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The Ocean Sound monitoring sub-system for the "Italian Integrated Environmental Research Infrastructures System (ITINERIS)" project

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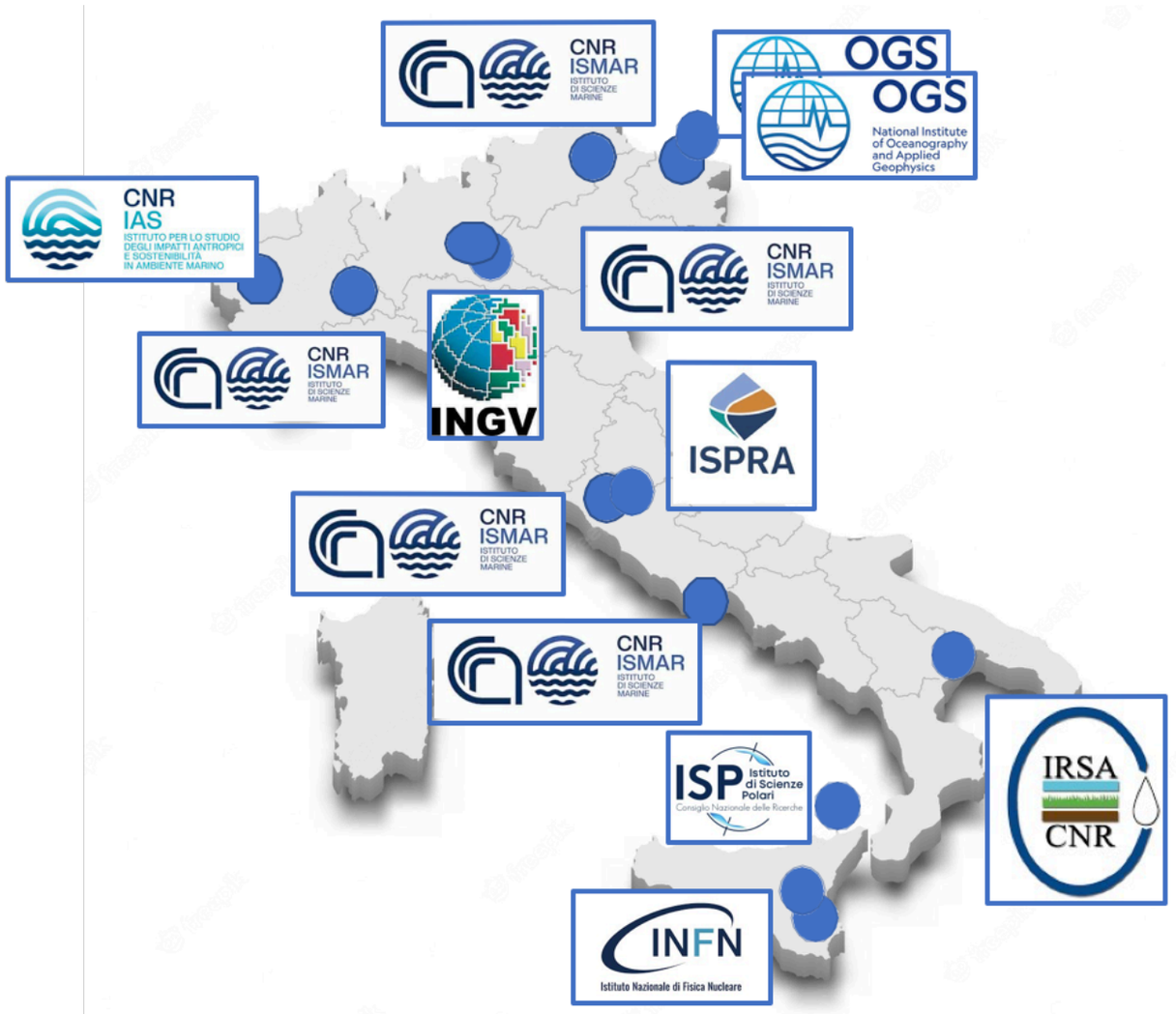
What ITINERIS IS..

- The aim of the **Italian Integrated Environmental Research Infrastructures System (ITINERIS) project**, is to establish the Italian Hub of Research Infrastructures within the environmental scientific domain.
  - ITINERIS will create a **flexible system** to collect and store, for the first time in a national integrated system, ocean data and metadata and make them **available**, **traceable**, **accessible**, **interoperable**, and **reusable** for the entire scientific community (**FAIR** principles)
- It includes **8 Work Packages** each organised in macro areas such as *Atmosphere, Marine Domain, Terrestrial Biosphere etc..*
- The project is funded under the **European Union and the Italian Ministry of Research (MUR)** in the context of the "Piano Nazionale di Ripresa e Resilienza (**PNRR**)

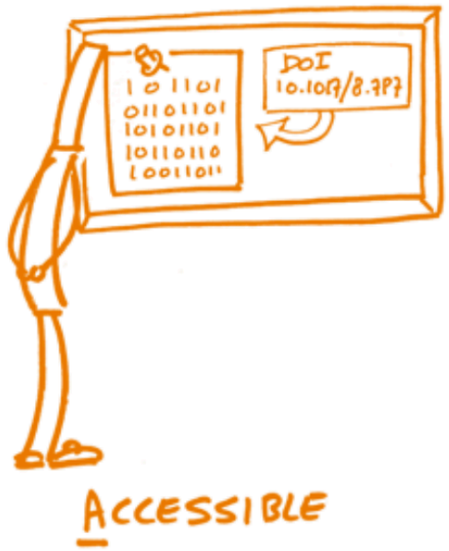


ITINERIS

FAIR(ness) in data analysis

- ***Findable*** *(data should be uniquely and persistently identifiable, re-findable and persistent. A data object should contain also a basic sets of metadata)*

FAIR(ness) in data analysis



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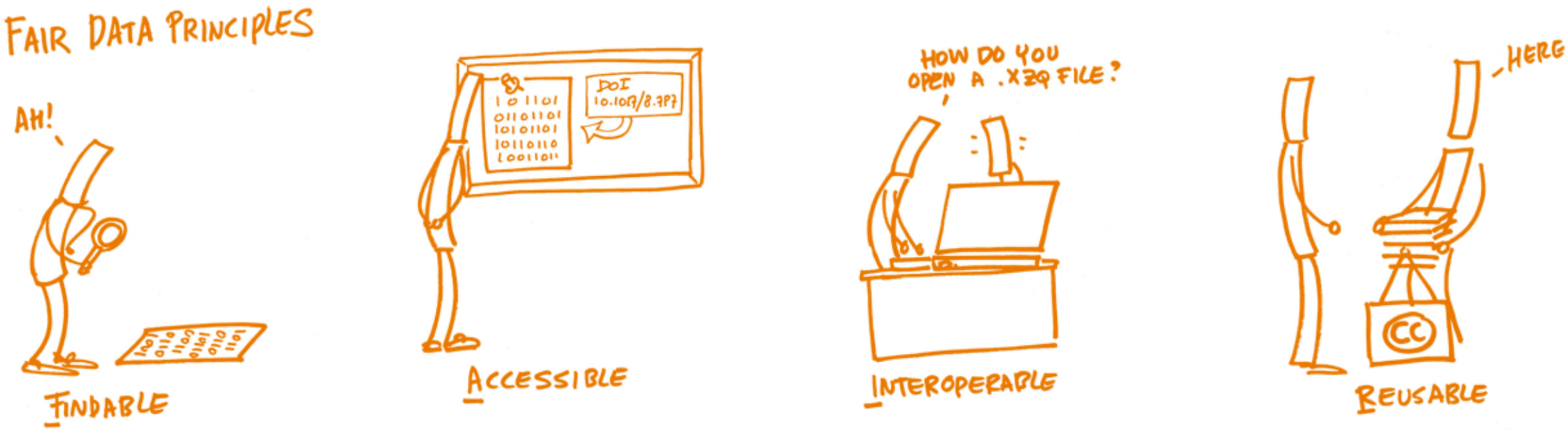

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https://www.fosteropenscience.eu/learning/assessing-the-fairness-of-data/#/id/5c52e8cf0d3def29462d8cb5

ITINERIS WP5: Marine Domain

TODAY'S OCEAN SOUNDSCAPE

ANTHROPOGENIC SOURCES

1. Acoustic deterrent devices
2. Fishing vessels
3. Recreational vessels
4. Cruise ships
5. Commercial shipping
6. Offshore oil & gas
7. Seismic airgun surveys
8. Military & civilian sonar
9. Offshore renewable energy
10. Underwater explosions
11. Construction and pile-driving

NATURAL SOURCES

- A Waves
- B Wind
- C Rain
- D Marine mammals
- E Currents
- F Underwater landslides, volcanos and earthquakes
- G Fishes
- H Invertebrates

jonas Joint Framework for Ocean Noise in the Atlantic Seas

European MARINE BOARD Advancing Seas & Ocean Science

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ITINERIS WP5: Marine Domain - Objectives

The ITINERIS Marine Domain aims to **integrate all marine Research Infrastructures (RIs)** to guarantee **access to Italian facilities**, **services and marine data and to ensure long term monitoring of EOVs, EBVs and ECVs.**

This will allow:

- to establish the **Italian Integrated Ocean Observing System (IOOS)** able to contribute to **European and** International effort on ocean observations: European Ocean Observing System (EOOS) and Global Ocean Observing System (GOOS)
- to contribute to **the major challenges** of **UN Ocean Decade of Science for Sustainable Development:** predicting improving quality and interoperability of ocean data, for three critical themes:

climate, operational services, marine ecosystem health

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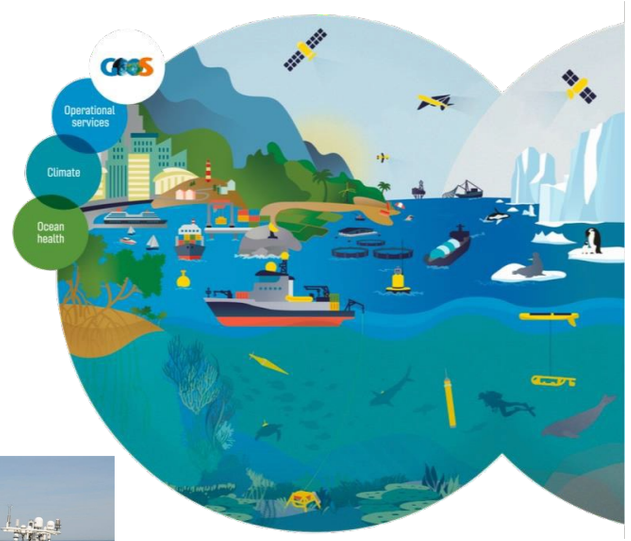
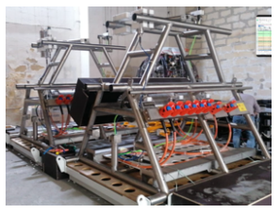
ITINERIS WP5: Marine Domain
IOOS (Italian Integrated Ocean Observing System)

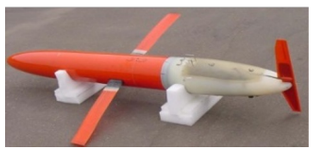
The aim is to **harmonise data and products** from the different RIs and **build up an integrated system of systems** able to ensure continuity of data and services and to respond to user requirements and contribute international effort

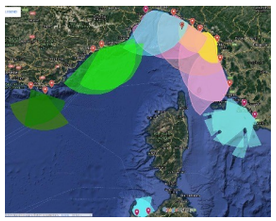
How:

- **Integration and harmonisation** of Marine Domain RIs
- **Design and implementation of IOOS**
  - Build a **vocabulary of metadata** to guarantee FAIR(ness) of the data
- Implementation of the **ITINERIS Marine Data Store**
- Upgrade the RIs by installing **new instrumentations responding to the** digital requirements
- Enhance capability of the **RI marine facilities to transfer data from** offshore to inshore









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ITINERIS WP5: IOOS metadata vocabulary

The most common definition is that **metadata are "data about data”**

"Metadata are pervasive in information systems, and come in many forms. [...] Metadata is key to the functionality of the systems holding the content, enabling users to find items of interest, record essential information about them, and share that information with others.” (Cit. Jenn Riley)

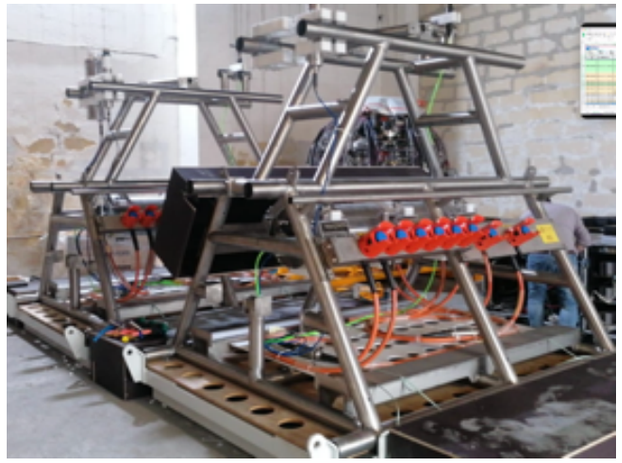
There are many different kinds of metadata. They are usually divided into categories:

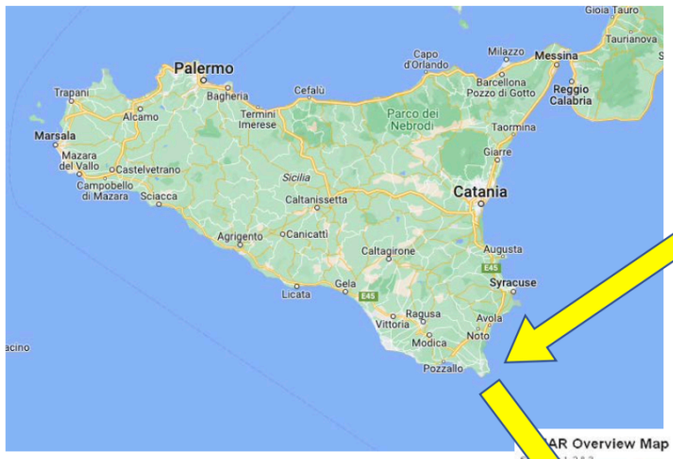
- **Administrative metadata**, including:
  - **Rights metadata** (i.e., intellectual property rights and use information)
  - **Technical metadata** (i.e., technical details about the object and its instantiation like its file format, file size, and how to open, access and use it)
  - **Preservation metadata** (i.e., a log of the series of actions taken against an object in order to ensure it longevity and viability)
- **Descriptive metadata** describes a resource, its content, its identifying characteristics and its "aboutness"
- **Structural metadata** describes how the pieces of a single object fit together and/or how an object exists in relationship to other objects

ITINERIS WP5 @ LNS

INFN – Laboratori Nazionali del Sud (LNS) is coordinating the production, integration, and testing of a new subsea **Junction Box** (a, b) to be installed at the 3450 m deep LNS infrastructure of Capo Passero – Italy (c), that will ensure power and high-speed data connection from shire to seafloor (WP5.7). The JB will also provide **optical link** for communication and **data control/transfer** between the observatories and the data acquisition systems hosted on shore. It will be equipped with **high-sensitivity** and large **band-width hydrophones** for real-time and long-term data capture.

a)





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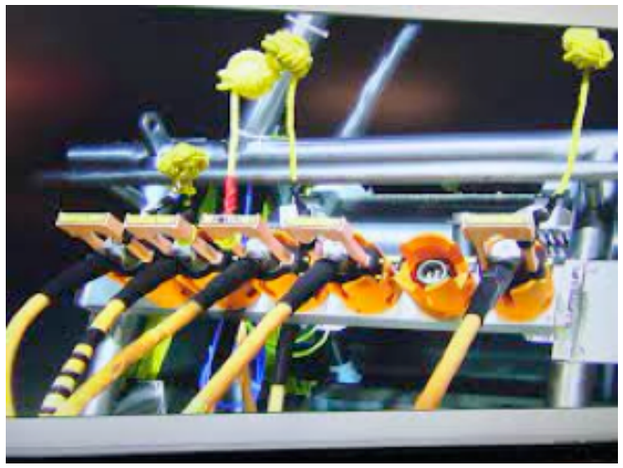

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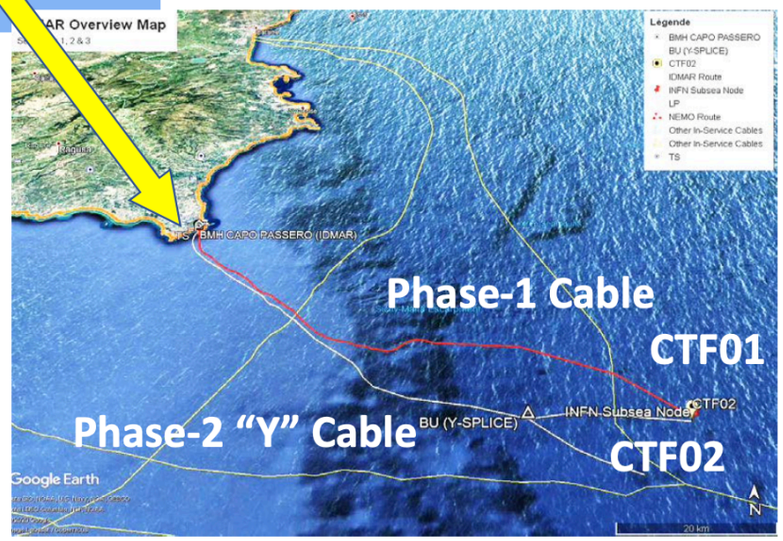

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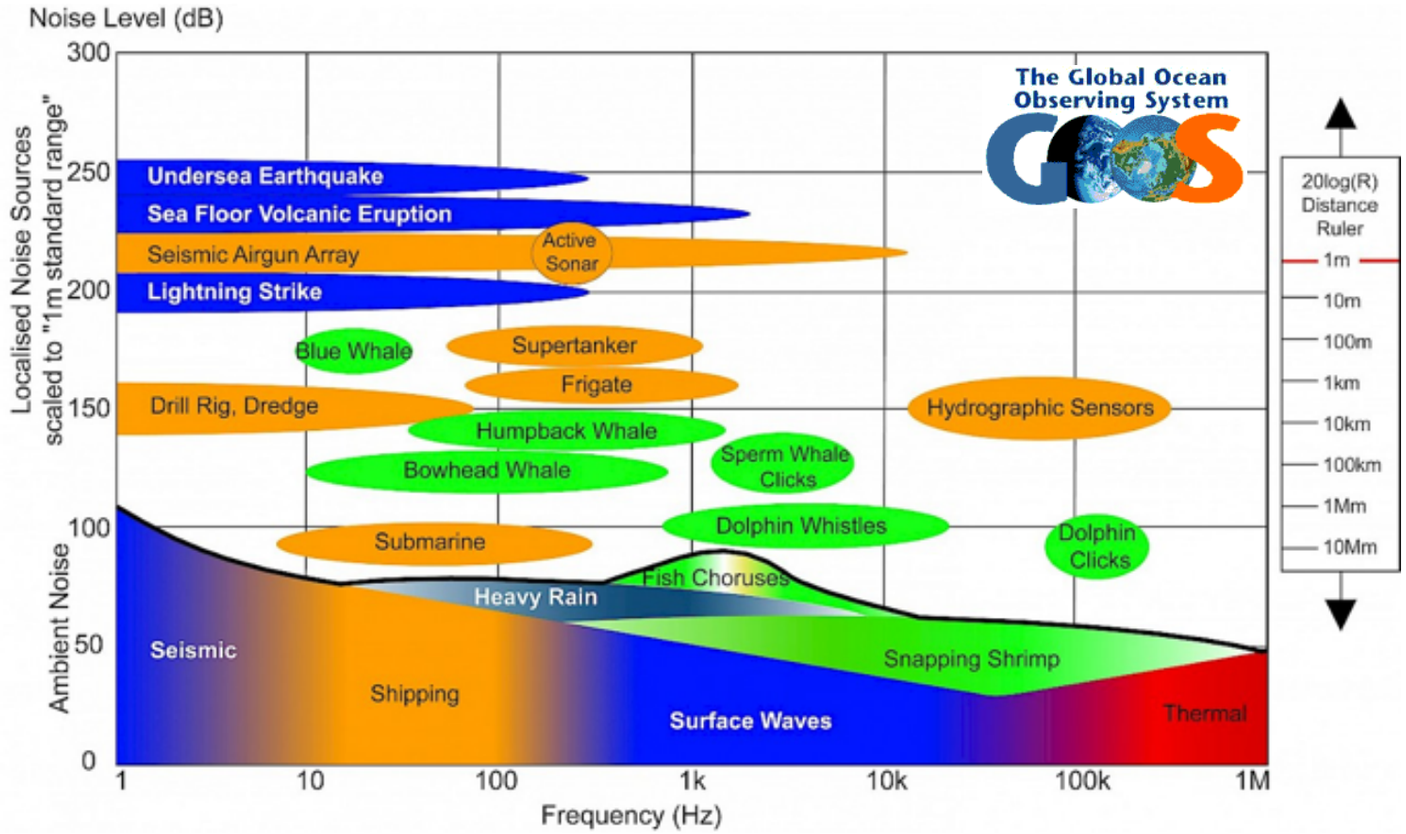
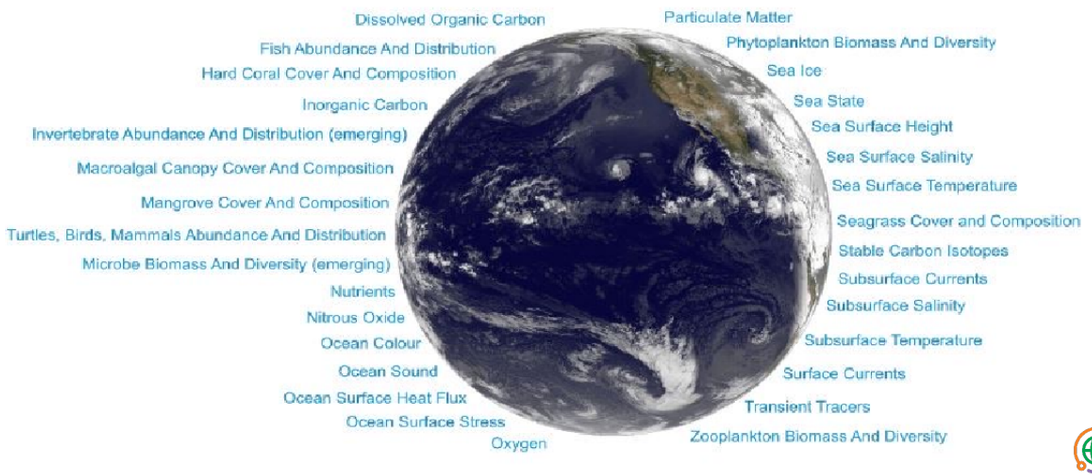
ITINERIS WP5 @ LNS: IOOS data

Global Ocean Observing System

Observing the ocean is **essential** to quantify the changes that have occurred in the recent past and to monitor current changes and predict the future

Ocean Essential Variable (EOV) includes the EBVs & ECVs





- **Good Environmental Status (GES)**:
  - *EU MSFD*: Indicators 11.1 and 11.2
    - diffuse noise: 65 and 125 Hz
      - **Sound Pressure Level** (SPL) is the most important EOV to look at

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ITINERIS WP5 @ LNS: analysis flow

Main Strategy:

- Save 5 minutes acoustic data from JB every 5 min (60 GB/day)
- **Real time analysis**
  - Produce Spectrograms
  - Calculates Sound Pressure Level (db re 1µPa) in 1/3-octave frequencies bands
    - Mean, 25, 50, 75 and 95 percentiles
  - Save outputs in PNG and HDF5 formats including metadata
  - Produce WAV and MP3 files for outreach purposes

Analysis input parameters:

- 2048 FFT points
- Sampling frequency (fs) = 195.3 kHz (2.034 kHz for the low frequency analysis after decimation)
- Overlap 50%
- Hamming window: 2048 samples
- Window length 1.5 s (15 ms) with 2 kHz (195.3 kHz) fs

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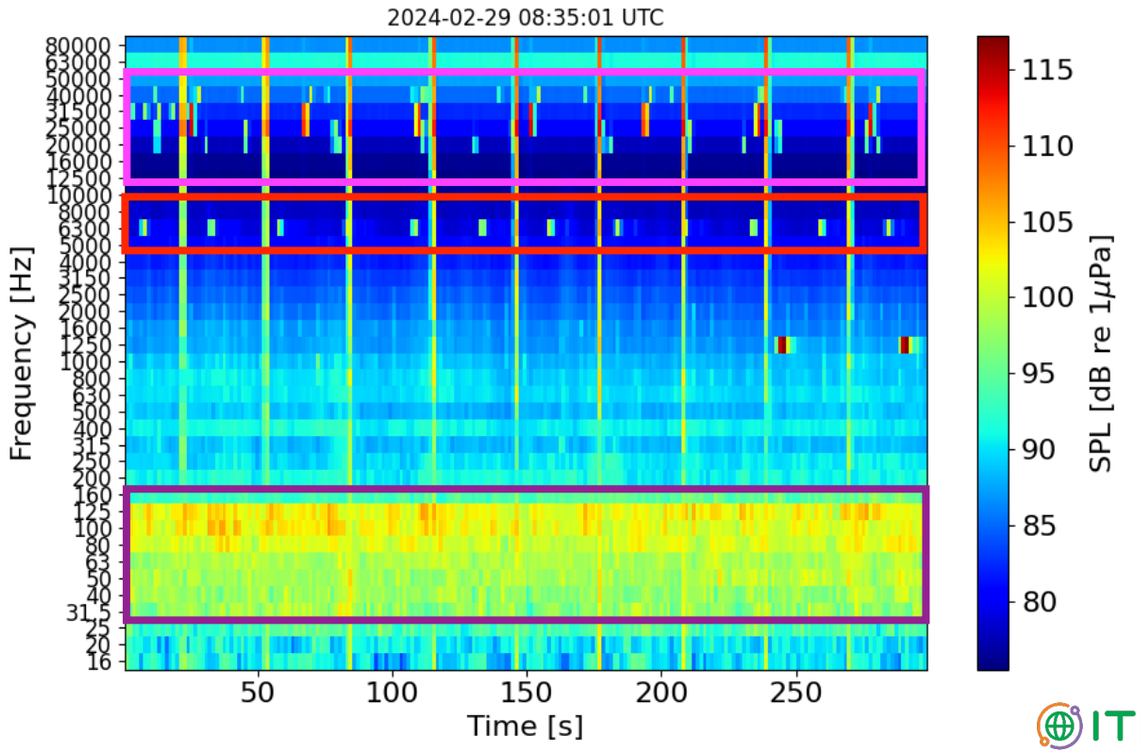
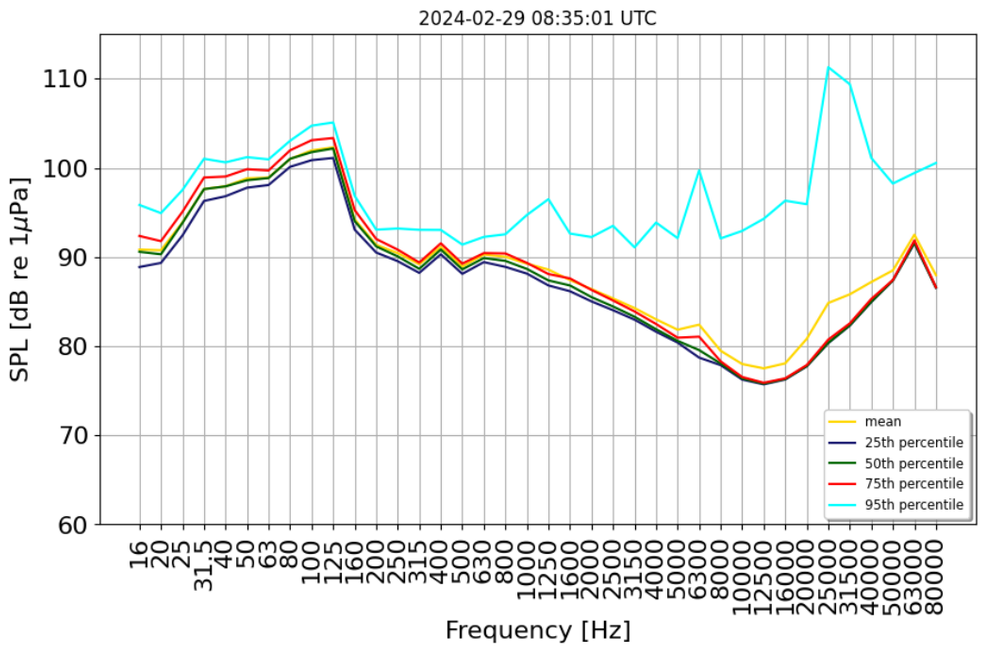
WP5 @ LNS: preliminary results

- **Sound Pressure Level (SPL) is calculated in third-octave** frequency bands comprising 63 and 125 Hz bands (central values, EU MSFD indicators 11.1 and 11.2)
  - for bio-acoustic underwater communication and high energy physics studies, *further bands should be included* (sampling frequency is about 195 kHz)
  - **The mean value of SPL** is calculated together with the 25th, 50th, 75th, and 95th percentiles





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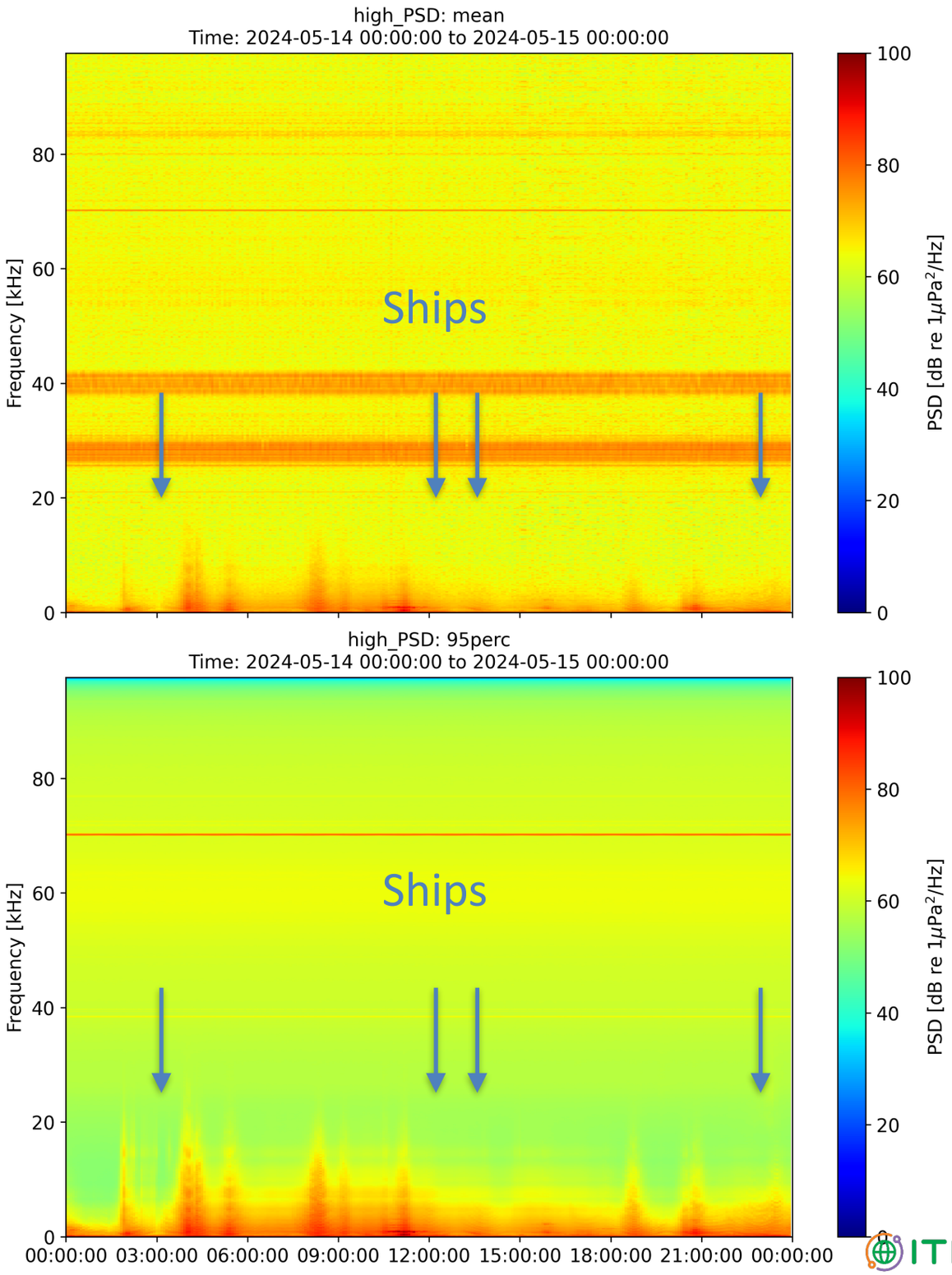
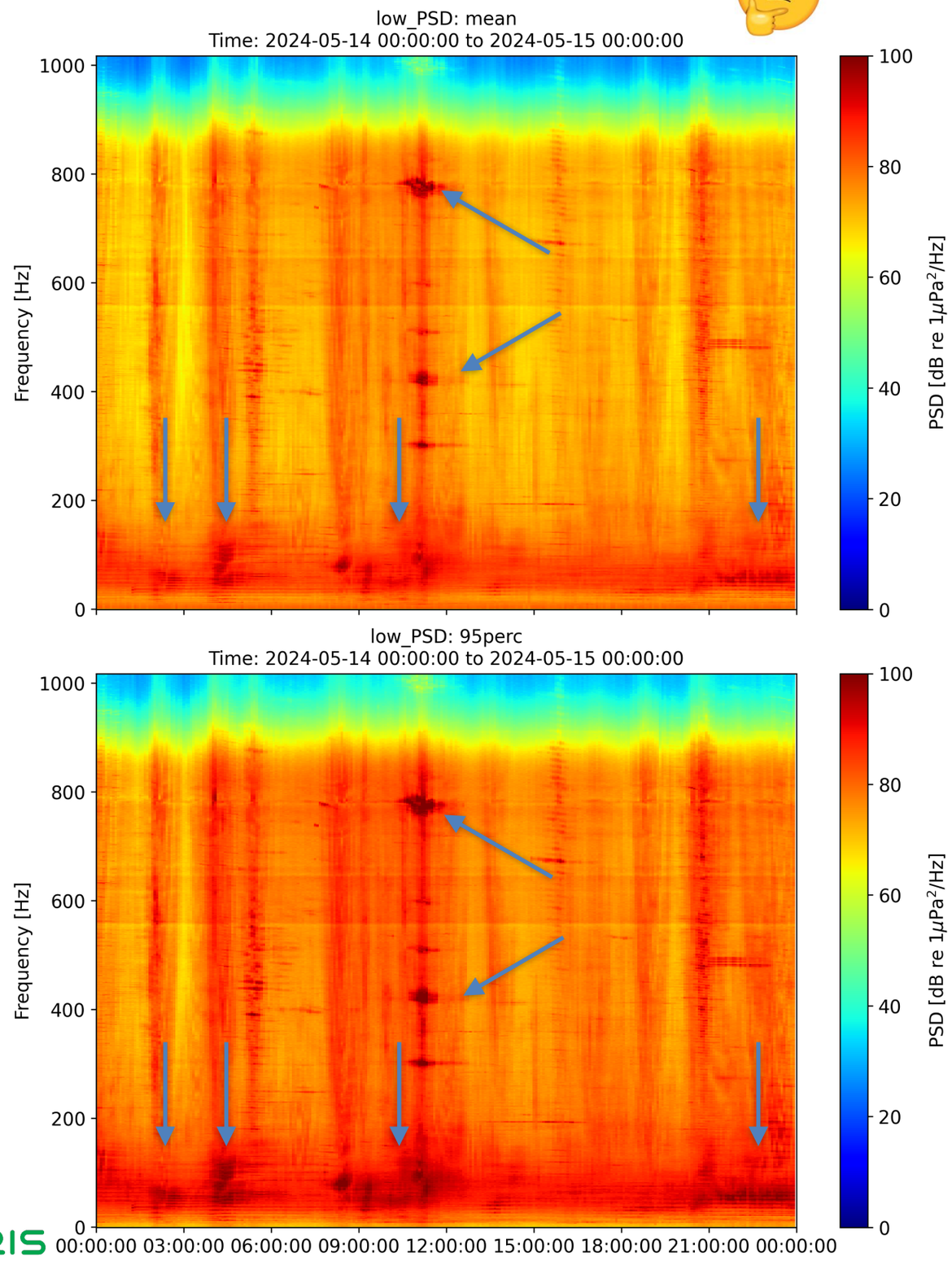
WP5 @ LNS: long-term data analysis





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ITINERIS WP5 @ LNS: outreach

[Listen our ocean recordings in real time]

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Conclusions and outlook

- Sound in the sea is a mandatory tool to improve our knowledge in geophysics, biology, oceanography and high energy physics studies
  - **Sound Pressure Level (SPL)** calculations in 1/3-octave bands is mandatory to **monitor the Good Environmental Status** (EU MSFD descriptor 11)
- **ITINERIS** project has the main goal to collect all the acoustic data from partners by developing, for the first time in the field, an integrated, flexible and **FAIR** national audio database (*ITINERIS HUB*)
  - **INFN - Laboratori Nazionali del Sud is leading the WP 5.7 of the ITINERIS project**
  - **Main goal** is the integration and testing of a new subsea Junction Box (JB) to be installed at the 3450 m deep LNS infrastructure of Capo Passero – Italy
  - We demonstrate the ability to efficiently store, collect and analyse acoustic data
  - **Future steps** are the finalisation and the deploy of the JB and to test the analysis chain/procedure with different data sources
    - Data can be also used to complement the **positioning system** of the *KM3NeT Neutrino telescope* and to start studies for **acoustic neutrino detection**.

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