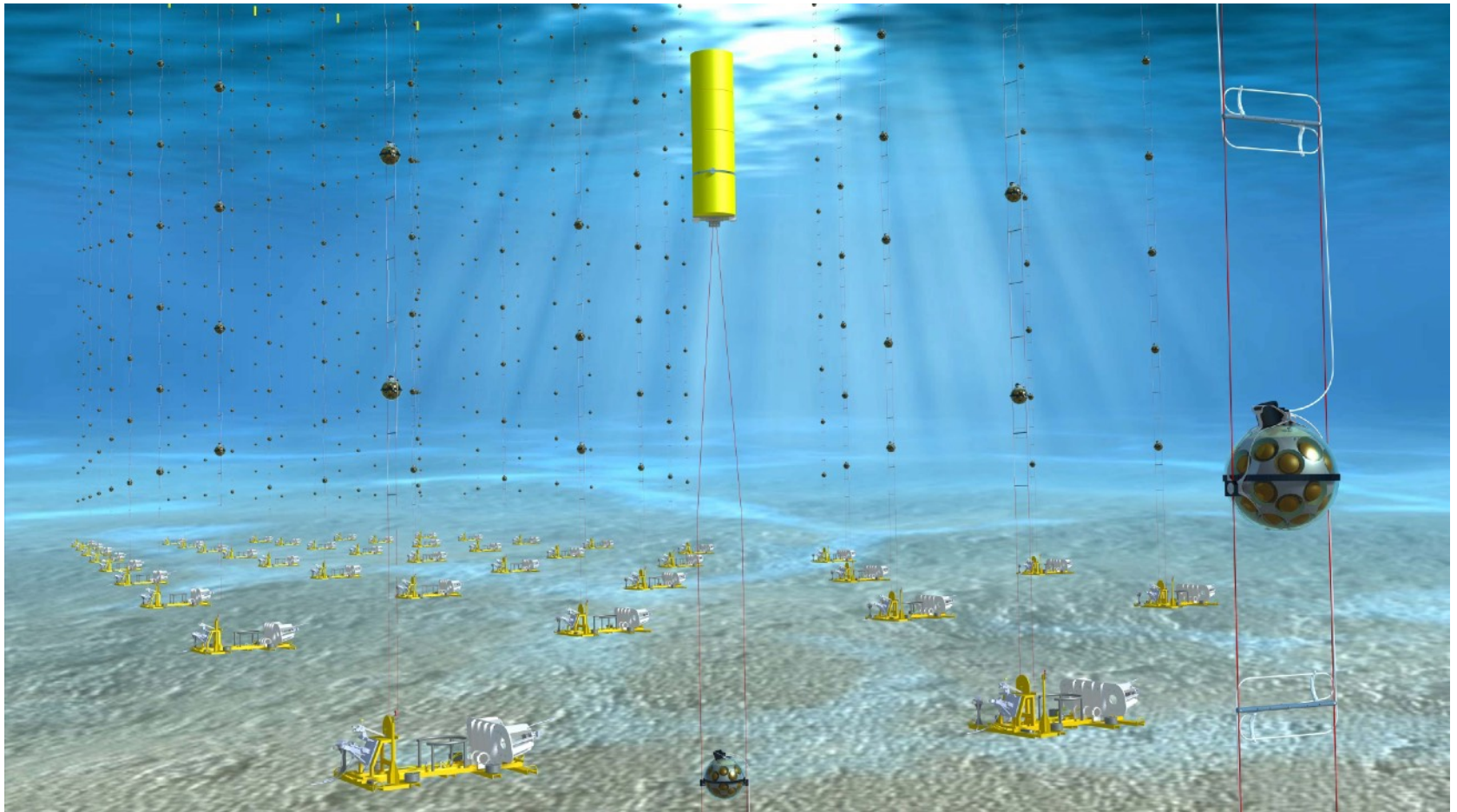


# *KM3NeT\_IT\_CT*

*Nunzio Randazzo - INFN Catania*

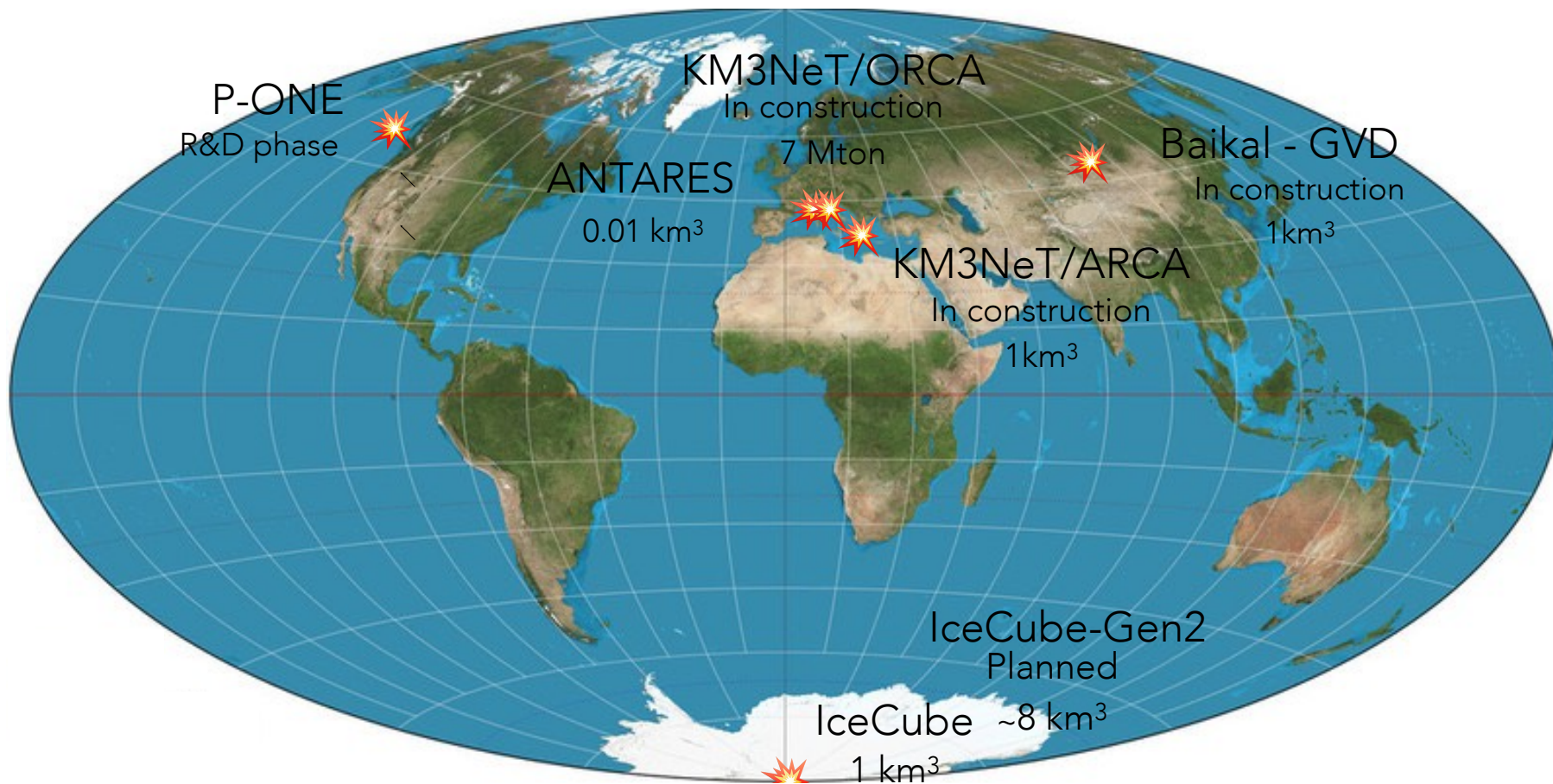
- i) the discovery and observation of high-energy neutrino sources in the Universe
- ii) the determination of the mass hierarchy of neutrinos.



A 3D array of photosensors sensitive to the Cherenkov radiation emitted by products of neutrino.

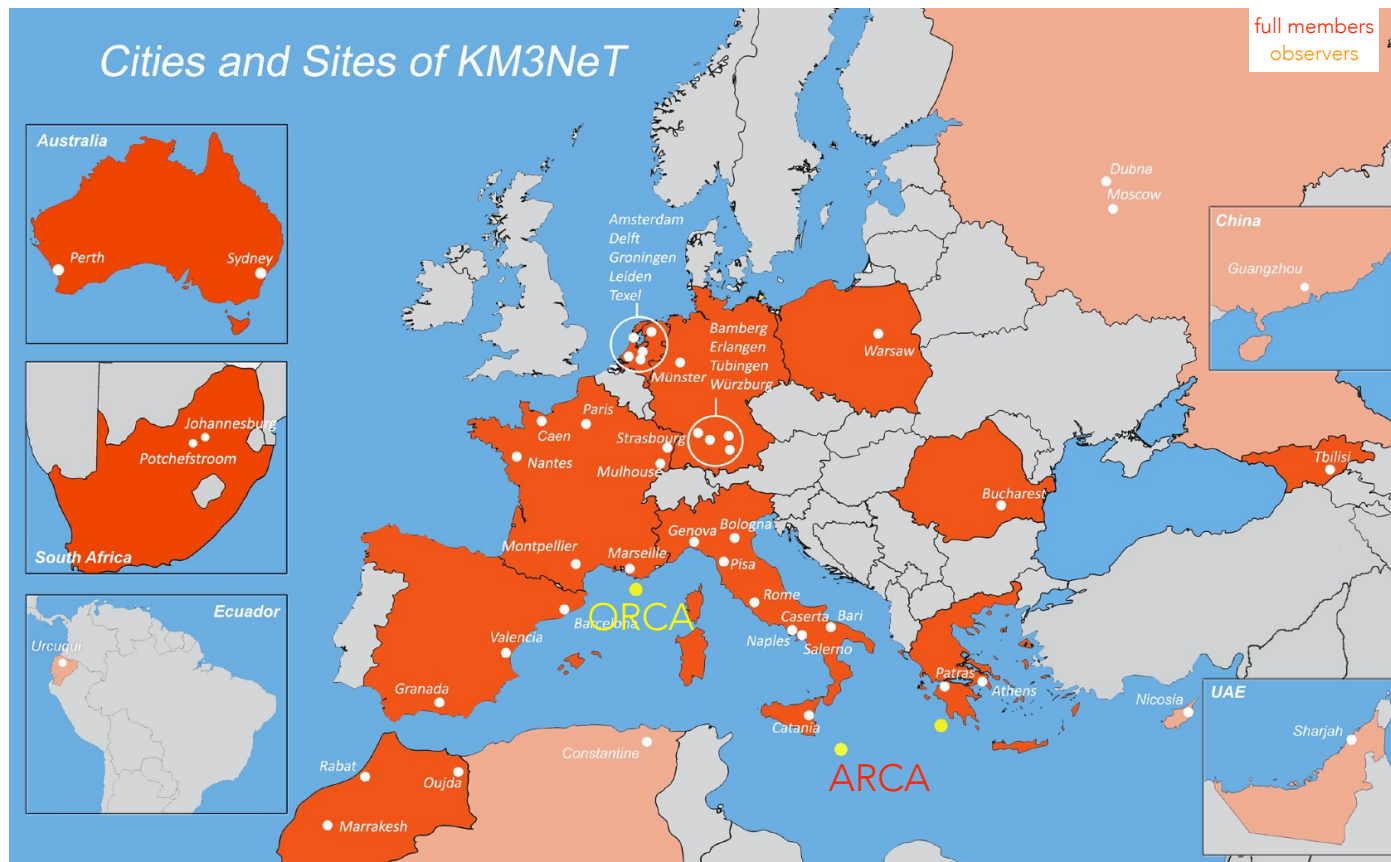
The photosensors are called Digital Optical Modules (DOMs)

## GLOBAL VIEW OF THE HIGH ENERGY NEUTRINO DETECTORS



## KM3NET COLLABORATION

56 institutes in 17 countries



1 collaboration 1 technology 🖱️ 2 detectors:

ORCA (Oscillation Research with Cosmic in the Abyss)

ARCA (Astroparticle Research with Cosmics in the Abyss)

# KM3NeT\_IT\_CT - KM3NeT Project

The basic elements:

- Optical sensors   👉 DOMs (Digital Optical Module)
- Strings           👉 DU (Detection Unit)
- Seafloor network   👉 Electro-optical cables and JBs (Junction Boxes)



## DOM

It is a 17" glass sphere with inside:

- 31 3" PMTs (photocathode area  $\approx 3 \times 10$ " PMTs)
- LED and Piezo
- Front-end electronics -> FPGA

all data to shore



# KM3NeT\_IT\_CT - Main Roles in the KM3NeT Project

- Deputy DOM integration : Emanuele Leonora
- Catania DOM integration Site Responsible. E. Leonora
- DOM production: F. Longhitano
- Local Quality Supervisor: R. Bruno

## DOM Activities

- Junction Box Project Manager: N. Randazzo
- Marine operation: N. Randazzo
- INFN Documentation manager: E. Leonora

## Junction Box Activities

- design of the new DOM testing environment : R. Bruno
- DPDQ co-convenorship : Anna Sinopoulou
- Multimessenger Astronomy: Iara Tosta e Melo

## Software e Data Analysis

Nothing going on without the crucial support from our technicians:

Antonio Grimaldi

Domenico Sciliberto

Francesco Librizzi

Maurizio Salemi

Antonio Rapicavoli

## Technical Activities

G. Imperiale 100% for 2 years (new!)

E. Cafici 100% for 2 years (new!)

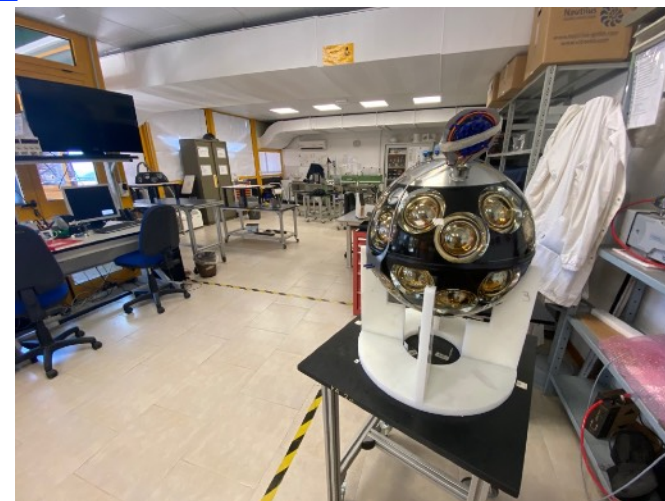
G. Richichi 100% for 2 years ( from July 1) (new!)

# KM3NeT\_IT\_CT - Main Roles in the KM3NeT Project



### Production status. 2022- 2023

- **6 DOM WWRS (Phase 2)**. Qualification DU. Completed in May 2023
- **8 DOMs Line D**. ARCA DU 95. Completed in January 2023
- **10 DOMs Line B**. ARCA DU 65. Completed in May 2022
- **8 DOMs Line B**. ARCA DU 61. Completed in March 2022
- **18 DOMs Line D**. ARCA DU 63. Completed in January 2022

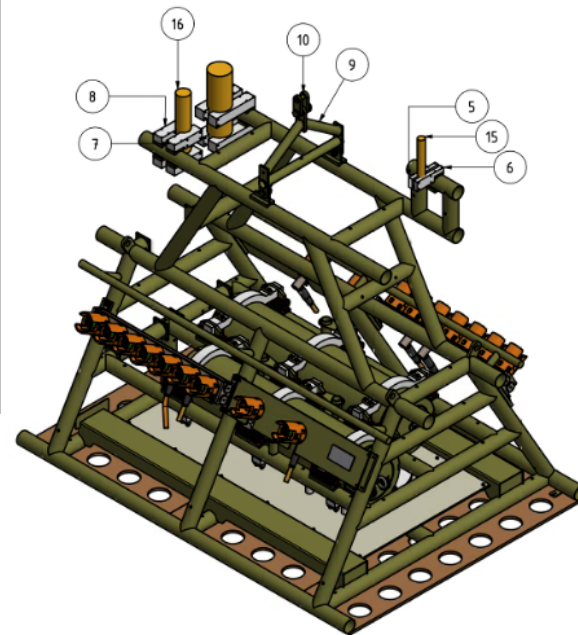
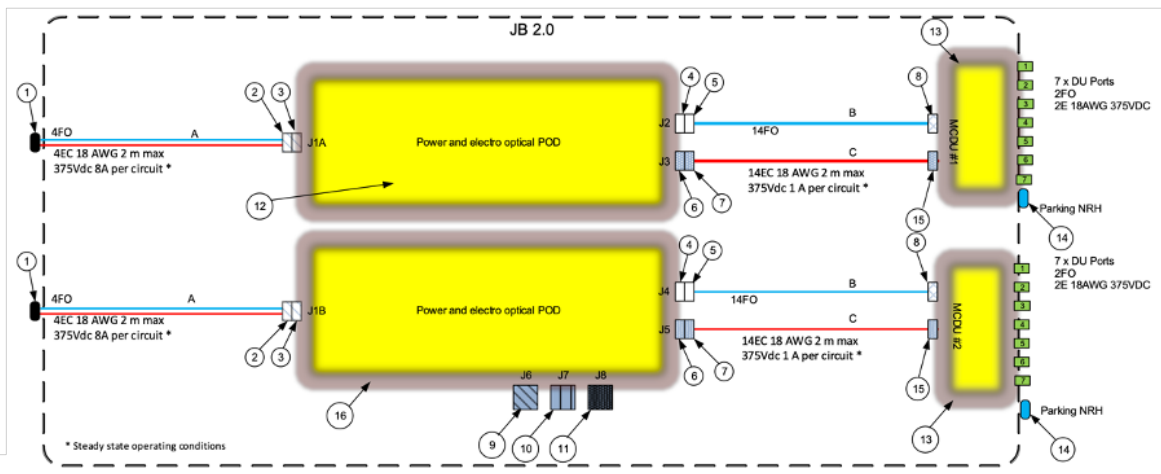


### Next DOM production:

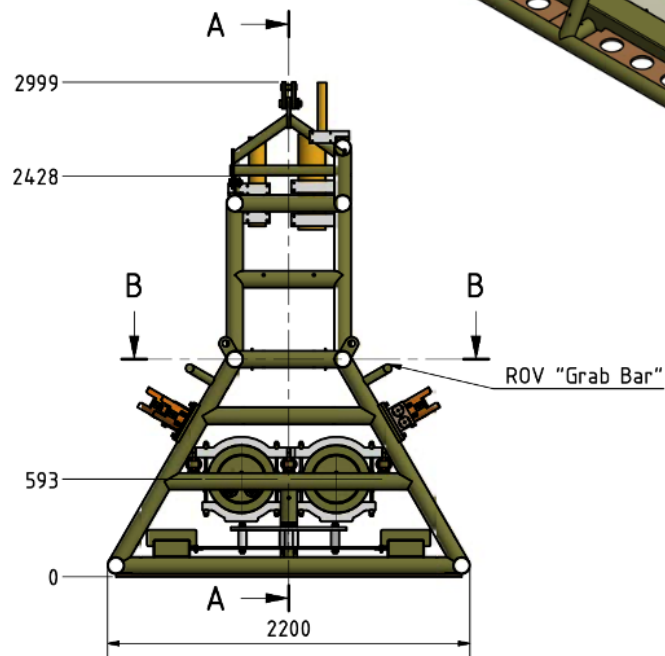
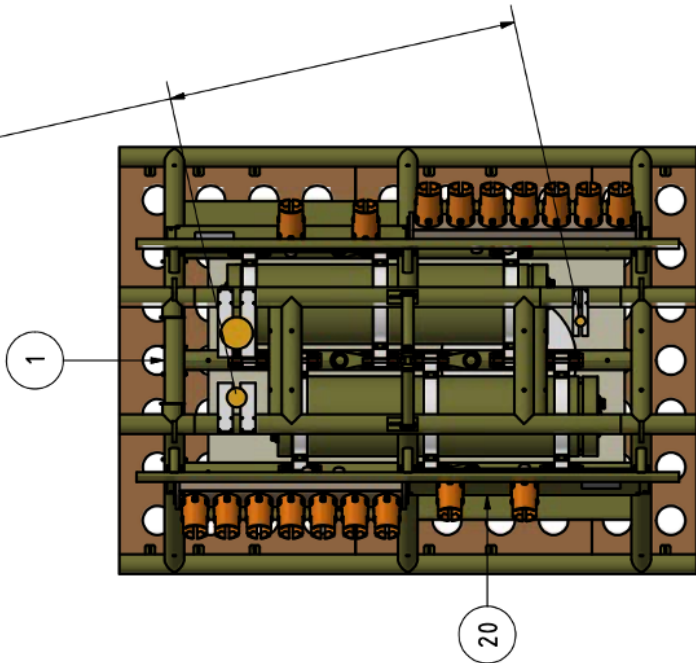
- **12 WWRS DOM currently on-going ( by July 2023 )**
- **18 WWRS DOM ( by November 2023 )**
- **...almost 300 DOMs in the next 3 years within the PACK and PNRR projects**



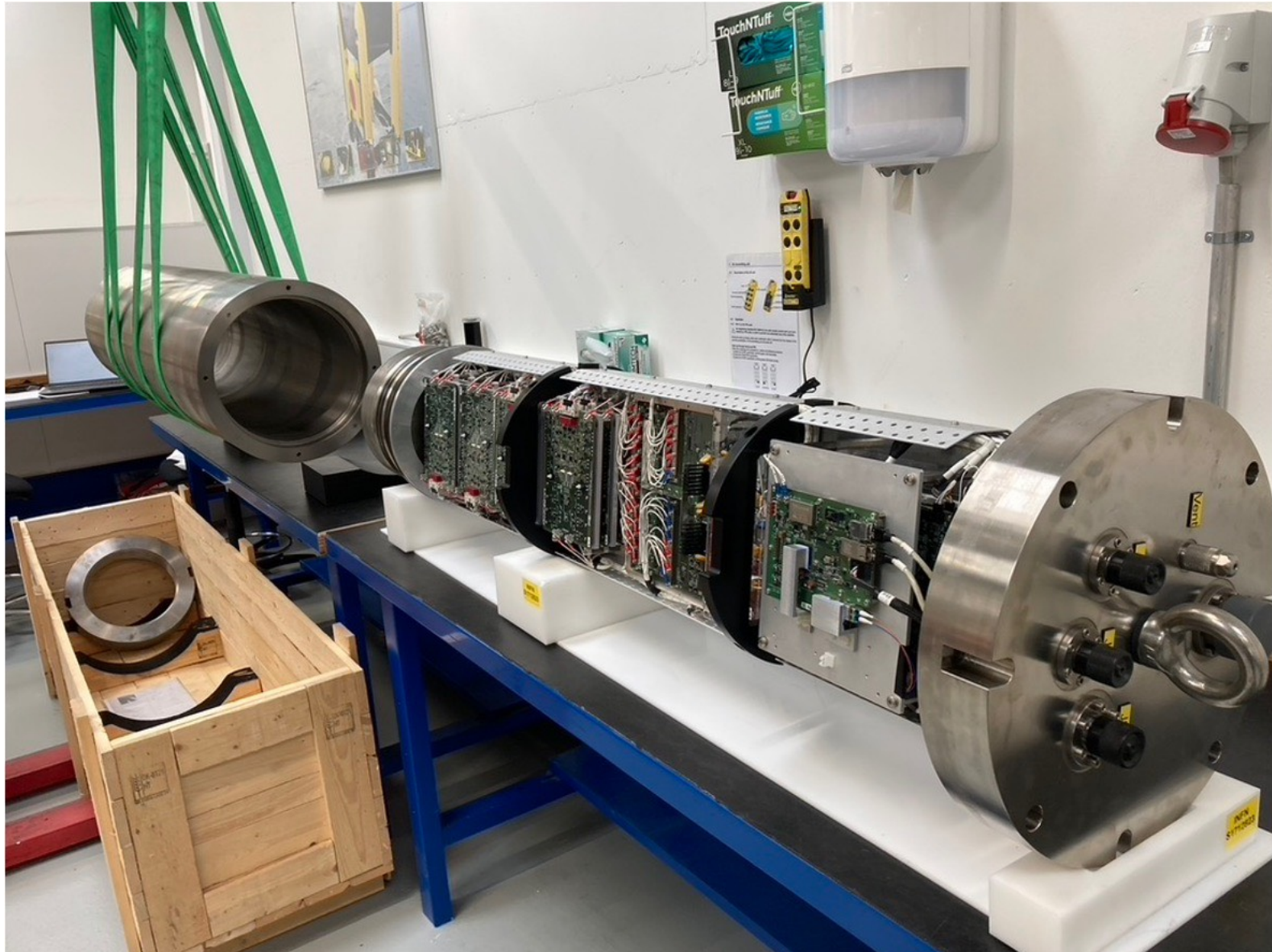
# KM3NeT\_IT\_CT - Single page KM3NET JB



1818 (hydrophone to acoustic beacon)



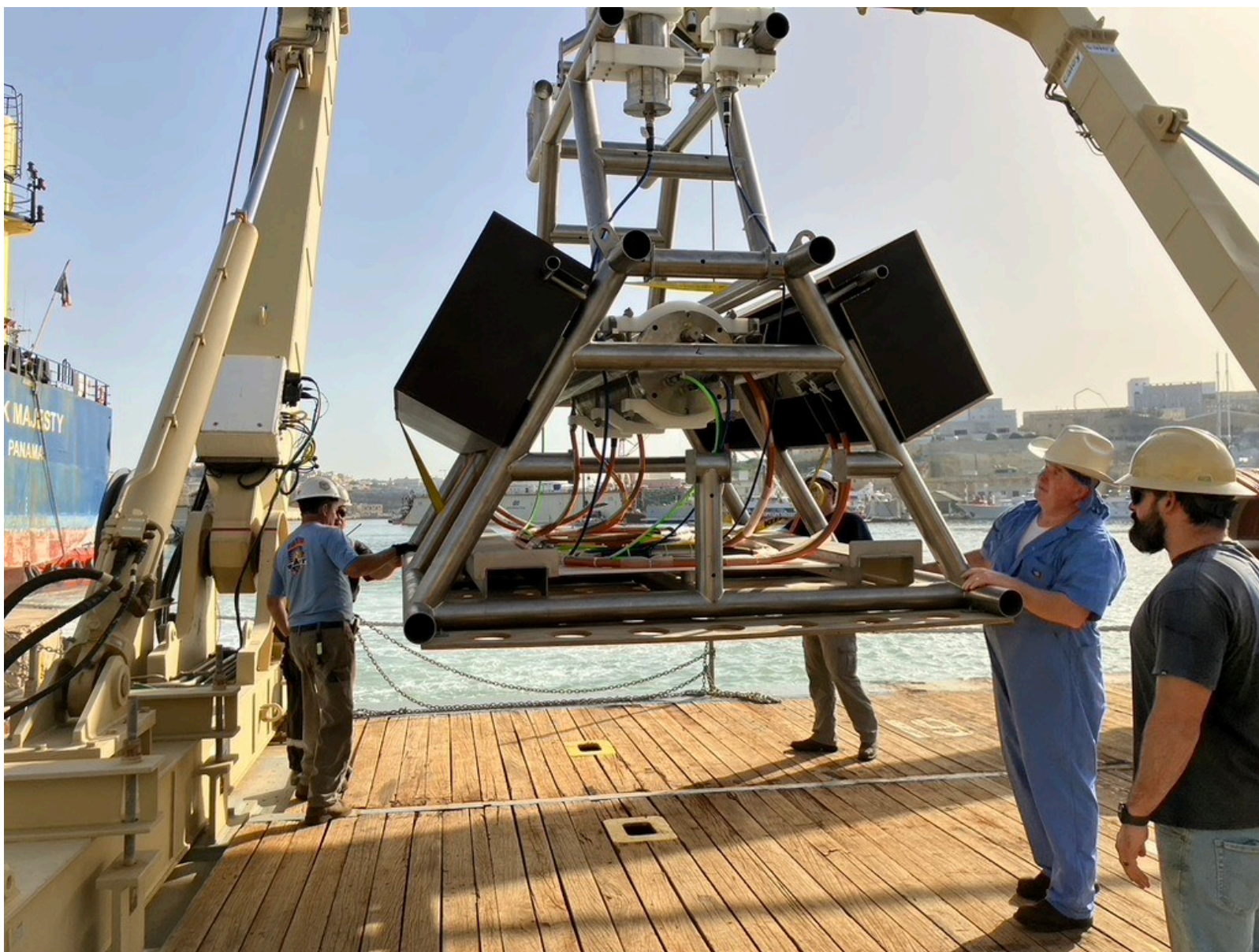
Characteristics of JB	
# Input	1
# Output	12
Input voltage	375 Vdc
Output voltage	375 Vdc
Max output current	1 Ampere
Max data thruputs	1 Gbit/s
Lifetime	> 20 Years
Operational depth	3500 m
Operational temperature at seabed	13 °C
Mechanical mainframe material	Titanium Gr. 2
Vessel material	Titanium Gr. 2
Reliability	Intrinsic redundancy

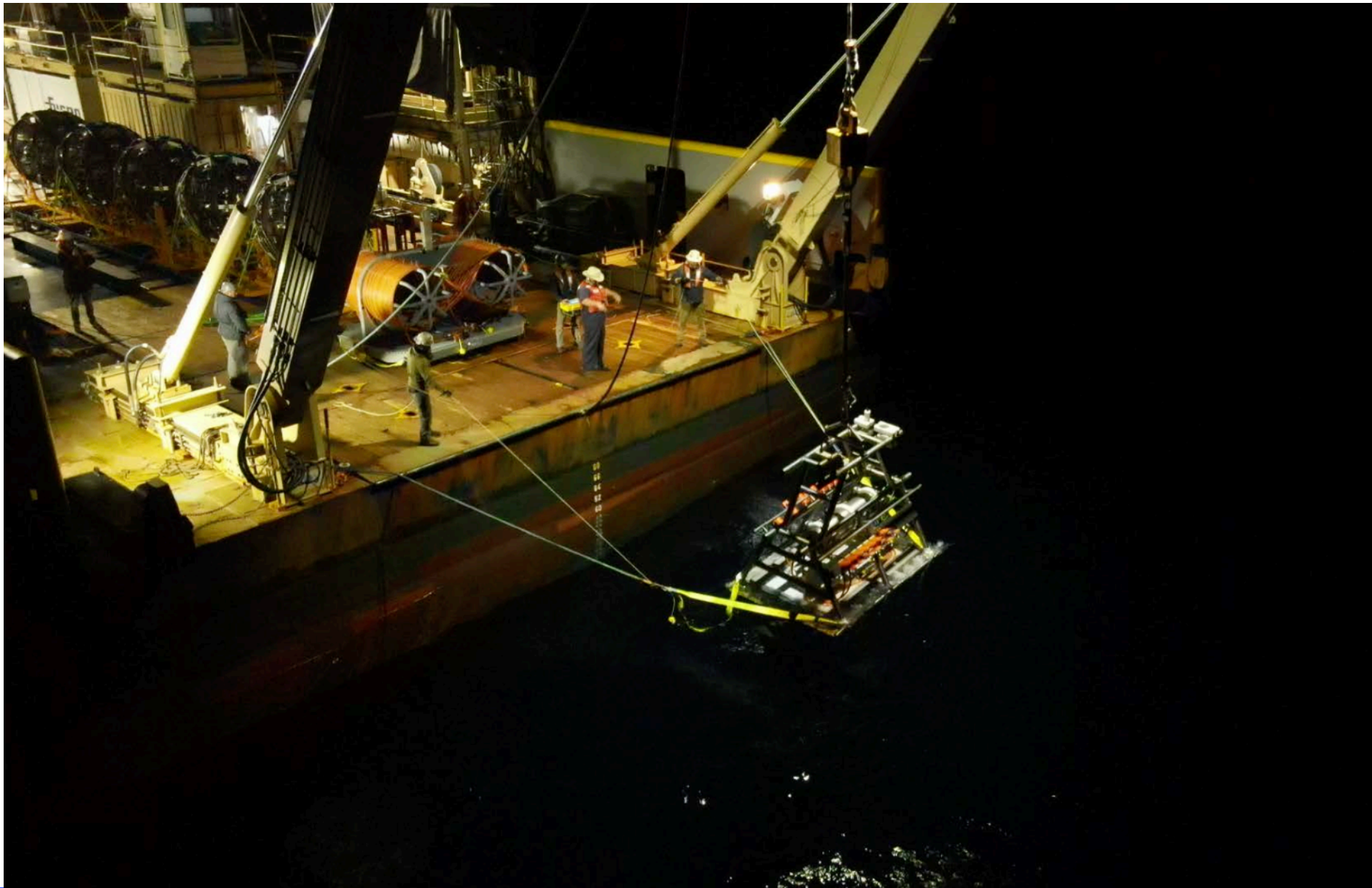






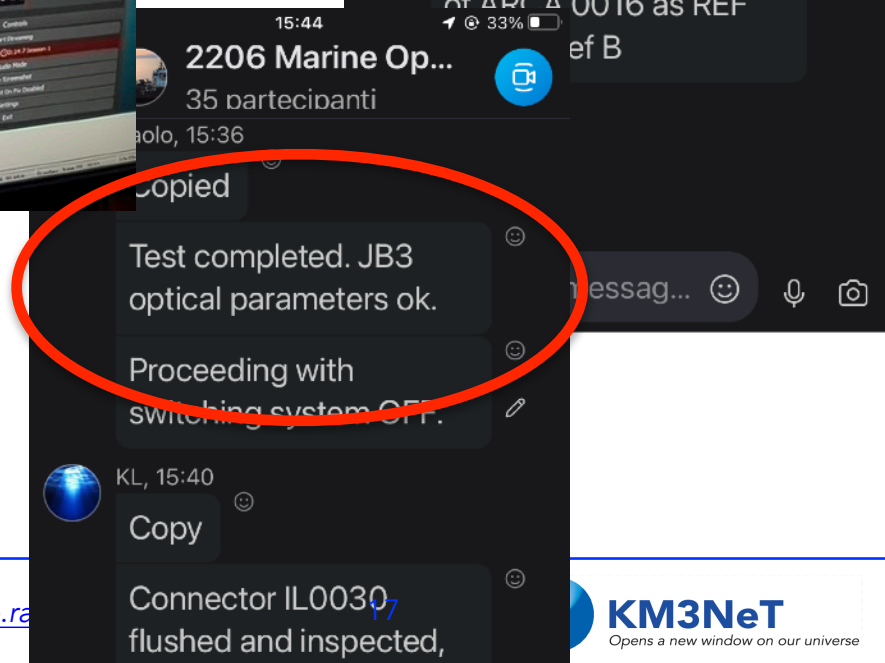
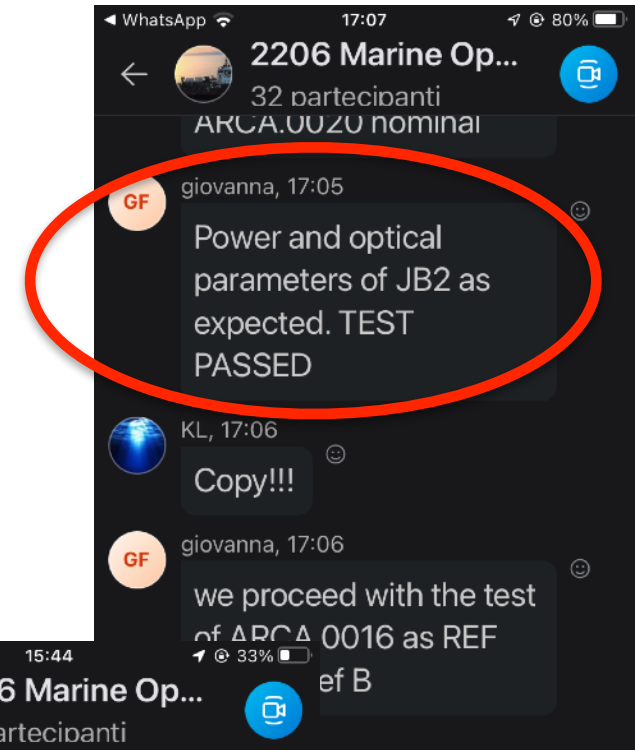
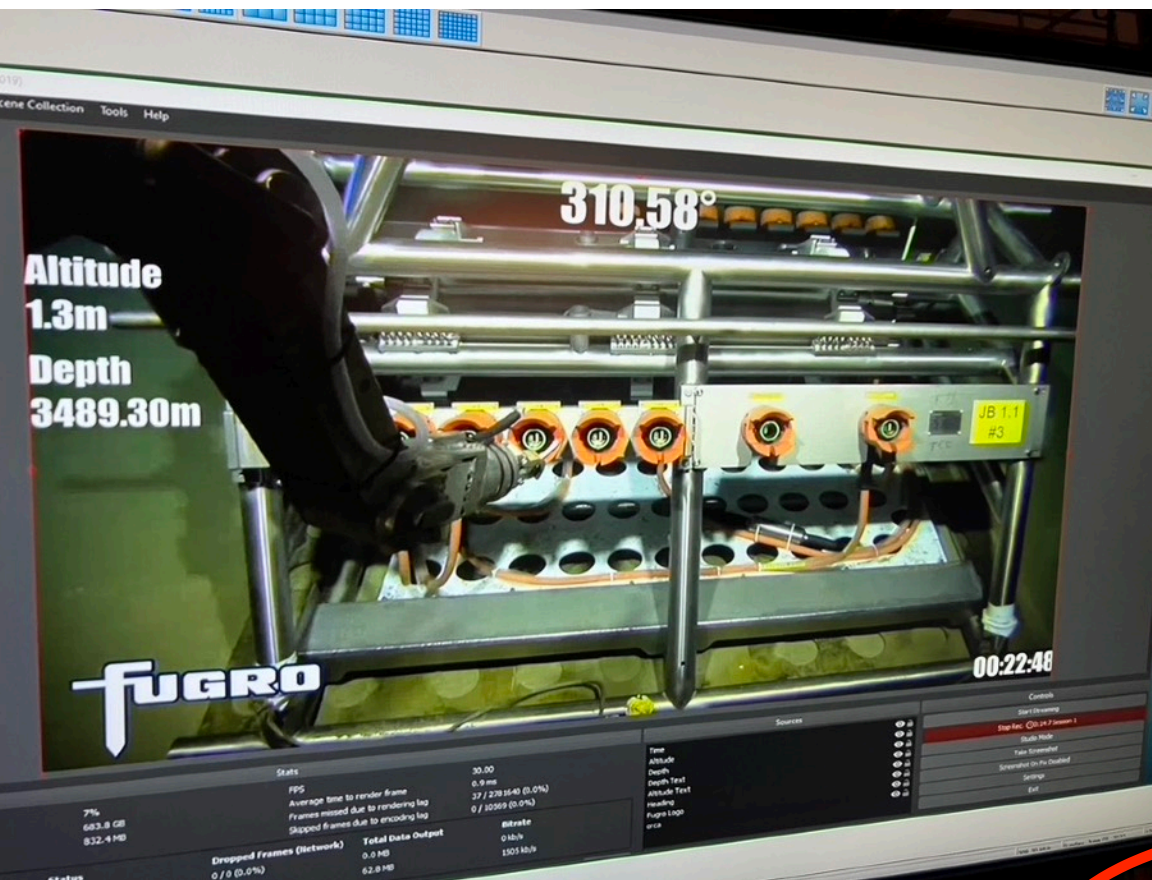








# Production of JB1.1 SN-02-03 – Nominal and working well on seabed





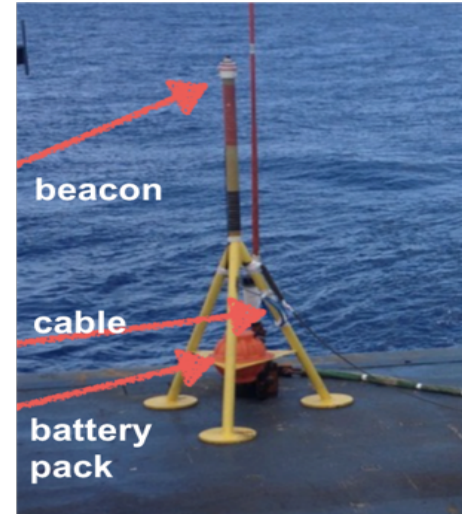
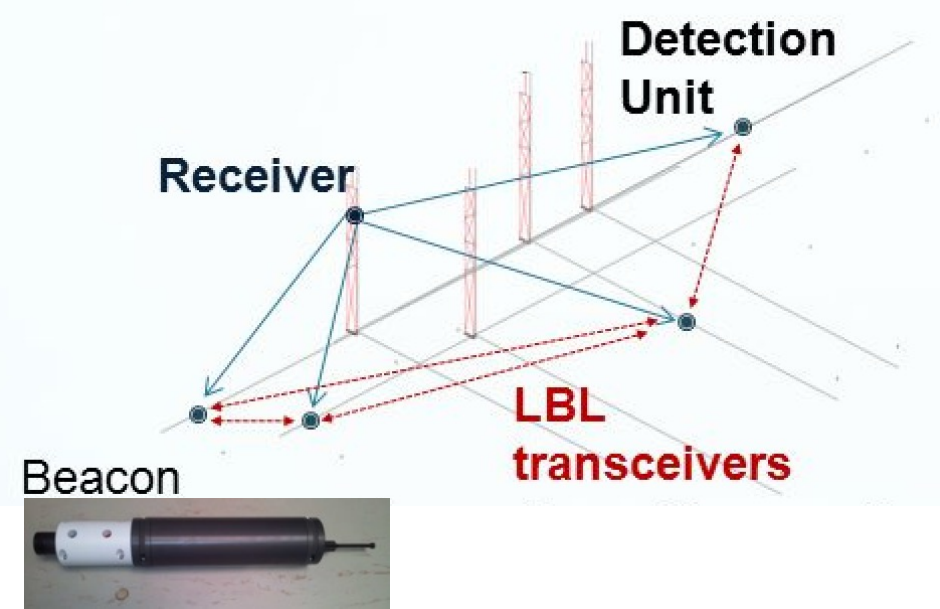
# The Acoustic Positioning System (APS)

A crucial component of the KM3NeT detector is therefore the Acoustic Positioning System.

It provides the position of DOMs and DUs in the deep sea with an accuracy of about 10 cm.

The system is based on measurements of acoustic signals between fixed seabed emitters and receiving hydrophones

The acoustic emitter consists of a beacon autonomously powered by a battery pack that provides the power



Beacon and battery pack are placed on a iron tripod.

VLVnT2021

[emanuele.leonora@ct.infn.it](mailto:emanuele.leonora@ct.infn.it)

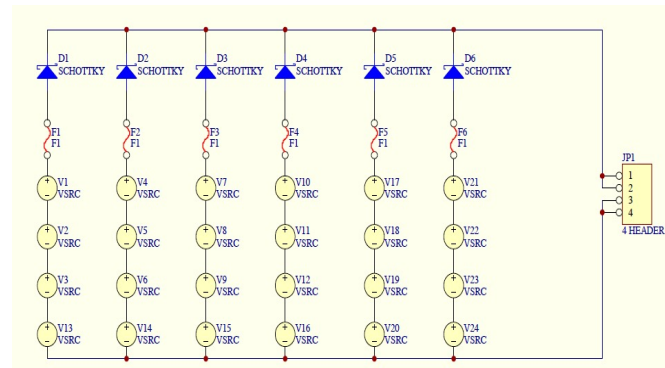
3

The cluster of batteries consists of a set of 4 boards used to stack 96 batteries.

Each board hosts 24 batteries, electrically connected in order to produce the output voltage for the beacon:

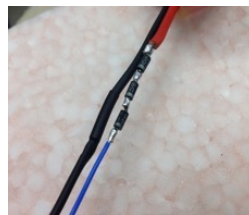
Output voltage: 14.4 Volt.

Total capacity: 410 Ah.



The whole system has been designed to supply the required voltage hosting the maximum number of batteries in the minimum volume.

To obtain the required 12 Volt, 3 UF4007 diodes are connected in series to the output positive cable.



Solution chosen for:

- simplicity,
- lowest power consumption
- highest reliability.



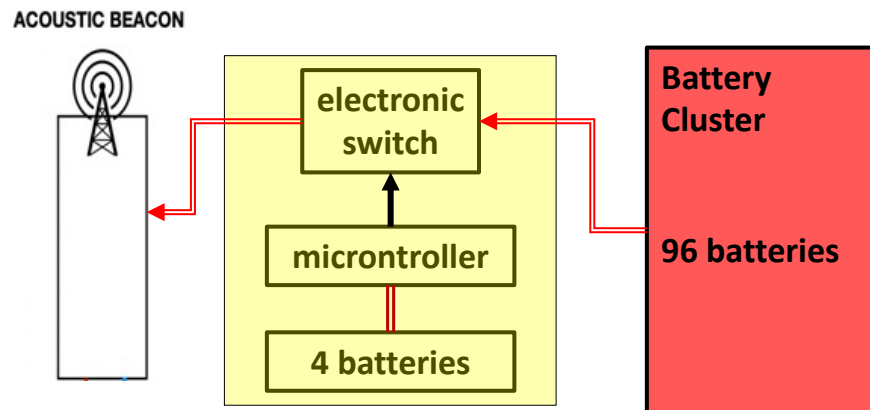
To increase the operating time of the beacon, a duty cycle operating mode was implemented for the battery pack.

An electronic switch connects the battery pack to the beacon only for a defined interval time.

The switch is controlled by an electronic microcontroller.

**Switch enabling:** the battery is connected to the beacon, enabling the acoustic emission.

**Switch disabling:** the beacon remains disconnected from the battery pack, disabling acoustic emission and preserving battery charge.



**The duty cycle is 10%, with a period time of 10 minutes:**

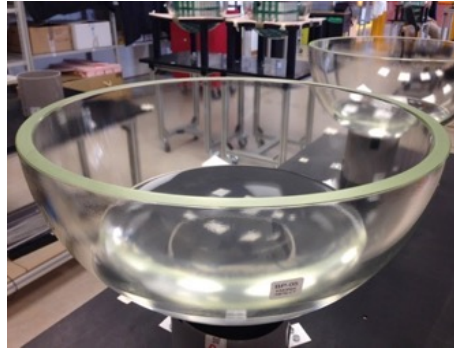
Every 10 minutes the beacon is connected to the battery pack for 1 min. For 9 minutes the beacon is disconnected.

**With the 10% duty cycle, the 410 Ah battery pack capacity and the expected current consumption of the beacon, almost 4 years of operating time is expected in deep-sea water.**

# Some integration phases



*The cluster of 96 batteries covered by gel*

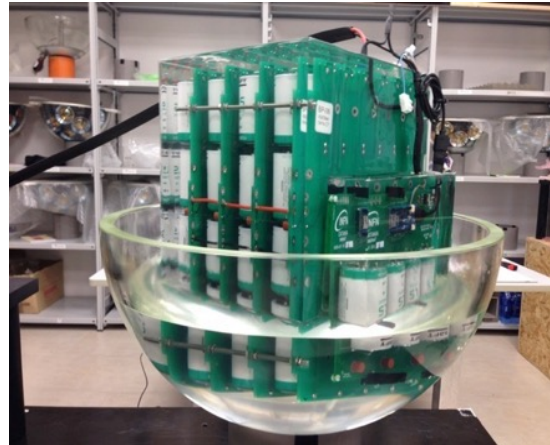


*The gel used as bottom base*



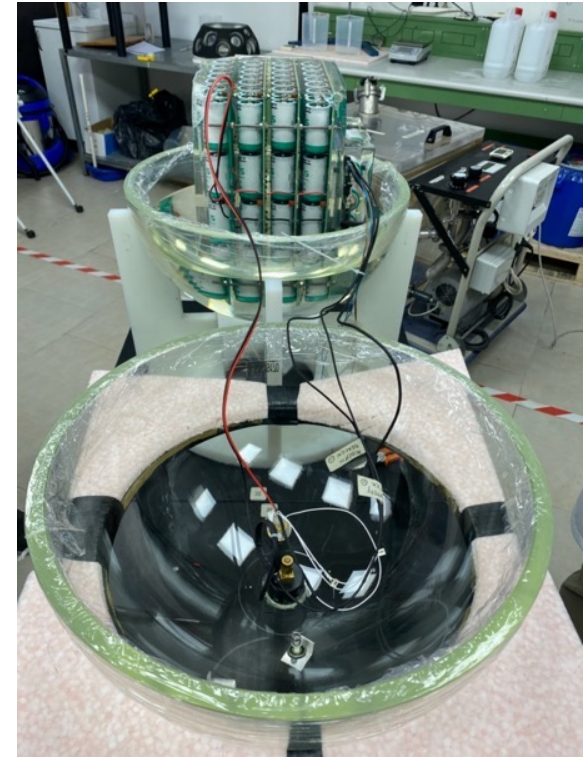
*The Wake-up board covered by gel*

VLVnT2021



*All the elements glued together*

emanuele.leonora@ct.infn.it



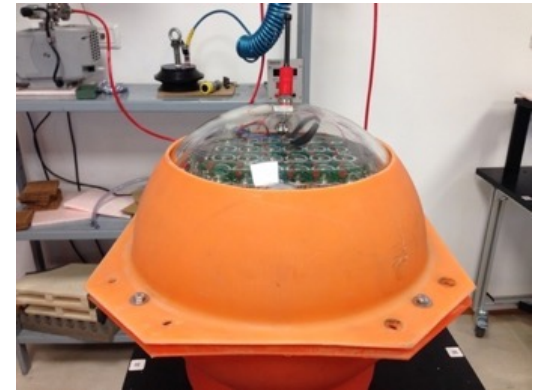
*Inner cabling. No connectors were used. All the wires and components have been connected by soldering.*

12

# Marinization



- ✓ To join the two hemispheres and close the vessel, a 0.5 bar under-pressure inside the sphere was achieved through the external vacuum port.
- ✓ An internal pressure gauge monitors the inner status.
- ✓ The application on the junction of the two halves of a sealant 20-mm terostat 81/20 and of 50-mm anti-corrosion tape scotchrap close the sphere definitely.
- ✓ The sphere is finally positioned into its protective plastic shell ready to be installed on the tripod for marine deployment.



- Data 22 novembre 2022
  - Luogo Istituto Nazionale di Fisica Nucleare INFN - sezione di Catania
  - Evento International Cosmic Day 2022
  - Attività Organizzatore locale per la sezione INFN di Catania (in collaborazione con il Dipartimento di Fisica a Astronomia "E. Majorana") dell'International Cosmic Day 2022.  
<https://agenda.infn.it/event/33413/>  
<https://www.ct.infn.it/it/news-eventi/news/1253-international-cosmic-day-2022-infn-catania.html>
- 
- Data 30 settembre 2022
  - Luogo Piazza Università, Catania
  - Evento SHARPER Night 2022 – Notte europea dei ricercatori
  - Attività L'INFN per la Salute e il Mare – Illustrazione delle attività svolte tramite materiale, strumentazione e rivelatori espositivi nei laboratori KM3NeT del Dipartimento di Fisica di Catania, presso i Laboratori Nazionali del Sud – LNS -, presso il laboratorio INFN presente al porto di Catania e la stazione di terra situata a Portopalo di Capo Passero (SR).
- 
- Data 23 settembre 2022
  - Luogo Istituto Nazionale di Fisica Nucleare INFN – LNS & sezione di Catania
  - Evento Virtual visit of KM3NeT
  - Attività Visita virtuale on line dei laboratori KM3NeT  
<https://www.youtube.com/watch?v=4VDGG-mRGag>
- 
- Data 24 settembre 2021
  - Luogo Cortile Platamone, Via Vittorio Emanuele II, 121, Catania
  - Evento SHARPER Night 2021 – Notte europea dei ricercatori
  - Attività Scrutare il cielo dalla profondità degli abissi – Illustrazione delle attività svolte tramite materiale, strumentazione e rivelatori espositivi nel laboratorio KM3NeT presente nel Dipartimento di Fisica di Catania.
- 
- Data 22 luglio 2020
  - Luogo Istituto Nazionale di Fisica Nucleare INFN – LNS & sezione di Catania
  - Evento Programma televisivo Superquark
  - Attività Partecipazione al noto programma televisivo Superquark nel servizio sui neutrini nell'ambito del progetto KM3NeT  
<https://www.raiplay.it/video/2020/07/Superquark-I-neutrini---22072020-a333ad70-ec8d-4b5e-8fd7-c7a4bbade2dd.html>  
<https://www.youtube.com/watch?v=hHLkeLweP6s>





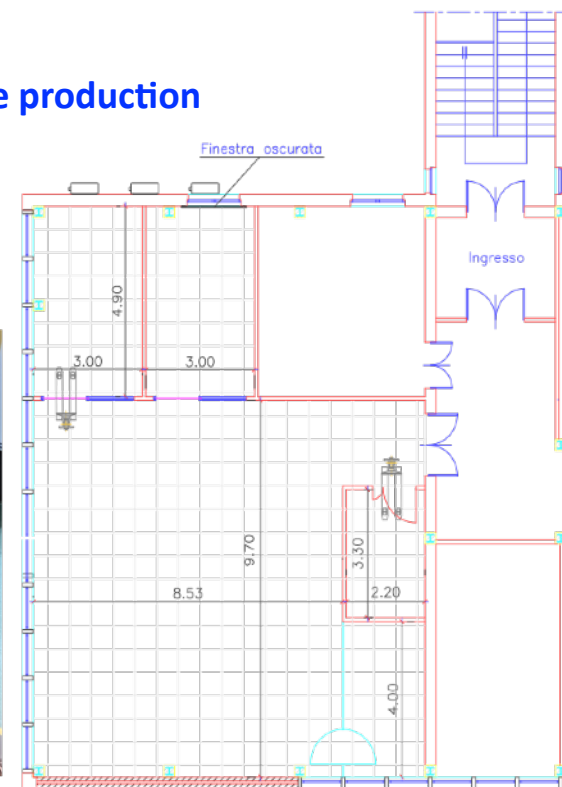
- **DOM production**
  - to be continued (present production capability 1 DU every 2months)
- **Activities on KM3NeT-IT Site**
  - Project management production # 2JB 2.0
  - Documents management
- **Marine campaigns**
  - Survey/maintenance of the Seabed network
  - Multiple deployment of JB2.0s
- **Outreach**
  - ...as usual
- **KM3NET4RR ( PNRR 67 M€ )**
  - New DOM integration lab (building 10)
  - Six more JB2.0 to build

# KM3NeT\_IT\_CT- Planned Activities 2024

We are working to arrange a second DOM integration site in Catania thanks to PNRR found (Edificio 10. Secondo piano. Cittadella Universitaria)

We are working on the purchasing of new tools to increase the rate of the production

- gel mixing machine
- machine to electrically bend the deflector rings
- machine to close the DOMs



Procedures under going for purchasing tools and machines

2 procedures under going for construction works in the second DOM integration site

... estimated cost : 480 k euros ... estimated time: ready for January 2024!

- **People**

Nunzio Randazzo	50 % (Dipendente)
Emanuele Leonora	80% (Dipendente)
Fabio Longhitano	100% (Dipendente)
Sebastiano Aiello	70% (Dipendente)
Riccardo Bruno	70% (Dipendente)
Anna Sinopoulou	100% (Borsa di studio per stranieri)
Iara Tosta e Melo	Formally 10 % (RTA -PNRR) -

**4.8 FTE**

Technicians

Antonio Grimaldi	20% (Dipendente)
Francesco Librizzi	20% (Dipendente)
Carlo Rocca	10% (Dipendente)
Maurizio Salemi	30% (Dipendente)
Domenico Sciliberto	20% (Dipendente)
G. Imperiale	100% for 2 years (new!)
E. Cafici	100% for 2 years (new!)
G. Richichi	100% for 2 years ( from July 1) (new!)

- **Financial request**

- travelling about 30 k€
- Lab DOM consumable about 15 k€
- DOM transportation to DU integration site about 10 k€