



VULKAN



COSTRUZIONI NAVALI TIGULLIO
- CASTAGNOLA GIOVANNI -
S.R.L. UNIPERSONALE

I.MAR.S.
Servizi portuali



Project Partnership



Research and Supervisor
Partnership



NAVIGAZIONE
GOLFO DEI POETI

Application Partnership



UNIONE EUROPEA



REPUBBLICA ITALIANA



REGIONE LIGURIA



FESR

Economical Support

PROJECT CO-FINANCED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND 2014-2020

BIIM

Battello Ibrido Innovativo Modulare
Innovative & Modular Hybrid Boat

BIIM Goals & Characteristics

Design Goals

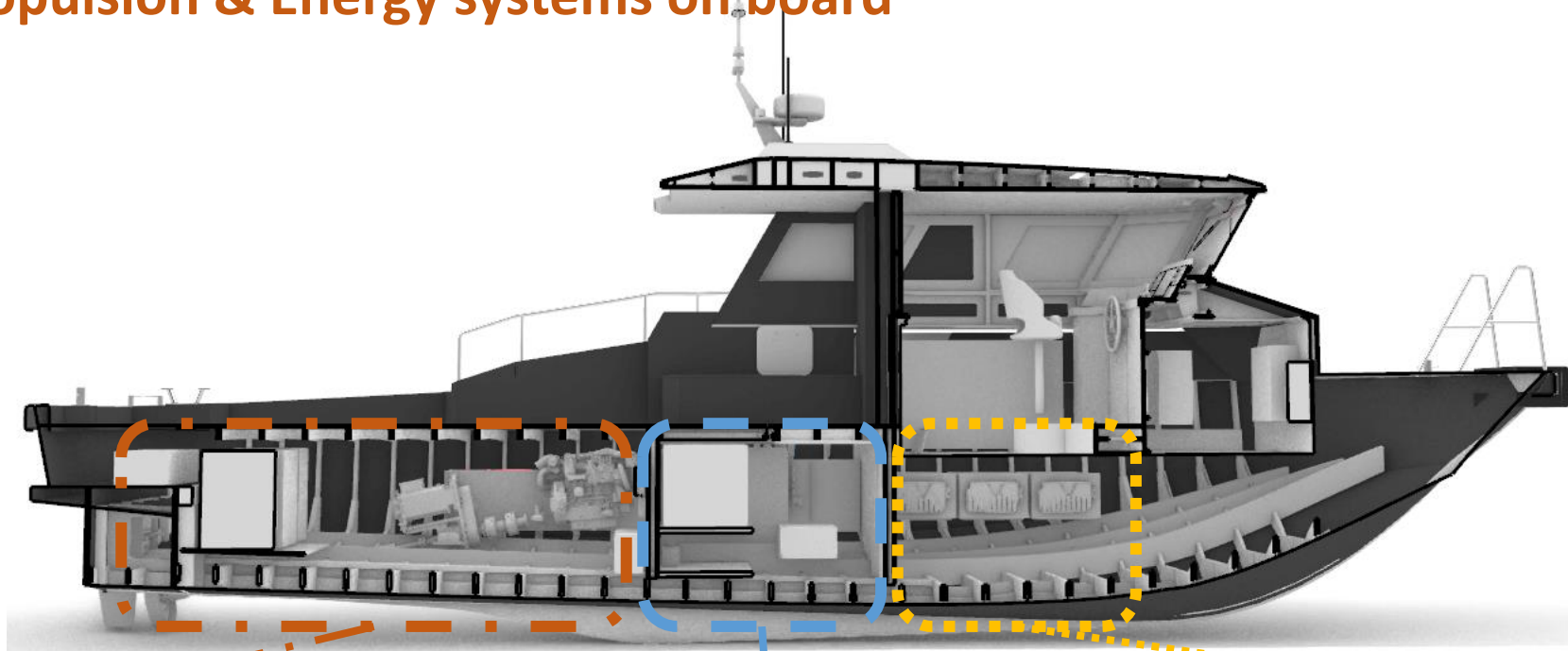
- Zero Emission Propulsion
- Hydrogen Marine Application
- Hybrid Energy System
- Low LCA Impacts
- Retrofitting Application Showcase
- Versatile: Pax and Load Transportation
- Harbour Management Usage

Vessel Characteristics

13 m	Length
4,25 m	Width
4,2 m	Height
19 t	Weight
10 kn	Velocity Max Diesel
8 kn	Velocity Cruise Diesel
6 kn	Velocity Zero Emission
800 l	Autonomy Cruise Diesel
208 kWh	Autonomy Zero Emission



Propulsion & Energy systems on board



Engine Room

- Diesel Engine
- Electric Engine
- VHD Shafts connection
- Electrical Transformer
- Electric Cabinets Chiller
- Diesel Tanks

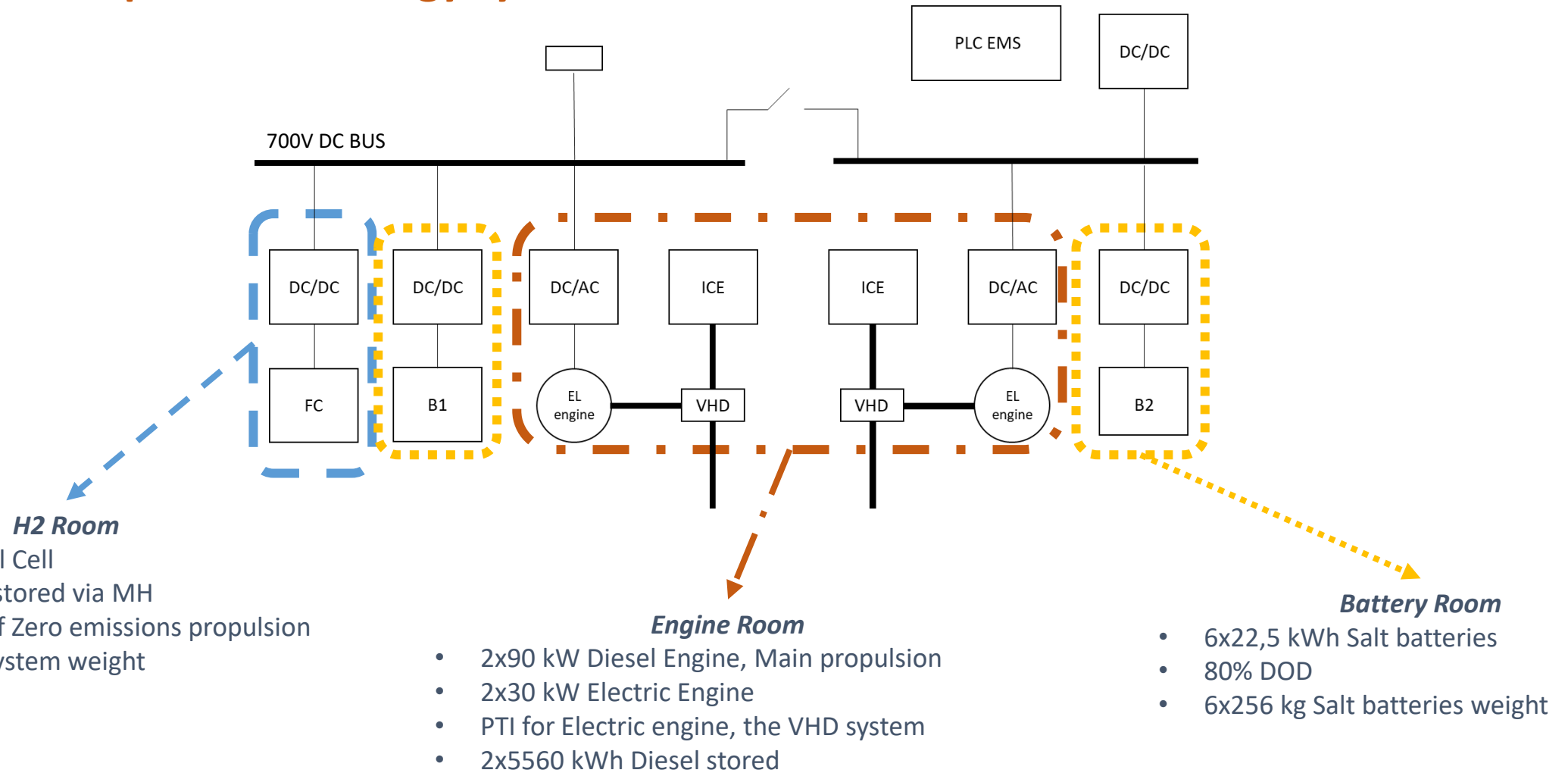
H2 Room

- PEM Fuel Cell
- DC Converter
- Metal Hydride racks
- Heat Exchange system
- Power Management
- PLC of H2 plant

Battery Room

- Salt batteries
- BMS batteries

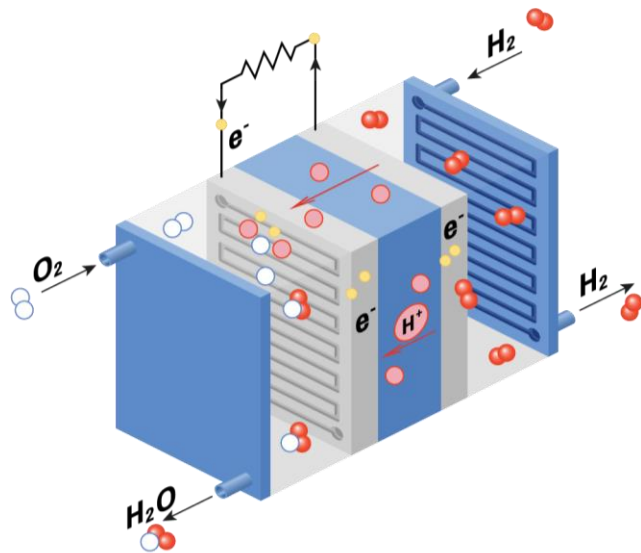
Propulsion & Energy systems on board



H2 system Technologies

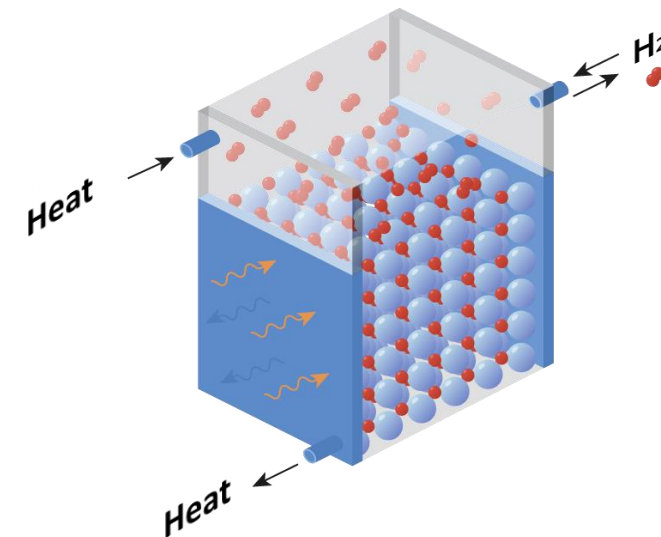
FUEL CELL

- DC electric current production
- **Redox reaction** (NOT FLAME)
- Automatically switch off without hydrogen flow (not electric production)
- Only plastic and metallic materials
- Cooled with liquid at $T < 90^{\circ}\text{C}$
- Proton Exchange Membrane (PEM) Technology



METAL HYDRIDE

- Pure hydrogen store as metal hydride
- **Endothermic release reaction**
- Pressure-Temperature-Concentration are linked by PCT
- Low work pressure and temperature
- AB5 Technology



Fuel Cell

FCBOAT 45

Developed Product by BluEnergy Revolution
From the BIIM prototype to the market product

45 kW	Max Power
320 A	Max Current Tension
290 V	Max Voltage
4,3 kg/h	Max Mass Flow Consummated
15 bar	Max Working Pressure
60-70° C	Cooling Temperature
1000x700x1020 mm	Size Dimensions
230 kg	Weight



PROBLEM	FC stack Permeability 1.3 x 10⁻⁴ g/s	Hydrogen vent (0.097 g/s) is regulated by a controlled valve and is opened for 20% of the working time
SOLUTION	Ventilated Case with dedicated air outlet pipe	Canalised and separated vents

Metal Hydride

HYDOR 50

Developed Product by BluEnergy Revolution
From the BIIM prototype to the market product

3 kg	H2 Stored per Tower
50 kWh	Electric Autonomy Provided in H2
3,6 kg/h	H2 Flow Realised
40 bar	Max Working Pressure
15-40° C	Working Temperature
15 kW	Thermal Required Power
1000x315x900 mm	Size Dimensions
850 kg	Weight



PROBLEM	Hydrogen pressurized storage system	Potential second order leakage from the connections
SOLUTION	PED certification and overpressure valve	Ventilated room and hydrogen sensor

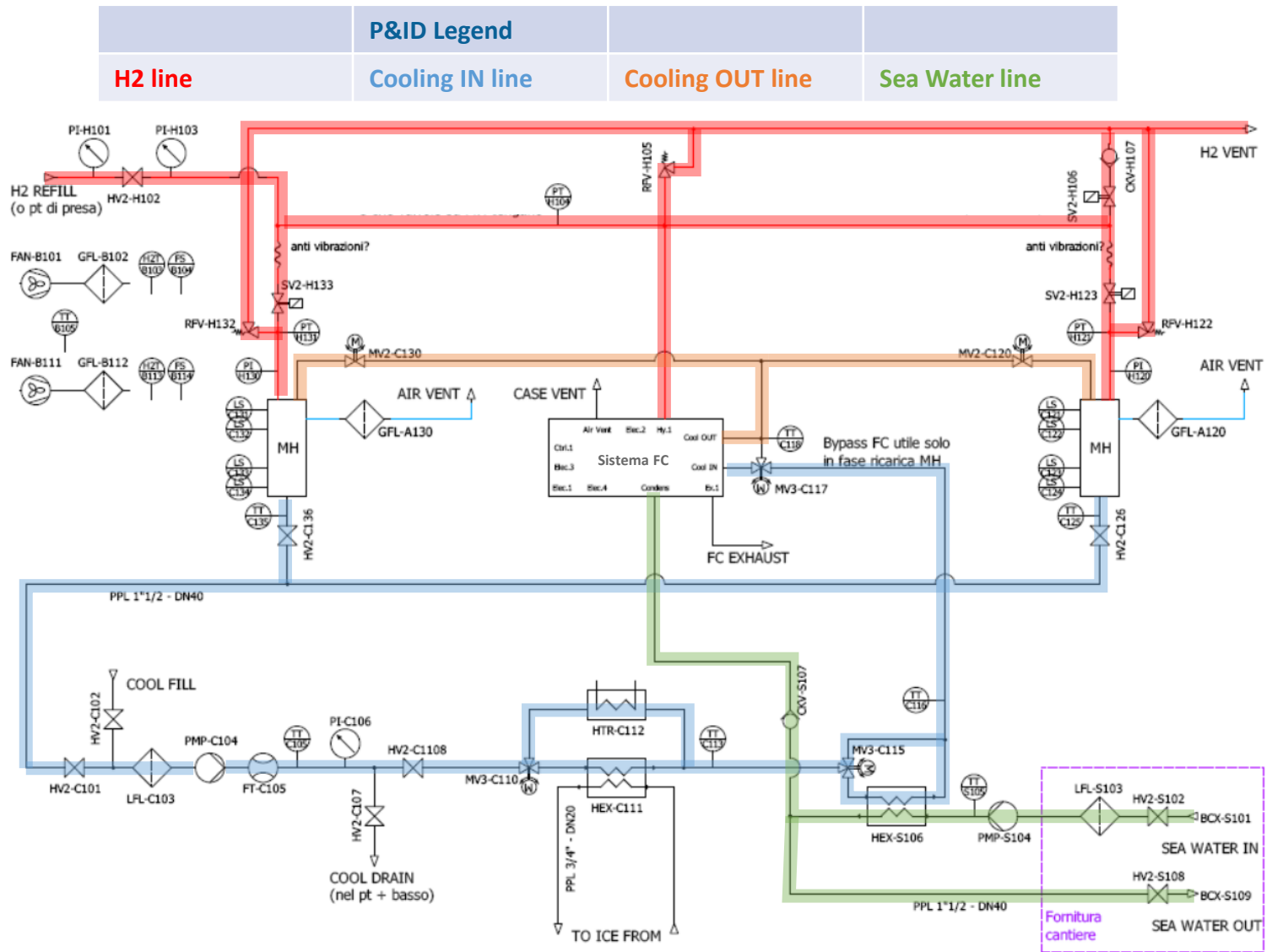
Hydrogen System Plant

Hydrogen line

- Design as a BUS line.
- Release Safety Valves are set at 40 bar.

Cooling line

- Metal Hydride as a heat exchange of the FC.**
- Low environmental impact: close plant and water mixture with glycol.
- Sea Water Heat Exchange to decrease the temperature.
- Electric Heater for the Start Time Readiness of the H2 system and Heat Exchange with ICEs.
- Fully controlled and automatic.

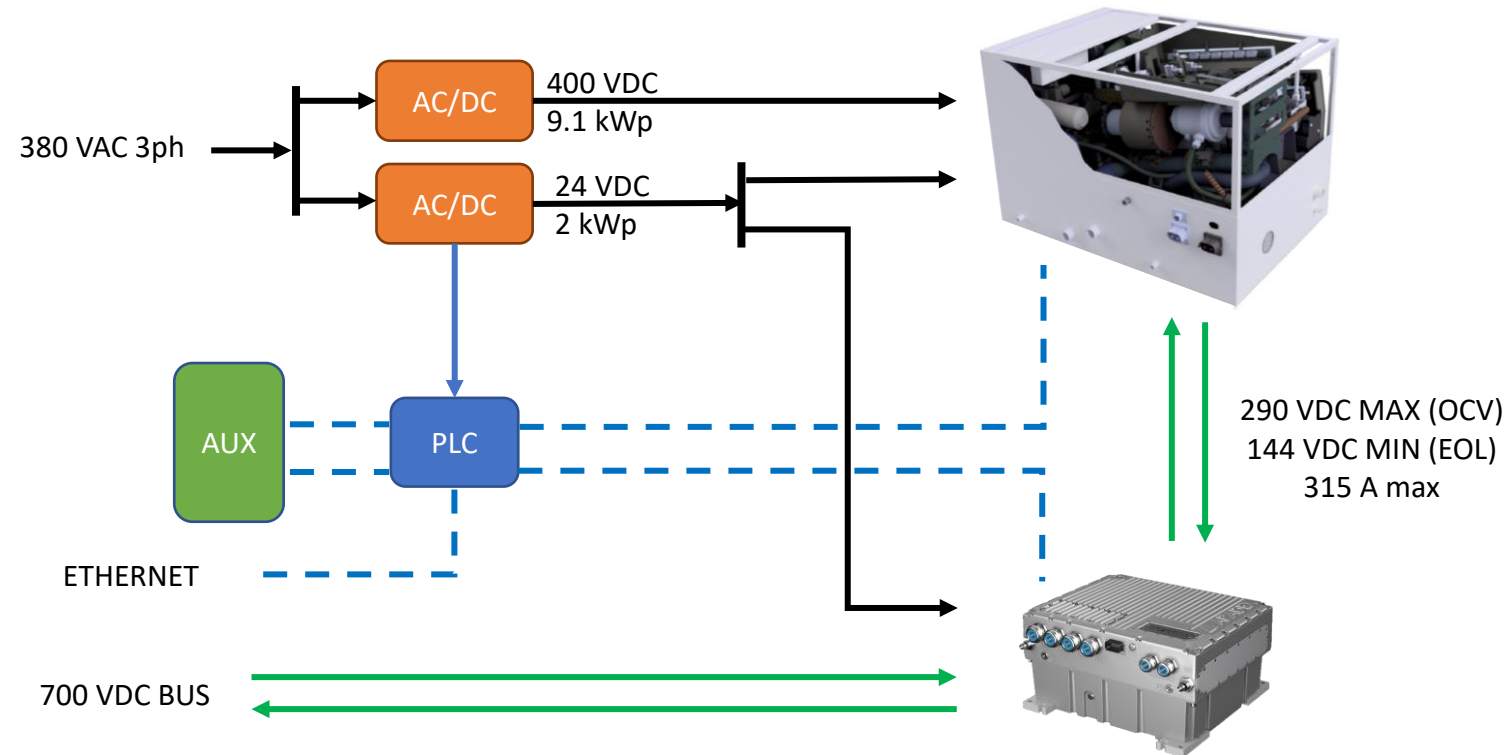


Hydrogen System Electric Management

DC Architecture & PLC are integrated

- FC module has its integrated Current-Voltage Management with logic functions for the stack work
- FC system with an integrated Programme Logic Control to manage its proper auxiliary works
- DC/DC in current control

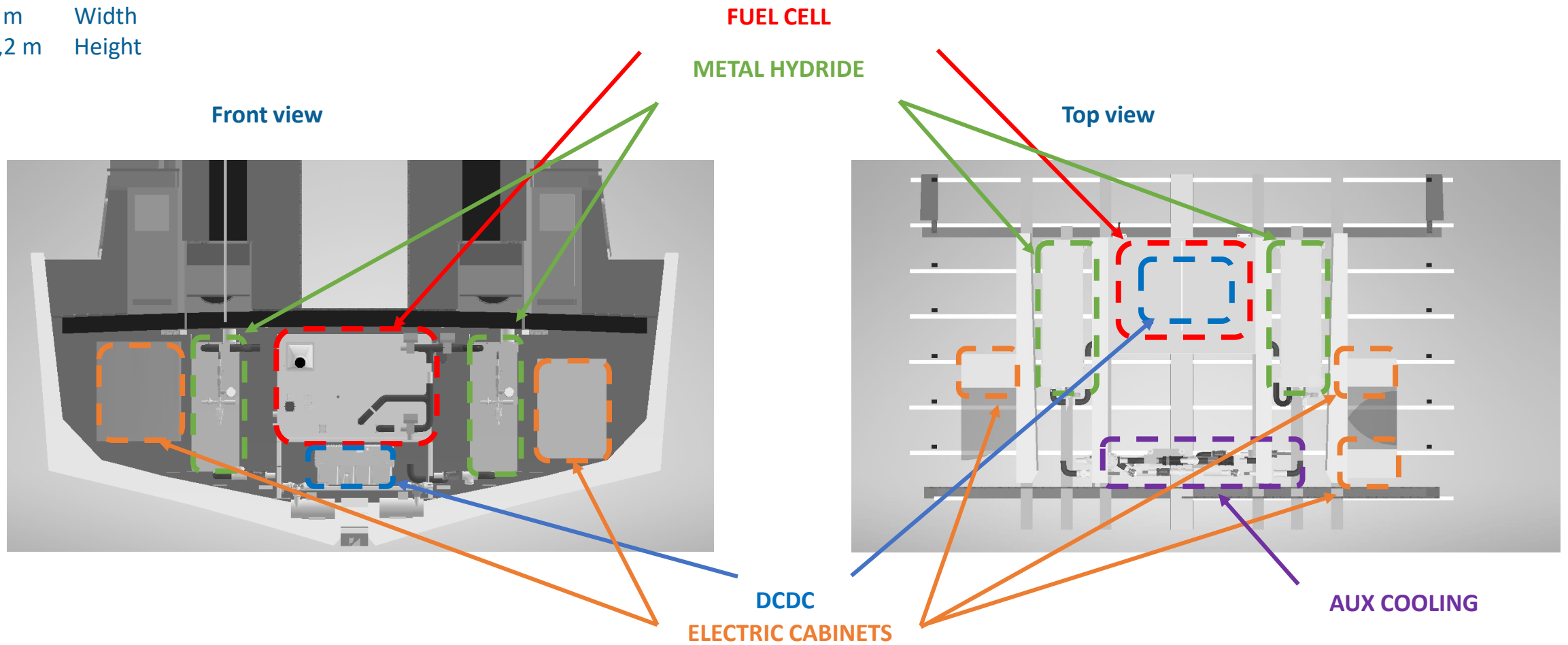
	WD Legend	
DC HIGH POWER line	AC AUX line	COMUNICACION line



Hydrogen Room

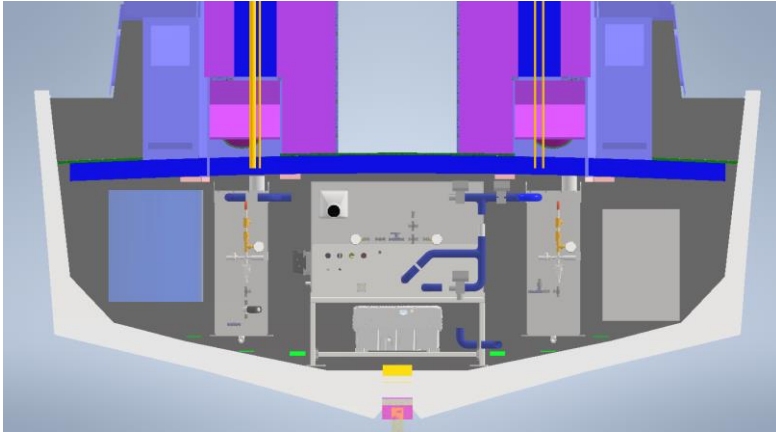
H2 room Size

- 4 m Length
- 4 m Width
- 1,2 m Height

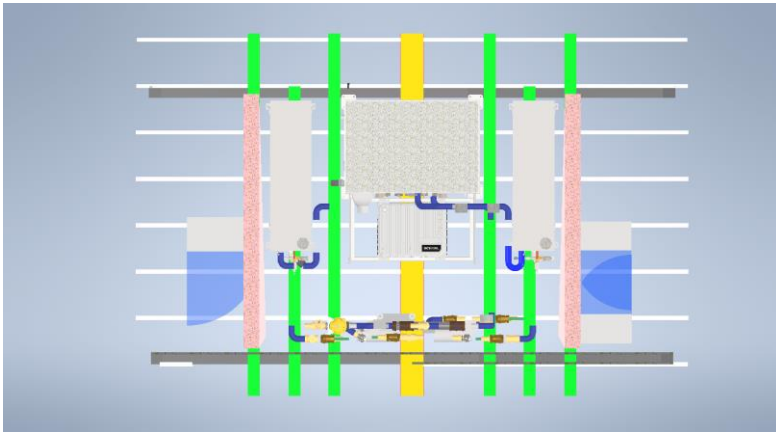


Hydrogen Room

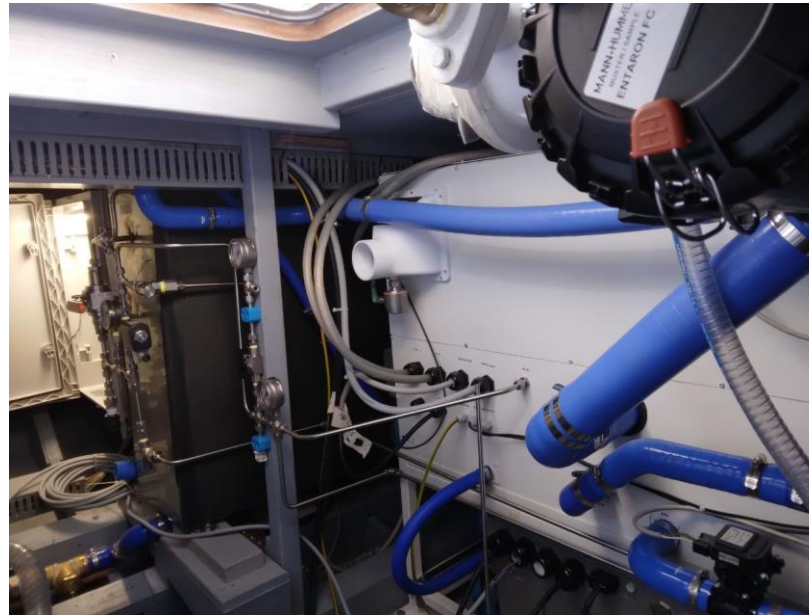
Front view



Top view



FC, MH and H2 system plants



Cooling Components



Hydrogen Ventilation system

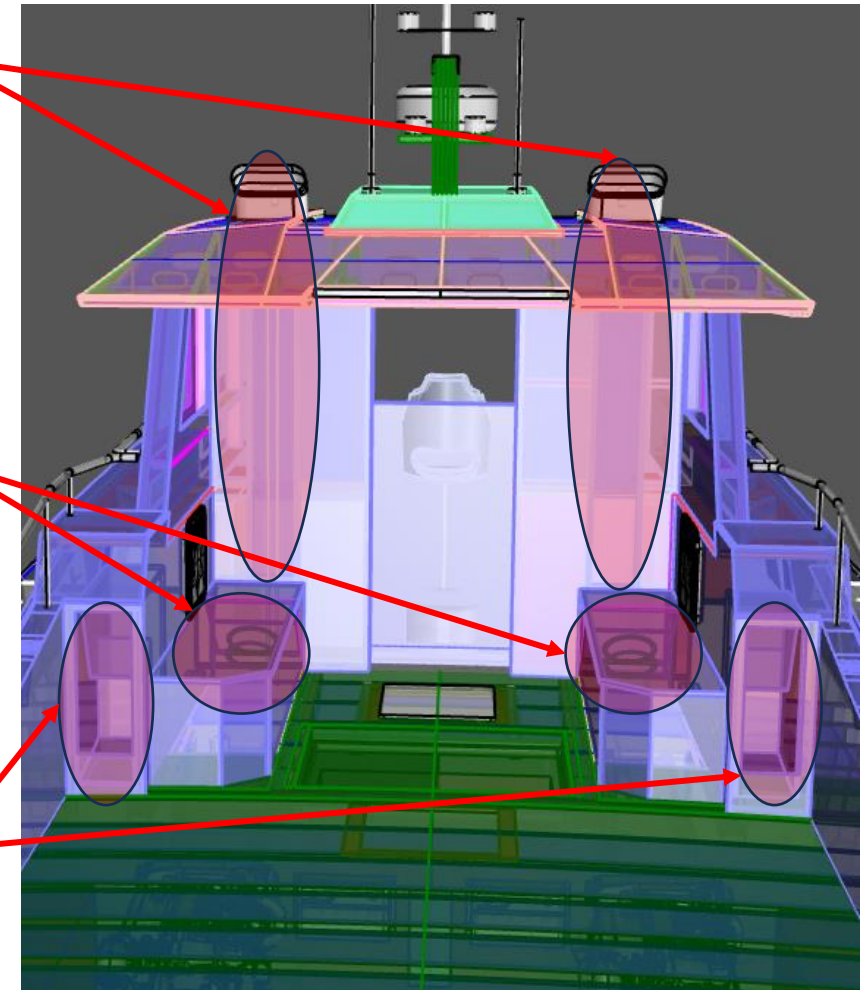
H2 Room Ventilation

- Hydrogen room is classified «Negligible»
- Hydrogen sensor inside the room
- Fan redundancy
- 1400 m³/h flow velocity per trunk
- 210 m³/h Fuel Cell air request
- Seawater protection: not exposed air inlets with water trap and condensation filter
- Ventilation cover all components: inlets aft side, trunks fore side

Ventilation Trunks

Ventilation Fans

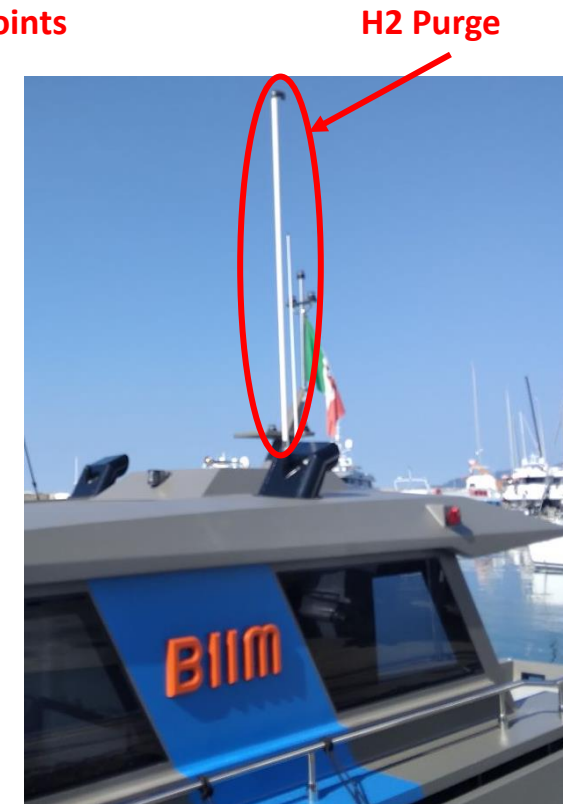
Ventilation Inlets



Hydrogen Ventilation system

H2 room Purge & Ventilation outlets

- Ventilation trunk outlets arranged over the superstructure roof
- H2 Purge has the dedicated line inside the left ventilation trunk
- FC cathode has the dedicated line inside the right ventilation trunk
- H2 Purge and FC cathode outlets not in contact are placed far apart



Hydrogen Refuelling

H2 Refuelling Request

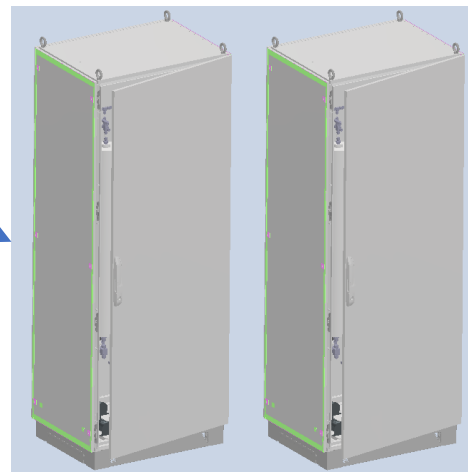
- 6 kg/h Max H2 refuelling flow.
- 30 bar Max H2 refuelling pressure.

H2 Refuelling Procedure

- Refuelling point is inside the H2 room.
- Hand procedure to have a human supervision.
- Pressure valve regulation must be set.



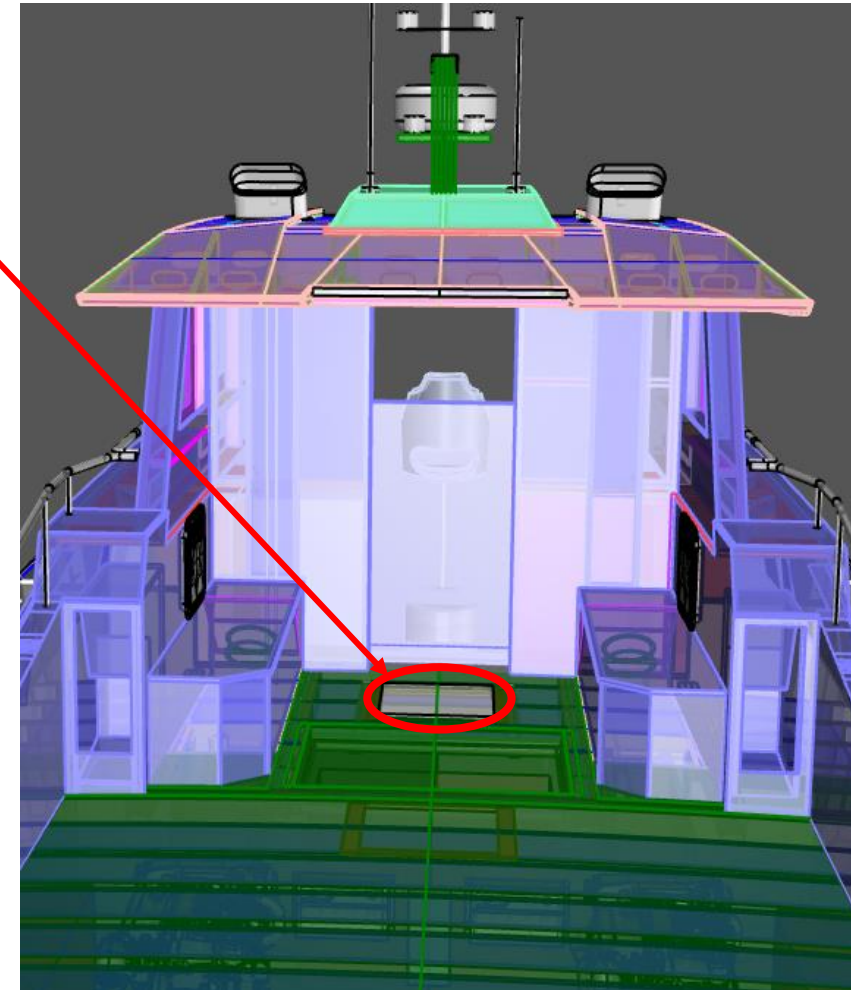
Tap water



Electricity



H2 Refuelling point



Boat Launch

31st March 2023, BIIM is launched in the Lavagna marina.

An example of the feasibility of the alternative propulsion provided by a hybrid system of H2 with Salt Battery and the availability of the retrofit on diesel engine boat.



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Purpose & Route

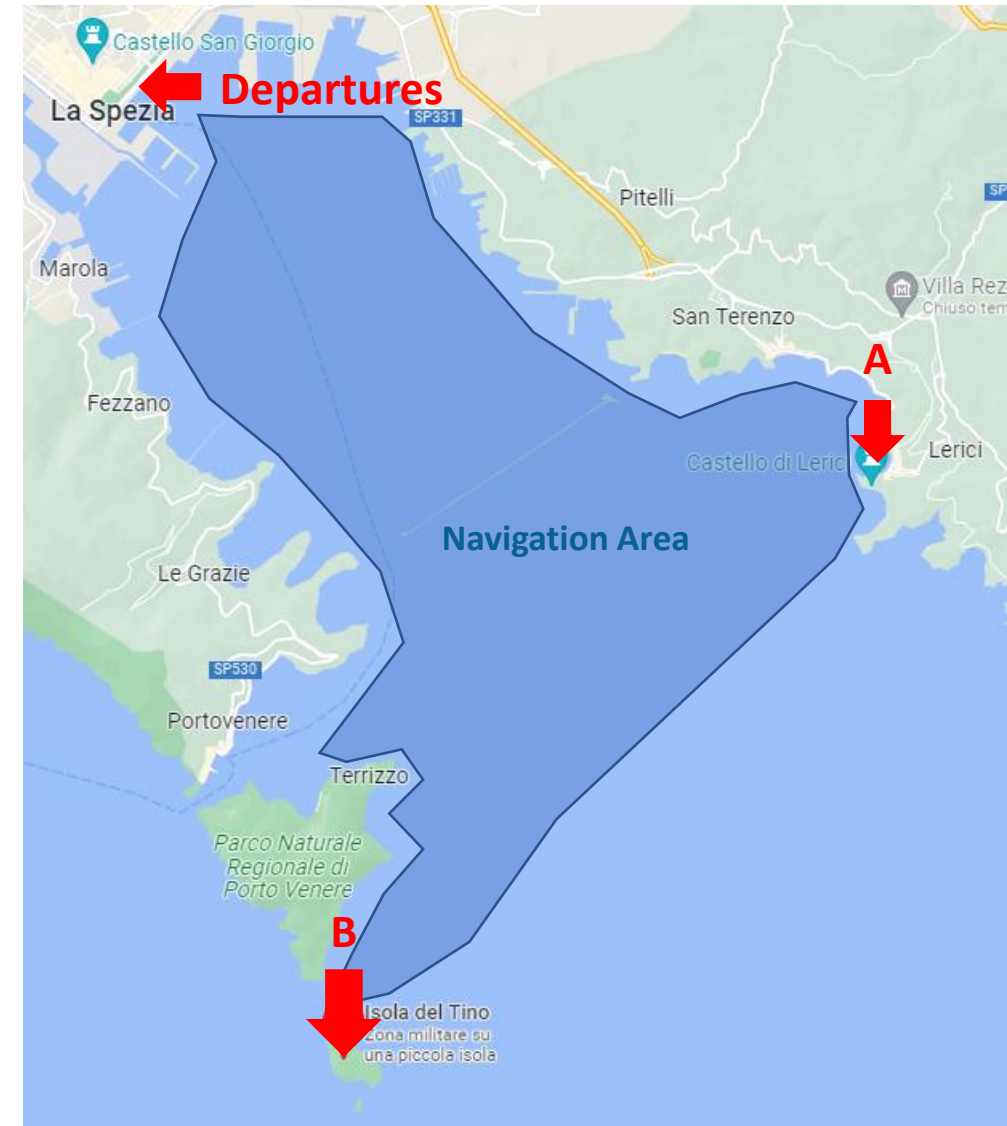
Purpose

- Support management of the commercial harbor.

Route

- Inside the La Spezia gulf.

Application Partnership



Location information



BIIM

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Thanks for your Attention

