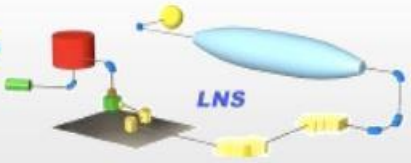
Activities and news for 2015 KM3NeT project

Pasquale Migliozzi

INFN Napoli

Istituto Nazionale di Fisica Nucleare

Laboratori Nazionali del Sud

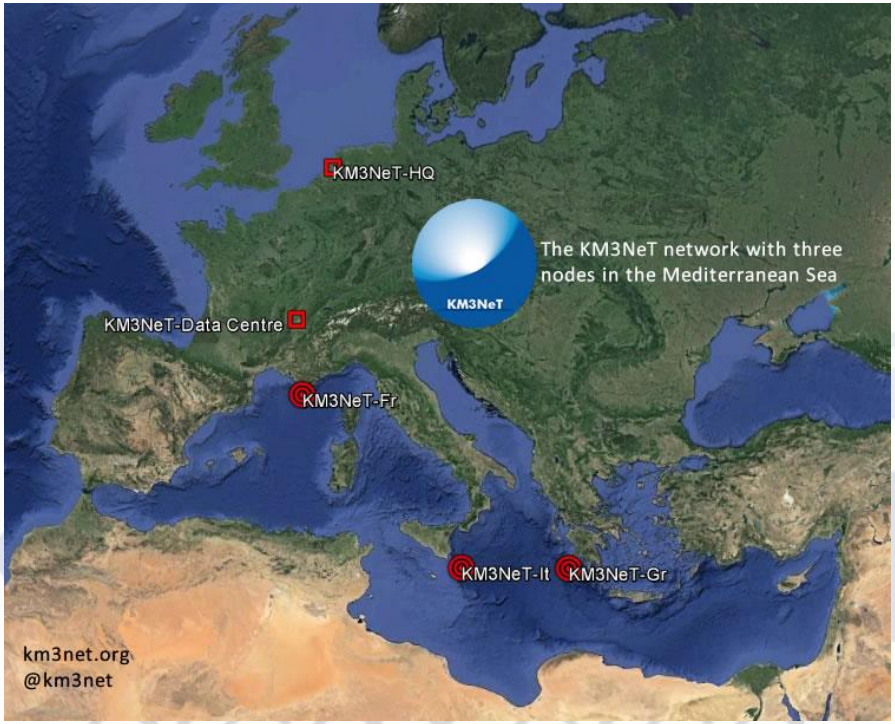


PROGRAM LNS USER MEEETING

What is KM3NeT?

KM3NeT aims to be the largest deep sea infrastructure in Mediterranean Sea consisting of a network of neutrino telescopes with user ports for earth and sea sciences. Its physics goals are:

- High energy neutrino astronomy (TeV-PeV energy range)
- Measurement of fundamental neutrino properties (GeV energy range)



ARCA- Astroparticle Research with Cosmics in the Abyss @KM3NeT-It

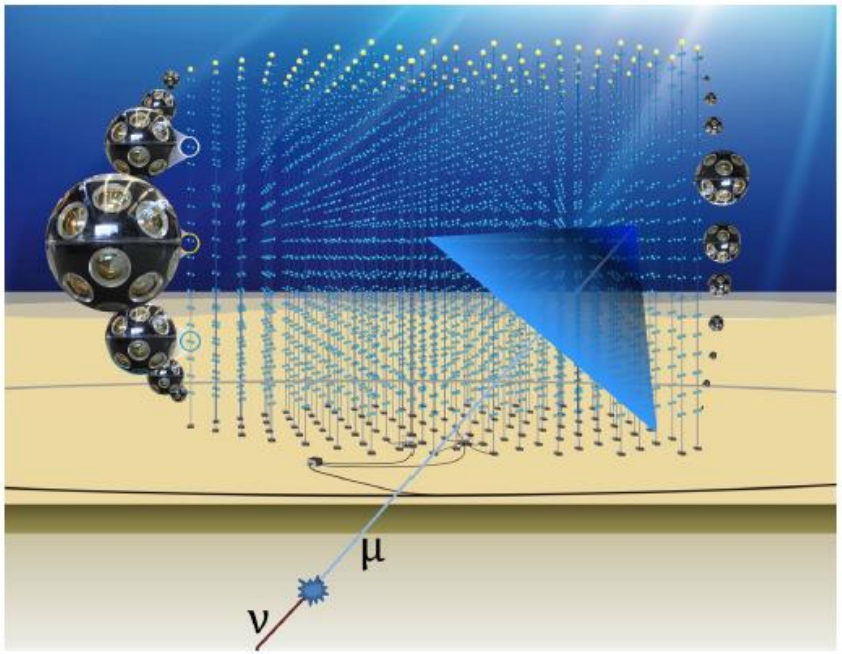
ORCA- Oscillation Research with Cosmics in the Abyss @KM3NeT-Fr

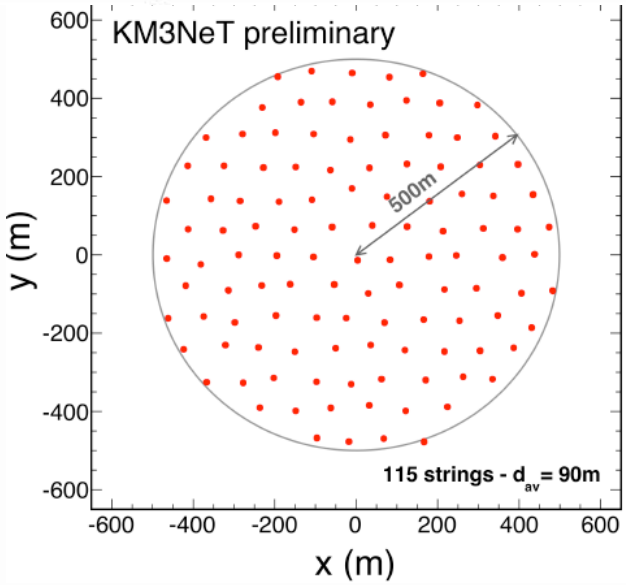
Single Collaboration

Single Technology

Single Management

KM3NeT building block (115 DUs)



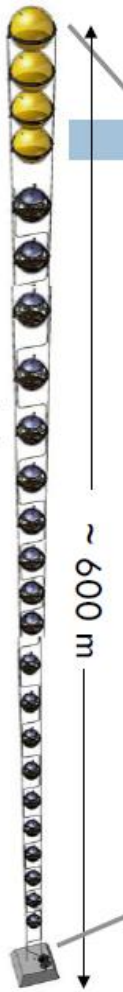


The Detection Unit

Optical module

17”

31 x 3” PMTs
PMT HV
LED & piezo inside
FPGA readout
White Rabbit
DWDM



18 DOM per DU

Vertical DOM spacing 36 m

Inter-DU spacing 90 m

Phased implementation

Phase	Blocks	Primary deliverables
1	0.2	Proof of feasibility and first science results (7 ORCA strings/24 ARCA strings by end 2016 + 8 towers)
2.0	2 *ARCA* at KM3NeT-It	*Neutrino astronomy with ARCA* *– focus on Galactic sources ("Raison d'être")* *– measurement of the IceCube signal with different methodology, improved resolution and complementary field of view* *– break-through capability of doing all-flavour neutrino astronomy*
	1 *ORCA at* *KM3NeT-Fr*	*Neutrino physics with ORCA* *– first determination of neutrino mass hierarchy (faster, better and cheaper)* *– improve measurements of neutrino oscillation parameters* *– essential and timely input for CP-violation experiments*

KM3NeT Phase-1

KM3NeT Phase-1: Proof of feasibility of neutrino detectors

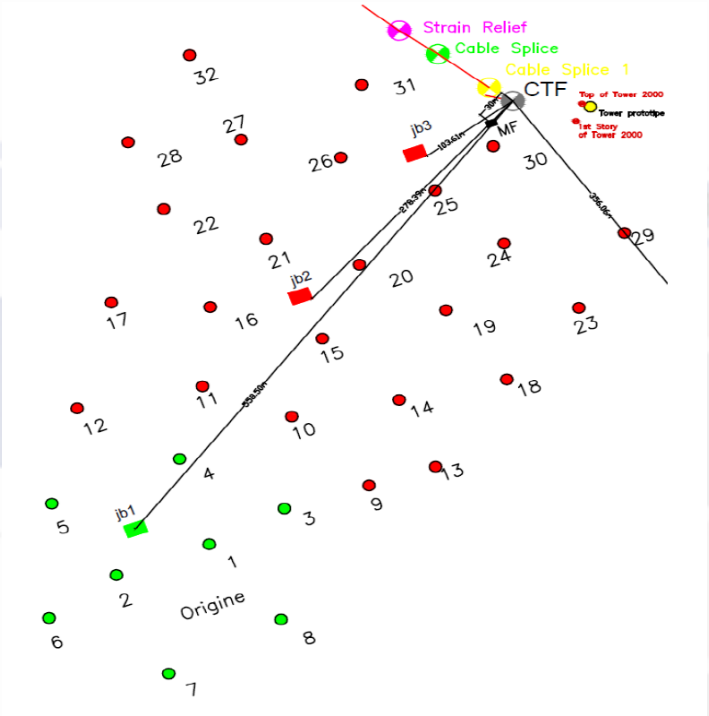
Started in January 2014

Detection Unit deployment in 2015-2016

Two sites

- KM3NeT-It (24 Strings + 8 towers)
- KM3NeT-Fr (7 DUs)

KM3NeT-It instrumented volume is 0.1 km^3,
i.e. 10 times larger than Antares

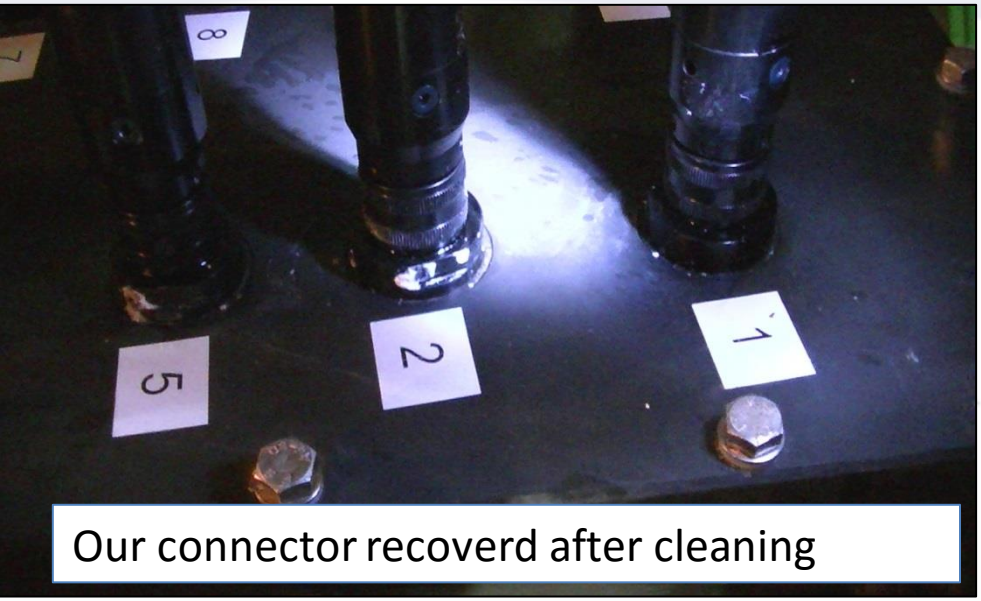


Marine Operations Tools
MSV Ambrosius Tide and CRS A. Meucci

- Multi Service Vessel ATide
- 30 t hydraulic A-Frame with 4500m lift lines
- Heavy work class ROV rated up to 4500 mwd (125 hp)

- Cable Repair Ship Antonio Meucci
- Fully equipped for cable jointing activities and cable deployment (drum and drum engine)

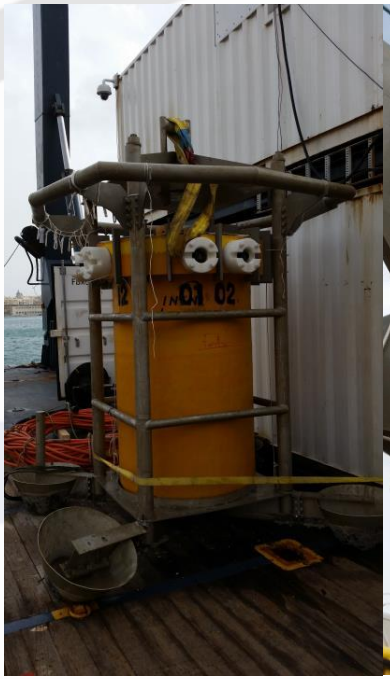
- During the sea operation on March 2015 the Junction Box deployed in November 2014 was recovered.
- The inspection on-board evidenced a corrosion problem on two anodized Aluminium connectors fixed on the Junction Box manifold.
- Corrosion in aluminium is always eye-catching because the corrosion pits are covered with white, voluminous and gelatinous alumina gel $Al(OH)_3$.
- The consequent decision was to bring the Junction Box back on shore at the LNS laboratory for further inspection and to implement corrective actions.



Our connector recoverd after cleaning


hard anodized Al sample with alumina gel

Experience at LNS



LNS has a long experience use of aluminum in marine engineering, two alloys have been chosen:
5083, to be used for **non anodised** structural items (main frames, storey, etc.);
6082, to be used for **hard anodised** pressure resistant vessels to house electronic boards

These structures in Al 5083 were recovered together seven years after the deployment. Can be inspected outside the lab

How to fix it

- After careful studies the corrosion is ascribed to some scratches on the anodization of the connectors that exposed the underlying metal surface. These scratched were produced during connector assembling.

- To avoid this problem:
  - a soft polymer mounting tool has been designed and used, in order to minimize the risk to damage the connectors during the assembly of the connector on manifold.
  - An accurate visual inspection was done to evidence possible scratches which are evidenced by the difference of the (brilliant) clear surface of the Al and the (opaque) black surface of the oxide.

July 2015 Marine operation report

- **Operation July 2015**

Recovery Old CTF and deployment of New CTF

- To prepare the operation supervisors of the AT had a crew transport to the Meucci and held a coordination meeting offshore. Communication during ops between vessels was handled through a Skype Group and a UHF radio as back up.
- The recovery of the old CTF went smooth using the AT and its ROV to guide and hook the Meucci Heavy Lift Line into the upfront purpose rigged old CTF. AT beacons were installed upfront on Meucci HLL and AT provided ROV friendly hook.
- The recovery was performed by the Meucci. Onboarding, change-out, splicing and testing happened on the Meucci
- Redeployment of the new CTF was initiated by the Meucci. As the Meucci has significant technical restrictions (type of DP, beacons not suitable for 3500m water depth, accuracy levels for cable deployment) the deployment was mainly guided by the AT. Using AT Survey and the AT ROV to maneuver the Meucci and correspondingly the new CTF to the old position. This has been achieved with an accuracy of +5 meters.

Final step of deployment took 15 hours of constant coordination of the two vessels!

July 2015 Marine operation report

- **Operation July 2015**

Deployment of JB1, JB2 and cables, T2001-T2007 cabling

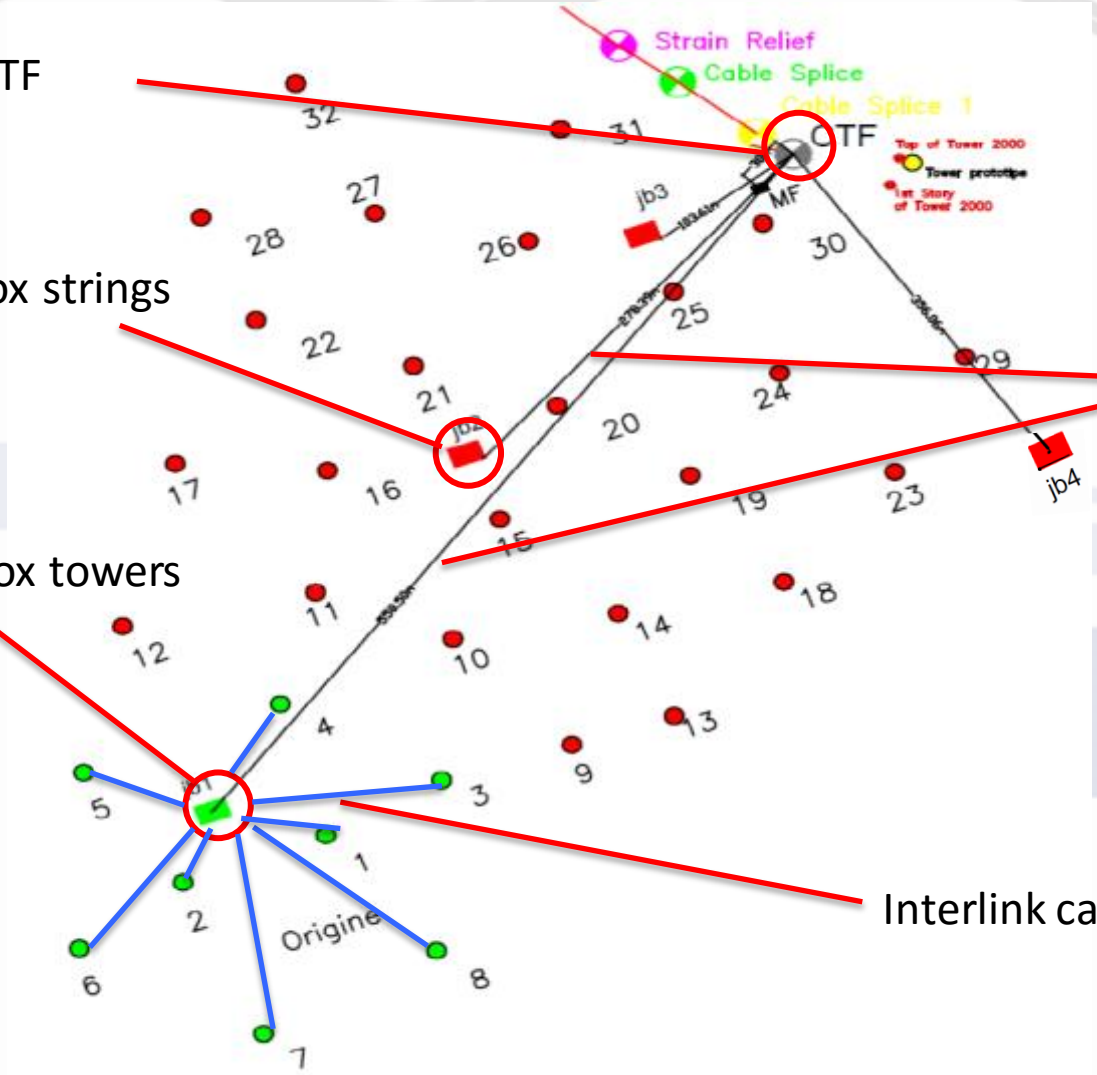
- Before and after the CTF activities the AT performed extensive field works.
- 585m cable between CTF and JB1 and 310m cable between CTF and JB2 were deployed using a purpose designed Cable Tray (designed in Genova)
- JB1 and JB2 were deployed and connected to the new CTF
- JB preparation pre deployment and design requires some adjustment to improve future activities (see lessons learned document)
- Afterwards the remaining 7 cables to the the Tower DUs to JB1 were deployed and connectors parked in a safe position. Deployment of interlink cable T2001 to 2007 went smooth using Cable Tray. The cable tray will be upgraded to also be used as a 'basket transporter' in the future to improve field works.

July 2015 summary report

New CTF

Junction Box strings

Junction Box towers



Interlink cables CTF-JB

Interlink cables Towers-JB

New Cable Termination Frame

Tower JB, 8 outputs
String JB same structure and layout, but with 12 outputs and a different Optics POD

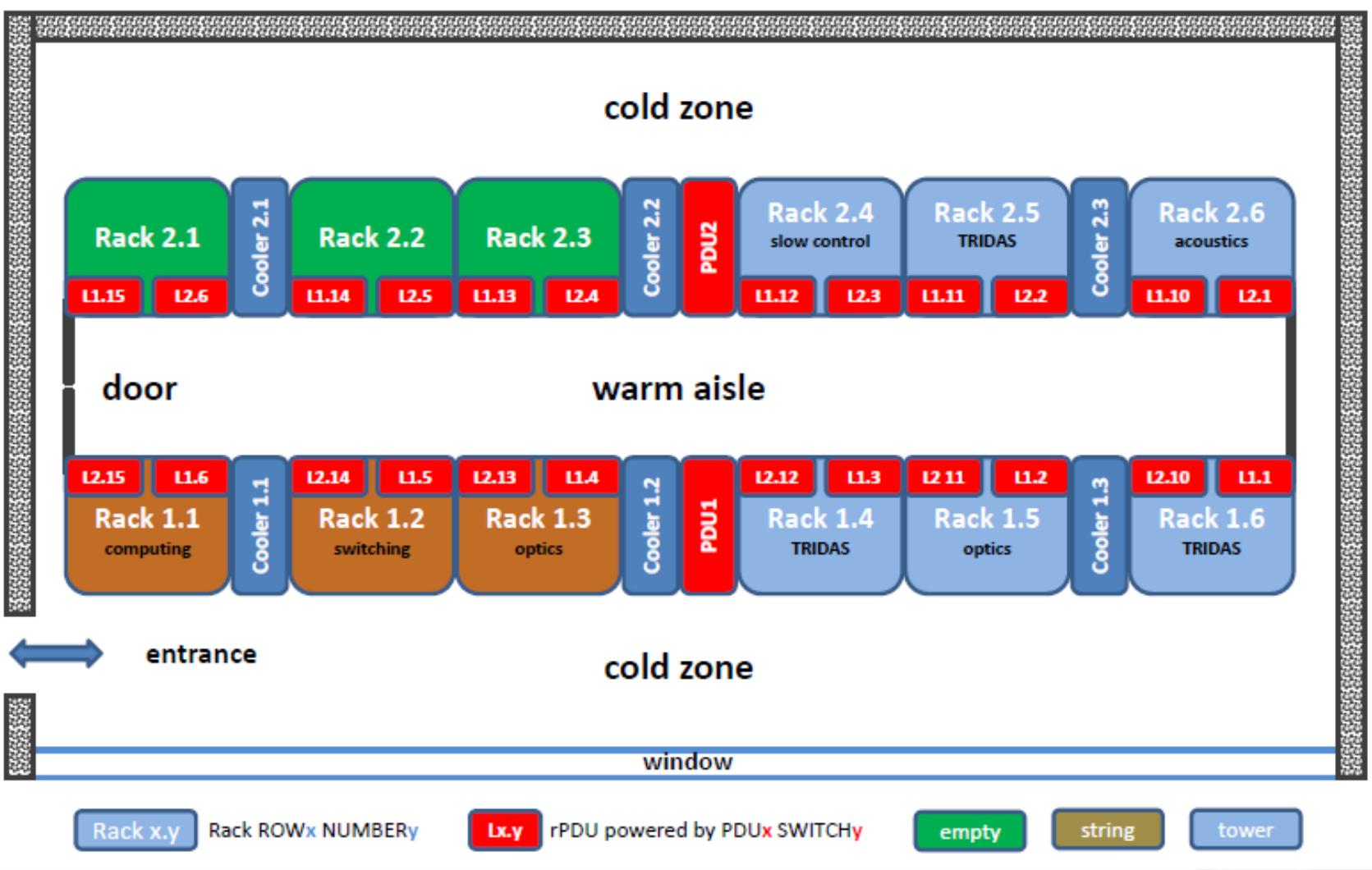
Marine operation in December

- Survey of the JB completed: OK
- Deployment of Tripod1
- Several interlink cables spooled on the sea bed
- Deploy first String S1009 (aka DU2) with inter link cable IL1009 (more details later)
- The PPM-DU recovery was not performed

The Laboratory at Portopalo of Capo Passero

The onshore infrastructure at Capo Passero was realized in 2010 in a restored old wine cellar close to the small harbour of Portopalo in the southeast extremity of Sicily. The building hosts the power supply connected through a 100 km long electro-optical cable (deployed in 2008 down to the 3500 m depth) to the termination frame. This termination includes a DC/DC converter and 3 wet mate hybrid (electro-optical) connectors one of which used to connect the first detection unit prototype (a tower with 8 floors) in April 2013.

Data Acquisition Center Layout



Facilities available at the shorestation

- The power supply: The submarine infrastructure is powered from the on-shore station by a Power Feeding Equipment (PFE) through the Main Electro Optical Cable (MEOC)
- The Power Generator: A Power Generator (PG) of 250 kVA has been recently installed in order to guarantee the functioning of the laboratory plants although the frequent interruption of the external energy supplier.
- The UPS: An uninterruptible power supply (UPS) guarantee the on-shore continuous functioning of both the PFE and Datacenter.
- The Data Center: A private local network is used for data acquisition, monitoring and control systems; it is connected to the INFN Laboratori del Sud in Catania via an optical link at 1 Gbps.
- The Laboratory Status: Today the laboratory is fully operating. In the last month an important marine operation has been performed successfully. All the laboratory resources have passed an important stress test allowing the persons of the KM3NeT European collaboration to operate the systems and assist the marine operation working locally and remotely (via INTERNET) from its own work location.

Status of the tower production

- The tower production is proceeding smoothly at a speed of 1 tower every 2 weeks
- Therefore, the 8 towers will be ready by the end of February
- The backbone is the bottleneck towards the completion of the 8 towers
- It should become available by mid of March
- Once available the completion of each tower will require 1 week


INFN

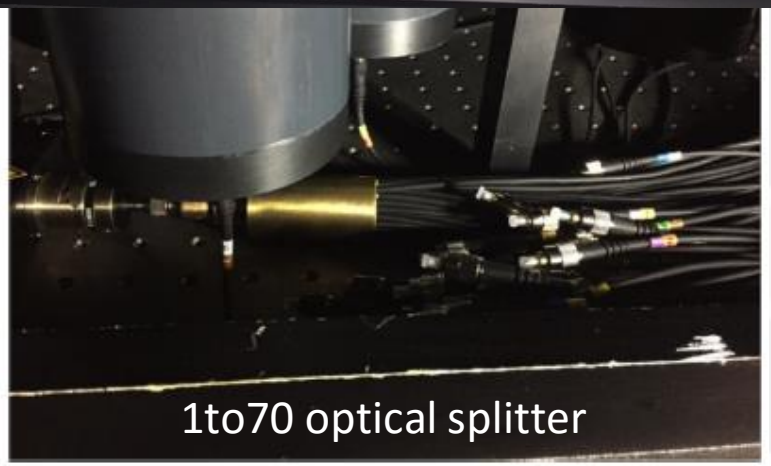
News on strings

Italian responsibility for the KM3NeT construction

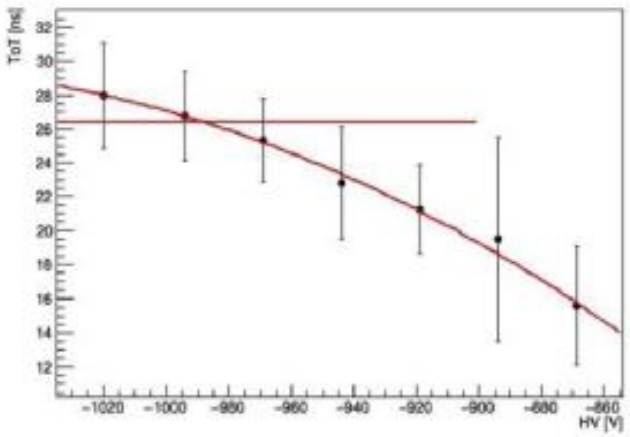
- Technical coordination
- Publication and Conference&Outreach Chairpersons
- DAQ, DB, Calibration, Power, PMTs, DU Integration Coordination
- Base module integration
- Test and calibration of all PMTs
- 2 DOM integration sites (3+1 in KM3NeT) in production
- 1+1 DU integration sites (2+1 in KM3NeT)

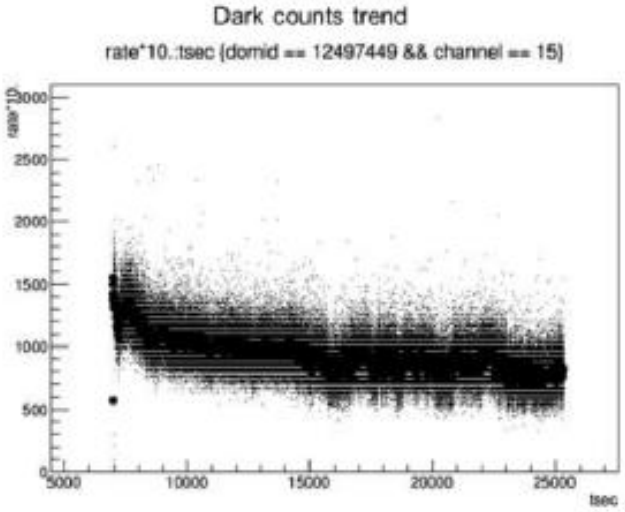
Each single PMTs is tested and calibrated. 120 PMTs are tested daily

DarkBox for PMT tests

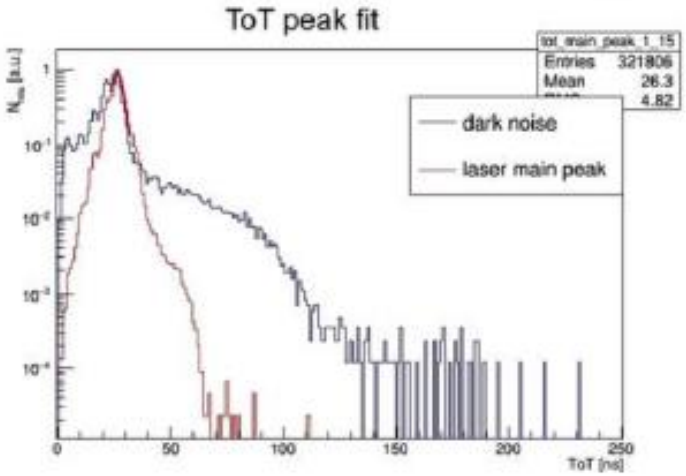


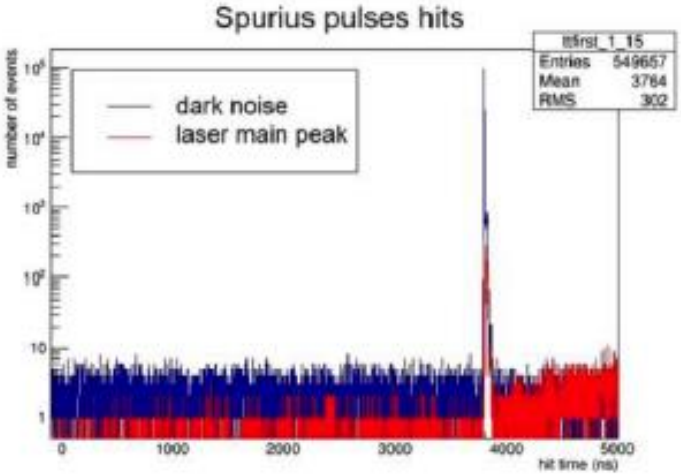
Test sheet for each PMT





DarkBox test summary (Test #33)
PROMIS ID: 0005C4
Quality : GREEN
UPI : 3.4.2.3/HAMA-R12199/2.4082
Tuned HV : -987.94 V
DarkRate : 793.13 Hz
ToT peak : 26.8561 ns
Prepulses : 0.00292931%
Delayed : 0.0709103%
Afterpulses : 0.476641%
TT peak : 3793 ns
TT FWHM : 3 ns

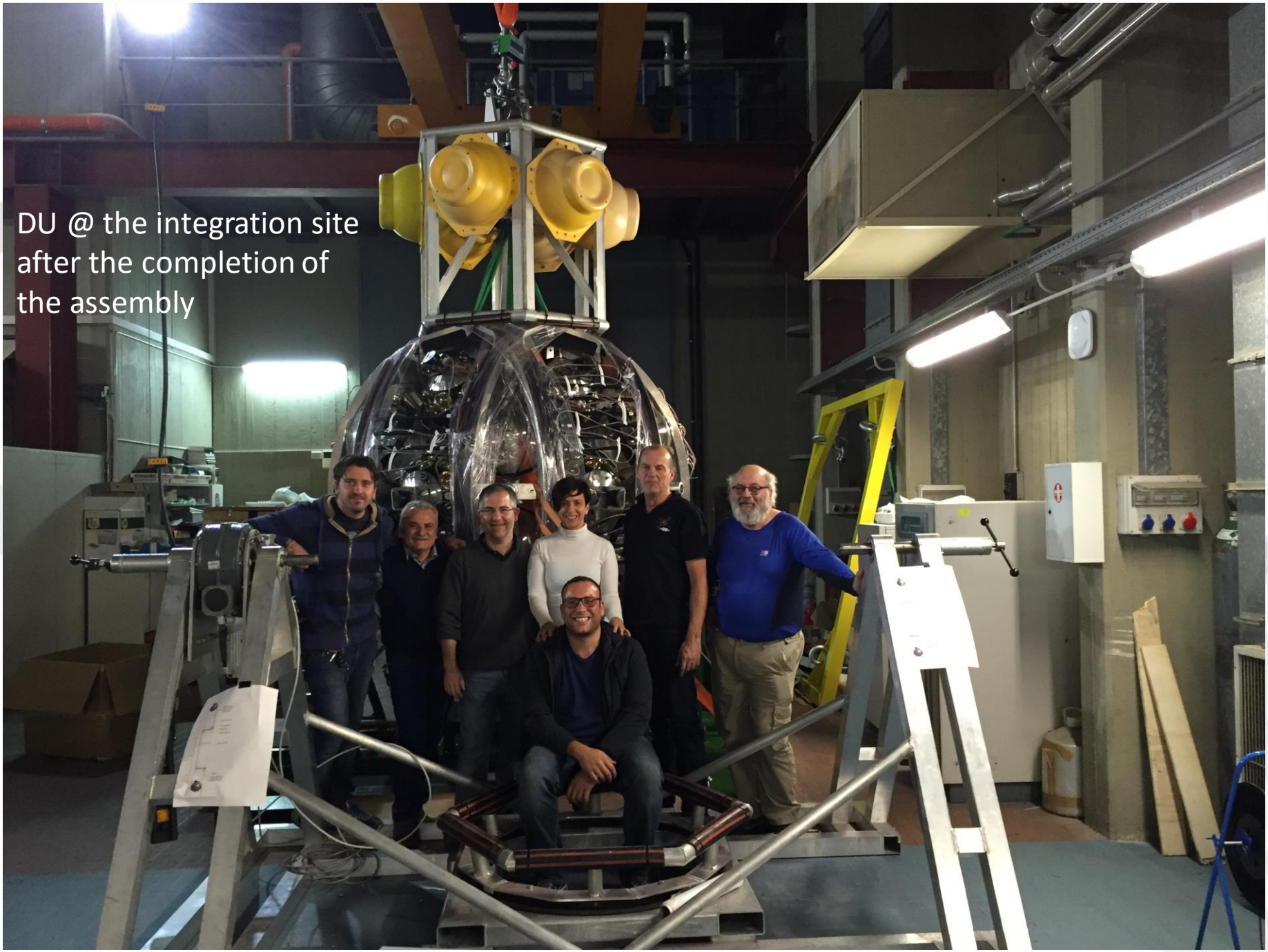




The DOM integration lab

Green box for acceptance test and calibration of the DOM

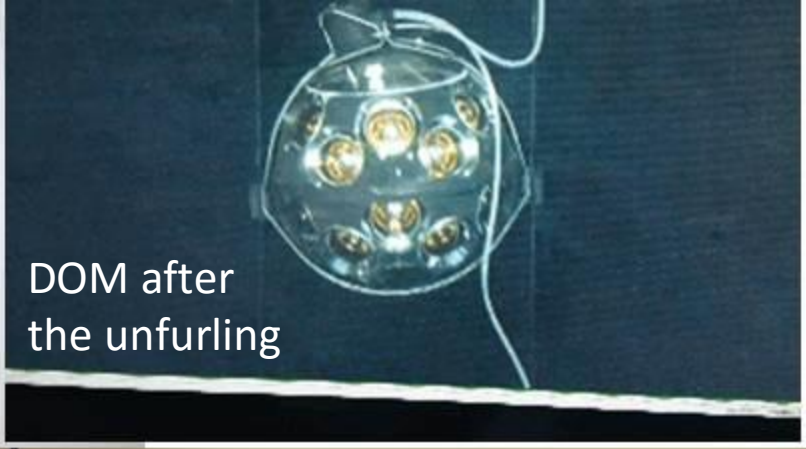
DOM closed and sealed


DU @ the integration site
after the completion of
the assembly

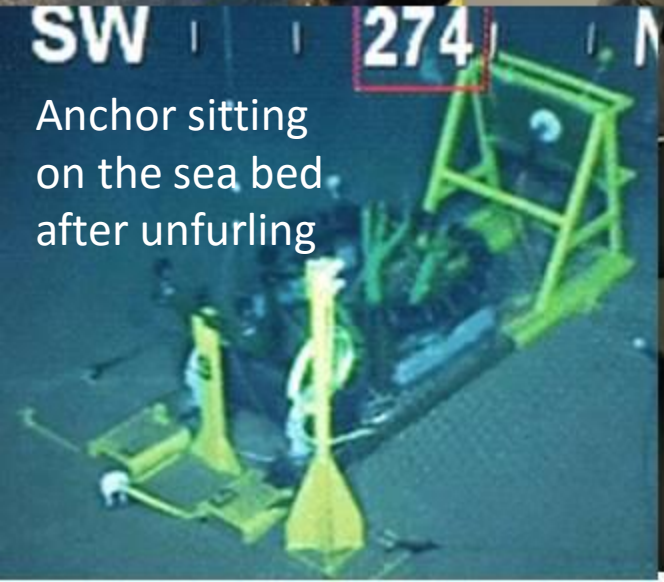

DU packed
on the LOM
ROV mate
connector
BaseModule
Zinc Anode

DU ready for the splash

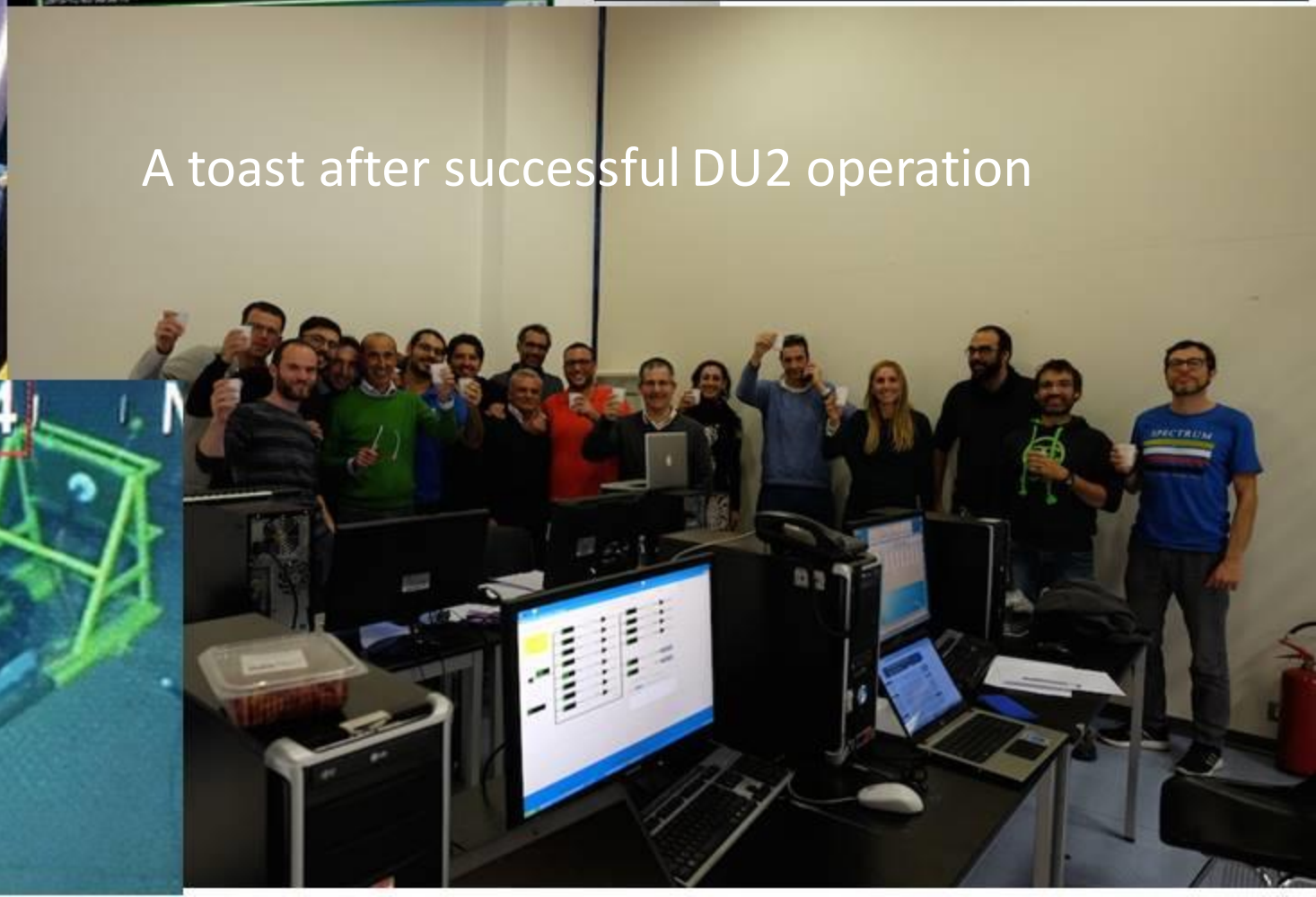
DU sitting on the sea bed before unfurling



DOM after the unfurling

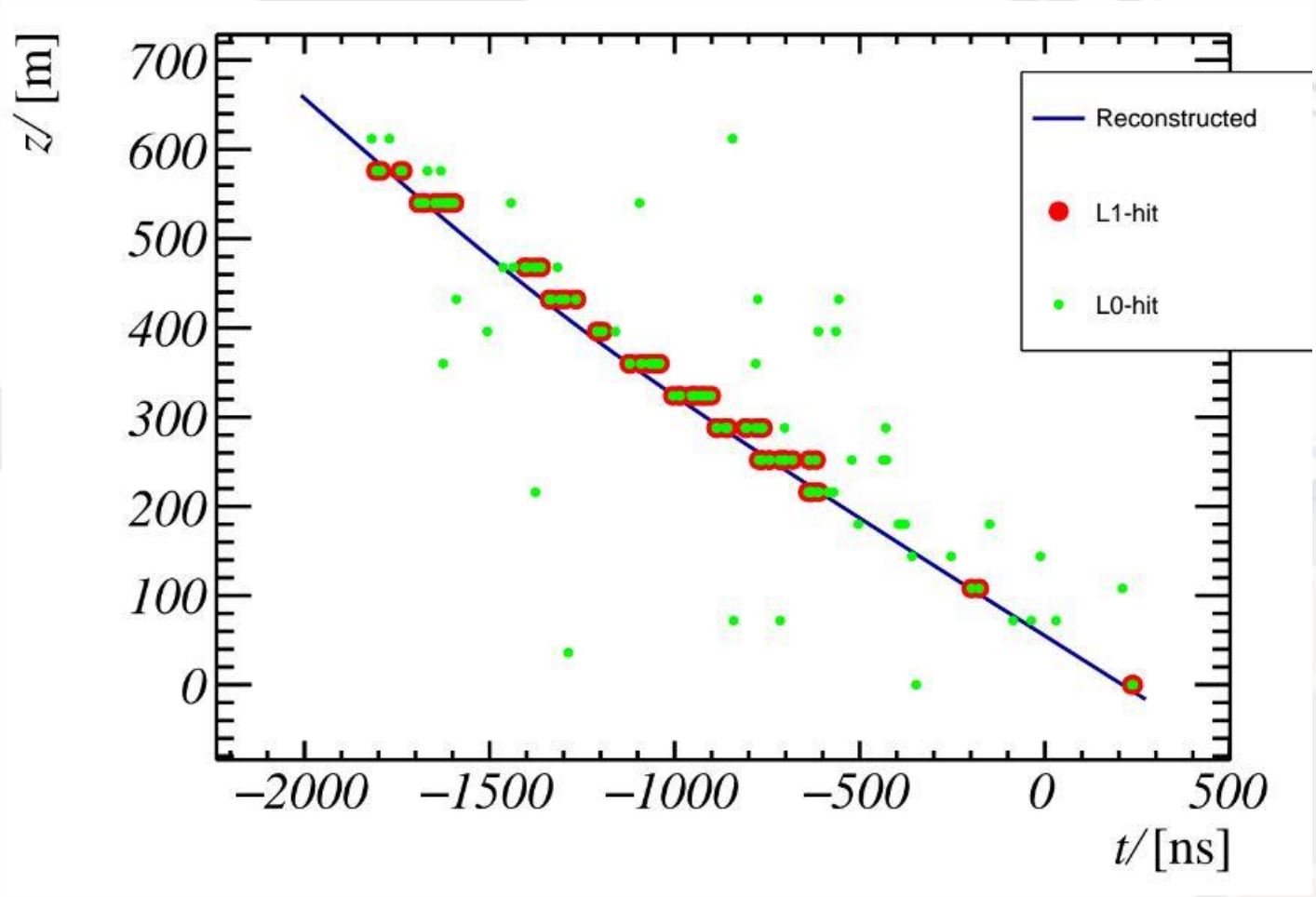


Anchor sitting on the sea bed after unfurling

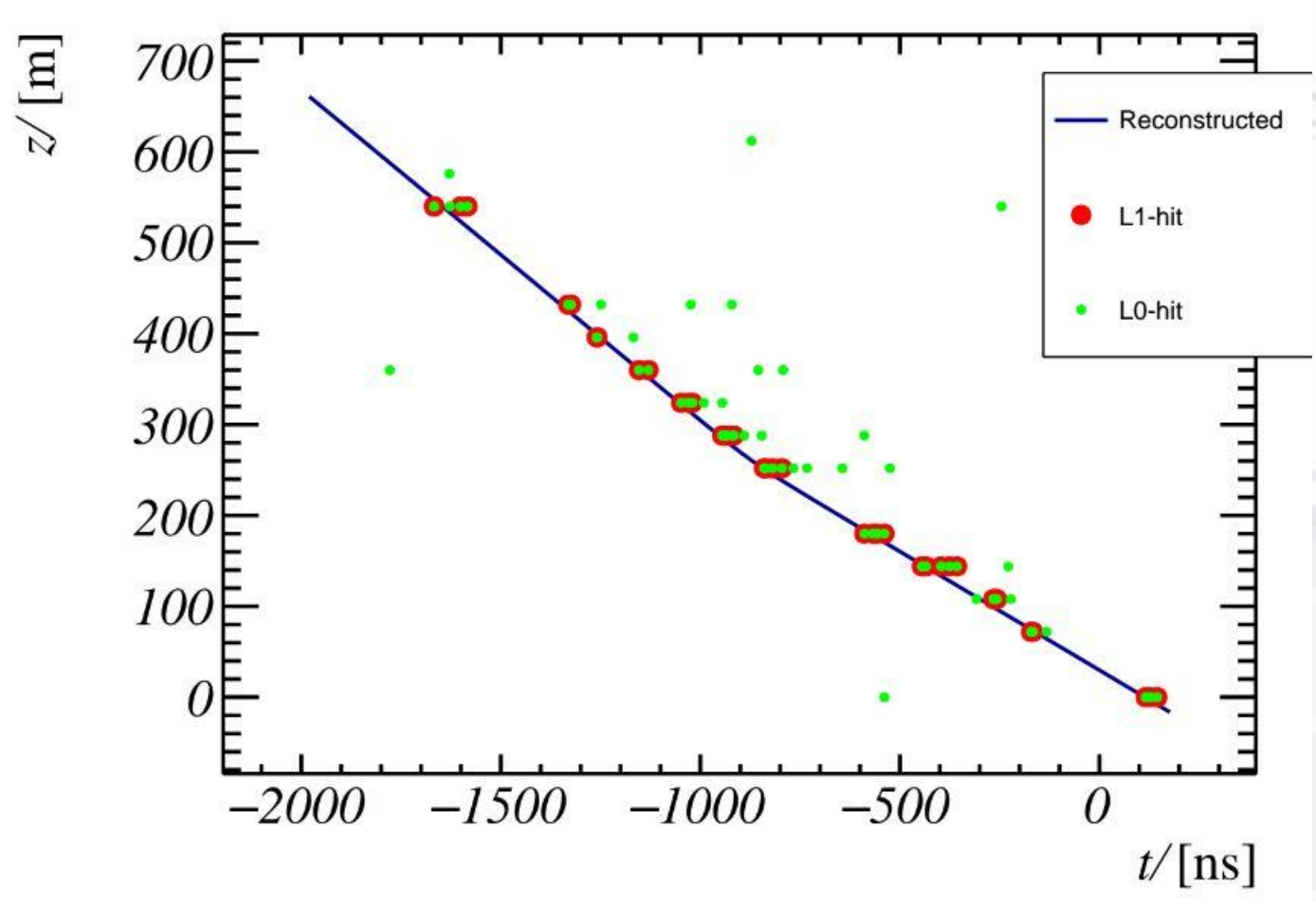


A toast after successful DU2 operation

Downward going muon



Downward going muon



Shifts already started...

Acknowledgement

- All Italian based activities strongly rely on the support of Technical services
- In particular the development and the maintenance of the infrastructures running at the Portopalo laboratory are possible only thanks to the support of the LNS technical services

Conclusion

- Phase 1 is proceeding quite smoothly
- Marine operations under control. The objectives are reached (whether permitting) in the due time
- The Portopalo shore-station underwent a major upgrade and it is ready to “handle” a full block (115 DUs)
- The tower production is going on. So far the showstopper for the deployment is the backbone
- The DOM production and the DU integration procedures have been (almost) finalized and several sites are now ready
- Major result: DU2 deployed at the KM3NeT-IT off-shore site and currently taking data