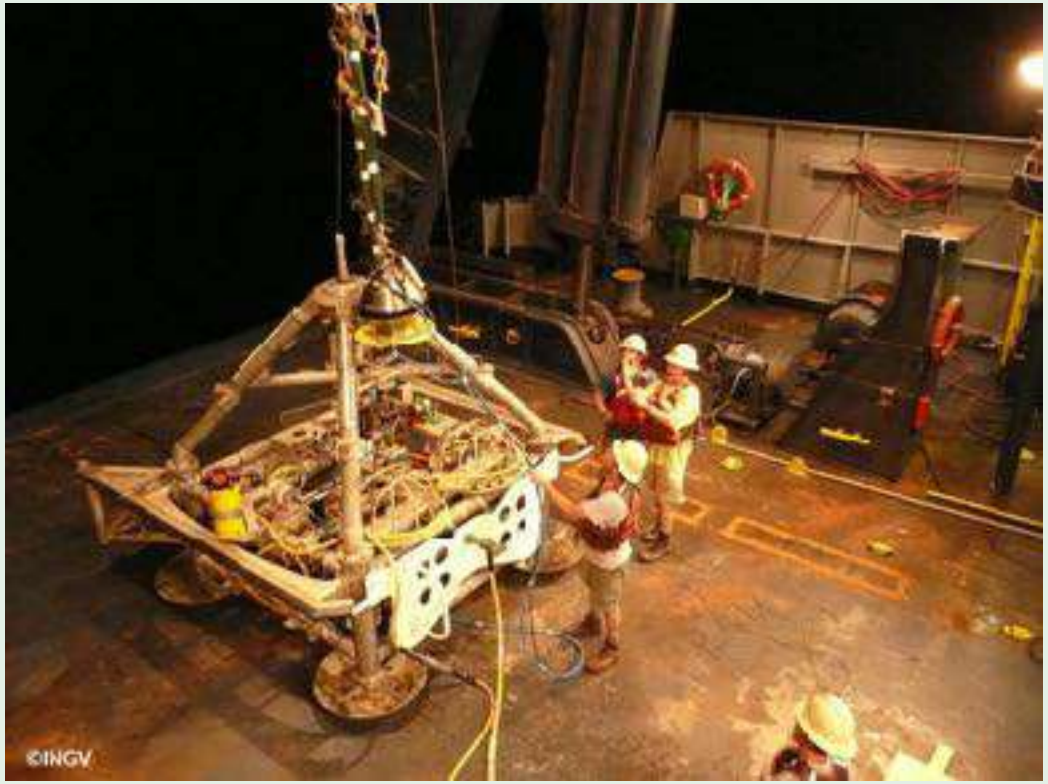


EMSO ERIC facilities in AQUARIUS

Mediterranean: Prevent and eliminate pollution

Western Ionian Sea



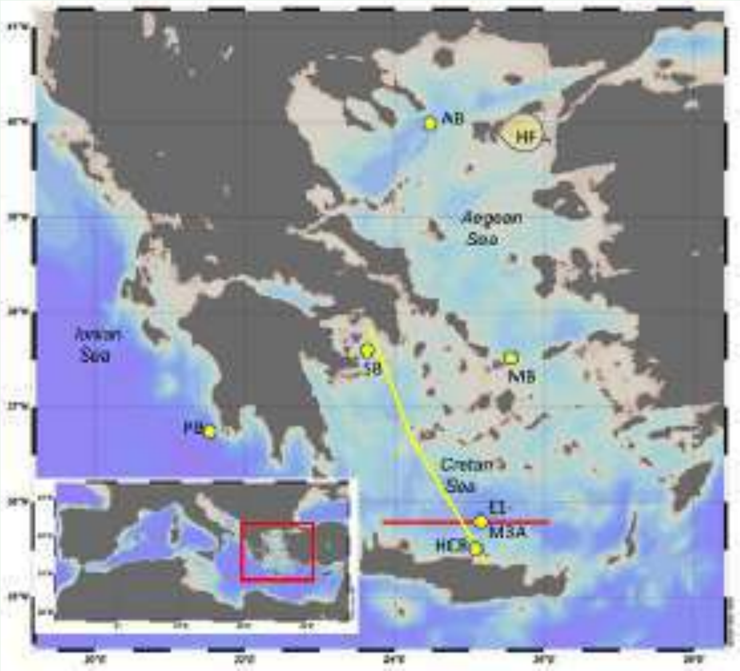


simo.cusi@emso-eu.org

EMSO ERIC facilities in AQUARIUS

Mediterranean: Prevent and eliminate pollution

Cretan Sea – E1-M3A



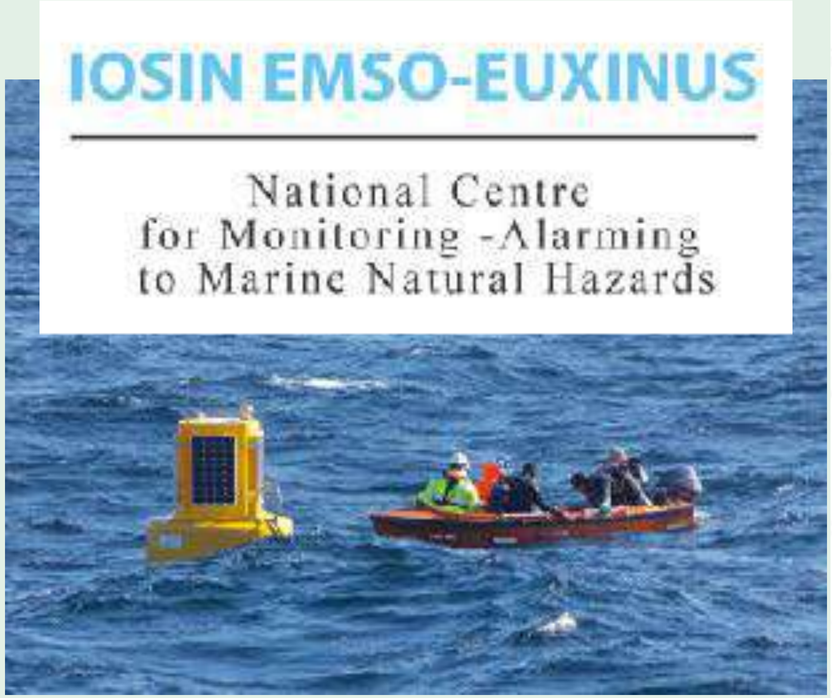
Operational observation systems & platforms	Current Status/ Operator	Variables	Background data	Data integrator
Ferrybox PFB (Heraklion - Piraeus transect every other day)	Restarting in March 2023 / HCMR	T, S, Fluo, Tur, O2,	4 years in total since 2003	CMEMS
Fixed platform HCB (3 hours)	Operational / HCMR	metoc; SSS, SST; pH, air-water CO2	Since 2016	CMEMS
Fixed platform E1-M3A (3 hours)	Operational / HCMR	metoc; SSS, SST; T, S, Chl-a, O2 at 20, 50, 75, 100 m; T, S at 250, 400, 600, 1000 m	Since 2000	CMEMS
Fixed platform SB (3 hours)	Terminated / HCMR	metoc; SSS, SST;	2007 - 2013	CMEMS
Fixed platform MB (3 hours)	Interrupted / HCMR	metoc; SSS, SST;	2001 - 2022	CMEMS
Glider PG (seasonal to biannual)	Operational / HCMR	T, S, O2 every 1m down to 1000m	Since 2017	CMEMS
Argo floats	Operational / HCMR	T, S (O2)		Argo Network/ CMEMS
Monitoring by R/V at HCB (Monthly to seasonal)	Operational/ HCMR	CTD cast (T, S, O2, Fluo, Turbidity, PAR) Niskin 2, 10, 20, 50, 75, 100, 120m (pH, CT&AT, inorganic nutrients, Chla, bacteria to phytoplankton) zooplankton net	Since 2016	CMEMS for CTD For bottle data CMEMS, SOCAT SDG 14.3.1 & some on request
Monitoring by R/V At E1-M3A (biannual)	Operational/ HCMR	Idem (with casts and sampling down to 1500m)	Since 2010	Idem

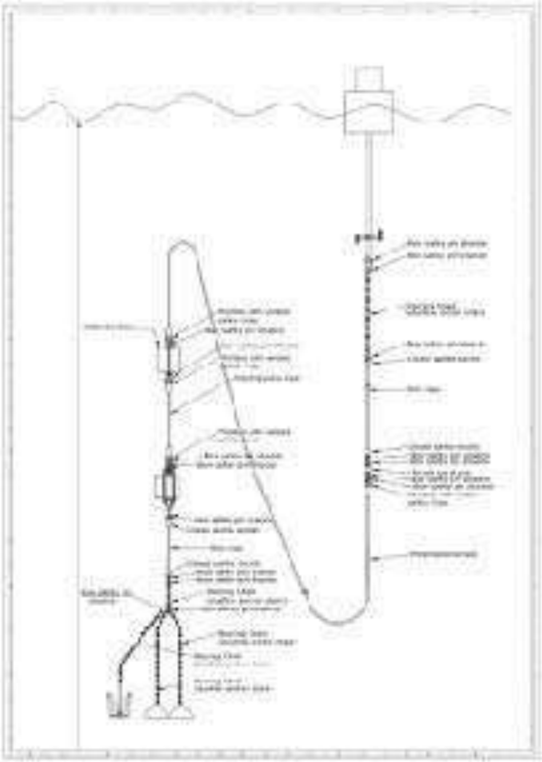
simo.cusi@emso-eu.org

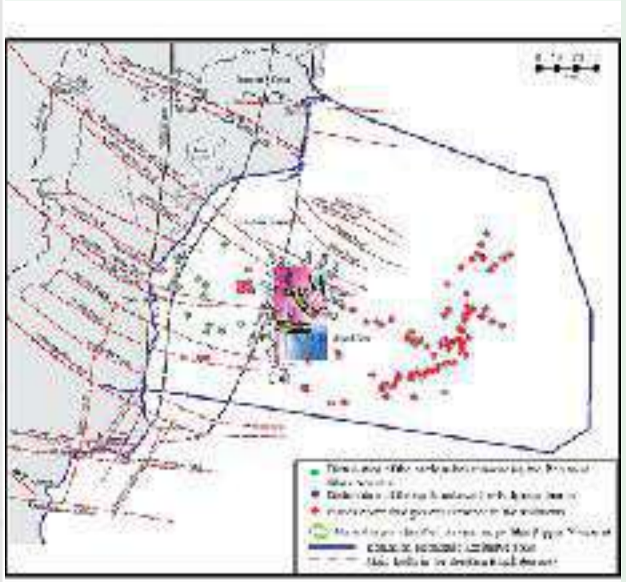
EMSO ERIC facilities in AQUARIUS

Danube – Black Sea: Protect and Restore Ecosystems

Black Sea – EUXINUS







Are you a scientist working in marine or freshwater research?

Are you an early career scientist and interested in training or internships?

Apply to our transnational access funding calls!

aquarius-ri.eu

get in touch: hello@aquarius.eu

stay informed & subscribe to our newsletter

follow us on LinkedIn

EMRA'24, Arenzano, May 27-29 2024

simo.cusi@emso-eu.org

VISIT

AQUARIUS-RI.EU

AQUARIUS

FOLLOW US

Integrating Research Infrastructures – Connecting Scientists – Enabling Transnational Access

For healthy and sustainable marine and freshwater ecosystems

Funded by the European Union

AQUARIUS has received funding from the European Union's Horizon Europe Framework Programme for Research and Innovation under grant agreement No 101130915. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

THANK YOU

simo.cusi@emso-eu.org

TRIQUETRA

Toolbox for assessing and mitigating Climate Change risks and natural hazards threatening cultural heritage

Project presentation

David Nguyen, CSEM

EMRA - 2024 | 28 May 2024

Project funded from the EU HE research and innovation programme under GA No. 101094818.

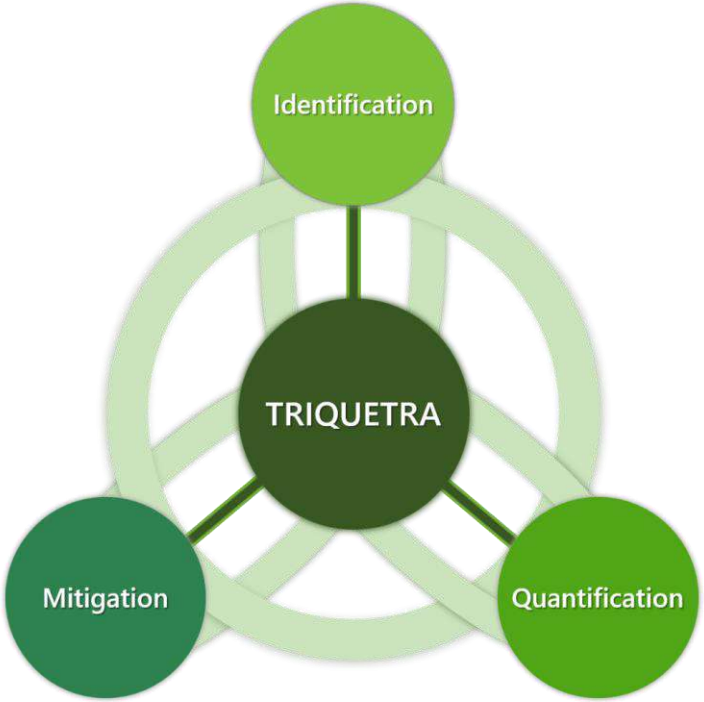
csem

TRIQUETRA

Creating:

- An evidence-based assessment platform
- A database of available mitigation measures and strategies

Acting as a Decision Support Tool towards efficient risk mitigation and site remediation



This "trifecta" approach creates a framework of risk assessment and risk mitigation so as to tackle as many of these risks as possible, in the most efficient way available.

Project funded from the EU HE research and innovation programme under GA No. 101094818.

csem

ADDRESSED CULTURAL HERITAGE TYPOLOGIES

Mainland – rural areas are less likely to be shielded in remote areas with scarce population and lack of surrounding infrastructure.

Underwater sites are increasingly affected by climate change (e.g. changes in the chemical composition of oceans).

Coastal areas shall be a focus for the approach to validate its various water-protection and water-related damage detecting techniques.

Innovative surveying techniques are developed:

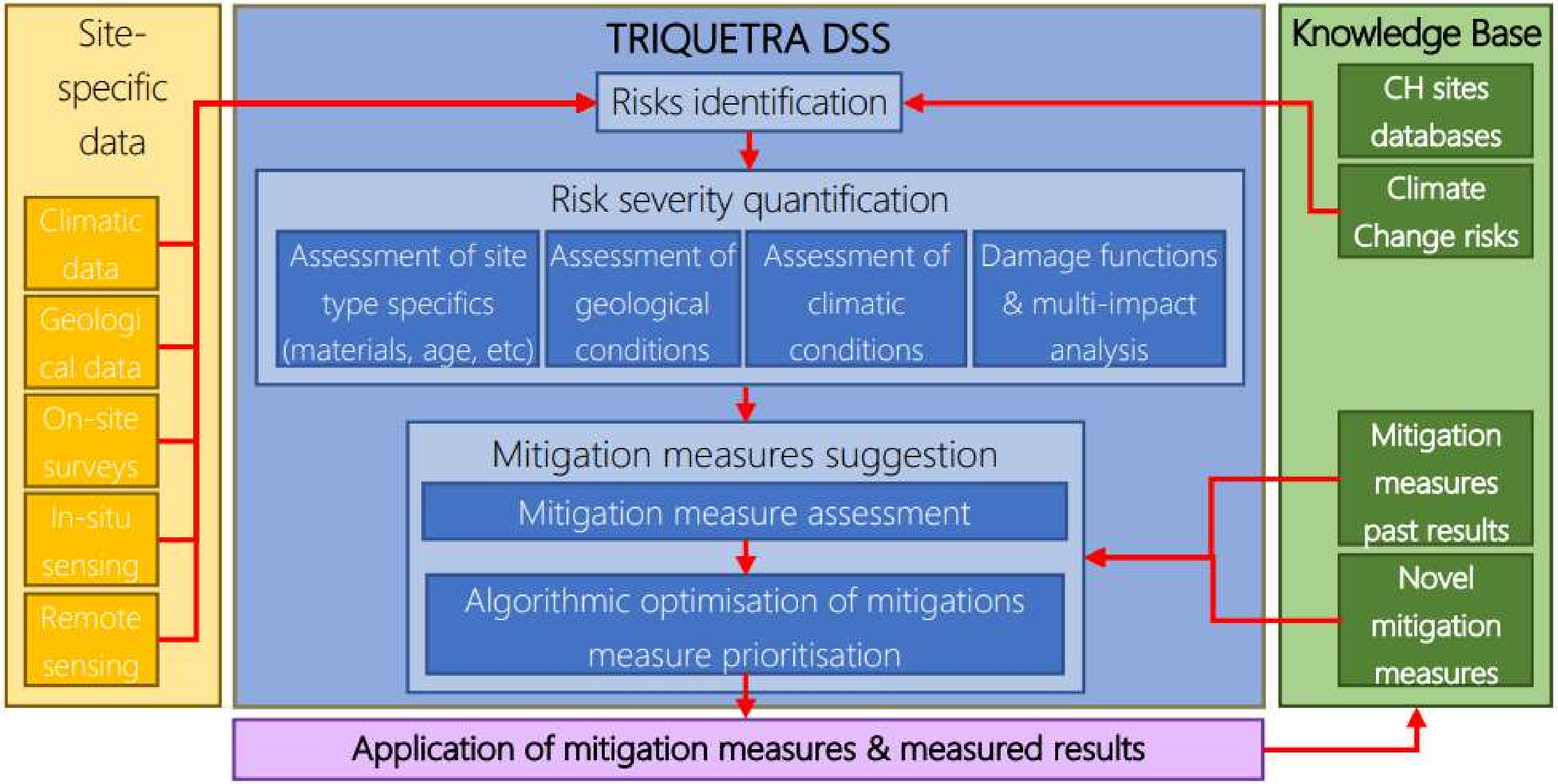
Hydrographic surveys, multi-beam sonars, UAVs with optical, multispectral & LiDAR sensors, underwater photogrammetry, laser spectroscopy, novel simulation models and more.

Project funded from the EU HE research and innovation programme under GA No. 101094818.

TRIQUETRA

DECISION SUPPORT SYSTEM

- **DSS development** integrating all modules and technologies in TRIQUETRA
- **DSS validation** in actual working conditions in 8 pilot sites
- The **TRIQUETRA DSS** to help stakeholders and decision makers to make the most educated decisions



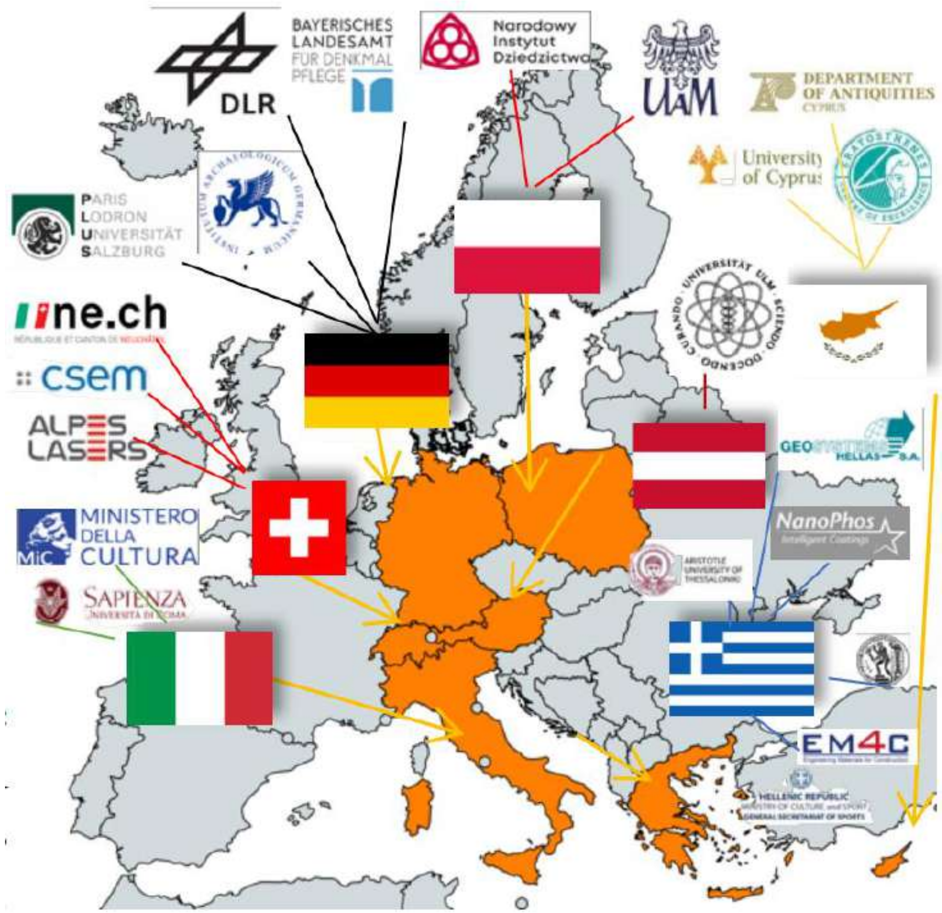
Project funded from the EU HE research and innovation programme under GA No. 101094818.

csem

CONSORTIUM

- 21 organizations: Greece (6), Germany (4), Italy (2), Cyprus (3), Poland (2), Austria (1) and Switzerland (3)
- 7 countries
- 8 Universities and Research Organizations
- 6 Cultural Heritage Authorities.

- The project started on 01/01/2023 and will last for 3 years.



Project funded from the EU HE research and innovation programme under GA No. 101094818.

csem

CSEM AT A GLANCE

We are a public-private, non-profit Swiss **technology innovation center**

We enable competitiveness by **developing and transferring world-class technologies to the industrial sector**

1984
FOUNDED

600
SPECIALISTS in 2023

100.4
MIO TURNOVER in 2022

> 50
VENTURES since 1984

Project funded from the EU HE research and innovation programme under GA No. 101094818.

csem

High-Precision Mechanisms

- Techniques and instruments for observation, characterization and testing - flextech based
- Make use of AM (Additive Manufacturing) technology for systems
- Microvibration damping and characterization & advanced control for mechatronic systems

Quantum & Laser Technologies

- Miniature atomic clock for portable applications, high-performance atomic clock, atomic sensors (Magnetometers, Gyroscopes)
- Development of lasers, stabilized lasers and laser-based devices at system level for scientific, industrial and space applications
- RF and optical metrology

Lidar & Sensing

- Flash lidar for space and underwater imaging & mapping
- Interferometric lidar for fiber sensing and metrology

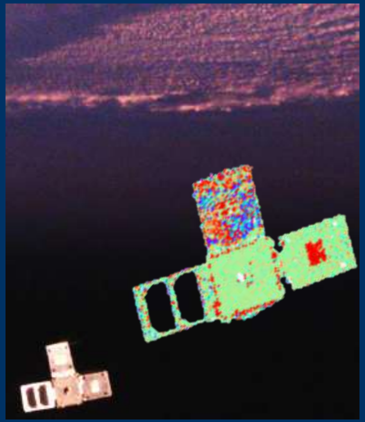
Project funded from the EU HE research and innovation programme under GA No. 101094818.

EXPERTISE

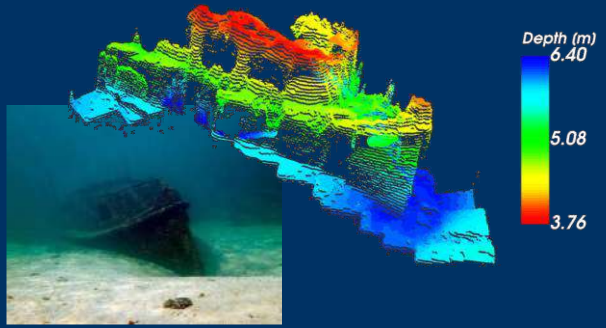
- System design & integration
- Data acquisition & processing

1. Flash lidar
   - ➢ Compact
   - ➢ Snapshot acquisition
   - ➢ High spatial resolution

APPLICATIONS



- **Space: 3D pose estimation**
- **Bathymetry**
- All-weather navigation
- Geodesy
- Environment perception

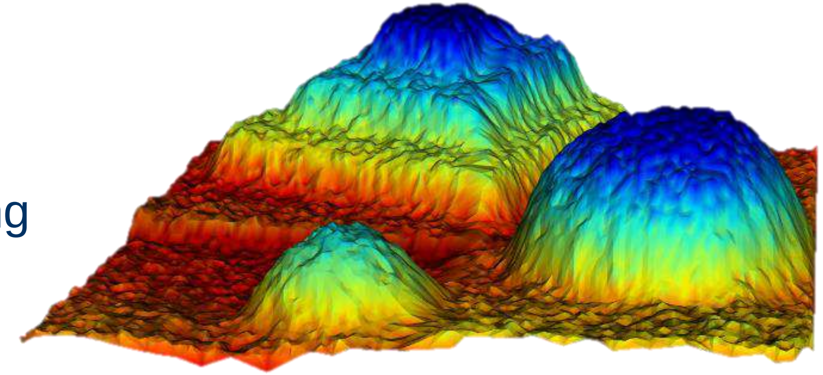


Project funded from the EU HE research and innovation programme under GA No. 101094818.

FLASH LIDAR

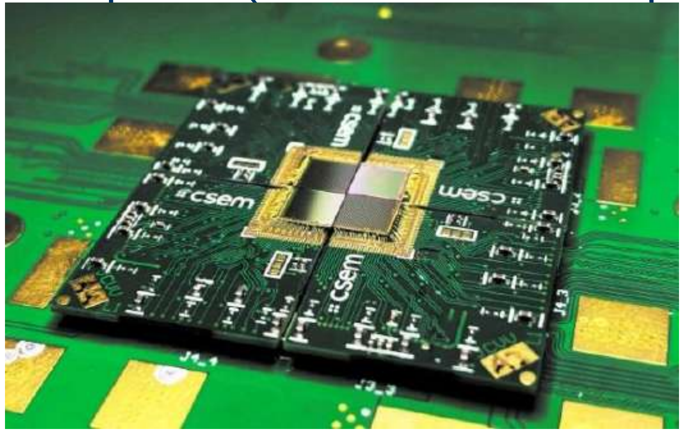
System design

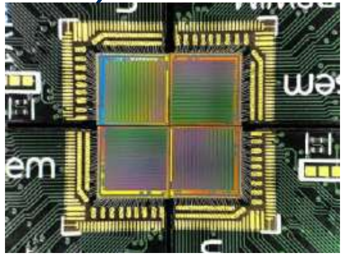
Processing



Focal plane array: time-of-flight detectors (SPAD)

128x128 pixels (512x512 in development)

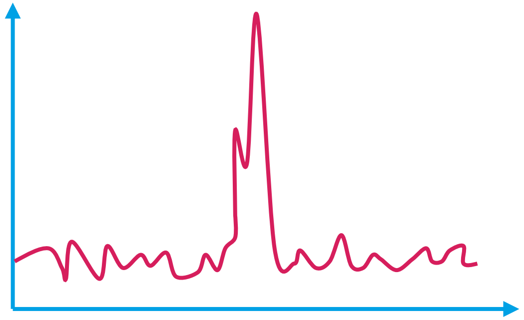




FONDAZIONE BRUNO KESSLER

Time-gating for highly-turbid water

& multiple echoes



Project funded from the EU HE research and innovation programme under GA No. 101094818.

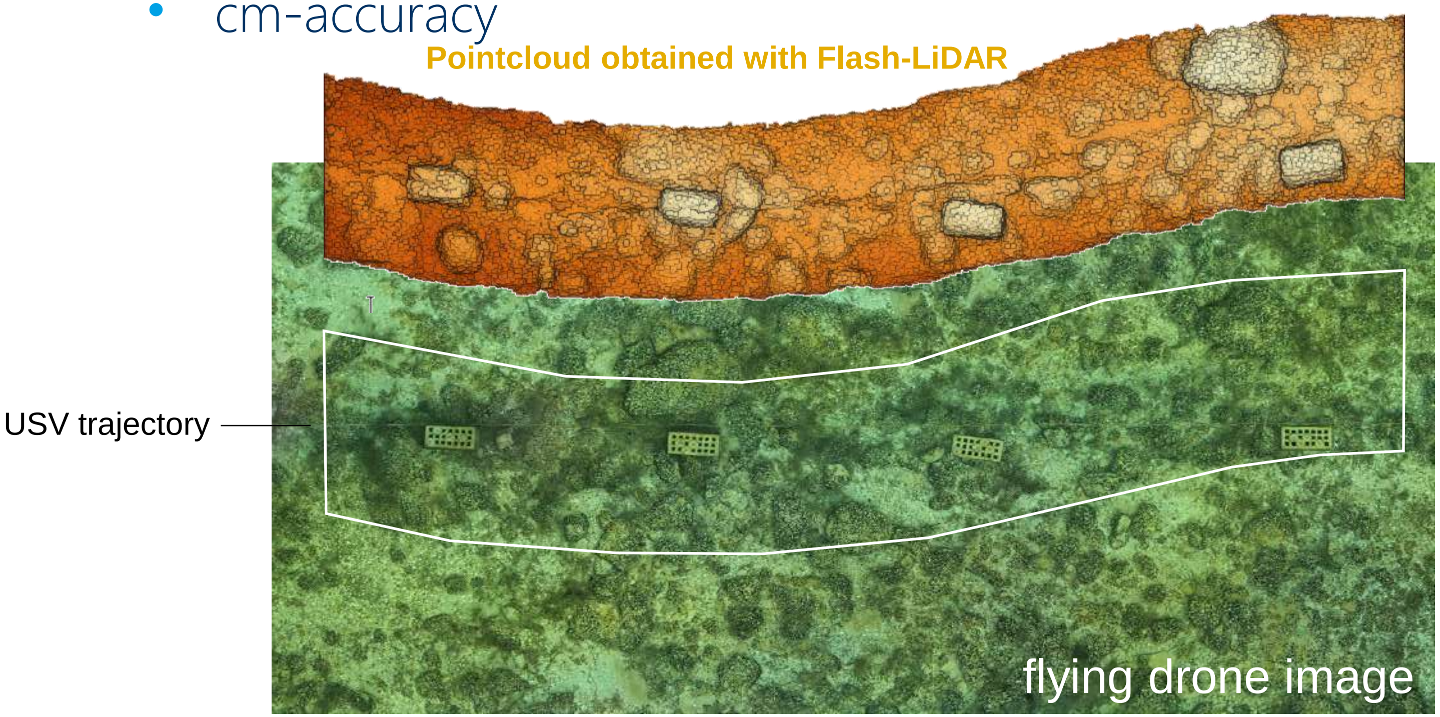
csem

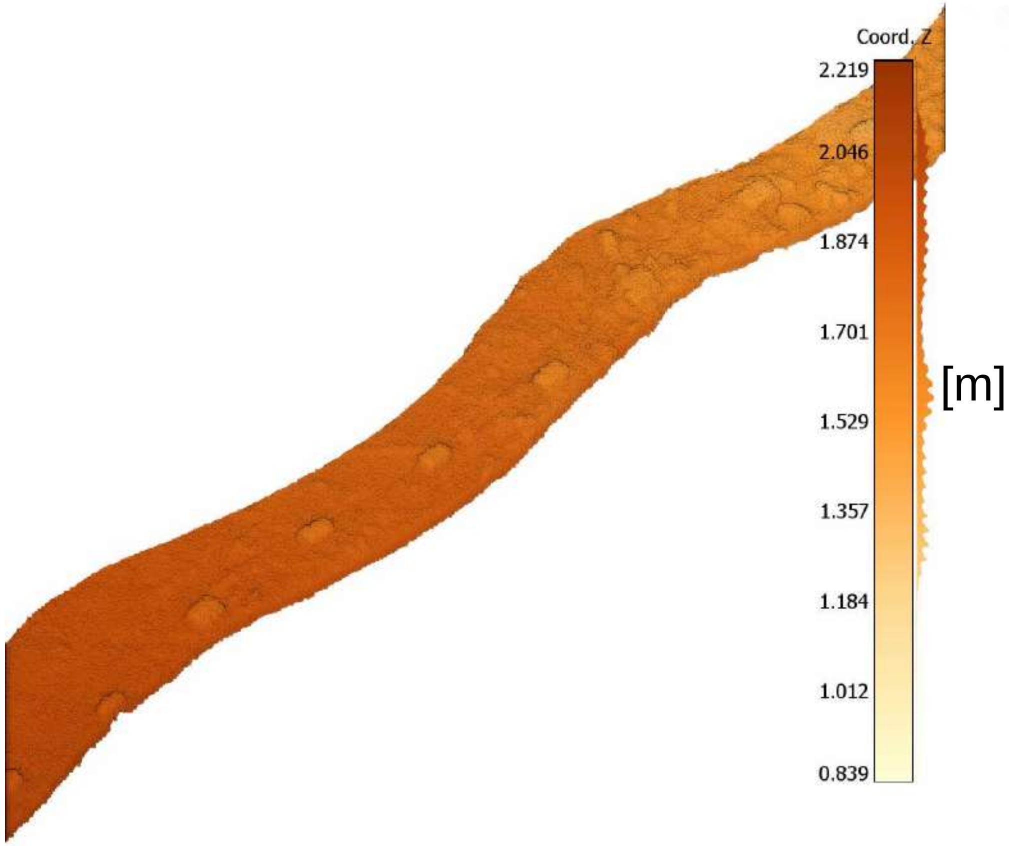
Synergies
with **Space**:

- **Remote operation → autonomy**
- **Low power**
- **Miniaturisation constraints**

NOVEL FLASH LIDAR FOR 3D MAPPING

- Short to medium (depends on water turbidity)
- cm-accuracy

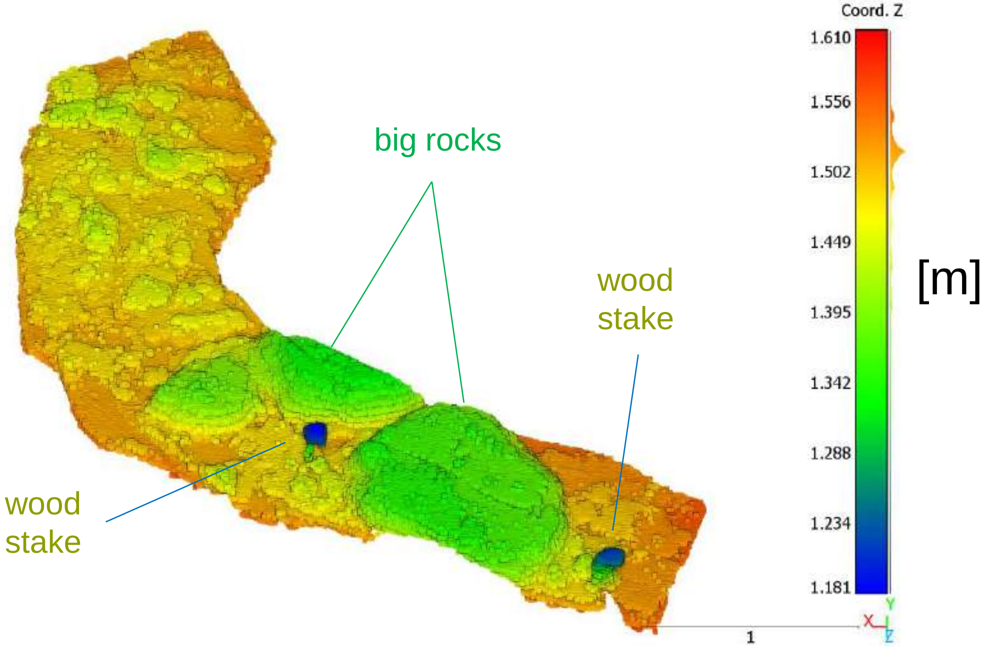


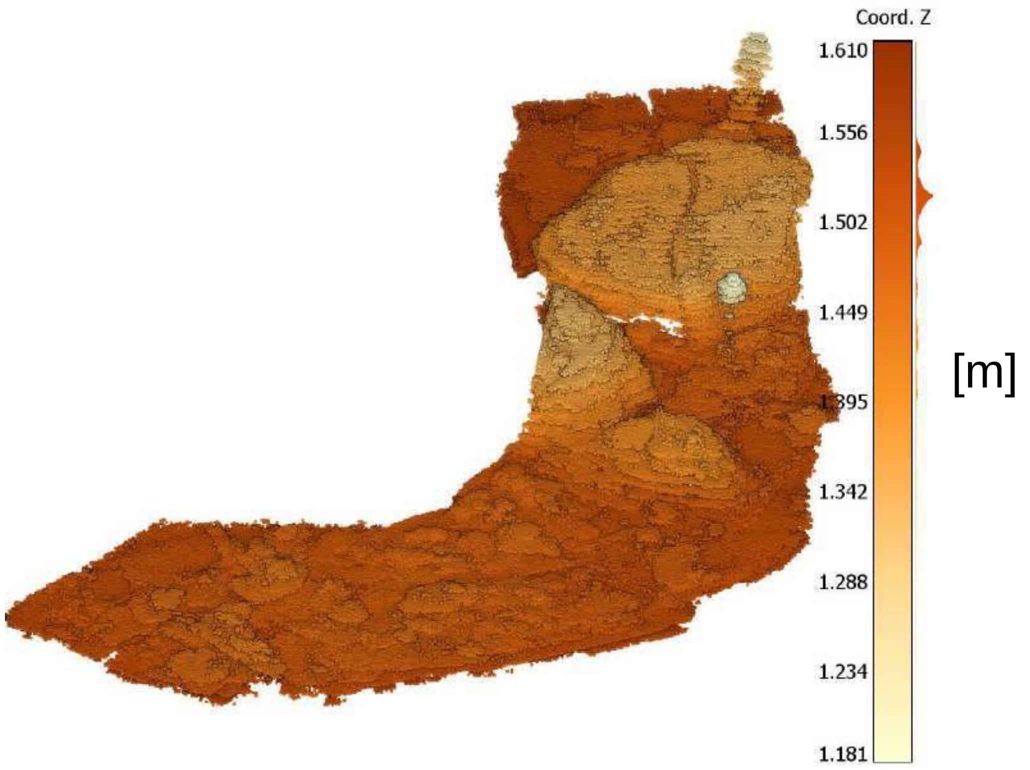


Project funded from the EU HE research and innovation programme under GA No. 101094818.

UNESCO SITE CLOSE TO LES ARGILIEZ

- Reconstructed pointcloud

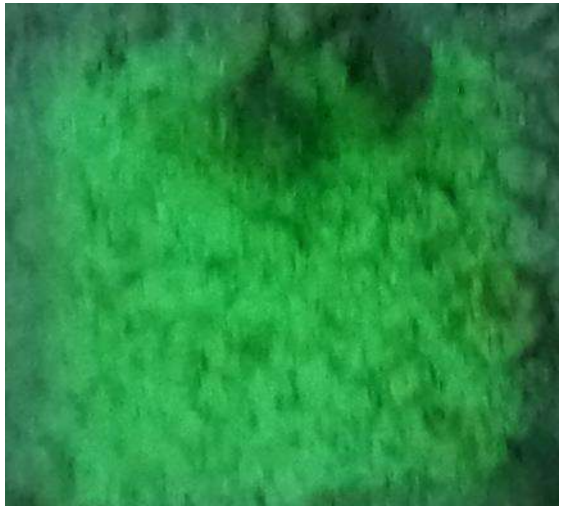


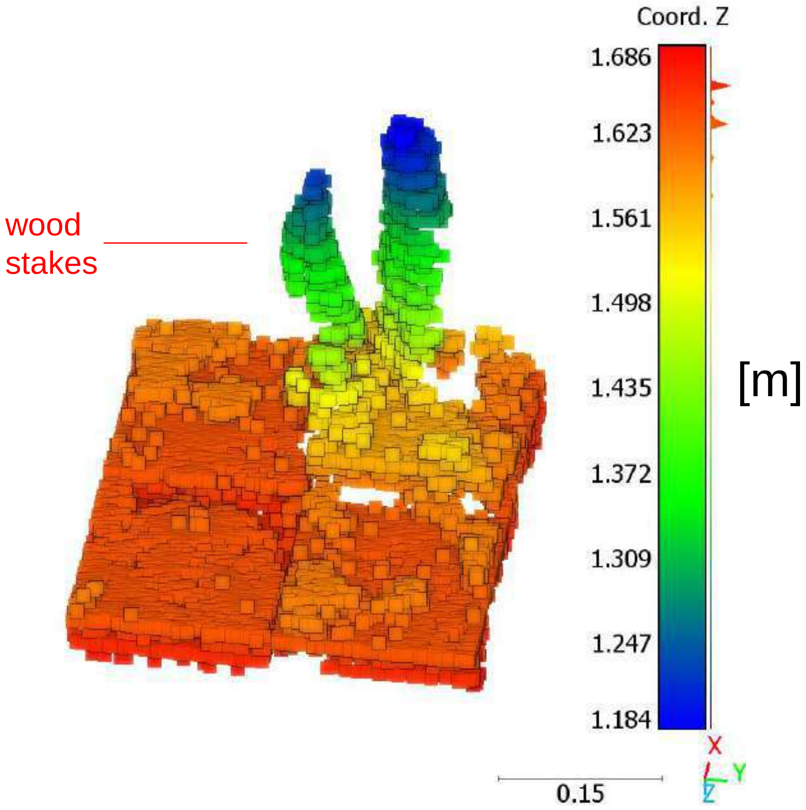


Project funded from the EU HE research and innovation programme under GA No. 101094818.

NOVEL FLASH LIDAR FOR 3D MAPPING

2D image





Project funded from the EU HE research and innovation programme under GA No. 101094818.

Thank you! Questions?

Email
david.nguyen@csem.ch

Address
Jaquet-Droz 1
CH-2002 Neuchâtel
Switzerland

Follow us:

Project funded from the EU HE research and innovation programme under GA No. 101094818.

TRIQUETRA PARTICIPANTS

Participant list

#	Short name	Participant organisation name	Type	Country
1	NTUA	National Technical University of Athens Coordinator	UNI	EL
2	DAI	Deutsches Archäologisches Institut (German Archaeological Institute)	RTO	DE
3	HMCS	Hellenic Ministry of Culture and Sports	PUB	EL
4	AFSLS	Archaeological, Fine Arts and Landscape Superintendence of Frosinone and Latina	PUB	IT
5	BLFD	Bayerisches Landesamt für Denkmalpflege (Bavarian State Conservation Office)	PUB	DE
6	DOA	Cyprus Department of Antiquities	PUB	CY
7	SUR	Sapienza Università di Roma – Research Centre for Geological Risk (CERI)	UNI	IT
8	DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)	RTO	DE
9	NID	Narodowy Instytut Dziedzictwa (National Institute of Cultural Heritage)	PUB	PL
10	ECOE	Eratosthenes Centre of Excellence	RTO	CY
11	PLUS	Paris Lodron-Universität Salzburg (Classical and Early Aegean Archaeology)	UNI	AT
12	GSH	Geosystems Hellas	SME	EL
13	UCY	University of Cyprus (Archaeological Research Unit)	UNI	CY
14	AUTH	Aristotle University of Thessaloniki	UNI	EL
15	AMU	Uniwersytet Im. Adama Mickiewicza W Poznaniu	UNI	PL
16	EM4C	Engineering Materials for Construction	SME	EL
17	NPHOS	NanoPhos S.A.	SME	EL
18	UULM	Ulm University	UNI	DE
19	OPAN	Office du Patrimoine et de l'Archéologie du canton de Neuchâtel (section achéo.)	PUB	CH
20	CSEM	Centre Suisse d'Électronique et Microtechnique	RTO	CH
21	ALPES	Alpes Lasers S.A.	SME	CH

Project funded from the EU HE research and innovation programme under GA No. 101094818.

csem

UNESCO

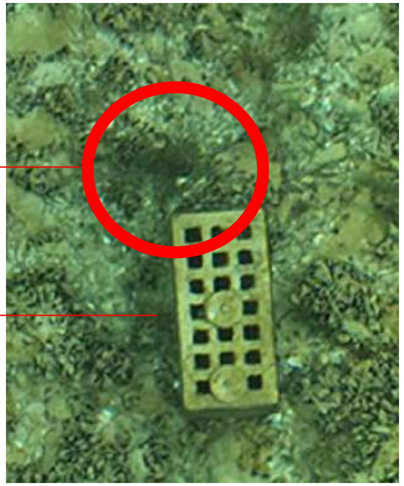
Project funded from the EU HE research and innovation programme under GA No. 101094818.

NOVEL FLASH LIDAR FOR 3D MAPPING

GoPro image(from top)

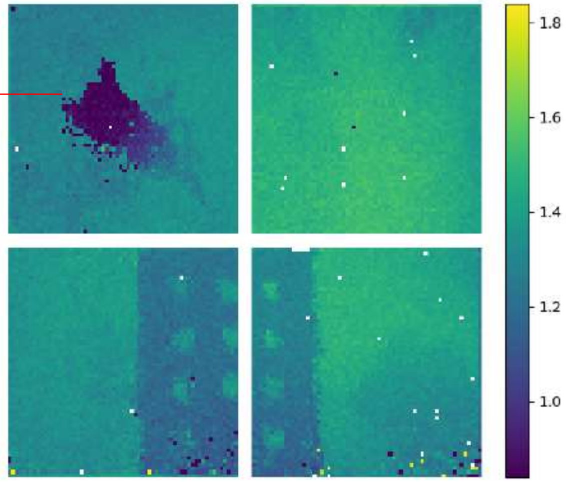
wood stake

brick



Low resolution lidar (ToF)

wood stake



Under water picture (OPAN)

Project funded from the EU HE research and innovation programme under GA No. 101094818.

EMJMD in Marine and maritime Intelligent Robotics

Erasmus Mundus MIR Master

Marine environment + AI + robotics
Multinational consortium
Scholarships & invited scholars

3 STUDY TRACKS	SEMESTER 1 30 ECTS	SEMESTER 2 30 ECTS	SEMESTER 3 30 ECTS
	TEACHING UNITS		
Study track 1 APPLIED ROBOTICS FOR UNDERWATER INTERVENTION MISSIONS	• Marine science & environment • Artificial Intelligence • Robotics	• Transversal skills (reliability & risk assessment, AI fairness & transparency, etc.) • AI & robotics, and its applications taught by UTLN and guest lecturers • Joint introduction to study track specialisations (UJI, NTSU, IST) • Industry led seminars (options) • Entrepreneurship industry & research project	# UNDERWATER INTERVENTIONS UNIVERSITAT JAUME I
Study track 2 SAFE AUTONOMOUS SUBSEA OPERATIONS			# DEEP SEA OPERATIONS NTNU
Study track 3 COOPERATIVE MARINE ROBOTICS FOR SCIENTIFIC & COMMERCIAL APPLICATIONS			# COOPERATIVE ROBOTICS TÉCNICO LISBOA

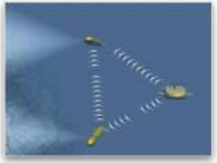
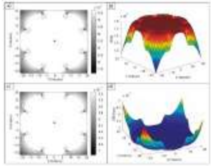
UNIVERSITÉ DE TOULON

SEMESTER 4

MASTER THESIS

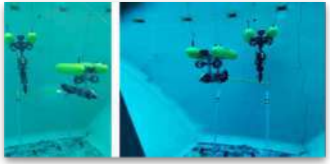
Marine and maritime Intelligent Robotics

- **Cooperative** robotics: communication, localisation, navigation

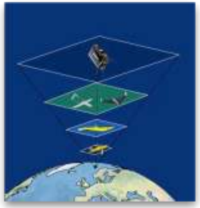
TÉCNICO LISBOA

- **Multi-robot** intervention: grasping, manipulation, coordination

UJI UNIVERSITAT JAUME I

- **Operations**: adaptive sampling, remote sensing, multimodality

NTNU

The right team of associate partners

Over 50 associate partners in 21 countries...

3 intakes so far

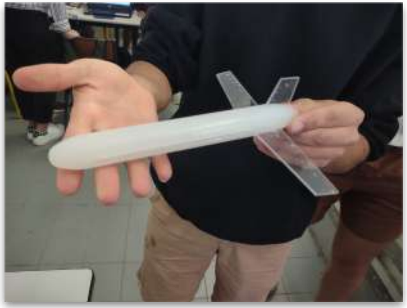
~25 students / year (22 with grants)
14 different nationalities

~400 candidates / year (growing)

Many hands-on activities

Visits to IFREMER & ixBlue (EXAIL)

From gliders to ROVs



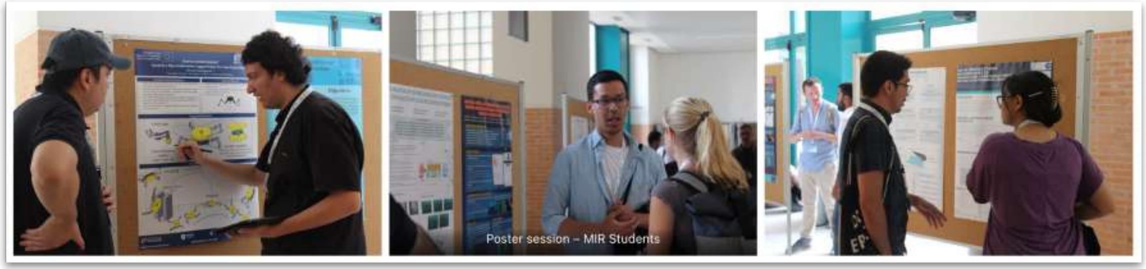




Fun and unique experiences… skiing and human ROVs!

Achievements

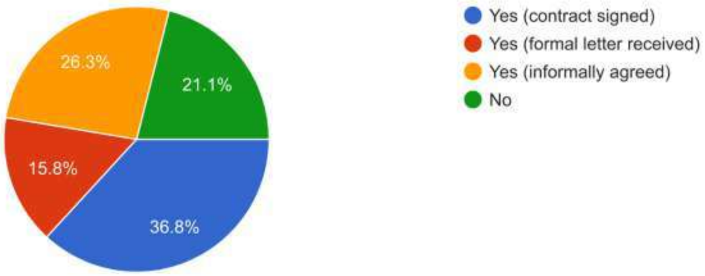
Annual symposium and championship



Positive labor integration

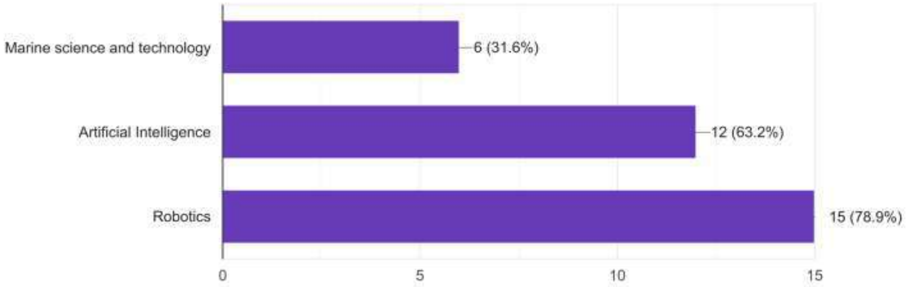
Have you already received an offer for employment after MIR?

19 responses



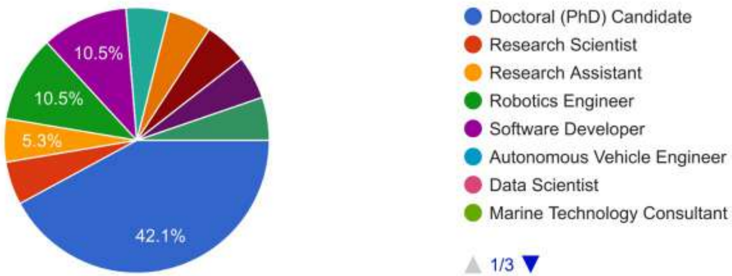
What MIR fields are related to the future activity?

19 responses



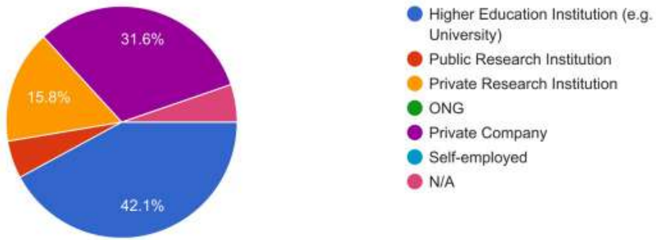
Which of these better describes your future activity?

19 responses



In what kind of organisation?

19 responses



Big thanks to the MIR team!!

Ricard Marxer

Martin Ludvigsen

Antonio Pascoal

Pedro Batista

Pedro J Sanz

Céline Barbier

Vincent Hugel

Célia Cau

Laïs Moutte

Anais Quentin

Mélissa Crasnier

Marie-Françoise Riotte

MIR

MARINE & MARITIME INTELLIGENT ROBOTICS

APPLY

DEC 2024

www.master-mir.eu

This work has been supported by the METRICS EU H2020 project, grant agreement No 871252.

RAMI23: an Inspection & Maintenance Robotics Challenge to Form the New Generation of Marine Scientists and Engineers

Alessandro Faggiani, Gabriele Ferri

NATO STO-CMRE

alessandro.faggiani@cmre.nato.int

What is RAMI

- **RAMI**: Robotics for Asset Maintenance and Inspection
  - One of the four challenge-led robotic competitions of METRICS European project
  - Focus on Inspection and Maintenance
  - Dual domain competition:
    1. Aerial (Physical & virtual) @ CATEC (Spain)
    2. Marine (Physical & virtual) @ CMRE (Italy)

- **METRICS**: Metrological Evaluation and Testing of Robots in International Competitions
  - Organize robotics competitions as reproducible and objective evaluation campaigns
  - Four priority areas identified by the European Commission.

RAMI for Marine Robots

OBJECTIVES

- **Advance** the state of the art of autonomous vehicles in a realistic underwater Oil&Gas scenario
- **Benchmark** robotic systems.
- **Encourage** young people today to participate to STEM programmes to develop the high-tech workforce of tomorrow
- **Prepare** young engineers and scientists by boosting their technical, problem-solving and managerial capabilities
- **Foster** ties between young engineers and the organizations involved in robotics.

RAMI for Marine Robots

- Organized by the NATO STO Centre for Maritime Research and Experimentation (CMRE) at La Spezia, Italy
- **Real-World** Challenges for AUVs in an **Oil&Gas** mock-up scenario.
- 2nd **Field** Evaluation Campaign(16-21 July 2023):
  - Competition area: protected sea water basin 50 m x 50 m with a depth of ~ 4 m
  - Realistic I&M environment
  - Advanced perception, autonomous decision-making and manipulation capabilities required
- 2nd **Cascade** Evaluation Campaign (June 2023):
  - Use a given dataset of marine OPIs to develop novel algorithms
  - Favors improvements on perception and navigation solutions
  - Involve communities in marine events (AI)

Robotics Competitions at CMRE since 2010

2010

Student Autonomous Underwater Challenge- Europe (SAUC-E)

- **Marine** domain
- **Realistic** underwater competition, set in a real sea water basin
- Targeting students

2015

euRathlon Grand Challenge

- First world's competition with **cooperative land, marine and aerial robots**
- Inspired by Fukushima disaster
- Held at Piombino power plant

2017

European Robotics League (ERL)

- **Land**, **marine** and **aerial** domains
- Held at Piombino power plant

2019

ERL Emergency (2018-2019)

- **Marine** and land domains
- Simulated Harbour disaster @CMRE basin

2022/2023

RAMI Competition

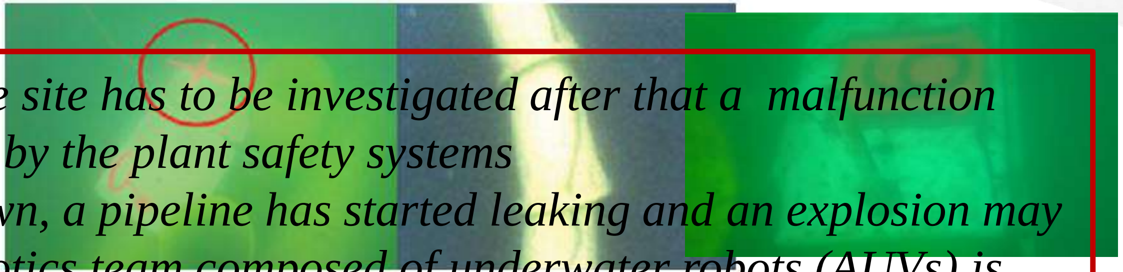
- **Marine** domain
- Focus on **Inspection & Maintenance**
- @CMRE basin

Organisation of the second Field campaign

OPIs are located in the area to create Inspection&Maintenance (I&M) tasks in a simulated but realistic environment with the following user story:

- 2 arenas built (one for practice and one for competition)
- **OPIs** in competition arena:

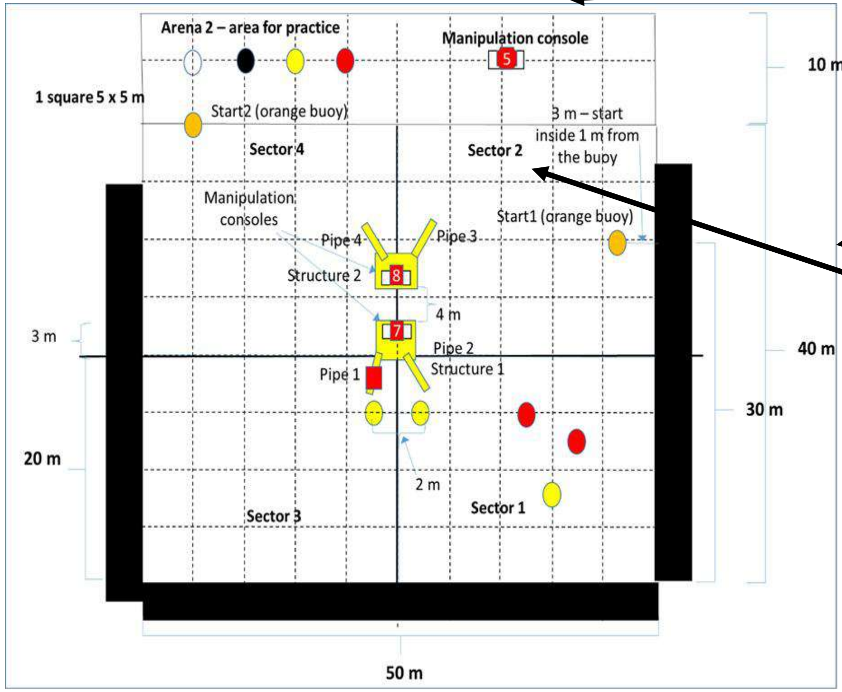
A gas&oil offshore site has to be investigated after that a malfunction has been reported by the plant safety systems
From what is known, a pipeline has started leaking and an explosion may occur soon. A robotics team composed of underwater robots (AUVs) is ready to intervene to inspect the area and intervene on the plant to stop the leak.



***Coloured buoys* Area**

resent t
)

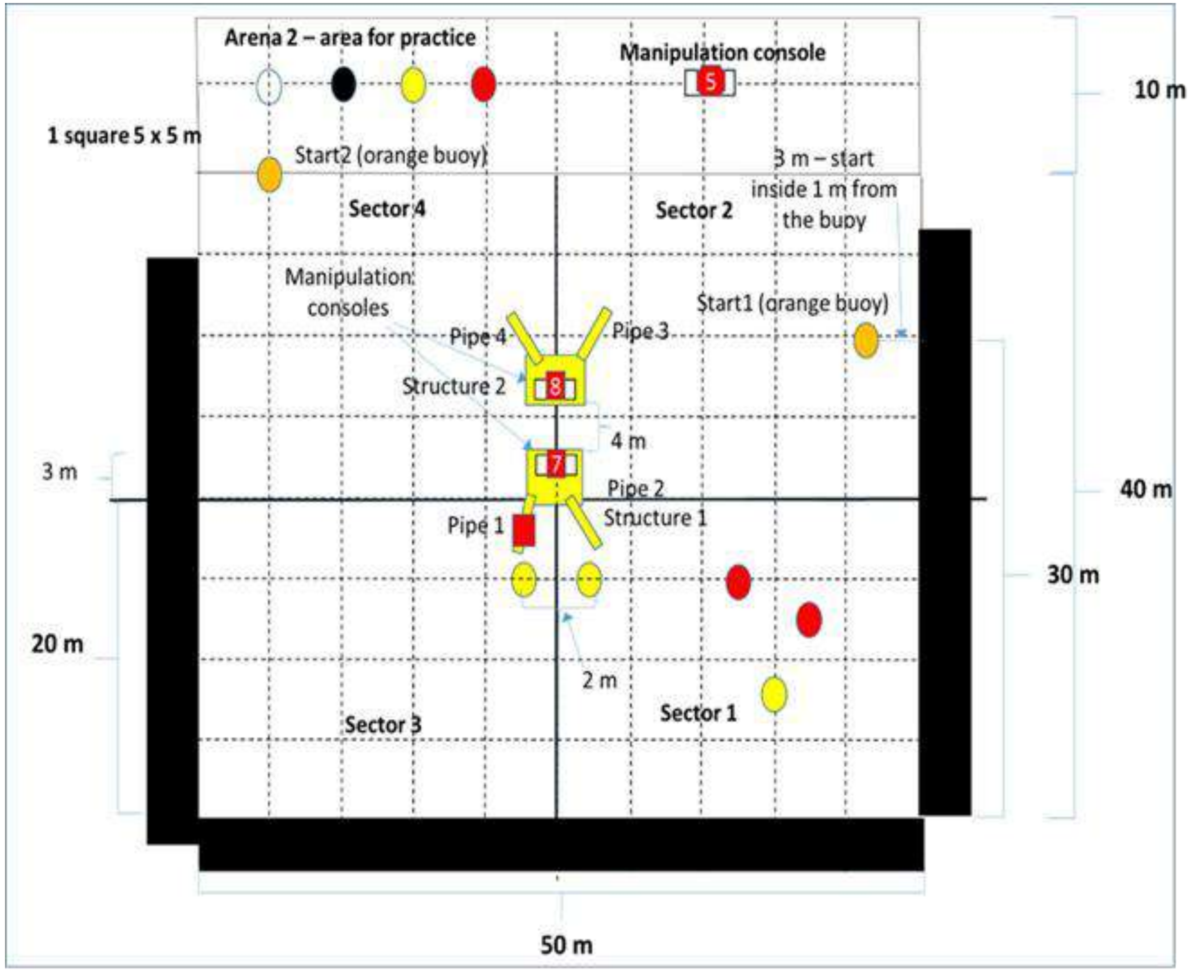
Manipulation console with a black number to recognize, a valve to close and a ring-pole to pick and bring to the surface



Red Marker
(the damage on the pipe)

SCIENCE & TECHNOLOGY ORGANIZATION
CENTRE FOR MARITIME RESEARCH & EXPERIMENTATION

RAMI Field Competition : Structure



Task Benchmarks Tasks (TBMs) :

- **TBM1 - *Pipeline inspection*:**
  - Autonomous navigation to the buoy area
  - Identification of the oil gauge (map buoys position)
  - Inspect the Pipeline
- **TBM2 - *Intervention on the pipeline structure:***
  - Assess eventual pipe damage (staying in touch with the pipe for some time)
  - Reach and recognize Manipulation console (Black Number on red background)
  - Close the valve on the console, grab and bring a pole-ring on the surface
- **TBM3 - *Complete mission at the plant:***
  - Combines TBM1 and TBM2

Functionality Benchmarks (**FBMs**) :

- **FBM1 - *Mapping the area:***
  - Create a metric map of the damaged area
  - Object Recognition- images and positions of the buoys
- **FBM2 - *Object detection:***
  - Vehicle Navigation Data
  - Mission Status Data
  - Object Recognition - Position and object instance of each detected buoys
- **FBM3 -*Shape recognition:***
  - Produce images of the black number over the manipulation console
  - Object Recognition - Position and object instance

Participant Teams

UNIFI Robotics Team from University of Firenze (Italy) - long experience in our events

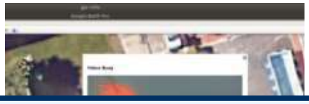
OUBOT Team from Obuda University (Hungary) - experience in past competitions, second with their AUV

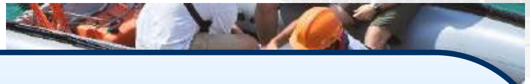
ITU AUV TEAM from Istanbul Technical University (Turkey)- first participation

Nautilus Team from ESTACA (France) - first participation

TEAM ERGO from University of Pisa (Italy) - mainly used the area for testing

RAMI Field Competition : Results (I)





- Good results in **autonomous navigation**, **mapping** and **intervention**: first results in real-time perception and autonomous behaviors (1 team)
- Good results from rookie team – ITU AUV Team, winner of SAUV-C in Singapore
- Further work is needed in **real-time perception** and **autonomy** – *cascade campaigns can help…*

First t… reaction), classification, identification and localization for a yellow buoy with related autonomous behaviour and post-processing identification of other 3 buoys (UNIFI)

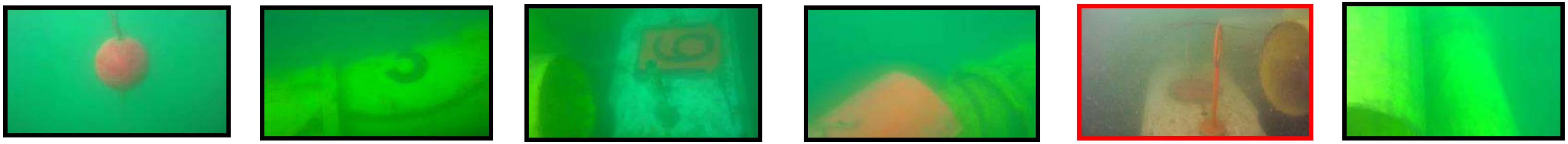
Estimated position by UNIFI Robotics Team and groundtruth for the four buoys, 2 red and 2 yellow.

Mosaicking of the area: the structures are visible

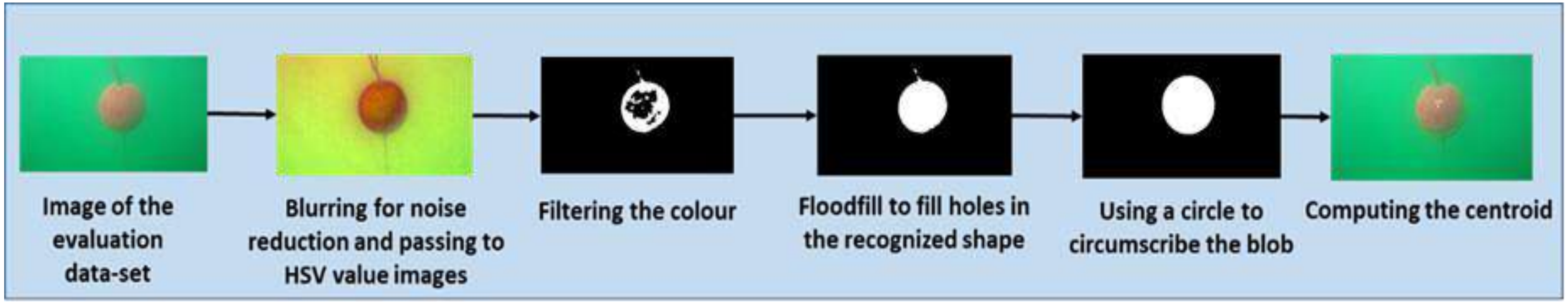
RAMI Cascade Competition

- 2nd Cascade evaluation campaign launched in June
- Focus on OPIs perception, detection, classification, identification and localization Tasks
- Created Dataset of 6 different classes of OPIs - a **new class** (manipulation multiple OPIs images) added

colored buoys | **numbers on pipes** | **number on console** | **red marker on pipe** | **manipulation console** | **no OPIs**

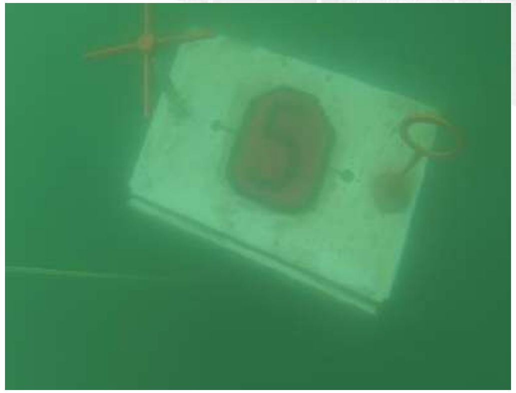


- **Enriched** Training set provided to teams using a Docker image
- Teams' software evaluated on a validation set of images



RAMI Cascade Competition: Results (I)

Team ERGO-UNIPI	Number of images	Achieved score on classification	Achieved score on identification	Achieved score on centroid computation	Total scoring
Class 1 (buoy)	4	12/12	12/12	12/12	36/36 (100.0%)
Class 2 (number on pipes)	3	9/9	3/9	9/9	21/27 (77.8%)
Class 3 (black numbers on red background)	4	12/12	8/14	12/12	32/38 (84.2%)
Class 4 (red marker)	2	6/6		6/6	12/12 (100%)
Class 5 (manipulation console objects)	3	8/12	4/8	6/12	18/32 (56.3%)
Class 5 (no OPIs)	4	4/4			4/4 (100%)
Total	20	51/55 (92.7%)	27/43 (62.8%)	45/51 (88.2%)	123/149 (82.6%)



- Teams were scored on 20 images concerning classification, identification and OPI’s centroid computation.
- Results are encouraging, showing good capabilities for the software to generalise the original training dataset (the “8” number): good classification, to improve identification (including in class 5).
- Further work has to be done to support teams in making their algorithms more robust and effective on a larger range of images and in images containing multiple OPIs.

Conclusions

- Successful launch of 2nd RAMI competition to foster autonomy and robotics in I&M missions for Oil&Gas scenarios
- Increasing interest in the community
- Positive feedbacks from Teams
- Results shows good performance in autonomous navigation, mapping and imaging
- Further work is needed for real-time perception and autonomy
- Cascade competition can help by improving teams perception software
- Difficulties in attracting and supporting teams

Future work & Suggestions

- Need of funding for travel and for supporting team participation
- Need to involve academia more deeply
- Funding model
- RAMI25 Organisation in progress at CMRE

Acknowledgements:

Special thanks to Fausto Ferreira, Milan Markovic (the RAMI23 Engineering Coordinator), Marin Stipanov, Stefano Biagini, Elisa Bettelli, Ilaria Saudella, Giovanni Sembenini (CMRE DD), Vladimir Djapic and all collaborators, participants, partners, exhibitors, supporters and our competition sponsors

In particular thanks for their fundamental support to:

Support of

Platinum sponsor

Silver sponsors

Bronze sponsors

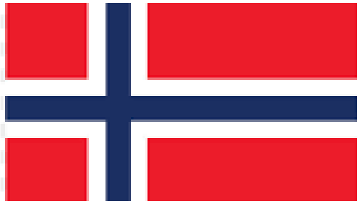
29.05.2024

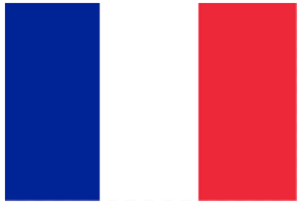
A collaboration among NORCE, NTNU, Fathom Robotics, Blueye Robotics

Presenter: Dr. Antonio Vasilijevic

UNDINA: UNderwater robotics with multi-moDal communIcation and Network-Aided positioning system
EMRA workshop
Arenzano

Partners





NORCE

NTNU
Norwegian University of Science and Technology

Fathom Robotics

DELAIR MARINE

Ifremer

ISEN ALL IS DIGITAL! BREST | yncréa

CELADON GATEWAY TO THE SEA

EvoLogics®

UNDINA aims

- robot-agnostic communication, networking and positioning solutions
- seamlessly operate over tri-modes: optics, acoustics, and inductive
- specifically designed for resource constrained AUVs
    - easy maneuverability
    - low weight, small dimensions
    - low associated operational costs
- reliable, scalable, compact, plug-and-play

Why Undina?

Enabler of:

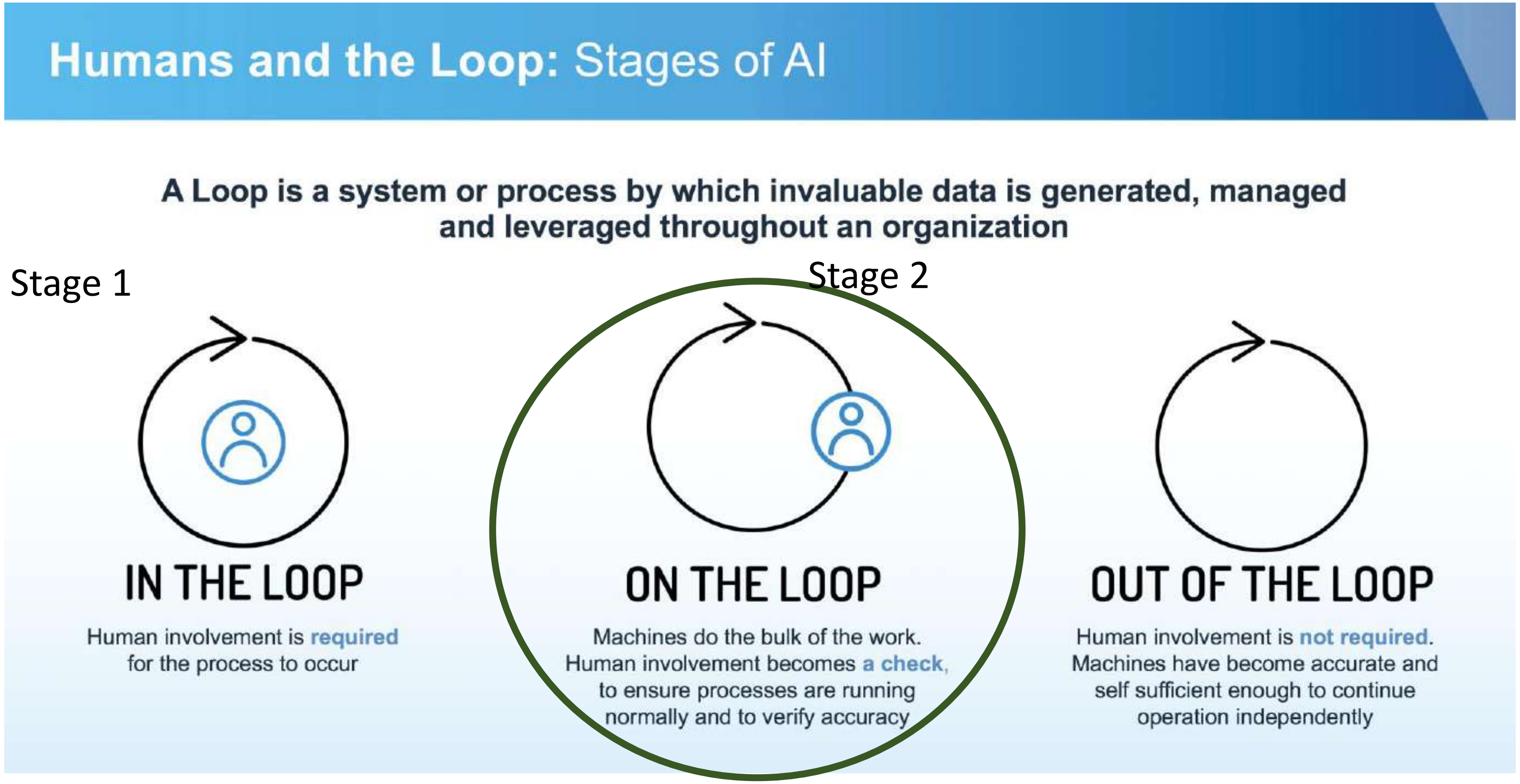
- Resident underwater robots - unattended residence in the ocean
- Autonomous data collection from remote scientific ocean observatory in harsh environments

Enabled by:

- Miniaturization of sensors/payload
- End user input: fit for inspection tasks, cost and CO_2 footprint reduction
- Scaling “down” existing solutions from work-class to observation class vehicles

Critical: communication and positioning and reliable docking

Humans, robots and the loop

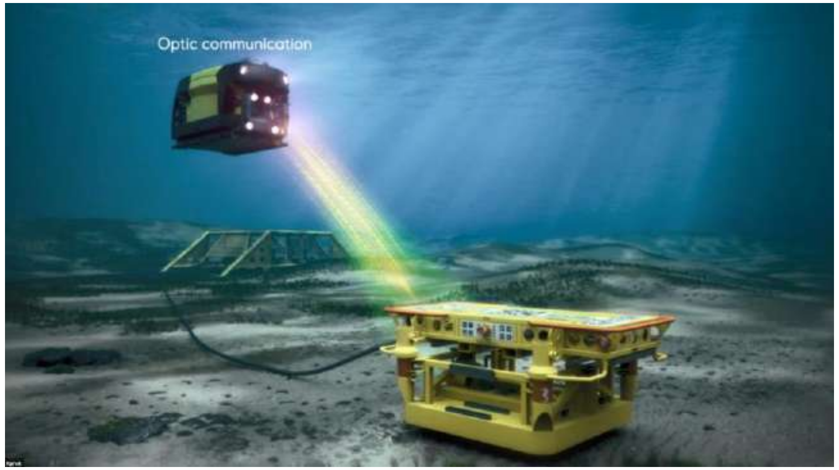


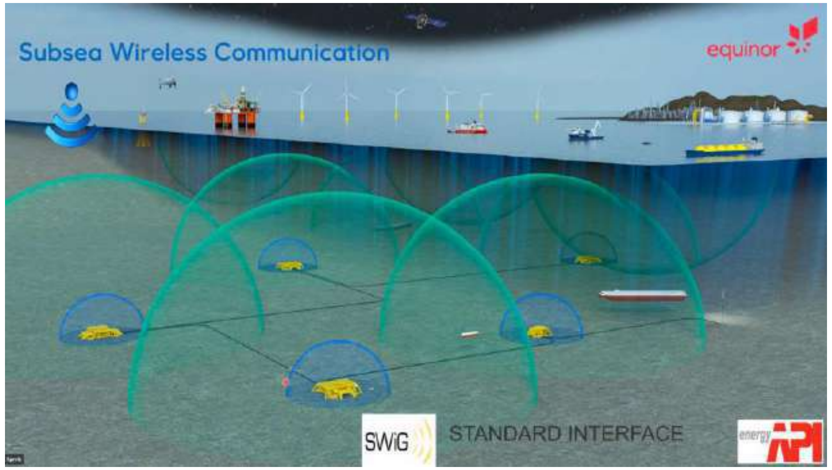
Source: https://www.datacenterdynamics.com/en/opinions/path-ai-connected-government/

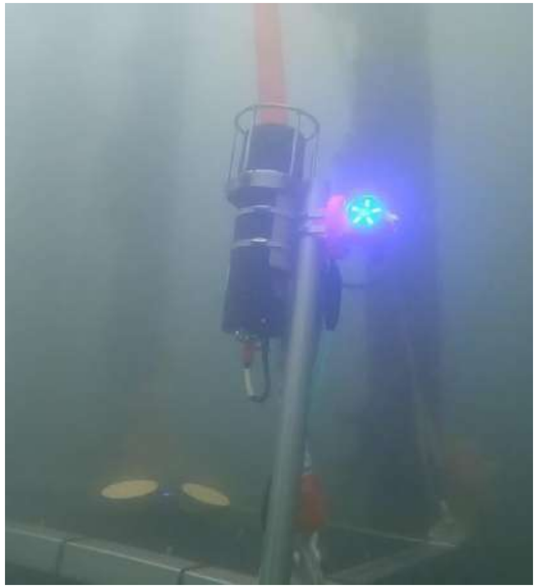
Charging and Wireless Subsea Communication Concept

Three-modal concept:

- Electromagnetic (Inductive) power and comm. while docked
  - Charging
  - Hi-bandwidth data transfer
- Optical - free space optics (uFSO)
  - Mid-bandwidth data 4-10Mbps
- Acoustics - larger area coverage
  - Low-bandwidth, essential and status data

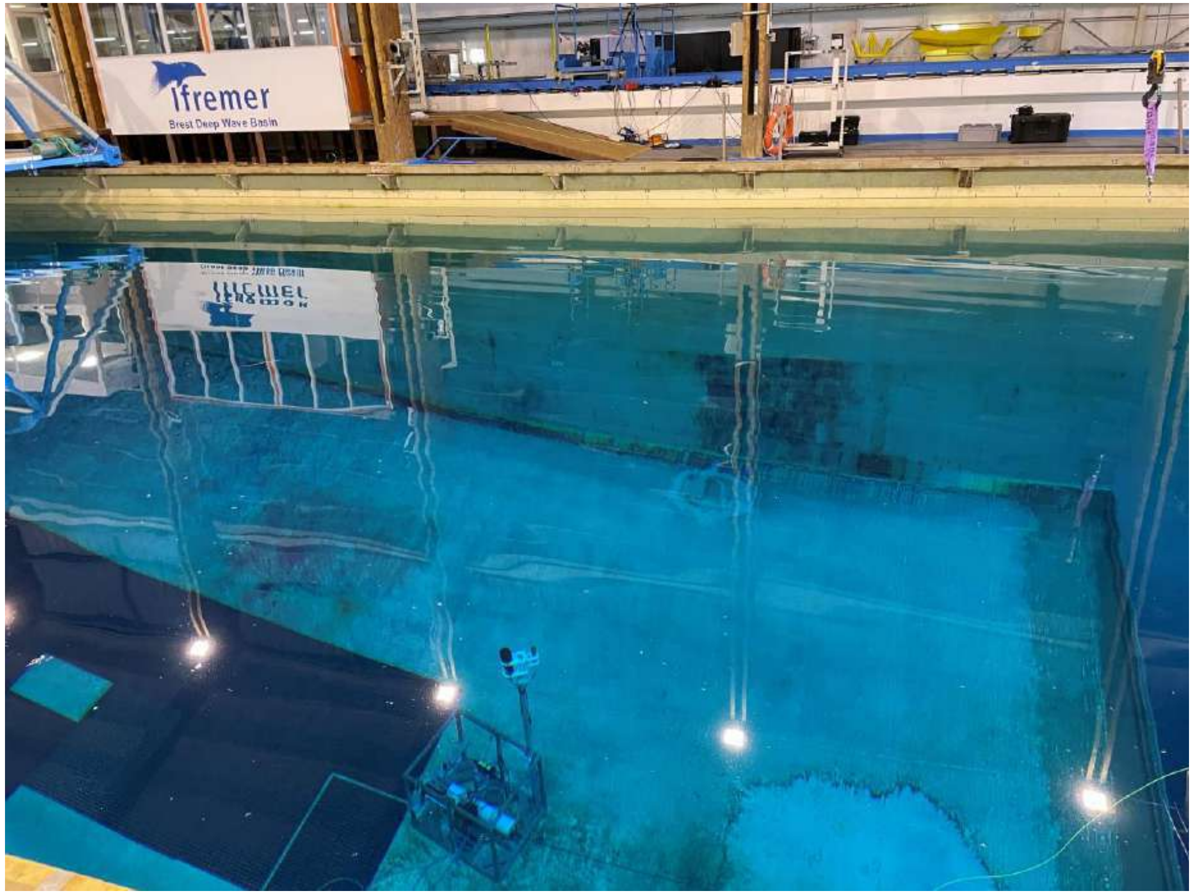






Courtesy of Equinor

UNDINA milestone: Optical and acoustic communication and positioning system integrated into the benthic station



UNDINA milestone: Three payloads integrated into the robot with the first implementation of the programmable protocol stack

DELAIR MARINE

High data rate (Mbps)

Control channel
and positioning

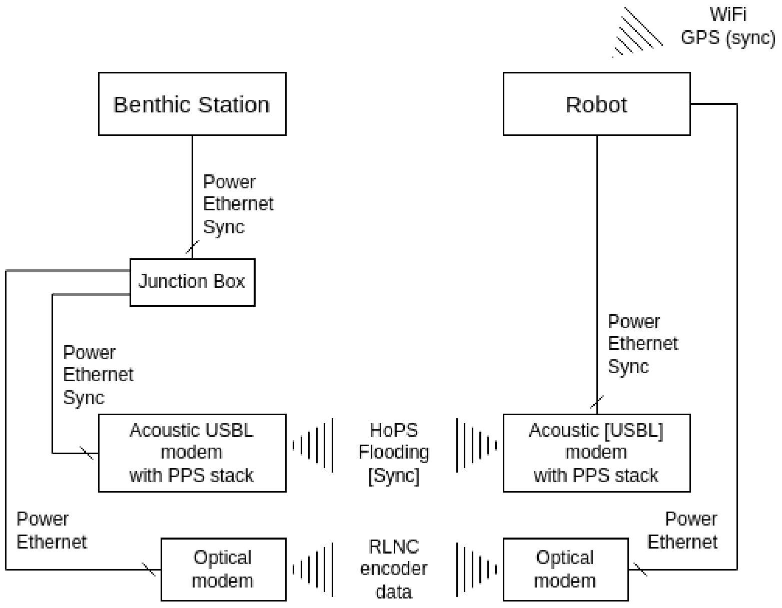
Recharge power (150 W)
upload-offload data (1Gbps)

UNDINA milestone: Initial controlled validation tests of Hybrid communication and Positioning System

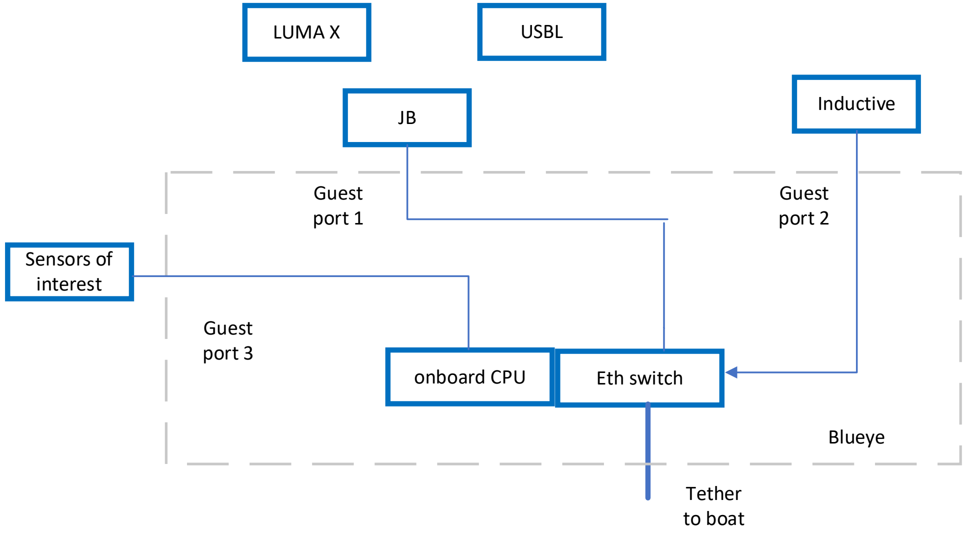
- Proof of concept: integration of both optical and acoustic modems.
- Optical comm.: vertical and horizontal link.
- Achieved about 5 Mbps over 7 m vertical distance and 16 m horizontal distance. Clear water conditions (pool).

Trondheim trials - UNDINA project

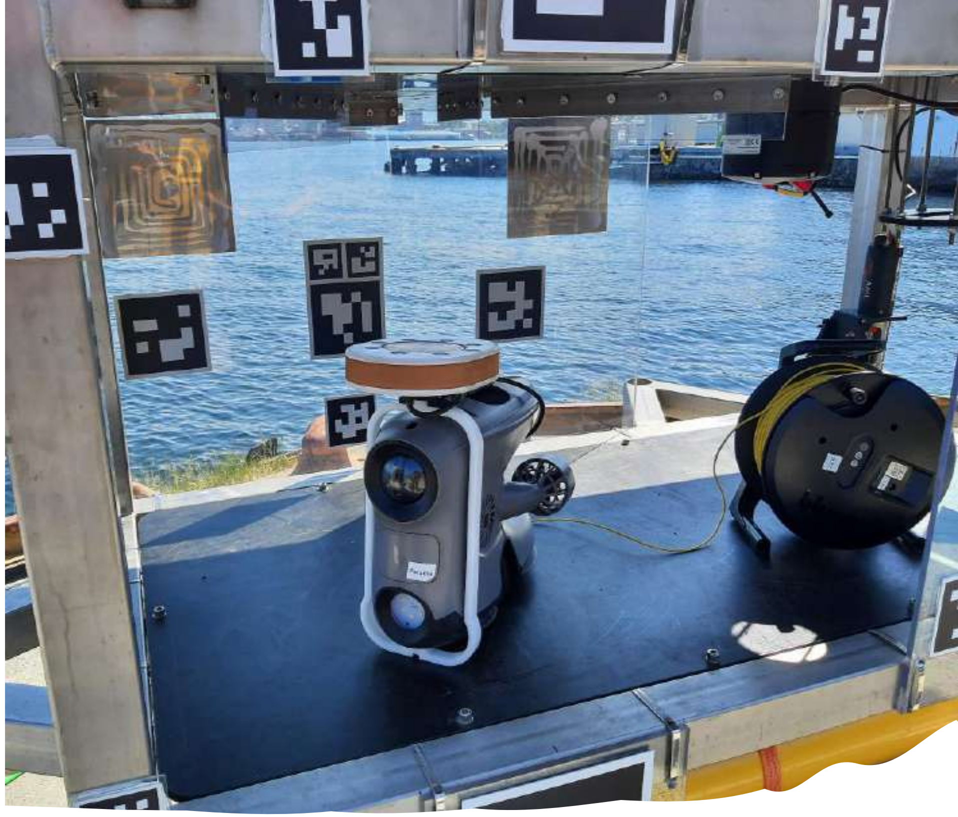
- We tested the optical comms in real conditions.
- Demonstrated an application of using multiple drones and a benthic station
- Vehicle/drone Blueye X3 with 3 guest ports to integrate additional payload
- The Blueye Remote and Onboard Software Development Kit, to write custom control system algorithms, add support for new sensors, custom image processing, or implement a range of other use cases.



Physical Interfaces



Blueye



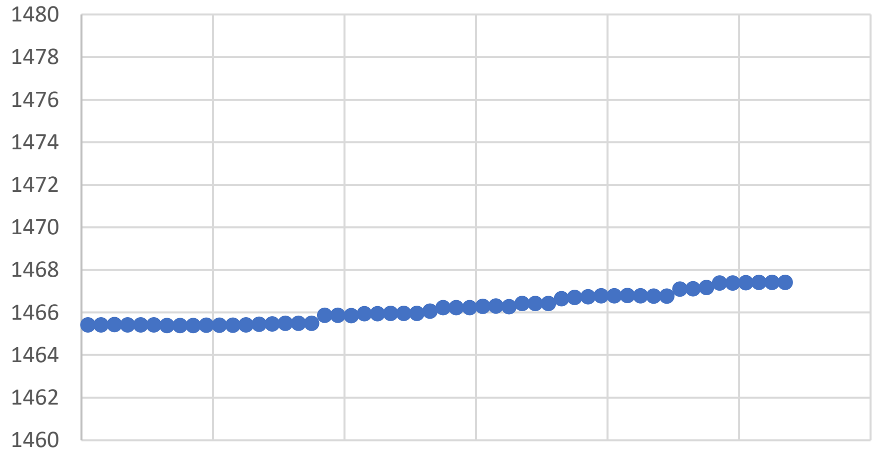
Docking with observation class Blueye X3

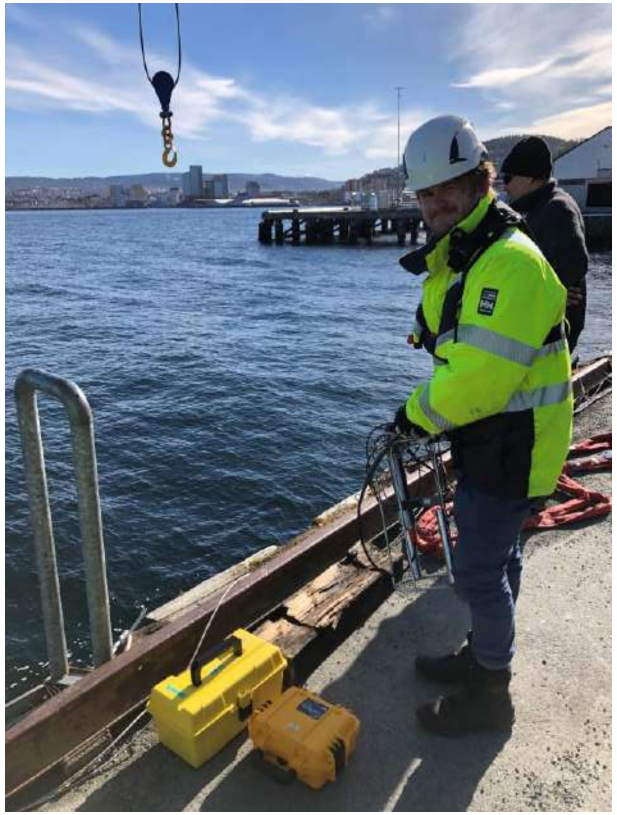
Experimental methodology: from bench tests to measurements in the Trondheim fjord in 4 days

- We performed initial verification tests at the pool and at the pier.
- 2 Blueye pilots, 1 person looking at 2 laptops each connected to one luma X.
- Sonar to measure more accurately the distance between the optical modems.
- Both Blueye X3 had a Luma X integrated.

Experimental methodology: from bench tests to measurements in the Trondheim fjord in 4 days

- Sea trials.
- Environmental measurements.
- We used iperf UDP traffic to measure the effective rate.
- We used simple pings to verify connectivity between the 2 drones.





Experimental methodology: from bench tests to measurements in the Trondheim fjord in 4 days

- 2 ROV Blueye pilots, 1 person looking at 2 laptops each connected to one luma X, boat driver, and one person to supervise operations.
- We systematically tested every 5 m from 10 m to 90 m depth.
- Distances were measured by a SONAR in real time, and span from 2 m up to 35 m.
- We followed a triangular testing area (the deeper the position of the drone the larger the distances).

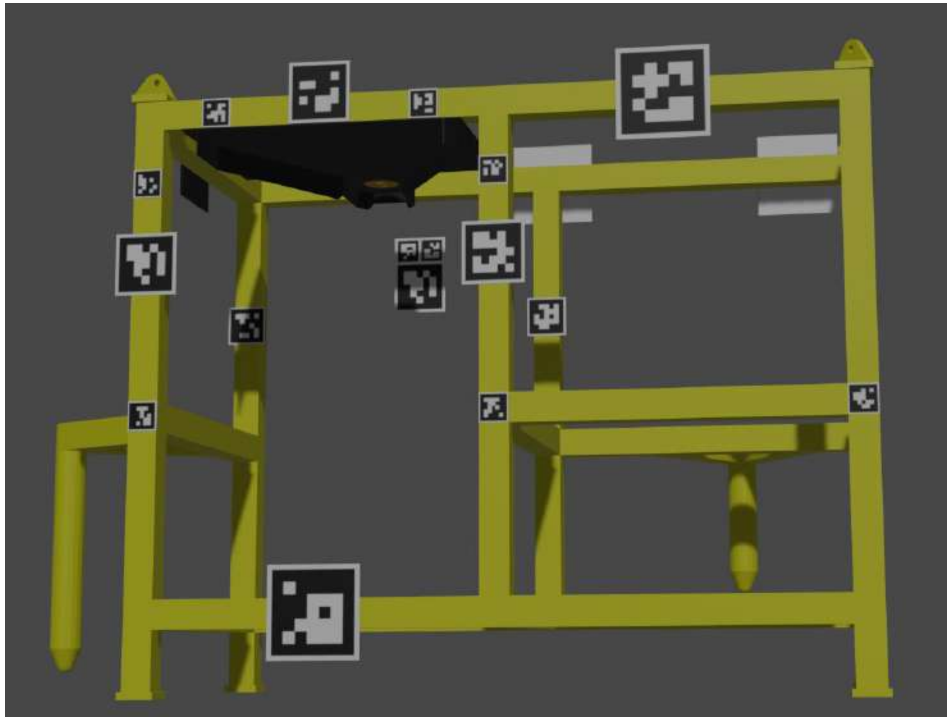
Underwater optical Average Rate (in kbps) vs Range and depth measurements

Depth [m] vs Distance [m]	5	10	15	20	25	30	35
60	3633	3278	2005	2150	1000	0	0
70	Not measured	Not measured	2005	2185	2155	695	0
80	Not measured	Not measured	2065	2000	2280	**1935**	0
90	Not measured	Not measured	2005	2215	**2145**	**1565**	0

Good connectivity from 10 m depth to 60 m depth with distances from 2 m up to 20 m, but the effective rate was not measured.

Docking - Aruco markers

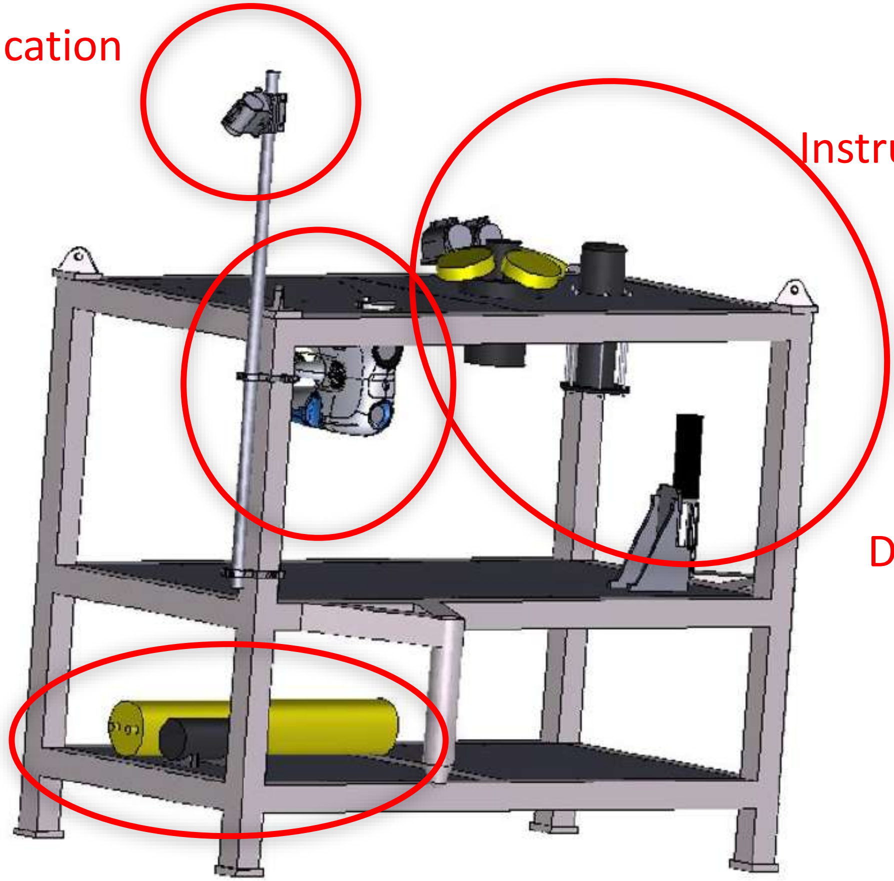
- Modified concept from offshore docking stations



* Thomas Rannestad master thesis

Seabed Observatory/Station

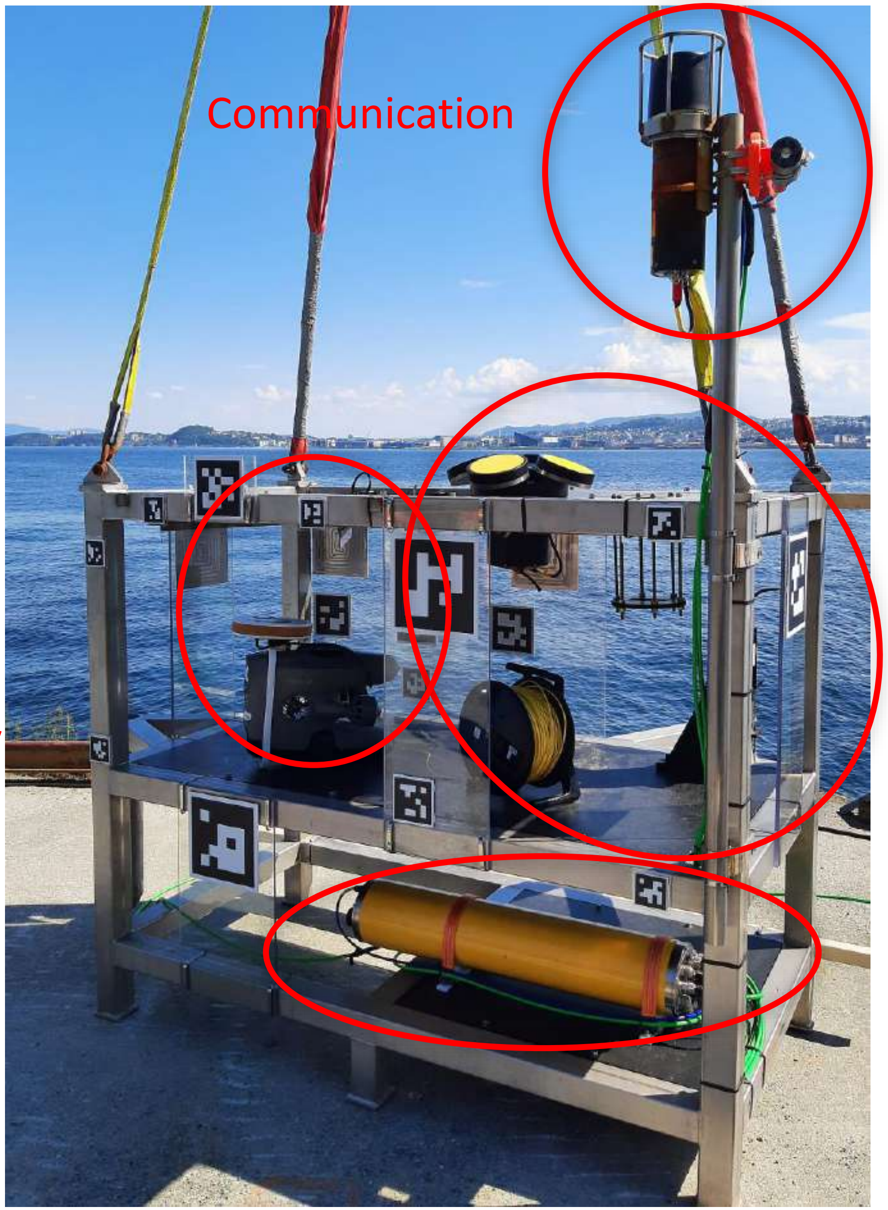
Communication



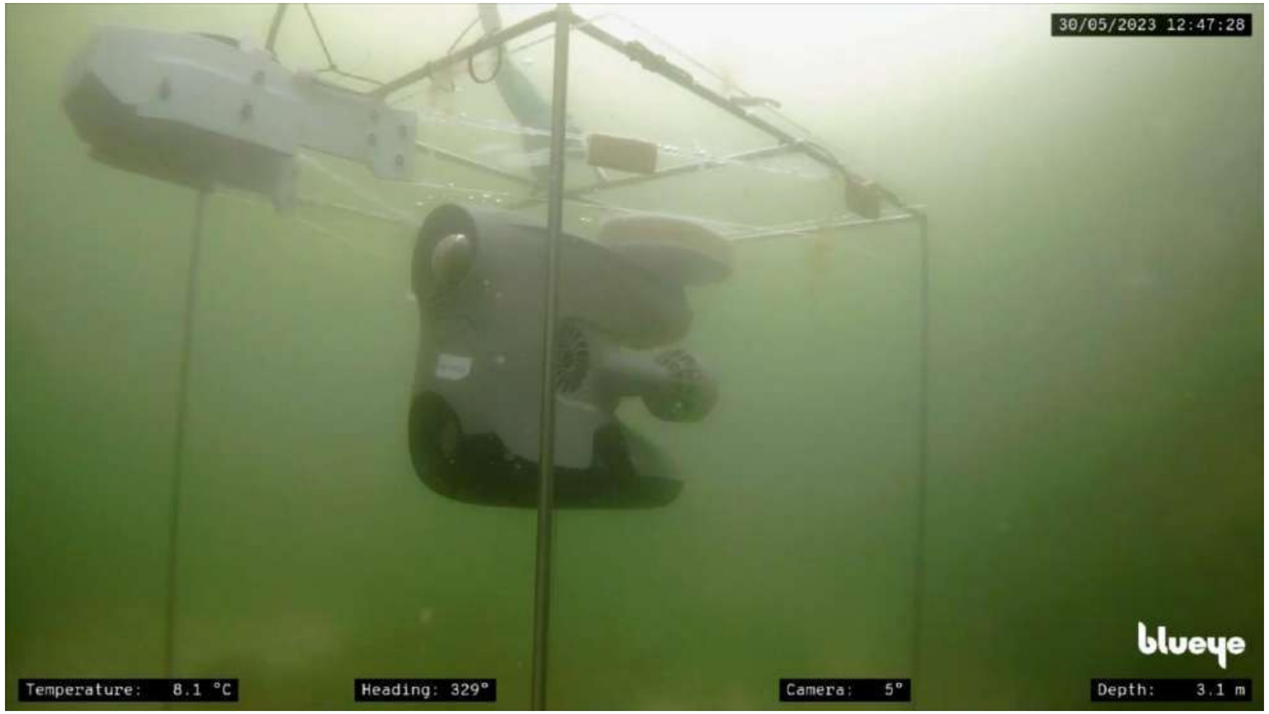
Instrumentation

Docking - SRV

Main JB and batteries optionally



Docking

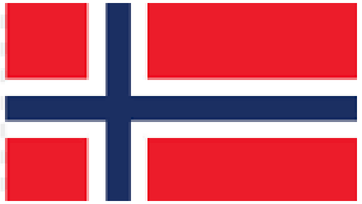

30/05/2023 12:47:28
blueye
Temperature: 8.1 °C
Heading: 329°
Camera: 5°
Depth: 3.1 m


blueye
Temperature:
Camera:

Lessons learnt and perspectives

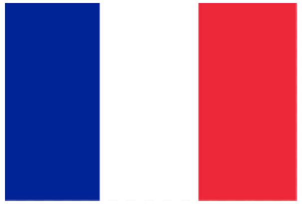
- X3 drones are an efficient and flexible platform to perform rate vs range and depth optical communication tests
- Optical modem performs satisfactorily for the use cases in UNDINA (horizontal close to sea bottom data transmissions from the drones to the benthic station).
- More systematic experiments are needed to better delimit the rate vs range and depths working regimes of the optical communications.
- Further experiments in Autumn with using together acoustic and optical modems for both positioning and data transfer, docking to seabed station and inductive charging and comms.

People acknowledgements:



Beatrice Tomasi
Marie Bueie Holstad*
Ingvar Henne*
Rune Øyerhamn
Bård Henriksen
Frank Ådland
Anders Vahlin
Martin Ludvigsen
Antonio Vasilijevic
Anna Vihovde
Karoline Barstein
Jens Einar Bremnes
John Mulholland

Håkon
Kjetil
Håvard
Students



Jerome Blandin
Pierre-Jean Bouvet
Antony Pottier*
Thomas Paviet Salomon
Leo-Paul Pelletier
Gerard Guyader
Morgann Le Bot
Nicolas Mertz
Sebastien Chalony
Sophie Chataing
Ivan Houly
Pierre Budan
Nicolas Cadart
Marie Ponchart

Oleksiy Kebkal
Emanuele Coccolo
Sergey Yakovlev
Konstantin Kebkal*
Veronika Kebkal*

Hydromea:
Alexander Bahr
Damien Doy

Blueye:
Jonas Follesø
Borja Serra
Andre Marquardt
Andreas Viggen

Bluelogic/Unplugged:
Helge Sverre Eide

Steinwurf:
Mikkel Højlund Larsen
Jeppe Pihl
Gianmarco Tasca
Morten V. Pedersen
Kavim Shroff

*From 07.2021 to 08.2022

Acknowledgments

The UNDINA project is funded by

Forskningsrådet

anr agence nationale de la recherche AU SERVICE DE LA SCIENCE

Bundesministerium für Wirtschaft und Klimaschutz

through the

MarTERA ERA-NET COFUND

Funded by the European Union

uBlueTec

— Blue Green Digital Skills —

Training framework on Underwater Tecs as key enabler for blue careers development

Fausto Ferreira, Assistant Professor, University of Zagreb, Faculty of Electrical Engineering and Computing, Laboratory for Underwater Systems and Technologies

Overview

- Introduction
- Project Overview
- Market needs and gaps analysis
- Curriculum development and pilots
- Conclusion

U**BLUE**TEC : MIND THE GAP

NEEDS analysis: Technologies used in underwater (UW) missions and activities (both commercial & scientific) are vital for several critical blue economy sectors, such as :

Offshore renewable energy, Aquaculture, Marine biodiversity protection, UW Cultural Heritage, etc.

GAP: Lack of skilled personnel in using and deploying UW technologies in the context of twin (green/digital) transition

UBLUETEC Objectives

AIM: uBlueTec aims to set up, test and validate a triple transition training and skills development model (green, blue, digital skills).

BLUE CURRICULUM

Development of educational material and curriculum, linked to microcredentials, and enabling skills-building in state-of-the-art UW technologies from a green/digital perspective.

PILOTING

Piloting the developed assets at HE & VET levels.

Emphasis on field and hands-on experience

HUB on UW TECS

Establishment of a **European Hub on UW Tecs**, as a **permanent capacity-building structure** nurturing the long-lasting collaboration of the involved stakeholders.

PLATFORM

Deployment of **recruitment platform** for
- blue jobs offering online courses
- facilitating demand-supply matching between current/future labour force and industrie
- intelligently identifying and publishing the skills-gap at regional-national-EU levels.

CAREER PATHS

Attraction of young talents in terms of Career Days and Entrepreneurial Bootcamps.

Consortium

Partners	Country	Type
AIX-MARSEILLE UNIVERSITE	France	University
ATLANTIS – Consulting Company	Greece	SME
University of ZAGREB – Faculty of Electrical Engineering and Computing	Croatia	University
BEIA CONSULT INTERNATIONAL	Romania	SME - VET provider
UNIVERSITA DELLA CALABRIA	Italy	University
ANP/WWF (ASSOCIACAO NATUREZA PORTUGAL)	Portugal	NGO
MARITIME TECHNOLOGY CLUSTER FVG Scarl	Italy	Maritime Cluster

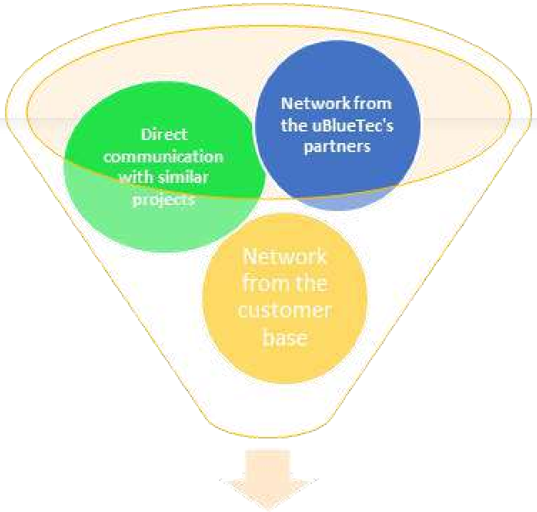
Project stages

Development of the content and ***educational material*** *of the courses and piloting phase*

STAGE 01

Dedicated ***platform*** *for (but not limited to) maritime and underwater technologies and the establishment of an European* ***UW Tecs Hub***

STAGE 02



The path for cooperation with other EU's project and initiatives

Liaison *and cooperation with other relative EU projects, initiatives, stakeholders and building long lasting* ***networks*** *of the quadruple helix*

STAGE 03

Market needs and gaps analysis

- Both desk research on good practices and a questionnaire sent to stakeholders
- 69 entities answered the survey, 45% were SMEs, large companies or start-ups
- strong demand for specialized skills in underwater robotics, which includes areas such as underwater vision, data processing, software development, artificial intelligence

Market needs and gaps analysis

- Digital and blue skills were the most sought-after
- 80% of respondents expressed difficulty in recruiting due to lack of skills, absence of targeted educational programs, non-competitive salaries and limited interest in niche markets

Market needs and gaps analysis

- Women are underrepresented (65% of institutions employ less than 40% of women among their employees)
- Average age range of 30-50 for technicians
- Successful organizations highlight robust networks with universities, investment in specialized skills training and in-house knowledge building

Curriculum development and pilots

- Both academic courses (full semester) and vocational education training (VET) courses will be offered
- Both types with 30h
- 3 formats: semester, 1 week summer school, 1 week long training (theoretical/practical classes)

Curriculum development and pilots

Blue skills topics include:

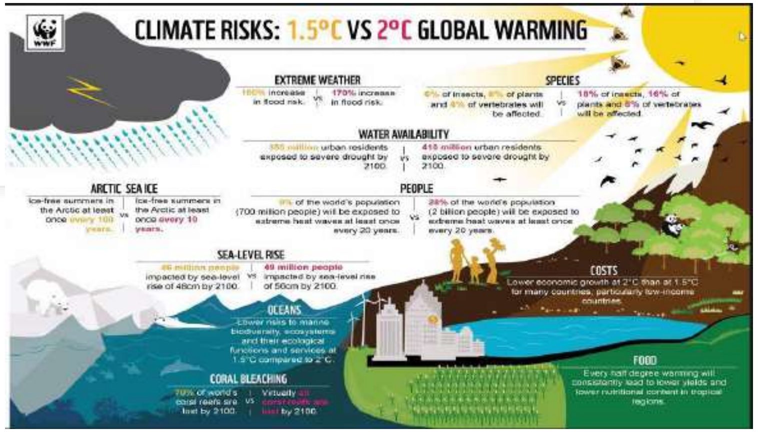
- ROV piloting, ASV mission planning and GNC
- VR and wearables for diver-robot interaction
- Underwater sensing
- Optical-acoustic data fusion
- Ocean literacy

Curriculum development and pilots

Digital skills topics include:

- 3D photogrammetry
- AI and machine learning
- Coastal and Shallow-water survey documentation techniques
- Intelligent predictive maintenance for aquaculture

Curriculum development and pilots



Green skills topics include:

- water pollution monitoring and assessment
- new techniques and materials for the preservation of underwater cultural heritage
- environmental leadership, nature-based solutions, sustainability

Curriculum development and pilots

- First pilot on green skills took place in May
- Second pilot on taking place in Greece in July

- Third pilot will take place at the Breaking the Surface 2024 Workshop (open to everyone)

Green skills - Pilot feedback

(Trieste + Monfalcone, May 2024)

Co-funded by the European Union

Pilot at the University of Trieste

- **Target: university students (Marine Ecology)**
- **Number of participants: 15**
- **Topics: Climate change; ecosystem services; nature based solutions (NbS)**
- **Methodology: group work brainstorming on NbS - developing green skills and critical thinking**
- **Duration: 2 hours**

Positive aspects	Negative aspects
The methodology worked nicely Good feedback from participants	Difficulty for the students to interact in English

BLUE, DIGITAL & GREEN SKILLS
Piloting Aigina island, Greece June 2024

Upskilling and reskilling in UW documentation technologies


SAVE THE DATE
29.9. – 6.10.2024.
BREAKING
THE SURFACE

Conclusion

- uBlueTec aims to setup an innovative triple transition training and skills development (Green, blue, digital)
- A market needs and gaps analysis was conducted
- Curricula are being prepared and pilots will start this summer

EOREA

European Ocean Research and Education Alliance

Elena Paifelman

EOREA Secretariat (CNR-INM)

elena.paifelman@cnr.it

EOREA

European Parliament
8th of December 2022

EOREA Launch Event

- **Vision**: Facilitate Europe's ocean research community in working together, contributing to reach the goals of the UN Decade of Ocean Science and Mission Restore our Ocean and Waters by 2030, the upcoming EIT KIC Ocean, the implementation and the use of the "Digital Twin of the Ocean", and any other relevant programme both at national as well as European/international level.
- **Mission**: To strengthen, expand and optimise EU ocean research capabilities through the sharing of world-class national facilities in Europe and the joint realisation of pan-European programmes.
- **Method**: Coordinated programs with emphasis on three key principles:
  - Promoting **interdisciplinarity** in the field of ocean science
  - Allowing research to fuel innovative **education programmes** to provide society expertise and competencies
  - Bringing together cutting-edge research and **key technologies** by overcoming barriers between the various fields of science and technology

14 MEMBERS STATE

EOREA
European Ocean Research and Education Alliance

Positioning in the EU Framework

Member states
European Commission

EOREA
Governance

Level 1 – Governance level

Industry,
Civil Society

Advisory board

JPI OCEANS
European MARINE BOARD
EFARO
European Aquaculture
blueMed
WATERBORNE

EOREA
Collaborative Research and
Educative Programes

Level 2 – Program level

EUROMARINE
Horizon Europe

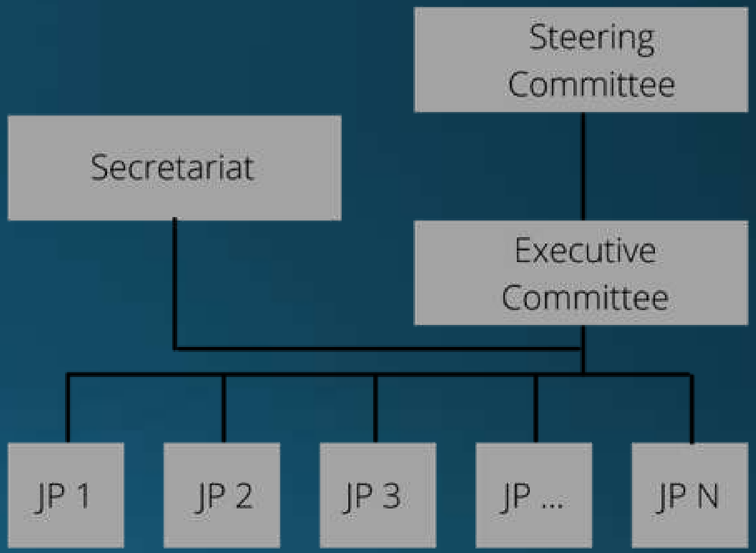
Level 3 – Project level

EOREA Governance Structure

- The Steering Committee
  - Composed by the highest-level representatives from the EOREA funding members (i.e., Rectors, Vice-Rectors, CEOs etc.), taking the role as political representation and having the overall strategy approval for the alliance.

- Executive Committee
  - Composed by executives from EOREAs funding members in charge of ocean science.
  - Responsible for driving processes (with support from a supporting Secretariat), identifying scientific priorities, defining governance & strategies, and the approval of proposed joint programmes.
  - Agreement in federating other actors through the joint programmes.

- Secretariat *(supporting layer)*
  - Supports the EOREA Executive Committee in the implementation of the strategic decisions through the running of the necessary actions
- Collaborative Research and Education Programs, CREPs (coordination CNR)



EOREA
European Ocean Research and Education Alliance

Collaborative Research and Education Programs, CREPs

What kind of cooperation can be foreseen?

- Harmonisation of research programmes
  - Exchange of information
  - Exchange of personnel

  Insufficient

  - Common strategy to tackle (new) research questions
    - Too many topics for a single institute
    - Avoid fragmentation, ensure complementarity of programmes
    - Agree on who does what (and share results)
- Facilities
  - Sharing facilities
  - Building new facilities
    - Owned by multiple institutes

  A breakthrough

Collaborative Research and Education Programs, CREPs

- Starting point: putting 'own resources' together to create joint programmes of research
- Possible themes matrix identified by the strategic board
- Open call for interest to define the Joint Programme(s)
- Selection to be made on «cold» criteria through the collection of questionnaires from applicants
- Selected core players («best 15») will be invited to an alignment workshop to analyse the collected information

  - Identifying research and education areas where jointly invest/collaborate
  - Identifying the gaps and need for additional resources
  - define the themes where there is enough critical mass of activities to justify the definition of a specific subprogramme

- Once the Technical annex is finalised and approved, it will be officially <u>launched</u> and <u>opened</u> to further stakeholders to join CREPs & EOREA.

The First CREPs

The four first CREPs' to be implemented:

- *Aquaculture* — NTNU Norwegian University of Science and Technology
- *Climate Change Impact on Marine Ecosystems* — Aix*Marseille université Socialement engagée
- *Marine Transport* — U LISBOA UNIVERSIDADE DE LISBOA; University of Southampton
- *Marine Robotic & new sensors* — INM

Coordinator: **Massimo Caccia**
Secr. Ref: Elena Paifelman

Want to get Involved?

- Other European institutions are welcome to join according to the development plan of the pilot phase

- To indicate your interest and be part of the EOREA mailing list:

Contact the EOREA Secretary

Elena Paifelman elena.paifelman@cnr.it

Marine robotic & new sensors CREP

Massimo Caccia massimo.caccia@cnr.it

Who will keep you informed and invite you to relevant initiatives

www.eorea.eu

European Ocean Research and Education Alliance

THANKYOU

EMRA
2024 EDITION

MASBBE partnership & Emilia-Romagna Region

in the Blue Economy

Maritime Sustainable Blue Bio-Economy

- **Partnerships: W3 *Who? Where? What?***
- **Priorities**
- **Mission & Vision**
- **Next Steps**

S3 Thematic Platforms

Agri-food

Energy

Industrial Modernisation

Sustainable Blue Economy

*Maritime Sustainable Blue Bio-Economy- **W3***

MISTRAL

Med Innovation STRAtegy for transnational activity of clusters & networks

15 Project Partners

9 Associated Partners

8 Countries

2 Ministries

8 Regions of which 3 leading with RIS3 on Blue Growth

5 Blue Growth Clusters

3 Scientific Research Organizations

B- Blue

BUILDING THE BLUE BIOTECHNOLOGY COMMUNITY IN MED AREA

10 partners with experience in the **Blue Bioeconomy from 8 Med countries** more than **300 Med stakeholders from**

- **Universities**
- **Research centres**
- **Public authorities**
- **Business support organizations**

Blue BioMED

Mediterranean Innovation Alliance for sustainable blue economy

Maritime Sustainable Blue Bio-Economy

Partnerships: W3 ***Who? Where? What?***

51 *Organizations*

18 *Regions/ Ministries*

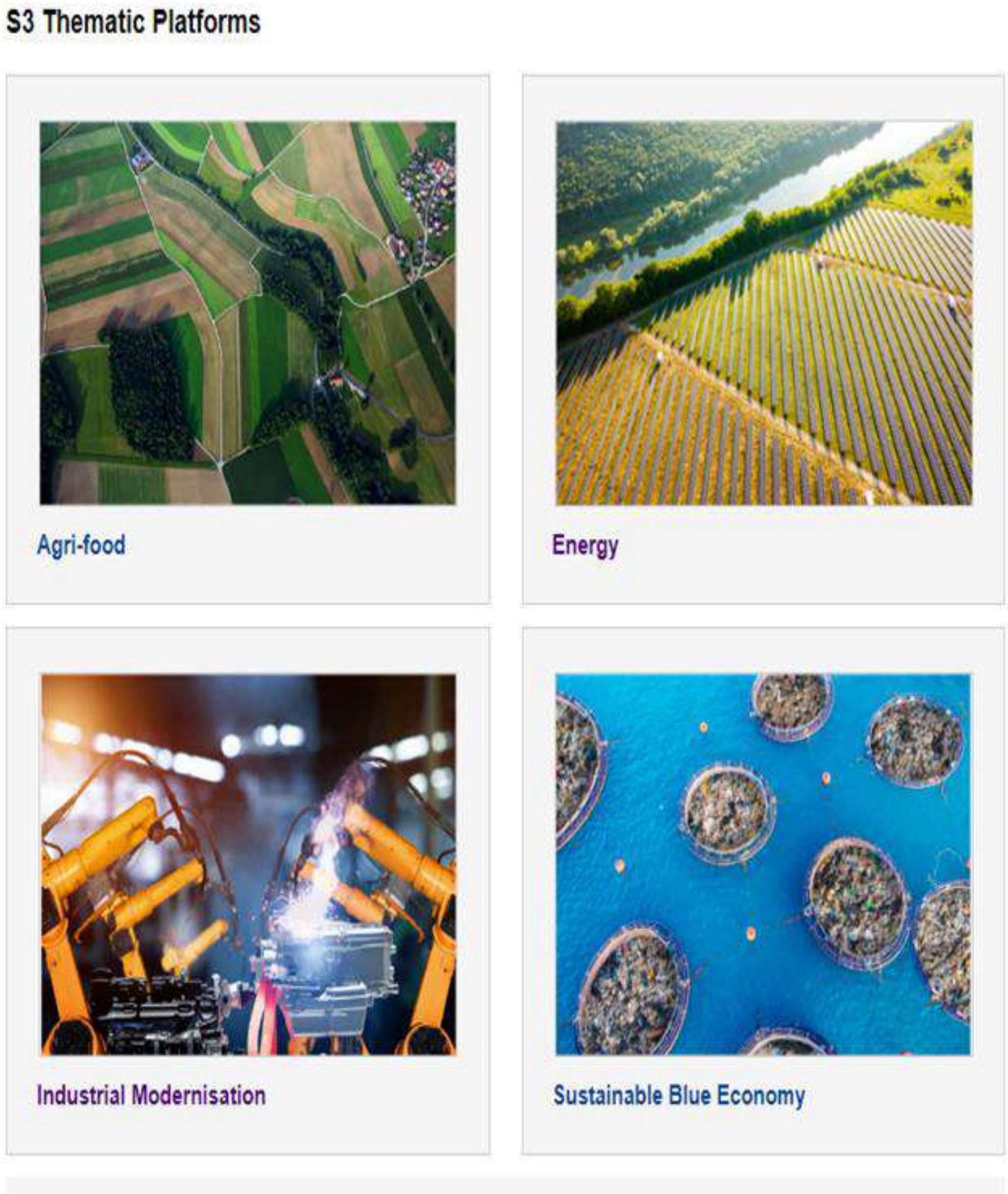
18 *Agencies, Clusters…Enterprises, NGOs*

14 *Research Community*

Coutries: Italy, Slovenia, Croatia, Albania, Greece, Rep. Of North Macedonia, Kossovo, Cyprus, Spain, Portugal….

New Entry: International Observatory of Mediterranean and Black Sea (created by **FISPMED** in 2004 by EU Commission and Italian Ministry of Environm., supported financially by Veneto Region since **2008,** it has **239 partners coming from 39 Countries:** representing more than 1.8M citizens

Main mission: improve water management, supporting urban and rural development, sustainable mobility and tourism and a more efficient use of energy.



COMMUNITY OF PRACTICE

MaSBBE PRIORITIES

- **Marine biotic resources,** including ***sustainable fisheries & aquaculture***

- **Marine environment and biodiversity conservation**, including challenges such as ***marine plastic litter, invasive alien species…***

- **Blue biotechnologies,** intended as an ***enabler for the transition to sustainable blue bioeconomy***, cross- cutting several economic sectors & value chains.

- **Digitalisation of the Blue BIoeconomy**
  Educational & Entrepreneurial ***aspects***; Collaborations with R&D stakeholders. Precision fishing & fish farming, discovery of ***new biotech compounds***

Maritime Sustainable Blue Bio-Economy

Mission & Vision

Finding **new sustainable way …..**

- **To produce *FOOD* & *ENERGY***
- **To reduce the anthropic pressure**
- To reduce ***WASTE***

..unprecedent challenges …at ***Regional, National and European level***

Blue bioeconomy & biotechnologies can offer new potentials for
- ***Economic growth***
- ***Sustainable transition***
- new ***employment opportunities***

MaSBBE purpose is to share knowledge, expertise and acting together to face challenges & contributing to a ***more cohesive***, ***innovative***, ***competitive*** & ***sustainable maritime cooperation area***

E-R as coordinator will share.....

Vanguard Initiative

E-R leading the Pilots:

- *Artificial intelligence & Human-Machine Interface* **(AI&HMI)**
- *New Nano-enabled Products* **(NANO since 2018)**
- *Advanced Manufacturing for Energy Related Application in Harsh Environments* **(ADMA since 2022)**

and participating to:

- *Pilot 3D-PRINTING*
- *Smart Health ESM Efficient And Sustainable Manufacturing*
- *Bioeconomy*
- *Hydrogen*

Experience at International level….

Undersigning the ***Under2MOU coalition***, leaded by the ***Governor of California***
- more than **260 Governments globally**
- representing **1.75 billion people** and **50% of the global economy**

S3 Hydrogen Valleys partnership

Clean Hydrogen JU (CH-partnership)

Since 2019 E-RR part of it, involving more than **40 European Regions from 13 Countries to support t**he production of clean **Hydrogen via renewable energy sources; energy transport and industry….**

Sharing Blue European Network.......

TN Cluster BIG
CTN Trasports

EUSAIR

ERRIN-
Blue
Economy
WG

CPRM

EU Mission
Restore our Ocean &
Waters

Mediterranean Blue
Economy Stakeholder
Platform

Mediterranean
University Union

Vanguarde Initiative

Western
Mediterrenean
Initiative

A.Tiziana De Nittis – Project manager & coordinator

Emilia - Romagna Region

DG Knowledge, Research, Labour, Enterprises

Sustainable innovation, Enterprises, Industrial chain

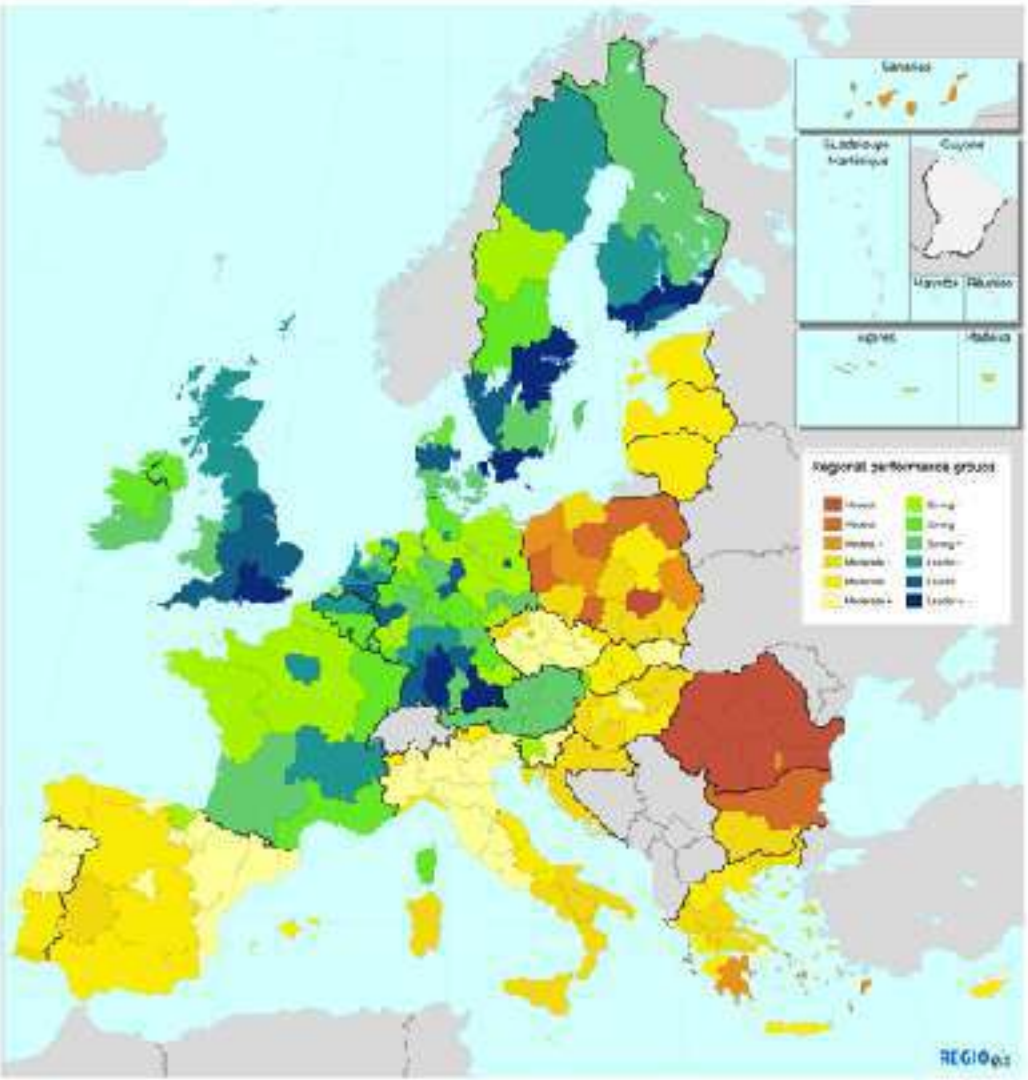
Energy & Green Economy area

Email: apollonia.denittis@regione.emilia-romagna.it

Spreading Excellence and Widening Participation under Horizon 2020 and Horizon Europe: Tour d'horizon

Adeline Kroll
European Commission
DG RI

Innovation Divide versus Participation gap



The **innovation divide** is a reality

Innovation Performance has increased for the EU but not for all Member States

Performance in **Horizon 2020 and Horizon Europe** is related but no strict causality

Source: Regional innovation Scoreboard 2017

Past studies on widening status

Reasons for comparably lower share and success rates of EU-13 / widening countries in FP

Commission's analysis (2011)

- ✓ Insufficient R&D investments
- ✓ Lack of synergies between certain countries' national research systems and EU research
- ✓ Lagging system learning effects and access to existing networks
- ✓ Differential wage levels between countries
- ✓ Insufficient and ineffective information, communication, advice and training

High Level Expert Group on the Ex-post evaluation of FP7 (2014), STOA report (2018)

- ✓ Relative weakness of national R&I system compared to advanced countries
- ✓ information and language barriers;
- ✓ uneven success rates across topics and instruments (e.g. higher in CSA, lower in ERC)
- ✓ lack of professional contacts and research networks;
- ✓ lack of Universities and Research organisations leading in proposal matters and therefore lower quality of proposals;
- ✓ weak training in preparing successful proposals;
- ✓ lack of practice in project management;
- ✓ Low connectivity and little experience in cross-country cooperation;
- ✓ generally low focus on R&D in policy and in business;
- ✓ few options for exploitation of research results at the national level.

Eligibility criteria for WIDENING COUNTRIES

- Targeted approach to help those participants with low performance in R&I, as "*low performing RDI Member States and regions*" (H2020) to "*less advanced countries*" (HE).

Eligibility Criterion: **The Composite Indicator of Research Excellence:** Threshold: MS below 70% of the EU average

MS: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia

AC *with equivalent characteristics in terms of R&I performance* **:** Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Former Yugoslav Republic of Macedonia, Georgia, Moldova, Montenegro, Serbia, Tunisia, Turkey and Ukraine

Outermost Regions Guadeloupe, French Guiana, Martinique, Mayotte, Réunion and Saint Martin (France), the Canary Islands (Spain) and the Azores and Madeira (Portugal)(defined in Art. 349 TFEU)

The Spreading Excellence and Widening Package under Horizon Europe

1. **Teaming** -> institution building
2. **Twinning** -> institutional networking (Twinning bottom-up and Green Deal)
3. **ERA Chairs** -> bringing excellence to institutions
4. **ERA Talents:** career prospects for R&I talents academic and non-academic sectors
5. **ERA Fellowships** *jointly implemented with MSCA*
6. **European Excellence Initiative** (EEI)
7. **Pathways to synergies**
8. **Dissemination an exploitation support facility**
9. **Hop on Facility**
10. **Excellence Hubs**
11. **NCPs** -> information, communication, support
12. **Policy Support Facility** -> support for R&I Policy design

COST *-> stimulating cross border science networks (50% funding under SEWP, implementation by COST Association)*

Total Budget in H2020 ~ ***€ 900 million***

Lessons learnt from core actions:

- *Overall high acceptance and encouraging results for Teaming, Twinning and ERA Chairs, **high oversubscription;***
- *For **Teaming** the quality of the partnership with the advanced partner is essential;*
- ***Availability of national/regional co-financing instrumental for sustainability of Teaming projects**, need to improve synergies with structural funds;*
- *For **Twinning** clear definition of **the scientific strategy** for excellence in the relevant research field (incl. joint research projects, enlarging the scope and research partnership) is instrumental;*
- *Consideration needs to be given to the **benefits for the 'advanced partners**' and the way they would materialise through the partnership;*
- *For **ERA Chairs quality**, independence and **autonomy** of chair holders instrumental for success*
- ***Institutional environment and bureaucracy** sometimes obstacles.*

Status of Widening in 2024 ? (1)

- *Participation gap between widening and non widening countries still existing, but **reduced**;*
- *Widening countries top group in participation success i.e. **EE, SI, CY**;*
- ***Outperforming some EU 15 countries;***
- *Strong **regional disparities in R&I performance in some EU 15 MS;***
- *Barriers to participation: lack of **motivation** to (re)submit proposals, lack of **readiness** (capacity) to submit, culture of shame on the **failure**;*
- *Low rates of participation in FPs due to **weakness of the R&I systems** of the widening compared to non widening (R&D intensity, Innovation performance)*

<u>Sources</u>: Horizon 2020 assessment and Horizon Europe mid-term assessment, internal studies and analyses of the Commission and the European Parliament.

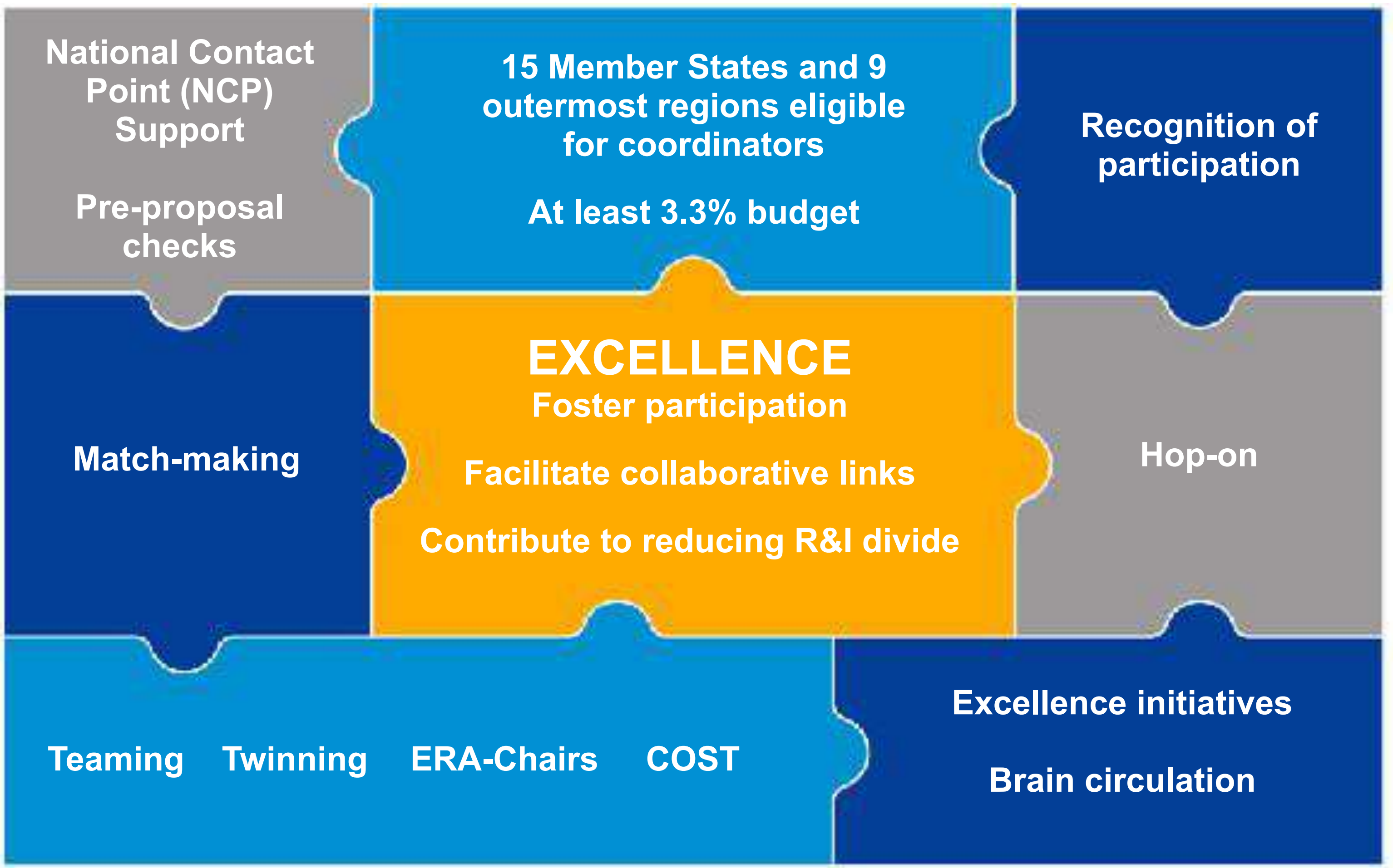
Status of Widening in 2024 ? (2)

- ***Lower quality*** *of proposals still in some widening countries;*
- *Limited access to **networks** for widening countries inhibits participation success, however measure such as Hop on now exist;*
- ***Brain drain*** *of researchers from widening countries till relevant (e.g., RO, BG)*
- ***Quality and commitment of national support systems such as NCP*** *still variable and instrumental for success;*
- *Need for **structural reforms at institutional**, **(regional) and national** level still important;*
- *Need to improve **administrative and managerial capacities in RI institutions of** widening countries.*

In Horizon Europe:

- *More integrated policy approach and enhanced **synergies with European Structural and Investment Funds (ESIF),** transnational missions, smart specialisation strategies ERA;*
- *Further **simplification and harmonisation of rules** across funding systems;*
- ***Continuation of core widening instruments** with some improvements in response to lessons learnt*
- ***Research cost for CSA eligible** under widening;*
- *More emphasis on focussing **management capacities;***
- *Full integration of **COST** under widening, 80% of actions must have significant widening dimension;*
- *Fixed list of **eligible countries to host the main beneficiary** (EU13 + PT + EL) based on new indicators and internal study;*
- ***EU outermost regions** fully eligible to host the co-ordinator*
- *"Advancing Europe" package with a bunch of additional support schemes to boost participation of less research performing countries*

Widening participation/spreading excellence



European Commission

Bridging research and innovation funding with regional funding in the area of marine research and engineering in Europe

Backing visionary entrepreneurs

European Innovation Council

Francesco MATTEUCCI
Programme Manager – EISMEA-01
Advanced Materials for Energy and Environmental Sustainability

European Innovation Council

Horizon Europe Structure

HORIZON EUROPE

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

Exclusive focus on defence research & development

- Research actions
- Development actions

SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

Exclusive focus on civil applications

Pillar I
EXCELLENT SCIENCE

- European Research Council
- Marie Skłodowska-Curie
- Research Infrastructures

Pillar II
GLOBAL CHALLENGES & EUROPEAN INDUSTRIAL COMPETITIVENESS

Clusters

- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

Joint Research Centre

Pillar III
INNOVATIVE EUROPE

- European Innovation Council
- European innovation ecosystems
- European Institute of Innovation & Technology*

WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

- Widening participation & spreading excellence
- Reforming & Enhancing the European R&I system

EURATOM

- Fusion
- Fission
- Joint Research Center

* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

What's holding back European innovation?

European Innovation Council

Innovation **performance**	• **Strong research performance not translated** into innovation • **Lack of breakthrough/ disruptive innovations** that create new markets
Innovation **funding**	Financing gaps (2 "valleys of death") in • **Transition** from lab to enterprise • **Scaling up** for high-risk innovative start-ups
Innovation **ecosystem**	• Many national & local ecosystems, but **fragmented at European** level • Need to **include all regions and all talent** (especially female)

We need to overcome European Paradox – perceived failure of EU countries to translate scientific advances into marketable innovations.

Deeptech

European Innovation Council

Problem and Hardware oriented

Multidisciplinary

High risk, high fund needed

Open innovation approach (ecosystem of innovation)

investments include private investments, minority stakes, initial public offerings and M&A

Source: Boston Consulting Group and Hello Tomorrow

The main EIC Support Schemes

European Innovation Council

Pathfinder

For advanced research on breakthrough / game-changing technologies

Pathfinder Open: bottom-up approach; no predefined topics

Pathfinder Challenges: top-down challenge-driven calls for tackling specific issues by portfolios of projects

Transition

For transforming research results into innovation opportunities;

follow up results from EIC Pathfinder and ERC Proof of Concept

Transition Open: no topic prescription

Transition Challenges: selected challenges

Accelerator

For individual companies to develop and scale up breakthrough innovations with high risk and high impact

Grant Funding

Equity Funding

Business Acceleration Service

EIC Fund: VC fund – EC shareholder / Bridging equity funding gap at early stage / Crowding in other investors

Business Acceleration Service: access to advice, to business partners and to innovation ecosystems & peers

Hands on approach

European Innovation Council

EIC BAS

- Access to advice/skills
- Access to business partners
- Access to innovation ecosystem & peers

Explore — EIC Pathfinder

Exploit — EIC Transition activities

Scale up — EIC Accelerator & equity

Hands on approach

European Innovation Council

Identify emerging challenges for Europe's deep-tech roadmap

Science and innovation intelligence activity

Hands-on approach

Strategic assessment and clustering of projects

Building strategic intelligence portfolios

Scientific / Business portfolios management

EIC Ambassador

Networking with other programmes and with innovation ecosystem communities

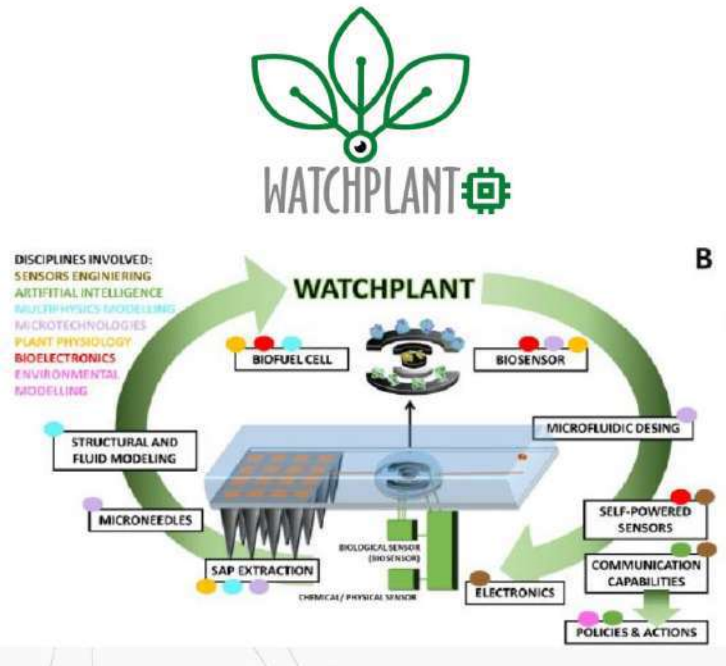
Outreach and organization of events, participation to national events / workshops

EIC Proactive Management

EIC Thematic portfolio Environmental intelligence (examples)

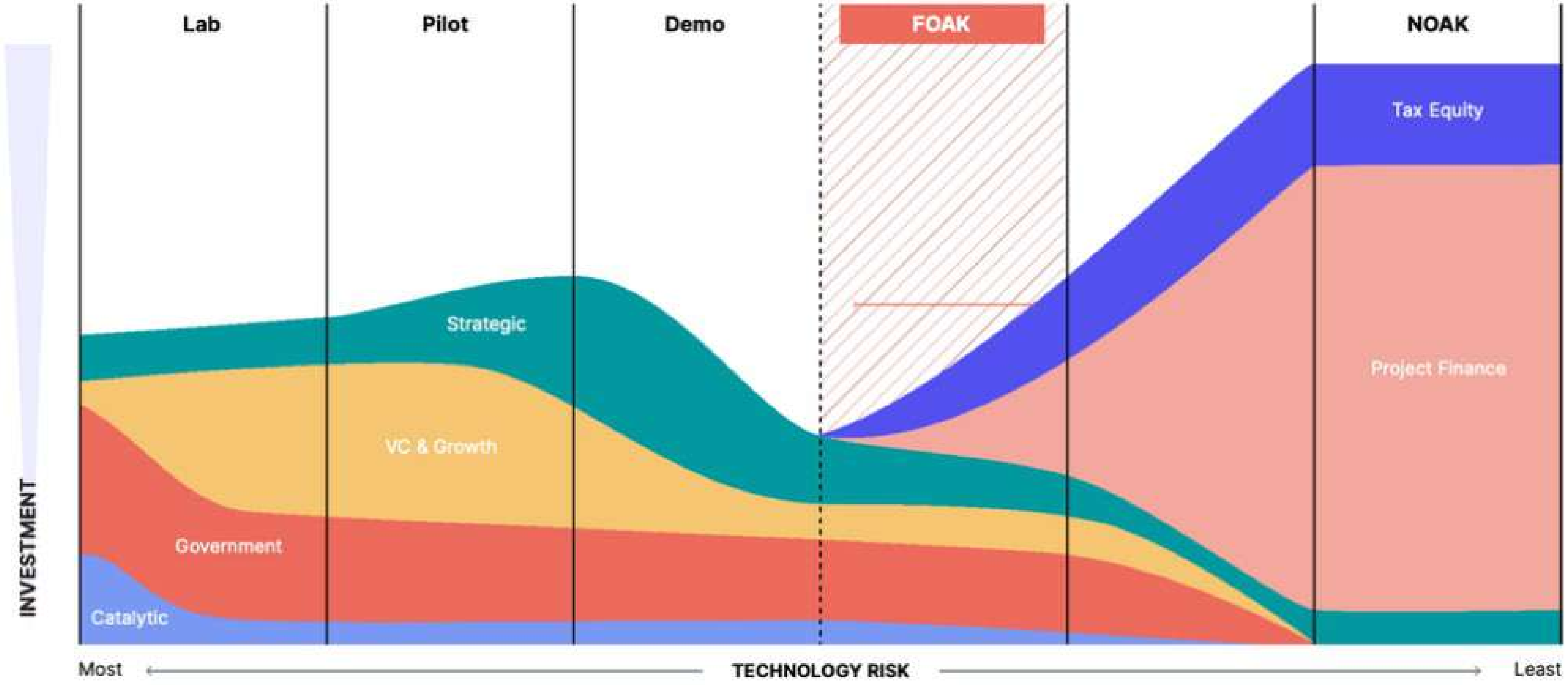
European Innovation Council

Biodegradable soft miniaturized robots, inspired by the morphology and dispersion abilities of plant seeds, to perform in-situ detection of key environmental parameters in air and topsoil.



European Innovation Council

The blended capital stack: from FOAK to NOAK



Capital availability against project stage (Source: Sightline Climate)

Thank you!

Francesco.matteucci@Ec.europa.eu