

The Calibration Units of KM3NeT

R. Le Breton^a, M. Billault^b, C. Boutonnet^a, C. Champion^a, S. Colonges^a, A. Cosquer^b, A. Creusot^{a,g}, S. Henry^b, A. Ilioni^a, P. Keller^b,
P. Lagier^b, R. Lahmann^d, P. Lamare^b, J. Lesrel^a, M. Lindsey Clark^a, J. Royon^b, G. Riccobene^e, D. Samtleben^{c,f}, V. Van Elewyck^{a,g}

On behalf of the KM3NeT Collaboration

^a: Université de Paris, CNRS, Astroparticule et Cosmologie, F-75013 Paris, France; ^b: Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France; ^c: Leiden University, Leiden Institute of Physics, PO Box 9504, Leiden, 2300 RA Netherlands
^d: Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Strasse 1, 91058; ^e: INFN, Laboratori Nazionali del Sud, Via S. Sofia 62, Catania, 95123 Italy;
^f: Nikhef, National Institute for Subatomic Physics, PO Box 41882, Amsterdam, 1009 DB Netherlands; ^g: Institut Universitaire de France, 1 rue Descartes, Paris, 75005 France;

KM3NeT: Kilometer Cube Neutrino Telescope

S. Adrián-Martínez *et al.*, Letter of intent for KM3NeT 2.0, JoP G, 2016, <https://iopscience.iop.org/article/10.1088/0954-3899/43/8/084001>

Main science goals:

- Origin of high energy cosmic rays ?
- Neutrino Mass Hierarchy ?

ORCA : Oscillation Research with Cosmics in the Abyss

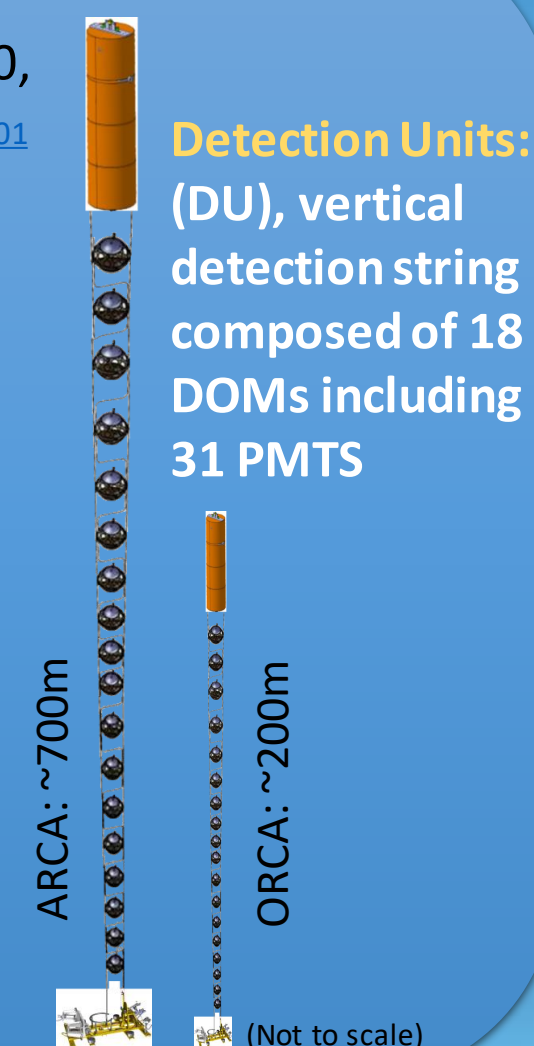
- Denser telescope
- 8 Mton instrumented
- Low Energies : ~ GeV

ARCA : Astroparticle Research with Cosmics in the Abyss

- Larger telescope
- 1 Gton instrumented
- High Energies : GeV to PeV

Two detectors <=> Same Technology

Digital Optical Module (DOM)



Acoustics

Positioning calibration (Commercial Items)

Acoustic Emitter

- FFR SX30 acoustic transducer
- Own signature from 10 kHz to 40 kHz
- One hydrophone on a DOM can detect unambiguously signals from different emitters at the same time
- From Mediterraneo Senales Maritimas

Hydrophone

- 195.3 kHz sampling
- bandwidth from 5 kHz to 90 kHz
- Double gain, DG330 POM-C, Gisma Connector
- From Colmar

Positioning Calibration of the Detector

Goal:

- Compute the speed of sound and speed of sea currents, needed for the positioning system

Used to monitor sea water properties:

- Conductivity, Pressure, Temperature, Salinity, Current meter

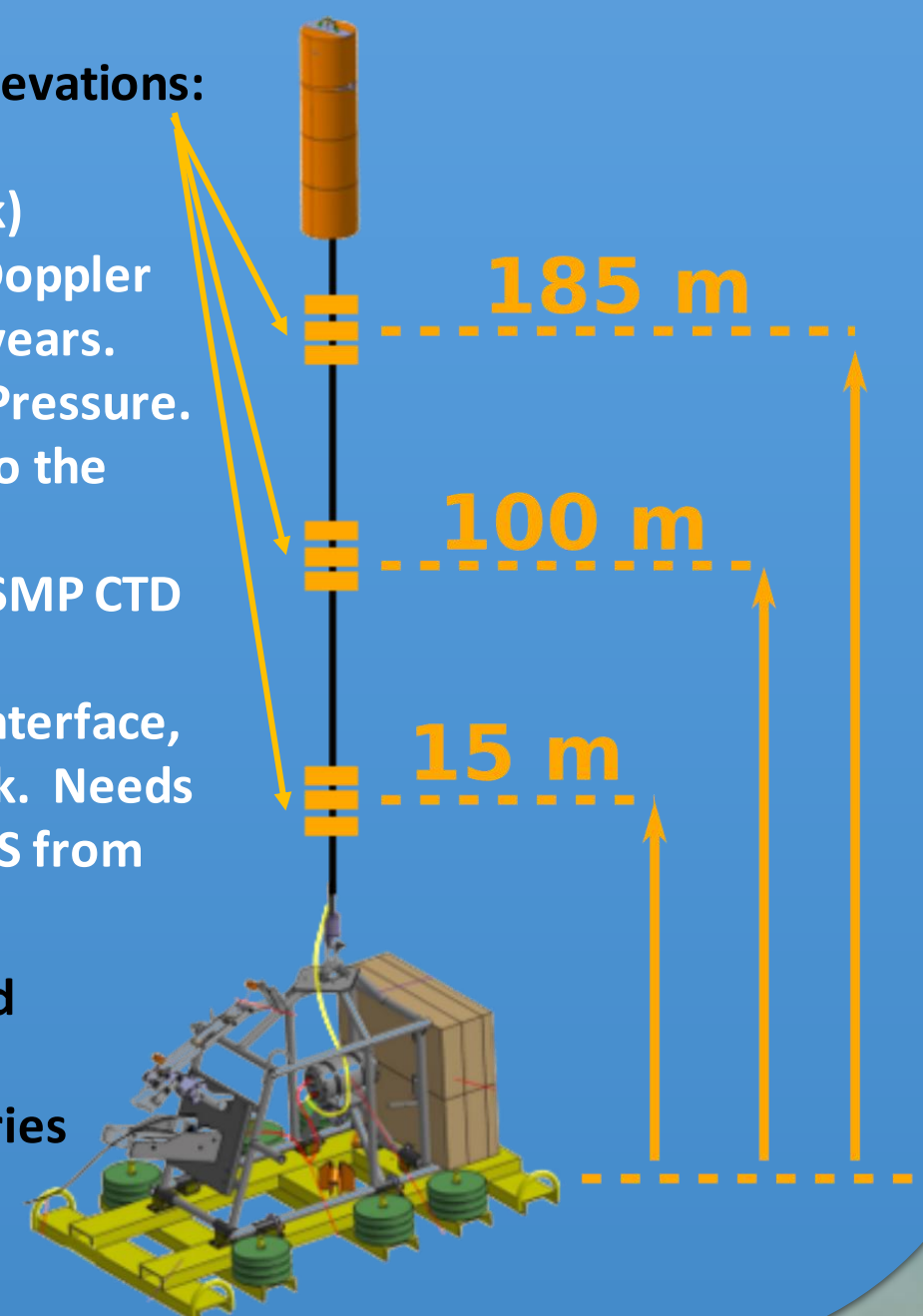
The Instrumentation Unit is composed of:

- **Instrumentation Base titanium container:** electronics boards (power management, communication with the CB, Inductive Manager Module), the penetrator for the IU to CB interlink cable.
- **Anchor:** keeps the system on the seabed.
- **Instrumented Line:** inductive cable, autonomous instruments powered by internal batteries, kept vertical thanks to a buoy in synthetic foam. An Inductive Cable Coupler makes the links between the inductive cable of the line and the Base.

Same inductive instruments at 3 different elevations:

- **Current meter:** (AQUADOPP from Nortek) Measurements are made thanks to the Doppler effect. Needs to be recalibrated every 2 years.
- **CTD sensor:** Conductivity, Temperature, Pressure. Used to infer the sound velocity thanks to the seawater equation of state. Needs to be recalibrated every couple of years. (SBE SMP CTD device from Seabird).
- **Sound Velocimeter:** no native inductive interface, which is made with a RS232-inductive link. Needs to be recalibrated every 2 years. (Mini SVS from Valeport)

The Instrumentation Unit will be recovered every couple of years for recalibration of instruments and replacement of the batteries

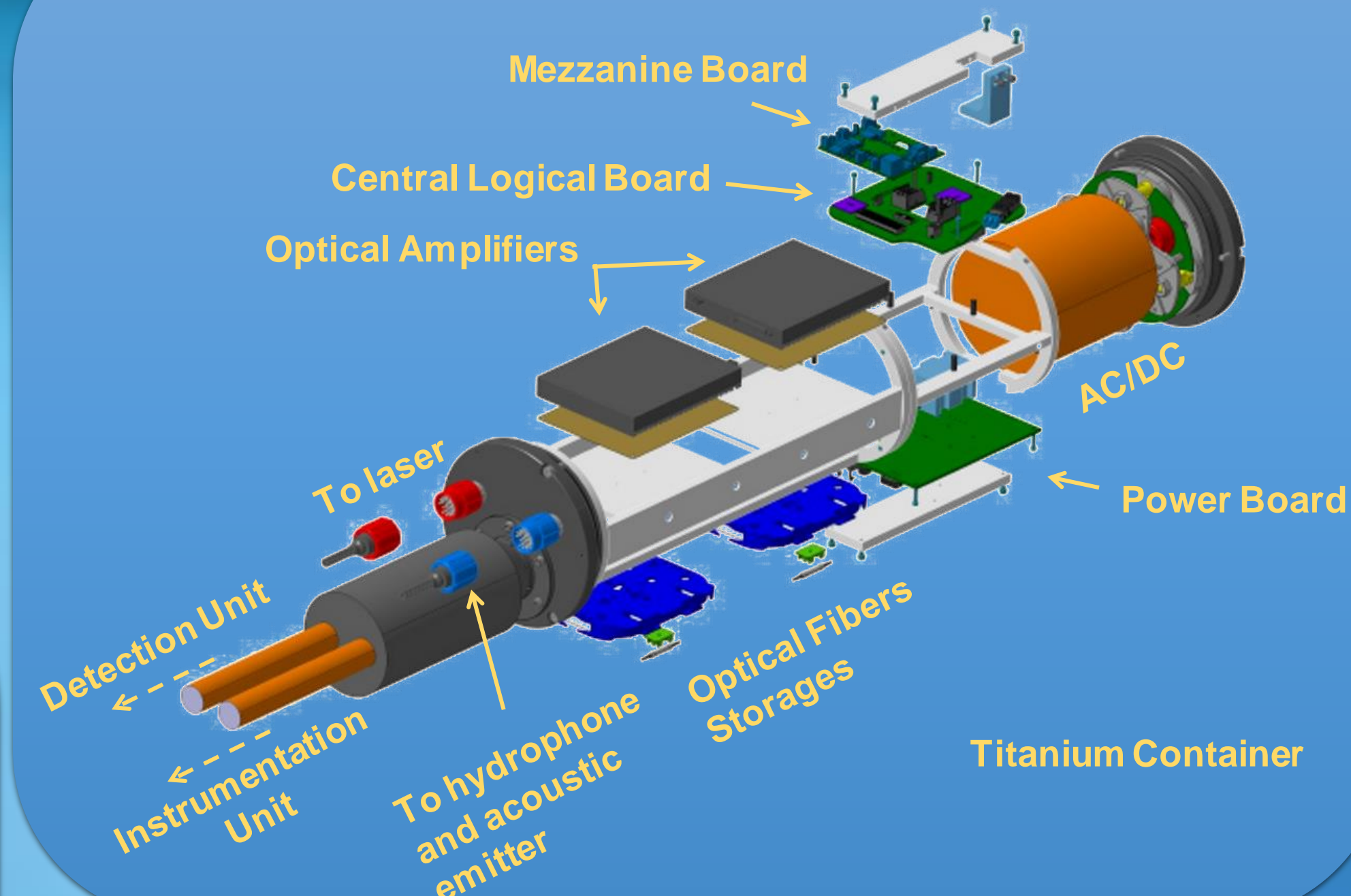


Instrumentation Unit (IU)

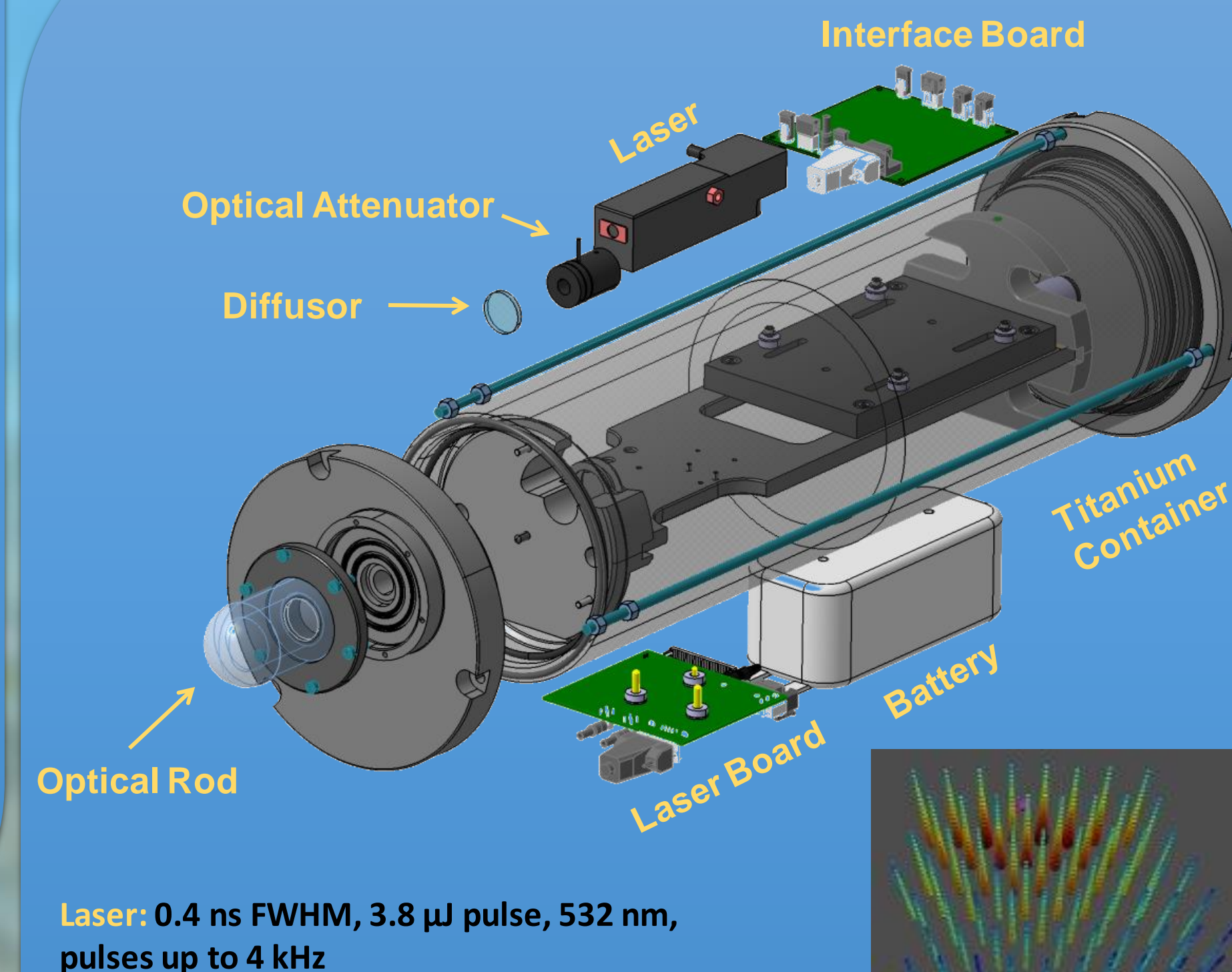
Status

- All the subsystems of the CU, including the firmware, software and user interface necessary to control the whole system, are in final configuration and under tests.
- The final integration and tests between CB and IU will start during the summer 2021.
- The deployment of the CU is currently foreseen in the second half of 2021.

"Central Unit" of the Calibration Unit

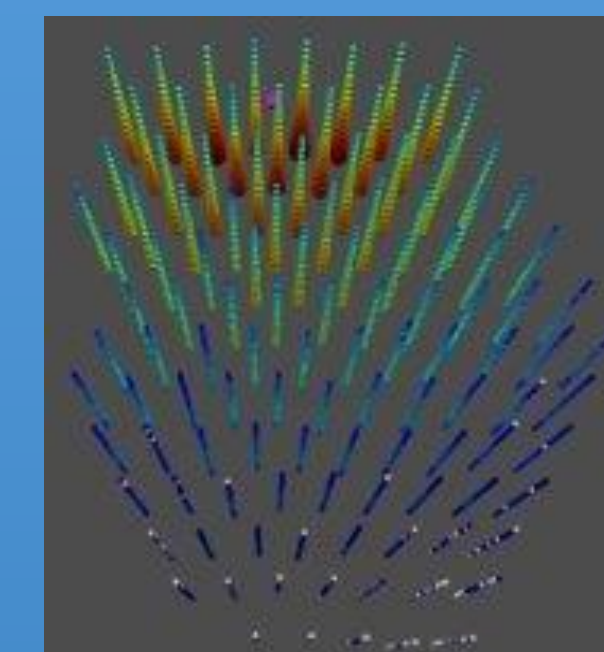


Time Calibration between Detection Units



Optical simulation:

- Check design of optical part (Quartz Rod)
- Check agreement with specification concerning time calibration



Base Module

Laser Beacon

KM3NeT (in a nutshell)

Goals

Calibration Base (CB)

Calibration Goals: Time, 1 ns; Position, 10 cm.

Goals of the Calibration Unit:

- Time calibration (Inter DU synchronization)
- Contribute to the positioning calibration
- Monitor the water properties

Calibration Units: (CB + IU)

Calibration Base + Instrumentation Unit

This poster: focus on ORCA

Anchor (steel)
Host of instruments
Interlink cables
Counter-weights

Base Module

Anodes Corrosion protection (all sides)

