2nd Meeting of the Joint Bycatch Working Group
Online, 5-6 February 2025

On a new smart acoustic deterrent device based on dolphin recognition through artificial intelligence

Alessandro Lucchetti
CNR IRBIM (Ancona, Italy)

Other authors: De Marco R., Di Nardo F., Li Veli D., Novelli G., Petetta A., Screpanti L., Scaradozzi D.

Main question

Are the pingers available on the market really “Interactive”?

Main purpose

Develop a new interactive pinger to avoid dolphin habituation

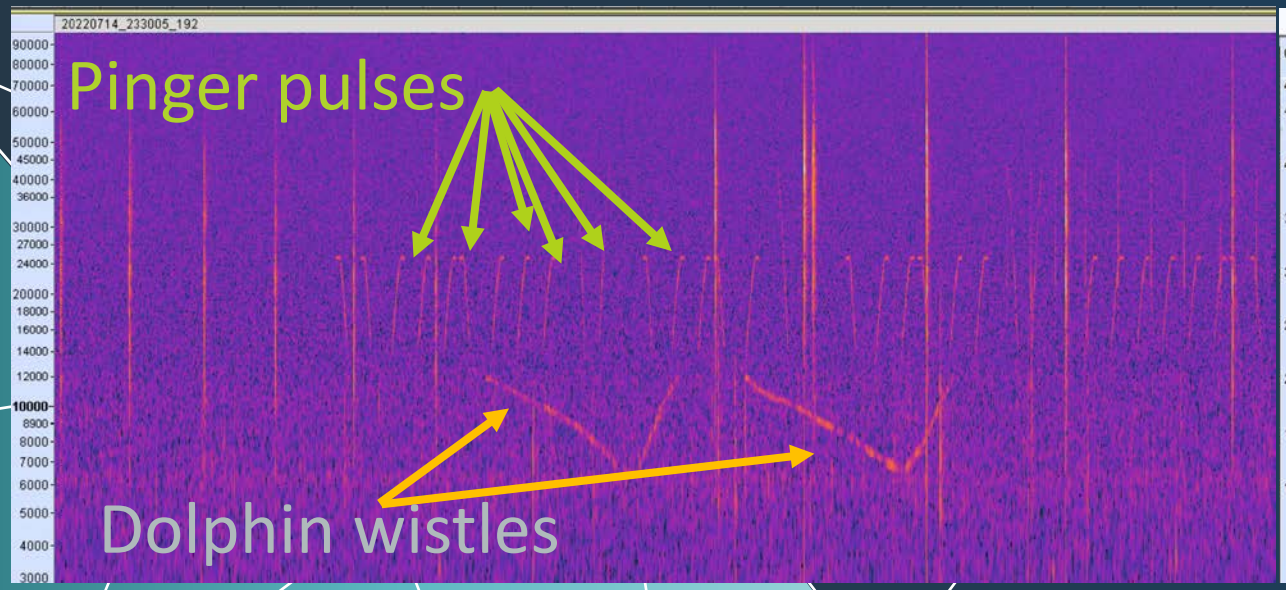
LOWERING FISHING INTERACTIONS life DELFI

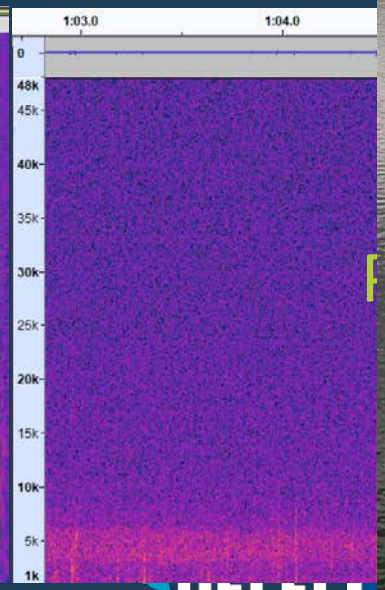
NATIONAL BIODIVERSITY FUTURE CENTER

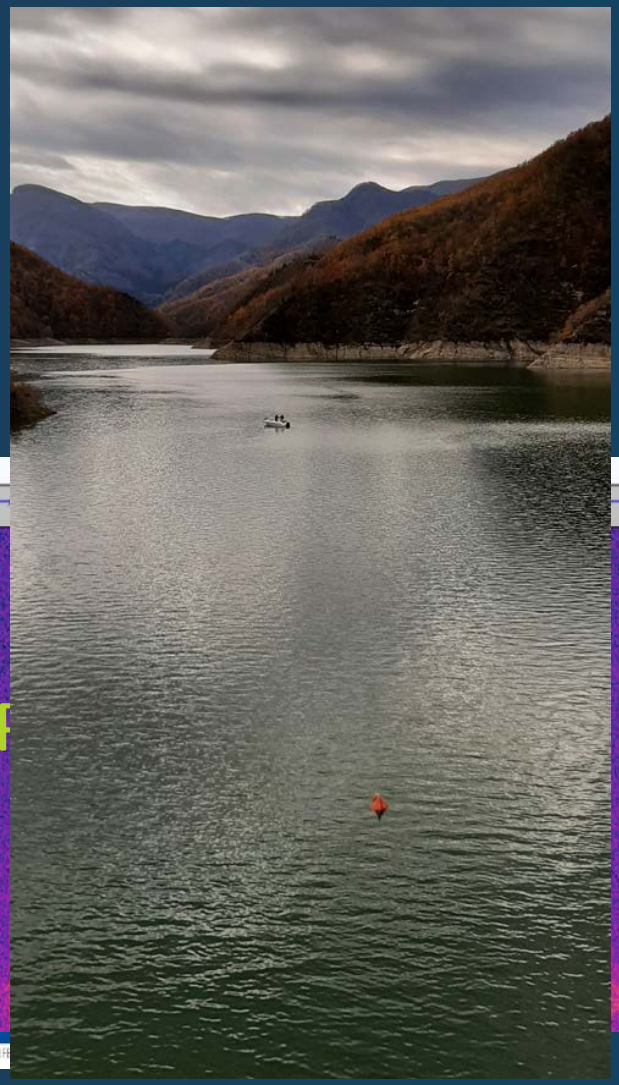
Main question

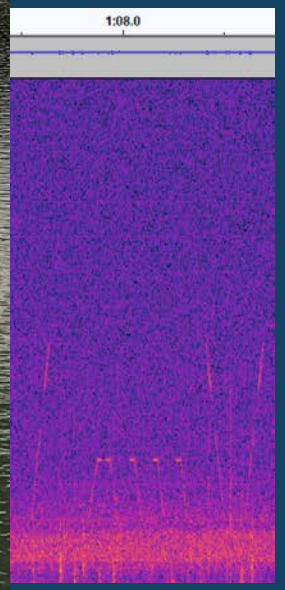
Are the pingers available on the market really "Interactive"?

- We had 50% of reduction of interactions with passive nets
- Ineffective with trawls
- But concern for habituation after 3 years





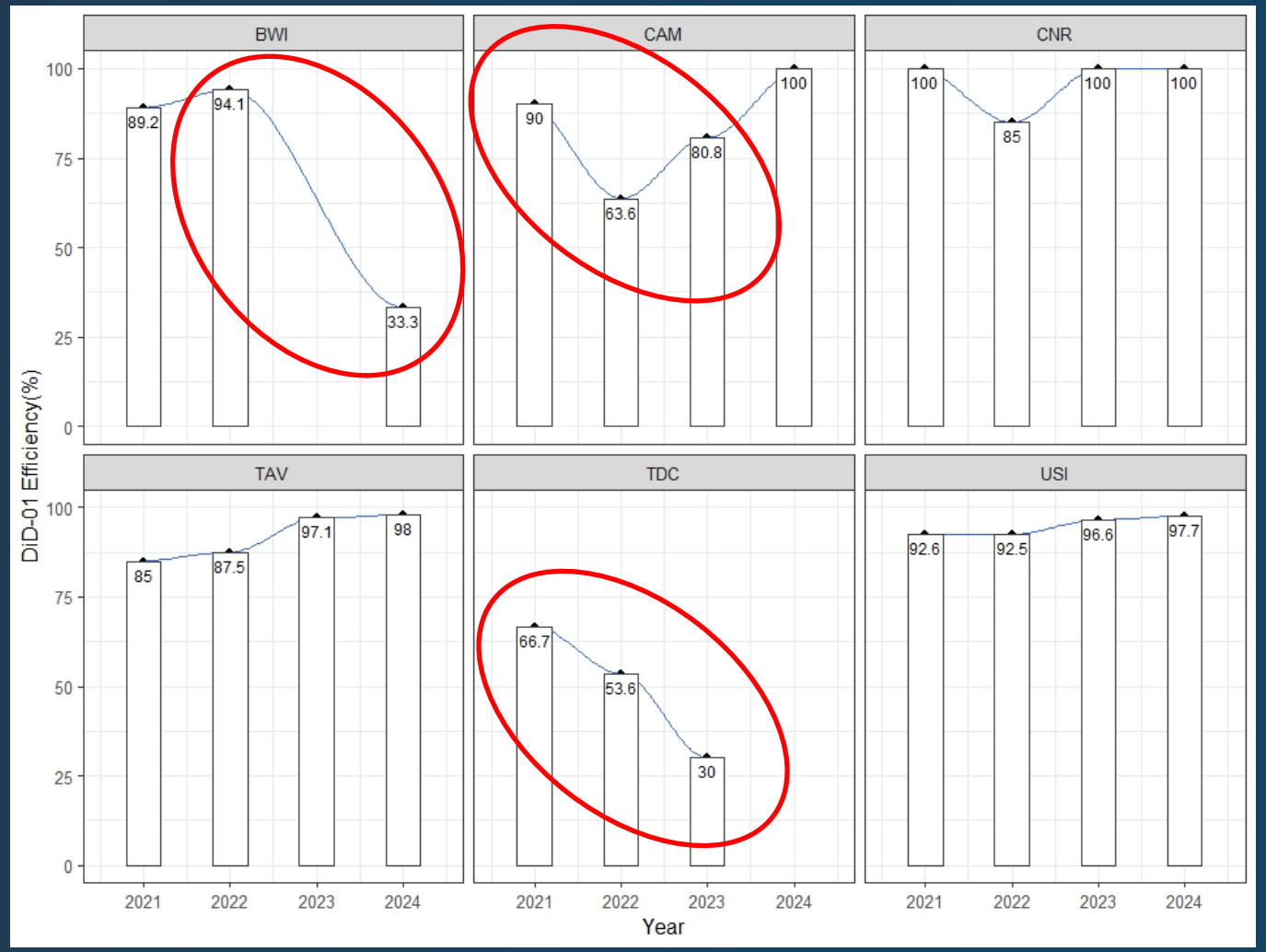




Main question

Are the pingers available on the market really "Interactive"?

Percentage of hauls with pingers where no interaction was recorded



Our dream

- *Record sounds*
- *Process the recordings*
- *Identify the presence of dolphins*
- *Activate a deterrent response*

Our Problem

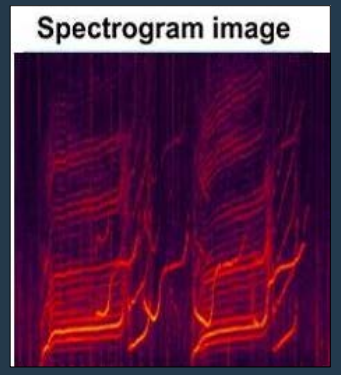
How to do this

LOWERING FISHING INTERACTIONS

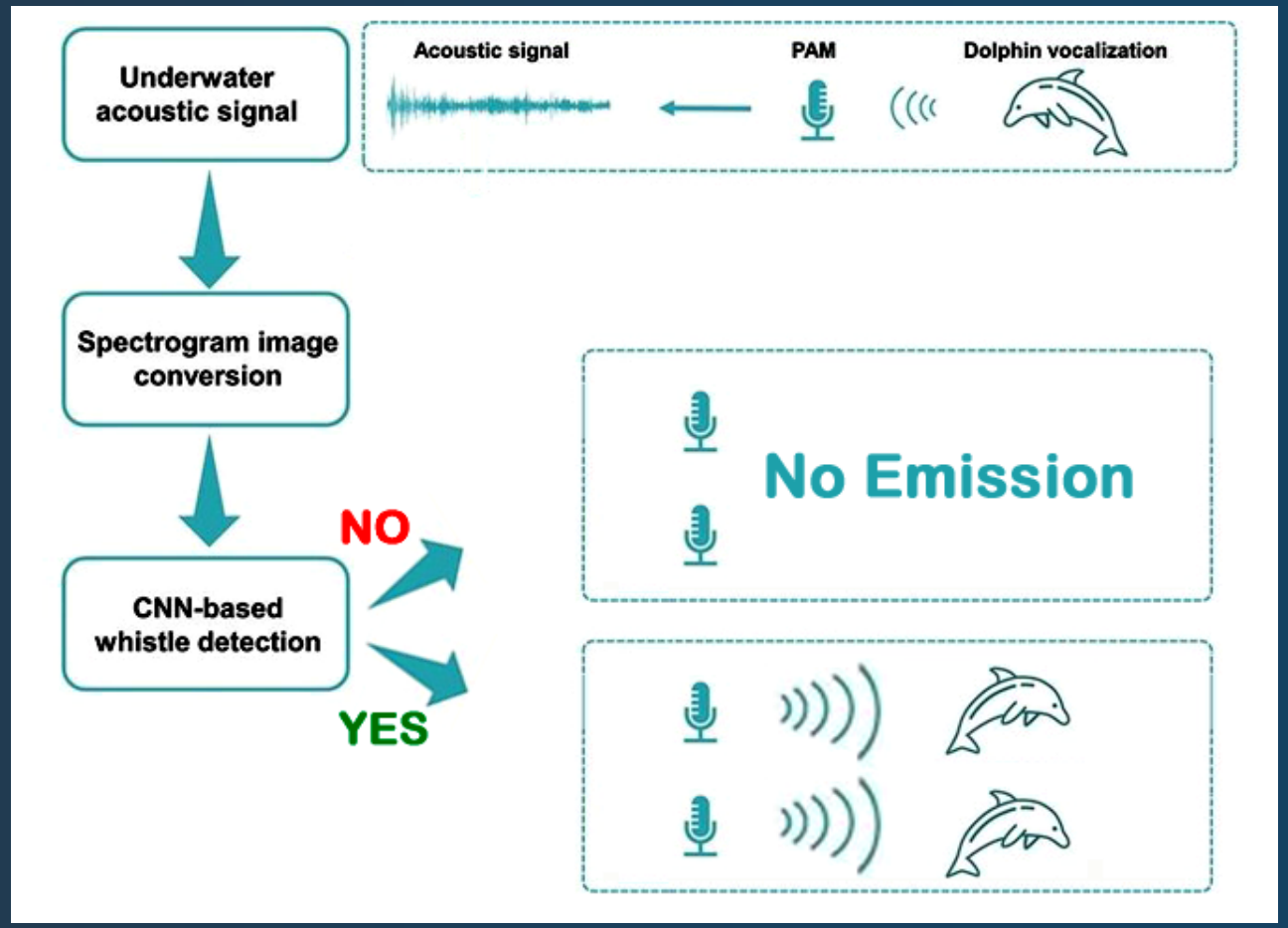
life DELFI

NATIONAL BIODIVERSITY FUTURE CENTER

Rationale of AI-based pinger



Spectrogram processing



LOWERING FISHING INTERACTIONS
life DELFI
NATIONAL BIODIVERSITY FUTURE CENTER

How to do this?

Recording unit

AI based Dolphin detection

Acoustic Emission or other output

Challenge

Technology

AI Algorithm

Reduce dimensions

Reduce Costs (<500 euros)

LOWERING FISHING INTERACTIONS

life DELFI

NATIONAL BIODIVERSITY FUTURE CENTER

1 - Passive acoustics

A dataset of acoustic recordings (WAV files) collected during interactions between common bottlenose dolphins (*Tursiops truncatus*) and fishing activities in the Adriatic Sea.

NATIONAL BIODIVERSITY FUTURE CENTER

Need for OPEN DATA on acoustic records for different species!!!

www.nature.com/scientificdata

scientific data

Check for updates

OPEN

DATA DESCRIPTOR

A WAV file dataset of bottlenose dolphin whistles, clicks, and pulse sounds during trawling interactions

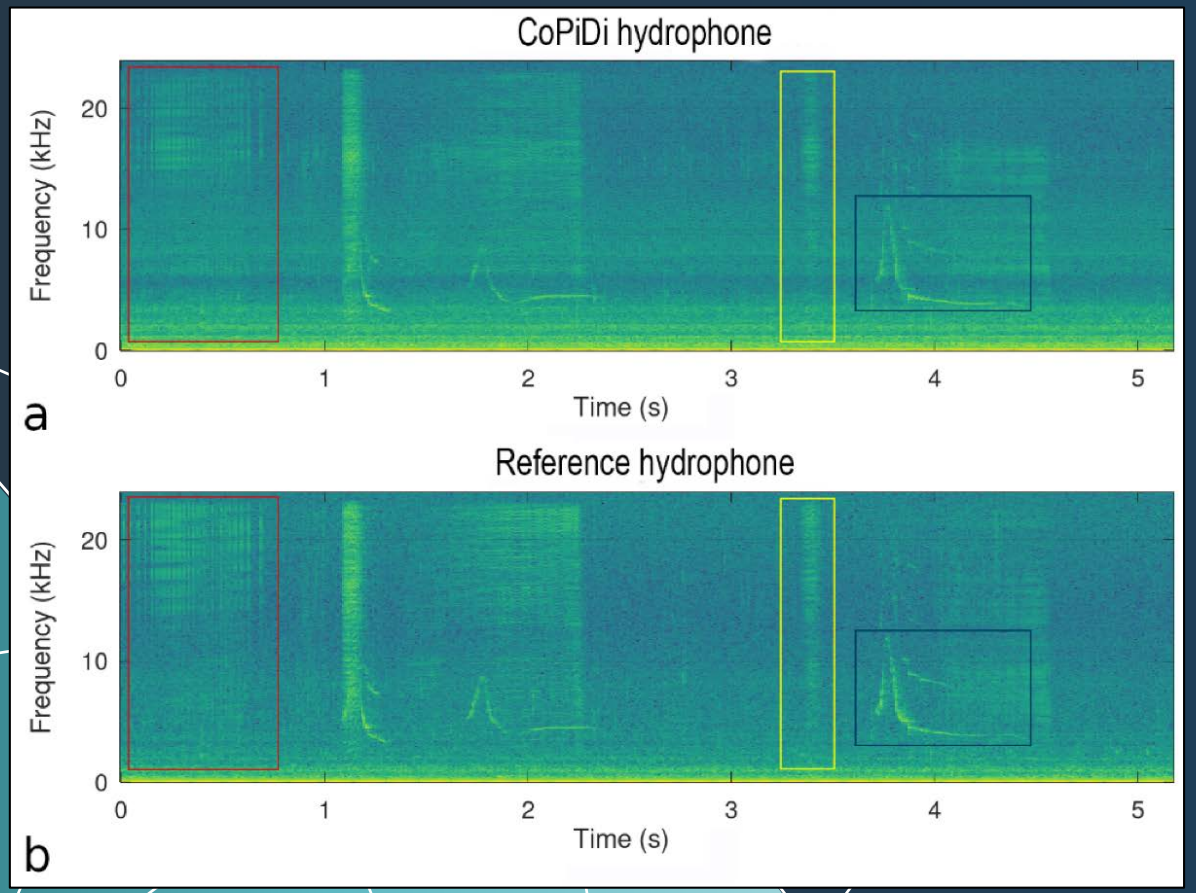
Francesco Di Nardo[1✉], Rocco De Marco[2✉], Alessandro Lucchetti[2,3] & David Scaradozzi[1✉]

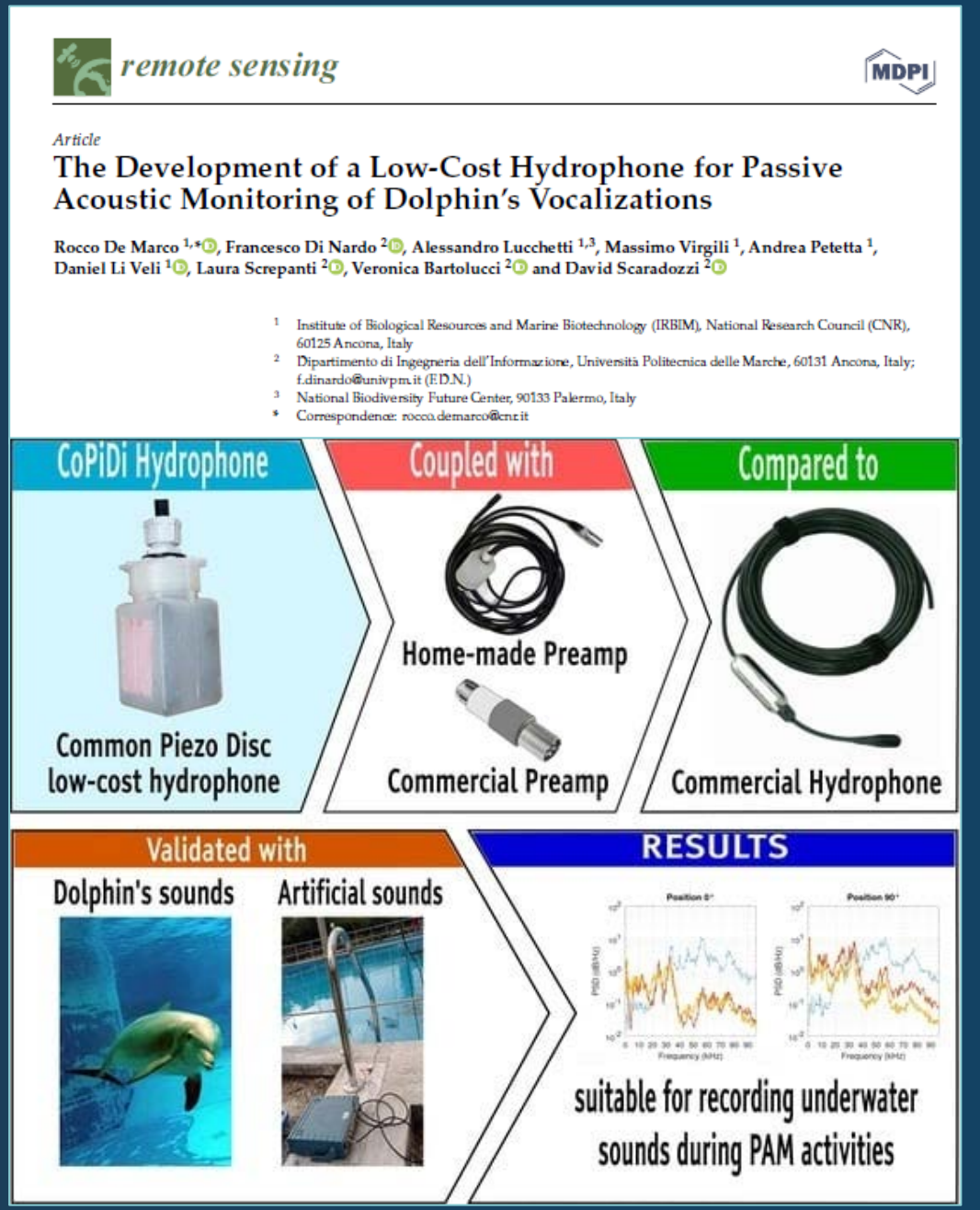
Globally, interactions between fishing activities and dolphins are cause for concern due to their negative effects on both mammals and fishermen. The recording of acoustic emissions could aid in detecting the presence of dolphins in close proximity to fishing gear, elucidating their behavior, and guiding potential management measures designed to limit this harmful phenomenon. This data descriptor presents a dataset of acoustic recordings (WAV files) collected during interactions between common bottlenose dolphins (*Tursiops truncatus*) and fishing activities in the Adriatic Sea. This dataset is distinguished by the high complexity of its repertoire, which includes various different typologies of dolphin emission. Specifically, a group of free-ranging dolphins was found to emit frequency-modulated whistles, echolocation clicks, and burst pulse signals, including feeding buzzes. An analysis of signal quality based on the signal-to-noise ratio was conducted to validate the dataset. The signal digital files and corresponding features make this dataset suitable for studying dolphin behavior in order to gain a deeper understanding of their communication and interaction with fishing gear (trawl).

2 - Low-cost hydrophone

De Marco et al., 2023

The validation revealed that the significant cost savings associated with cheap technology (€10.00) minimally affected the recording device's performance in the frequency range of 0–35 kHz.





2 - Low-cost hydrophone

De Marco et al., 2023

remote sensing

MDPI

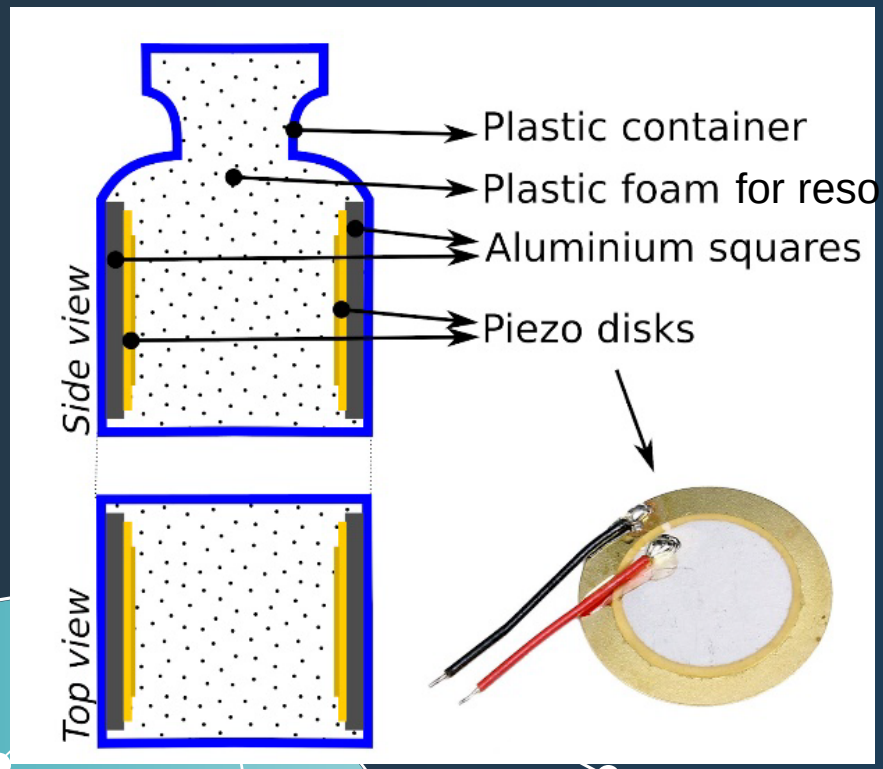
Article

The Development of a Low-Cost Hydrophone for Passive Acoustic Monitoring of Dolphin's Vocalizations

Rocco De Marco [1,*], Francesco Di Nardo [2], Alessandro Lucchetti [1,3], Massimo Virgili [1], Andrea Petetta [1], Daniel Li Veli [1], Laura Screpanti [2], Veronica Bartolucci [2] and David Scaradozzi [2]

1 Institute of Biological Resources and Marine Biotechnology (IRBIM), National Research Council (CNR), 60125 Ancona, Italy
2 Dipartimento di Ingegneria dell'Informazione, Università Politecnica delle Marche, 60131 Ancona, Italy; f.dinardo@univpm.it (F.D.N.)
3 National Biodiversity Future Center, 90133 Palermo, Italy
* Correspondence: rocco.demarco@cnr.it

The validation revealed that the significant cost savings associated with cheap technology (€10.00) minimally affected the recording device's performance in the frequency range of 0–35 kHz.

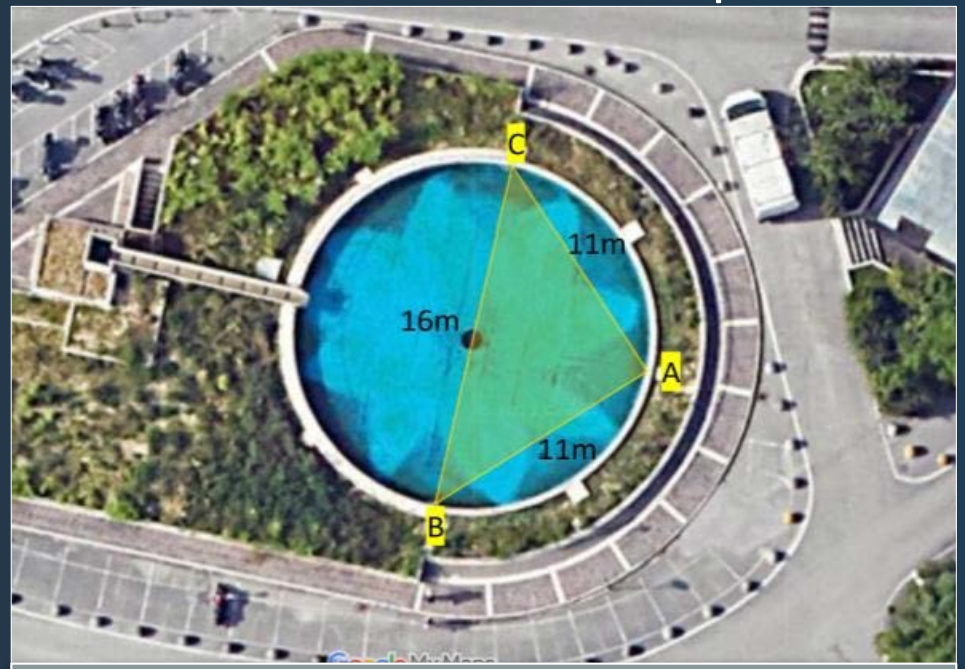


37 x 37 x 67 mm

Cost = 10-20 €

3 – Algorithm for dolphin detection

Tests and validations took place in different operational environments:



UNIVPM faculty pool (Ancona, Italy)

Oltremare (Riccione, Italy)

- The LABMACS aquarium was employed to assess the functionality of individual components
- The UNIVPM faculty pool served as a testing ground for the final version of the prototype
- At the 'Oltremare', the recording system underwent testing in presence of dolphins.

LOWERING FISHING INTERACTIONS
life DELFI
NATIONAL BIODIVERSITY FUTURE CENTER

3 – Algorithm for dolphin detection

Tests and validations took place in different operational environments:

LOWERING FISHING INTERACTIONS
life DELFI

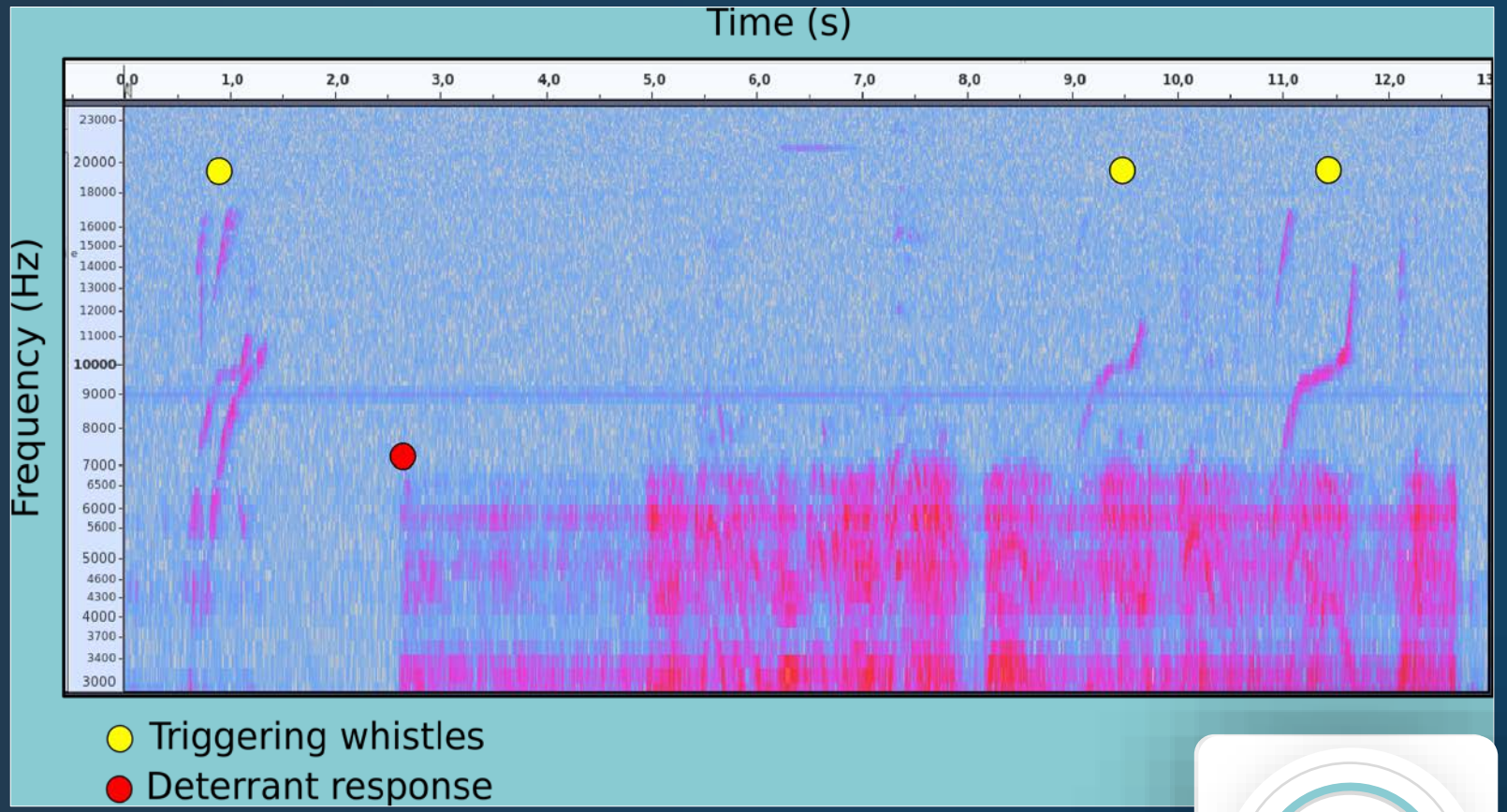
NATIONAL BIODIVERSITY FUTURE CENTER

3 – Algorithm for dolphin detection

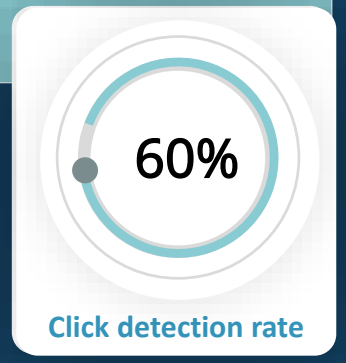
Test cases

1. Watertightness tests
2. Operating Temperature Test
3. Electronic Stability
4. Battery Endurance
5. Dolphin detection test
6. Sound reproduction test to ward off dolphins.
7. Testing of CNN neural network execution on hardware
8. Checking the volume of data processed and then stored.

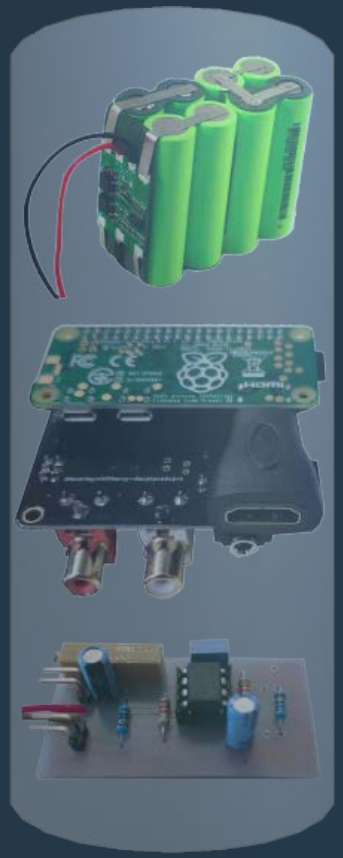
Validation of the vocalization detection



- As soon as a dolphin whistle has been recognized, a deterrent sound is emitted by the AI pinger
- Emission sound can vary (up to 96kHz frequency)



4 – First prototype



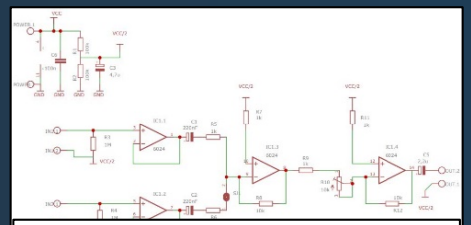
PSU
10000mAh
power bank

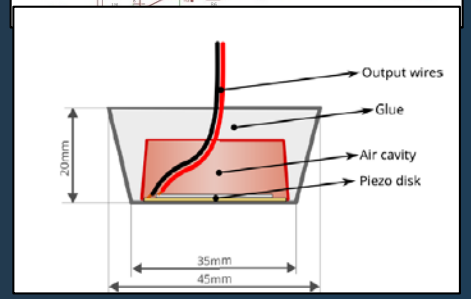
15 €

COMPUTING UNIT
Rasperry P0 v2

80 €

PREAMPLIFIER
60dB gain

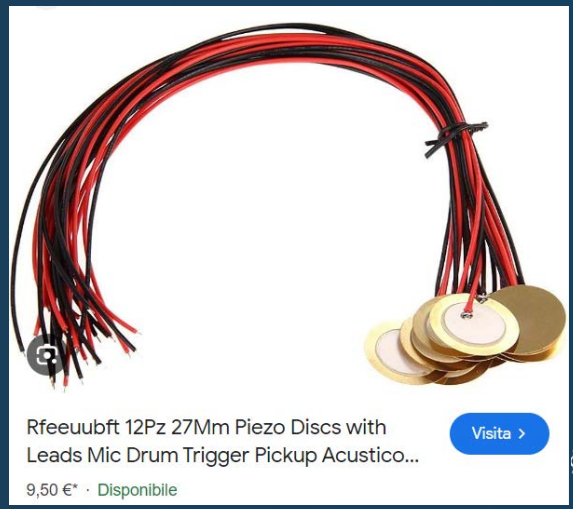




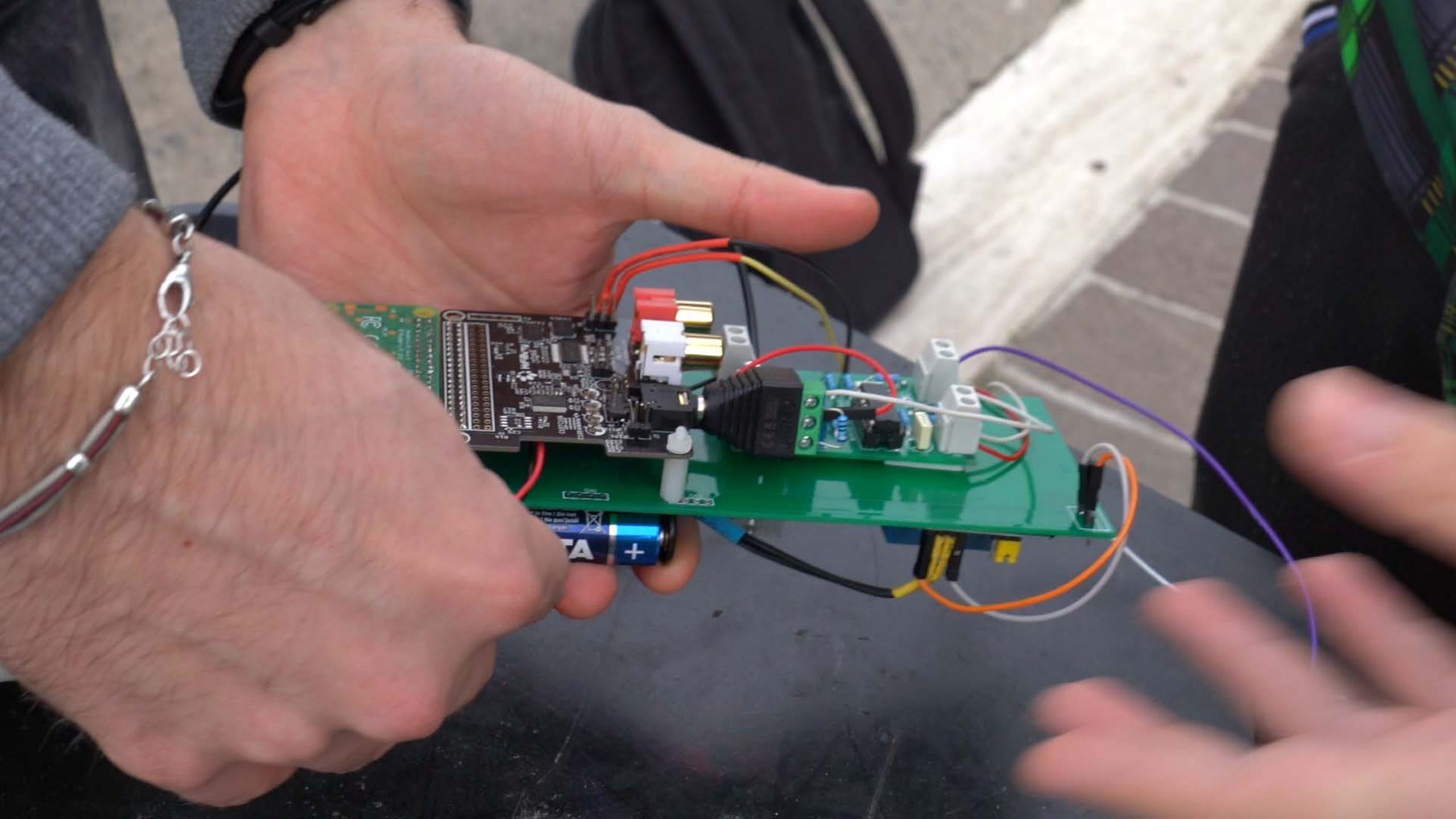
HYDROPHONE
/
TRANSDUCER

20 €

The total material cost of the device was < 150 €

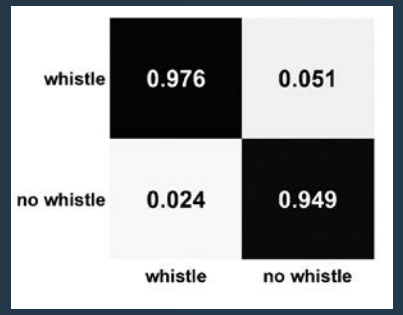


LOWERING FISHING INTERACTIONS
life DELFI
NATIONAL BIODIVERSITY FUTURE CENTER

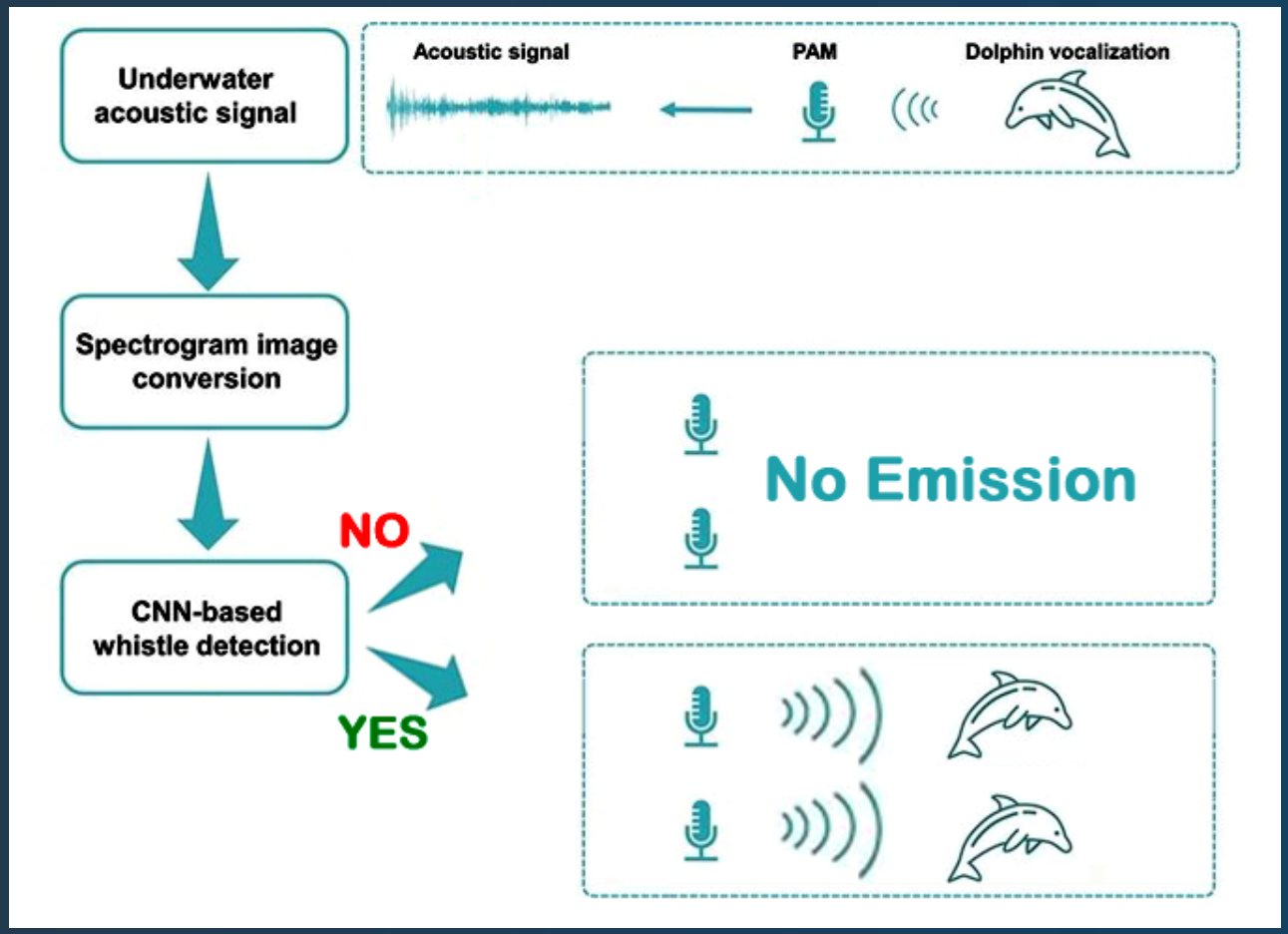


5 – Advanced prototype

Confusion Matrix



Fold	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
1	99.0	98.6	99.3	99.0
2	99.9	99.9	100.0	99.9
3	99.8	99.8	99.8	99.8
4	99.9	99.8	100.0	99.9
5	99.8	99.6	100.0	99.8
6	100.0	100.0	100.0	100.0
7	100.0	100.0	100.0	100.0
8	99.5	100.0	99.0	99.5
9	99.8	99.7	100.0	99.8
10	100.0	100.0	100.0	100.0



5 – Advanced prototype

- **Recording**: At least 200 m
- **Emission** : at least 600 m
- **Costs** < 500 €

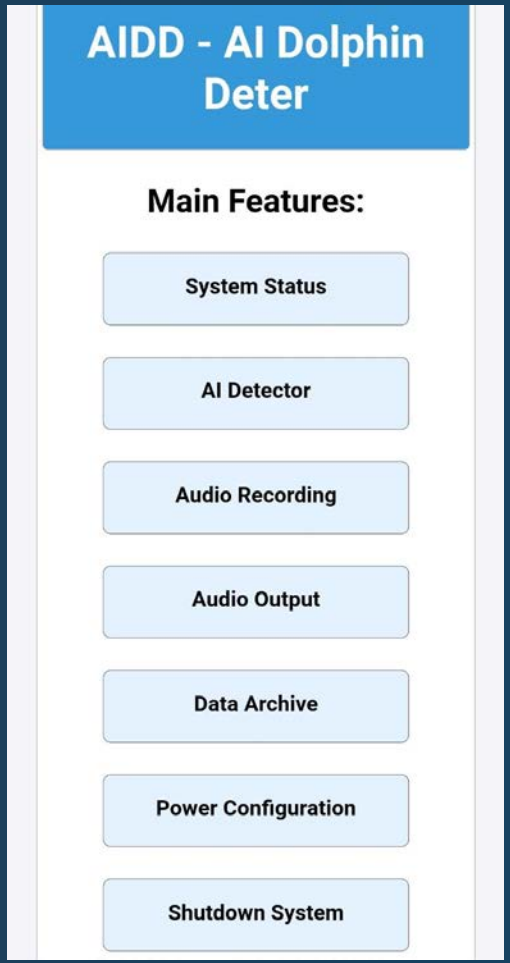
First prototype

5 – Advanced prototype

Technical specifications

Diving Depth	40 m
Operating Range	600 m
Recording Frequency Band	1 Hz – 192 kHz
Emission Frequency Band	1 Hz – 192 kHz
Recording Pattern	Wide-angle, 180 degrees
Emission Pattern	Wide-angle, 180 degrees
CONNECTIVITY	
Wi-Fi Wi-Fi	Device management via web interface
USB-C Port	Device charging
Magnetic Switch	Power on/off using a magnet
POWER SUPPLY	
Battery Pack	3.7V LiPo 20Ah (74Wh)
Battery duration	80 – 40 hours

App interface



LOWERING FISHING INTERACTIONS
life DELFI
NATIONAL BIODIVERSITY FUTURE CENTER

5 – Advanced prototype: pros

- **Reducing acoustic pollution**
- **Reducing possibility of habituation**
- **Increasing battery duration**

5 – Advanced prototype

Flexible and modular

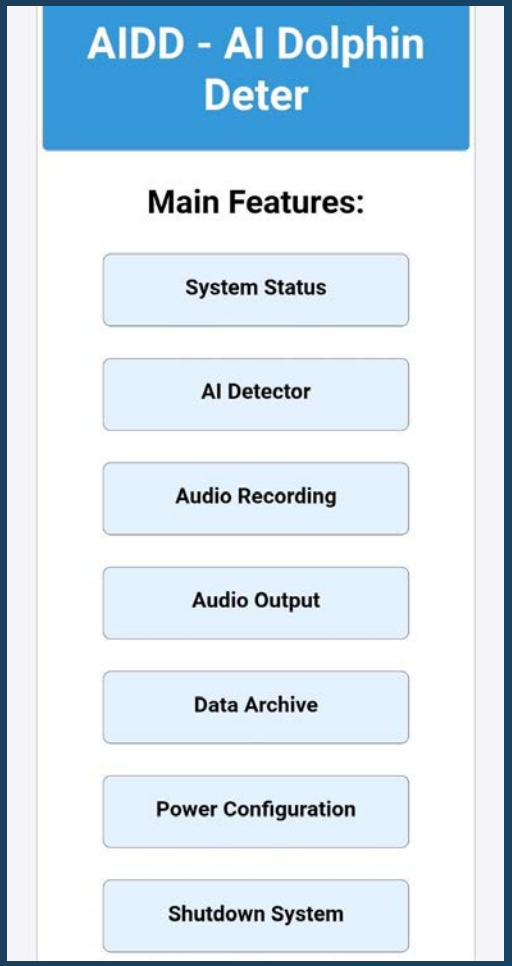
- Can be used as simple recorder (increasing battery duration)
- Different types of emission
- Different output (i.e. alarm)
- Different species

6 – Next step

Identify the best output signal

The device is able to record and thus it enable to study the reactions

App interface



Alessandro Lucchetti

alessandro.lucchetti@irbim.cnr.it

CNR-IRBIM Ancona, Italy

THANKS FOR THE ATTENTION