



The ANTARES adventure

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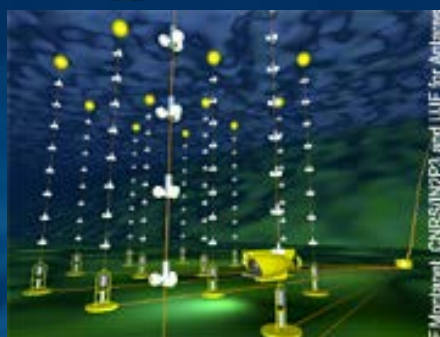
What's ANTARES?

The first undersea neutrino telescope ever and, for a long time, the largest neutrino telescope in the Northern hemisphere

A long-term, real-time, high-bandwidth deep submarine platform for Earth and sea sciences



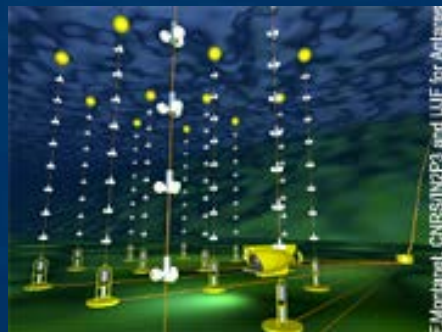
ANTARES: ninth scientific wonder of the world!



Colossal construction: The world's nine largest science projects
6/19/2008 11:27:00 AM - Dragana Kovacevic and Peter McMahon



ANTARES: ninth scientific wonder of the world!



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9. The ANTARES underwater neutrino detecting array

In short, ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch project) and its counterpart to South Pole neutrino telescopes AMANDA and IceCube Neutrino Detector is a telescope designed to look down while its more-traditional star-gazing cousins look up. Don't think there's much to see? Think again.

Neutrino telescopes are capable of detecting radiation produced by high energy muons (an elementary particle with a negative charge) that is the result of Earth-core-penetrating neutrinos (an elementary particle with zero charge and zero mass) that enter our planet's southern hemisphere.

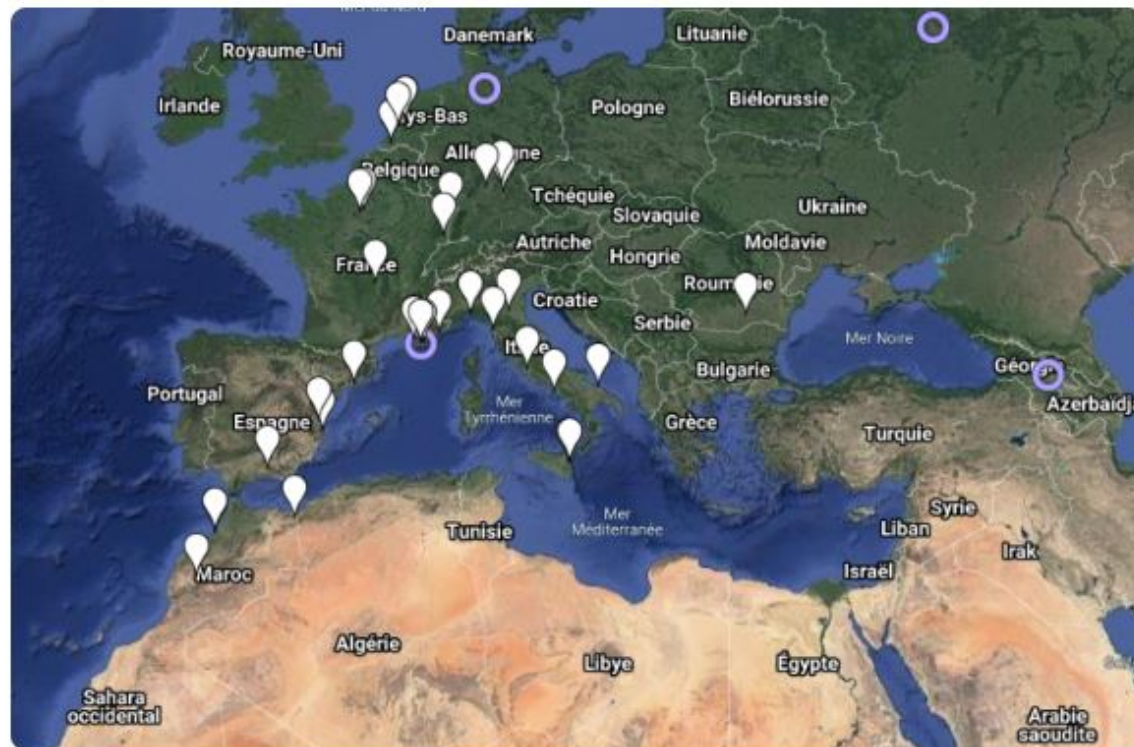
Adding to its all-around neatness, ANTARES is built at the bottom of the Mediterranean Sea, off the coast of Toulon, France. It will compliment the research of its counterparts in the South Pole, neutrino telescopes AMANDA and IceCube Neutrino Detector.

The primary aim of the experiment is to use neutrinos as a tool to study particle acceleration mechanisms. It just might revolutionize the way we see and think about what's beneath our feet, and how it relates to what's above our heads: the universe. ([more...](#))



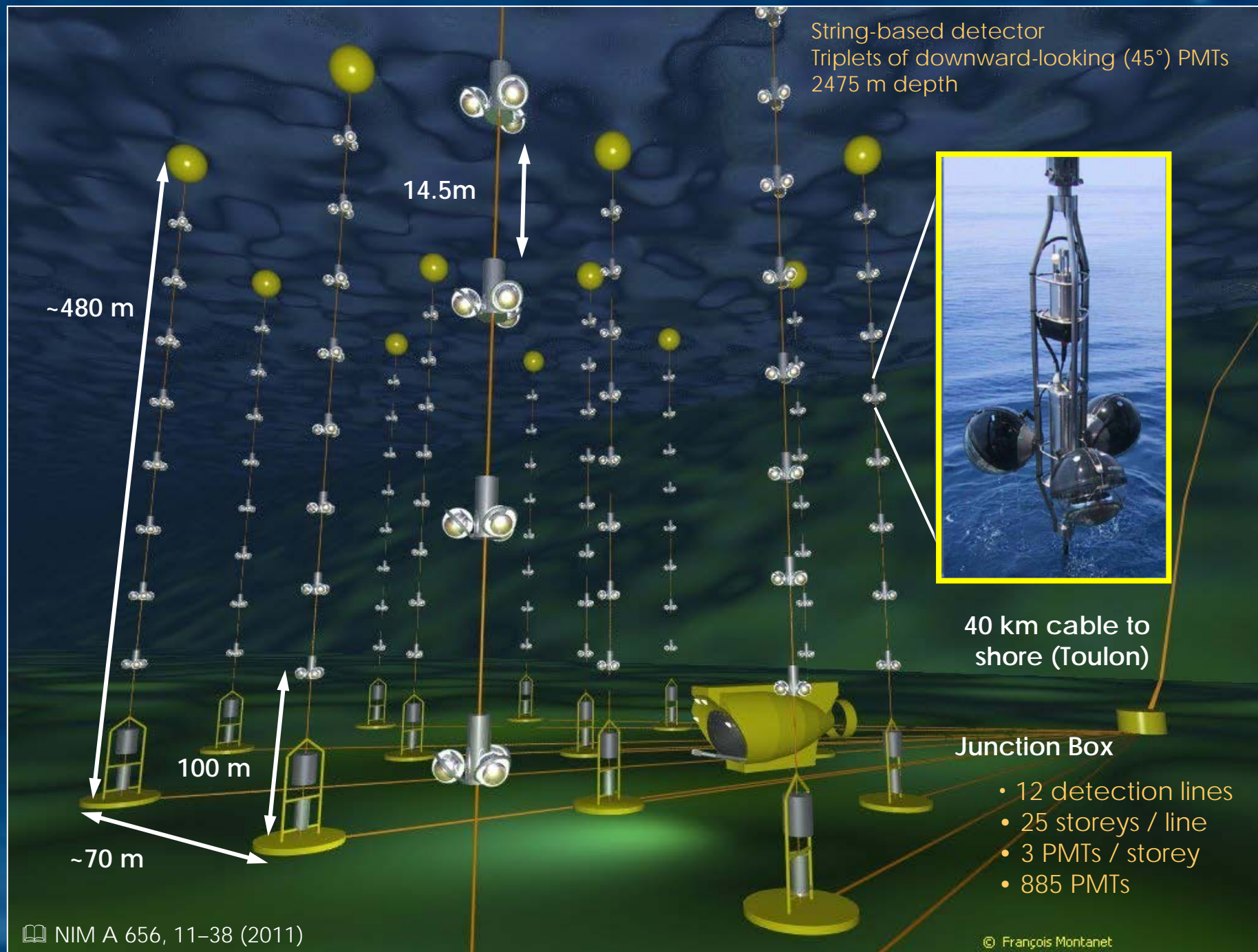
The ANTARES Collaboration

The ANTARES collaboration is composed of around 150 engineers, technicians and physicists from different institutes principally located in Europe



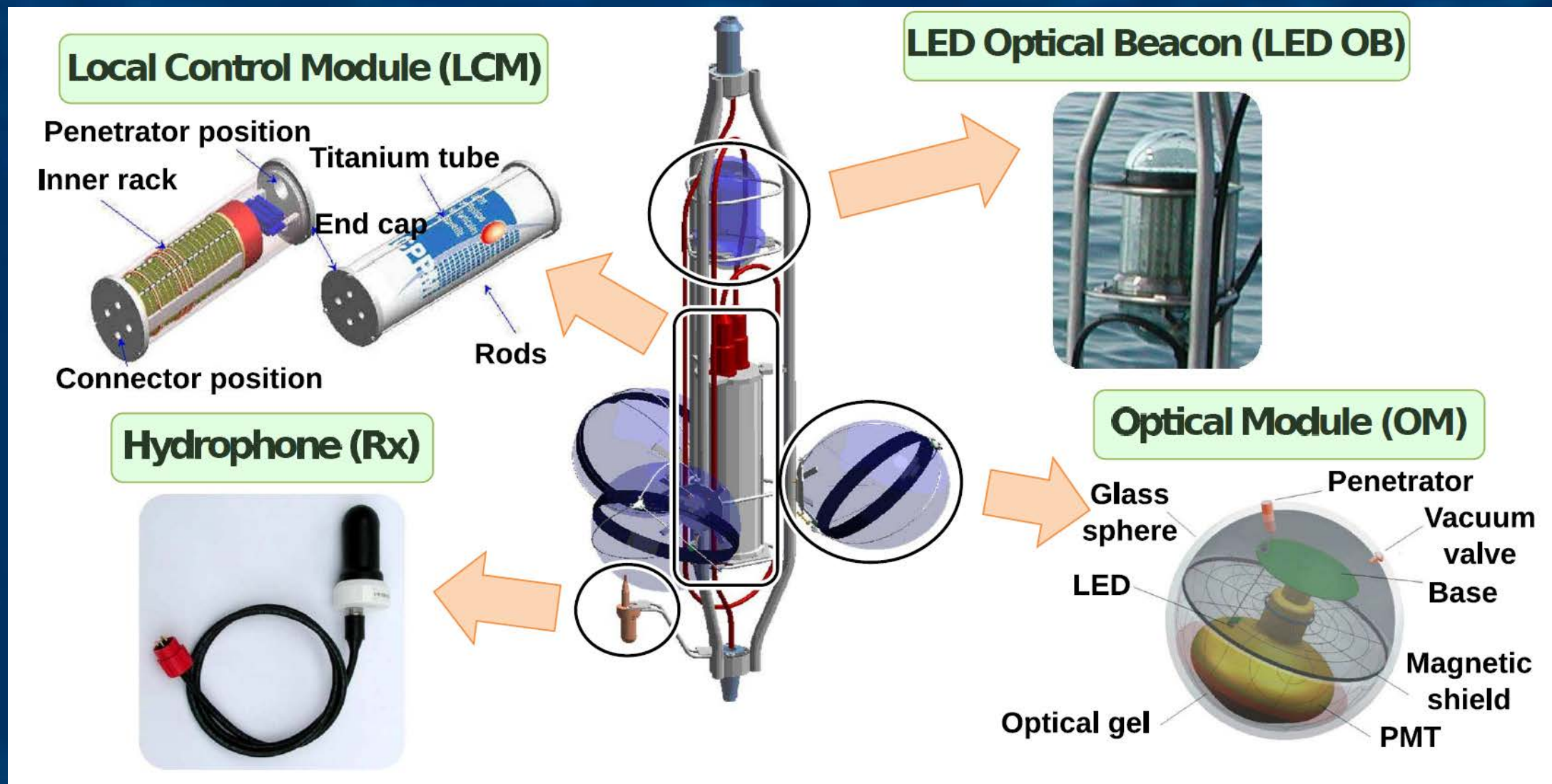


The ANTARES apparatus





The ANTARES (optical) storey



- 25 storeys per line = 5 sectors (except L12)
- Two storey types:
 - Optical (shown above) some with LED optical beacon and some with hydrophone



The ANTARES optical module



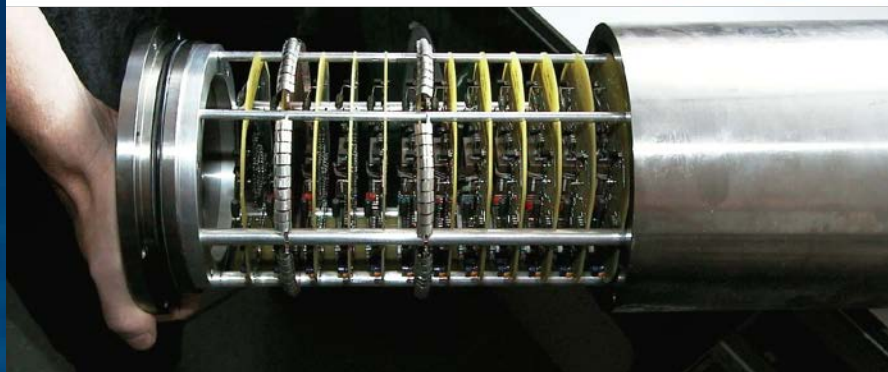
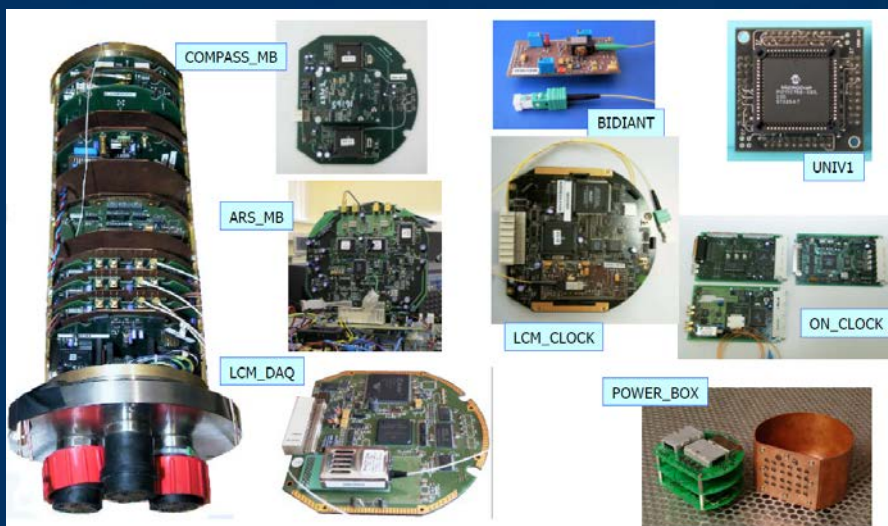
- Borosilicate sphere, 17" (~43 cm), $n \sim 1.47$
- PMT: 10" Hamamatsu R7081-20 ($\uparrow 22\%$ QE)
300 - 650 nm [$\uparrow 420$ nm]
TTS $\sim 3,5$ ns
- μ -metal cage (TTS)
- Optical gel (matching the optical properties of borosilicate)
- Internal LED pulser



Electronics and hydrophones

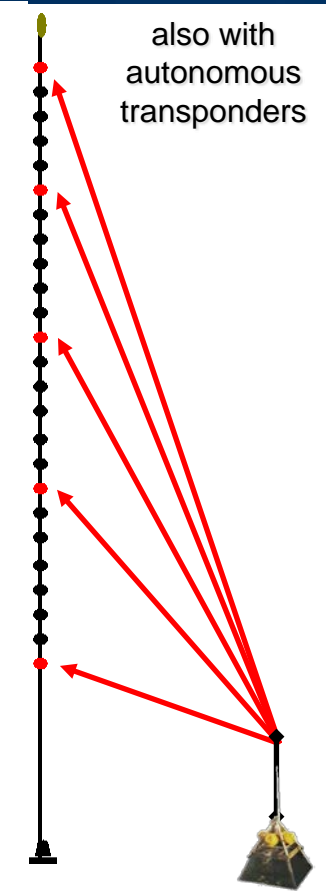
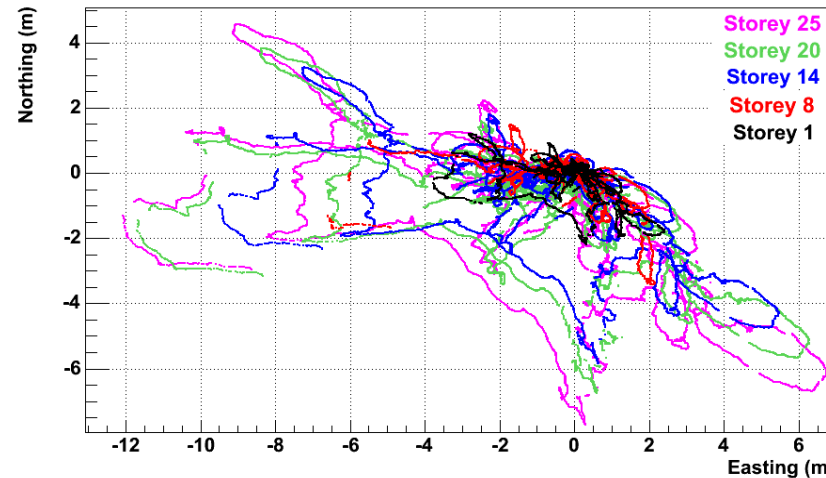
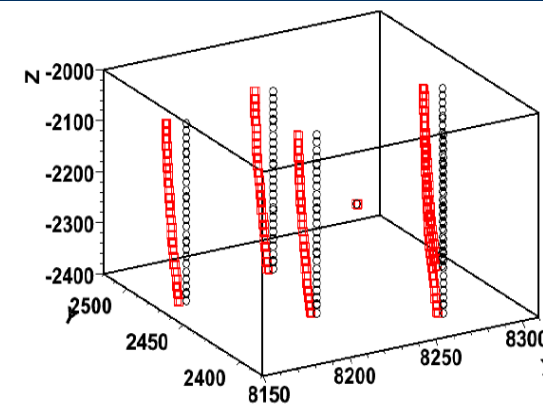
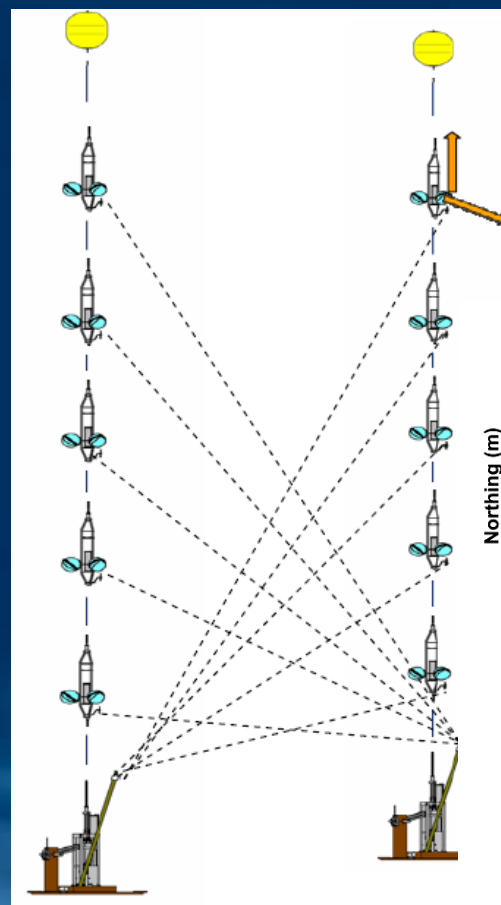
Local Control Module

- Front-end ASIC
- DAQ/SC
- DWDM
- Clock
- tilt/compass
- power distribution



Acoustic Positioning

- 5 Rx per line (floors 1, 8, 14, 20, 25)
- 1 RxTx (on anchor) + pressure sensor + sound velocimeter per line
- High frequency (40-60 kHz) Long Base Line
- Measurement cycles every 2 minutes
- Acoustic positioning (triangulation): $< 10\text{ cm}$





The optical beacon (OB)

- 4 LED OB per line (floors 2, 9, 15, 21)
- Several storeys illuminated
- 36 LEDs per capsule + 1 fast mini-PMT

472 nm (blue)

$T_{\text{rise}} 1.8 \rightarrow 2 \text{ ns}$

FWHM 4.5 \rightarrow 6.5 ns

- Special editions:

- X-mass beacon @ L06F02

(385/400/440/472/460/505/518 nm)

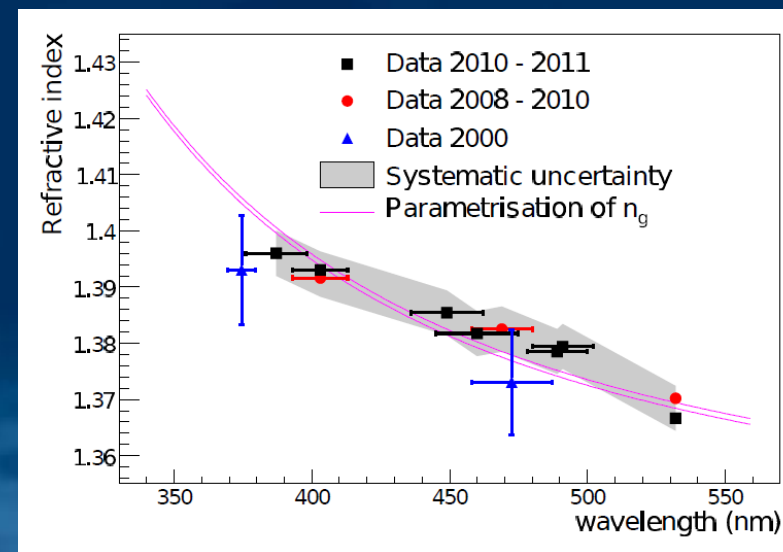
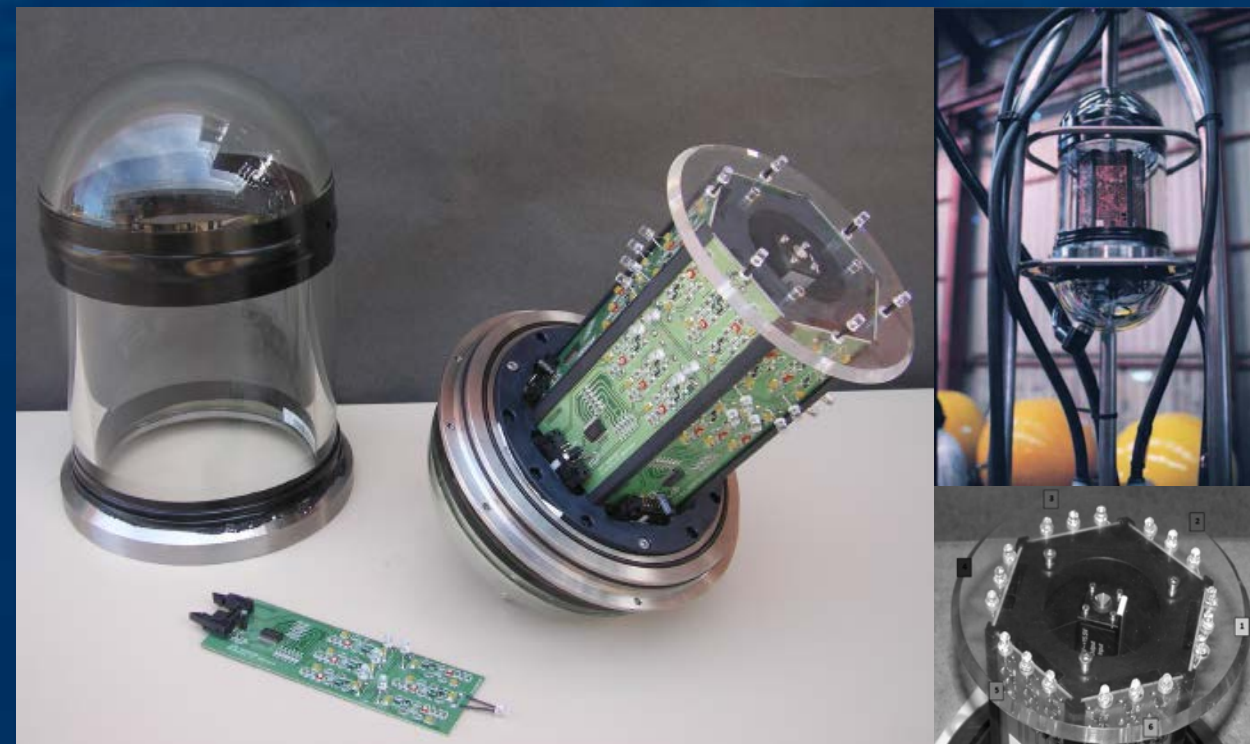
- UV LED beacon @ L12F02

(400/470 nm)

- Nanobeacons @ L09F01 OMs

(470 nm)

- In-situ time calibration + optical properties of water





The laser beacon

- Installed on L08 + IL (special edition)
- All lines illuminated
- Titanium container with quartz rod
- Nd-YAG laser: NG-10120-120

532 nm (green)

<1 ns ~1 μ J pulses

- In-situ time calibration + optical properties





The Bottom String Socket (BSS)

- It hosted a String Control Module equipped for wet-mateable connection
- Equipped with an acoustic release (and automatic disconnection system for the interlink cable)
- Acoustic emitter for positioning triangulations





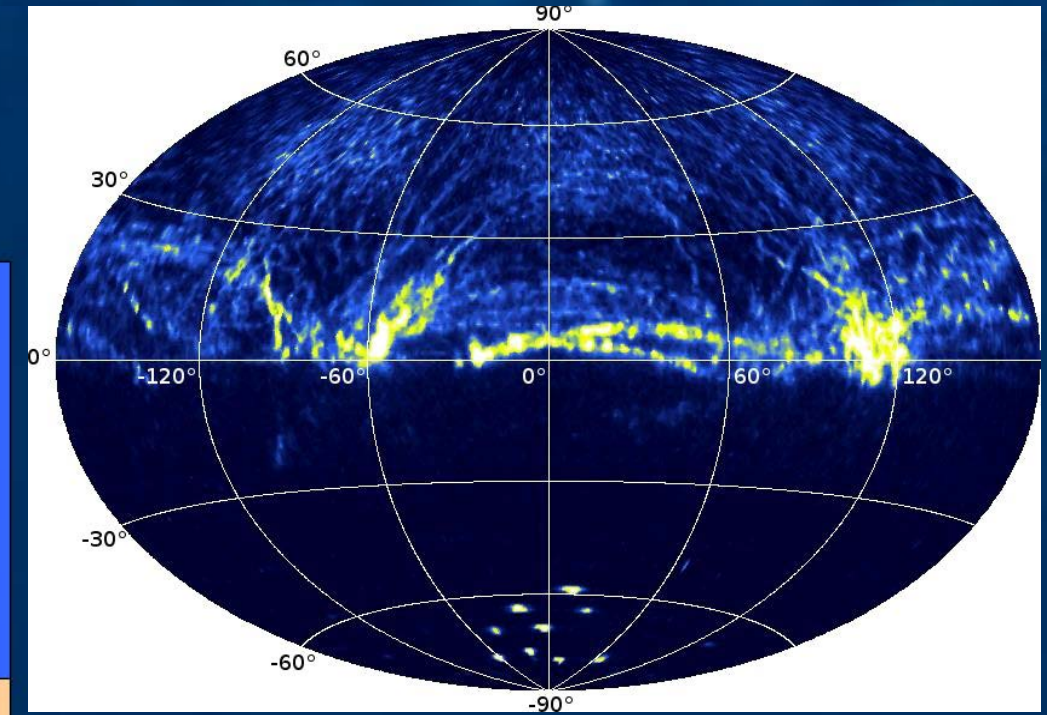
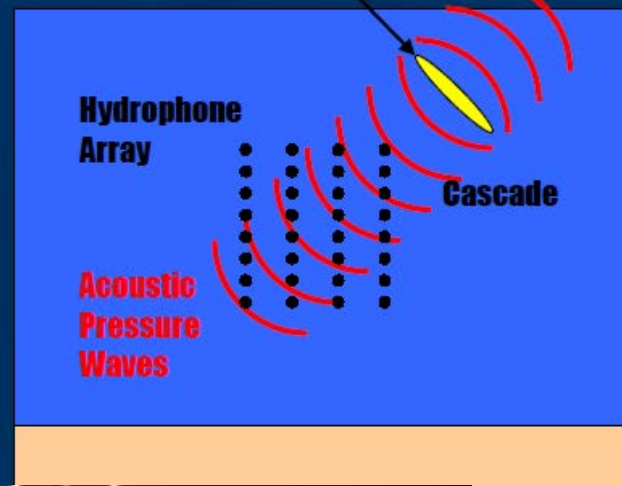
AMADEUS

AMADEUS comprised a series of hydrophones on the Instrumentation Line and L12

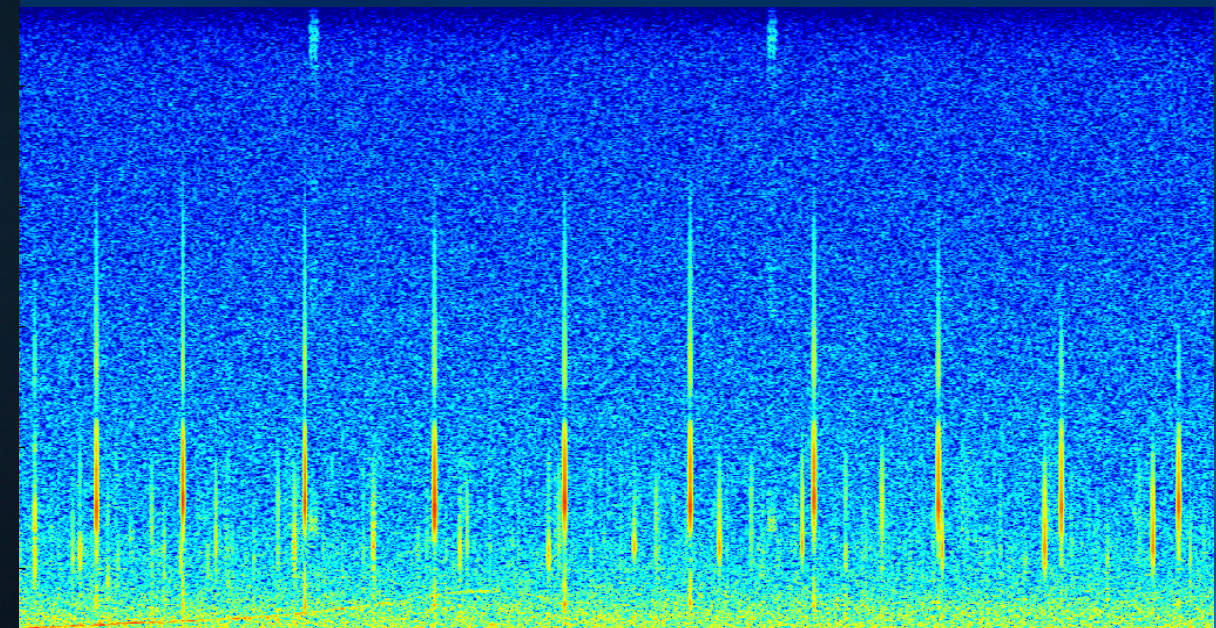
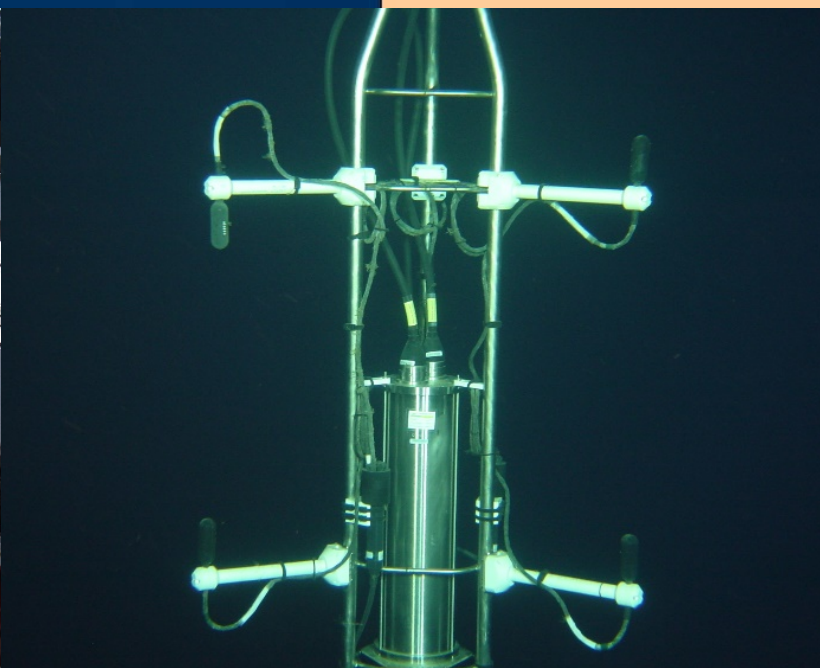
UHE neutrino detection

All types of transient signals detected, sea mammals, ships, etc.

neutrino



Direction reconstruction from one storey

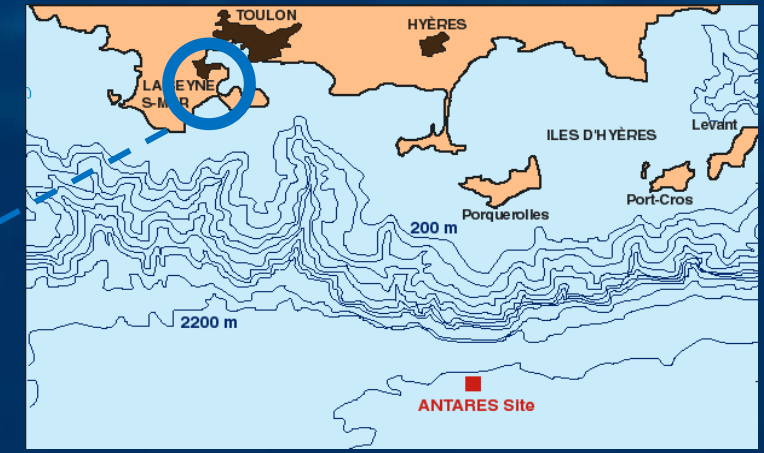




The ANTARES shore station

Land Cable
(Fibre optics)

Power Hut
Les Sablettes



Shore Station
Villa Michel Pacha

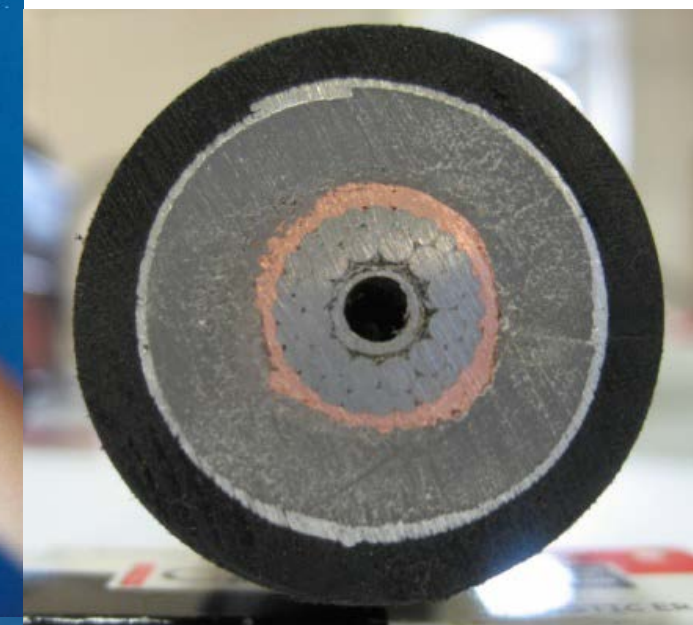
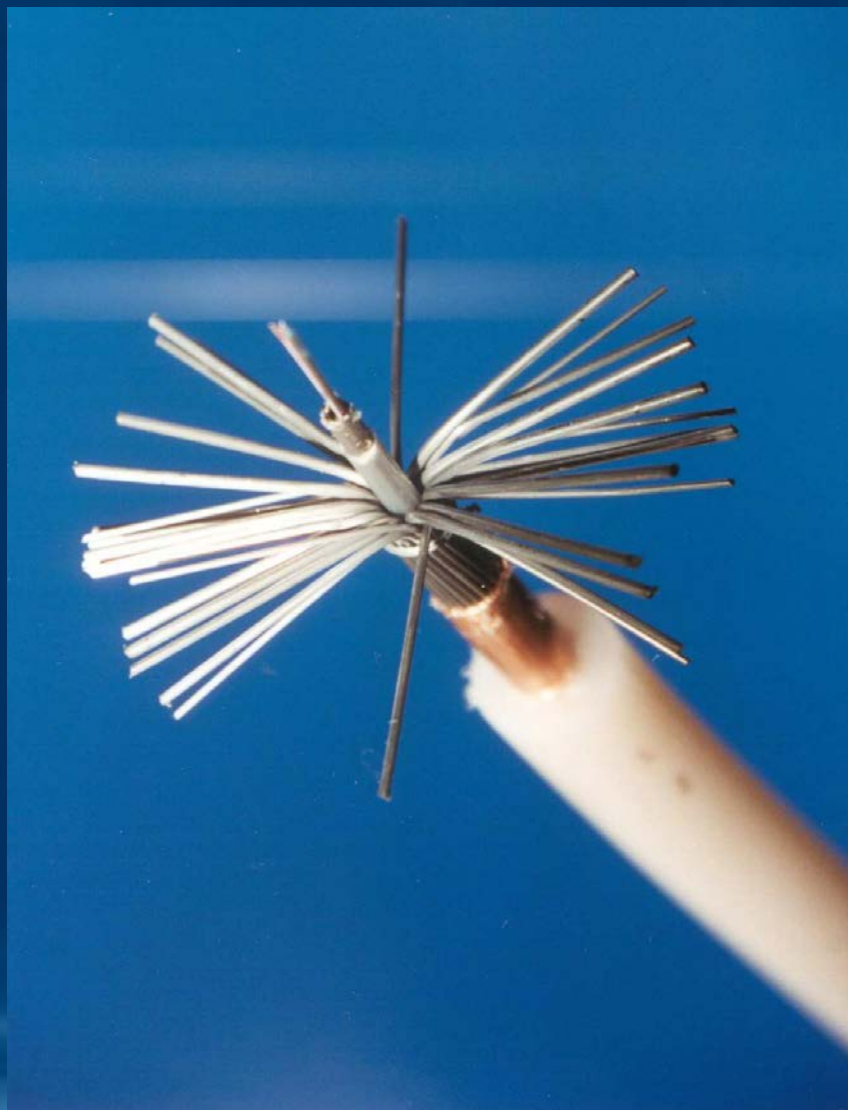
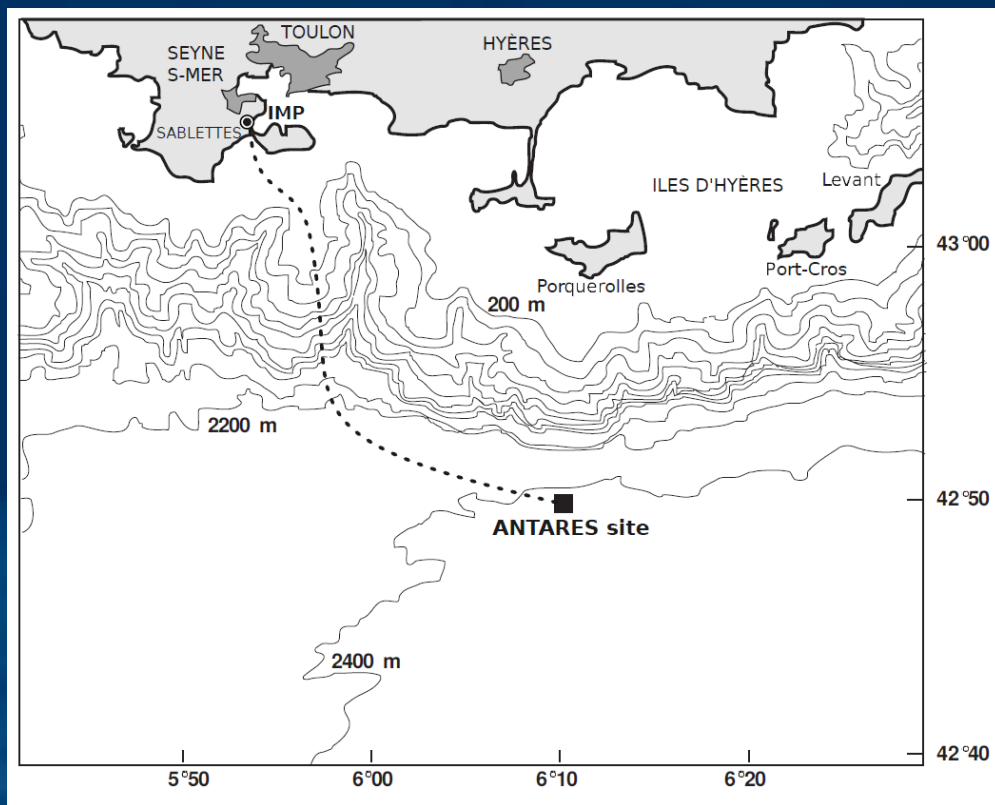
Submarine
(Fibre optics + power)





The main electro-optical cable (MEOC)

- 45 km ALCATEL electro-optical cable
- 1 conductor + 48 optical fibres
- Current return is done by sea anode
- Protection regarding the zone





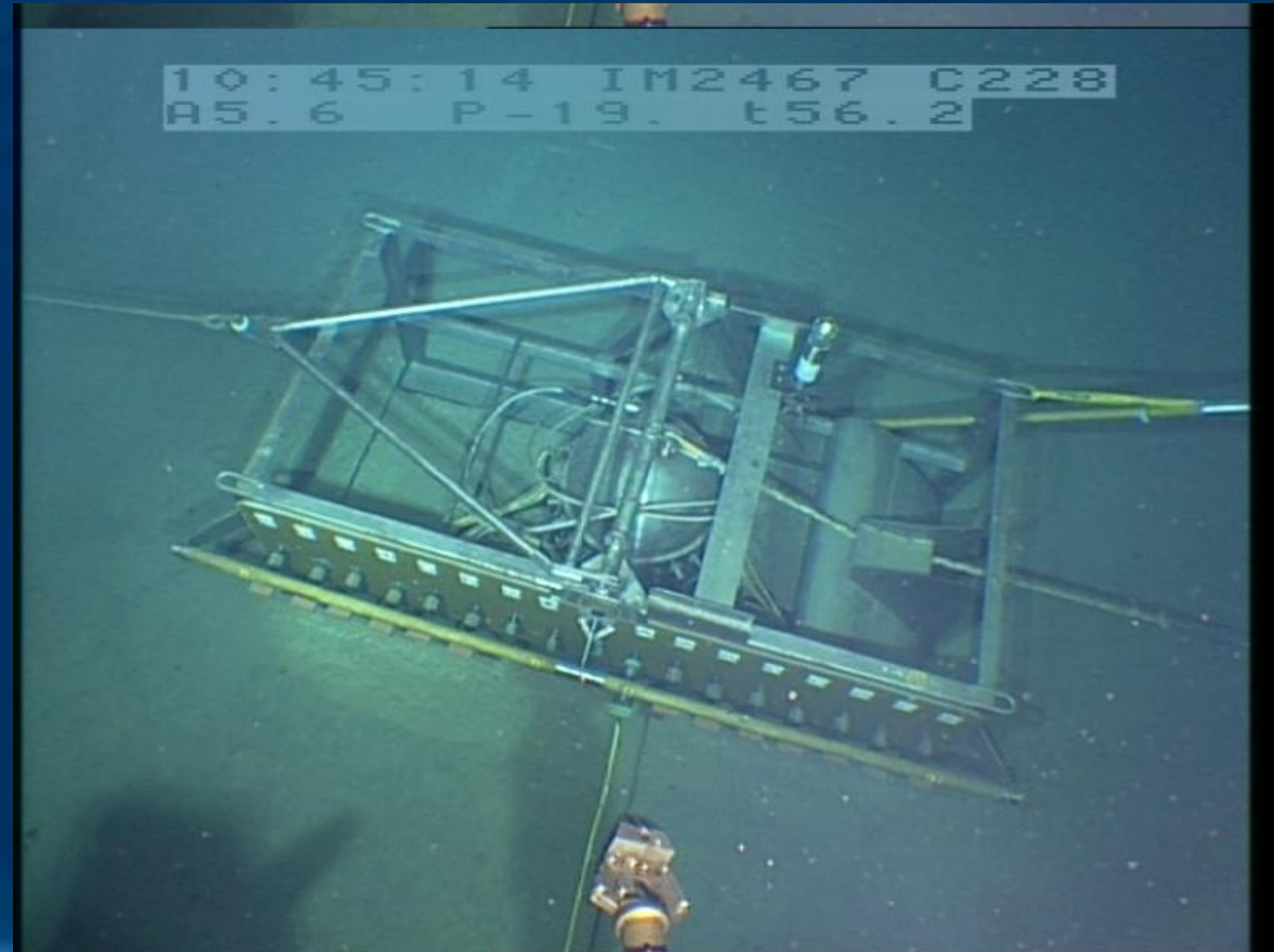
The submarine Junction Box (JB)

Two main tasks:

- Power distribution to detector lines (transformer 3000 VAC[®] 16x 500 VAC)
- Data collection from detector lines (Ethernet DWDM with 6x 1Gb/s per line)

Equipped with 16 outputs

It worked for 20 years in the sea without any maintenance!!





Into the deep!





Site evaluation (1997-1999)

Floor inspection



Cyana
(manned sub)

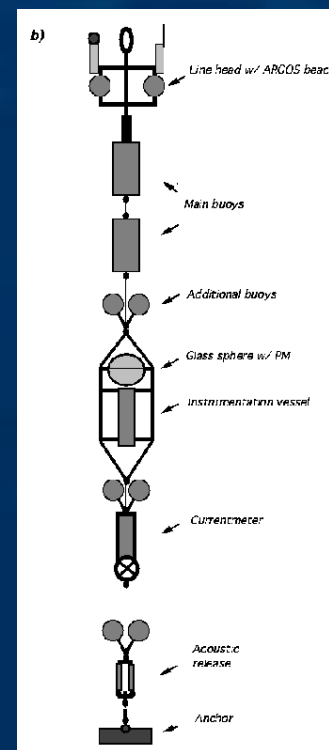


XVII century cannon

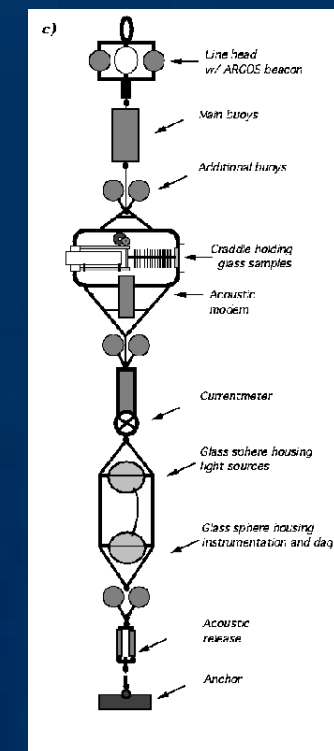
- ~1 big object per ha
- Deployment 5m accurate

(all large objects around detector location measured)

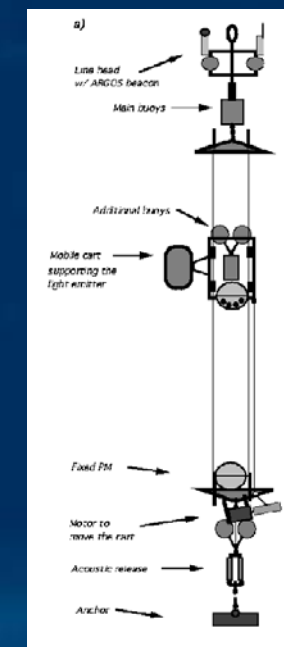
- Optical background studies: 15 deployments
- Biofouling-sedimentation studies: 4 deployments
- Optical properties studies: 28 deployments
- And sea variables (sea current, temperature, etc.)



Optical background



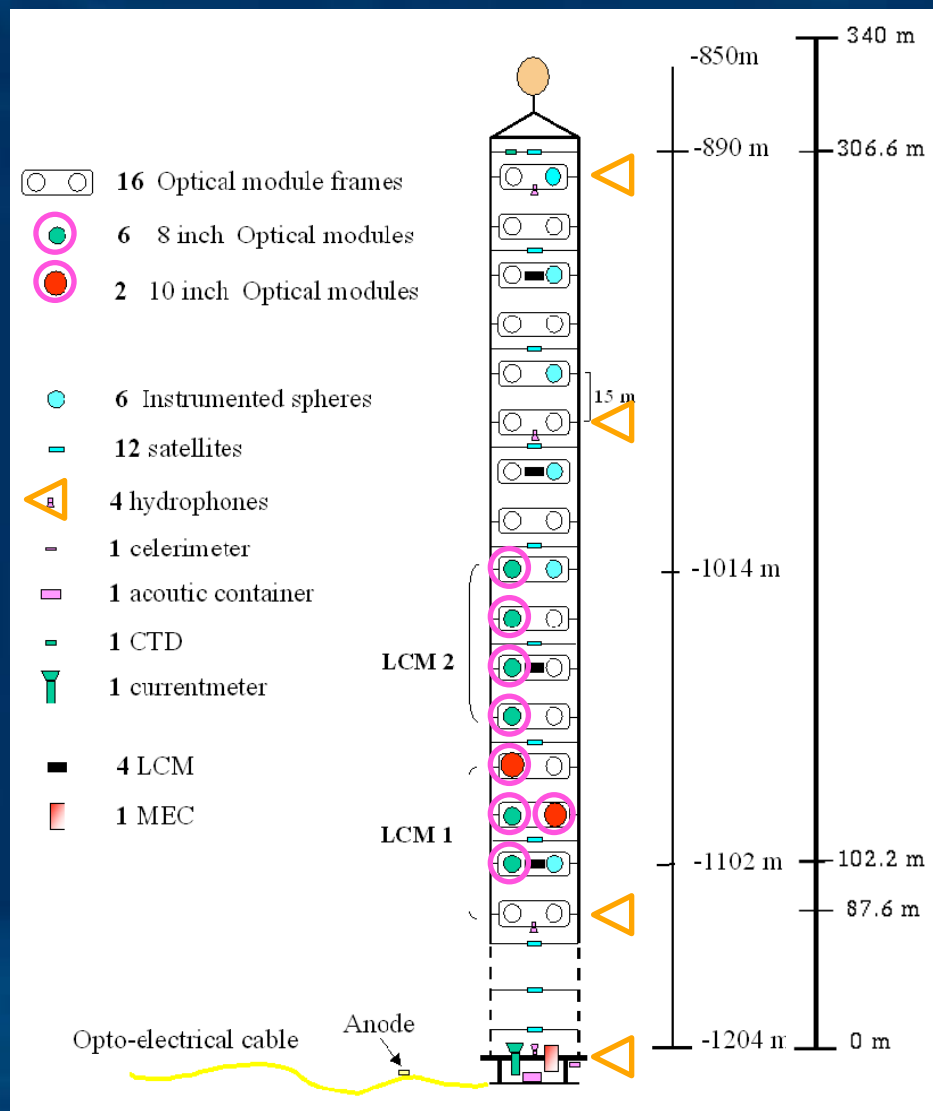
Optical fouling



Light attenuation



Demonstrator line (1998-2000)



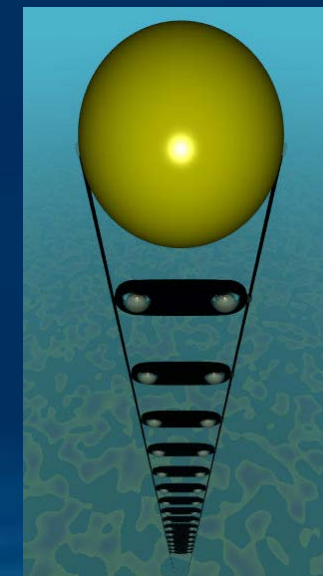
Deployment test @ 2300 m (Summer'98)

Cable connection test @ 2400 m (Dec'98)



Operation of instrumented line linked to shore station (Nov'99 – Jun'00)

- 7 PMTs: 6 x 8", 2 x 10" hemispherical phototubes
- CTD, tiltmeters, acoustic positioning system
- Deployment site: 40 km from Marseille at 1100 m
- Read out via 37 km electro-optical cable (cable donated by France Télécom)
- > 50k 7-fold coincidences (down-going muons)



Proved acoustic positioning system (< 5 cm accuracy) and reconstruction of cosmic-ray muons



Starting of detector construction (2001-2002)

MEOC installation
October 2001



Junction Box deployment
December 2002





The prototype lines (2002-2003)

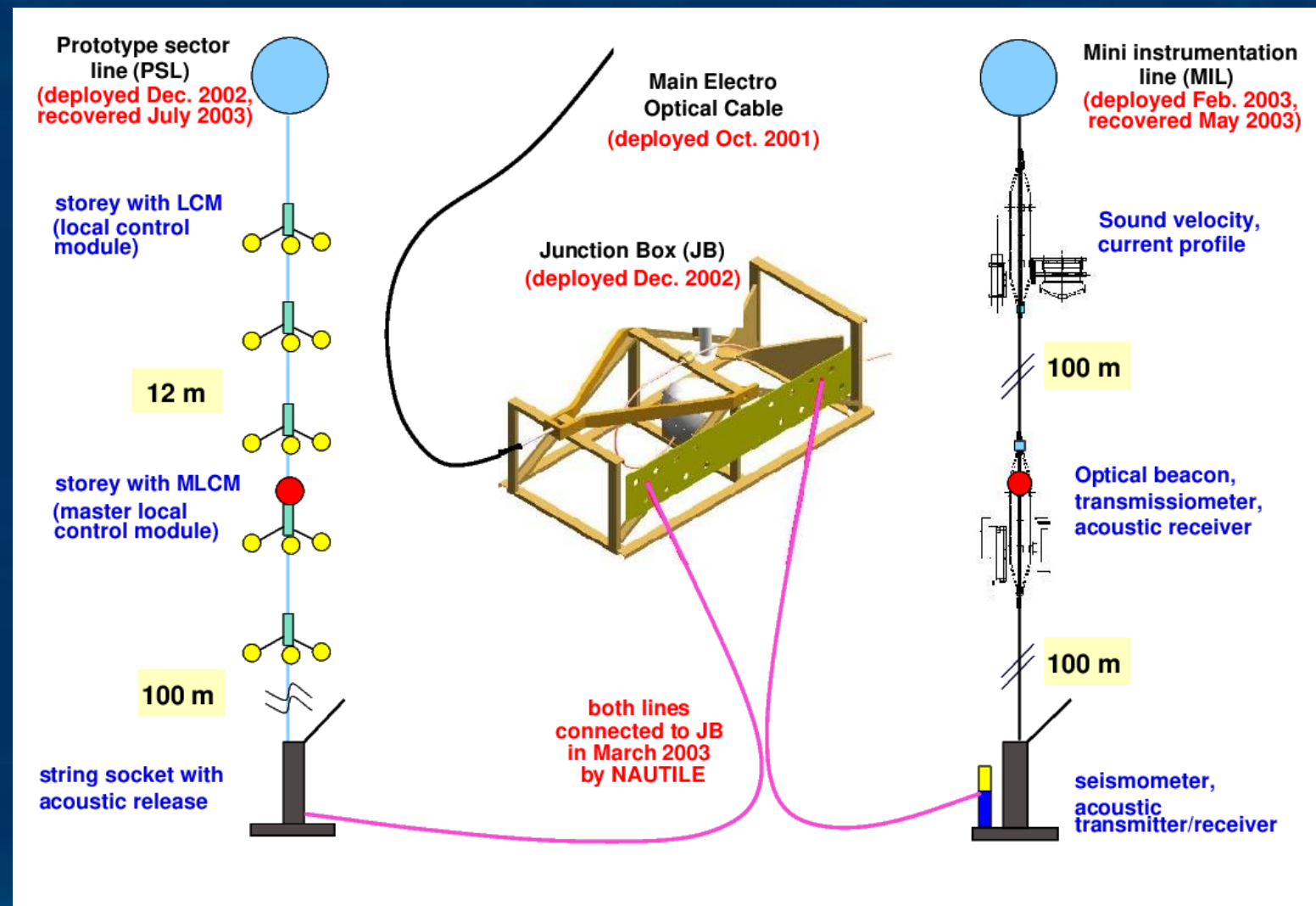
Prototype Sector Line (PSL)

Deployed: Nov'02
Connected: Mar'03
Retrieved: Jul'03

Mini-Instrumentation Line (MIL)

Deployed: Feb'03
Connected: Mar'03
Retrieved: May'03

Indicated certain problems with loss of optical transmission in the line electro-mechanical cables (EMC), plus leaks in the cables and containers





New prototype structures (2005)



Line zero

Deployed: Mar'05
Connected: Apr'05
Recovered: May'05

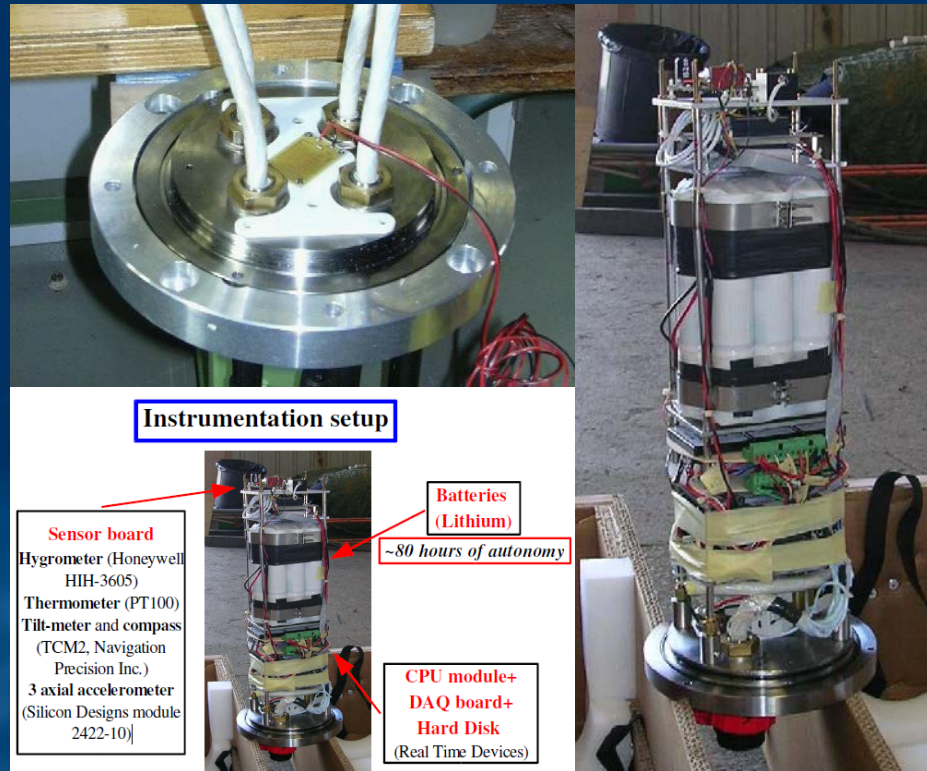
An “empty” ANTARES line

No leaks!

No evidence of critical shocks!

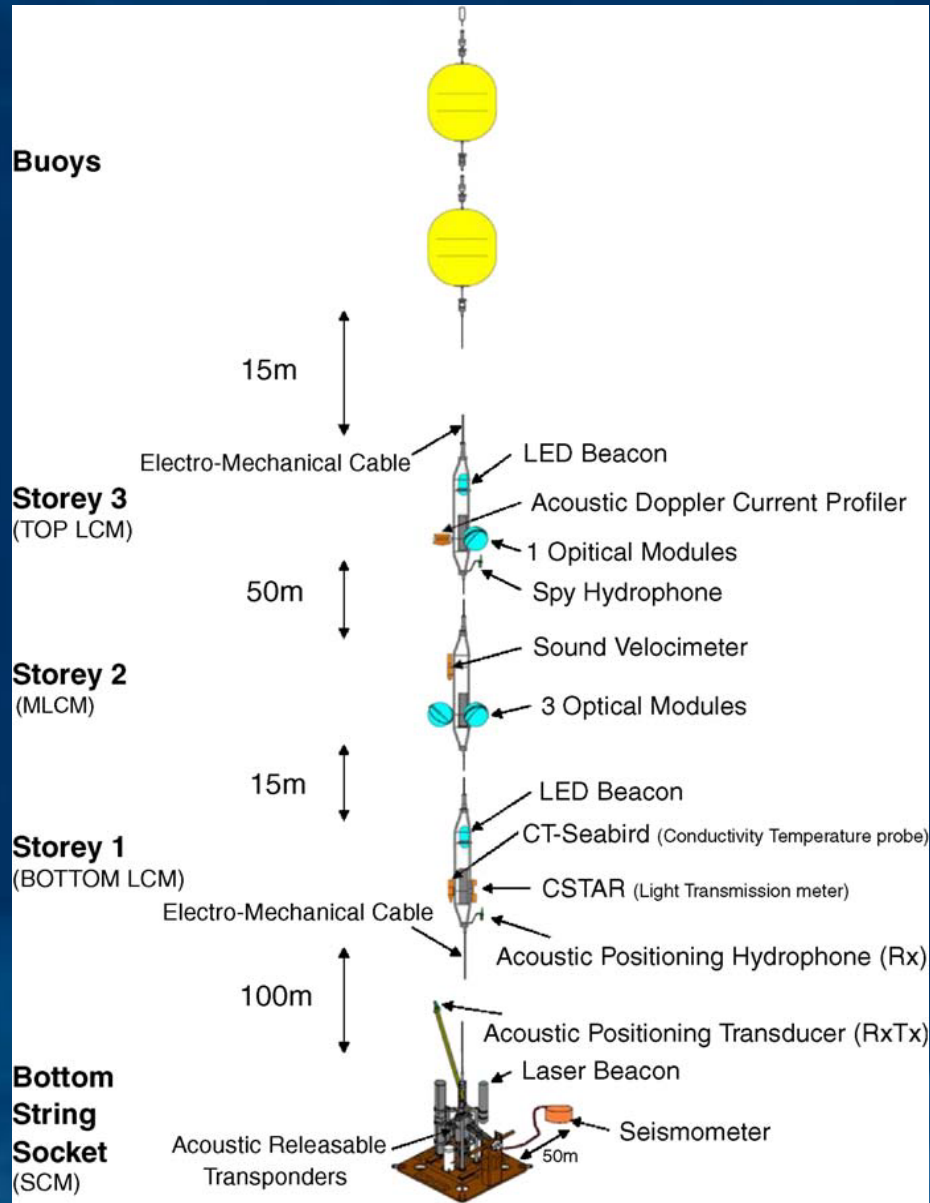
Understanding of previous problems on optical losses

Great experience for production!





New prototype structures (2005)



MILOM

Deployed: Mar'05
 Connected: Apr'05
 Recovered: Apr'07

Great experience for production and detector operation!



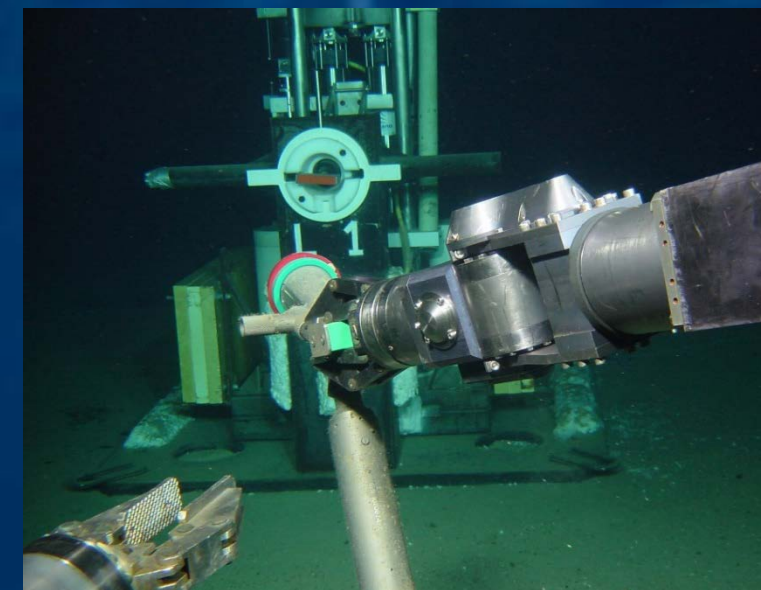


The first ANTARES line (2006)

Deployment: 14 February 2006

Connection: March 2006

Disconnection and recovery: February 2022





Installation of the ANTARES lines

1st: a pallet hosting a complete line is moved onto the deck of the deployment ship

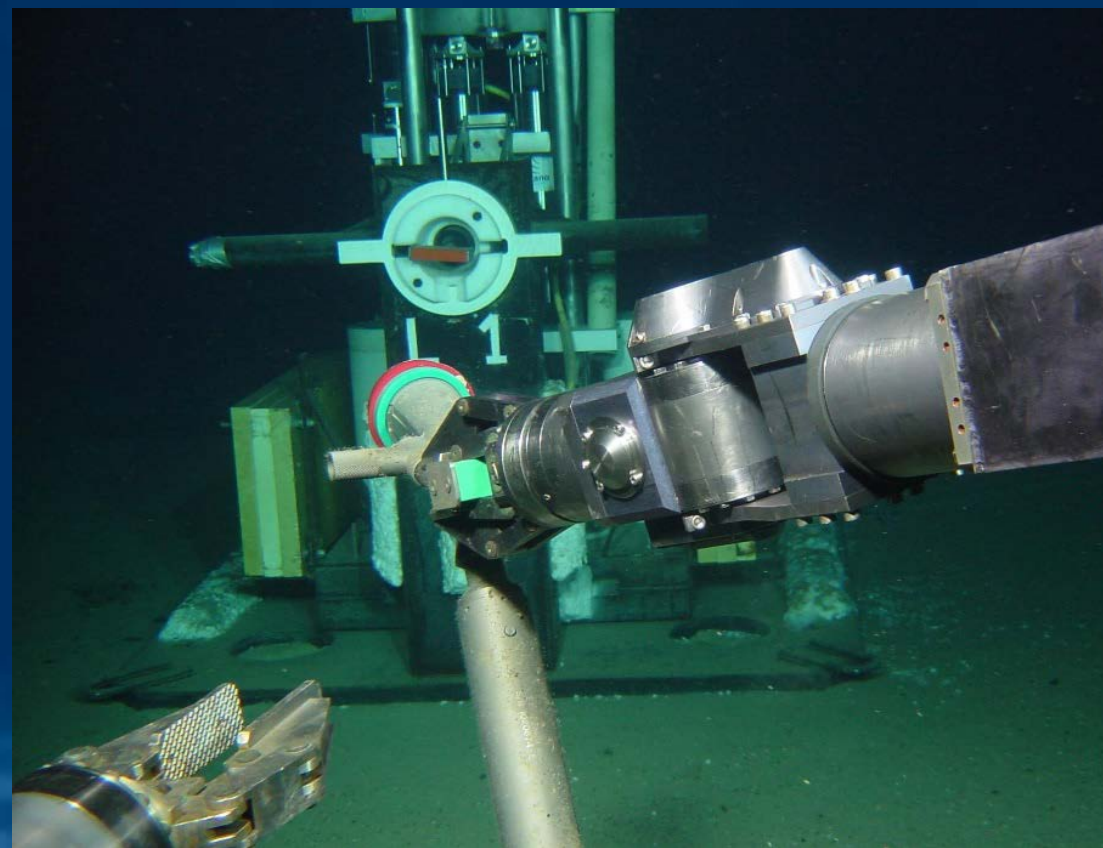
2nd: once on site, the BSS, the storeys and the top buoys are, one by one, handled overboard





Installation of the ANTARES lines

- 1st: a pallet hosting a complete line is moved onto the deck of the deployment ship
- 2nd: once on site, the BSS, the storeys and the top buoys are, one by one, handled overboard
- 3rd: the line is carefully deployed on the sea bottom
- 4th: an underwater vehicle connects the line to the submarine Junction Box

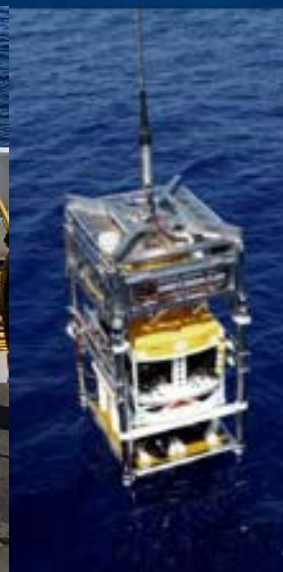




The underwater vehicles

Cable connections
[Remotely Operated Vehicle]

VICTOR (IFREMER)



COUGAR



Apache (COMEX)

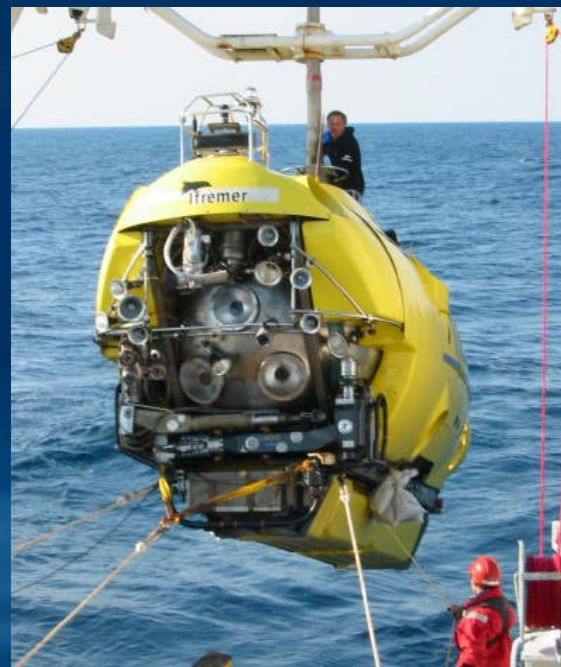


Cyana (IFREMER)

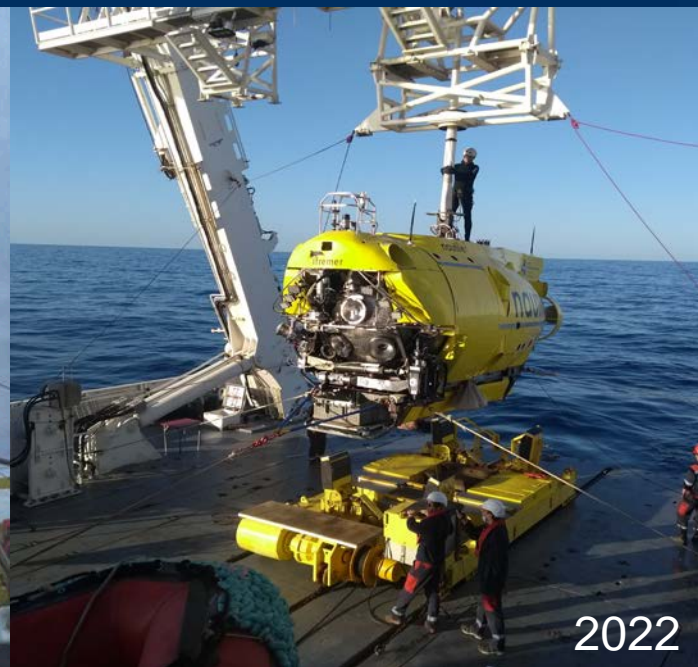
Site inspection

[Manned Submersibles]

NAUTILE (IFREMER)



2001



2022

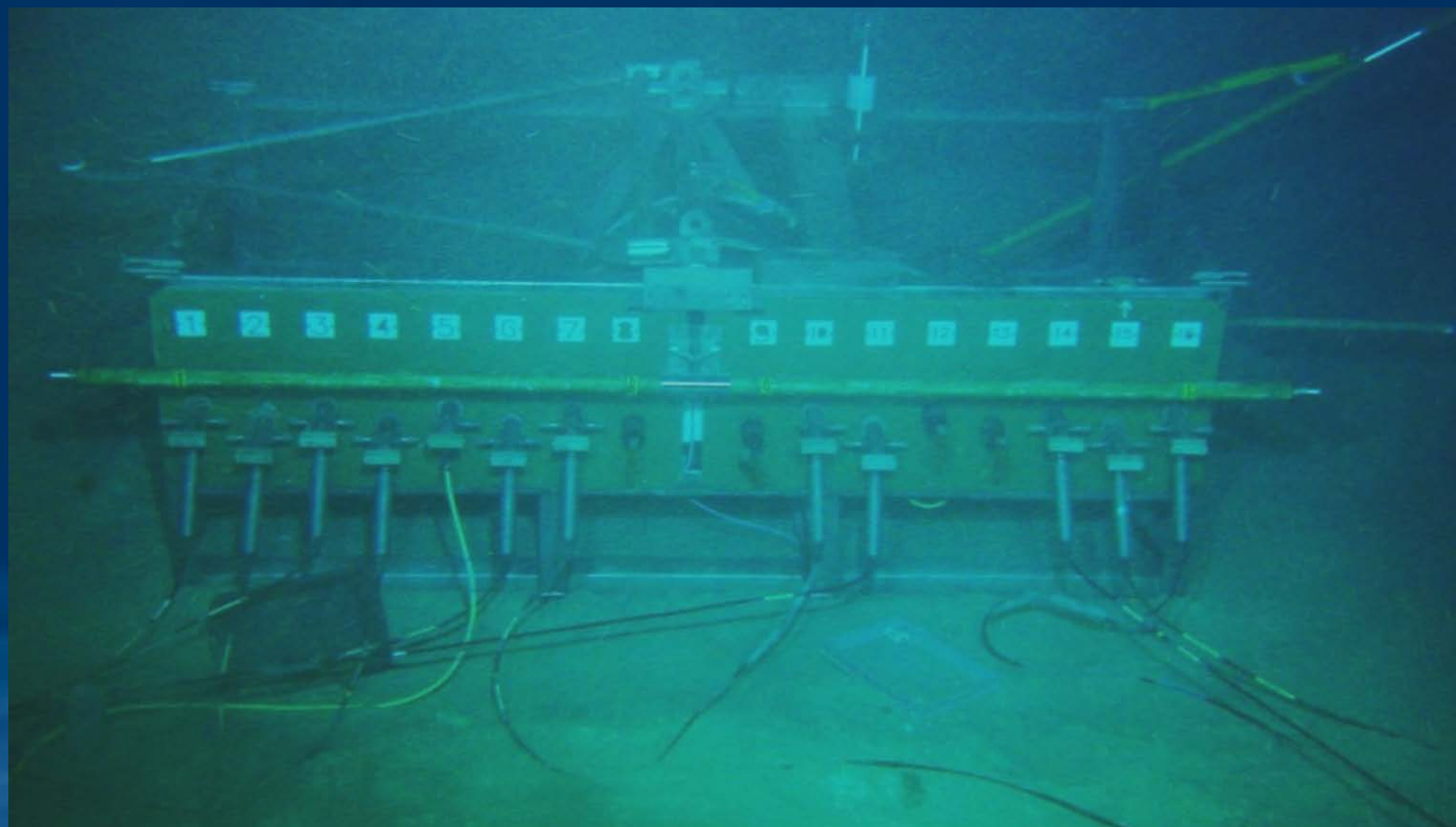


Detector construction and operation (2006-2022)

All lines installed by May 2008

Smooth (more or less!) data taking until 2022

3 lines recovered and redeployed after refurbishment in 2009-2011



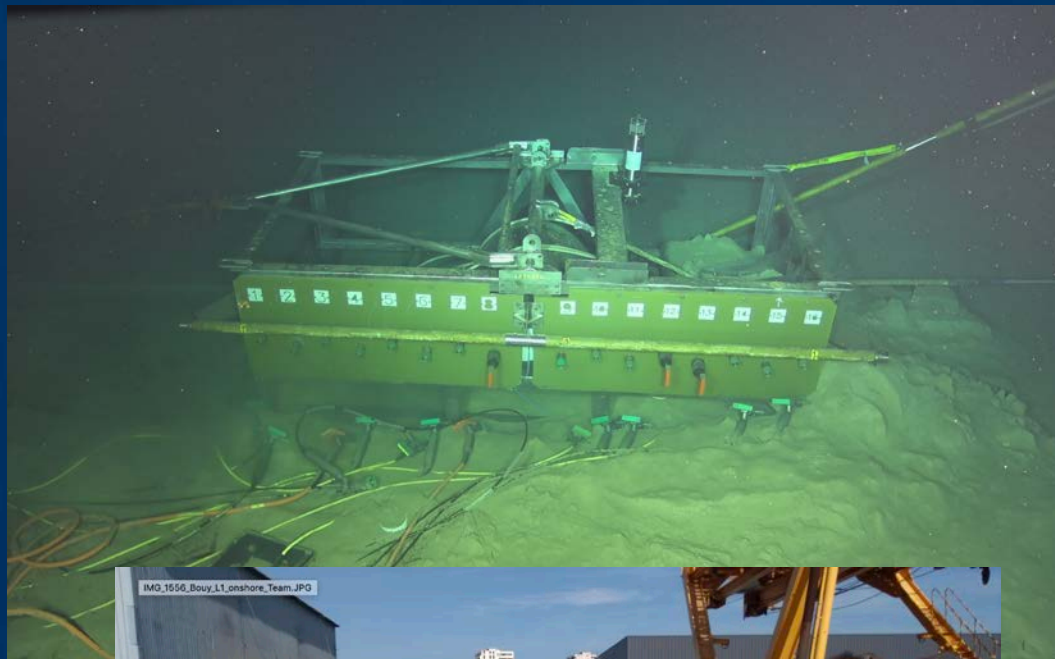


Every journey has an end
2022



The ANTARES dismantling

Dismantling of ANTARES took place in February 2022





The ANTARES legacy

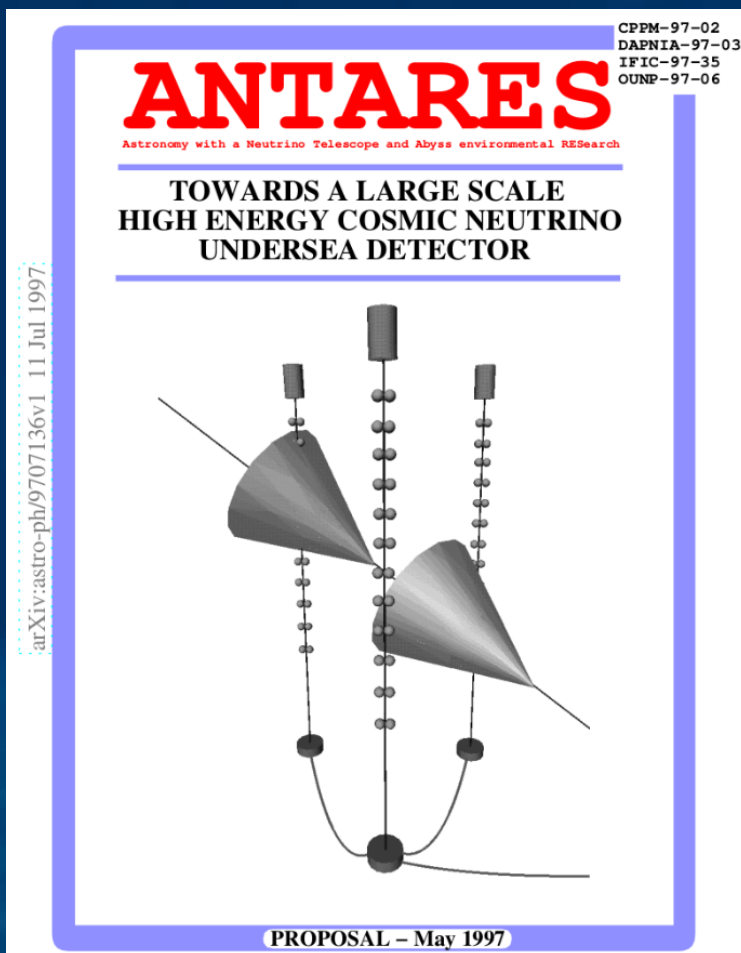
A variety of results produced in 16 years of data taking!

Legacy papers being published

We went well beyond all expectations

And... perhaps this is not the real end, as KM3NeT has taken over!

Message ID: 46719	Entry time: Sat Jun 18 23:51:28 2022	Reply to this: 46720
Author:	Brunner J	
Run_Type:	Sea operation	
Subject:	Antares dismantling	
The recovery of the PPM-DOM, the first prototype of the future KM3NeT DOMs, still in good shape. This marks the passage to the next generation - KM3NeT		
The yellow cylinder is an ADCP (Acoustic Doppler Current Profiler), the other glass sphere contains a Biocam		



The first DOM of KM3NeT ever operated in the sea (installed on the instrumentation line of ANTARES in 2013)



We propose to build and install a demonstrator (a fully equipped 3-dimensional test array) the design of which can be extended to a km³ scale detector.