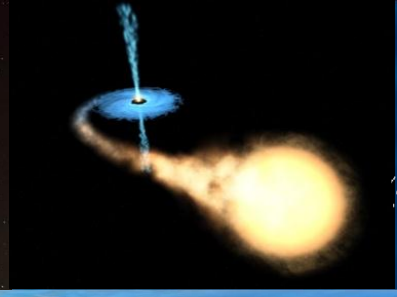
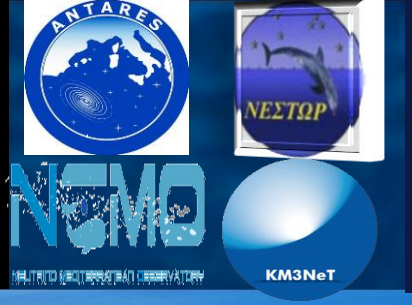
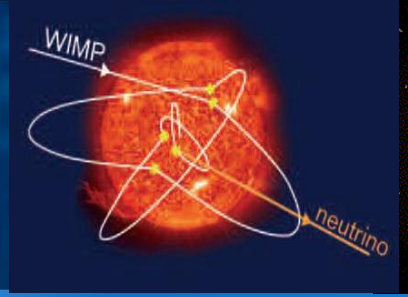
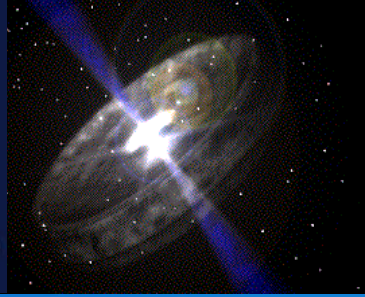






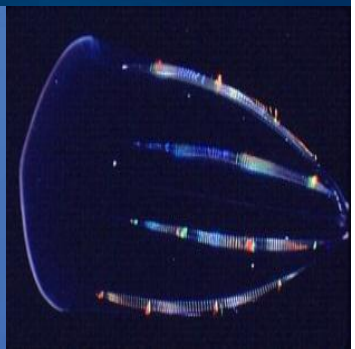
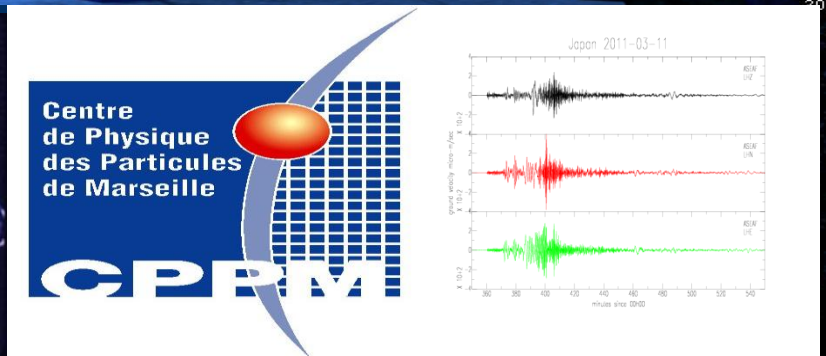


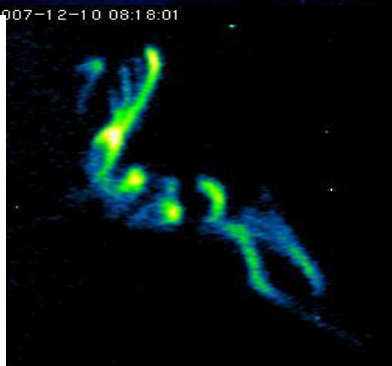
Introduction to Current Synergies in the Mediterranean Sea

Deep Ocean Cabled Observatories
Amsterdam, 24/5/12

Paschal Coyle

Centre de Physique des Particules de Marseille



Synergies

Astroparticle + Earth and Sea Science communities

Not competition but synergetic cooperation of mutual benefit

Shared infrastructures

Shared knowledge and experience

Shared costs

-> new sensors, new infrastructures
-> explore new frontiers
-> new innovative pioneering, quality science

Has started but can be intensified and improved

The Science

Advantages of **cabled** observatories:

- Real-time
- High bandwidth
- High frequency
- Continuous
- Long term

Oceanography (water circulation, climate change):

Current intensity and direction, water temperature, water salinity, oxygen, radionuclides...

Geophysics (geohazard):

Seismic phenomena, low frequency passive acoustics, magnetic field variations,...

Biology (micro-biology, cetaceans,...):

Passive acoustics, biofouling, bioluminescence, video, water samples analysis,...

KM3NeT and EMSO

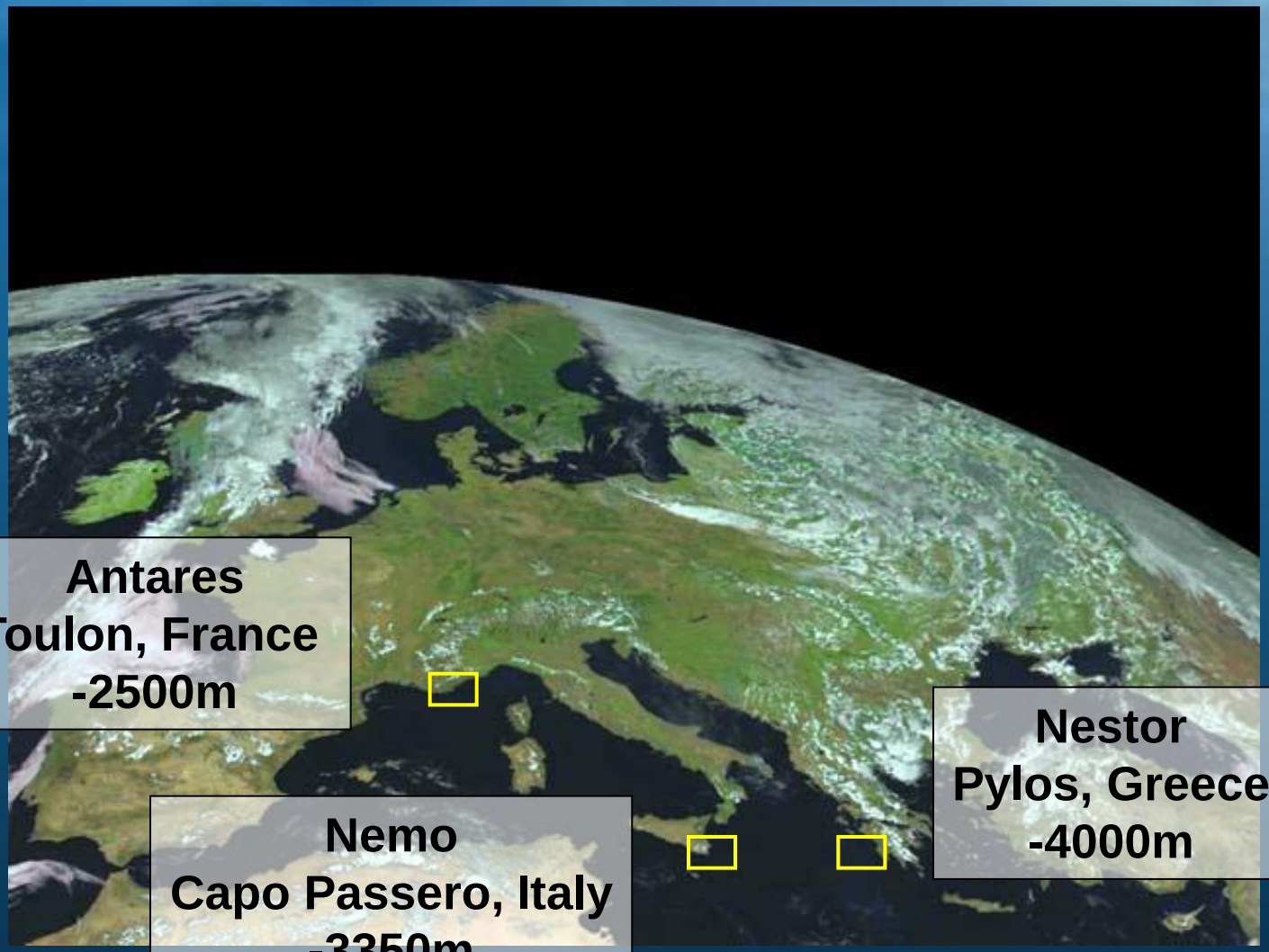
KM3NeT: a large deep sea infrastructure incorporating a VLV neutrino telescope

Common efforts with the Earth and Sea Science Community

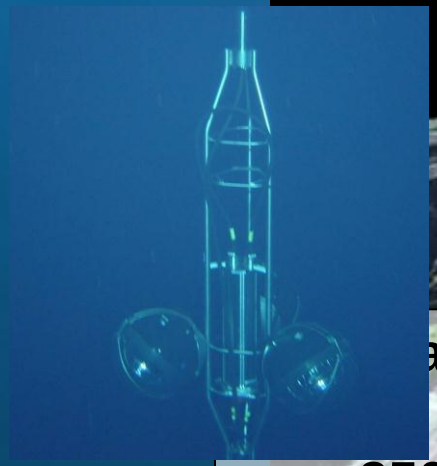
Joint studies of long term and real time envionmental monitoring in the three KM3NeT sites

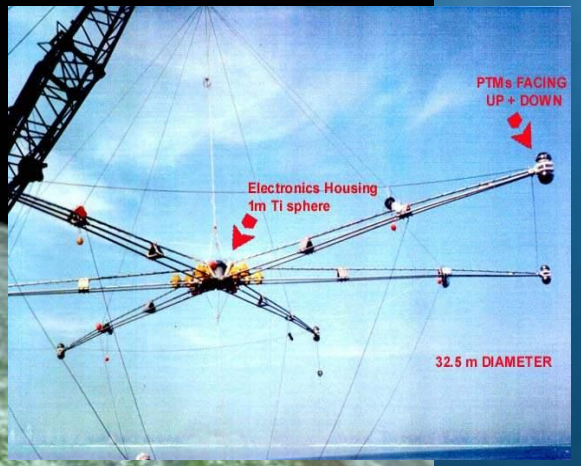
Toulon, Sicily and Hellenic sites of common interest for KM3NeT and EMSO

The Neutrino Telescope Sites



The Neutrino Telescope Sites





Since 1996
Data taking
for science
~150 members

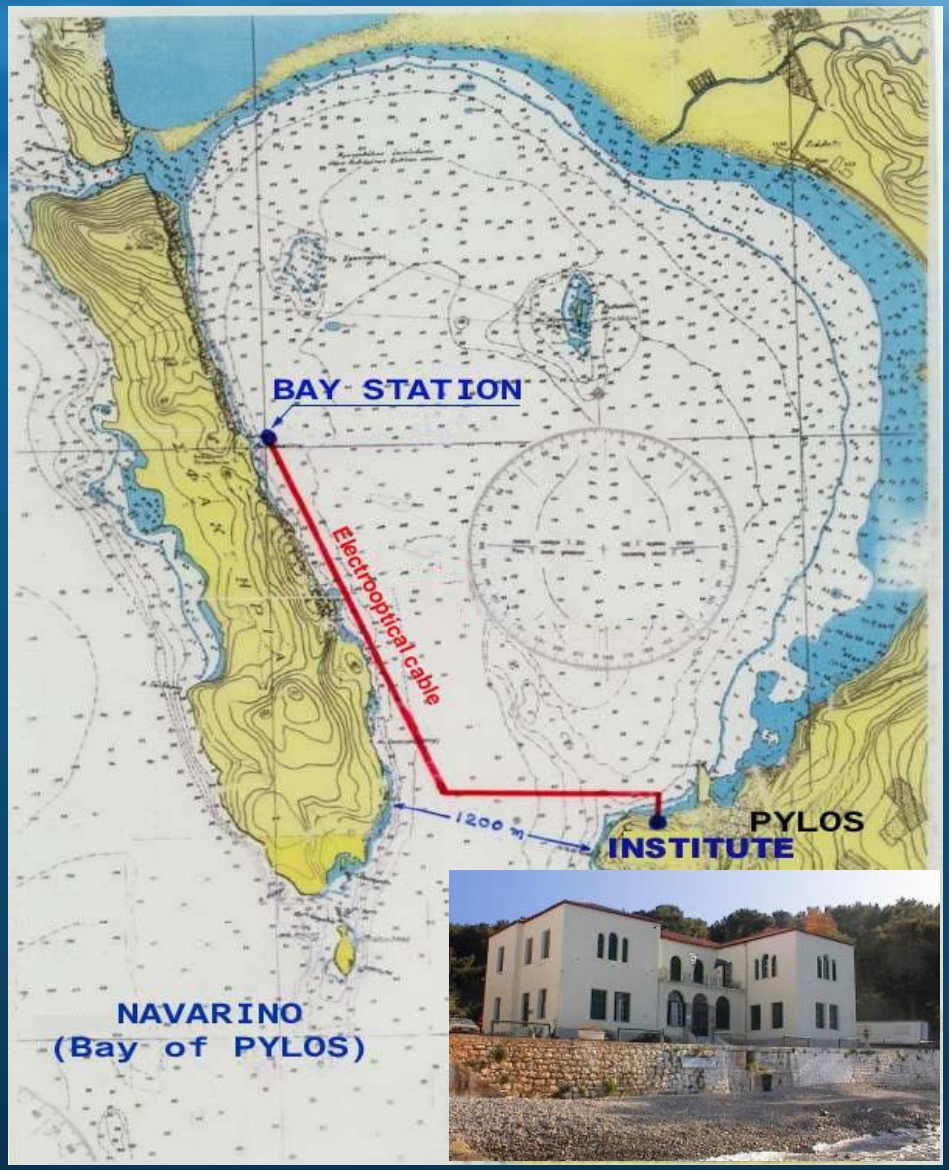
Nemo
Capo Passero, Italy
-3500m

Since 2000
R&D
~ 80 members

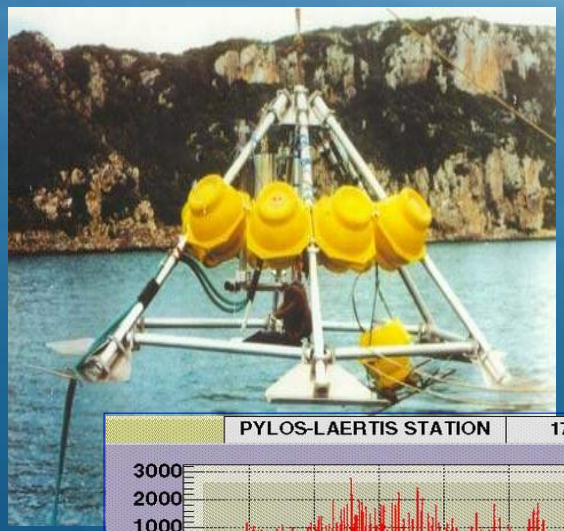
Nestor
Pylos, Greece
-4000m

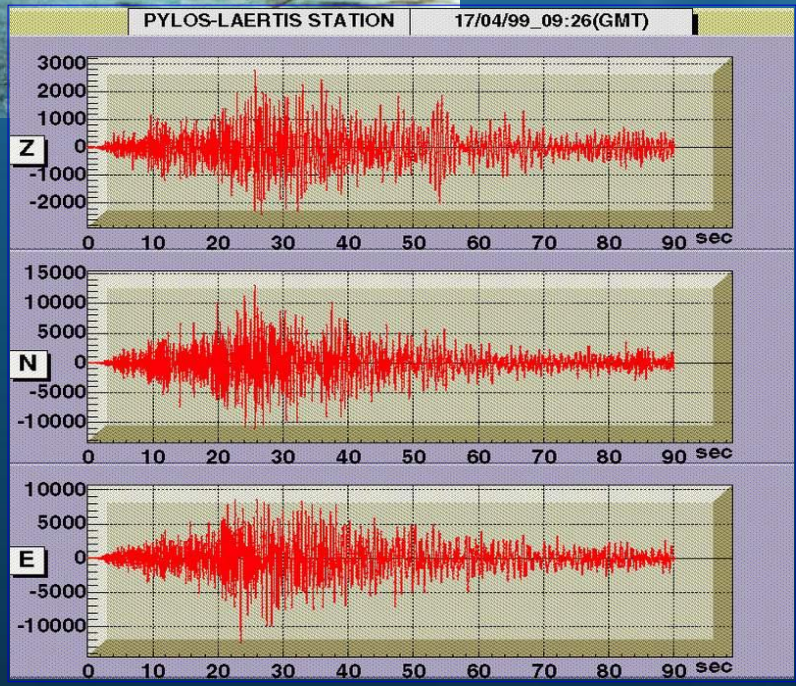
Since 1990
R&D
~ 50 members

NESTOR TEST SITE

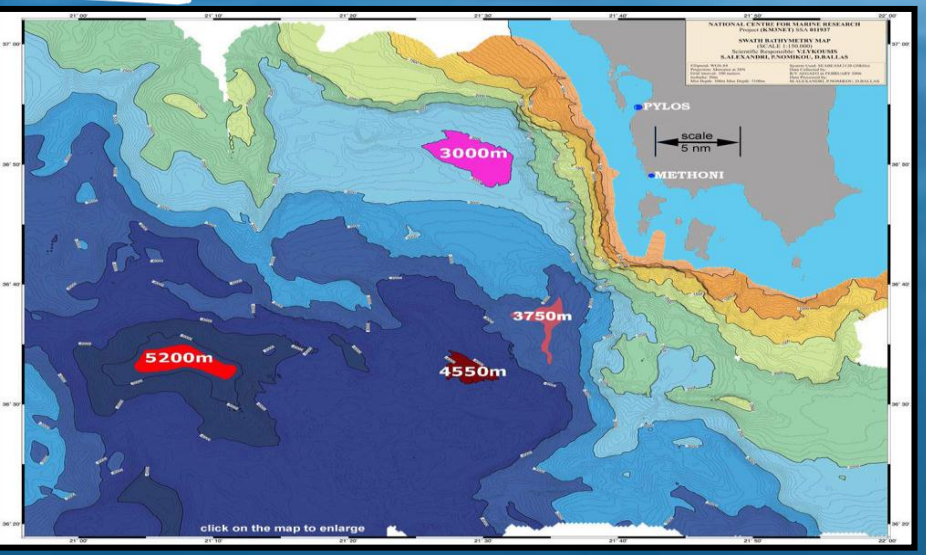


Real-time data from 50m



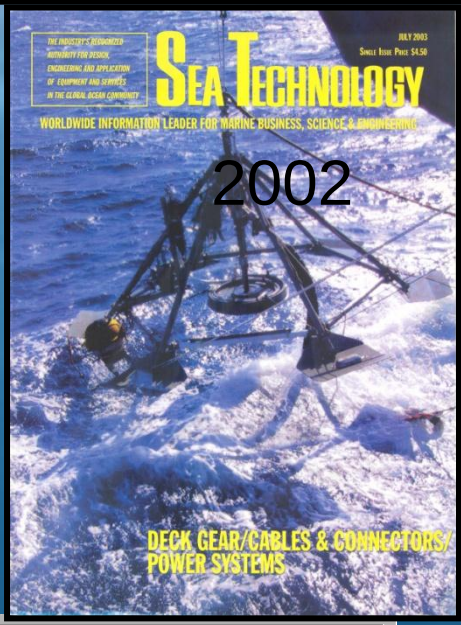


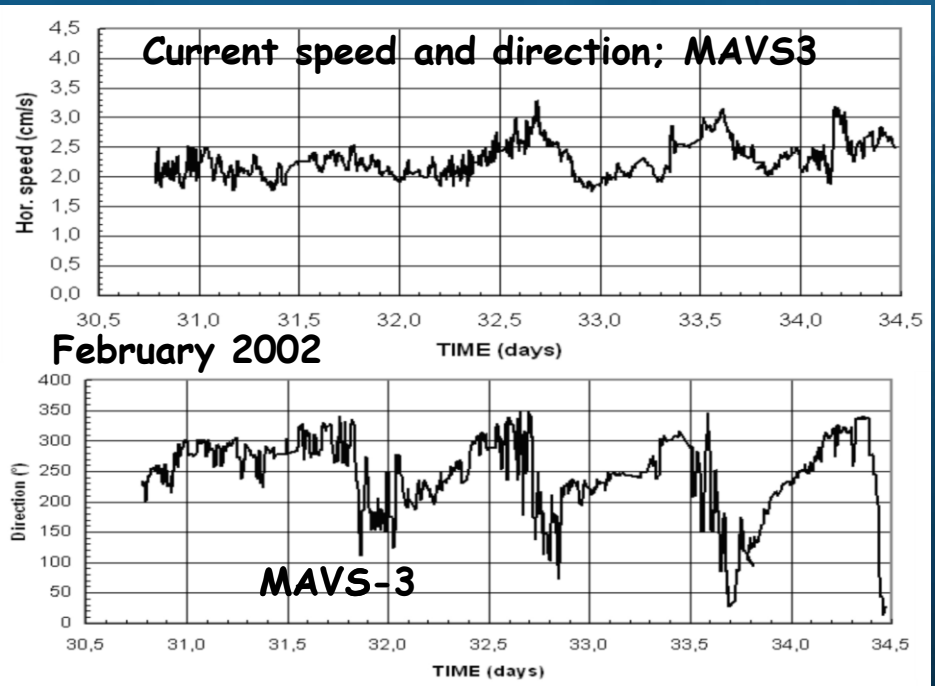
Data from a depth of 4200 m

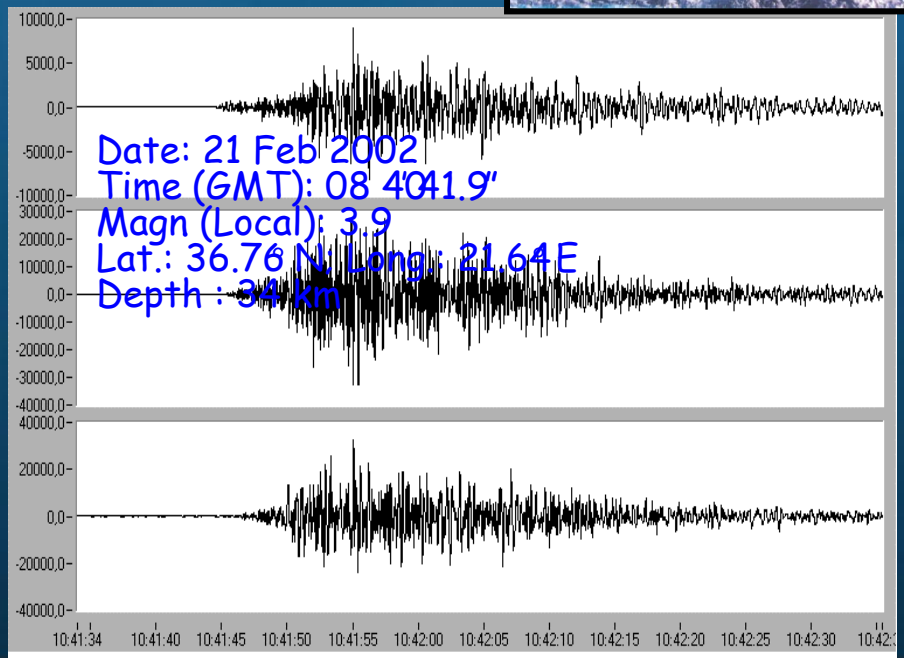


4200m depth
South-west
Peloponnese
(2002, Pylos)

Connected to shore
with 35 km of
Electro-optical cable
(18 fibers +1 conductor)





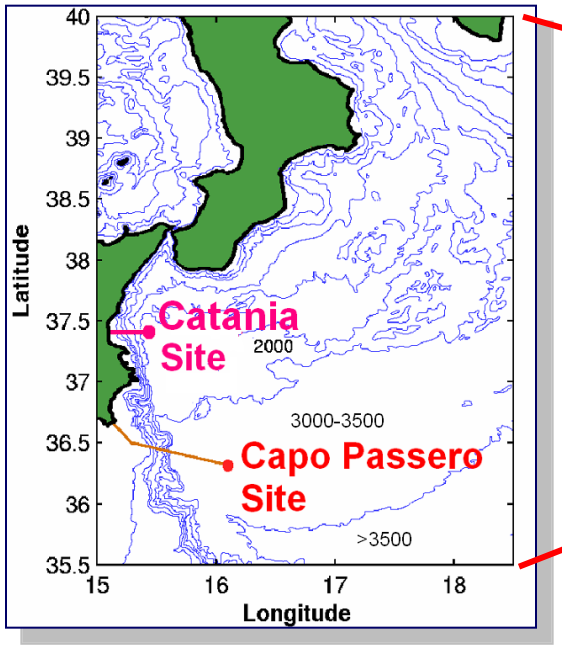


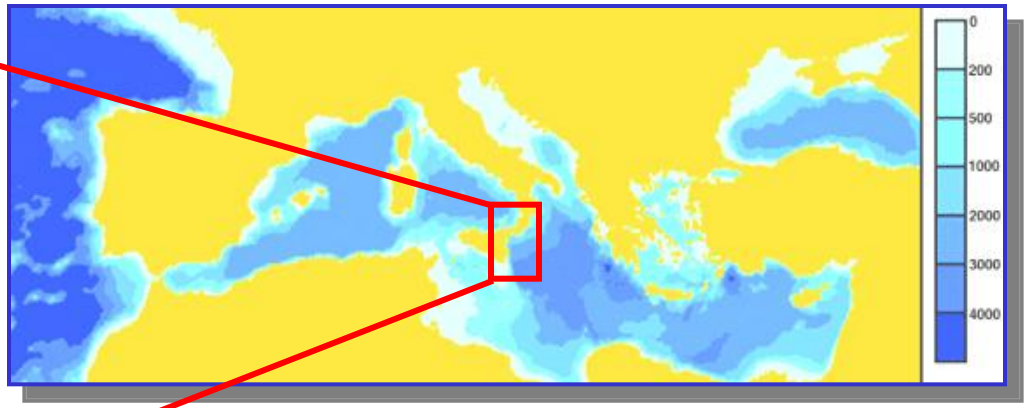
NEMO INFRASTRUCTURE

Two deep sea infrastructures are operational in Sicily

Catania Test Site (first multidisciplinary abyssal laboratory in Europe):
25 km East offshore the port of Catania, 2100 m depth

Capo Passero KM3NeT Site:
90 km South East offshore Capo Passero, 3500 m depth





INFN

NEMO
NEUTRINO MEDITERRANEAN OBSERVATORY

Catania Test Site: a multidisciplinary deep sea-lab

LIDO demo mission of ESONET-EMSO: Refurbishment of SN1 and OnDE observatories
Goals: Bioacoustics, ocean monitoring,Tsunami warning Ready for deployment

Internet
Radio Link

LNS Test Site Laboratory at the port of Catania

20 km

5 km

5 km

North Branch:
4 LBW hydrophones
2 LF hydrophones
CTD, ADCP,
Seismometers
magnetometers
pressure gauges
GPS time stamping

South Branch:
4 LBW hydrophones
Underwater GPS
time stamping

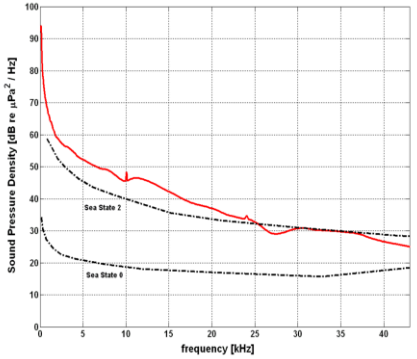
Infrastructure requested by UCL and CSIC for installation of deep-sea stations in 2013

Bioacoustics and Geophysics at the Catania Test Site

First experiment to perform long-term monitoring of acoustic noise @ 2000 m depth. 4 large-bandwidth hydrophones, real-time data to shore

Sea noise measurement for UHE neutrino detection

Study of sperm whales population in the Med Sea



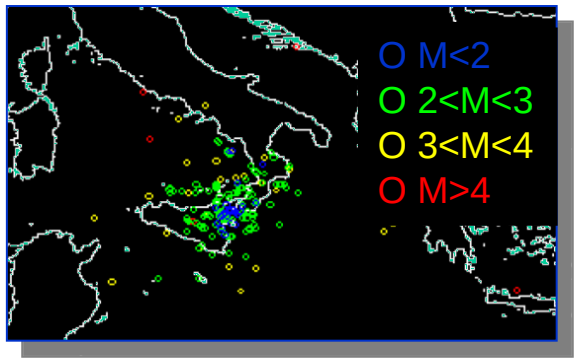
INGV **Submarine Network 1**

Monitoring of volcanic and seismic activity in East Sicily

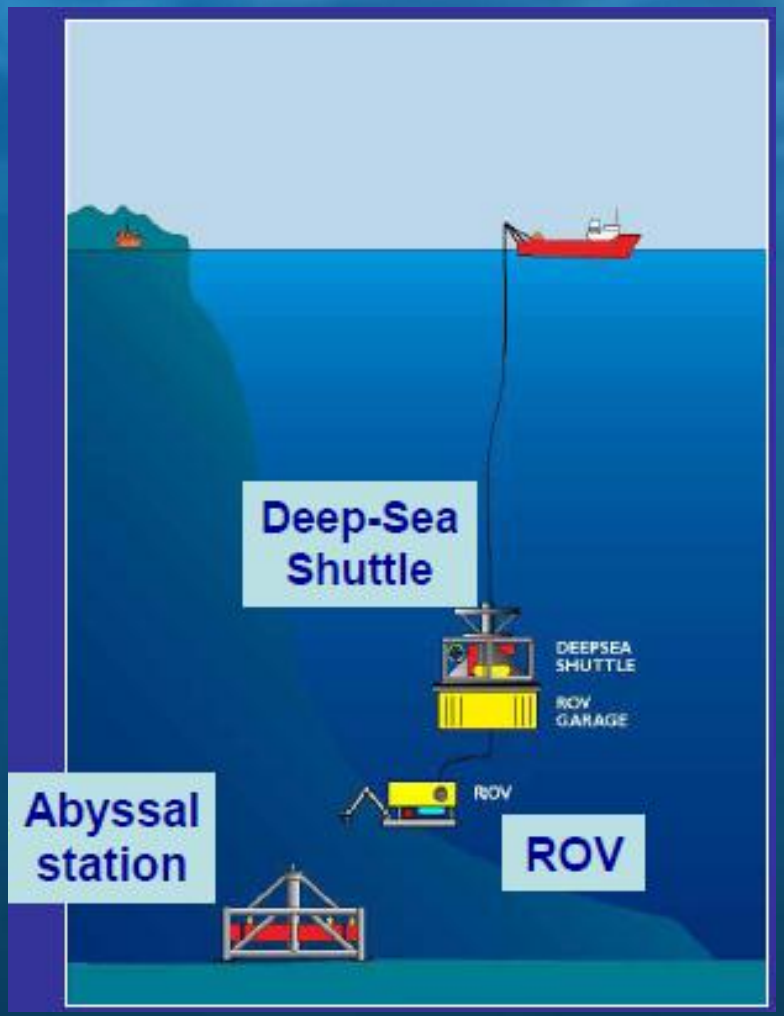
Test and development of Tsunami early warning systems

Ocean Monitoring systems embedded

Thanks to reduced noise SN1 has improved sensitivity with respect to inland observatories



Remotely Operated Vehicles



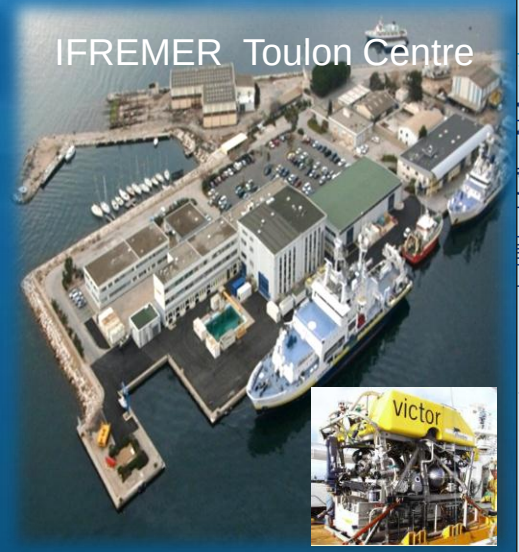
Sicily:
COUGAR-INFN/INGV
4000m

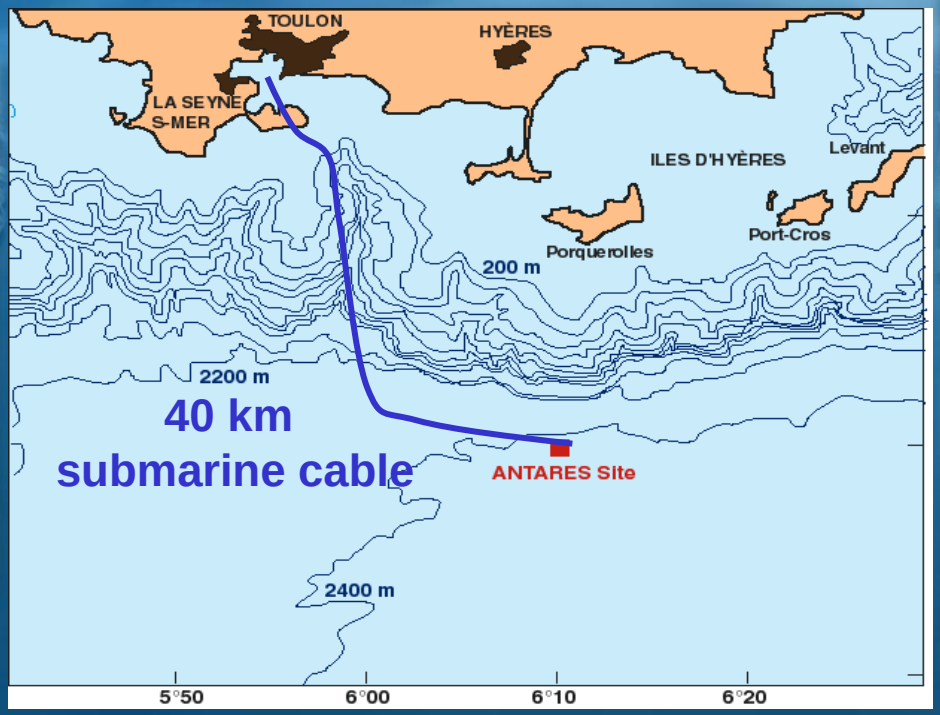
Toulon:
VICTOR-Ifremer
6000m

APACHE-Comex
2500m

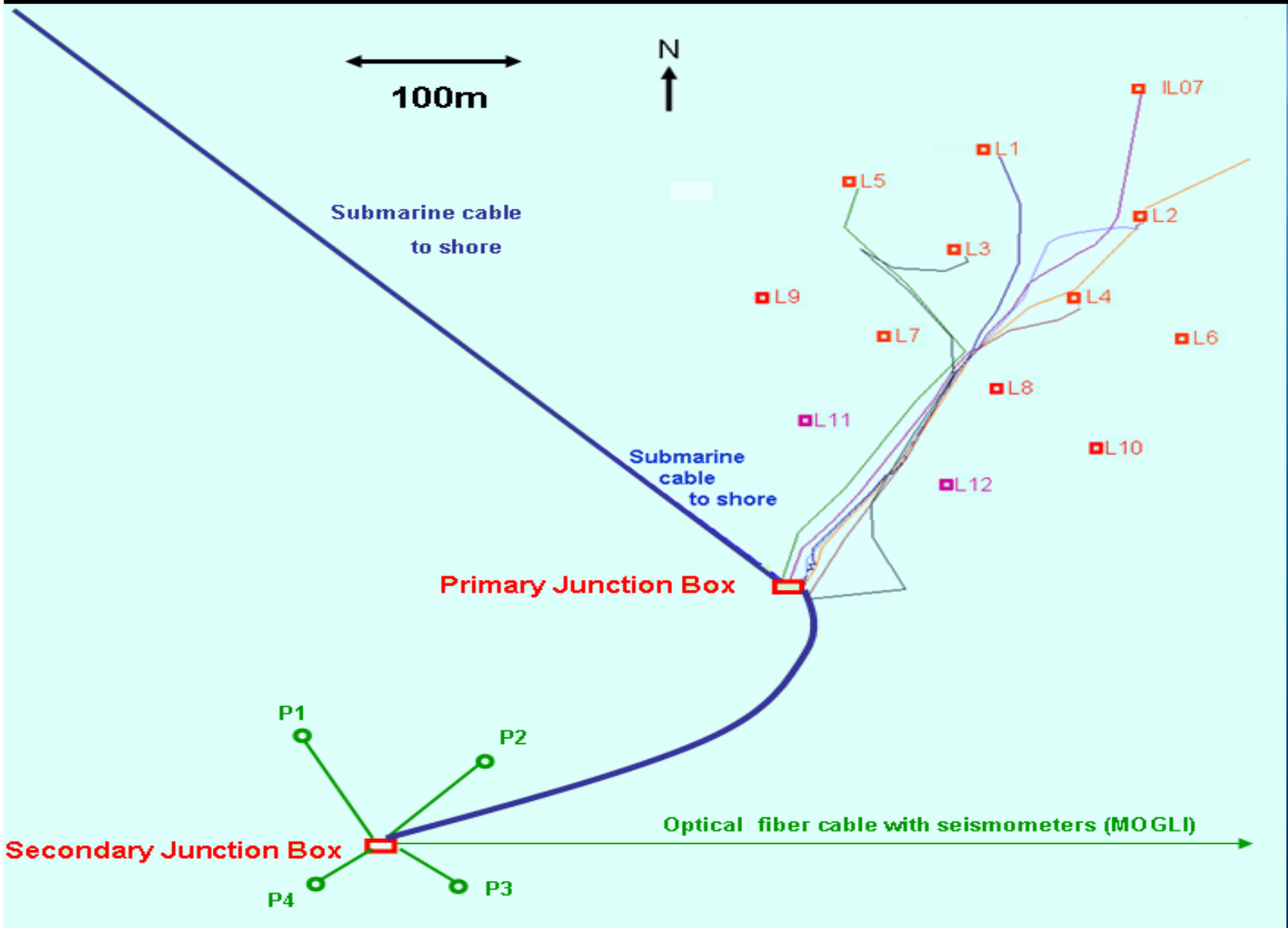
In the past, availability of ROVs and boats has been important constraint

The ANTARES Site & Infrastructure

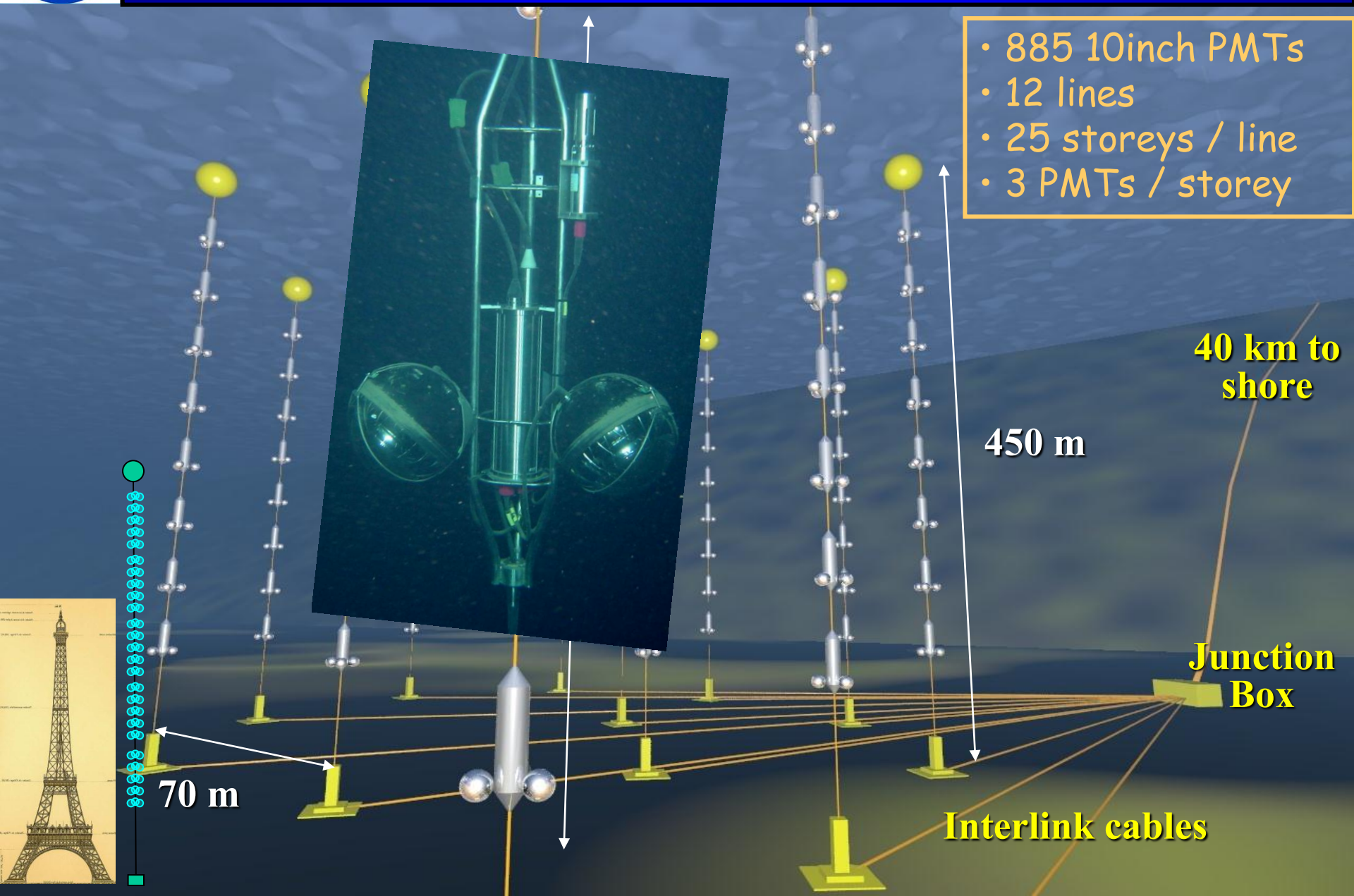




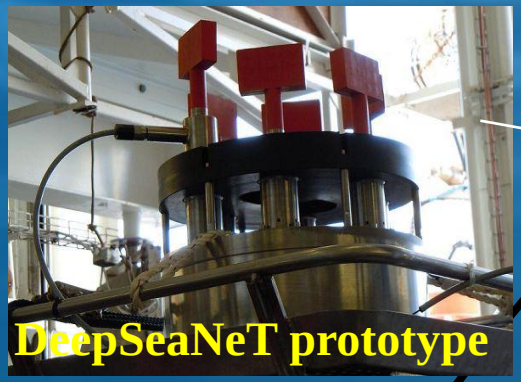
ANTARES INFRASTRUCTURE

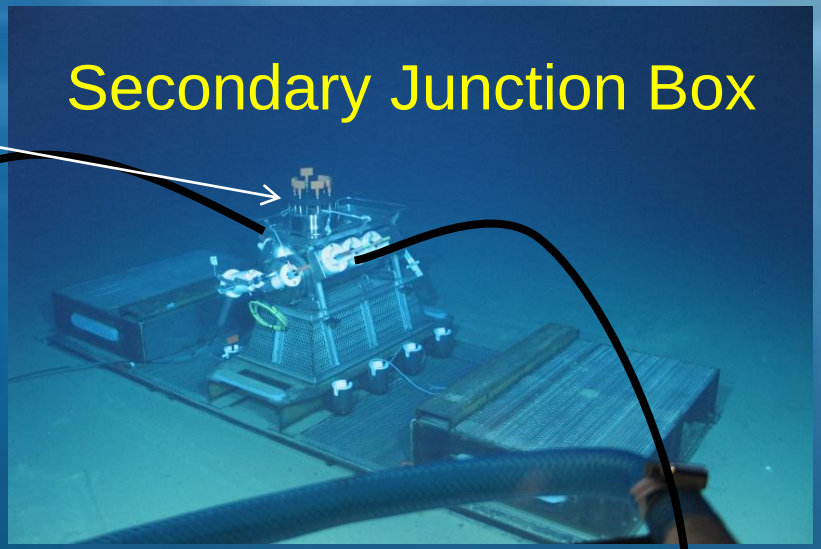


The ANTARES Detector

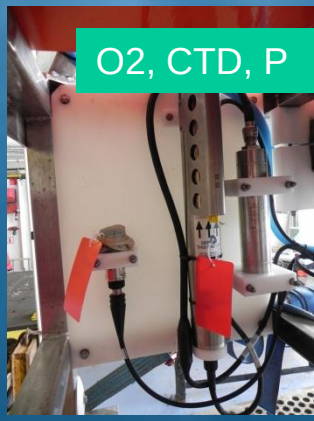


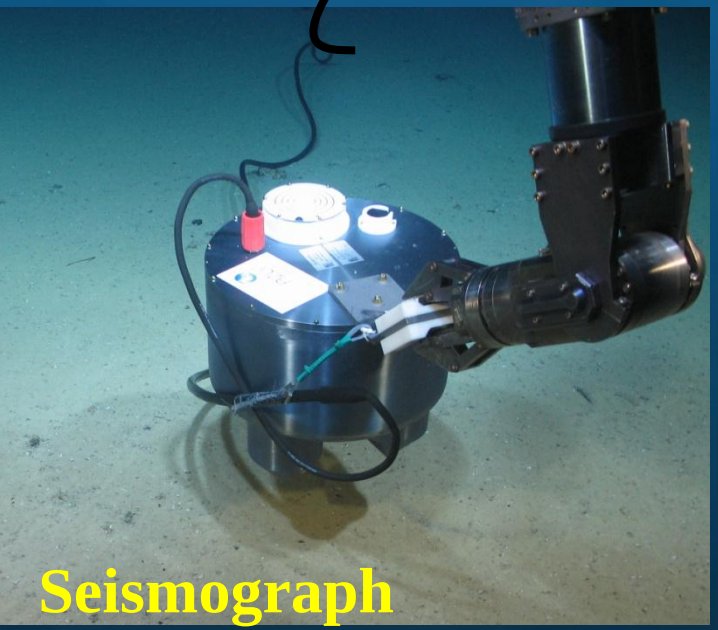
Secondary Junction Box

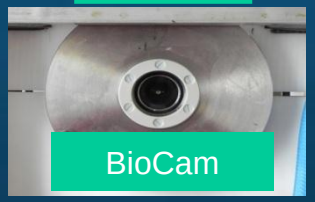


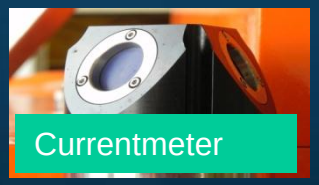


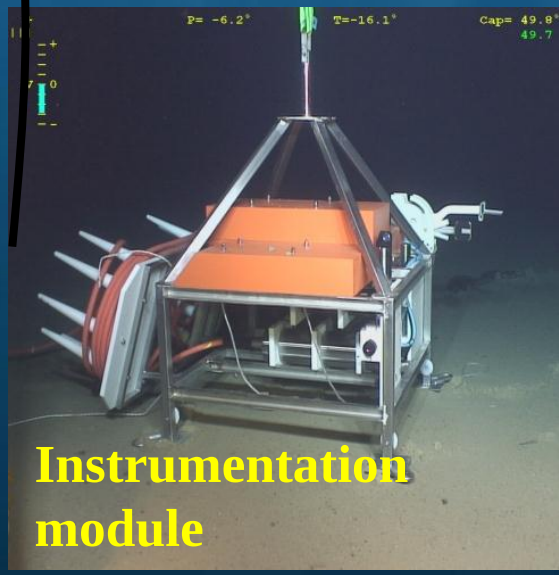
Connected
30 Oct 2010









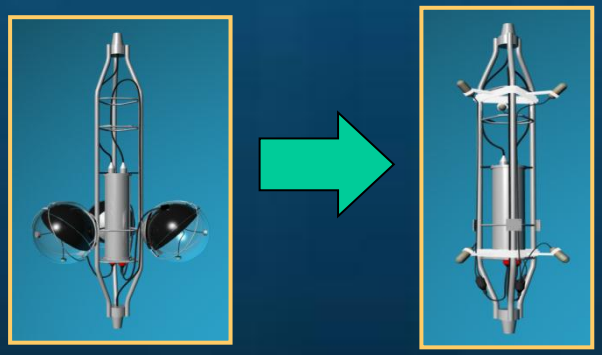


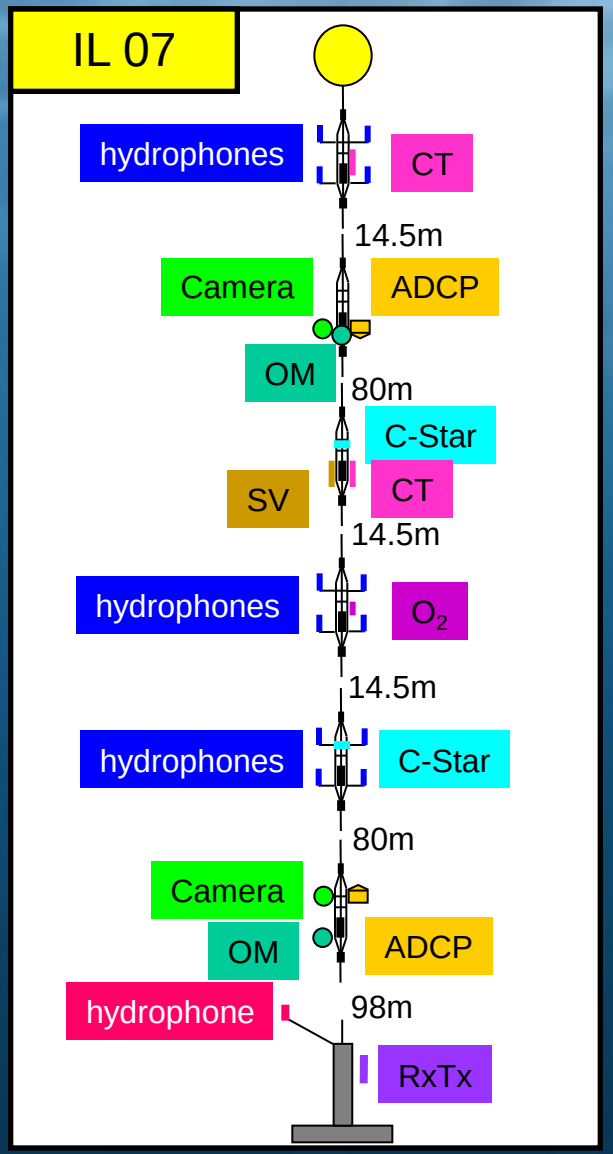
ANTARES: Instrumentation Line

Monitoring of Environmental Parameters 2007-2010
(reconnection planned later this year)

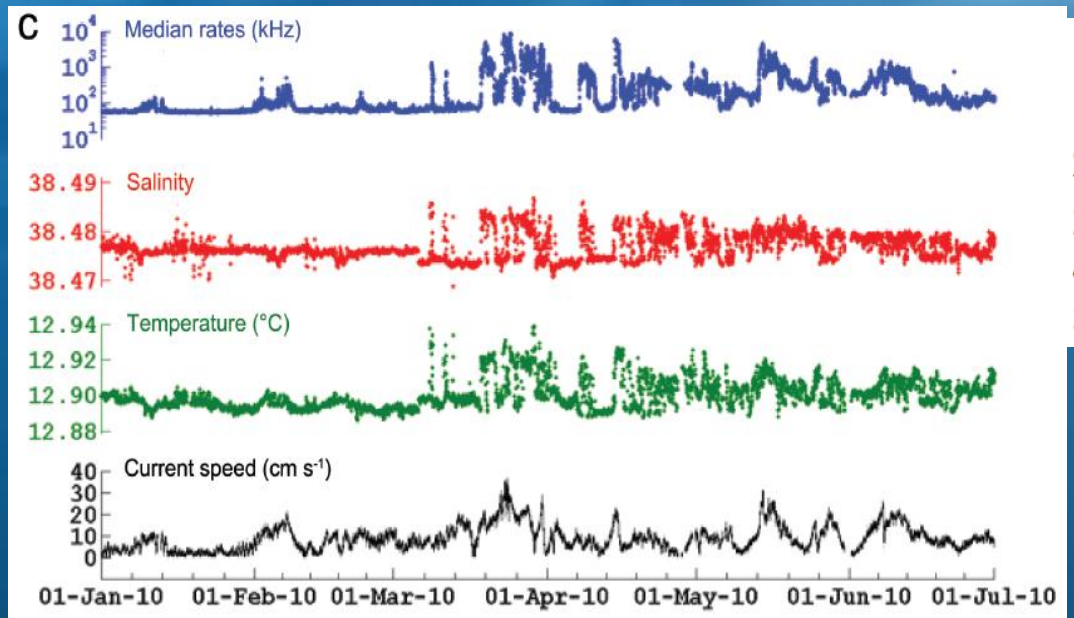
- **CSTAR** light transmission
- **CT** = Conductivity-Temperature
- **SV** = sound velocity
- **ADCP** = Current meter
- GURALP seismometer
- 2 Optical Modules
- Acoustic positioning RxTx & Rx
- Oxygen meters
- 2 cameras

  +
- 3 storeys of UHE neutrino acoustic detectors





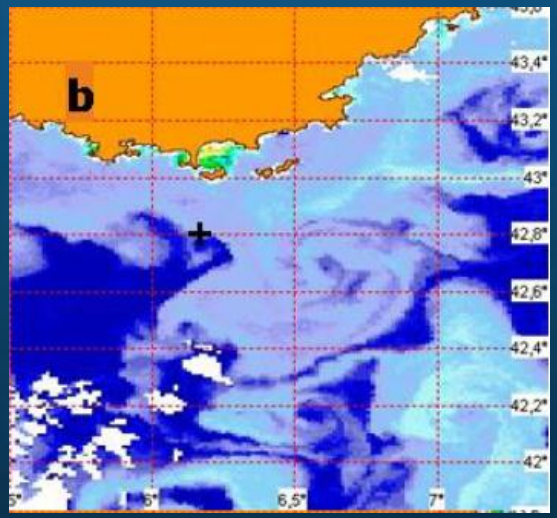
ANTARES: Long Term Oceanographic Parameters



Submitted to PNAS

Enhancement of deep-sea biological activity by dense water formation

C. Tamburini*[1], M. Canals[2], X. Durrieu de Madron[3], L. Houpert[3], D. Lefèvre[1], S. Martini[1], F. D'Ortenzio[4], A. Robert[1], P. Testor[5], J. A. Aguilar[6], I. Al Samarai[7],



Deep-Sea Research I 58 (2011) 875–884

Contents lists available at ScienceDirect

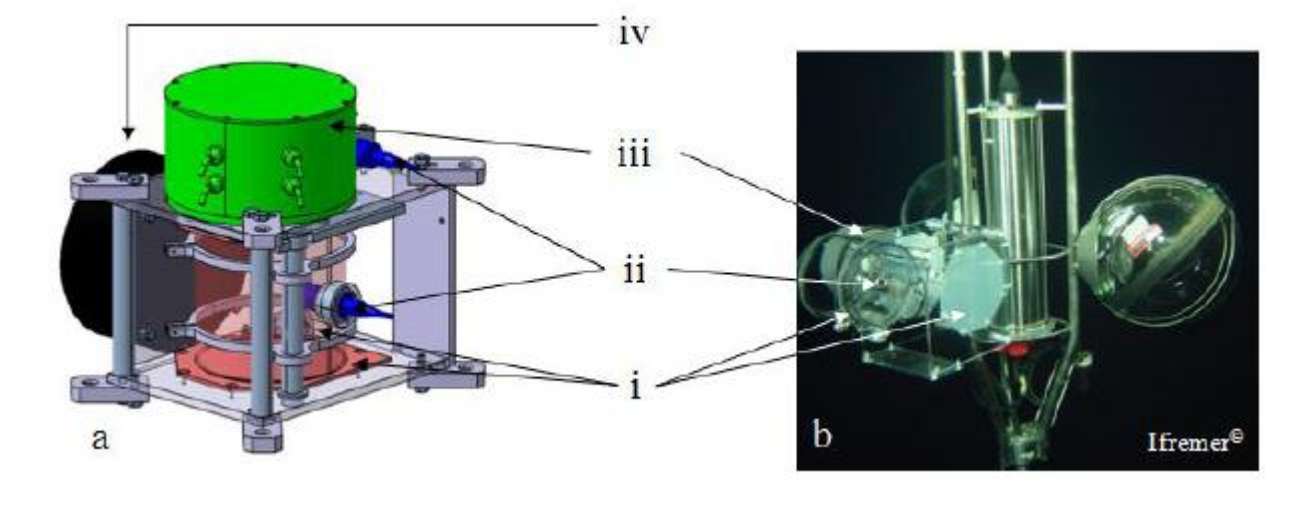
Deep-Sea Research I

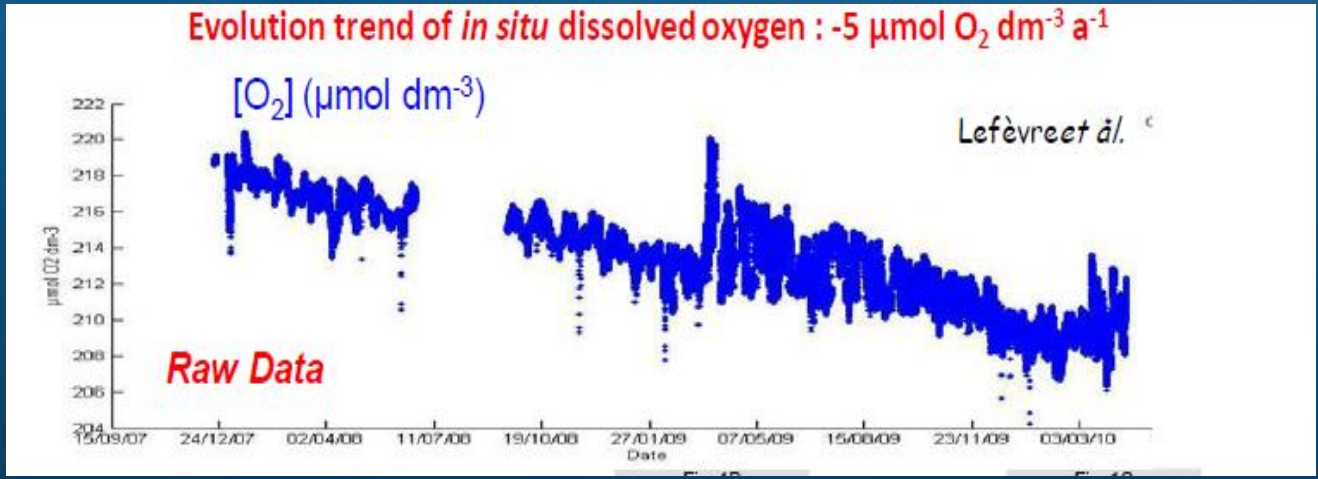
journal homepage: www.elsevier.com/locate/dsri

Acoustic and optical variations during rapid downward motion episodes in the deep north-western Mediterranean Sea

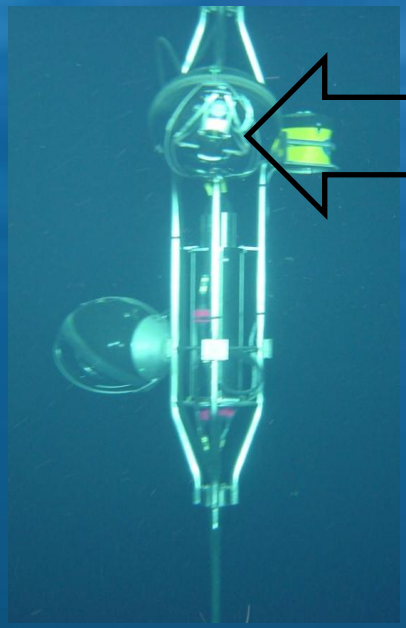
H. van Haren[z,*], I. Taupier-Letage[ah,1], J.A. Aguilar[a], A. Albert[b], M. Anghinolfi[c], G. Anton[d], S. Anvar[e], M. Ardid[f], A.C. Assis Jesus[g], T. Astraatmadja[g,2], J.-J. Aubert[h], R. Auer[d], B. Baret[i], S. Basa[j], M. Bazzotti[k,l], V. Bertin[h], S. Biagi[k,l], C. Bigongiari[a], M. Bou-Cabo[f], M.C. Bouwhuis[g], A. Brown[h], J. Brunner[h,3], J. Busto[h],

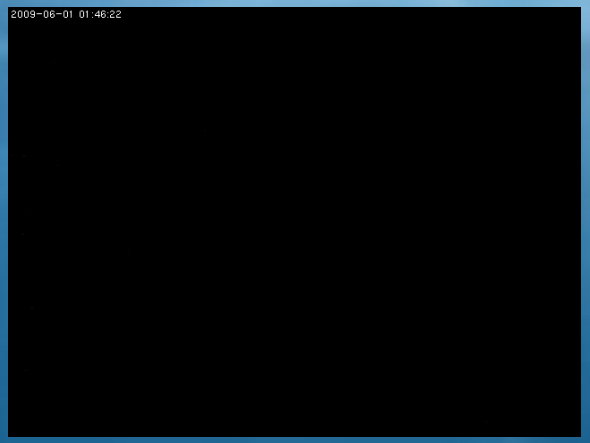
ANTARES: Oxygen



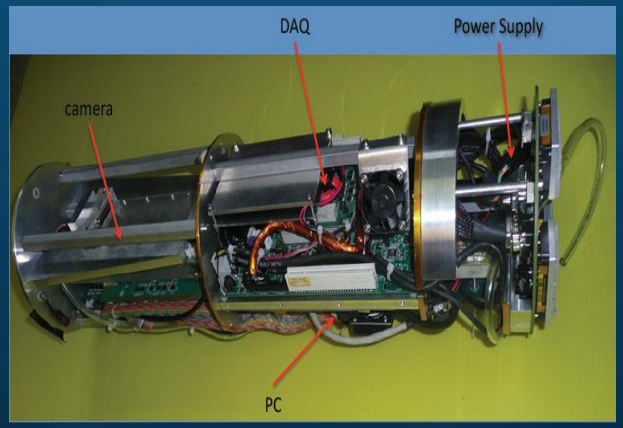


World's Deepest Real Time Cameras





AXIS221 vidéosurveillance
Sensistivity: 0.1 lux
Field of view: up to 90 degrees
Infra red night vision

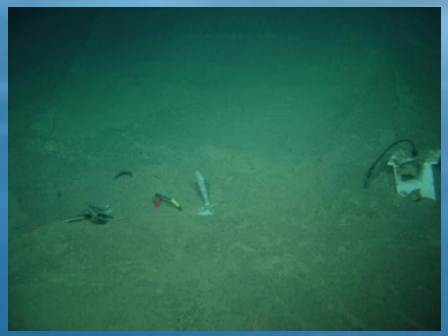


ebcmos technology
Imaging with
Single photon sensitivity
Very fast frame rate

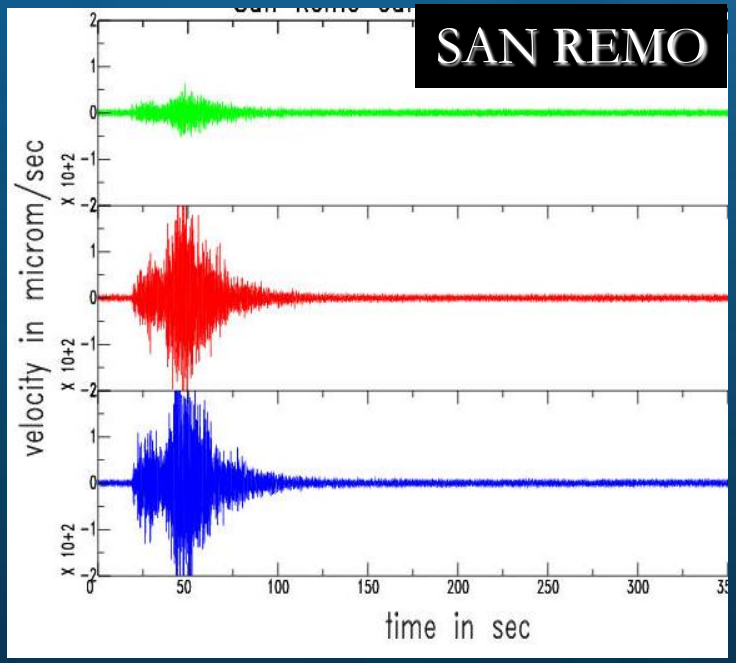
ANTARES: Seismology

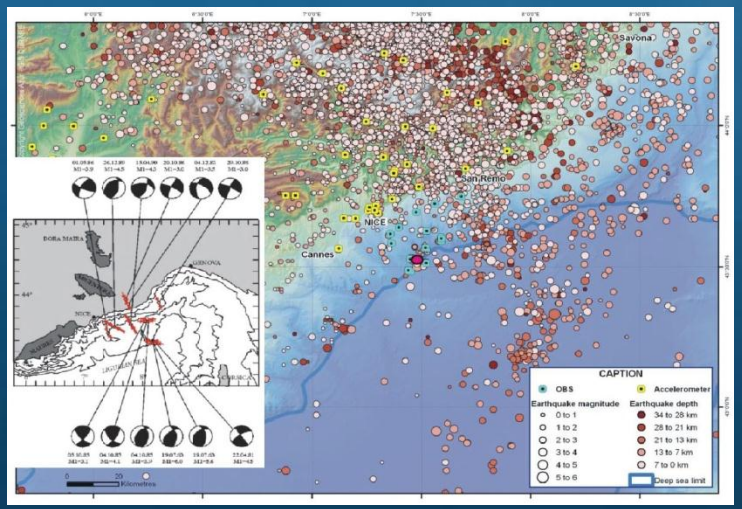
In laboratory

deployment



Buried at site Antares
(gain 20 dB of noise)

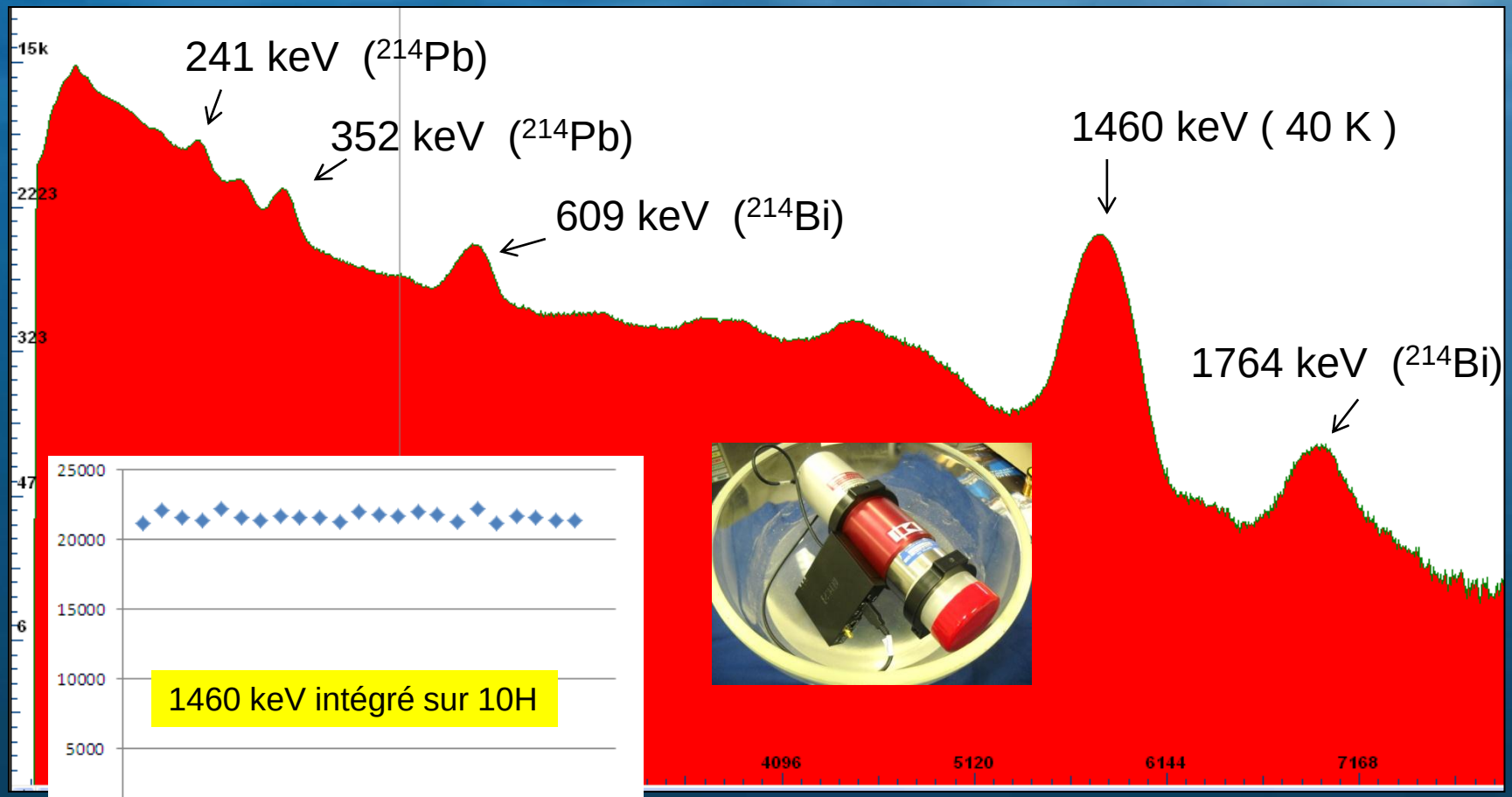




part of a seismic monitoring network, complementary to the terrestrial stations.

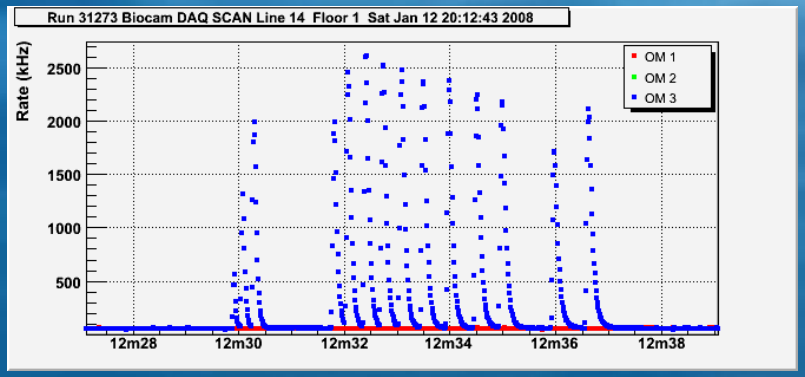
Gamma Spectra in Deep Sea

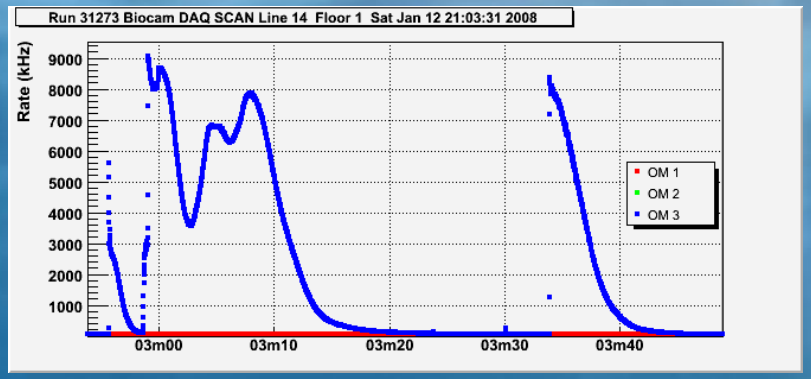
Log scale

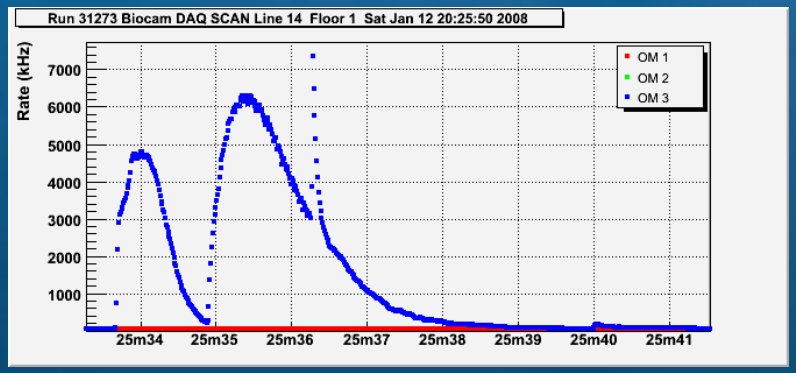


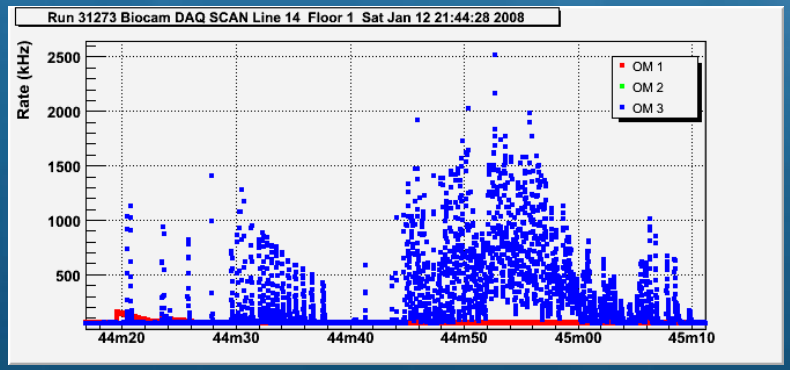
Only Uranium and Potassium

Example Bioluminescence Evts Observed on PMTs

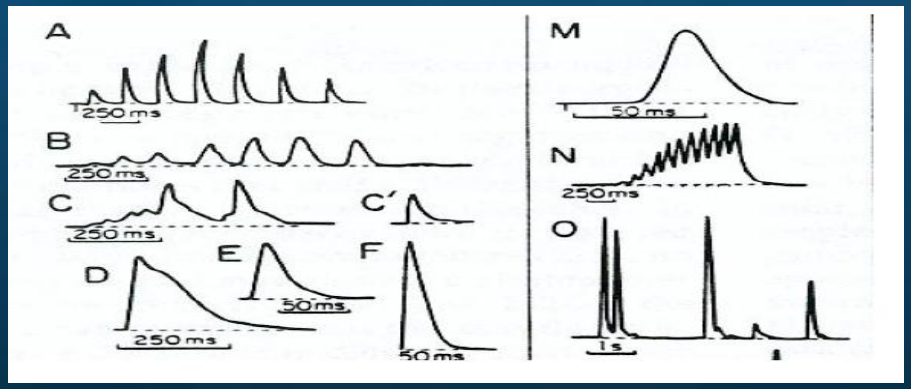








versus literature



Access to the Data

It's a lot of data! e.g.

- 900 PMTs with counting rate every 107ms for 10 years
- Environmental parameters (ADCP, CTD, O2….) every 2 minutes
- Acoustic data streams
- Seismic data streams

Database (Oracle) to store the data

Web interface for extraction and analysis

Transfer of selected sensor data to other databases

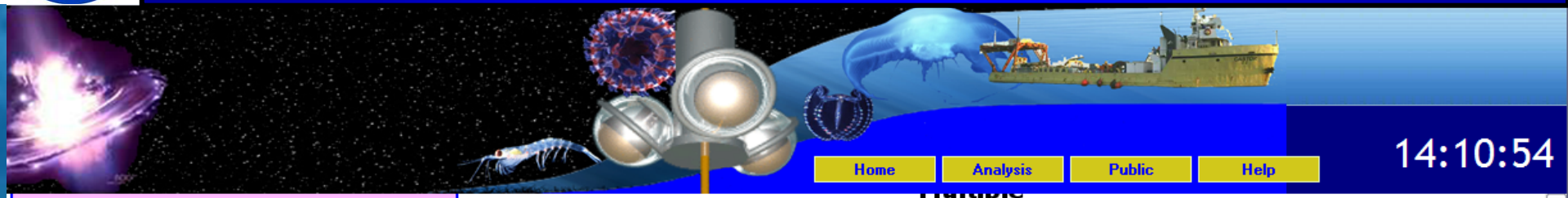
Online monitoring via web page tools

Real time alerts for 'unusual' events e.g. Tsunami, earthquake, biolum storms

Can trigger dedicated 'conventional' studies

- e.g. deployment of autonomous sensors, gliders etc.

Marocean Web Site



Pressure

SVEL-CTD (Line 4 - Floor 24)
PARO (MII)
CTD (MII)

Salinity

CTDRome (IL07 - Floor 4)

Temperature

CTDCOM (IL07 - Floor 6)
CTDRome (IL07 - Floor 4)
CTD (MII)
SVEL-CTD (Line 4 - Floor 24)
O2 (IL07 - Floor 3)
O2 (MII)

Next Back

LEVEL 4

Type of representation : All in one

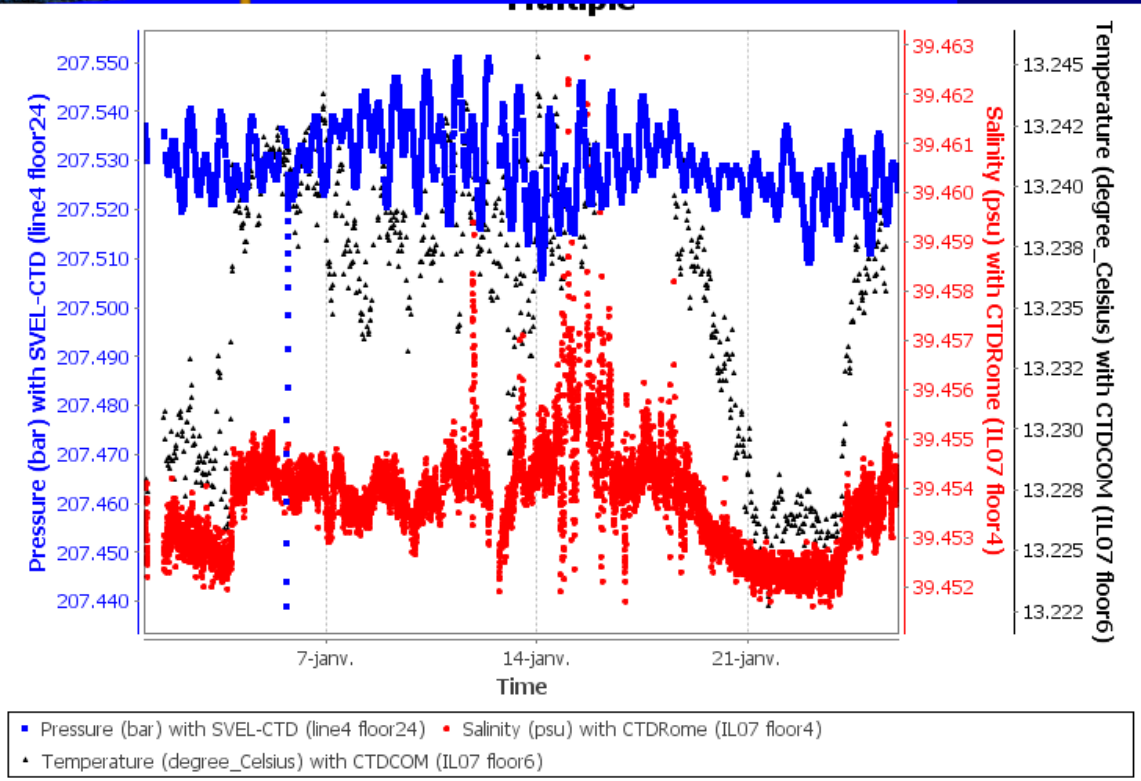
Start date (dd/mm/yyyy) : 01/01/2009

End date (dd/mm/yyyy) : 25/01/2009

☐ Show the ASCII data
☐ Quality Informations

Point-number-based average

Next Back



http://marocean.in2p3.fr/antares3Dev/

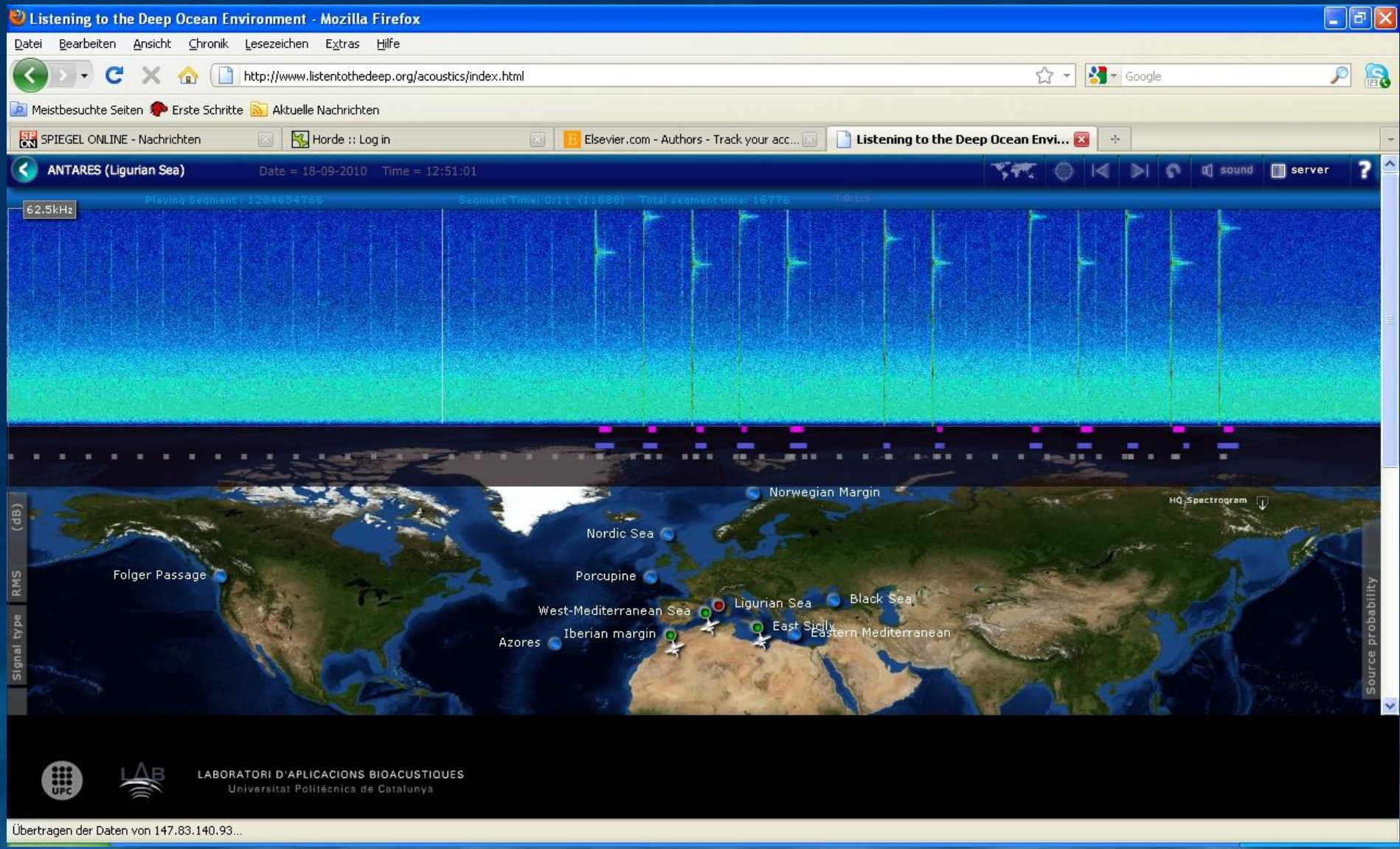
Plot can be edit (color, type of point, zoom, etc) and saved

LISTEN TO ANTARES LIVE

Lido
LISTENING TO THE DEEP-OCEAN ENVIRONMENT

http://www.listentothedeep.org/

(click on “Enter the bioacoustics page”, then “Ligurian Sea”)



Access to the Infrastructures

- Pylos
  - Navarino bay (50m)
  - Deep site (>3500m) new cable to be installed
- Catania
  - Test site (2000m)
    - 1 connector for KM3NeT R&D
    - 1 connector for associated science projects
  - Capo Passero (3500m)
    - 2 connectors for KM3NeT R&D
    - 1 connector for associated science projects
- Toulon (2500m)
  - Main junction box- 1 connector for KM3NeT R&D
  - Instrumentation line - recoverable platform for associated science projects
  - Secondary junction box - 1 connector for KM3NeT R&D
    - 4 connectors managed by Ifremer,
    - 1 acoustic link (next year)

All sites have policy to allow installation of equipment from external groups (suject to evaluation and verification of non-interference with NT operation)

Organizational/Sociological Issues

Culture of ESS and astropaticle communities rather different:

Astro: large collaborations, significant technical resources, multiple funding sources, alphabetical authorlists

ESS: many small independent groups, single funding source, prioritised authorlists

ANTARES:

Some ESS institutes pay to common fund for operation/maintenance of infrastructure
-> installation of sensors within infrastructure
-> immediate access to ALL data
-> author for all papers (Astro+ESS)
-> input to important decisions, voting rights

Other ESS institutes do not pay common fund
-> latency for access to selected data (unless special agreement with collab)
-> sign only their papers with acknowledgement to ANTARES
-> no input to important decisions
-> no voting rights

Publications:
ESS papers – main authors (prioritised) + “ANTARES Collaboration”

Summary

• neutrino telescopes are also deep-sea observatories

• High-power, real-time, continuous, high-bandwidth data transmission from innovative deep-sea sensors has opened new opportunities for the ESS sciences, many of which have important societal implications for monitoring of climate change, global warming, tsunami alerts, etc.

Oceanography,
Seismology,
marine biology
Acoustics
.....

• The combined expertise of the astroparticle and ESS communities has been (and will be) essential to address the tremendous technical challenges of building large-scale infrastructures in the deep Mediterranean Sea

• ESS community encouraged to propose additional projects at the 3 neutrino sites

• Larger KM3NeT/EMSO infrastructures currently in preparation will offer further opportunities-this is only the beginning