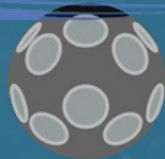




KM3NeT
arca&orca



KM3NET FROM THE COSMOS TO THE SEA

LIZETH MORALES GALLEGOS

ON BEHALF OF THE KM3NET COLLABORATION



Università
degli Studi
della Campania
Luigi Vanvitelli



Neutrino Telescopes

Idea: John Learned and Mark M. Boliev (1960s)

Primary motivation: Limitations of conventional telescopes (hindered by absorption, scattering and electromagnetic interactions).

Characteristics:

- Large volume of transparent material (typically water or ice) instrumented with 3D arrays of detectors.
- Ordered string-like structures

Detection principle

Detection of Cherenkov photons emitted by relativistic charged secondary leptons from ν interactions.

Time, position, and amplitude of photon pulses are used to reconstruct ν direction and energy.

$$\theta_{\nu\mu} \approx \frac{1.5^\circ}{[E_\nu(\text{TeV})]^{1/2}}$$





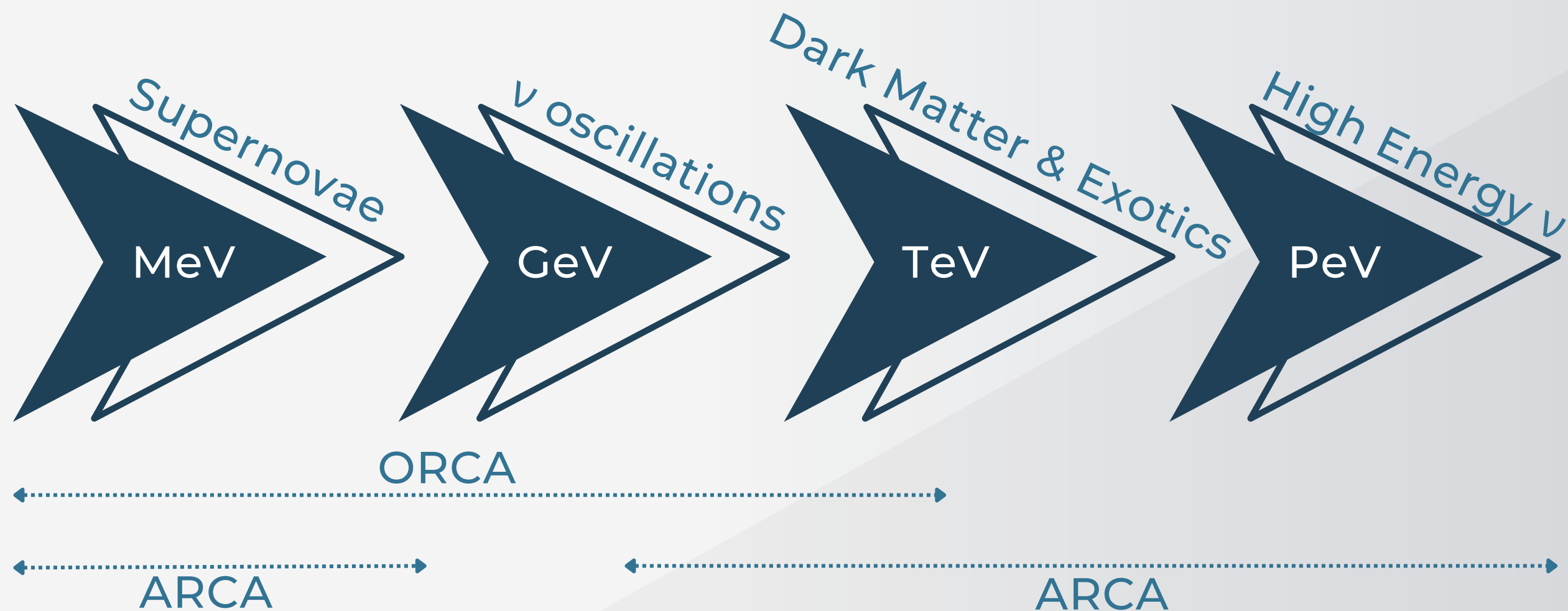
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ORCA: Oscillation
(France)

Research with
Cosmics in the
Abyss

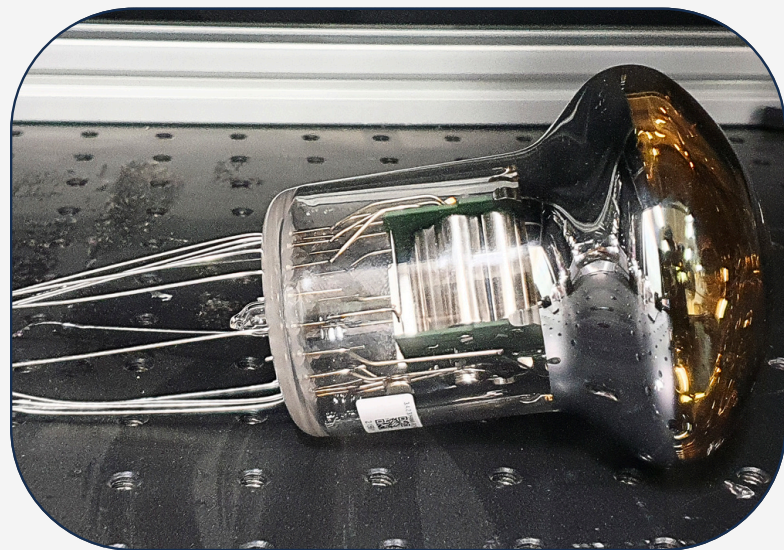
ARCA: Astroparticle
(Italy)





Same principle and technology
Complementary goals

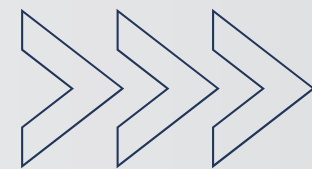
KM3NeT technology



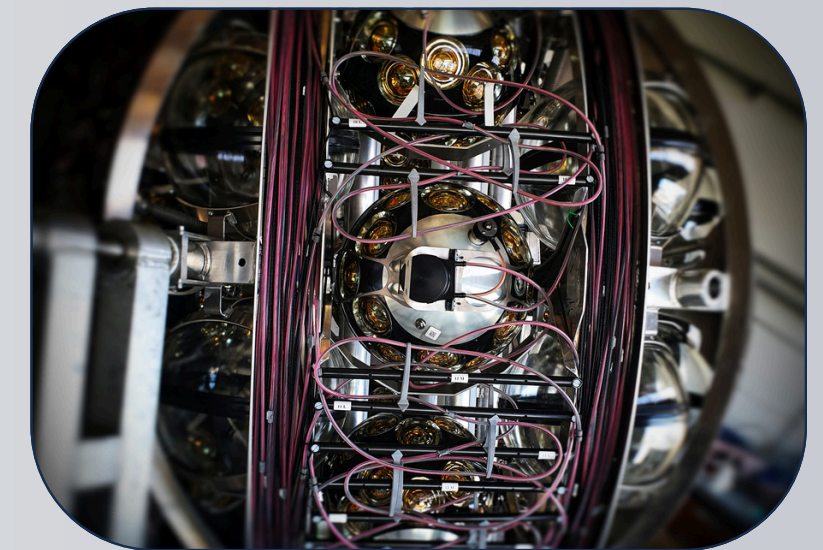
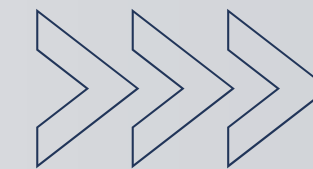
PMTs



DOM

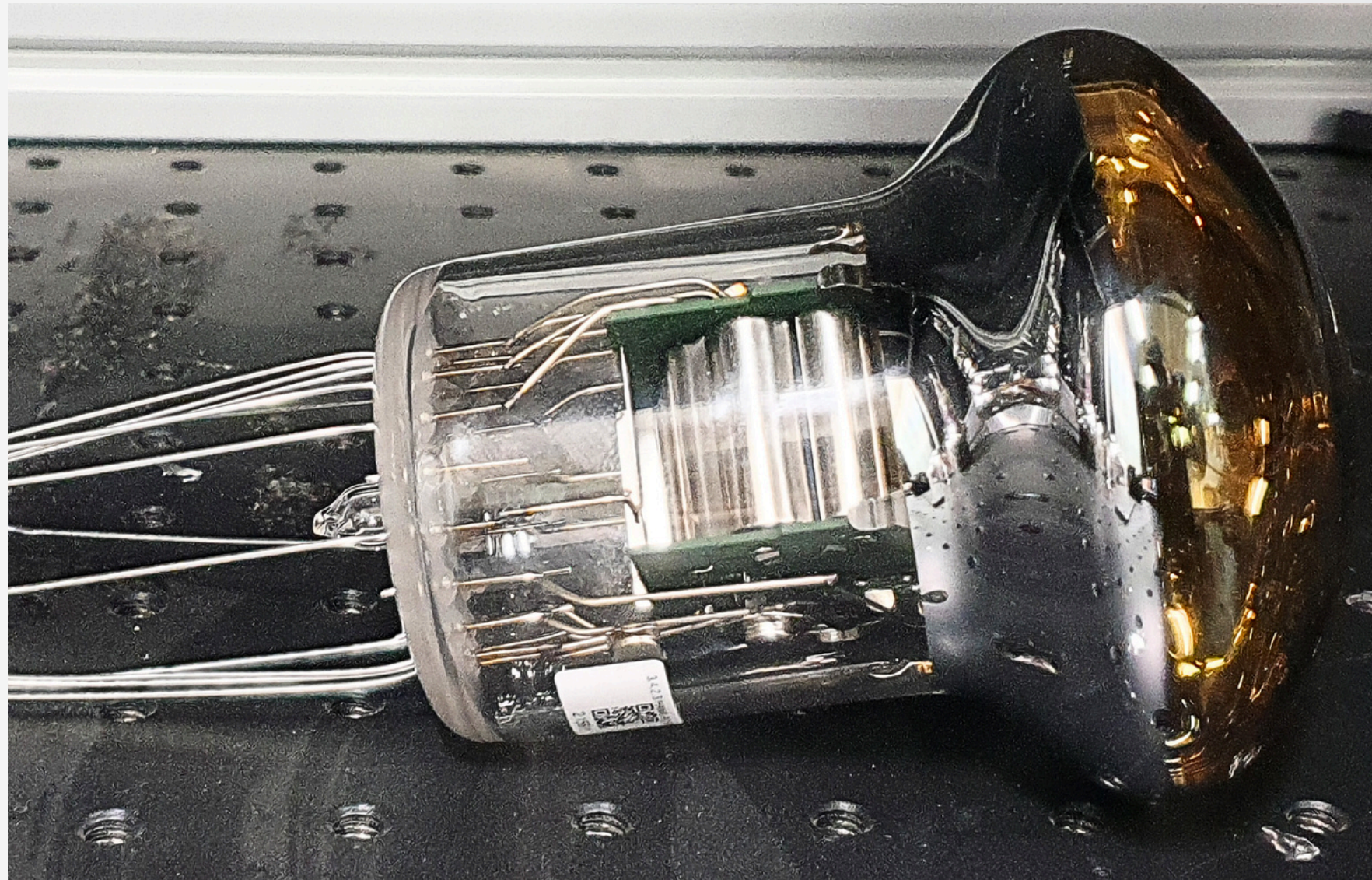


DOMs



DU

KM3NeT technology

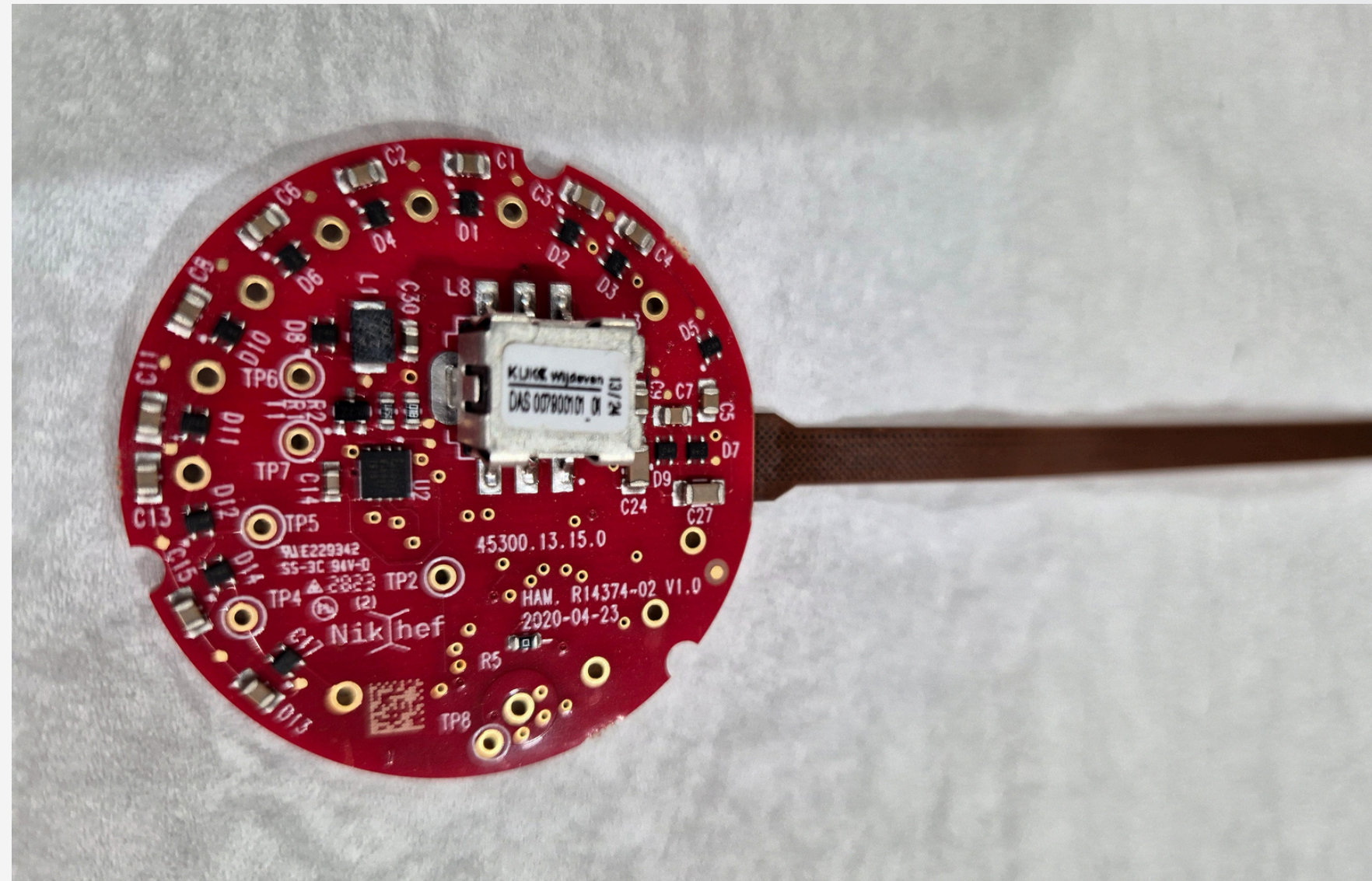


Hamamatsu
80-mm diameter
hemispherical PMT
with 10 dynode stages.

A dedicated
base is used to connect
the dynodes.

3" PhotoMultiplier Tubes (PMT)

KM3NeT technology



Total power dissipated for HV generation in an optical module is about 102.3 mW

Using commercially available state of the art PMT power supplies: 1.55 W

Very low power, high voltage base

KM3NeT technology

17" HIGH-PRESSURE-RESISTANT GLASS
SPHERE CONTAINING:

Digital
Optical
Module

- 31 PMTs
(12 in the top hemisphere, 19 in the bottom)
- Readout electronics
- Gbit/s optical fibre transmission
(all data to shore)
- White Rabbit time synchronisation
- LED beacon for auto-calibration
- Acoustic sensor for position reconstruction
- Tiltmeter/compass chip



KM3NeT technology

31 small PMTs instead of 1 large

Digital
Optical
Module

The segmentation of the photocathode area provides each optical module with sensitivity for the incoming direction of the detected photons, and, in combination with the nanosecond timing accuracy, an effective tool for the reduction of background from light induced by 40K decay and bioluminescence in seawater.



KM3NeT technology

Advantages of this multi-PMT design:

- A projected photocathode area of about 1300cm^2 in each sphere.
- An almost uniform and extended angular coverage of the telescope with a field of view above the horizon.
- Sensitivity to the incoming direction of detected photons.
- Good photon counting performance and good position and timing calibration.
- The possibility to define local triggers based on the pattern of PMT signals.
- A mechanical infrastructure of the detection unit with a small number of pressure housings and barriers as well as electronics, allowing for a significant cost reduction at parity of detector performance.
- Uniformity of the most important component of the detectors, which allows for reliable production and eases scientific analysis.

KM3NeT technology



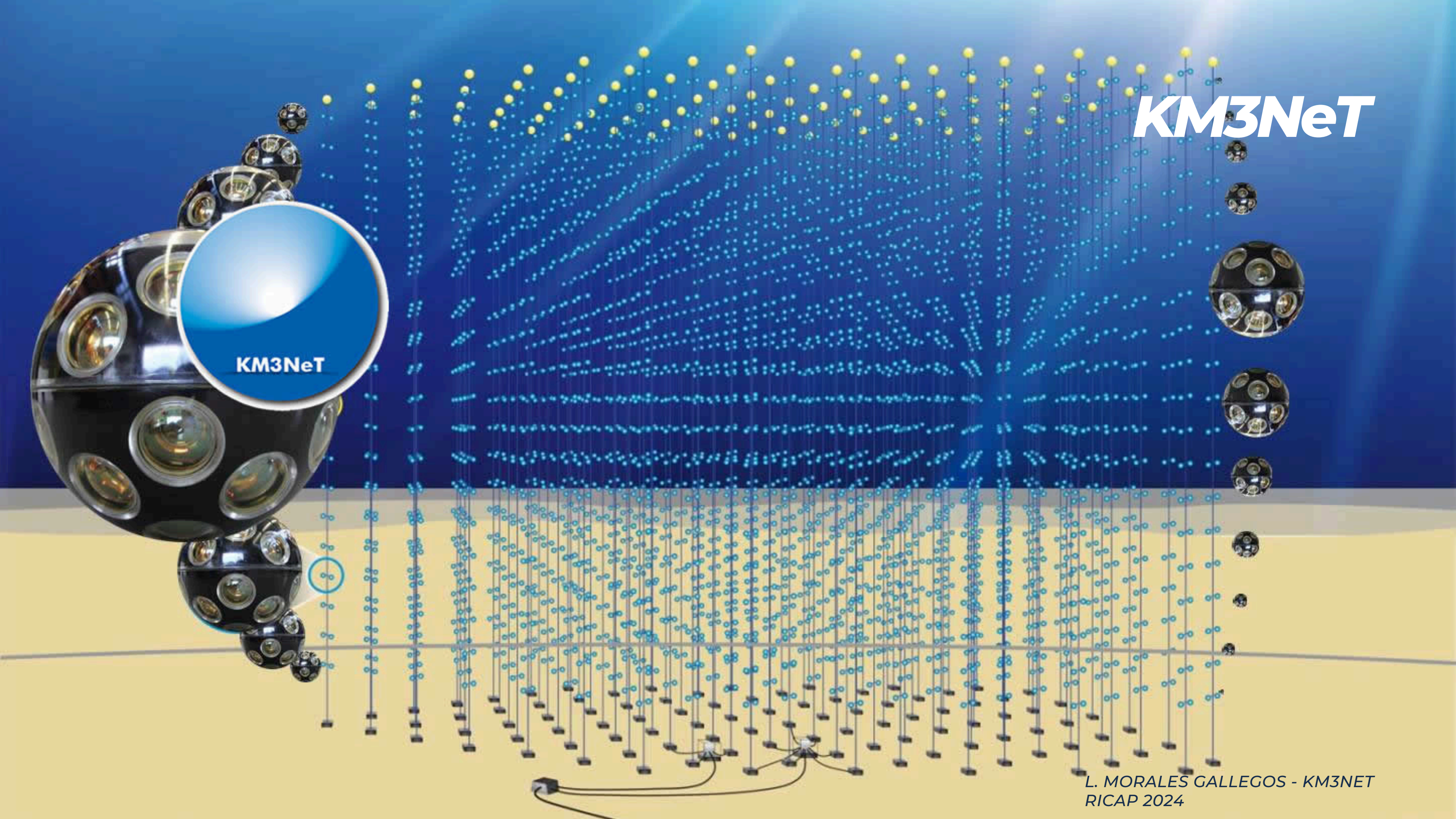
1566 DOMs integrated!
(+48k PMTs)

DOM Integration sites:

- Naples
- Catania
- Athens
- Nikhef
- Erlangen
- Strasbourg
- Nantes
- Rabbat

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How do they get there?



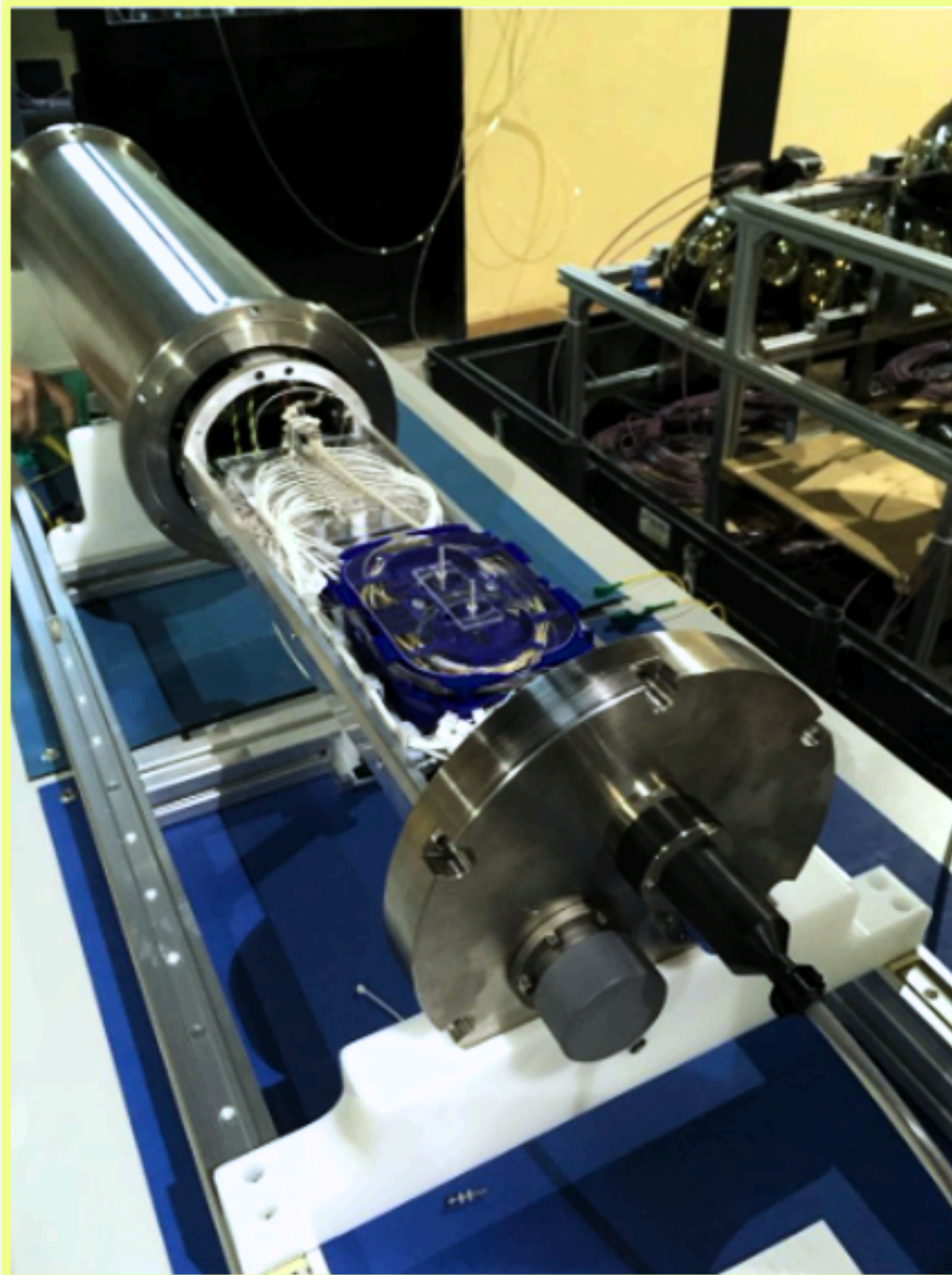
18 DOMs are connected by a Vertical Electro-Optical Cable

To form a Detection Unit

VEOC
Pressure-compensated oil-filled polyethylene (PE) assembly.

Establishes electrical power and glass fibre connections to each DOM of a DU.

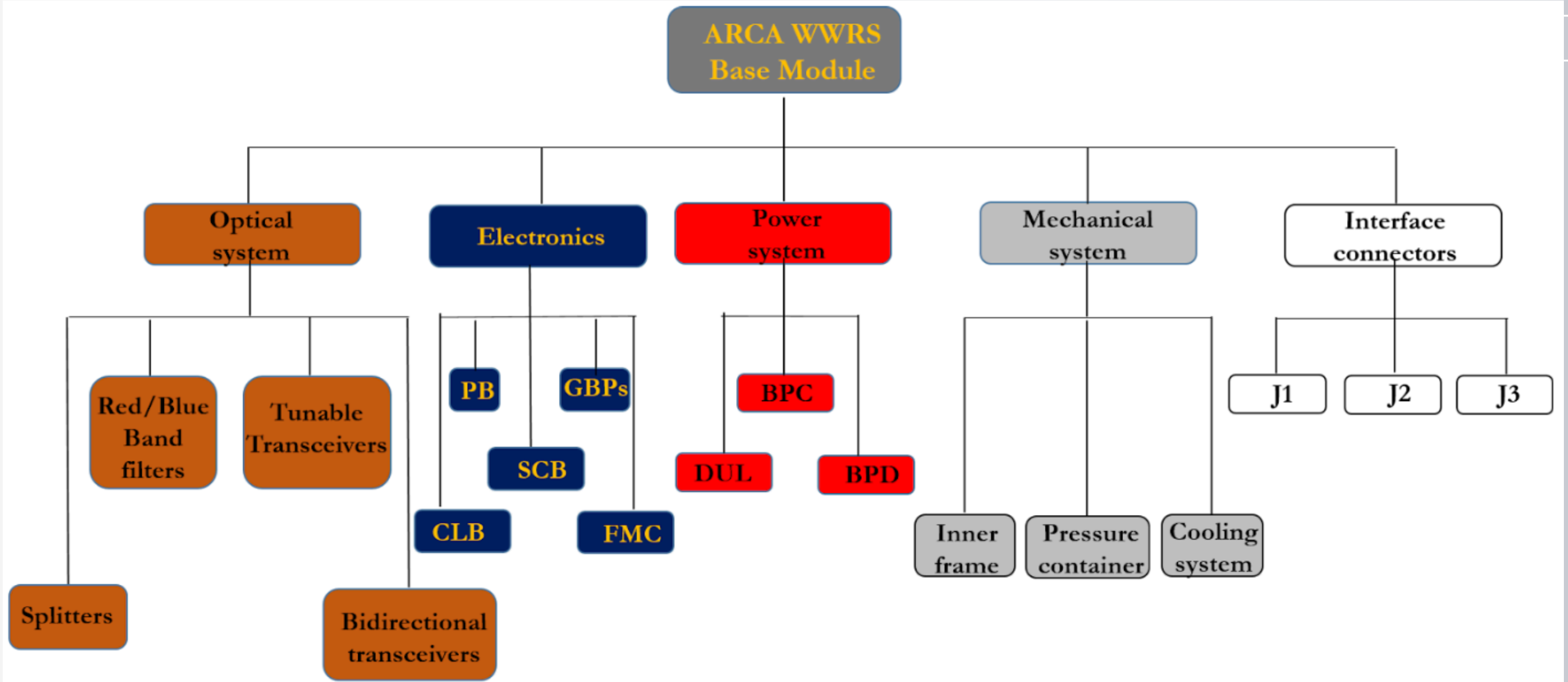
How do they get there?



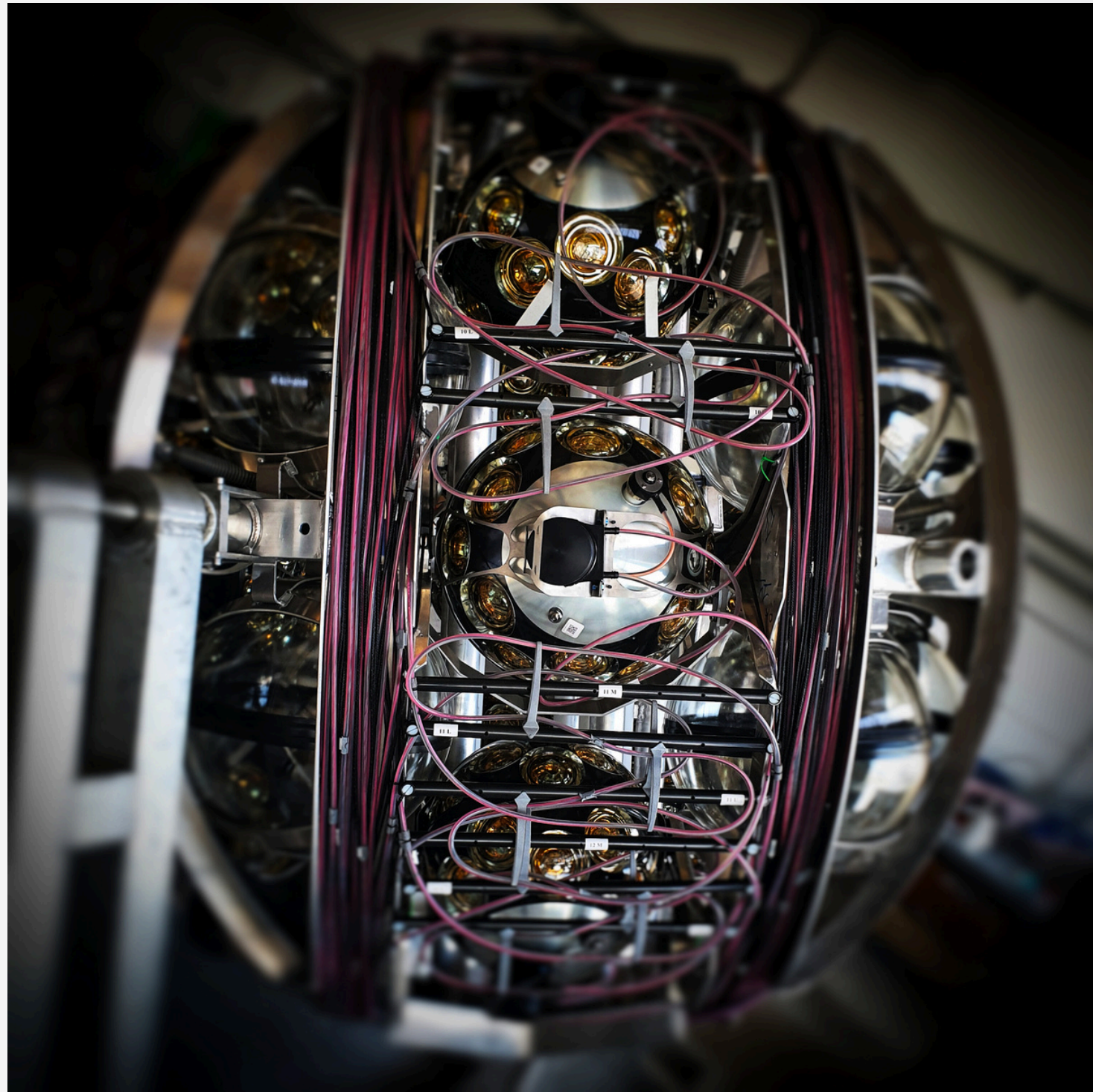
VEOCs then get connected to the DU brain:

Base
Module

- Collects the data arriving from the 18 DOMs via the VEOC.
- Packs and transmits data to the on-shore station through the sub-marine infrastructure.
- Distributes to the DOMs the power and the communications broadcasted from shore.



Load, furl and have fun!



These 18
connected
DOMs are
systematically
loaded to a
Launcher
Optical
Modules

2m diameter
450kg

12 flotation spheres
for recovery

Load, furl and have fun!



75 DUs integrated

DU integration sites:

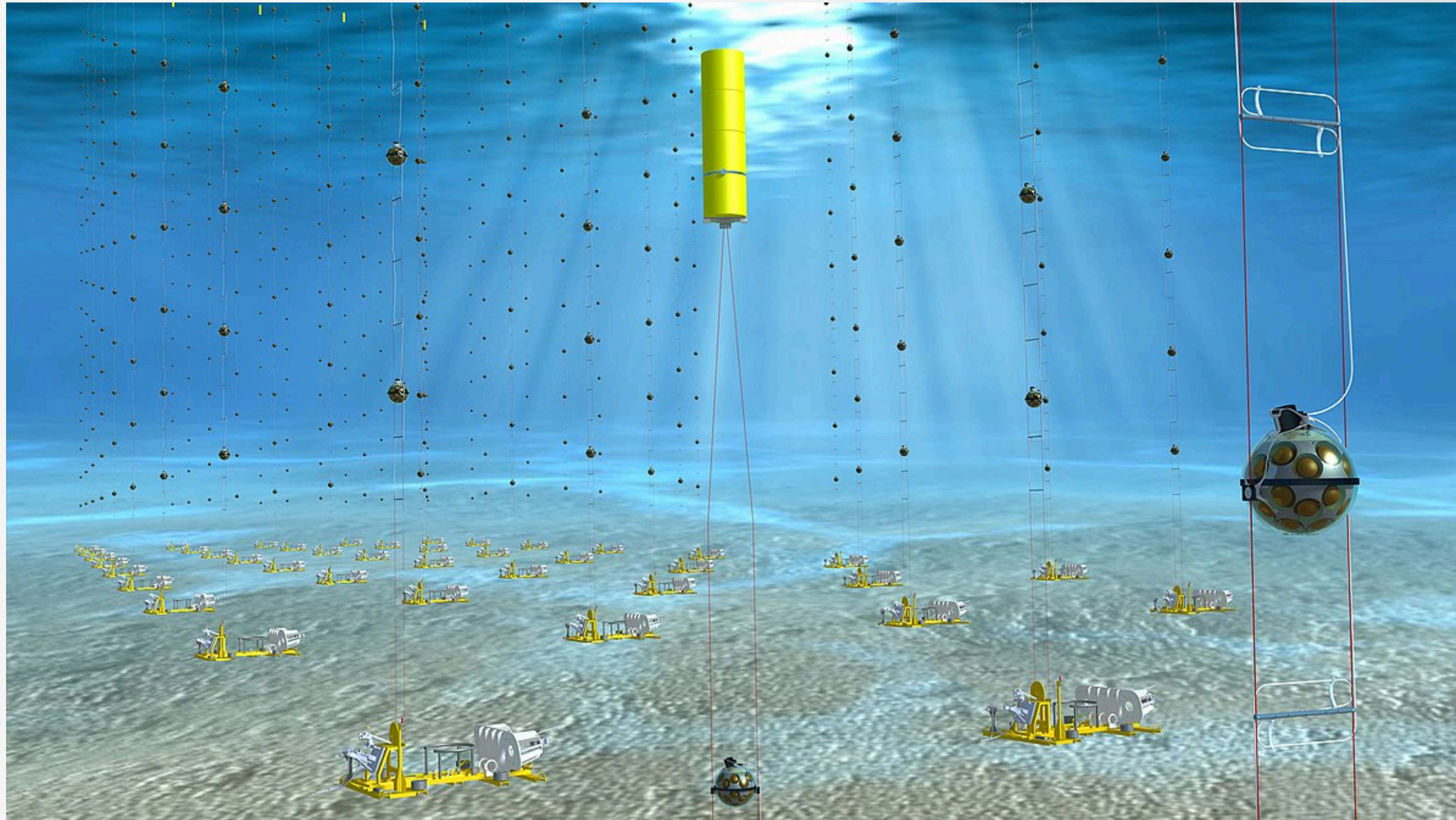
- Caserta
- Catania
- Genova
- ORMET
- Nikhef
- CPPM
- Caen

How do they get there?



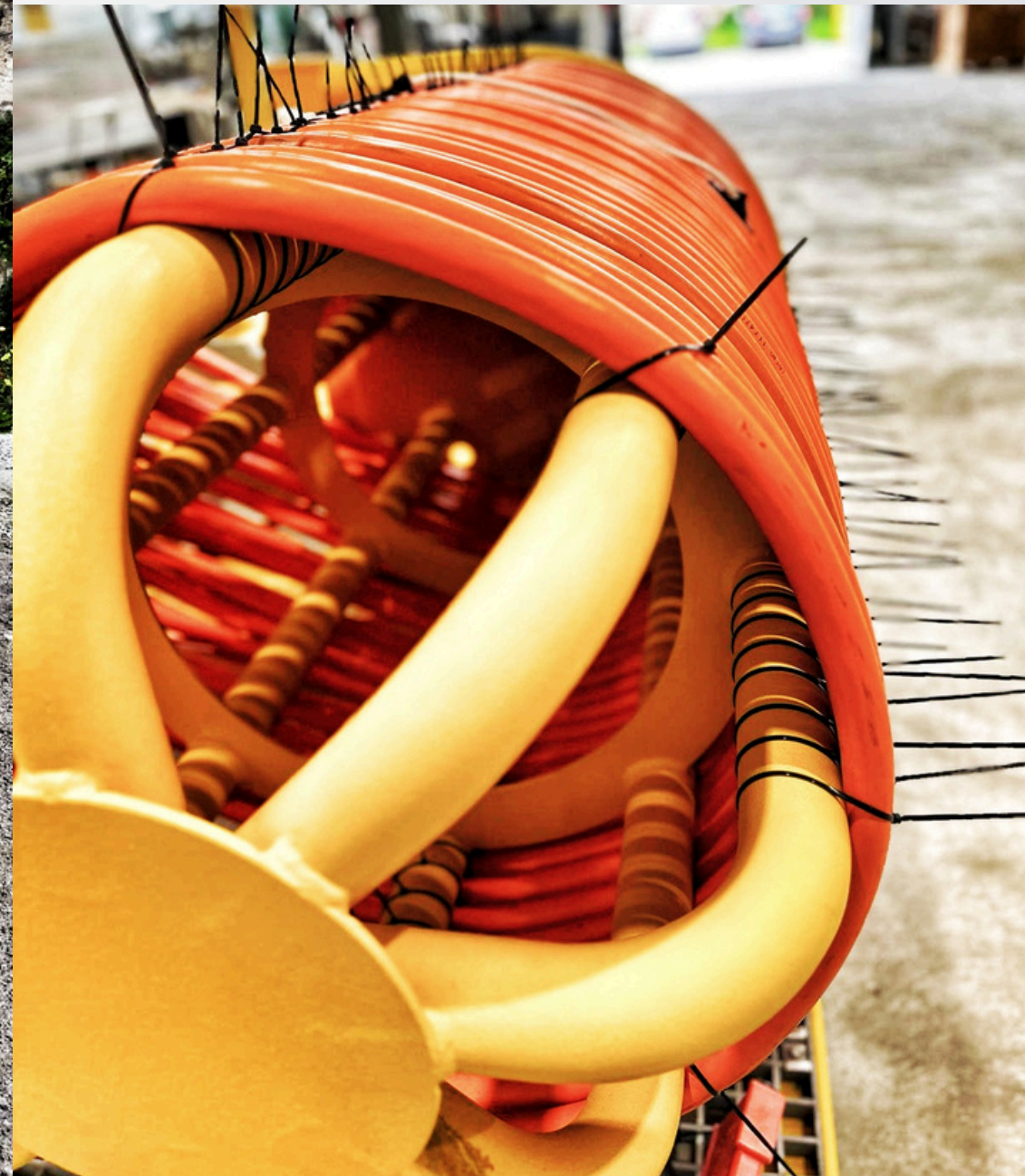
DUs and BMs are systematically loaded and secured to anchors (4 x 2 m)

Artistic seabed



Different distances
from DUs to
communication
Junction Box
=
different lengths of
Interlink cables
(60 - 300 m)

Big anchors!



Different distances
from DUs to
communication
Junction Boxes
=
different lengths of
Interlink cables
(60 - 300 m)

Complete DU



Interlinks are
connected to the BM

Ready for shipment!



The background of the slide features a photograph of a ship's deck on the left side, showing various cables and mechanical components. The right side of the image shows a vast ocean under a clear blue sky, with a bright sun low on the horizon, creating a shimmering path of light on the water's surface. A large, white diagonal graphic element cuts across the right side of the image.

Sea operation

Sea Operation



ARCA getting ready!

2 Junction boxes

19 Detection Units

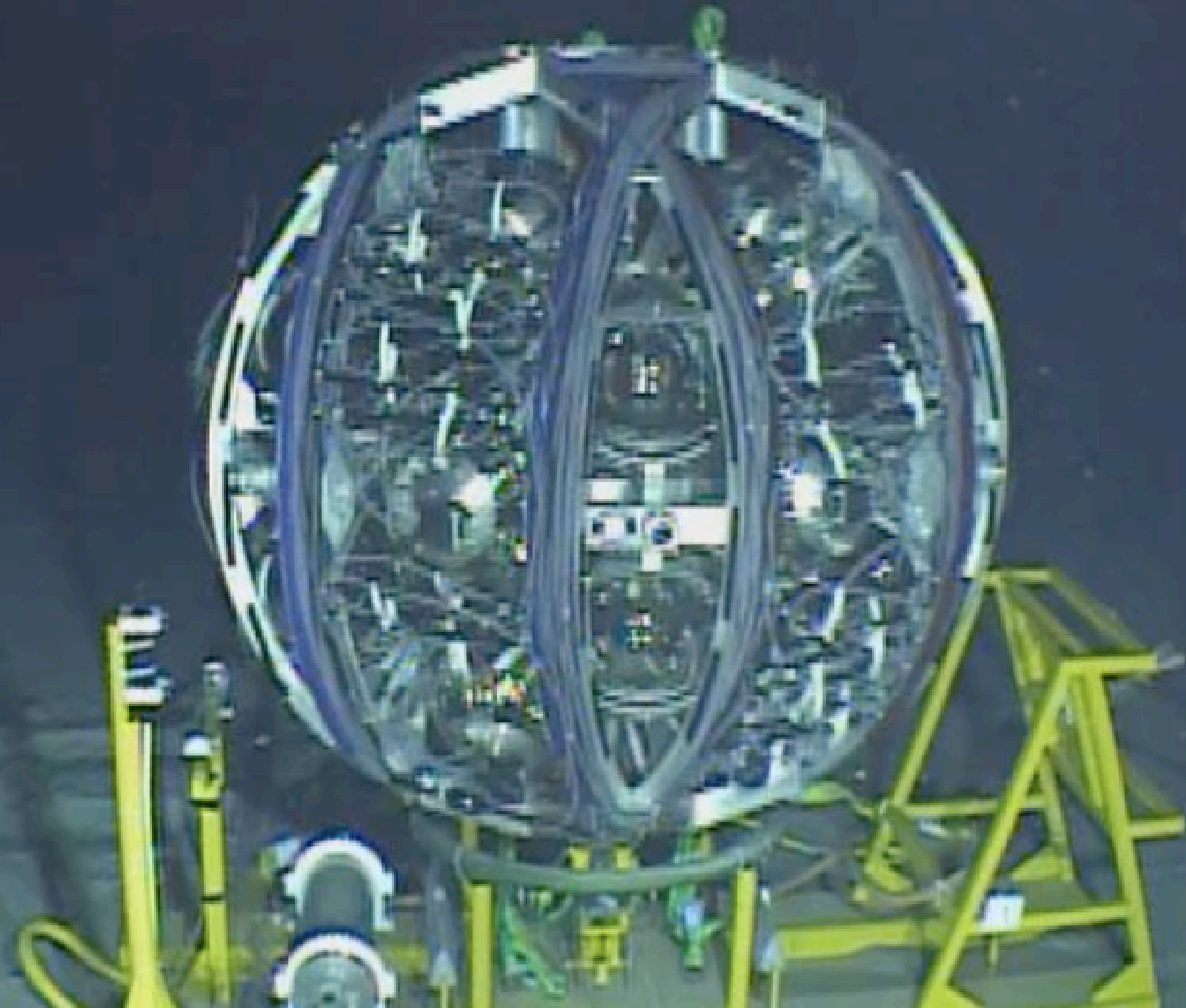
1 Calibration base



Sea Operation



Sea Operation

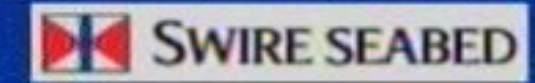


- Unfurling by autonomous ROV
- Rapid deployment
- Multiple strings in one sea campaign

Time: 12:34:27
Date: 13.01.19



System: XLX35



Time: 12:24:28
Date: 13.01.19

Heading: 203.30
Alt: 4.55
Depth: 3474.87
4016899.40
587713.63



**THANK
YOU**

