



**REINFORCE**  
REsearch INfrastructures FOR Citizens in Europe

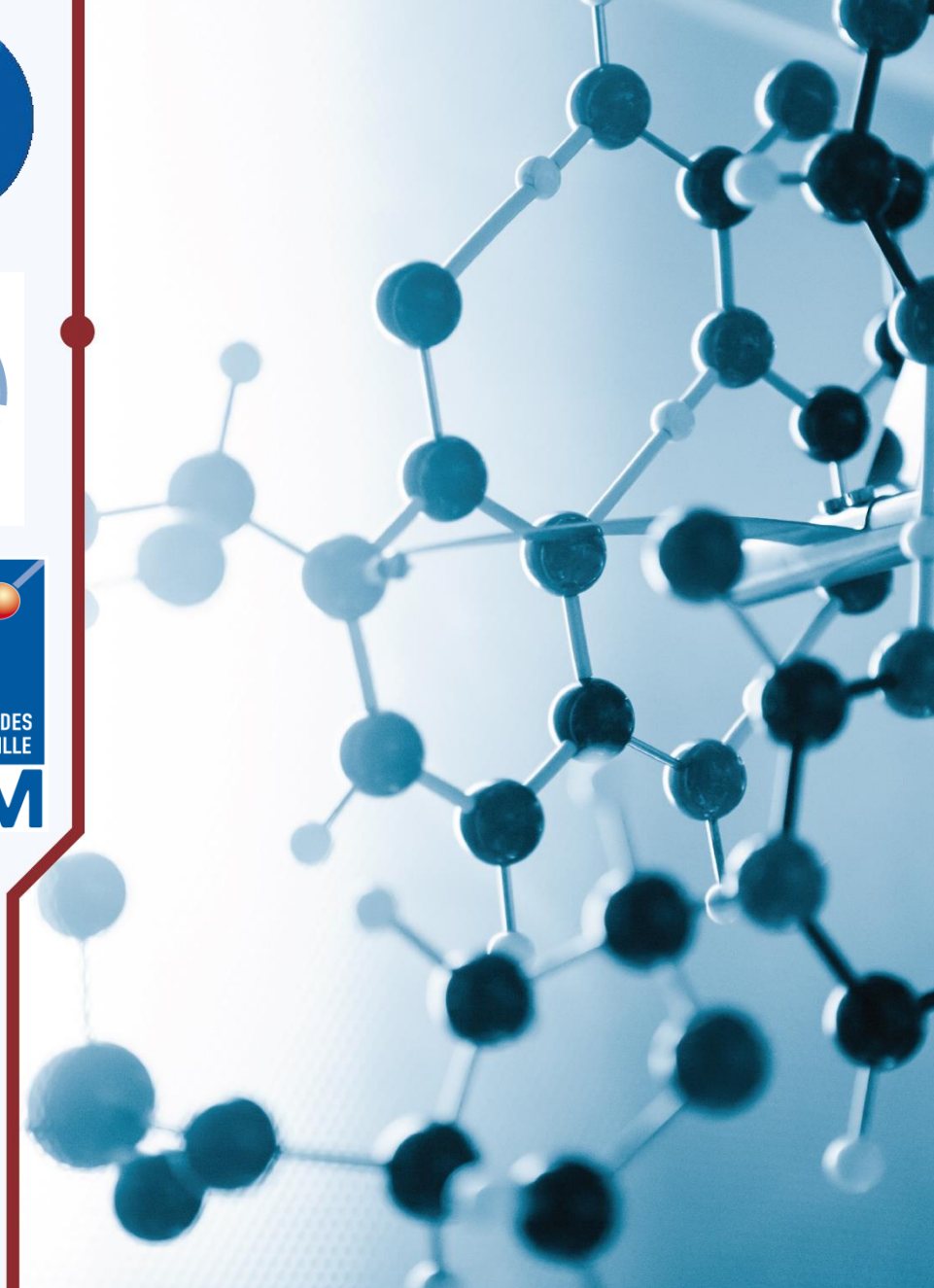


## WP4: Deep Sea Hunters

**Paschal Coyle, CPPM**

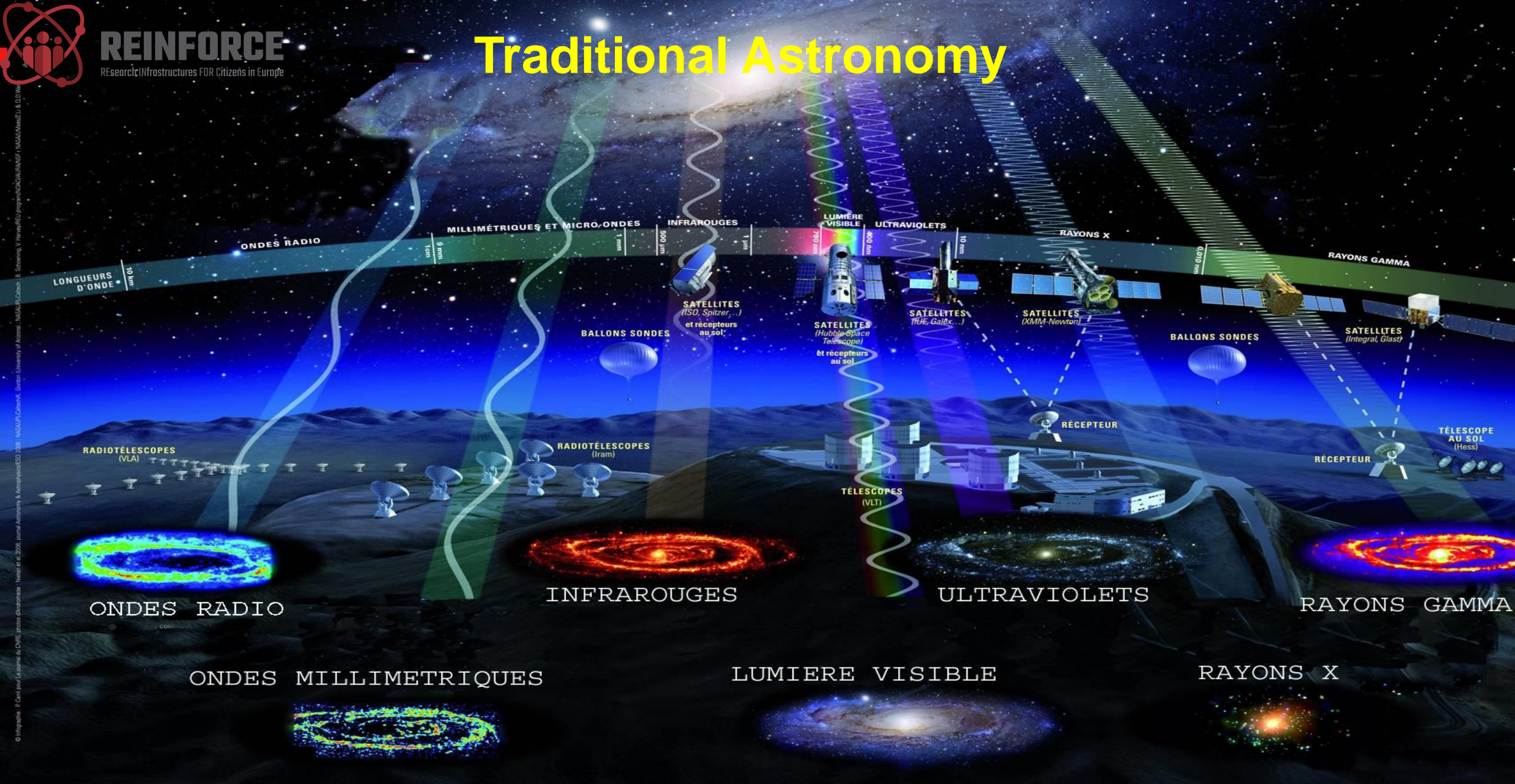
WEBINAR

June 1, 2020, 11:00 AM CEST



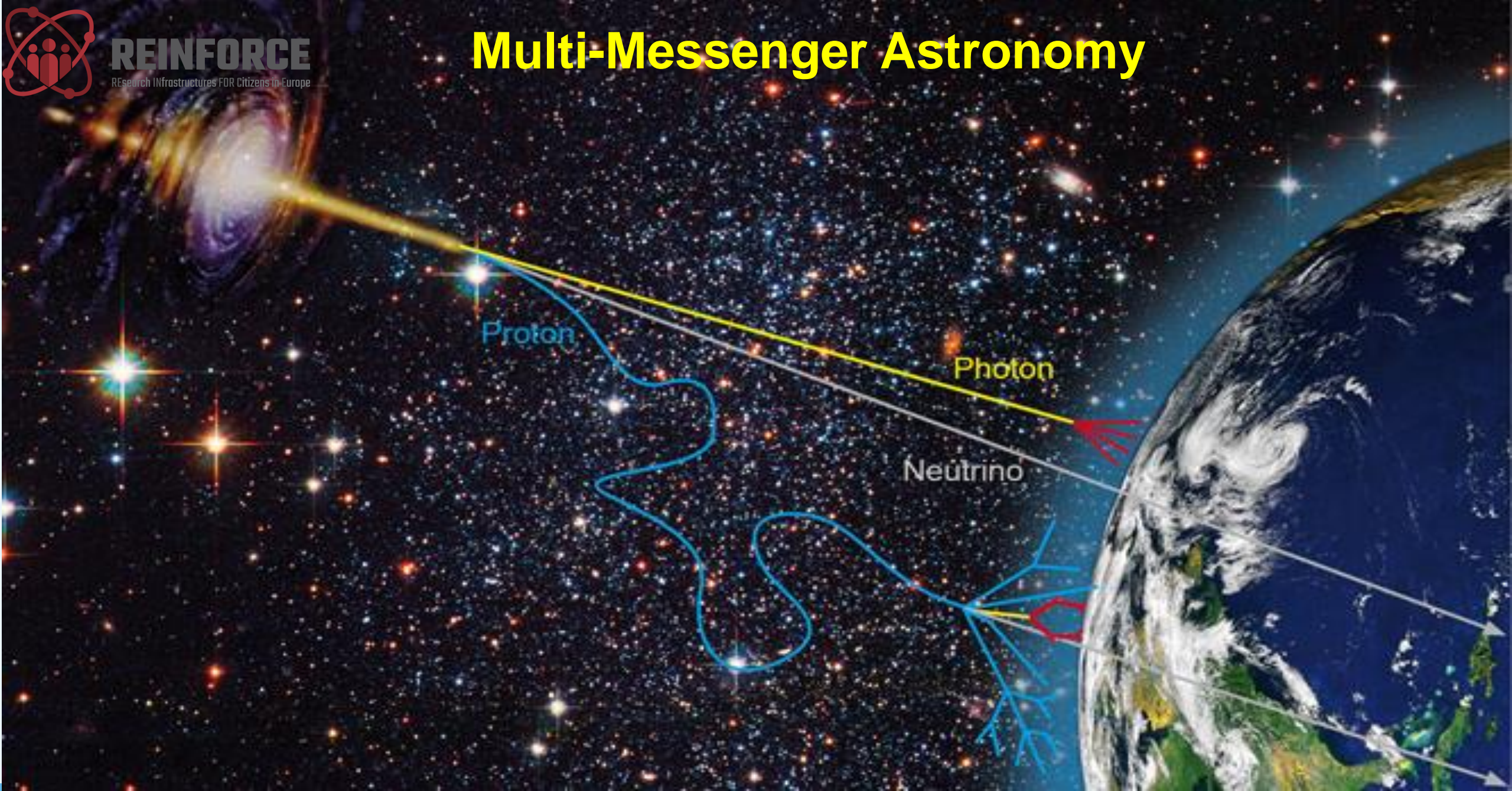


# Traditional Astronomy



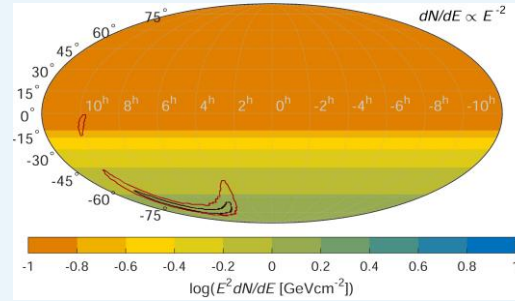


# Multi-Messenger Astronomy



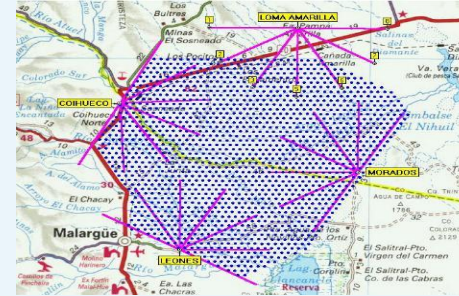
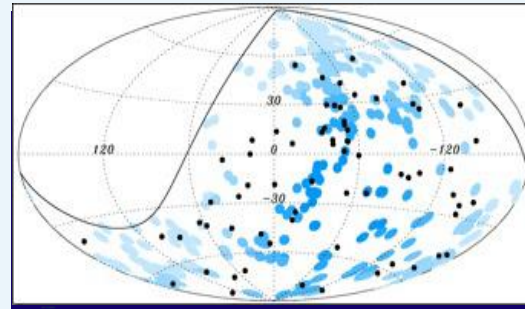
# Multi-Messenger Astronomy II

Gravitational  
Waves



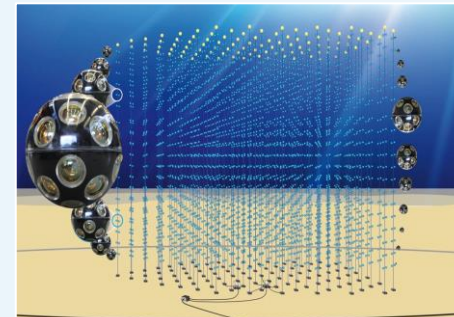
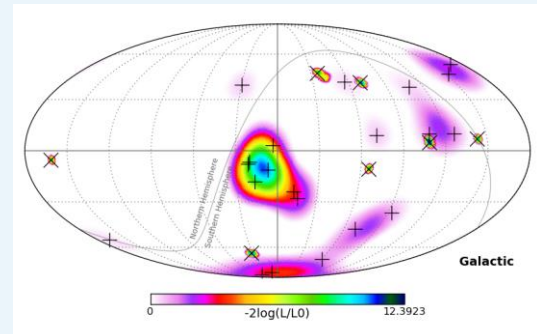
VIRGO,  
LIGO

Protons



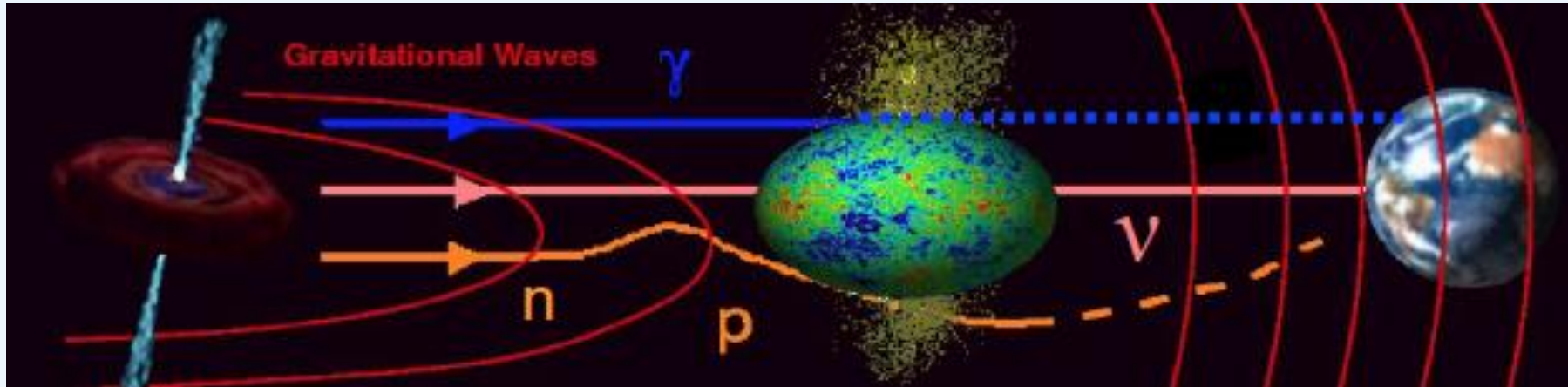
AUGER,  
EUSO

Neutrinos



ANTARES,  
ICECUBE  
KM3NeT

# Neutrinos: cosmic messengers



## Neutrinos: neutral, stable, weakly interacting

- not absorbed by background light/CMB
- not absorbed by matter
- not deviated by magnetic fields
- ⑨ access to cosmological distances
- ⑨ access to dense environments
- ⑨ astronomy over full energy range

‘Smoking gun’ signature for hadronic processes

Correlated in time/direction with electromagnetic and gravitational waves

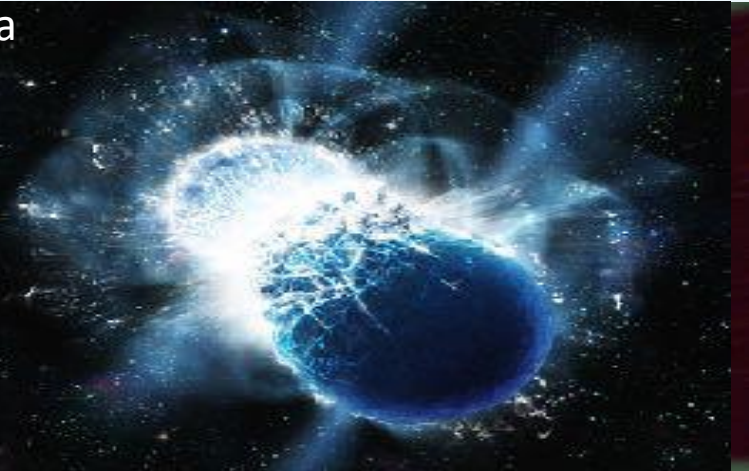
New window of observation on the Universe

# Neutrino Sources?

Supernova Remnants



Kilonova



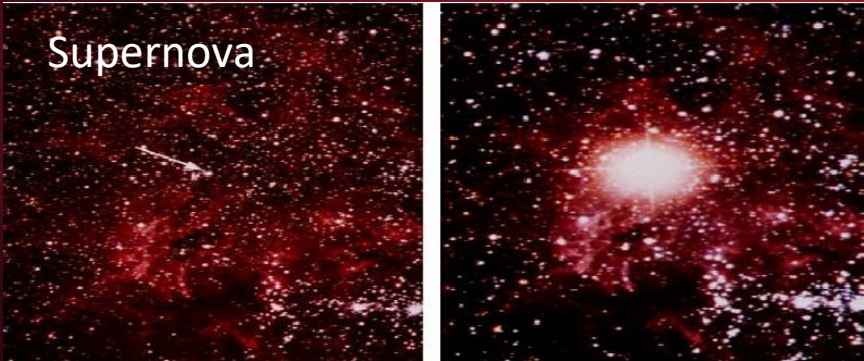
Blazars



Gamma ray bursts



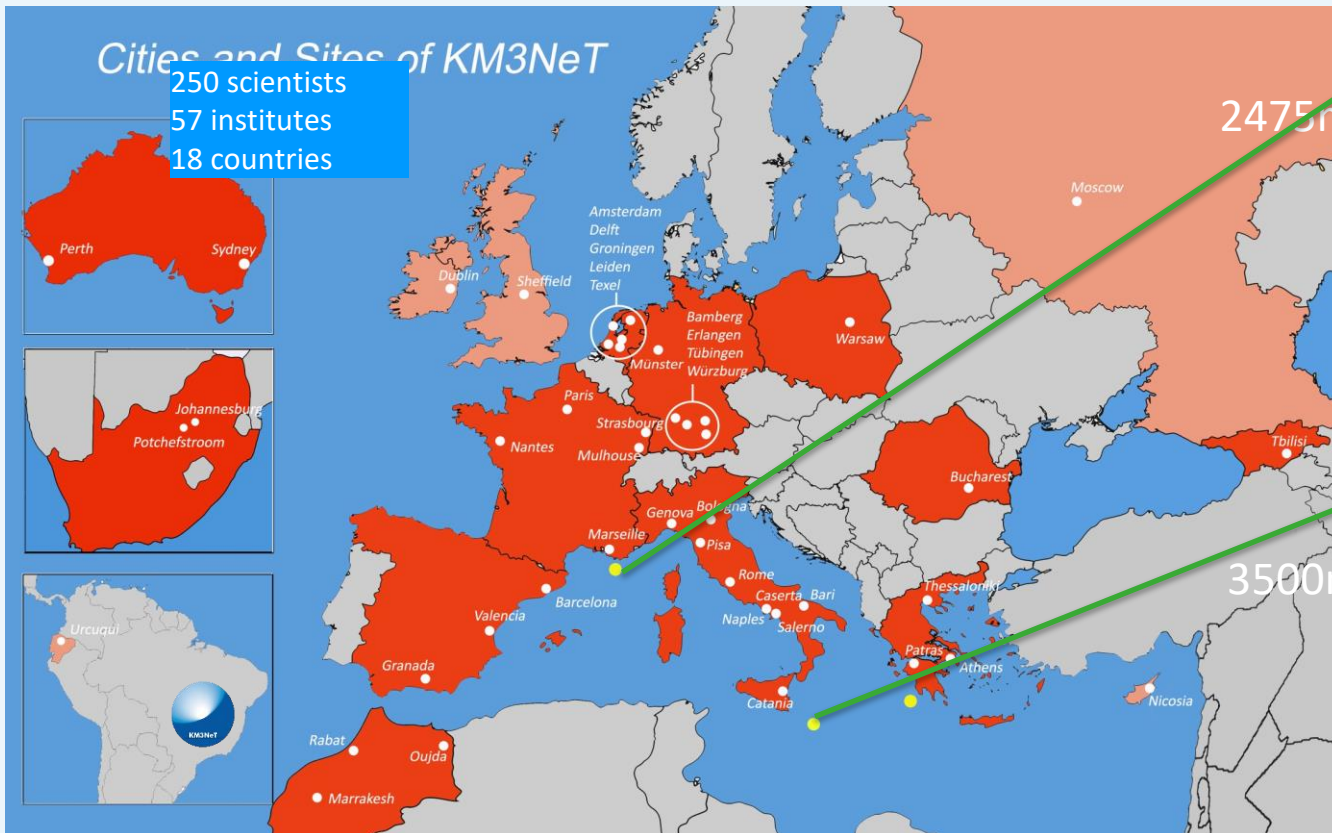
Supernova



Dark matter



Multi-site, deep-sea infrastructure  
 Selected by ESFRI roadmap  
 Single collaboration, Single technology



Oscillation Research  
with Cosmics In the Abyss



Astroparticle Research  
with Cosmics In the Abyss

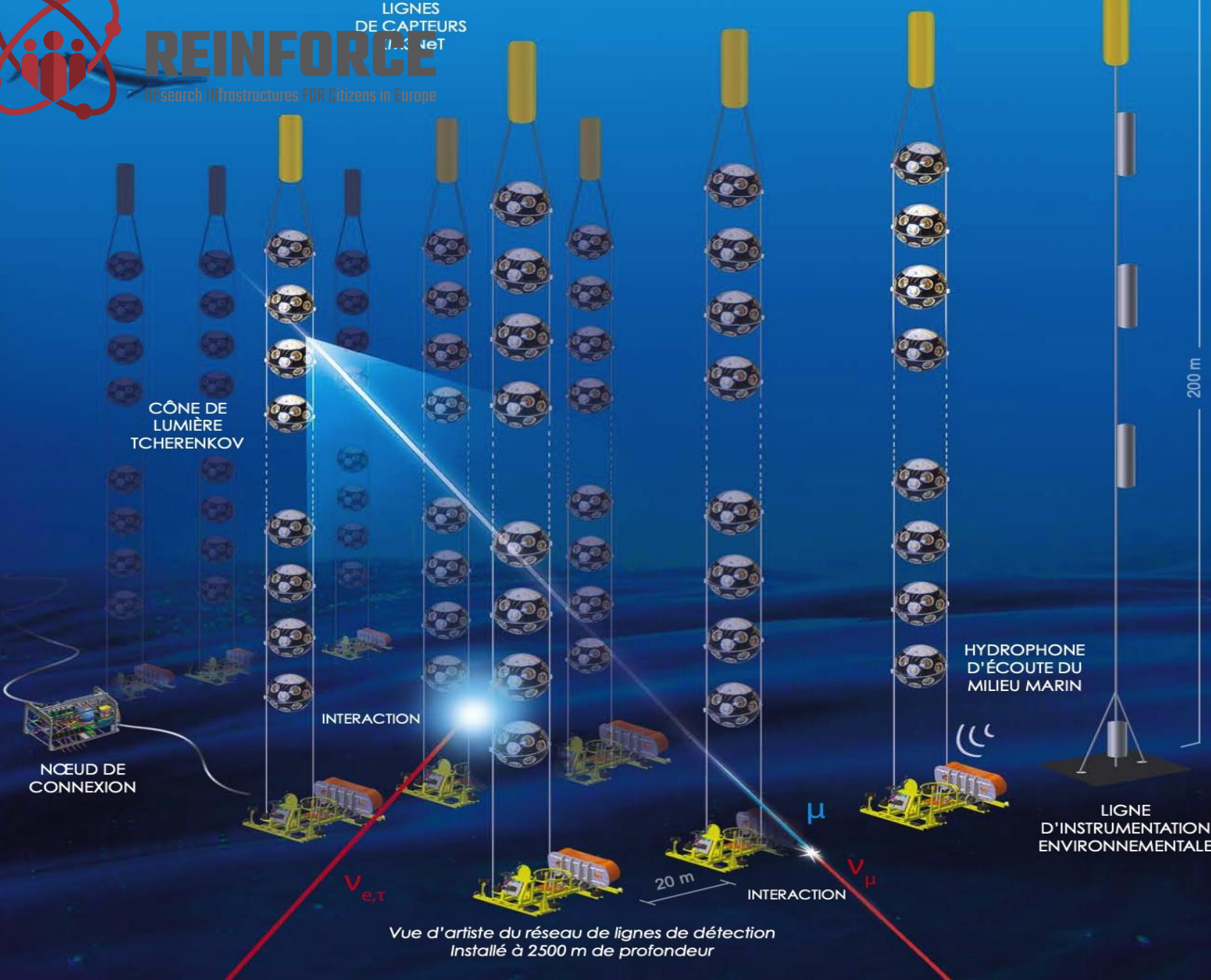


# REINFORCE

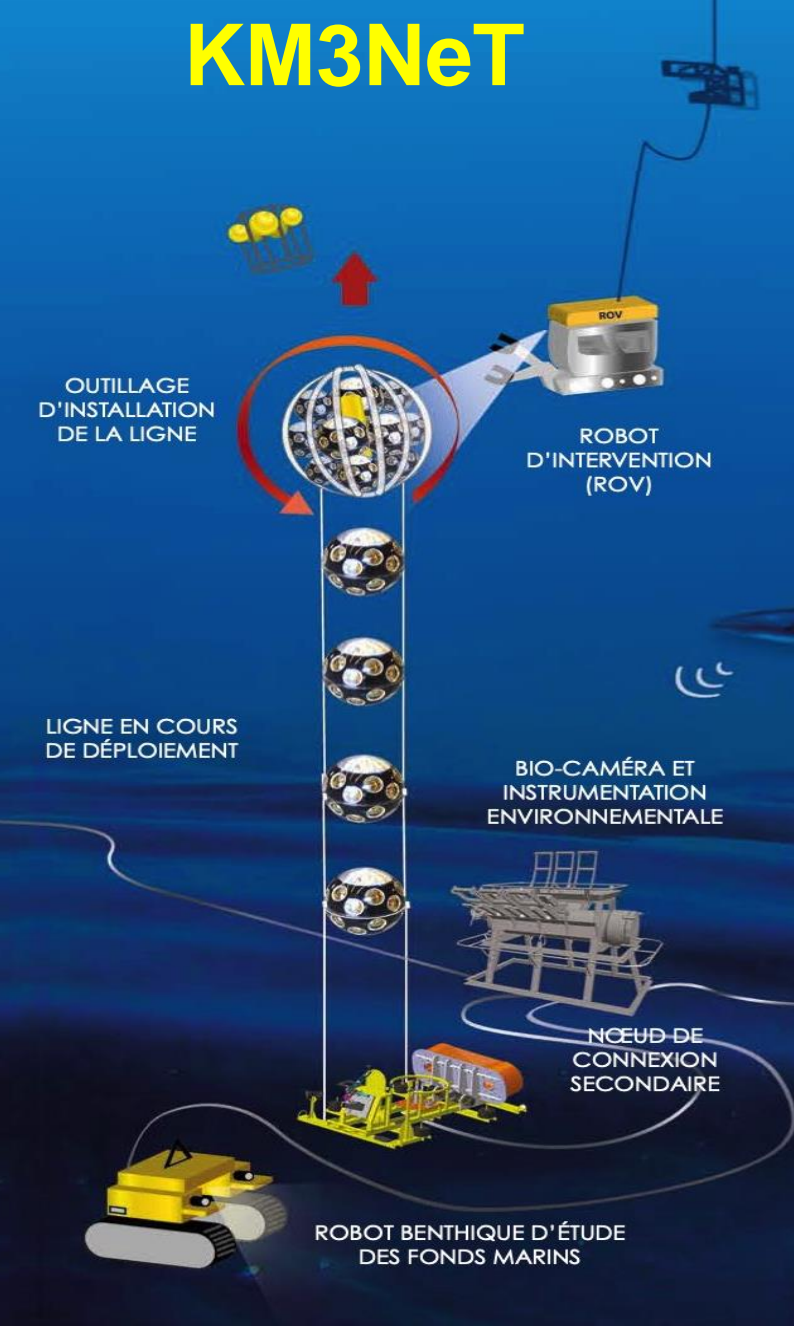
Research Infrastructures FOR Citizens in Europe

LIGNES DE CAPTEURS J.3.3eT

# KM3NeT



Vue d'artiste du réseau de lignes de détection Installé à 2500 m de profondeur

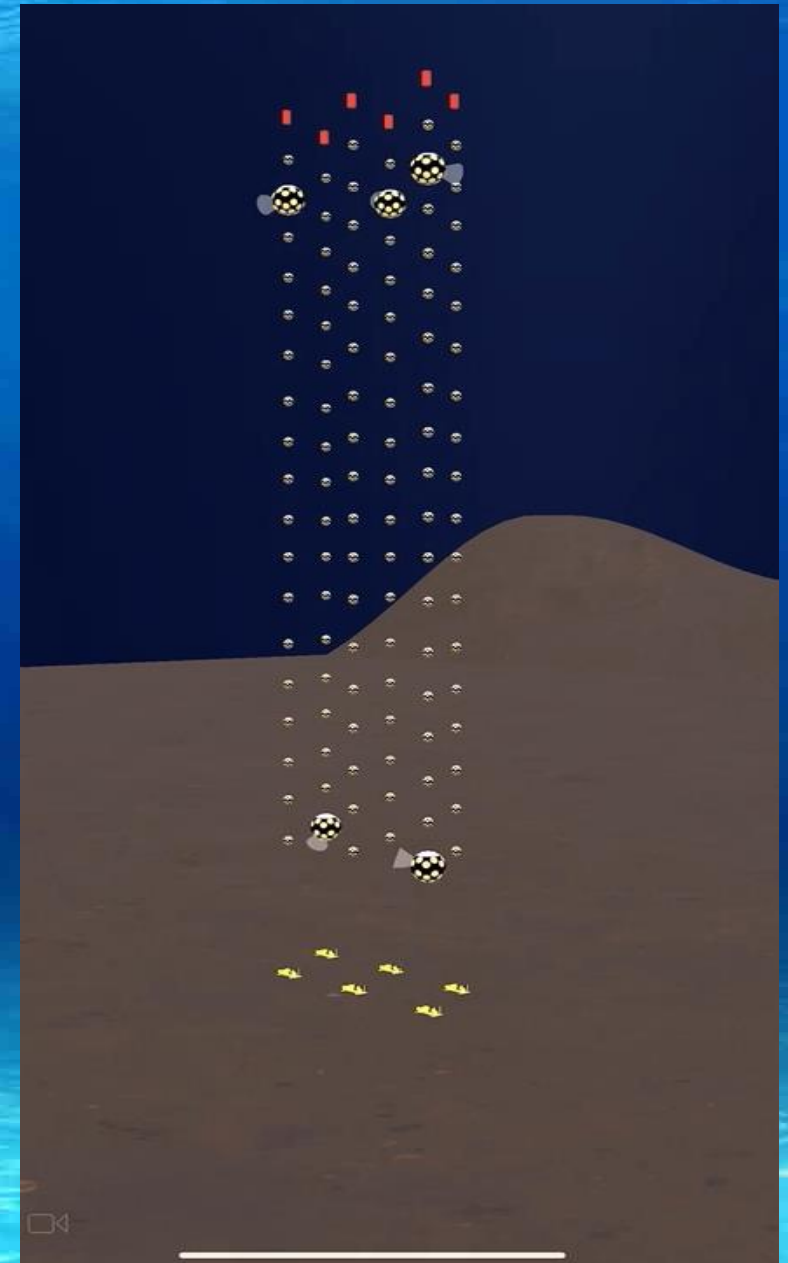






[A video of telescope deployment here:](#)

<https://youtu.be/dMjN93H7Nvo>



# Deep Sea Hunters

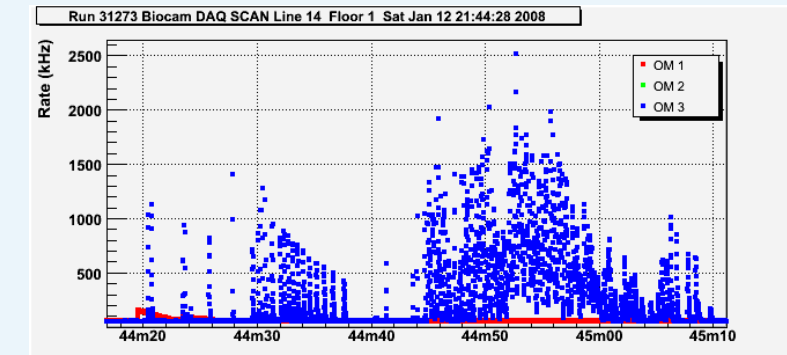
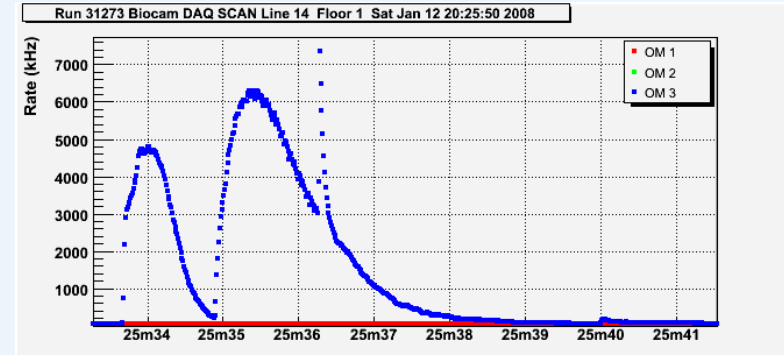
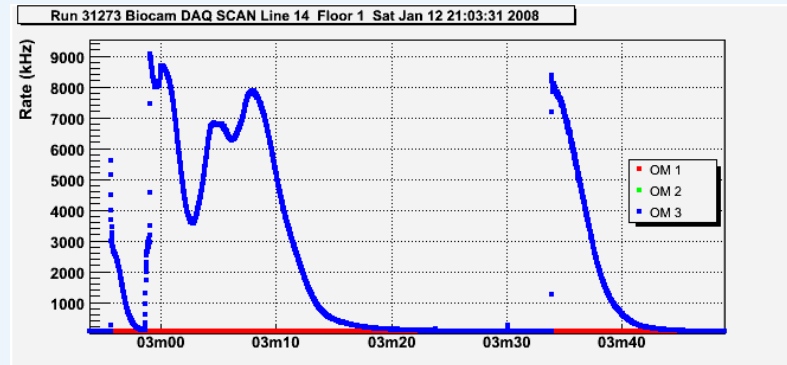
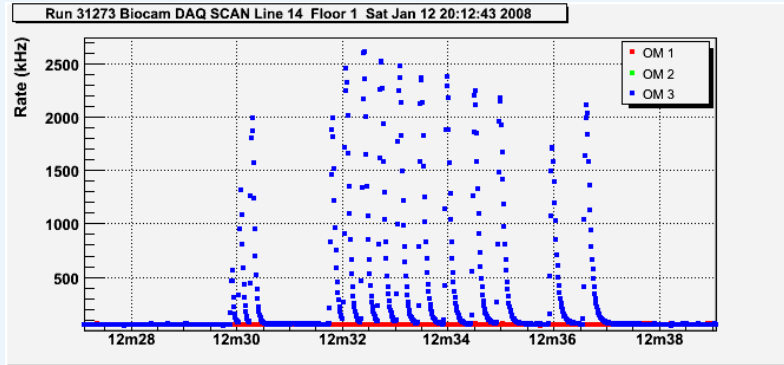
Bioluminescent organisms:  
Optical Signals



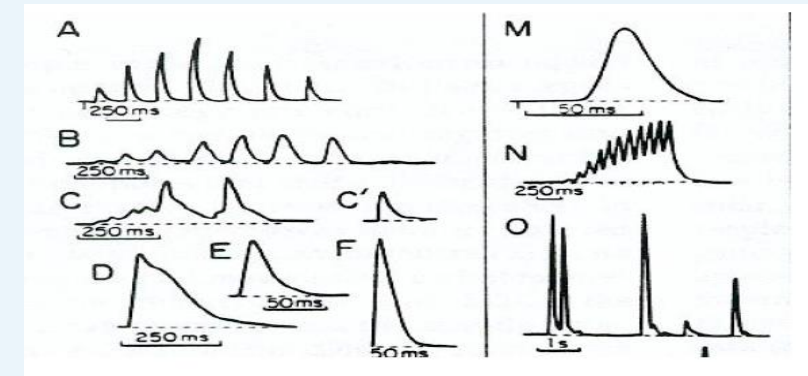
Ceteceans:  
Acoustic Signals



# Example Optical signals

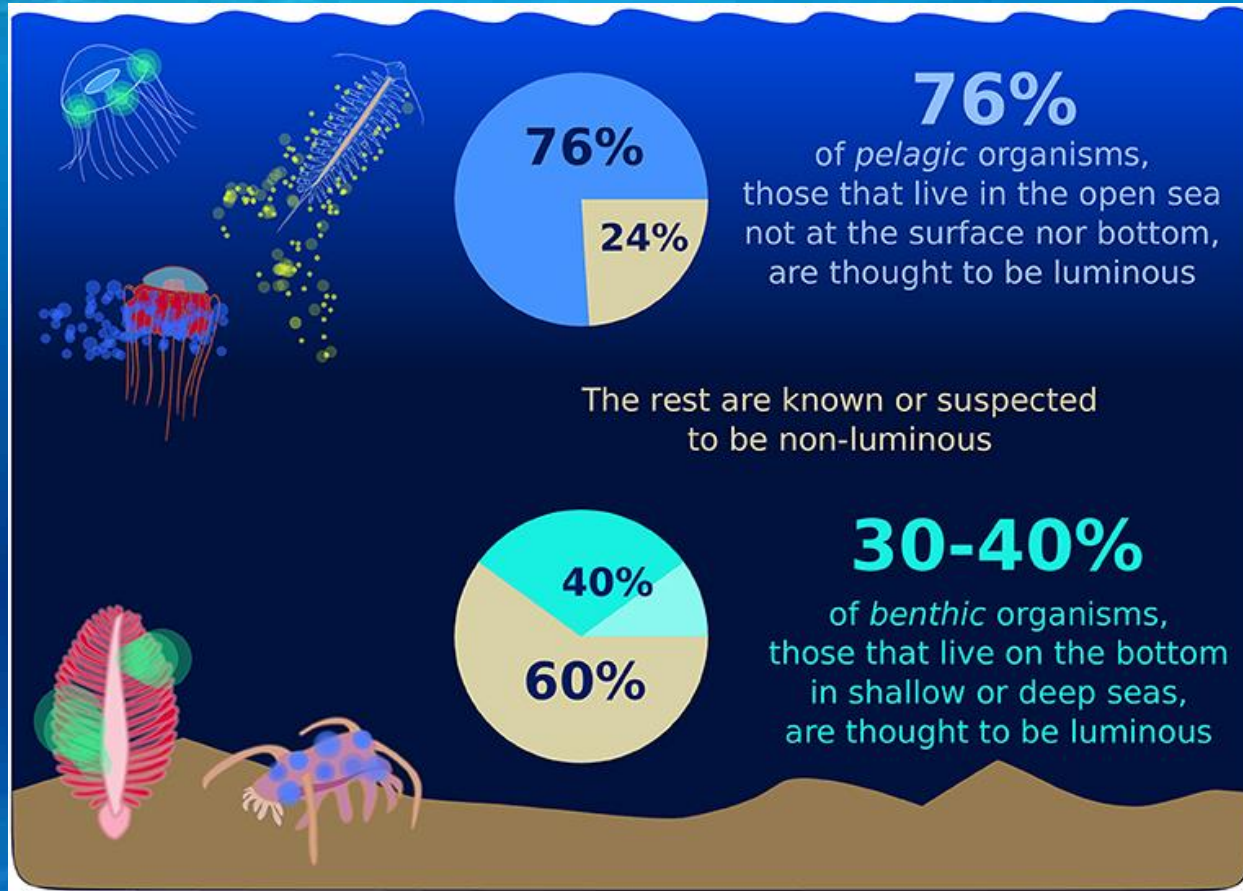


versus literature





# Bioluminescence



**A) Luminous lure**  
The anglerfish has a lure full of symbiotic, glowing bacteria. Small prey approach the lure, and get eaten.

**B) Smoke screen**  
This copepod makes a cloud of blue light to blind a predator while it escapes.

**C) Counter-illumination**  
The fish creates light on its belly. This way, its outline is not seen by a predator from below.

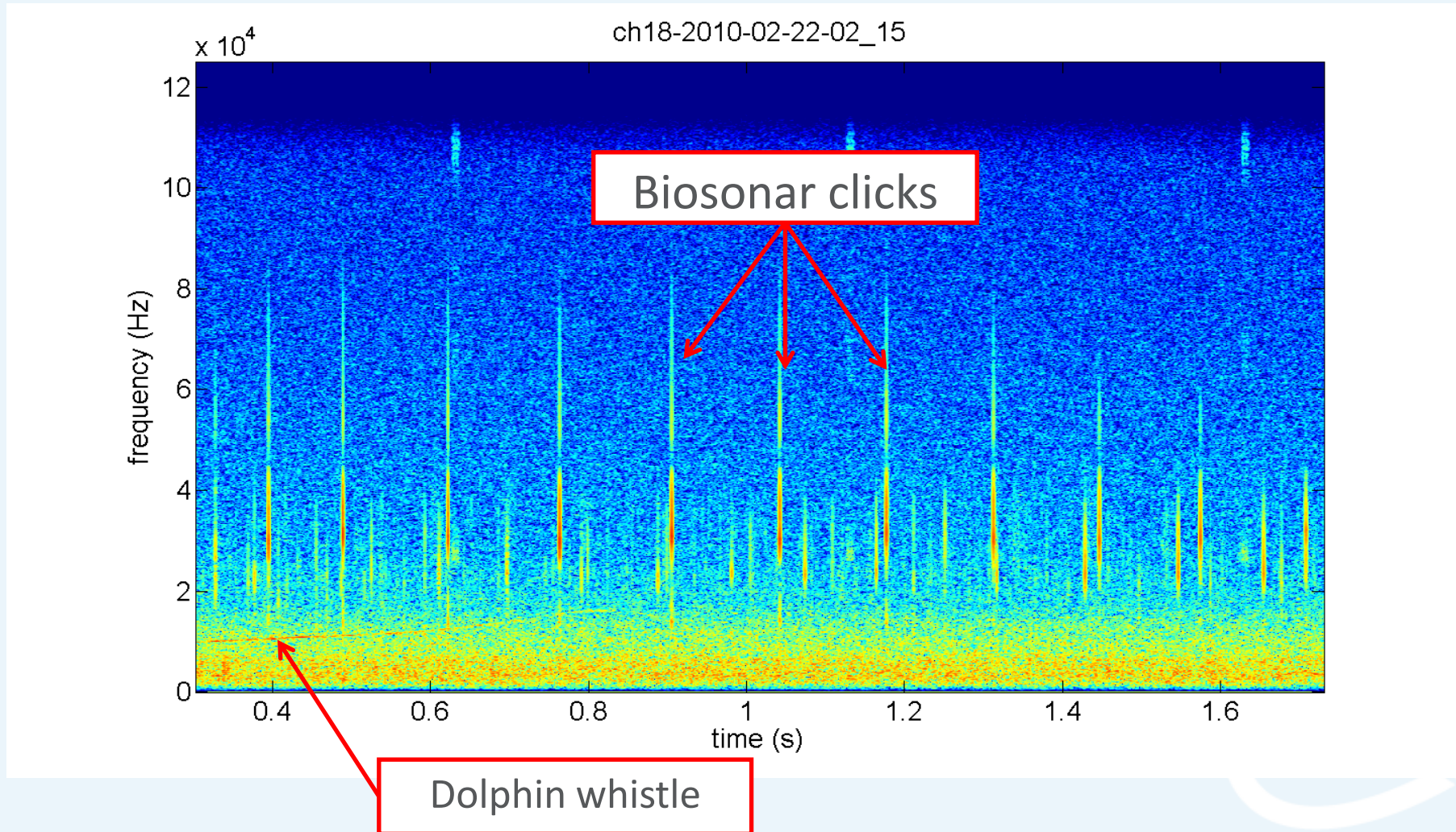
**D) Separable body part**  
This worm snaps off a glowing "bomb." The predator chases the "bomb" while the worm can escape.

**E) The "burglar alarm"**  
Jellyfish is attacked by a prawn, and responds by producing light. A nearby squid sees the light from the jellyfish. Then, the squid attacks the prawn and the jellyfish is saved.

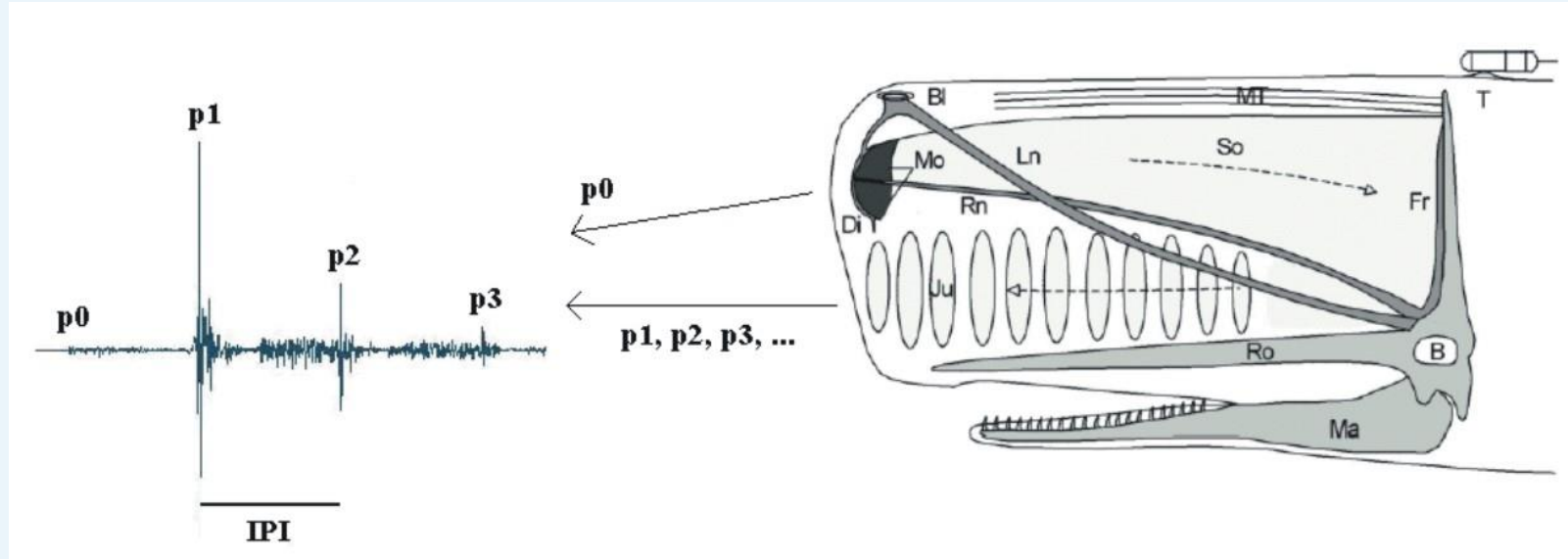
Images from:

<https://kids.frontiersin.org/article/10.3389/frym.2020.00069>

# Example Acoustic signals



# Understanding Biosonar Signals

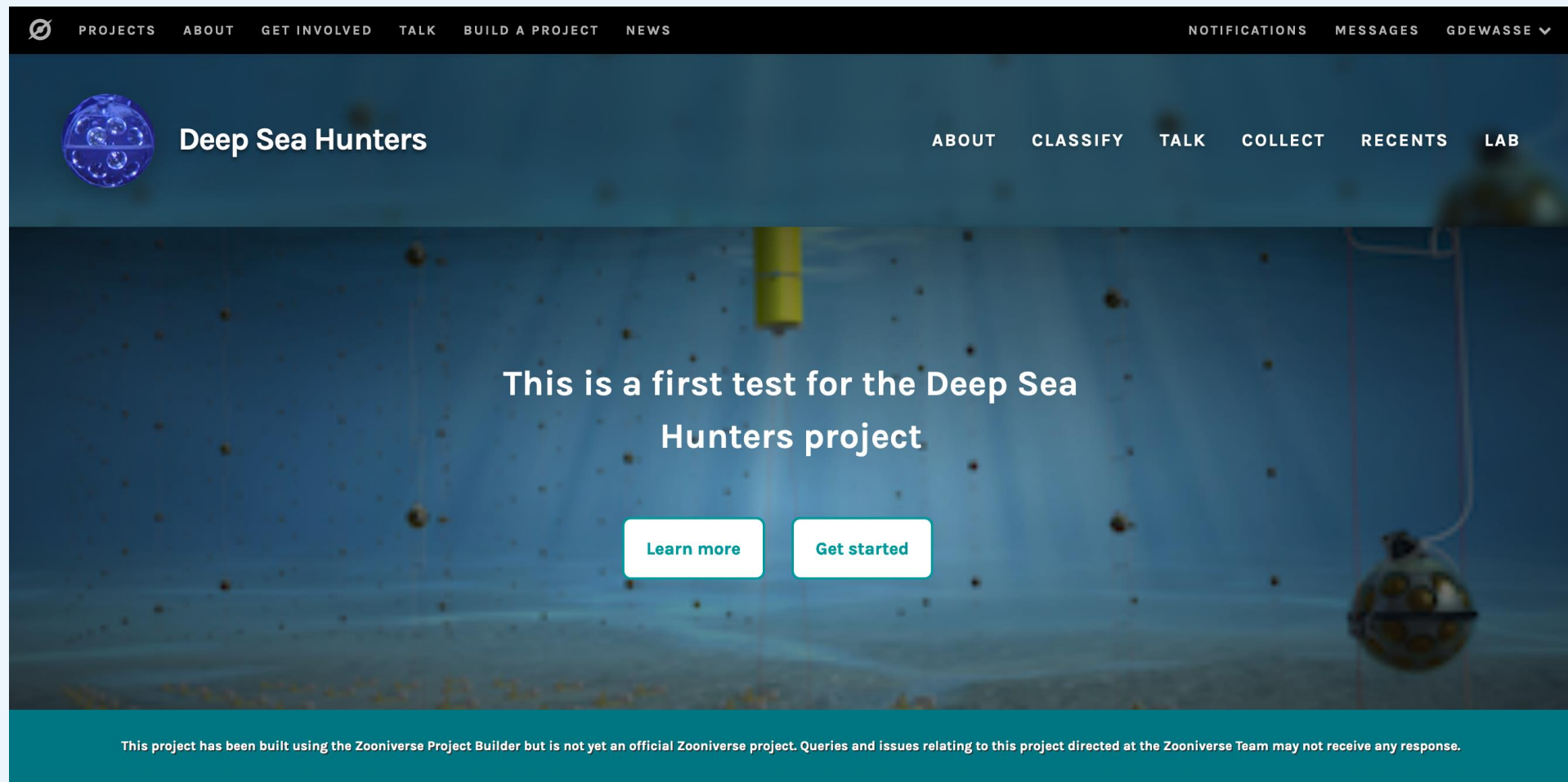


100% of cetaceans:

- Communication
- Locate prey
- Repel predators

Give information on  
size, sex, age of whale

# Deep Hunters Zooniverse Project



The screenshot shows the Zooniverse project page for 'Deep Sea Hunters'. At the top, there is a navigation bar with links: PROJECTS, ABOUT, GET INVOLVED, TALK, BUILD A PROJECT, NEWS, NOTIFICATIONS, MESSAGES, and GDEWASSE. Below this, the project title 'Deep Sea Hunters' is displayed next to a blue globe icon. A secondary navigation bar includes links for ABOUT, CLASSIFY, TALK, COLLECT, RECENTS, and LAB. The main content area features a large background image of a deep-sea hydrothermal vent with a yellow tube and a black sphere. Centered text reads: 'This is a first test for the Deep Sea Hunters project'. Below this text are two buttons: 'Learn more' and 'Get started'. At the bottom of the page, a teal banner contains the following text: 'This project has been built using the Zooniverse Project Builder but is not yet an official Zooniverse project. Queries and issues relating to this project directed at the Zooniverse Team may not receive any response.'

work in progress

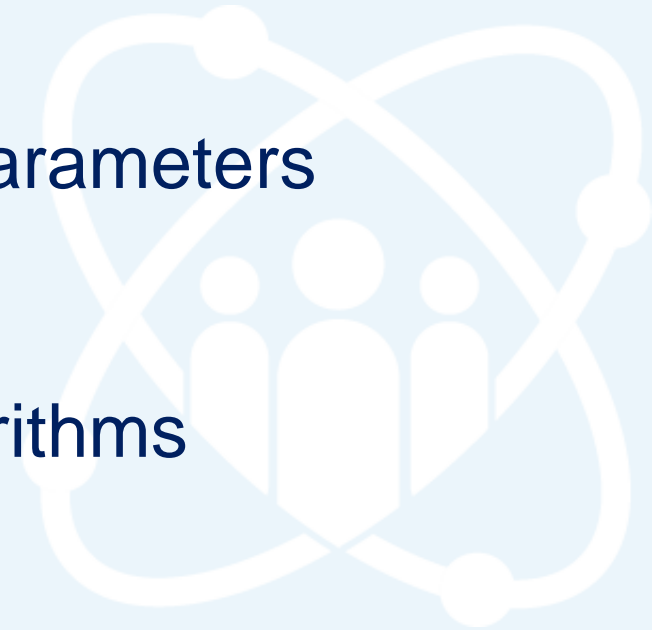
# We need your help to:

## Be our Eyes/Ears

Classify bioluminescence/biosonar waveforms  
via Zooniverse interface

Understand dependence on time, season, other parameters  
(temp, current)

Compare with and improve machine learning algorithms





# Summary

Will take about a year to get things set up, then....

Help us to understand our optical and acoustic backgrounds

Help us to improve our sensitivity to neutrinos

Learn about the new field of neutrino astronomy

Appreciate the biodiversity in the deep sea even at these enormous depths

Such studies have not been done before-really unexplored territory-  
big potential for interesting discoveries

**Come and join the fun – Thanks!**

