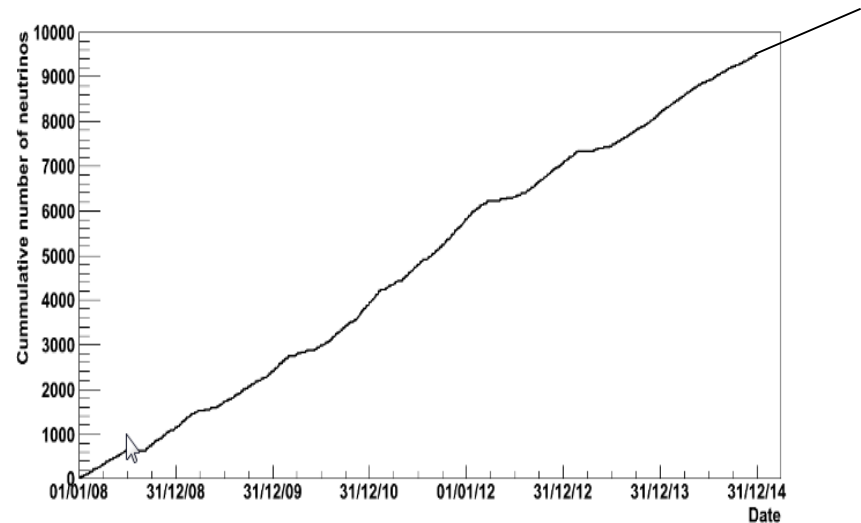
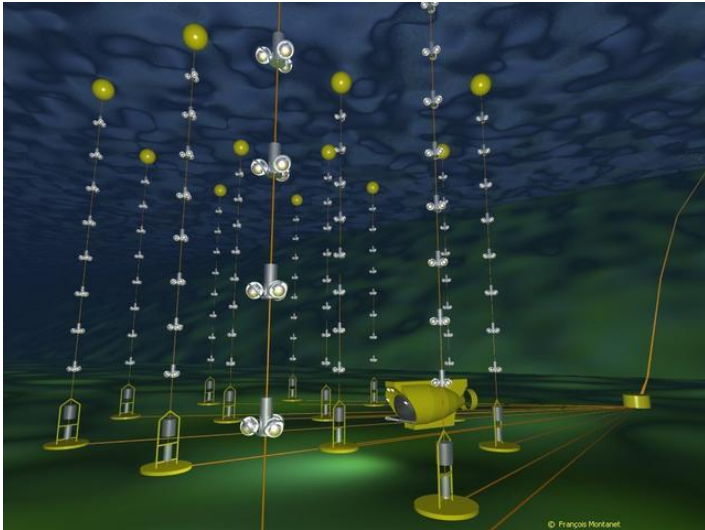


KM3NeT and ANTARES In 2015



- | | |
|-------------------------|---------------|
| 1. Overview : | Aart Heijboer |
| 2. Results from Antares | Tino Michael |
| 3. Dom production++ : | Ronald Bruijn |
| <i>Bonus track:</i> | |
| Data from deployed line | Karel Melis |

Antares

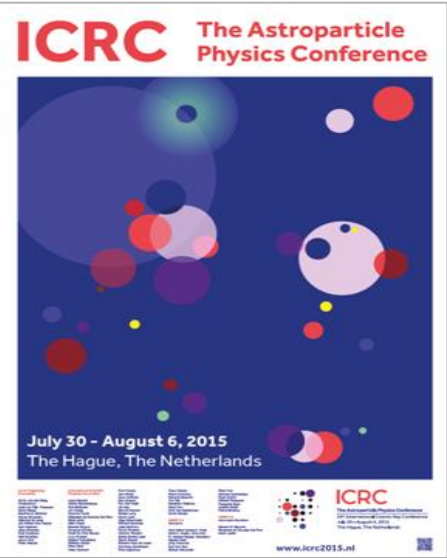
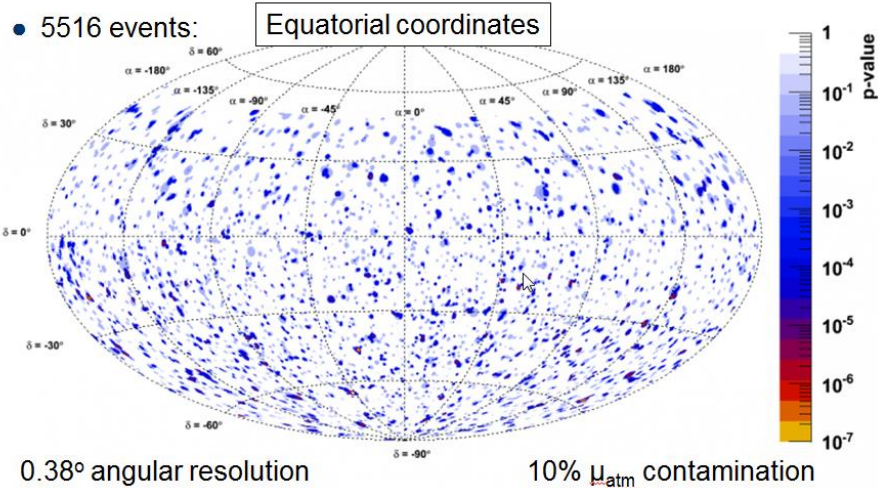


- 2007 < data-taking <= 2016(+)
- Very competitive results in
 - Dark matter searches
 - Galactic (point) sources (Tino)
- Proving ground for KM3NeT (e.g. degree-level resolution for showers)
- Nikhef efforts ramping down.
- Currently taking data with 10/12 lines
- >10000 neutrinos recorded

Antares output

Adrián-Martínez et al., ApJ Lett, 786, L5 (2014)

Muon track events: skymap of pre-trial significance



1000
participants

- Our reconstruction, Event selections, etc
- Now added electron and tau neutrinos to these datasets (my Vidi), see Tino's talk.

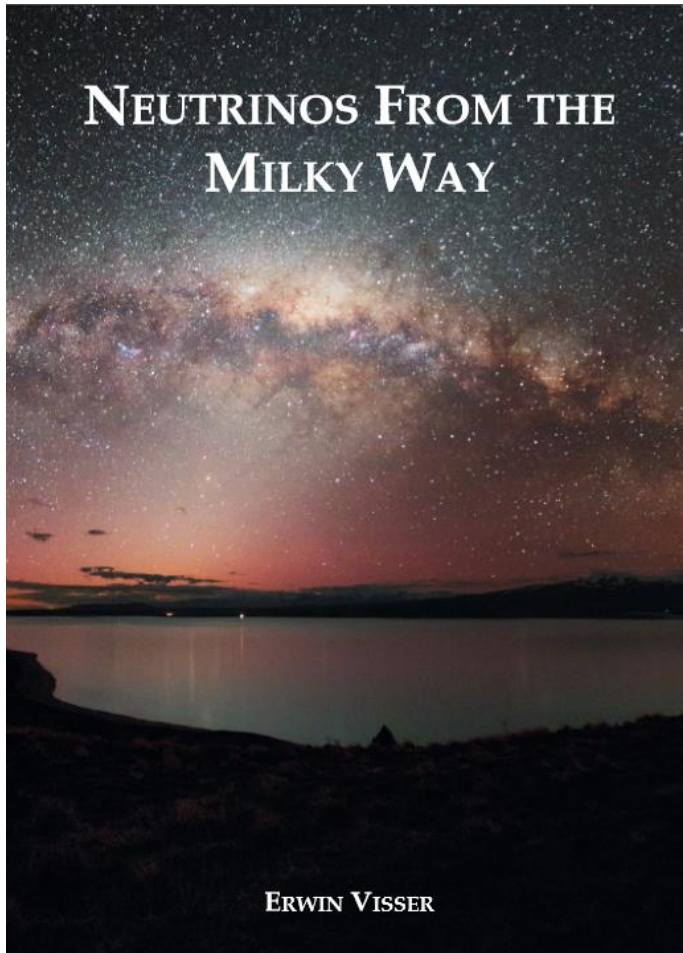
Will benefit many Antares analyses
In coming years.

ANTARES searches with this data:

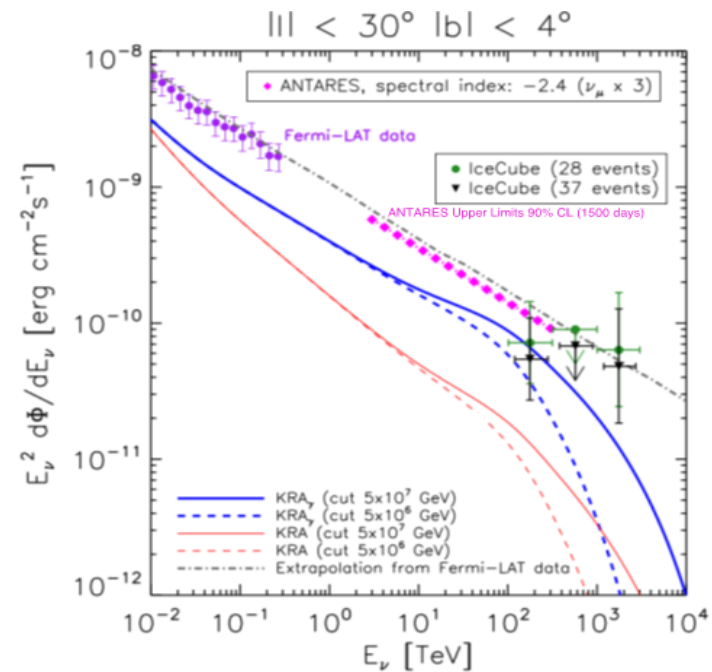
(that I don't have time to talk about)

- Blazars: A. Sanchez-Losa, (ID 624)
- X-ray binaries: D. Dornic (ID 173)
- Point sources above the horizon: C. Perrina (ID 986)
- Autocorrelation analysis: R. Gracia (ID 592)
- Multiscale search: S. Geißelsöder (ID 300)
- Gravitational waves w LIGO/VIRGO: V. van Elewyck (ID 1219)
- GRBs w. photospheric model: M. Sanguineti (ID 493)
- GRB Stacked analysis: D. Turpin (ID 341)
- Nuclearites: G. Pavalas (ID 351)
- Magnetic Monopoles: L. Elbojaddaini (ID 1077)
- Moon shadow analysis: M. Sanguineti (ID 488)

Neutrinos from Galactic plane



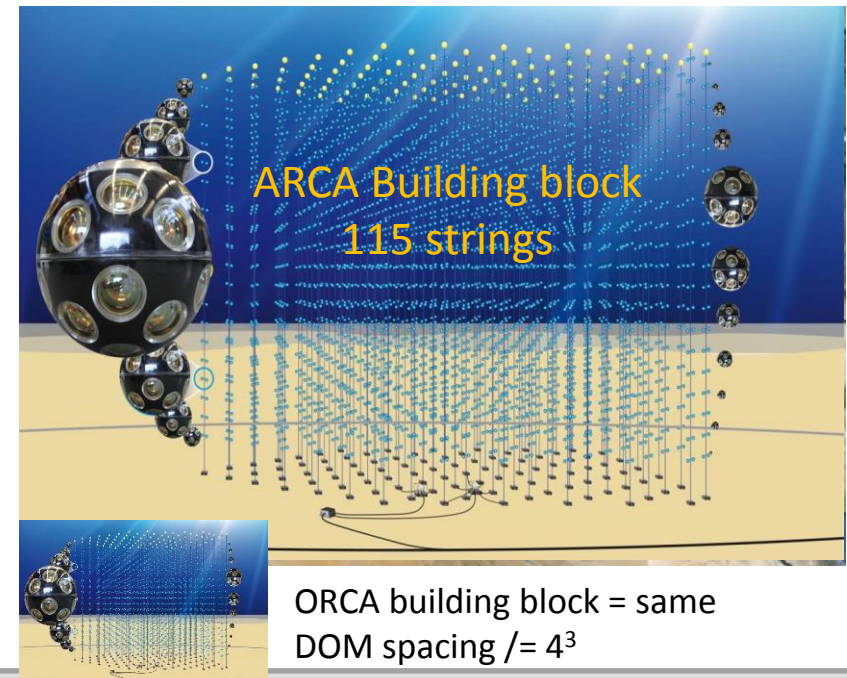
- Hot Topic due to IceCube
- Analysis to be continued at APC Paris
- Collaboration with Theorists (at Grappa)



Many more Antares results in Tino's talk

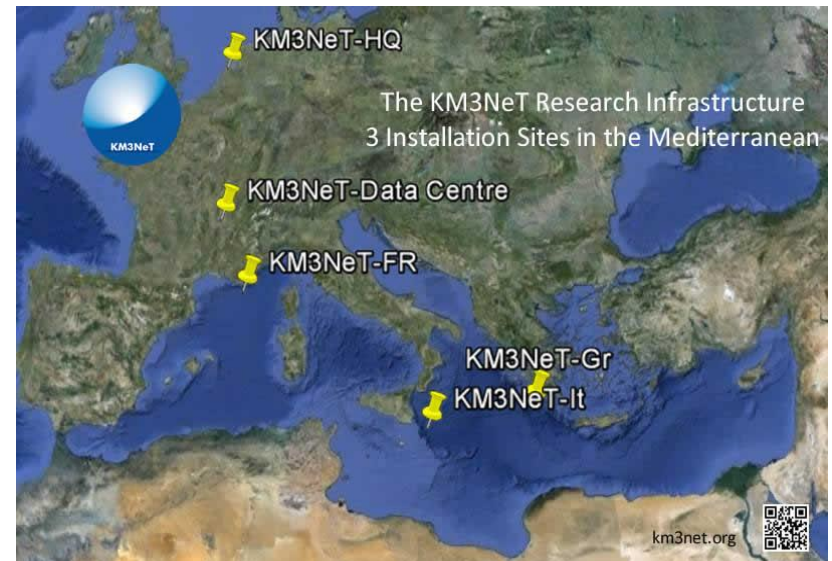
KM3NeT sites and deployment

- **ARCA:** Astrophysical Research with Cosmic in the Abyss
 - Study astrophysical neutrino fluxes at $E > 100 \text{ GeV}$
 - 2 'blocks' at KM3NeT-It
- **ORCA:** Oscillations Research with Cosmics in the Abyss
 - Resolve the neutrino mass hierarchy ($1 \text{ GeV} < E < 100 \text{ GeV}$)
 - 1 block at KM3NeT-Fr
- **Phase 1:**
 - 31 strings, ~10% ARCA, ~5% ORCA
 - Funded! Construction begun
 - 2017 completion
- **KM3NeT 2.0:**
 - 100% ARCA and ORCA
 - Completion 2020



KM3NeT sites and deployment

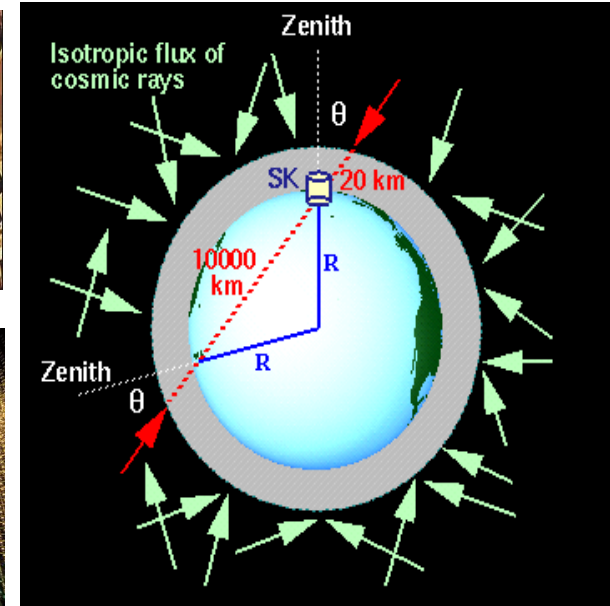
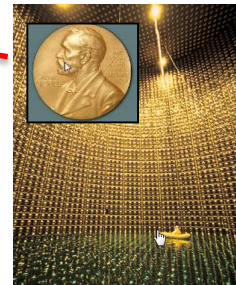
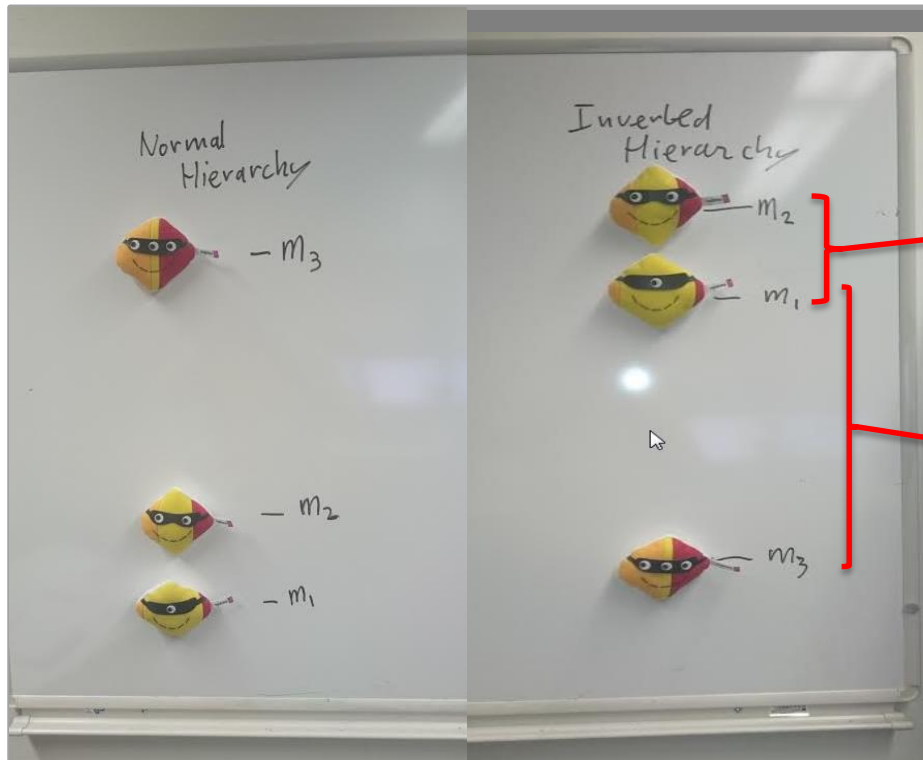
- **ARCA:** Astrophysical Research with Cosmic in the Abyss
 - Study astrophysical neutrino fluxes at $E > 100$ GeV
 - 2 'blocks' at KM3NeT-It
- **ORCA:** Oscillations Research with Cosmics in the Abyss
 - Resolve the neutrino mass hierarchy ($1 \text{ GeV} < E < 100 \text{ GeV}$)
 - 1 block at KM3NeT-Fr
- **Phase 1:**
 - 31 strings, ~10% ARCA, ~5% ORCA
 - Funded! Construction begun
 - 2017 completion
- **KM3NeT 2.0:**
 - 100% ARCA and ORCA
 - Completion 2020



KM3NeT: Science

- Cosmic neutrinos (ARCA, IceCube)
 - Softer spectra
 - (week) evidence for Galactic component
 - Sources still unknown
 - Strengthen motivation for ARCA
- Mass hierarchy (ORCA)
 - Studies enhanced (systematics)
 - MH: 3 sigma in 3 years (+ $\Delta m^2 + \theta_{23}$)
 - ORCA gaining fame and confidence
 - Opportunity to beat the competition

ORCA



- Hierarchy important for theory, cosmology, $0\nu\beta\beta$
- Atmospheric neutrinos (happy 50th birthday!)
- Like Super-K
- But now resolve matter-effects to determine mass hierarchy
=> need multi-Mton detector (SK=50kton)

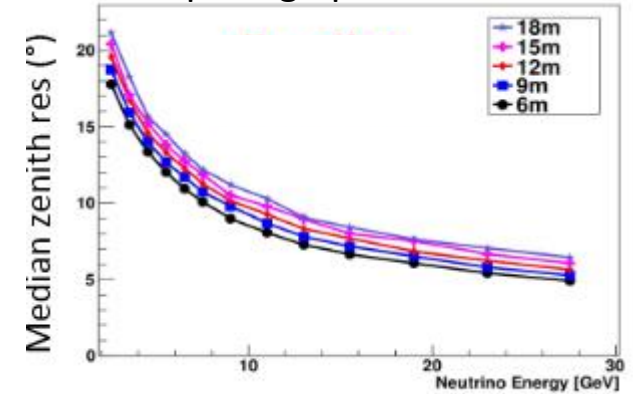
ORCA developments

Sensitivity Calculations now mature and realistic.

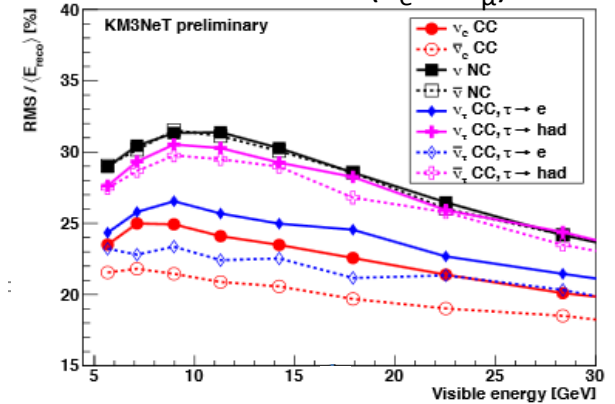
- Cascade channel (= ν_e appearance)
- Track / cascade reconstruction
 - up to 8 parameters (Bjorken γ)
- Particle identification done right
- Layout optimization done -> 9 m DOM spacing
- Atmospheric muon rejection (no veto needed)
- Detailed systematics

parameter	true value distr.	initial value distr.	treatment	prior
θ_{23} [°]	{40, 42, ..., 50}	uniform over [35, 55] †	fitted	no
θ_{13} [°]	8.42	$\mu = 8.42, \sigma = 0.26$	fitted	yes
θ_{12} [°]	34	$\mu = 34, \sigma = 1$	nuisance	N/A
ΔM^2 [10^{-3} eV ²]	$\mu = 2.4, \sigma = 0.05$	$\mu = 2.4, \sigma = 0.05$	fitted	no
Δm^2 [10^{-5} eV ²]	7.6	$\mu = 7.6, \sigma = 0.2$	nuisance	N/A
δ_{CP} [°]	0	uniform over [0, 360]	fitted	no
overall flux factor	1	$\mu = 1, \sigma = 0.1$	fitted	yes
NC scaling	1	$\mu = 1, \sigma = 0.05$	fitted	yes
$\nu/\bar{\nu}$ skew	0	$\mu = 0, \sigma = 0.03$	fitted	yes
μ/e skew	0	$\mu = 0, \sigma = 0.05$	fitted	yes
energy slope	0	$\mu = 0, \sigma = 0.05$	fitted	yes

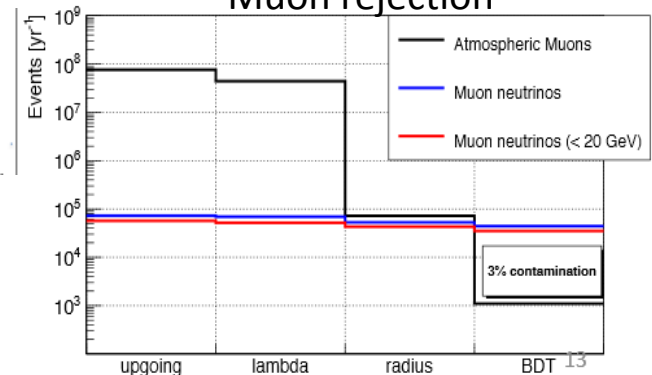
Spacing optimization



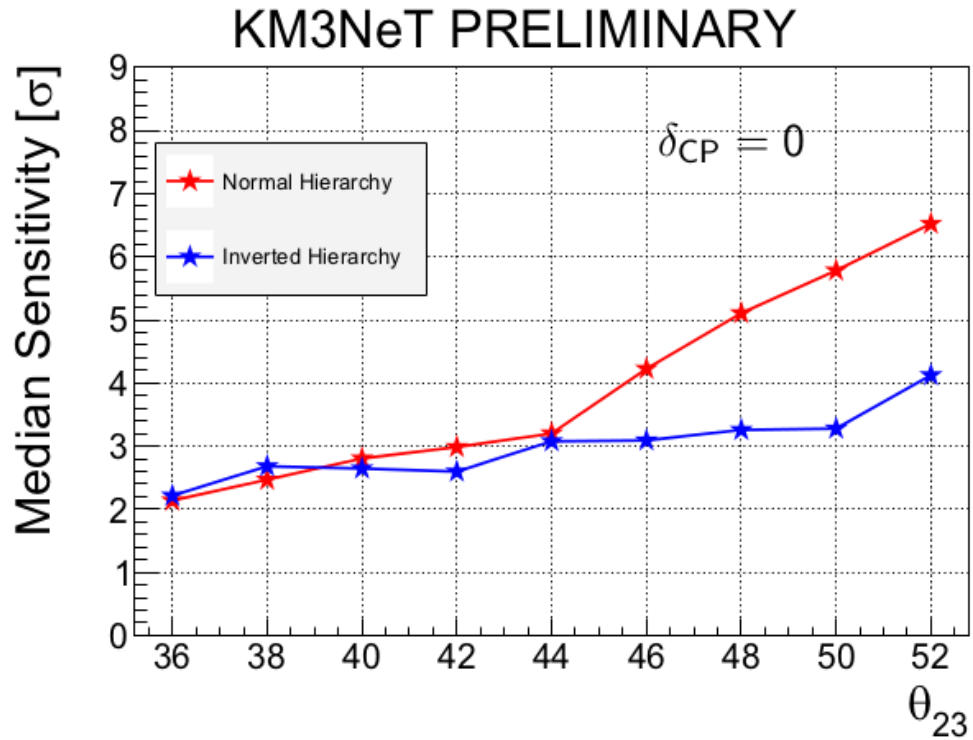
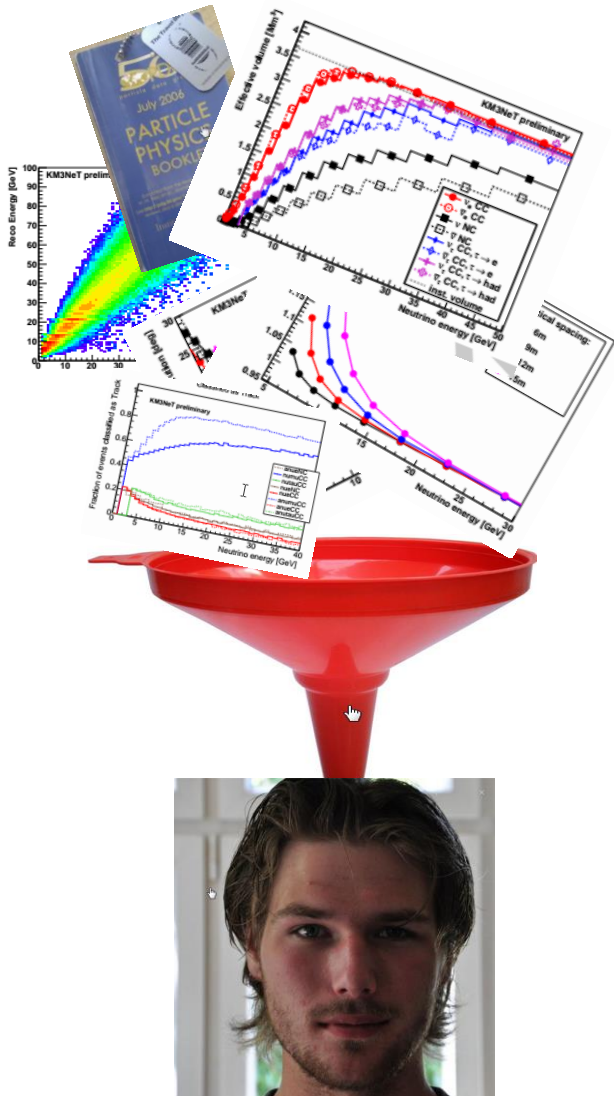
Particle id (ν_e vs ν_μ)



Muon rejection

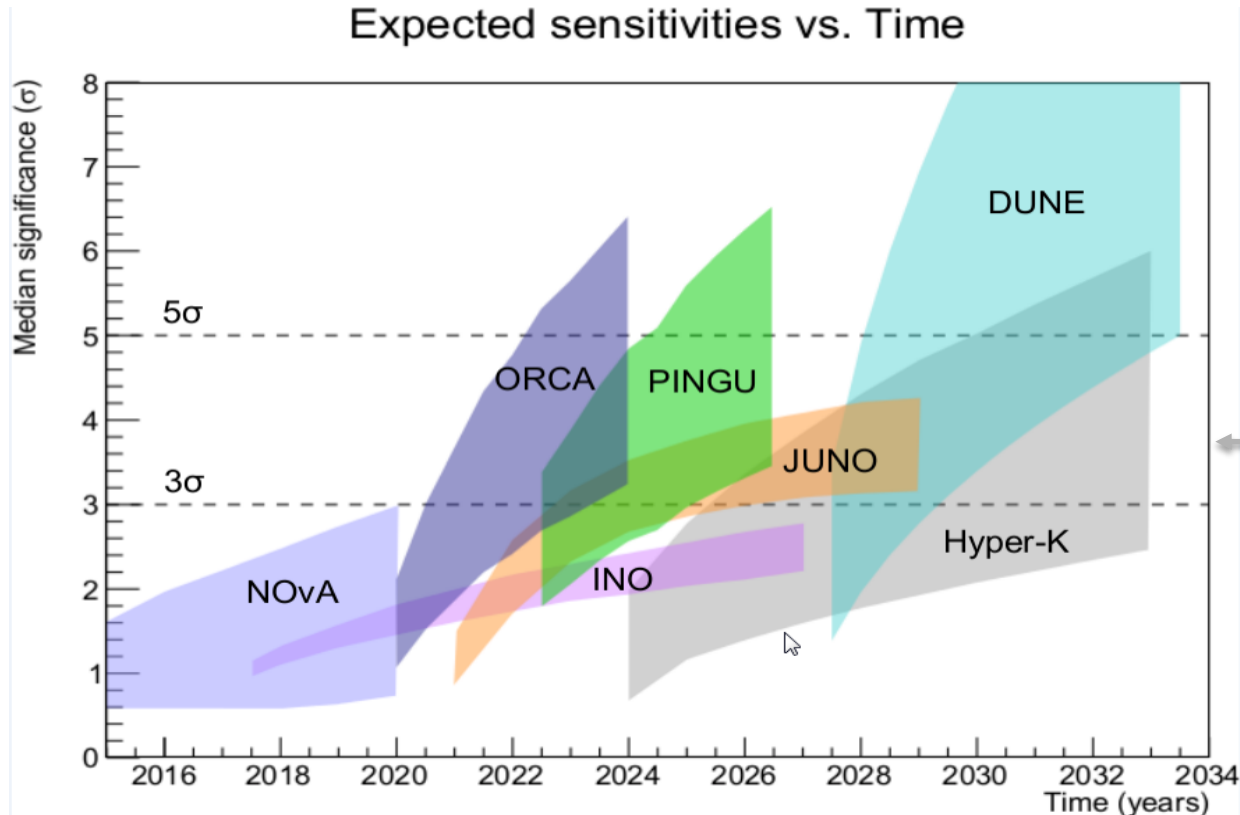


Sensitivity calculation



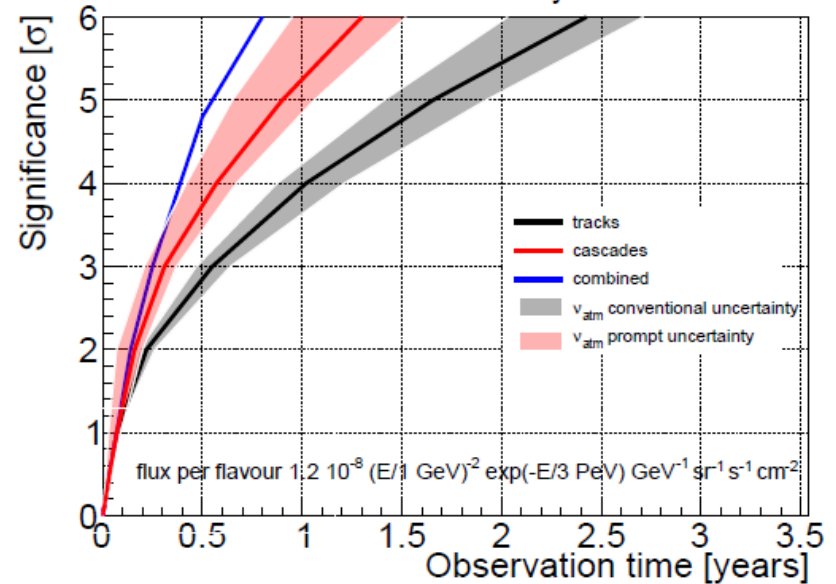
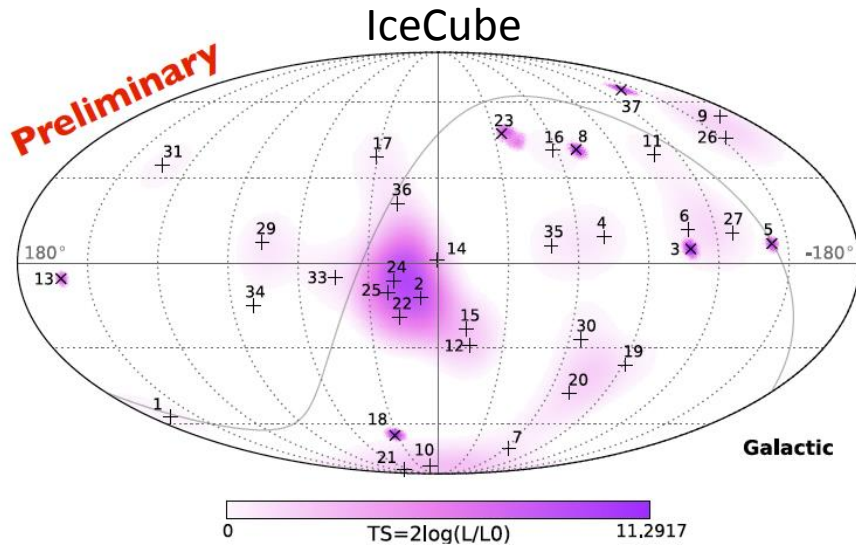
- ~ 3 sigma in 3 years
Depending on nature
- Measure Δm^2 & θ_{23} precisely

competition



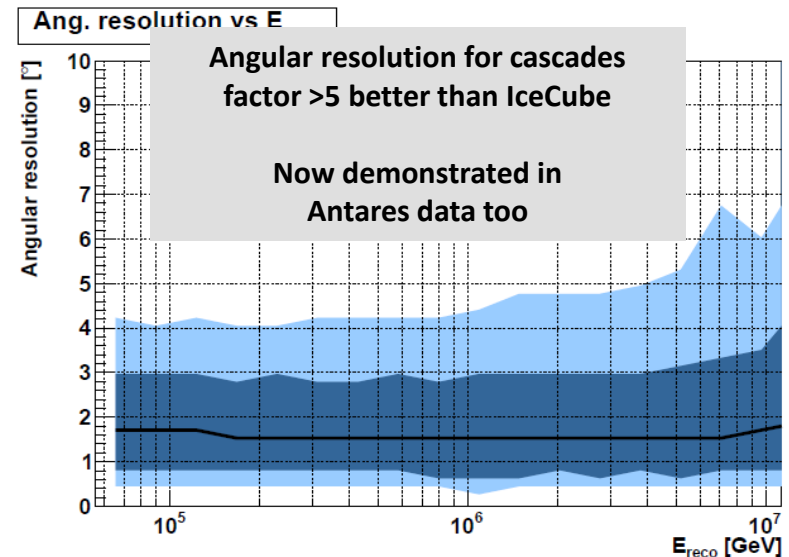
- ORCA can be *very* competitive
 - First lines 2016 + good prospects for more funding
 - Fast deployment possible (no accelerator, no polar logistics)
- Community starts to take note.

Neutrino astronomy



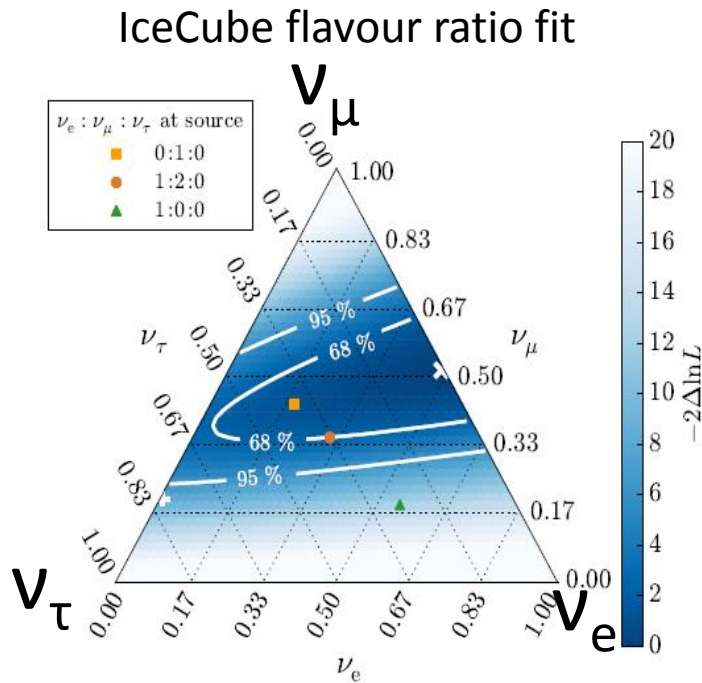
- Evidence for cosmic neutrinos increasing
 - IC sees it in several samples
 - Sources not identified
 - Soft spectrum/cut-off
 - Hints of Galactic Component
 - Flavour ratios carry physics
- Stronger Case for KM3NeT

KM3NeT/ARCA can see the signal within 1 year, and do high-resolution all-flavour follow-ups

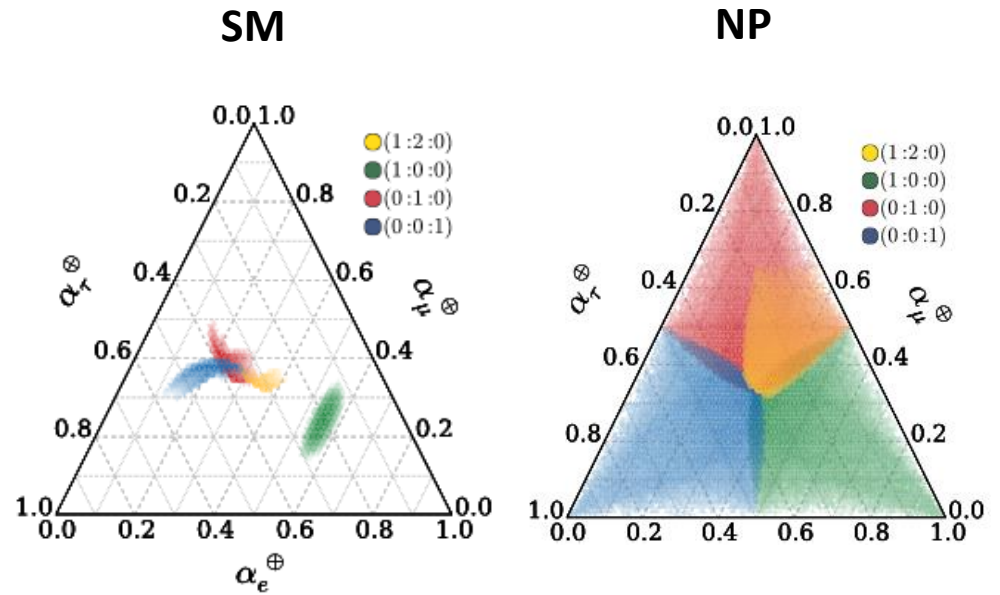


Flavour ratios => physics

Phys.Rev.Lett. 115 (2015) 161303



Fit to IceCube data consistent with 1:1:1



- New physics affects flavour ratios of cosmic neutrinos.
- non-standard interaction, Lorentz-invariance violation, ν -decay, steriles...
- Works better when sources are understood (and then, can also probe δ_{cp})
- *KM3NeT will contribute a lot here*

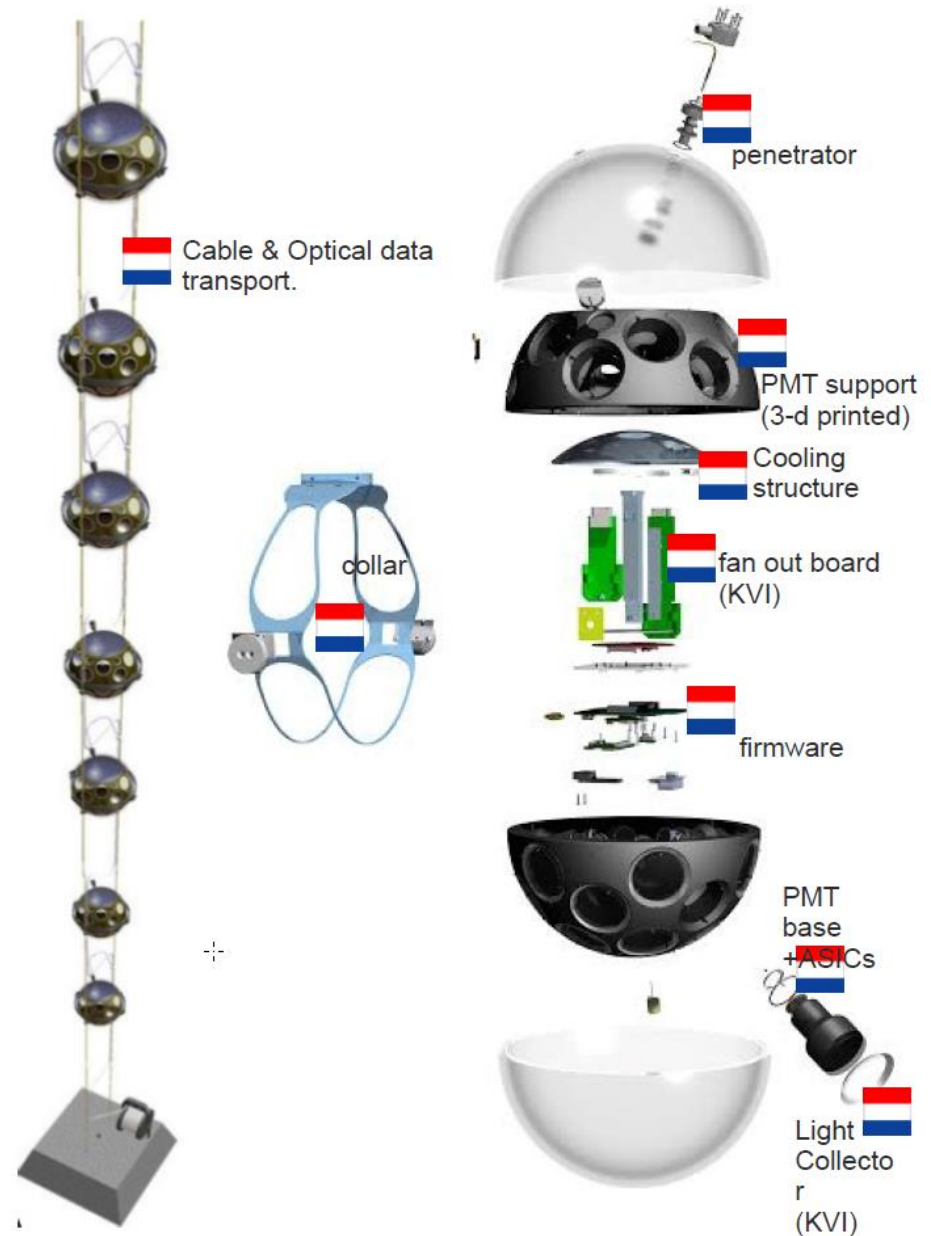
Our role in KM3eT



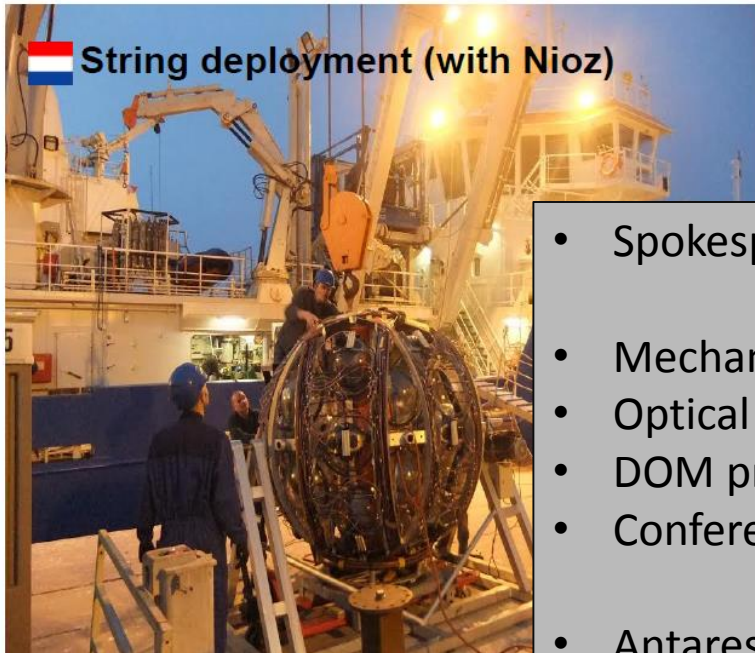
 String deployment (with Nioz)

Nikhef is not just 'participating',
but the main player

- Off-shore firm- and software
- On shore software (trigger, reconstruction)
- PMT bases, dc/dc convertors
...are all *big efforts we do at nikhef*

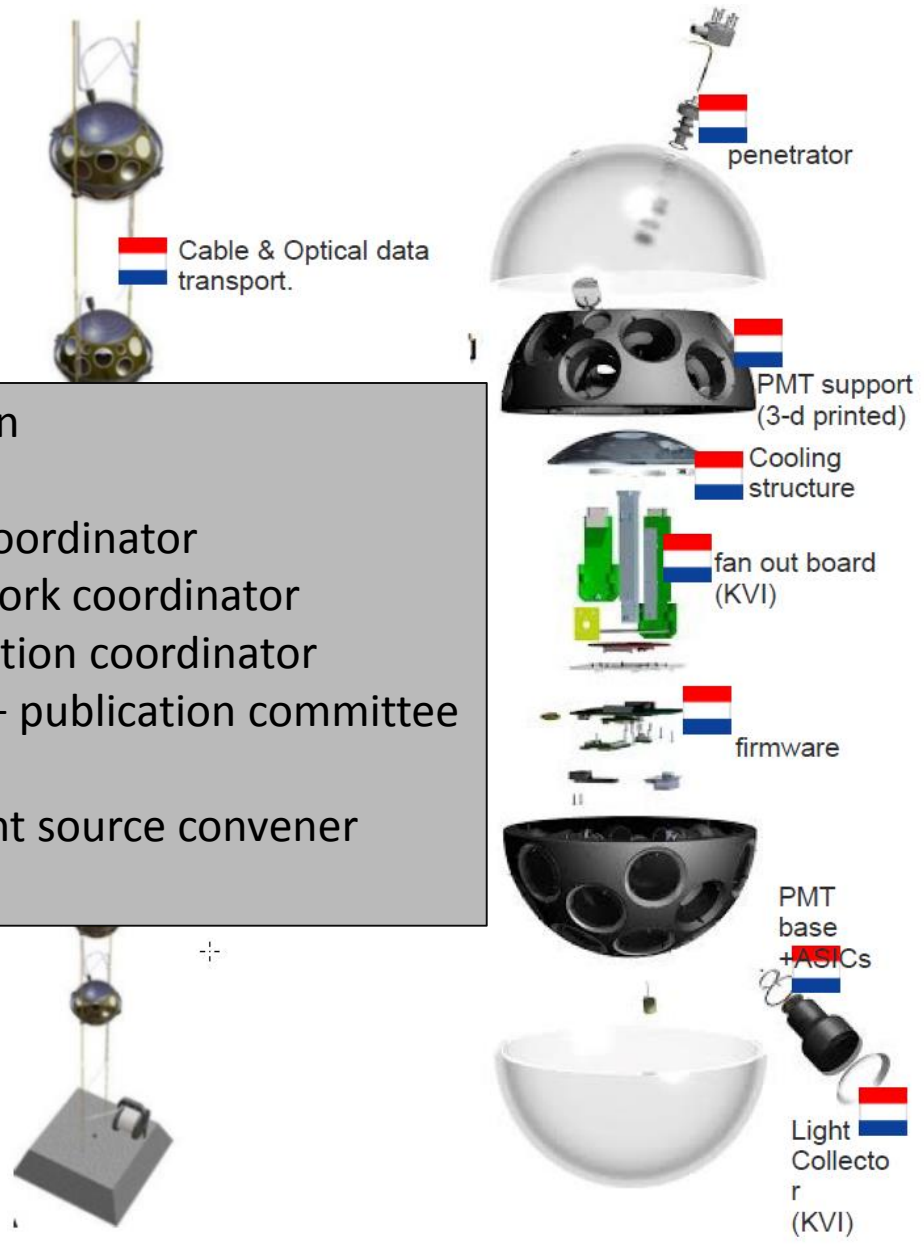


Our role in KM3eT



- Spokesperson
- Mechanics coordinator
- Optical network coordinator
- DOM production coordinator
- Conference + publication committee
- Antares: point source convener

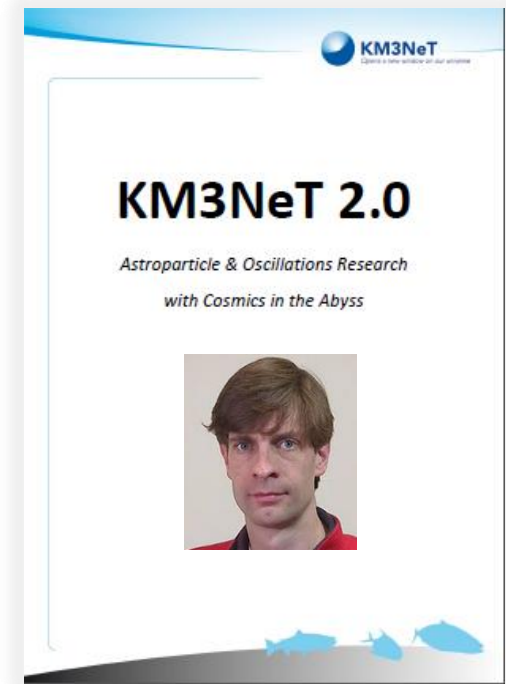
Nikhef is not just 'participating', but the main player



Nb: others also do a lot: sea-floor network, shore station, electronics, DAQ, software, production, testing, calibration instruments, physics analyses, database, etc

ESFRI roadmap

- European roadmap of large scale infrastructures
 - Considered important to facilitate funding.
- KM3NeT on it since 2006
- 2016: major update – 10 yr old projects to be taken off the list
- KM3NeT 2.0 applied for position on 2016 roadmap
 - Re-orientation
 - Show maturity (implementation)
 - Support by OCW and FR, It, Gr Ministries
- Notified **last Friday** application was successful!!
- National roadmap of NWO also to be updated in 2016



ESFRI roadmap

sneak peak of the report

RECOMMENDED STATUS	candidate
<p>KM3NeT 2.0 was the only project re-applying (as a project re-orientation) after ten years on the ESFRI roadmap. Its scientific case is evaluated `very high` and its <u>maturity `high`</u>. Both the SWG PSE and the IG are thus convinced that KM3NeT 2.0 has a <u>very strong scientific case</u>, with a better specification of the two-site option and the <u>novel proven technology</u> that was developed during the phase I, e.g. the previous status of ESFRI project since the 2006 Roadmap. With the own novel detector engineering and the updated budget plan, adjusted to the <u>lower cost</u> of the underwater infrastructure Km3NET 2.0 is considered <u>very likely to move quickly towards implementation</u>. <u>ESFRI fully supports the Km3NET 2.0</u> and thus proposes it for inclusion in the 2016 ESFRI Roadmap.</p>	

- Recognition of our main assets
- Future funding perspective is now very bright.

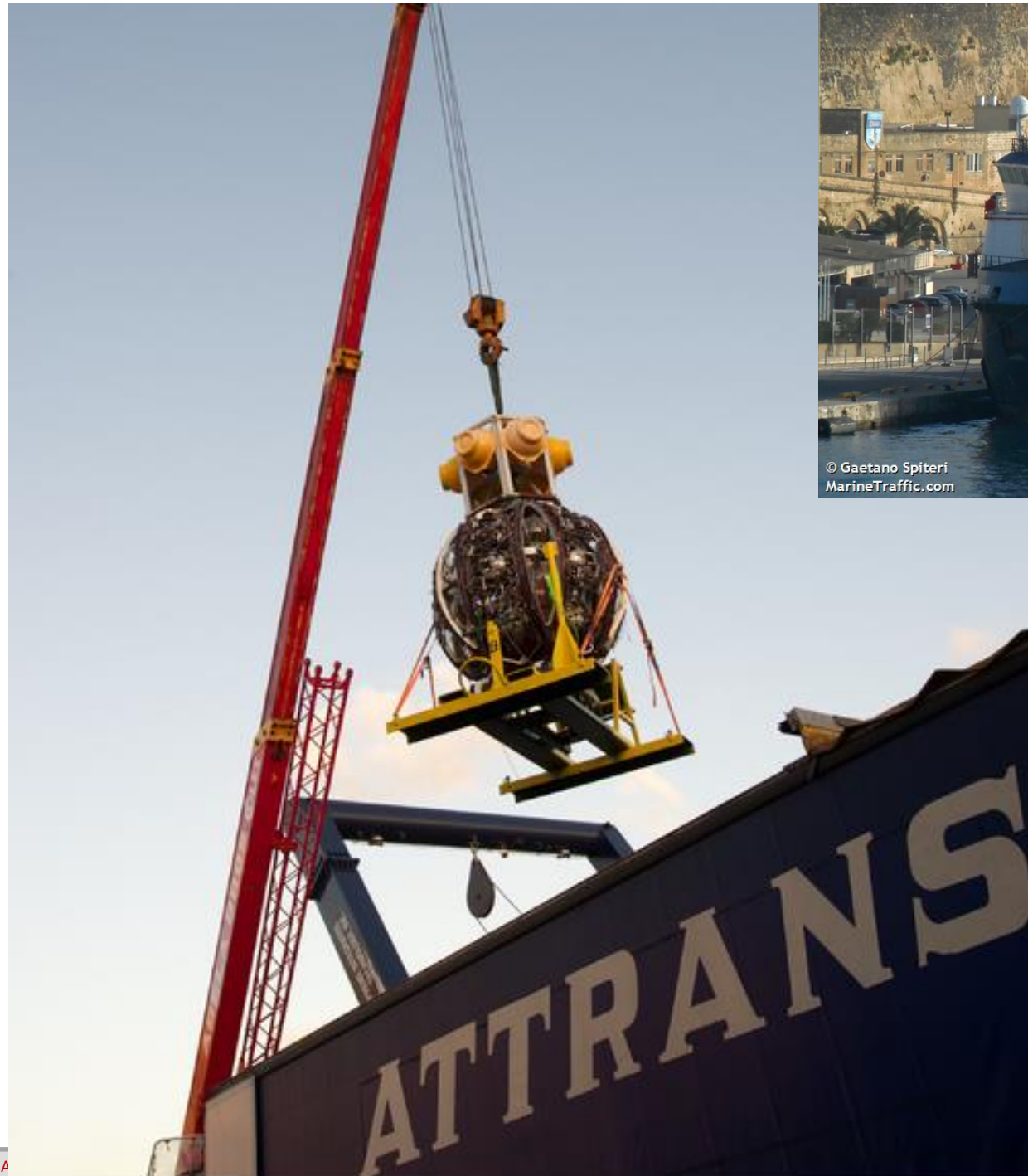
...thanks for help/support FOM(Job), OCW, Stan, Frank!











© Gaetano Spiteri
MarineTraffic.com



①

Malta

detector

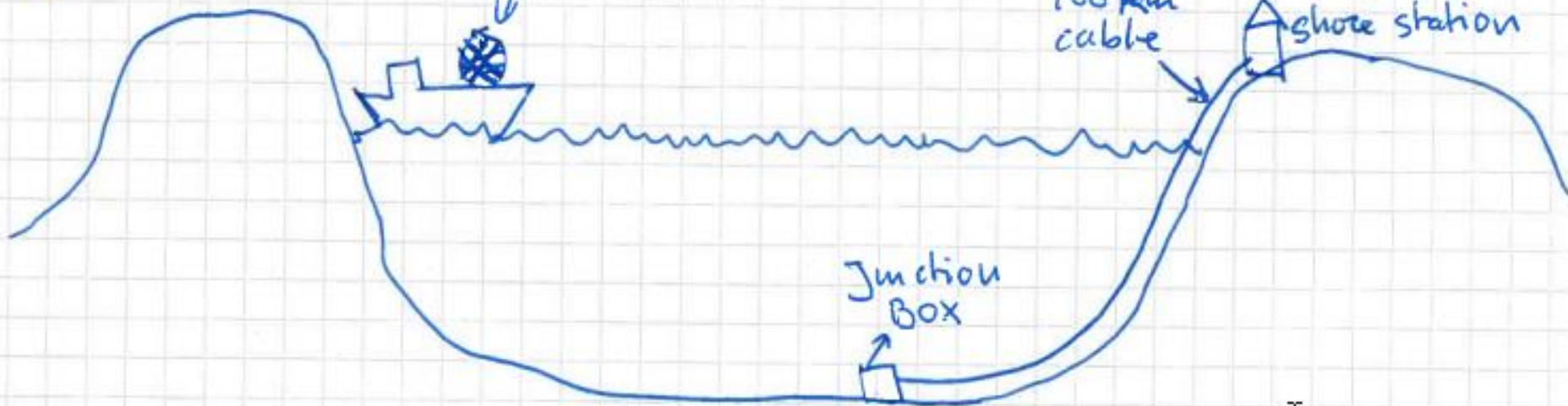
100 km
cable

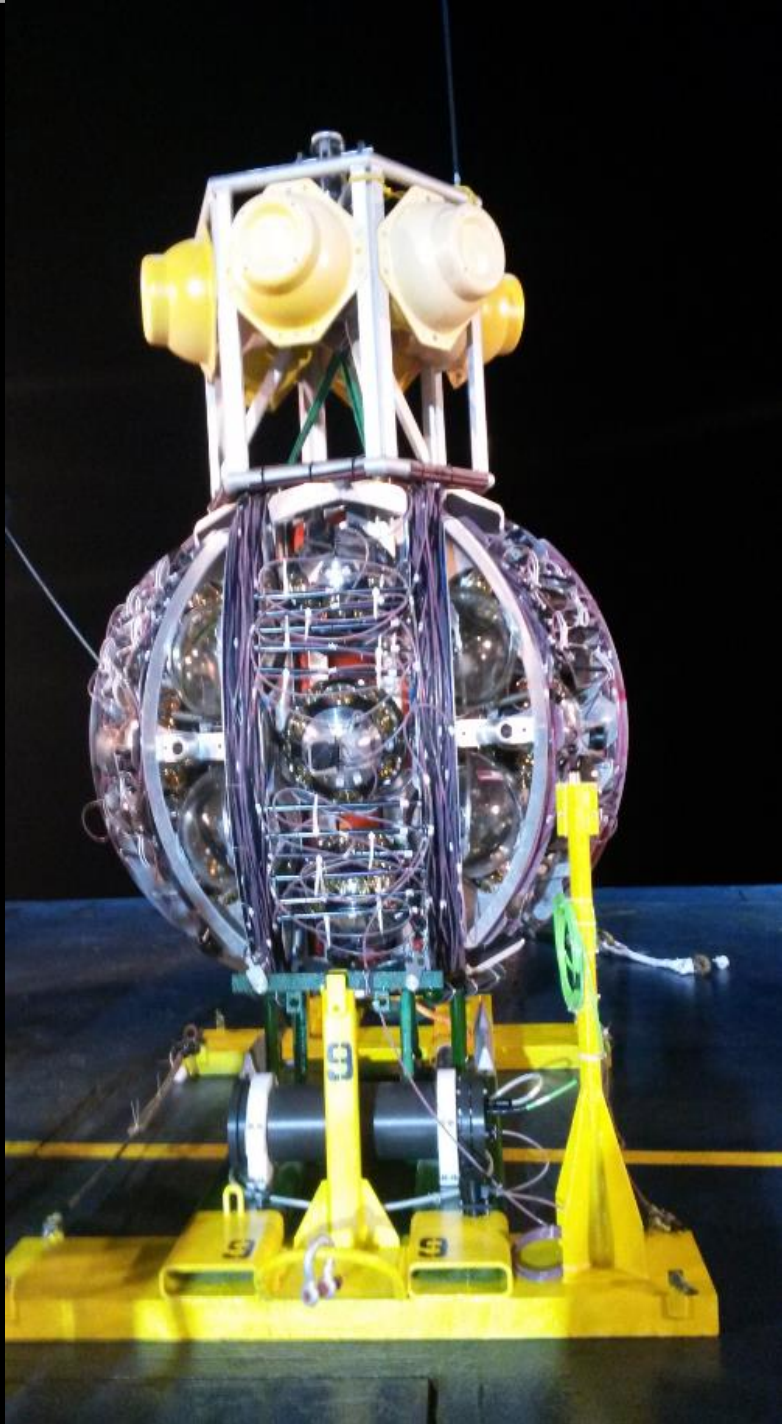
Sicily

shore station

Junction
Box

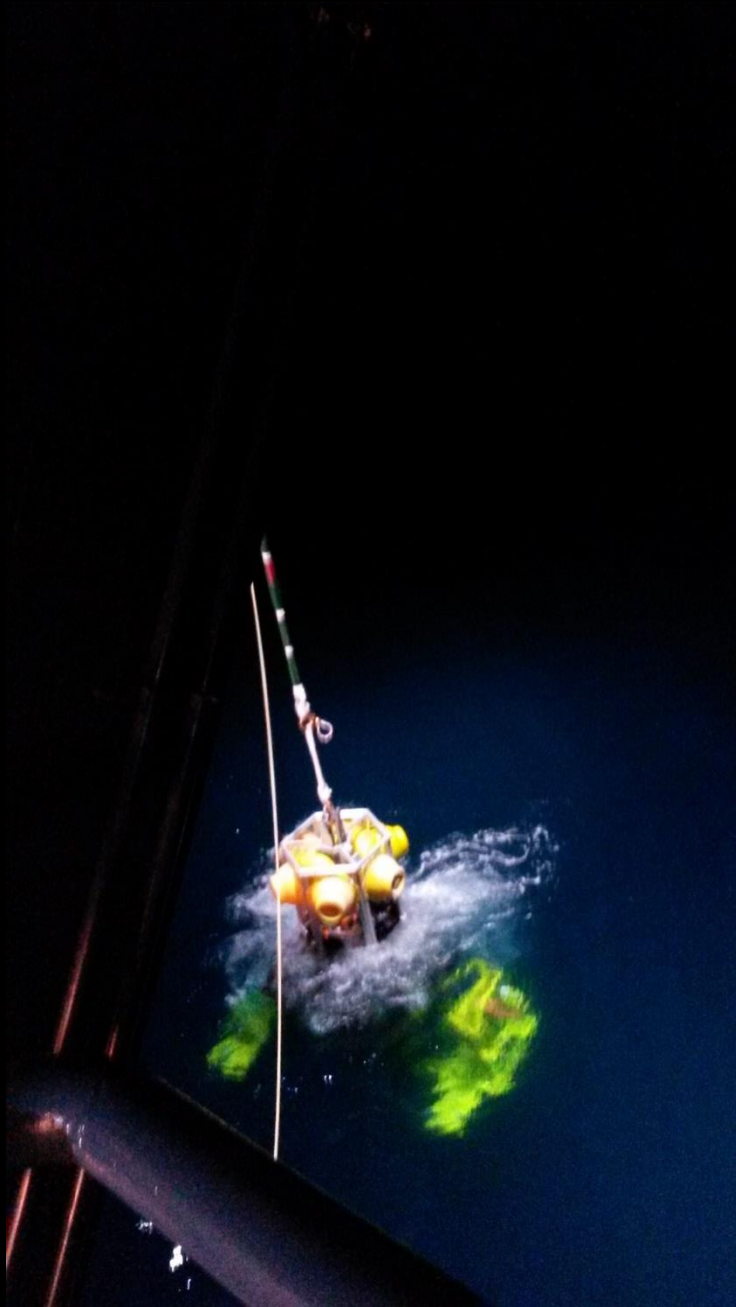
I









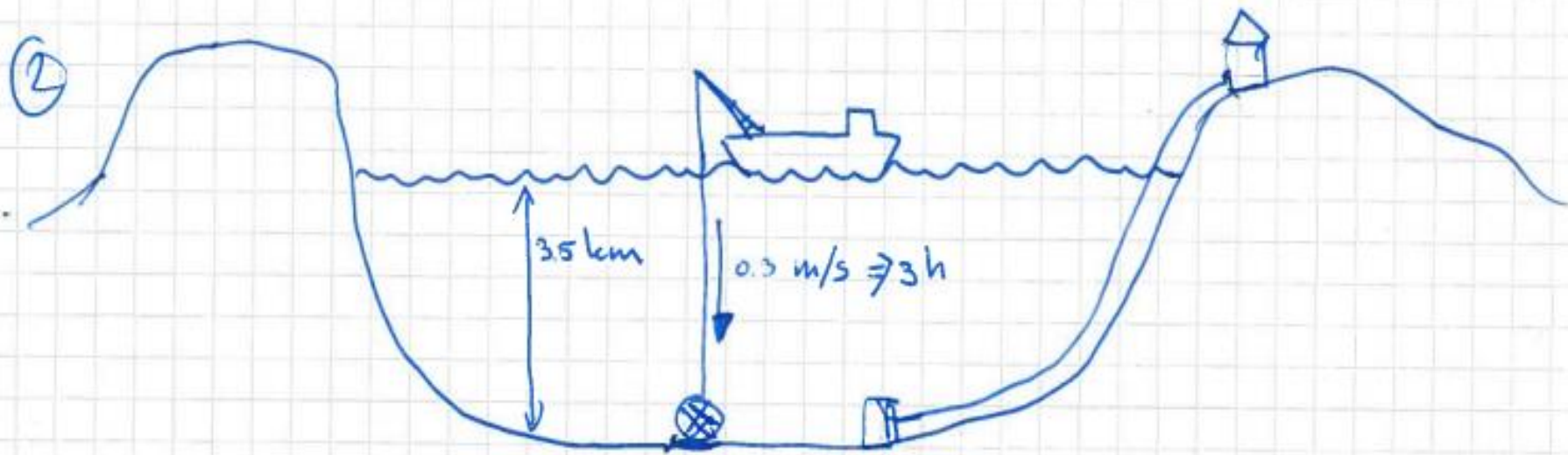












ROV Display Top Zoom 05:06:13 AM (GMT+0:00) 12/3/2015

TMS

3441.97

ROV

3476.10

E | 121SE |

S TURNS
0.00
ALT
3.09



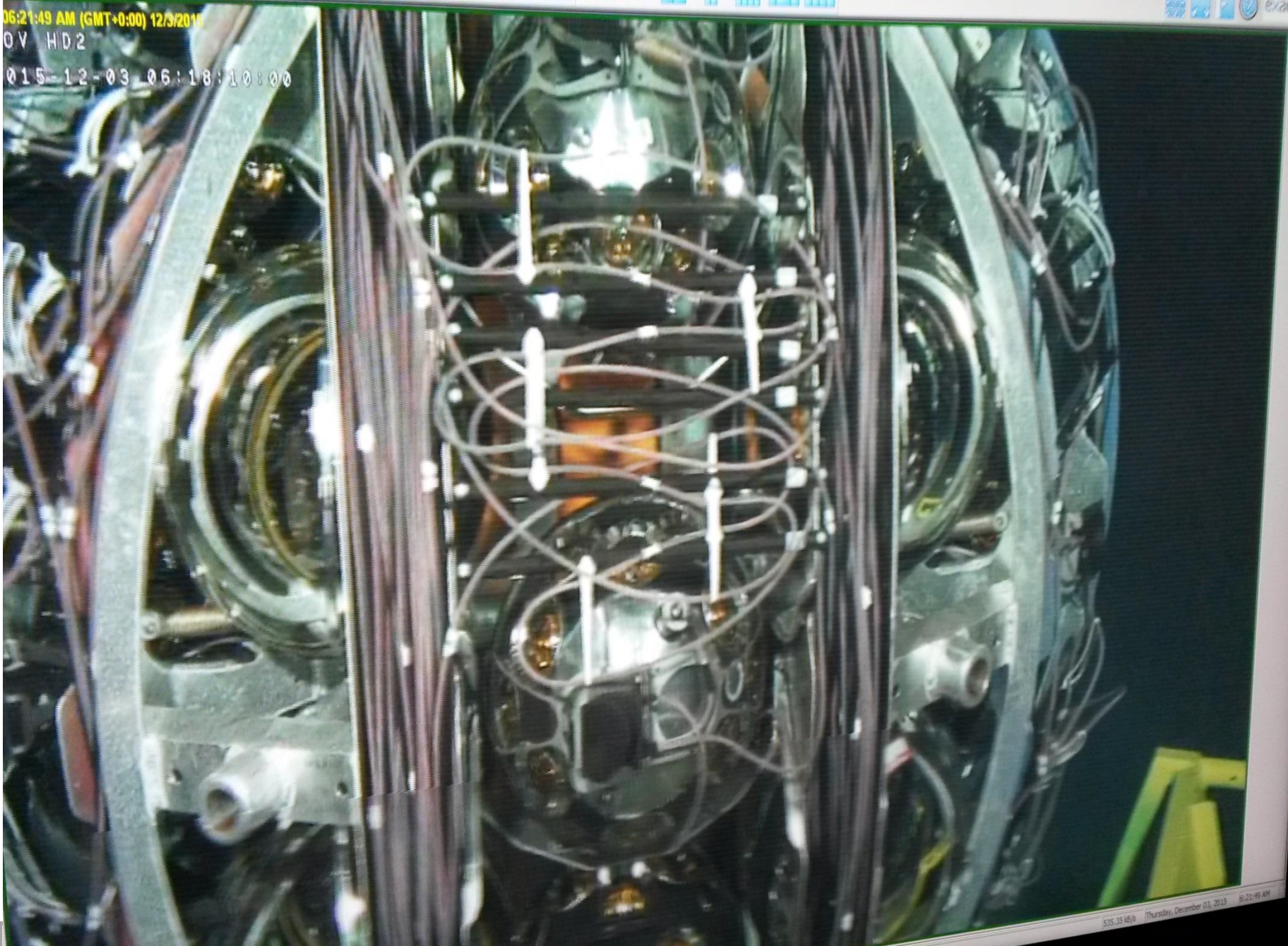
Author:	Riccobene G
Type:	Sea operation
Subject:	DU2 on the seabed
On spot again	
Attachment 1:	DU2_on_seabed.gif 14

05:06:13

06:21:49 AM (GMT+0:00) 12/3/2015

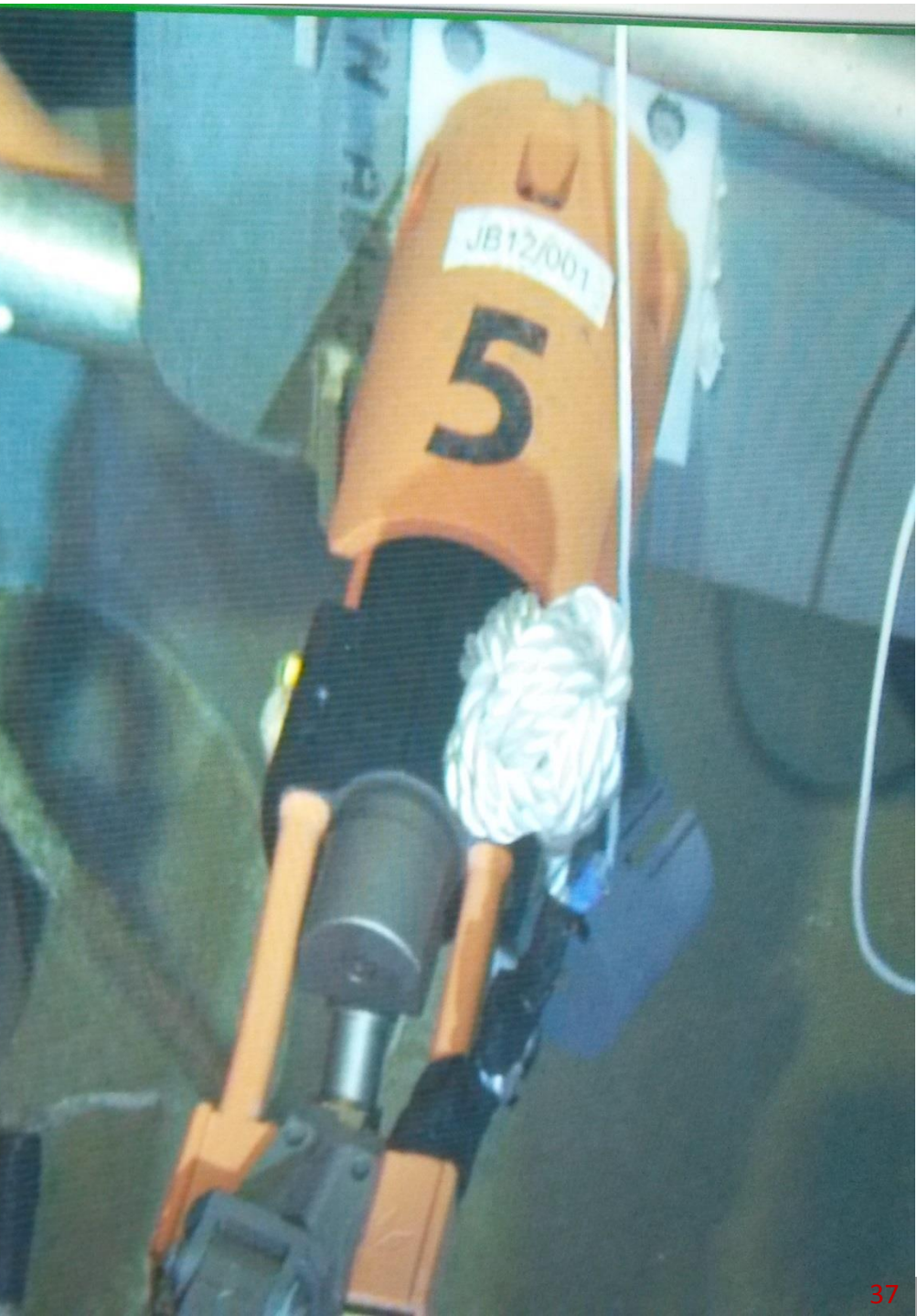
OV HD2

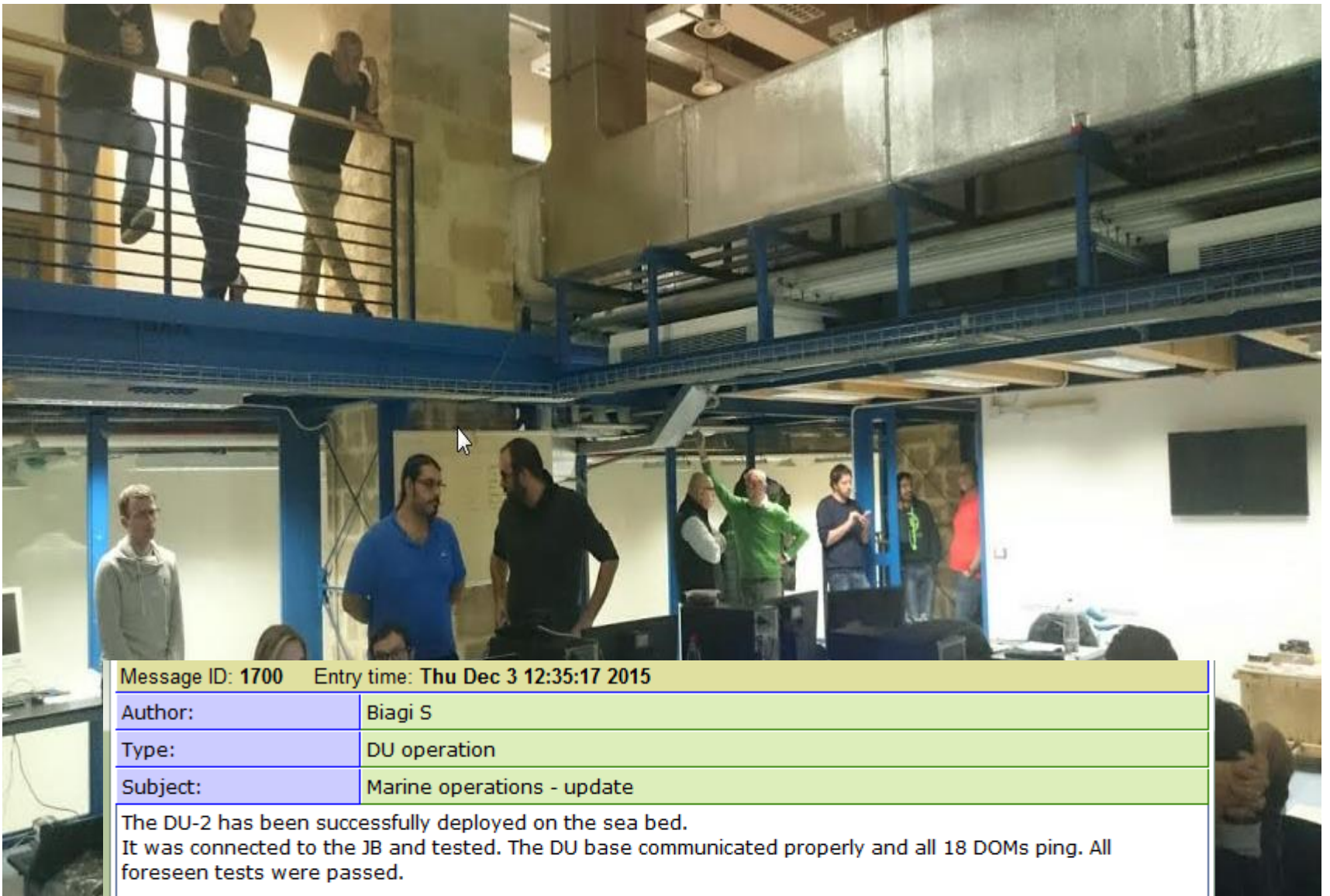
015-12-03 06:18:10:00



3







Message ID: 1700 Entry time: Thu Dec 3 12:35:17 2015

Author: Biagi S

Type: DU operation

Subject: Marine operations - update

The DU-2 has been successfully deployed on the sea bed. It was connected to the JB and tested. The DU base communicated properly and all 18 DOMs ping. All foreseen tests were passed.

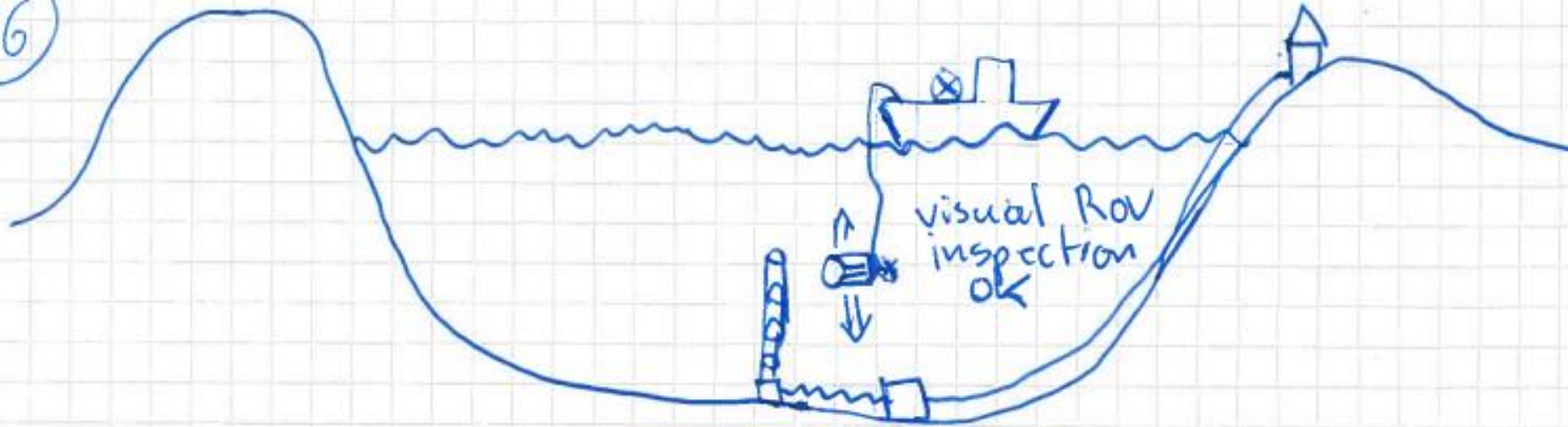
Then the DU and JB were switched off, to allow the offshore team to proceed with unfurling.

After several attempts, they finally manage to operate the acoustic release. The unfurling of the line started at 13:05. Currently the LOM is at 1500 m. They will inspect the DU with the ROV soon.

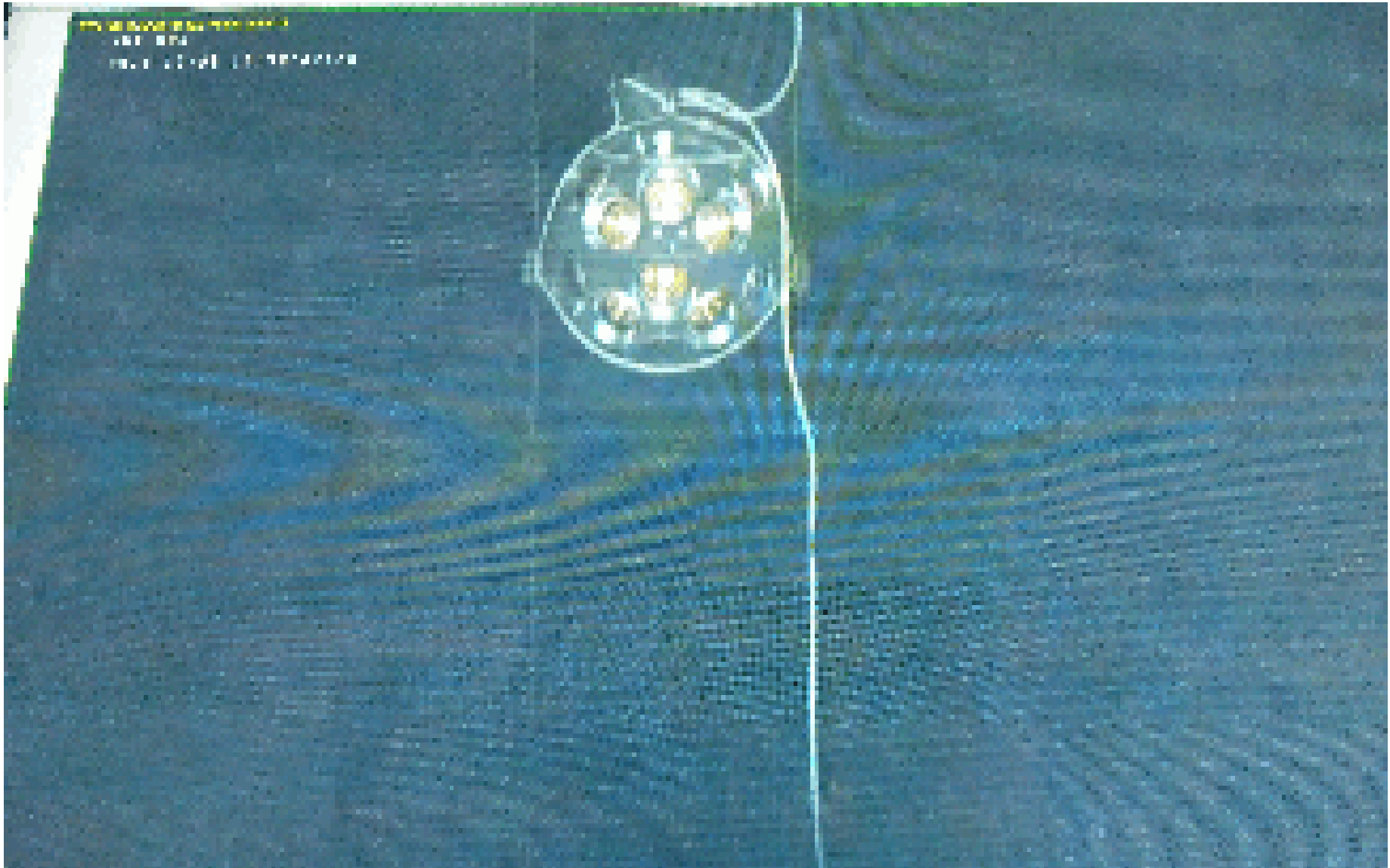
FLORIAN BAIFF



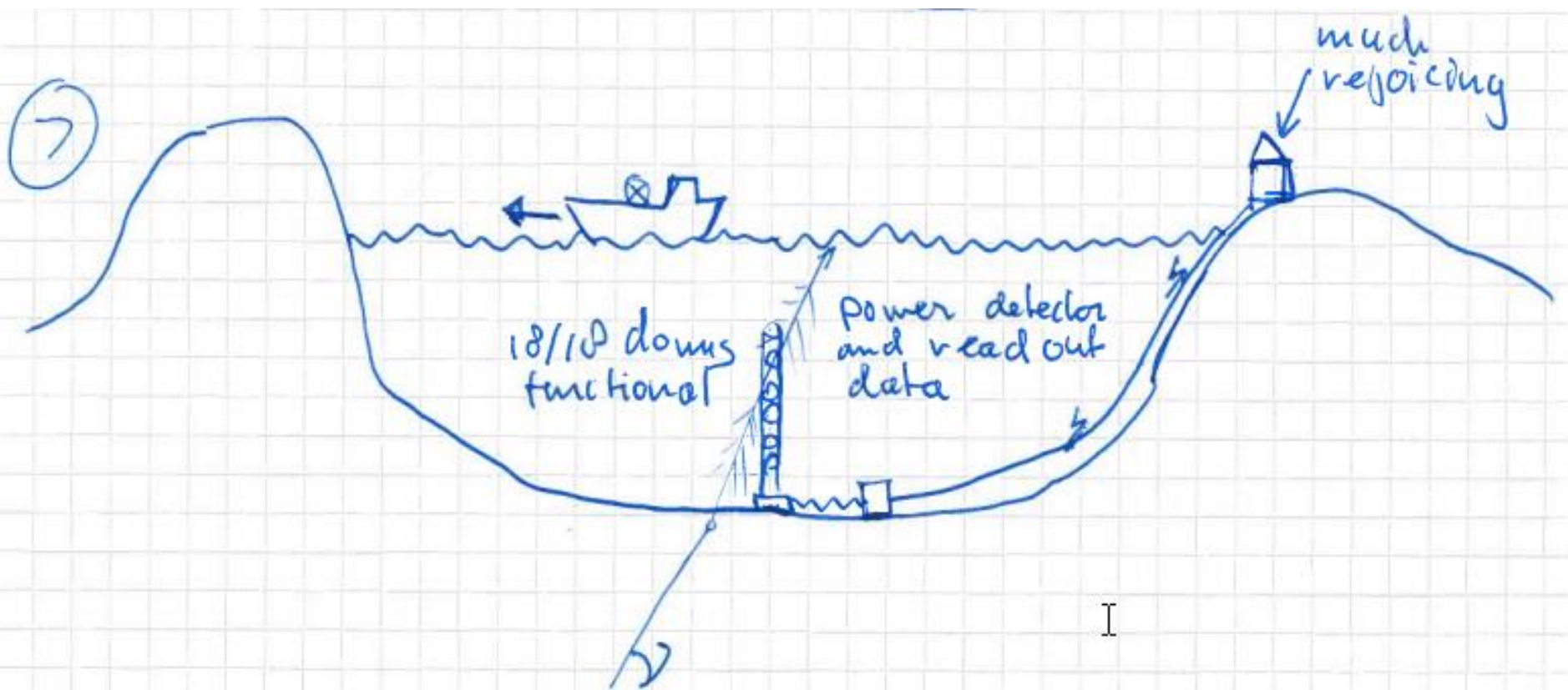
6

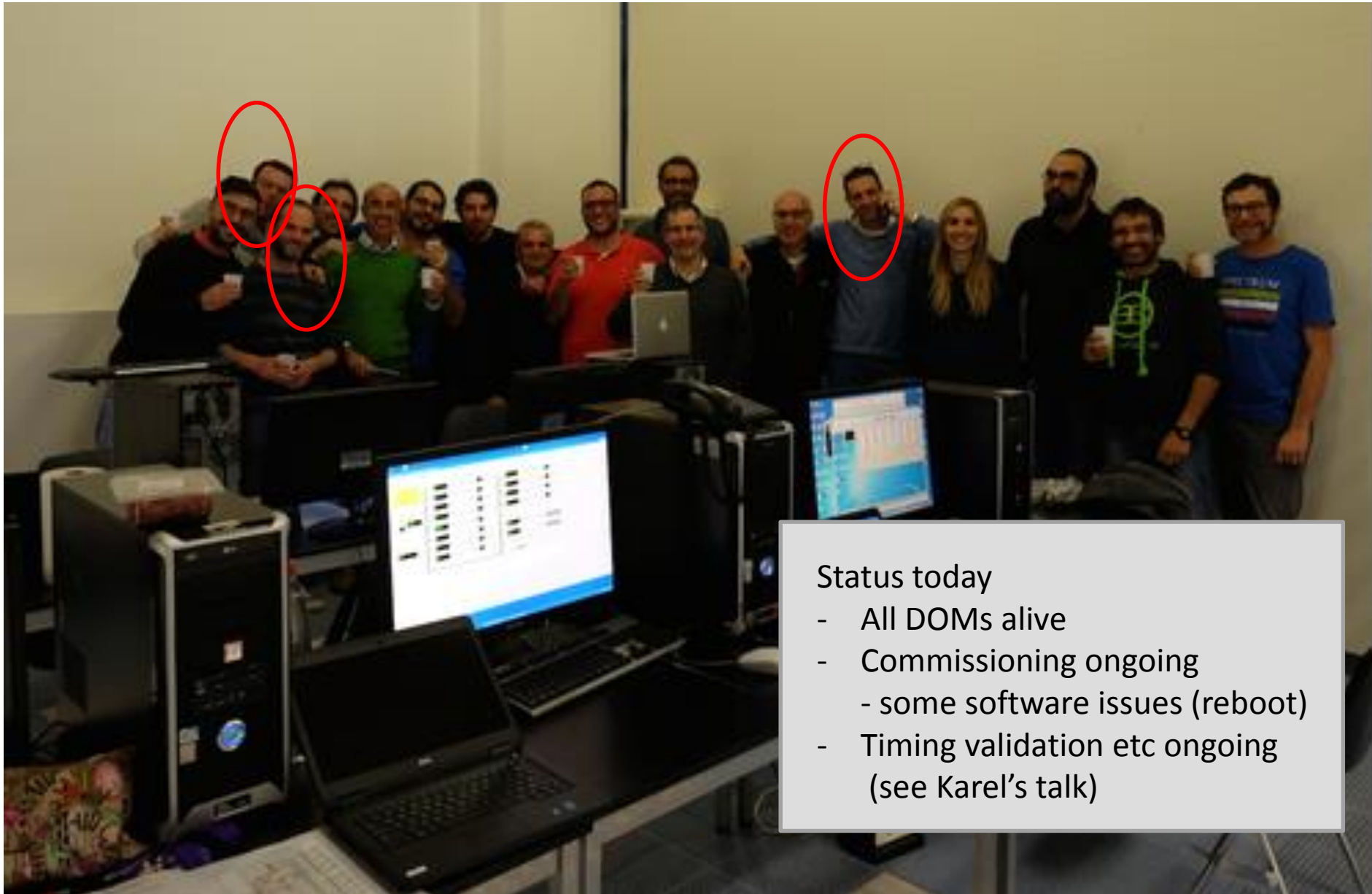


used










Status today

- All DOMs alive
- Commissioning ongoing
 - some software issues (reboot)
- Timing validation etc ongoing (see Karel's talk)

- 
- First string deployed!
 - Made possible by excellent technical groups of Nikhef!
 - ESFRI Roadmap succes
 - Recognition of progress.
 - Optimal funding prospects (It, Fr, NL)
 - Great science ahead.
 - Nikhef huge factor in succes!