EPJ Web of Conferences **116**, 09001 (2016)
DOI: 10.1051/epjconf/201611609001

The MEUST deep sea infrastructure in the Toulon site

Patrick Lamare on behalf of the MEUST contributors

Aix-Marseille Université, CNRS/IN2P3, CPPM UMR 7346,13288 Marseille, France

Abstract. The MEUST infrastructure (Mediterranean Eurocentre for Underwater Sciences and Technologies) is a permanent deep sea cabled infrastructure currently being deployed off shore of Toulon, France. The design and the status of the infrastructure are presented.

1. Introduction

MEUST [1] is a second-generation follower of the pioneering ANTARES [2] submarine observatory which is being operated since a decade. It is designed as a shared platform between the neutrino physics and astrophysics communities in the context of the KM3NeT project [3], and the Earth and Environmental Science (ESS) communities as the West-Ligurian site of the EMSO European network of submarine observatories [4] but opened to all scientific domains. Compared to ANTARES the MEUST submarine network has a modular and extendable topology which will exceed the ANTARES capacities by an order of magnitude in most respects. The MEUST infrastructure is primarily dimensioned to host a large neutrino detector so-called ORCA for measurement of low energy neutrinos. A dense array of neutrino optical sensors distributed on mooring lines, the Detections Units (DU) installed on the seabed constitutes the ORCA detector designed by the KM3NeT collaboration. A DU consists of 18 Digital Optical Modules (DOM), equipped each with 31 photo-multipliers, and linked to each other as a vertical flexible line of about 250 m anchored on the seabed. The inter-DOM distance within a DU and the inter-DU distance on the seabed are ∼9 m and ∼20 m, respectively. The first set of instruments from ESS to be installed on MEUST is an Interface Instrumented Module (MII) which will be connected to the infrastructure. The MII hosts dedicated sensors and provide real time acoustic communication with an autonomous mooring line (“ALBATROSS”) which instruments the whole water column on a height of 2000 m from the seabed.

2. MEUST site

The MEUST terrestrial base is located on the Brégaillon site of the Toulon Bay, where a new building is planned in 2018 to host the technical activities, including a control room. The MEUST submarine site has been selected after intensive characterization campaigns conducted in the past years at several possible locations, in order to find the best compromise between the site intrinsic qualities and external constraints such as existing cables and logistics costs. The MEUST final site (Fig. 1) is located ∼40 km

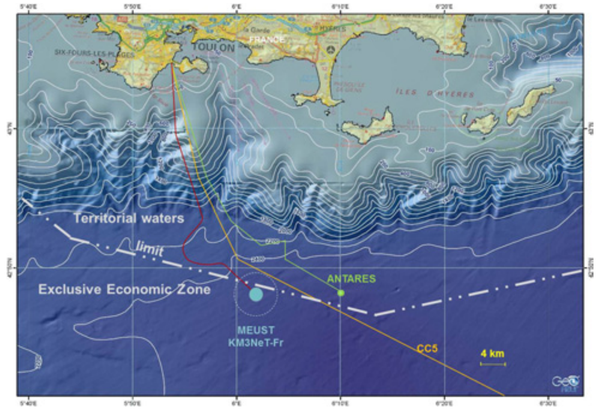

Figure 1. Geographic location of the MEUST site with the route of the MEUST cable to shore (red line).

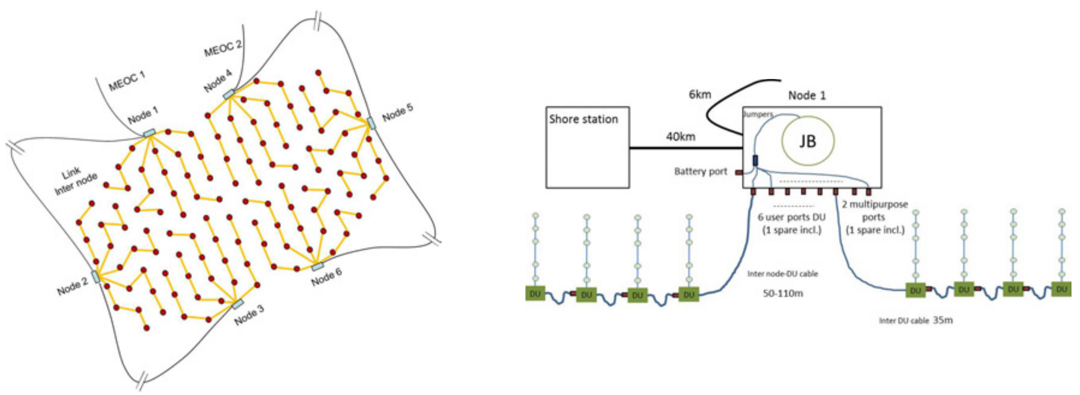

Figure 2. The MEUST generic submarine topology (left) and the layout of the 4-DU chain connected on the node (right).

offshore of Toulon at a depth of 2450 m and 15 km western of the ANTARES site. Acoustic and visual surveys of the seabed area have revealed a very flat and sandy area.

3. Submarine network topology

The full generic submarine network (Fig. 2 left) has a ring topology with up to 6 nodes connected to shore by two Main Electro Optical Cables (MEOC). The MEOCs are standard telecommunication cables with optical fibres for data transfer and one electrical conductor for power transfer. The network components (cables and nodes) are designed to allow a staged implementation using standard telecommunication marine deployment techniques and procedures.

The MEUST nodes are equipped each with 8 wet mateable connectors including 6 connectors usable for DUs only, and 2 multipurpose connectors suitable for both DUs and ESS instruments. The nominal instrumentation configuration connected to a node involves at least 20 DUs chained by 4 using 5 DU connectors and one set of ESS instruments using one multipurpose connector (Fig. 2 right). The 2 extras connectors are provisioned as spares in case of failures but may also allow to extend the available instrumentation.

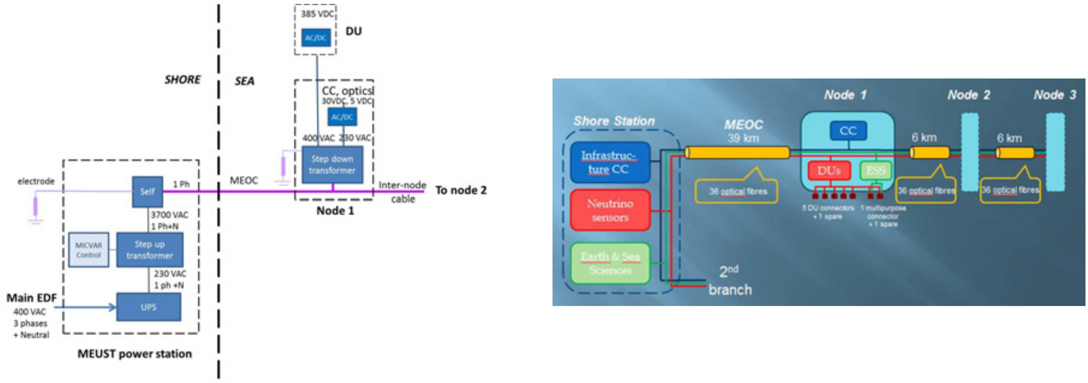

Figure 3. General schemes of the MEUST electrical power system for 1 node (left) and optical network (right).

4. Network functionalities

The MEUST infrastructure provides three main systems which are largely independent from each other: the electrical power distribution system, the optical network for data transfers and control of scientific instruments, and the Control Command for configuration and monitoring of the infrastructure network.

Proximity to the coast of the submarine site allows to perform the power transfer (Fig. 3 left) in High Voltage AC with sea return, as for ANTARES, using reliable electrical components with an overall acceptable offshore power loss. Power is transfer at 3700 VAC at maximum through the conductor of the MEOC and stepped down to 400 VAC by a transformer in each node. The DUs and ESS instruments include adequate AC/DC converters tailored to their DC current uses. The power system is primarily dimensioned by the DUs consumption and provides a usable power of ∼8 kW on each node (∼1 kW/connector).

The overall philosophy of the optical network is to provide an Ethernet network for a communication between the shore and the subsea instruments. The MEUST nodes include only passive optical components except optical amplifiers. The optical network (Fig. 3 right) comprises three independent sub systems distributed as following in the MEUST MEOC: the DU network using 30 optical fibres (10/node) to transfer and control the data of the neutrino detector, the ESS network using 2 optical fibres and the Control Command network using 2 optical fibres. Two extra optical fibres in the MEOC are reserved as spares. The DU optical fibres are distributed to the 8 node output connectors whereas the ESS optical fibres are distributed to the 2 multipurpose connectors only. The DU network uses Dense Wavelength Division Multiplexing (DWDM) with 50 GHz spacing (0.4 nm) in the C-band allowing up to 80 wavelengths in each optical fibre. Each DOM has its own wavelength with a point to point connection with the shore. A MEOC optical fibre can therefore transfer the data of 4 DUs (corresponding to 72 DOMs), which has guided the concept of the 4 DUs chained to one node connector. The ESS network uses bidirectional Coarse Wavelength Division Multiplexing (CWDM) with a wavelength grid of 20 nm, allowing the possibility of designing a sub network using a denser DWDM grid.

The Control Command manages the power, optical and monitoring systems of the infrastructure. It uses industrial Input-Output modules and switches, compatible with Linux for software developments, with a communication based on the Ethernet protocol. All the system is doubled from the sensors and actuators to provide a redundancy in case of failure of an individual component.

5. Infrastructure components

The components of the infrastructure have been prototyped and engineered from 2010 to 2015.

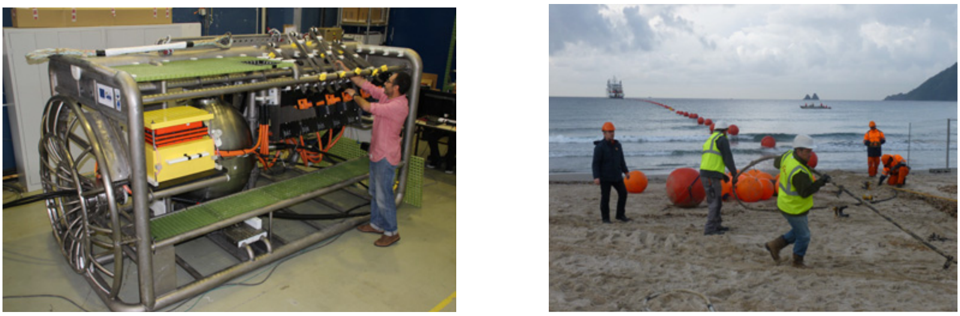

Figure 4. The node after assembly (left) and the MEOC cable under deployment (right).

A new power station, hosting an Uninterruptible Power Supply (UPS) with a Power Feed Equipment (PFE), is operational beside the ANTARES one on the Sablettes beach in La Seyne sur Mer where the MEOC cables land the shore.

The MEUST MEOC #1 (36 optical fibres) is a ∼39 km long standard telecommunication cable from ALCATEL (reference OALC-7). The MEOC #2 is the ANTARES one, compliant with the MEUST specifications, which will be re-routed after the ANTARES decommissioning scheduled in 2017.

The first node (Fig. 4 left) was built and deployed. Its main active element is a Junction Box made of a titanium sphere containing the electrical step-down transformer, the optical components and the Control Command devices. The Junction box is inserted in a titanium frame hosting 2 panels of each 4 output wet mateable hybrid connectors (reference PRH/APC from the Teledyne ODI company). The connector panels include specific connection tools which have been developed in order to be able to use light commercial ROVs to connect the instruments.

6. Status and plan

The MEOC cable was deployed by Orange Marine on the seabed in December 2014 (Fig. 4 right). In April 215 with Orange Marine, the MEOC was recovered from the seabed, thanks to a dragging tail, and connected to the node on board using standard telecommunication jointing technique. The node was then successfully deployed with half of the inter-node cable (3.6 km) for future extension. The infrastructure was powered on and successfully operated one month before a failure which required a repair operation held in June 2015. The operation of the node confirmed the functionalities of the power and Control Command systems with the expected temperatures and humidity inside the JB. The repair operation didn't allow for a complete repair due to time constraints, so the node was brought back to shore for the repair of the MEOC penetrators. The repair is in progress and the re-deployment of the node is planned in early 2016. The first DU and the MII are ready for deployment, waiting for the node installation, and the ALBATROSS line is installed on the seabed.

In the coming years the submarine infrastructure is expected to be extended by additional nodes for connections of DUs to achieve the realization of a KM3NeT Building Block. Further ESS instruments are expected and in particular the transfer to MEUST of the ESS Secondary Junction Box of ANTARES.

The authors wish to thank R. Cocimano, A. Damico, E. Heine, G. Kieft, S. Mos and J-W. Schmelling for their contributions to specific aspects of the design of the MEUST infrastructure. The MEUST development was financially supported by the CNRS, Aix-Marseille Université, the town of Marseille and the European Regional Development Fund (ERDF).

References

[1] MEUST web page, available on http://meust.cnrs.fr
[2] J.A. Aguilar et al., *ANTARES: the first undersea neutrino telescope, Nuclear Instruments and Methods in Physics Research,* Section **A 656** (2011) pp 11–38
[3] KM3NeT web page, available on http://www.km3net.org
[4] EMSO web site, available on http://www.emso-eu.org