KM3NeT

A launching vehicle for OMs of a deep-sea neutrino telescope

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On behalf of the KM3NeT consortium

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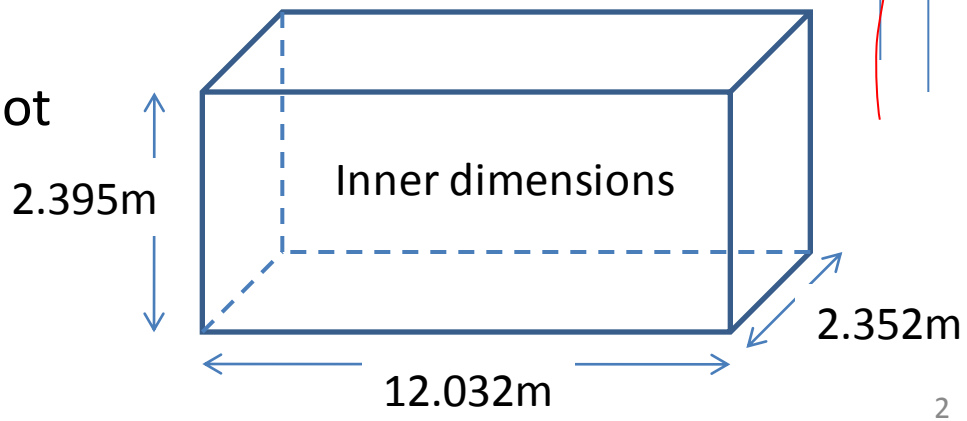
Project requirements

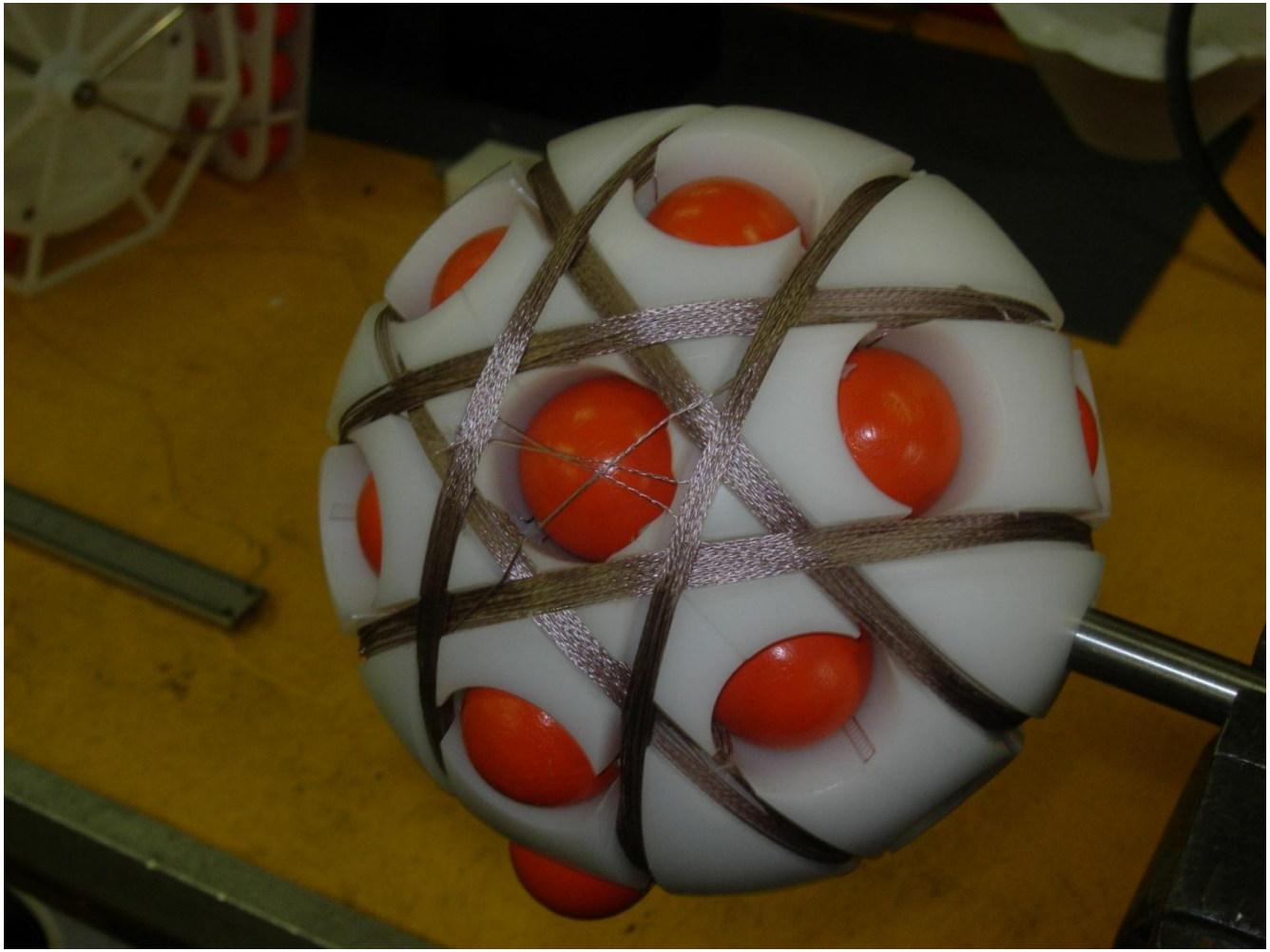
- Mooring definition
  - 20 optical modules (17 inch glass spheres)
  - 30 m vertical distance between optical modules
  - Total length about 700 m
  - 1 flexible e/o backbone cable running full length
  - 2 parallel supporting ropes
- Throughput
  - ≥ 8 moorings within a 3 days cruise
  - Mooring to be delivered at the vessel ready-for-deployment
- Transport
  - Use of standard 20/40 foot container



Technical concept

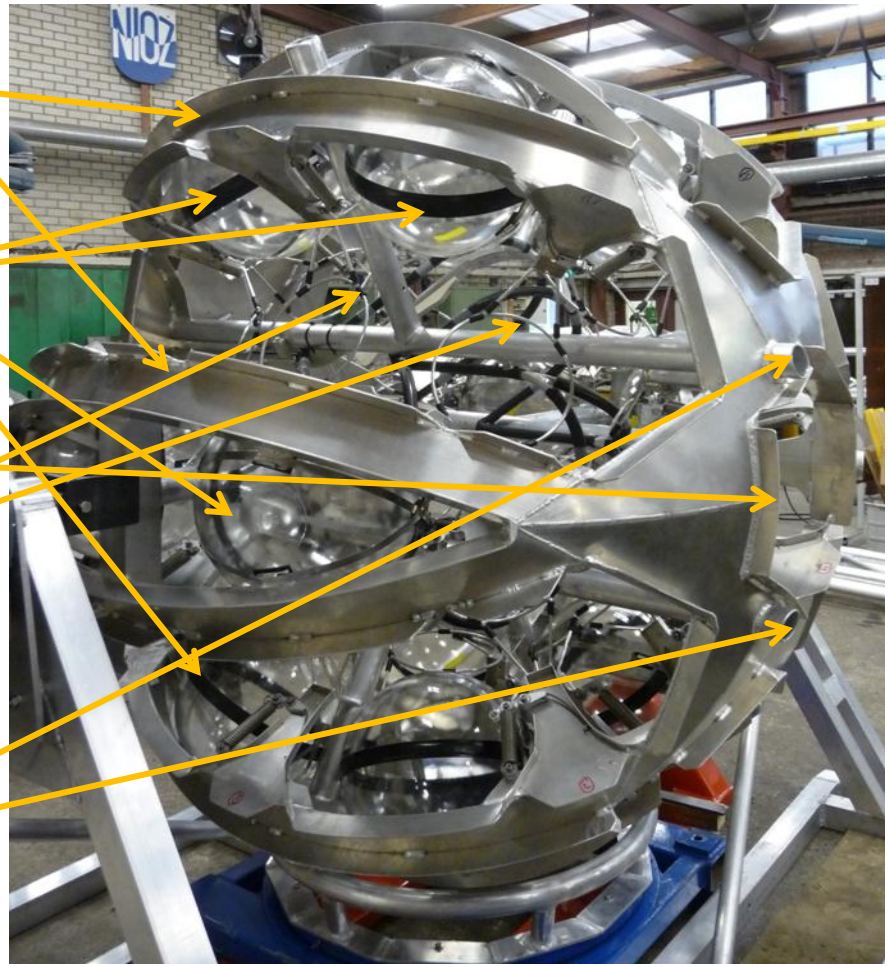
- Mooring packaged in a launching vehicle in the lab
- Transport of four packages in a 20/40 foot container to the deployment vessel
  - 3/2 transports required for an 8-mooring deployment cruise
- Anchor attached to the packaged mooring on deck of the vessel
  - Release requirements for cranes in the lab
- Deployment of packaged mooring to the seabed
  - Avoids peak tension on the supporting ropes during descend
  - Fast descend possible
- Recyclable acoustic release to start unfurling to full length
  - Start unfurling of the mooring at a convenient time
- Recycle launching vehicle for re-use
  - Cost effective

Technical concept



Launching vehicle in the lab

- 3 pairs of parallel cable trays
- 12 glass spheres for buoyancy of the frame
- Hole for entrance of buoy-spheres
- 20 rings to suspend optical modules
- 3 tubes to guide tension cables to fix the frame to the anchor during descend



Launching vehicle in rotator

Loading the frame

- Top down: first 5 buoy-spheres in the centre, followed by optical modules
- Cable and ropes are wound in the parallel cable trays
- Optical modules are attached to ropes and inserted in the launcher during winding

Technical details

- Weight in air of loaded vehicle 1170 kg
- Supporting ropes: Dyneema®, Ø 4 mm, 12 strands braided, low stretch produced, max. breaking load (MBL) 12000 N
- Markers at every 1 m
- Backbone cable: low density polyethylene (LDPE) oil-filled hose, Ø 6 mm

Technical details

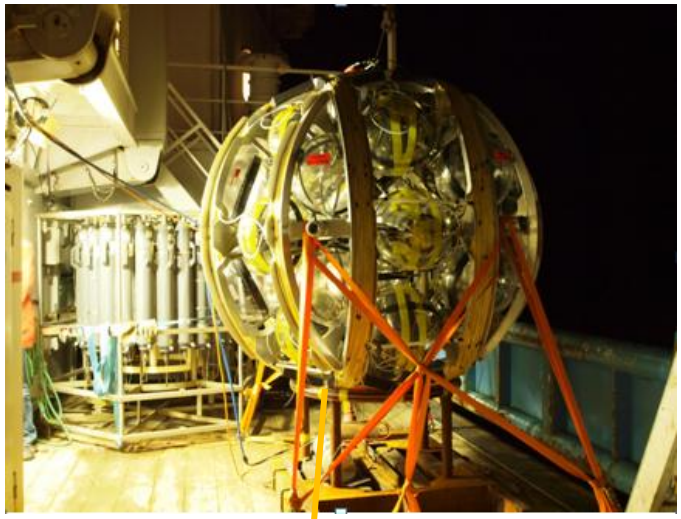
- Attachment of the sphere to the ropes
- Spring lock keeps optical module in its position
- Release by pull of rope

Transport loaded launching vehicle

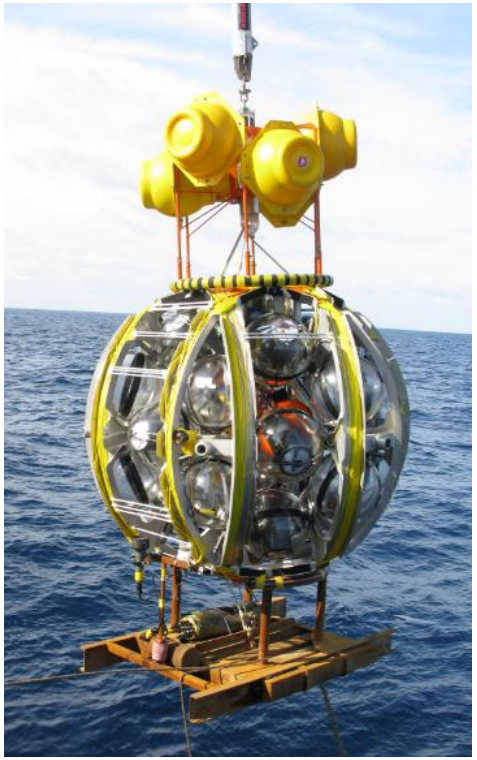
- Diameter frame: 2.18 m
- Fits in standard container
- Weight in air 1170 kg

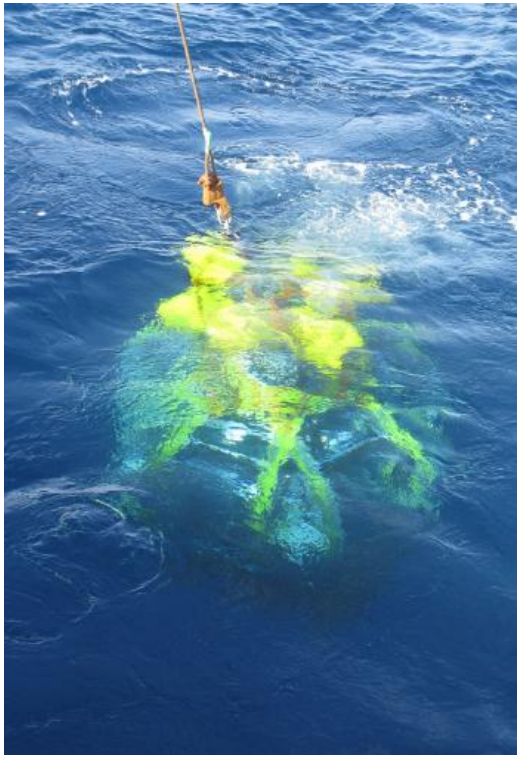
Preparing for deployment

- Launching vehicle placed on launching platform on the anchor
- 3 cables keep the launching vehicle fixed to the platform
- Loops of the cables fixed with acoustic release



Deployment

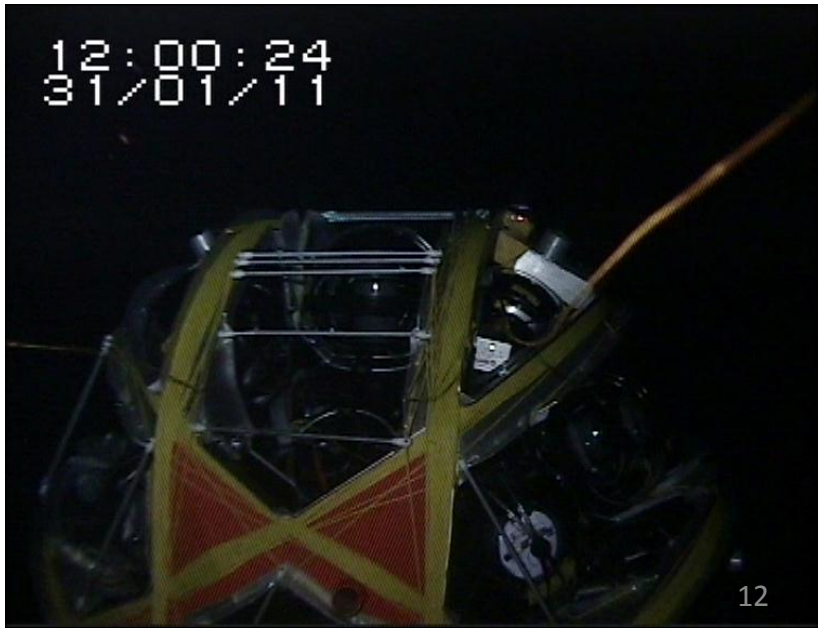




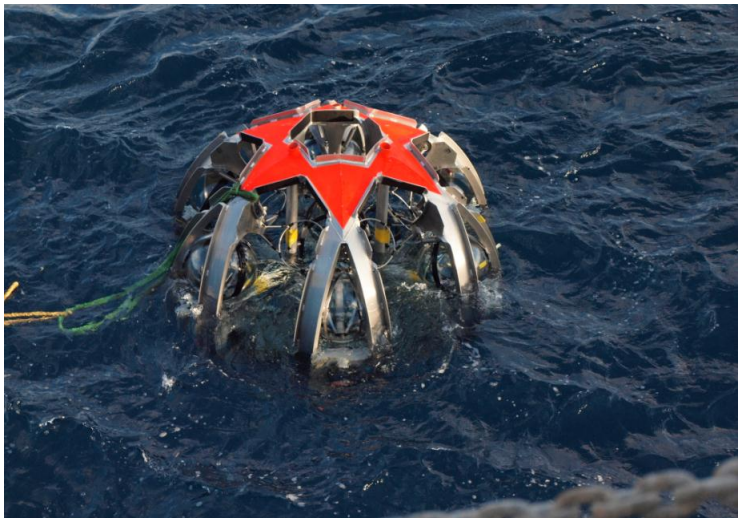
- Total weight in air 2265 kg
- Descend at ~0.40 m/s
- Acoustic release of deployment cable

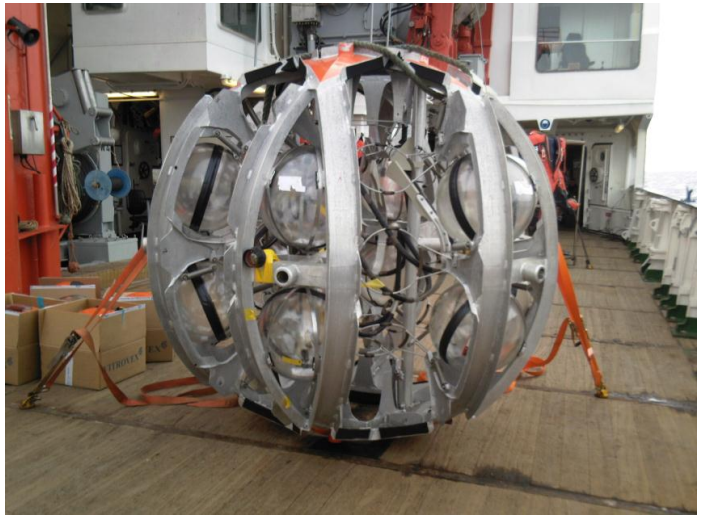
Release of the launching vehicle

- Launching vehicle is acoustically released
- Acoustic release floats to the surface
- Launching vehicle unwinds mooring to its full length (~1.2 m/s)
- Initial force on the ropes 5700 N, final force on the ropes 3900 N
- Launching vehicle floats to the surface

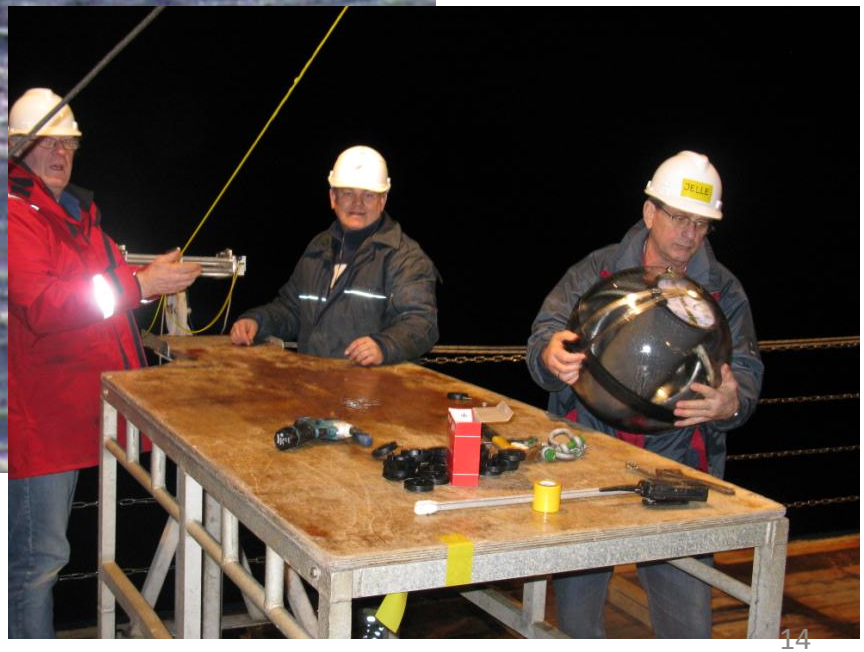


Recovery of launching vehicle





Recovery of mooring during tests



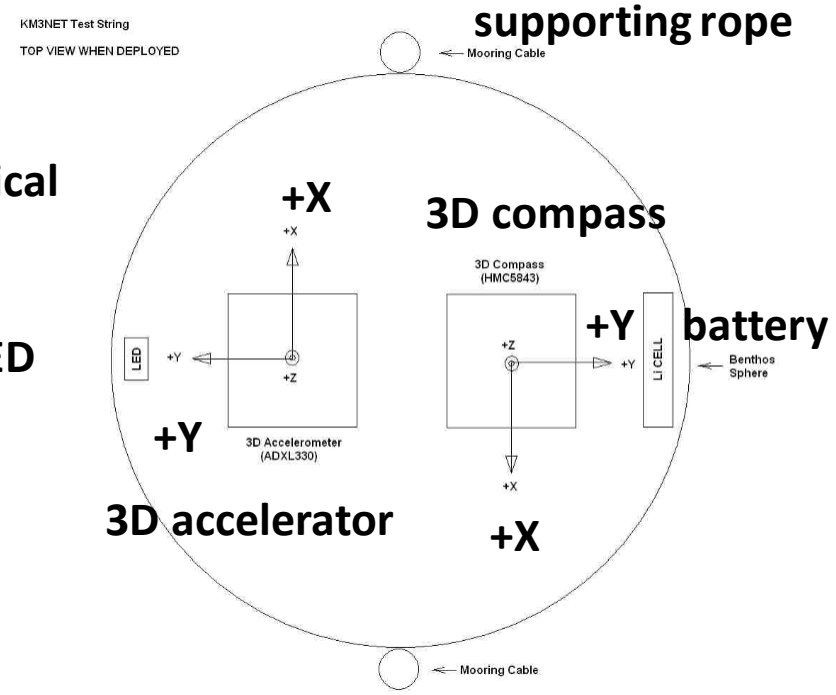
Data analysis

Compass and accelerators for monitoring unfurling

- In the optical modules
- One on the launching vehicle

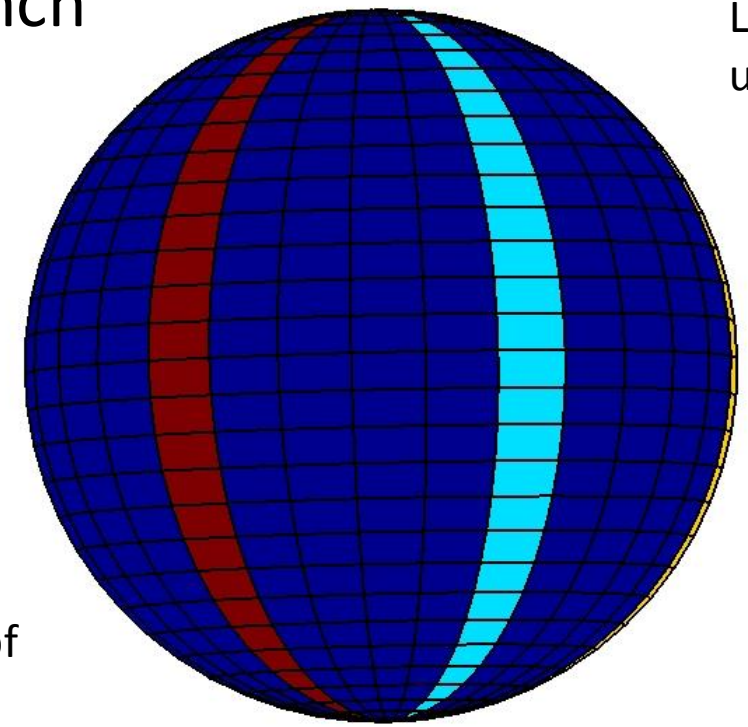
Top view optical module

LED

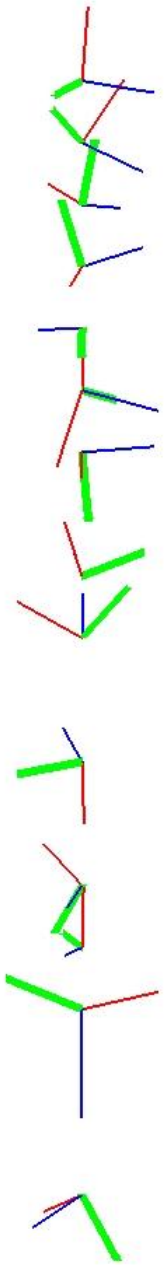


t=01/30 11:59:20.000 UTC

Before launch



Launcher in upward position



Compasses in top of the spheres show that spheres are not aligned

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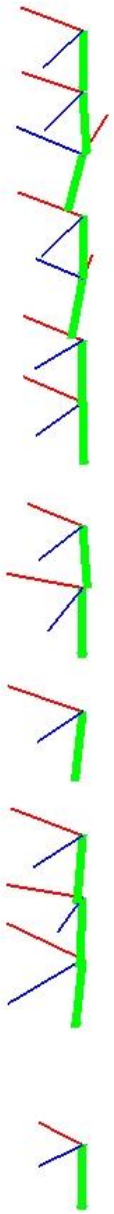
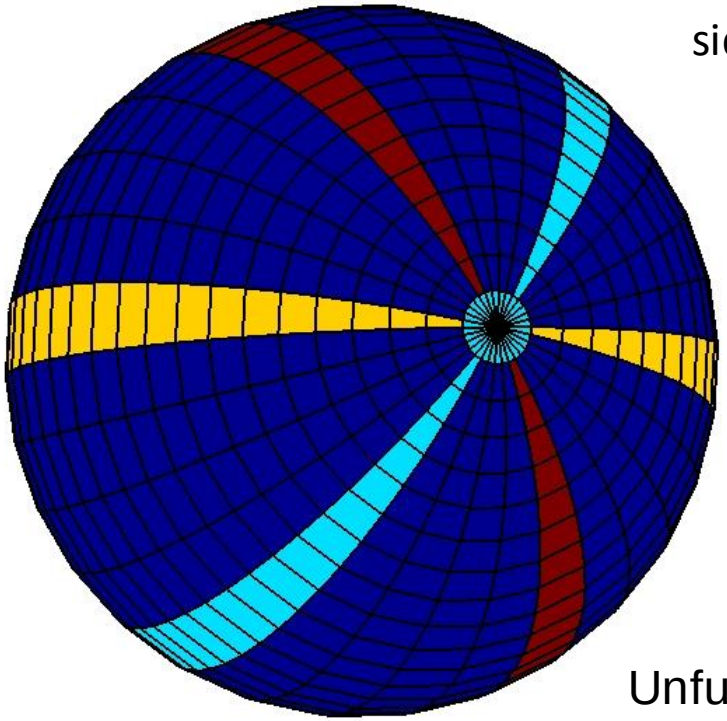


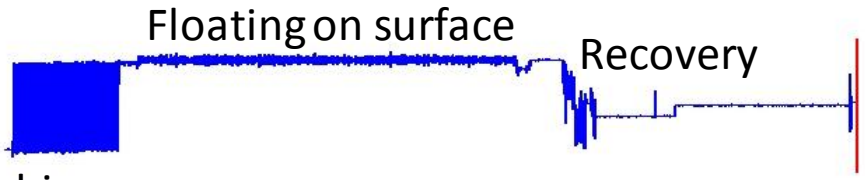
After launch



Launcher in sideway position

Compasses in top of the spheres show that spheres are aligned

Unfurling velocity 1.2 m.s

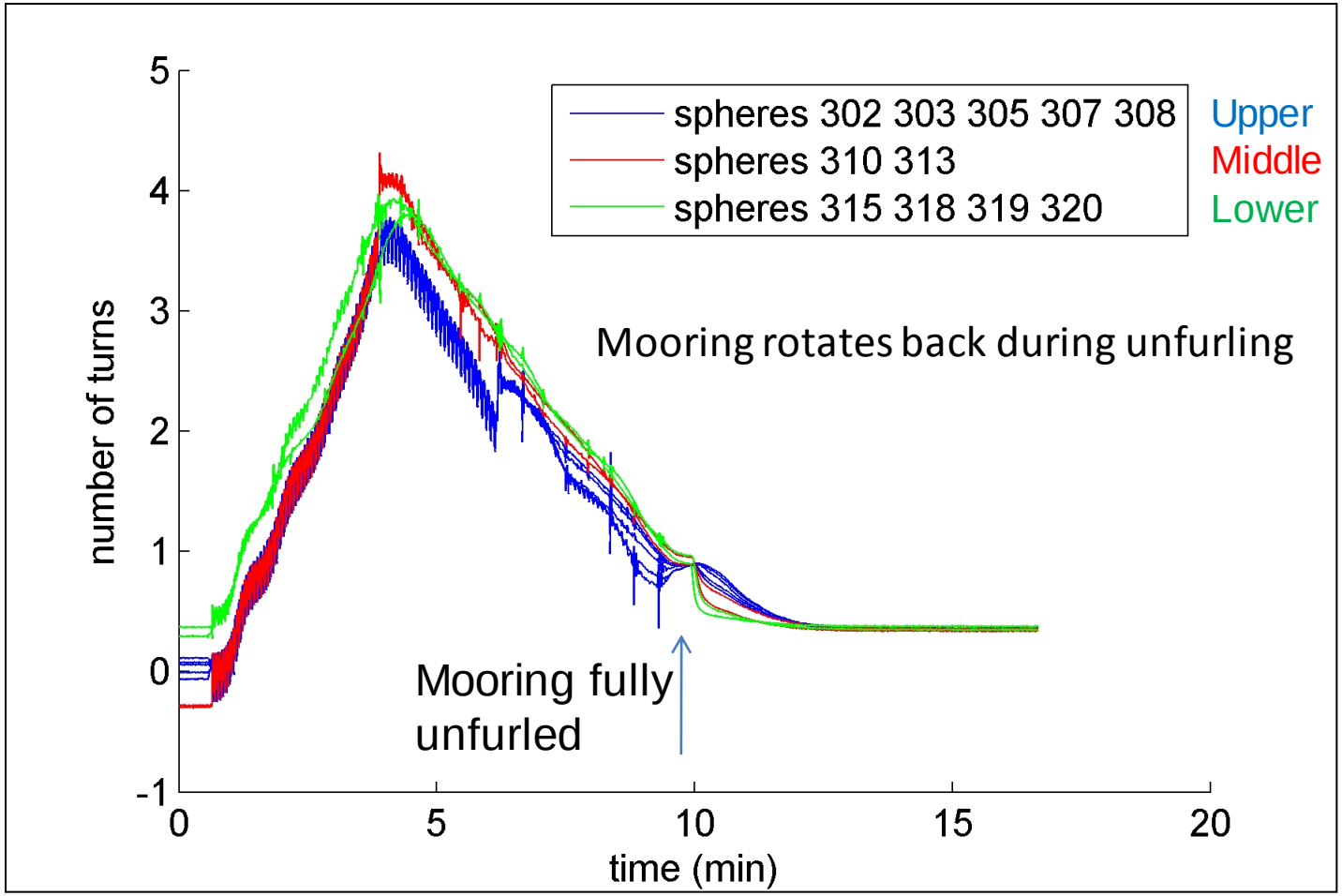


Floating on surface

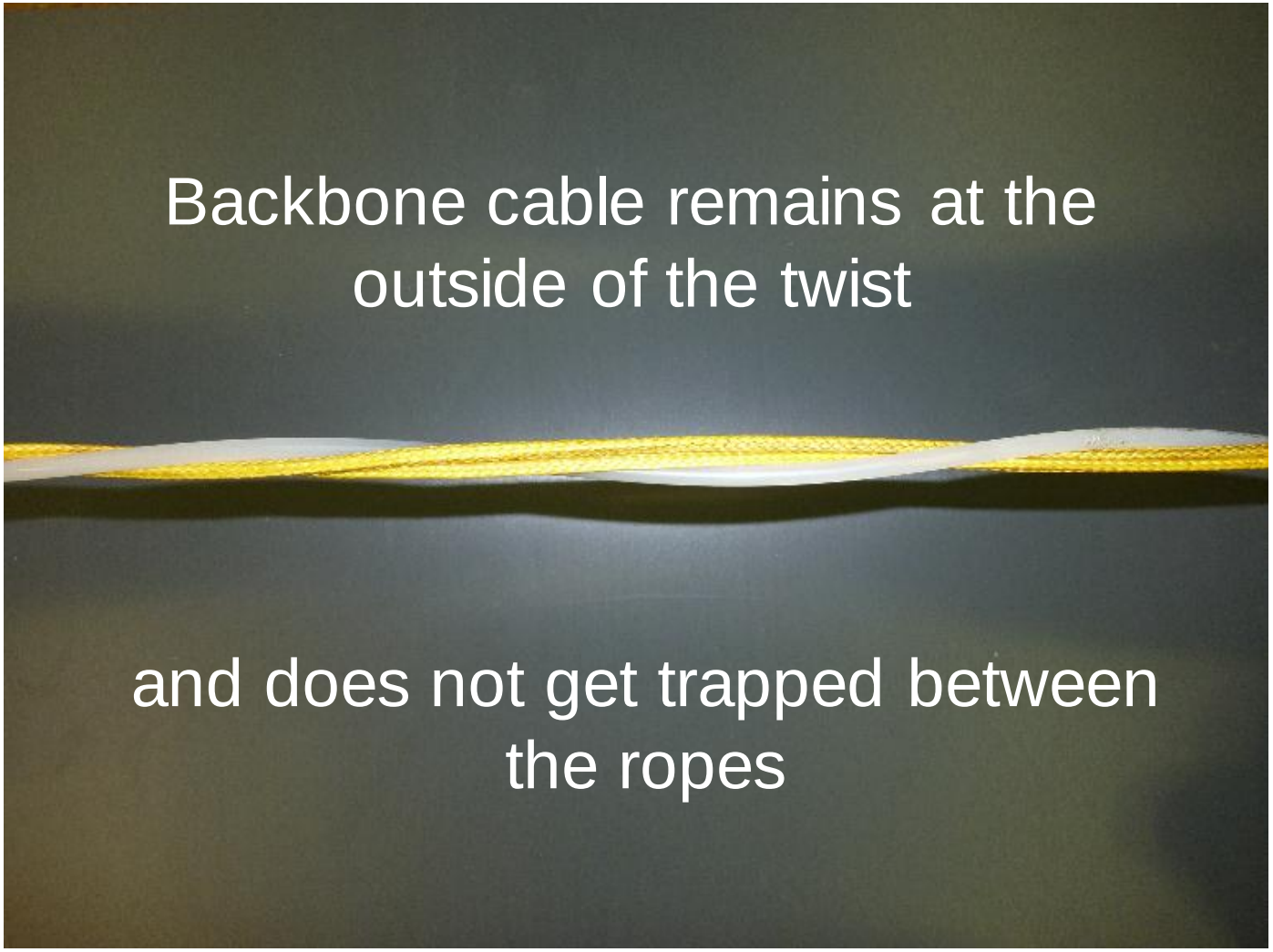
Recovery

Rotation launching vehicle during unfurling

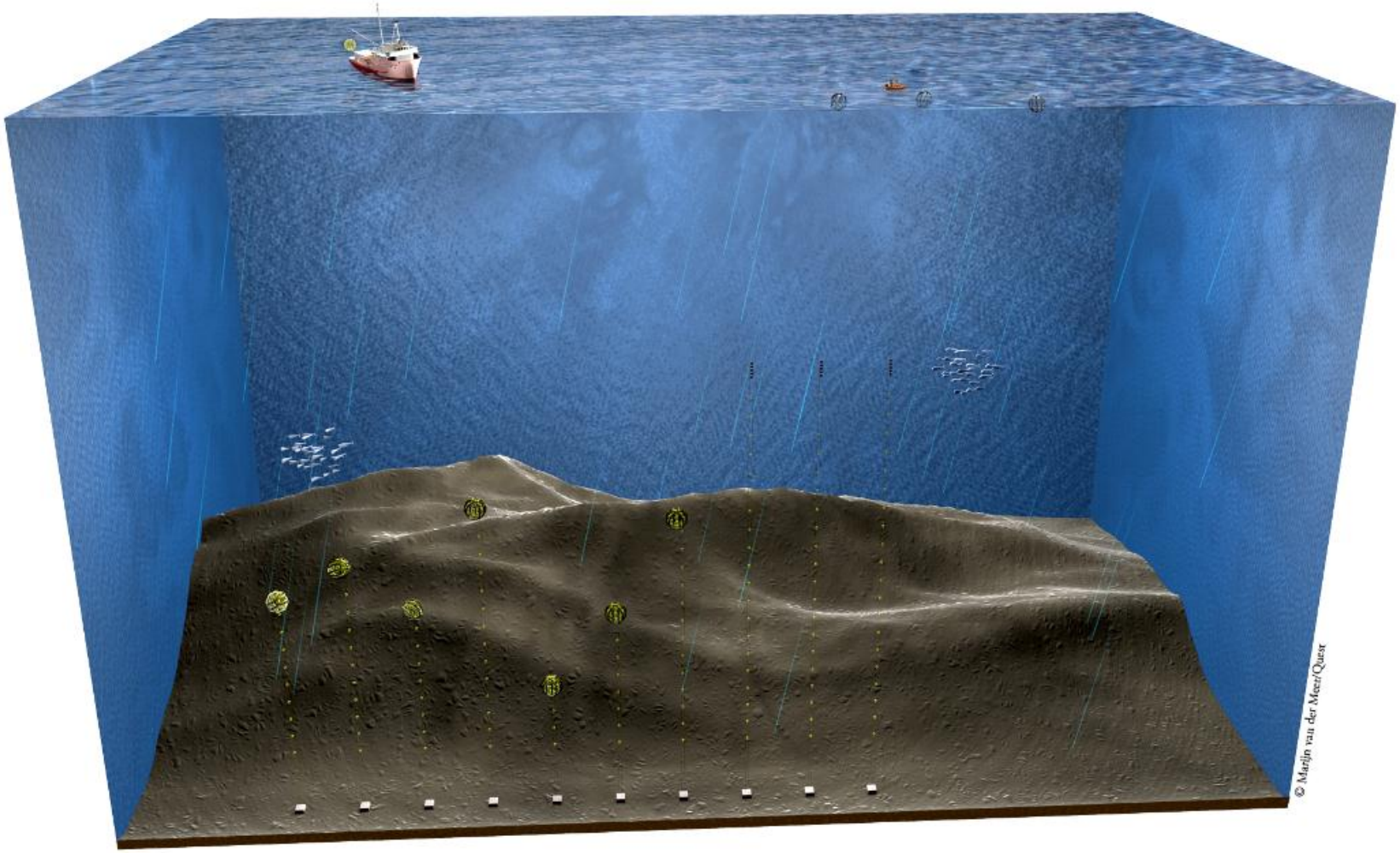
Rotations during unfurling



Twist-test in the lab

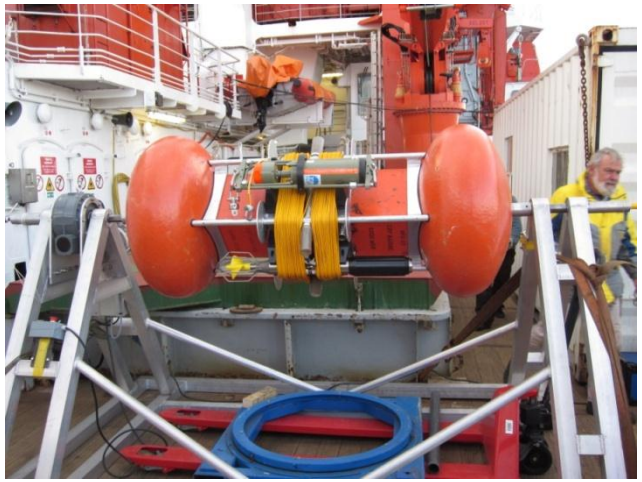


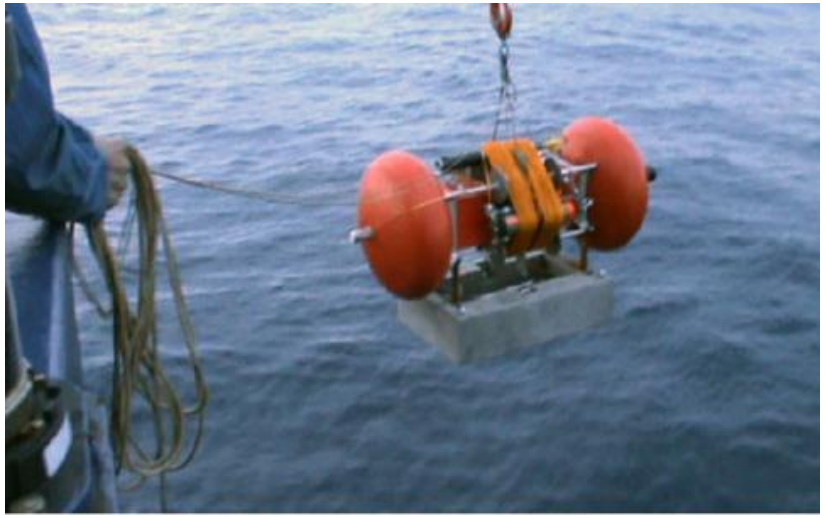
Quest magazine



Spin-off: LOEI

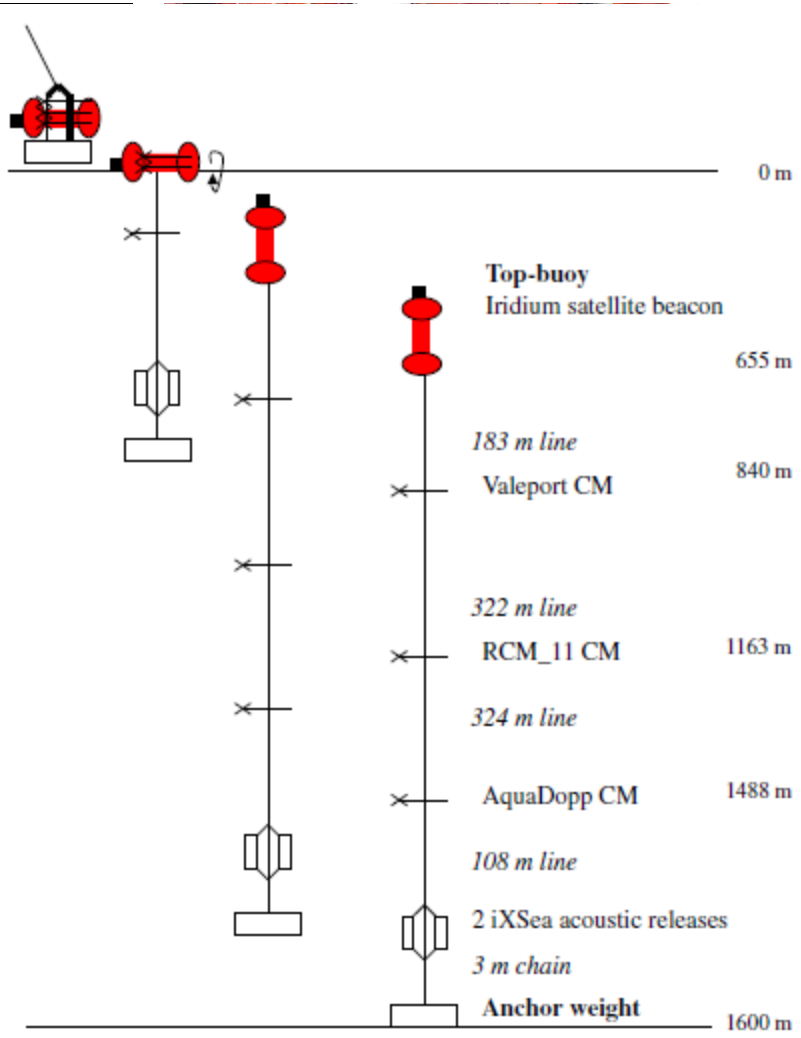
Launcher vehicle for Oceanographical Equipment and Instruments





Spin-off: LOEI

Launcher vehicle for Oceanographical Equipment and Instruments



Conclusions and recommendations

- Launching vehicle for optical modules validated in compliance with the requirements during three deployments
- Spin-off for compact mooring of sea science instrumentation
- Long term validation test of Dyneema® in seawater is recommended
- Deployment of connected multi-mooring system seems feasible
  (contact with Heerema Marine Contractors)

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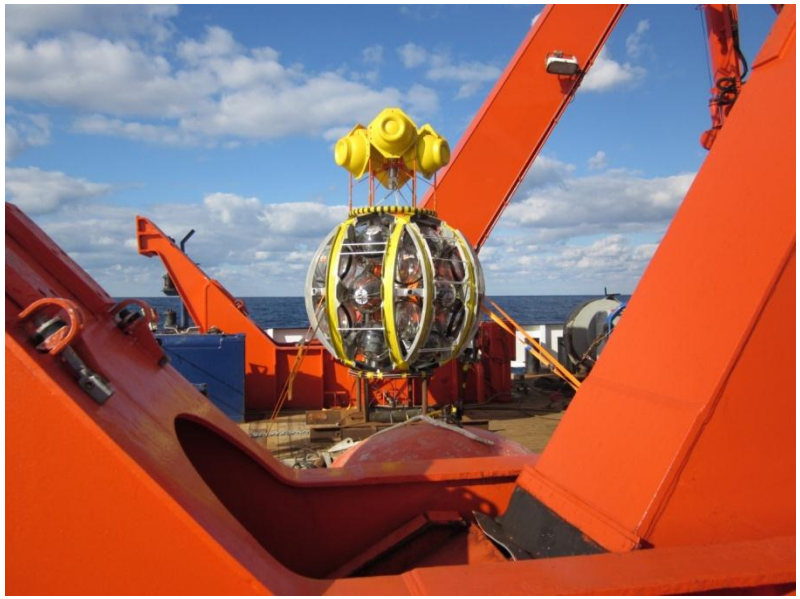
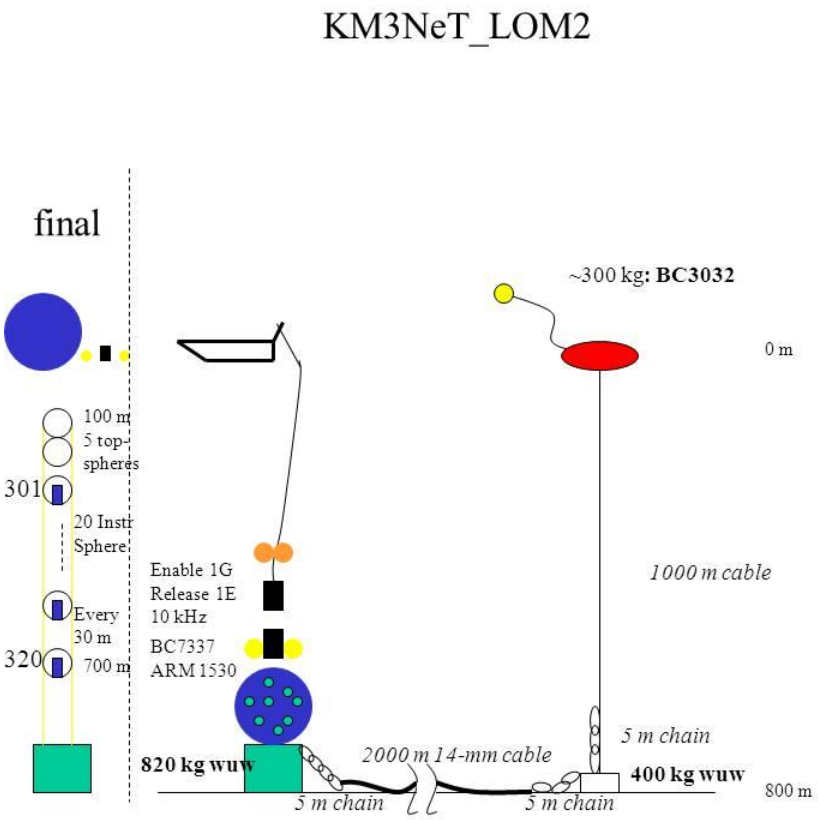
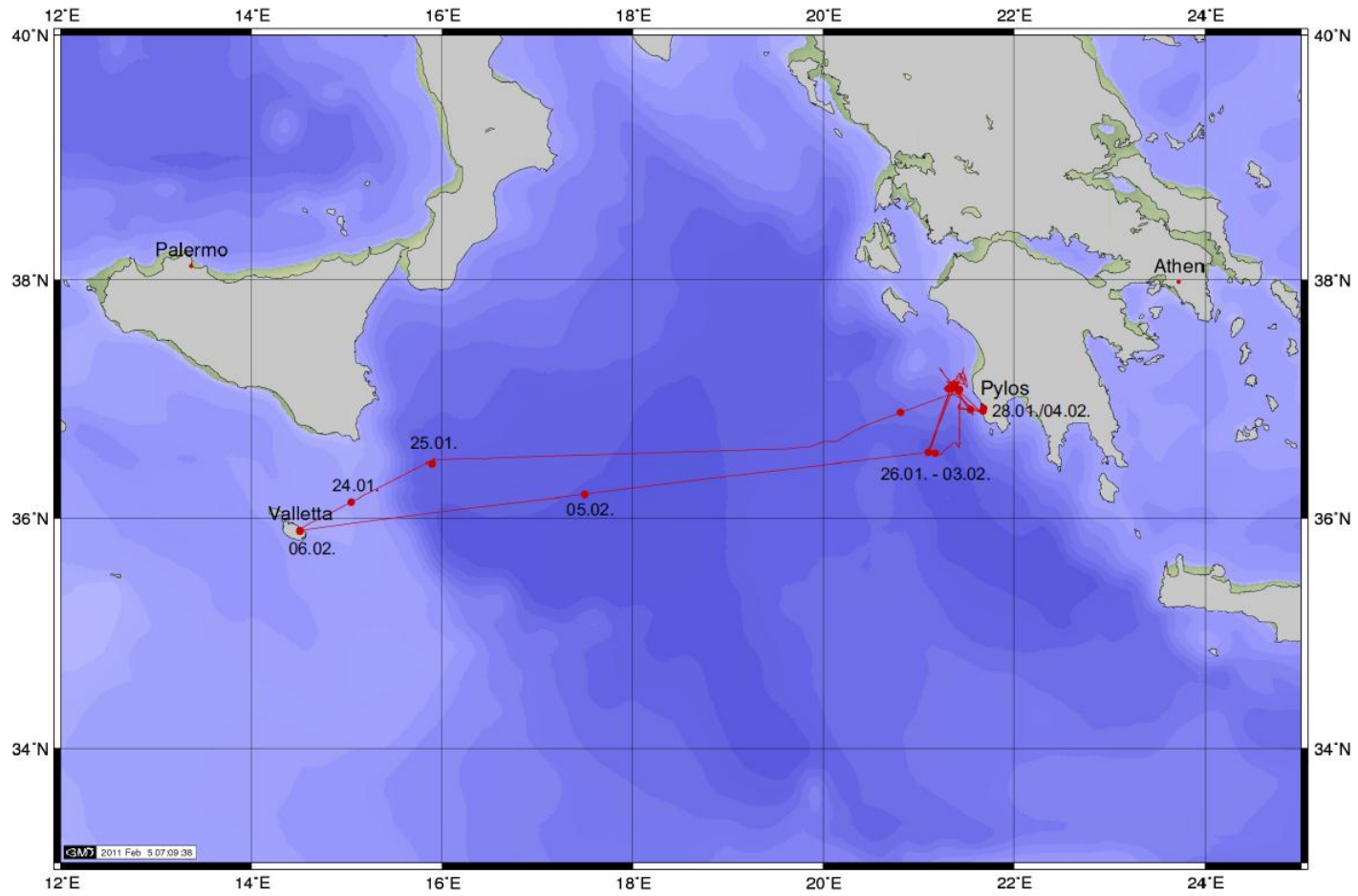
Multi-disciplinary use of the infrastructure!!



Backup slides

Mooring plan





FS METEOR

CRUISE M83/4

Valletta - Valletta, 24.01.2011 - 06.02.2011

Mercator Projection
Distance: 1130 nm

Royal Netherlands Institute for Sea Research