

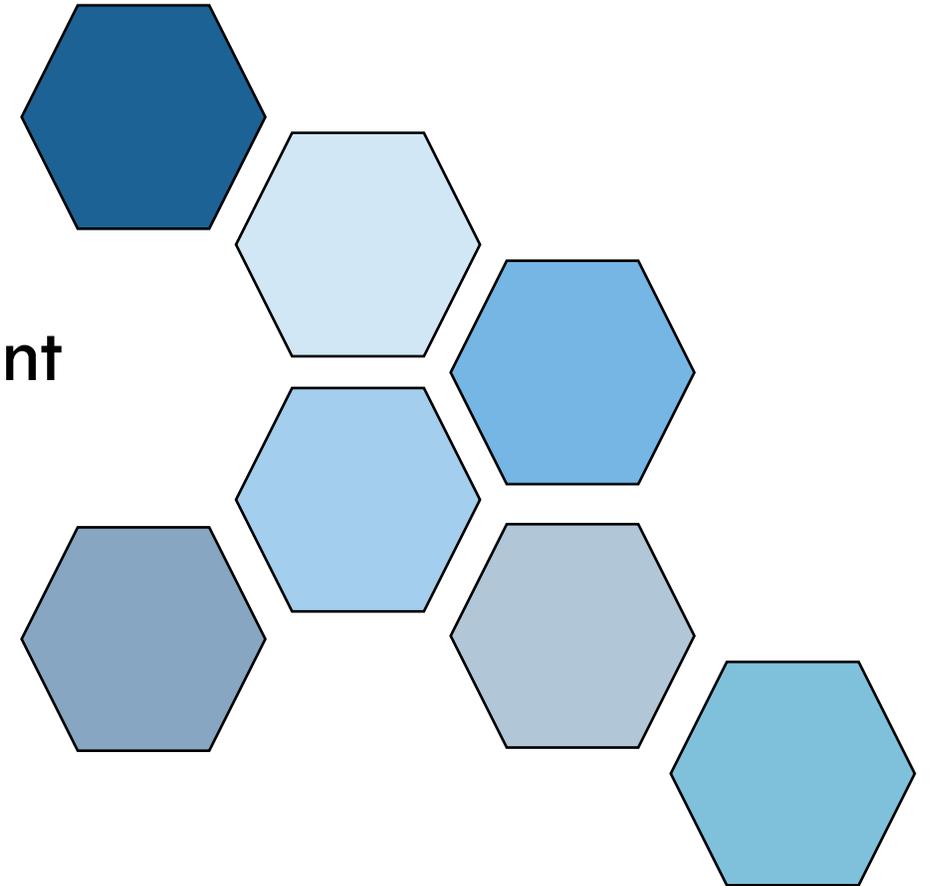
TeVPA 2021

P-ONE – Pacific Ocean Neutrino Experiment

pathfinder and pilot phase

C. Spannfellner on behalf of the P-ONE collaboration

TUM – Experimental Physics with Cosmic Particles



Pacific Ocean Neutrino Experiment – motivation & overview

P-ONE – a new complementary telescope

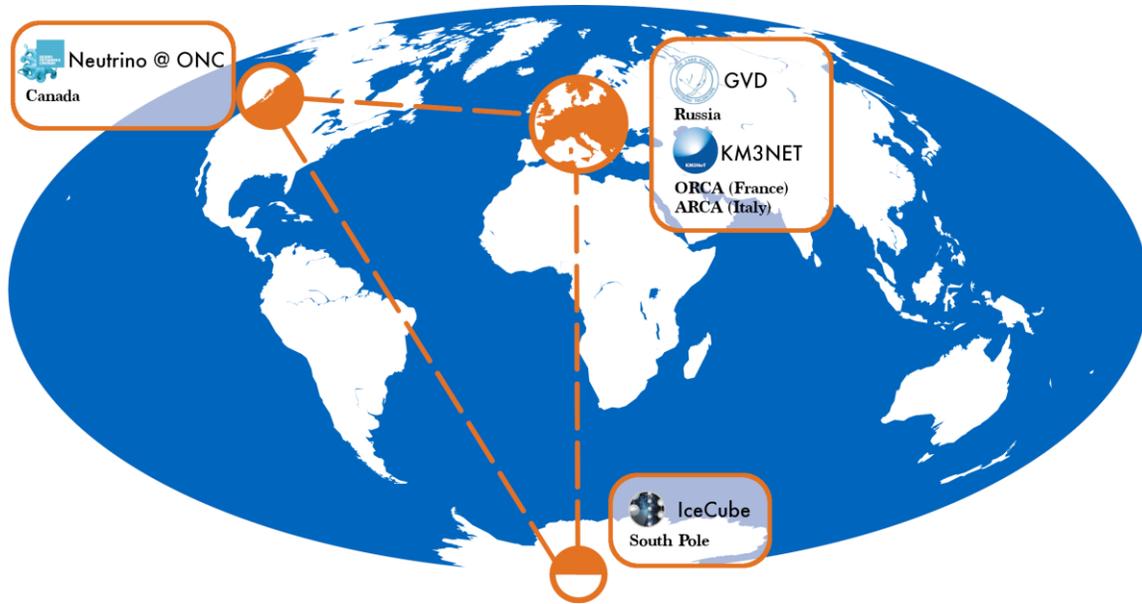


Image: A. Turcati

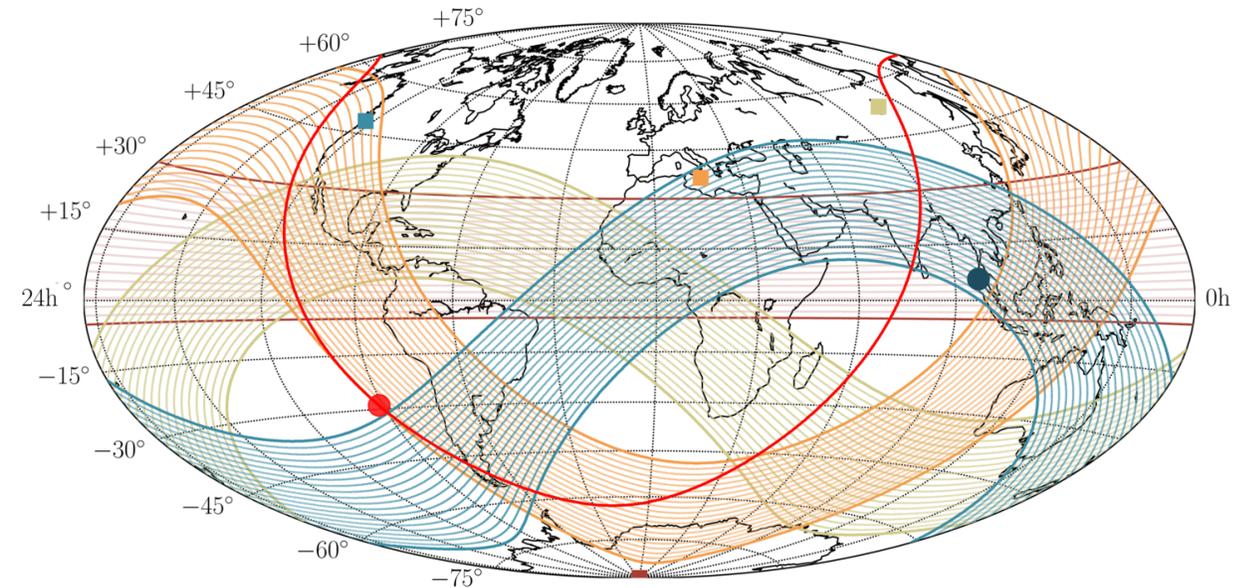
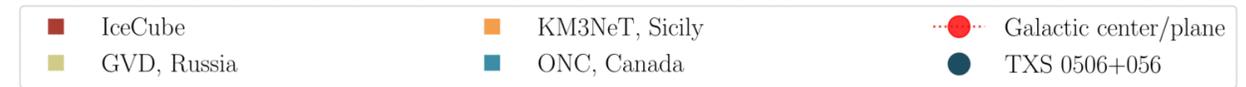
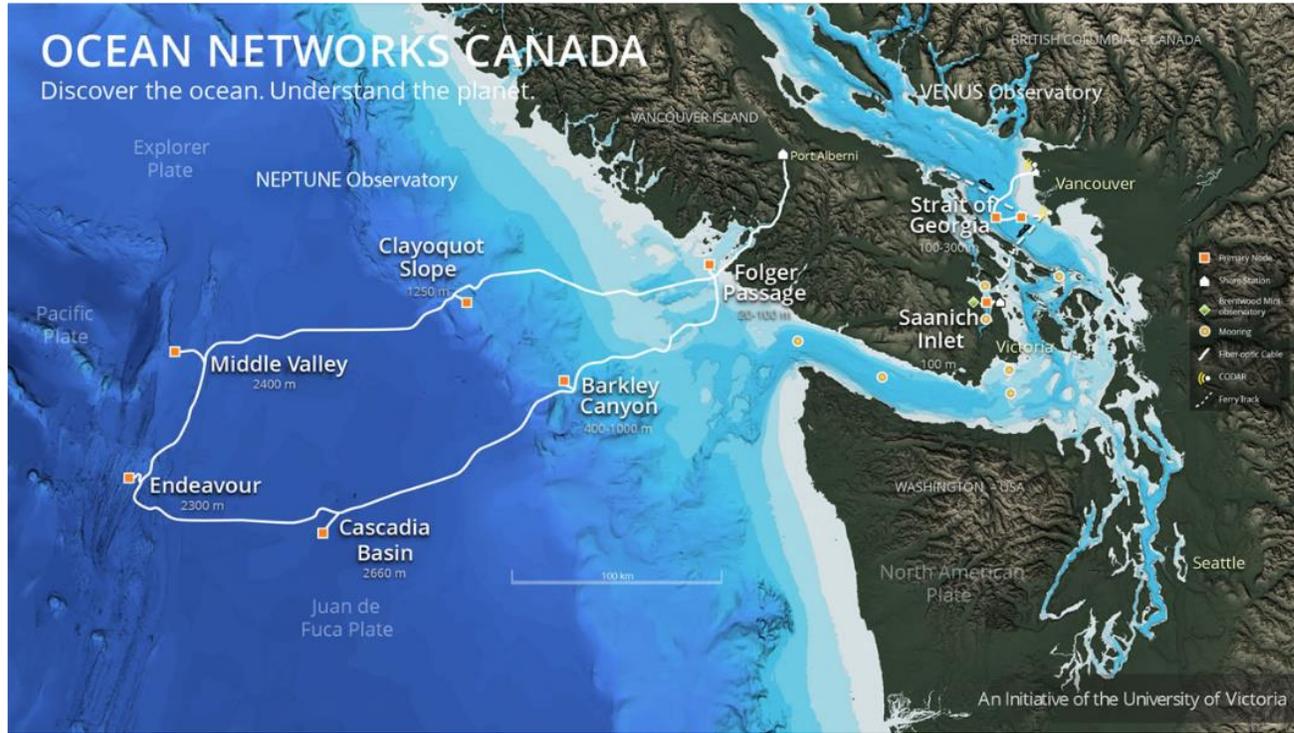


Image: M. Huber

PLEvM concept: L. Schumacher @ TeVPA 2021

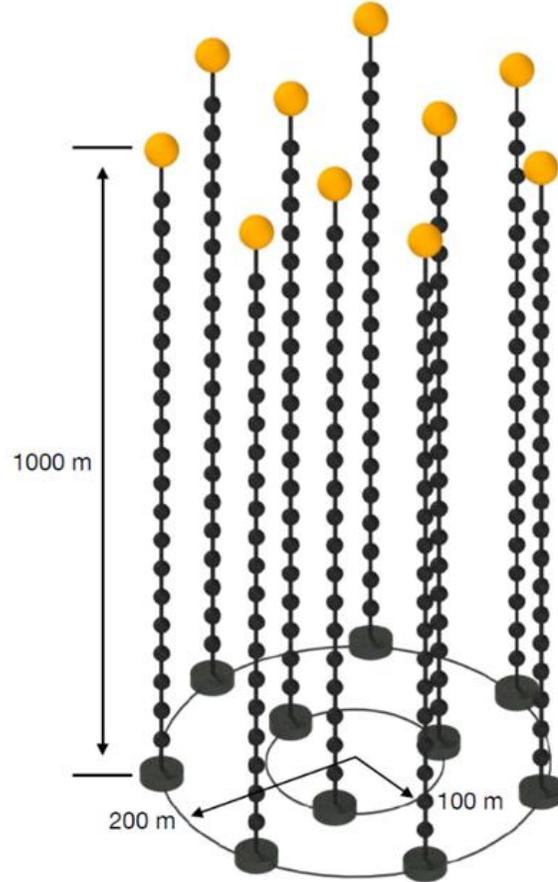
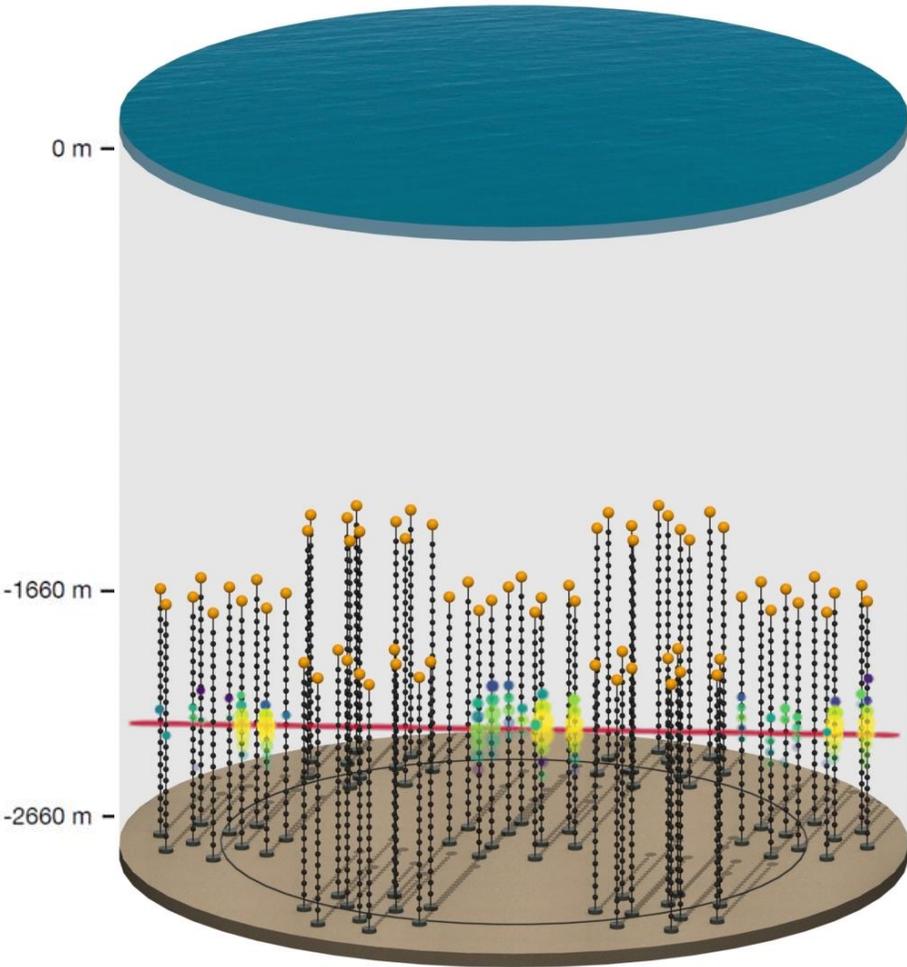


NEPTUNE observatory

- Cabled ocean observatory (completed 2009)
- Annual budget ~\$27M (CDN)
- 800km loop of fibre optical cable (4GB/s, 8kW/node)



P-ONE – detector overview

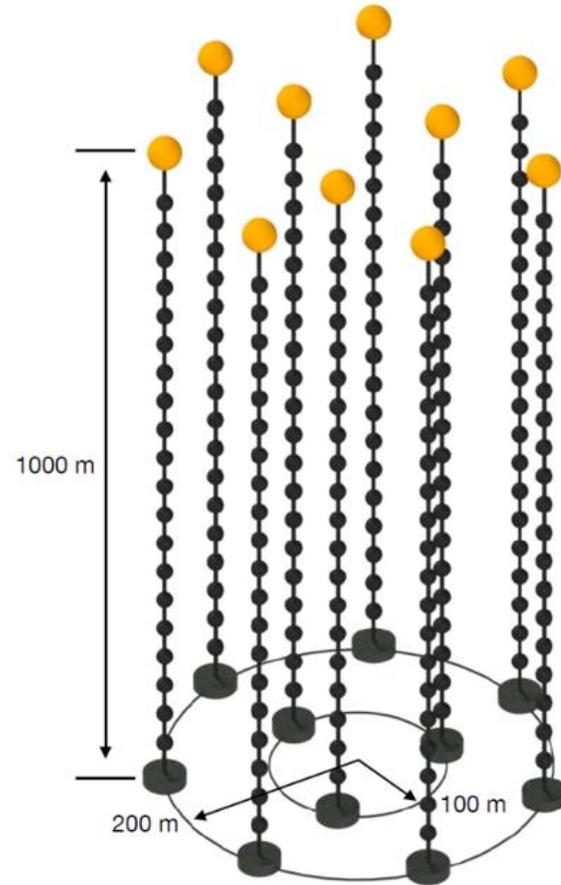
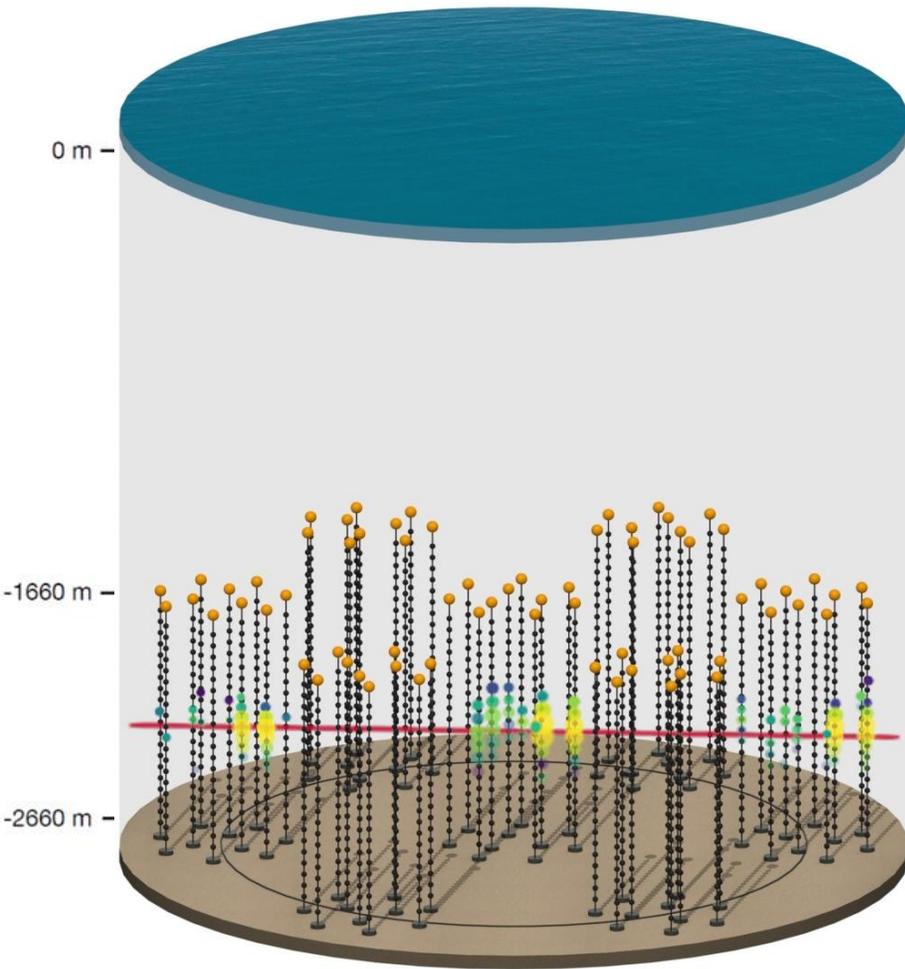


- **Please note:** Illustrations are preliminary studies!
- P-ONE detector design:
 - Clustered structure, focusing on horizontal tracks
 - Around 7 Clusters with 10 moorings each
 - Roughly 20 modules per mooring
- **P-ONE phases:**
 - Pathfinder(s): characterization of the site
 - Pilot phase: deployment of first P-ONE moorings

Image: K. Holzapfel

P-ONE – detector overview

M. Agostini et al. (P-ONE Coll), *Nature Astronomy* (2020)



- Please note: Illustrations are preliminary studies!
- P-ONE detector design:
 - Clustered structure, focusing on horizontal tracks
 - Around 7 Clusters with 10 moorings each
 - Roughly 20 modules per mooring
- **P-ONE phases:**
 - Pathfinder(s): characterization of the site
 - Pilot phase: deployment of first P-ONE moorings

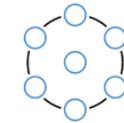
Image: K. Holzapfel

STRAW

Deployed 2018

STRAW_b

Deployed 2021

 P-ONE

Optical characterisation of deployment site

R&D on optical modules, further characterisation

Deployment of first P-ONE mooring lines

P-ONE – pathfinder phase

P-ONE – pilot phase (now)



P-ONE – pathfinder phase

STRAW – 1st pathfinder mission

- **Objective:** Measure optical properties and verify deployment of strings
- Deployed July 2018 in Cascadia Basin in collaboration with ONC
- Operational with a **duty cycle of around 98%**
- Concept of **2 lines and 2 different optical modules:**
 - 3x **POCAM**: Emission of nanosecond light pulses
 - 5x **sDOM**: Measurement of incident light via 2 PMTs

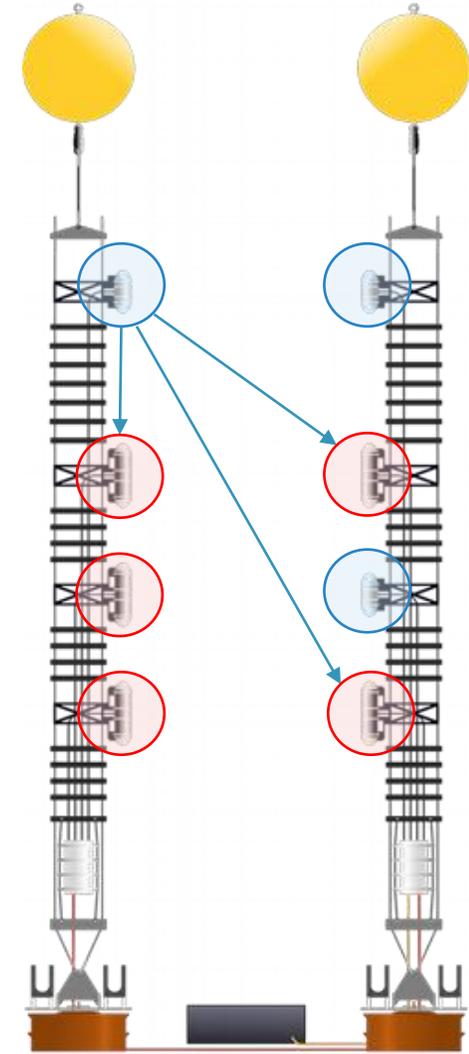


Image: K. Holzapfel



STRAW – 1st pathfinder mission

- Objective: Measure optical properties of strings
- Deployment
- Operation
- Concept
- 3x
- 5x measurement of incident light via 2 PMTs

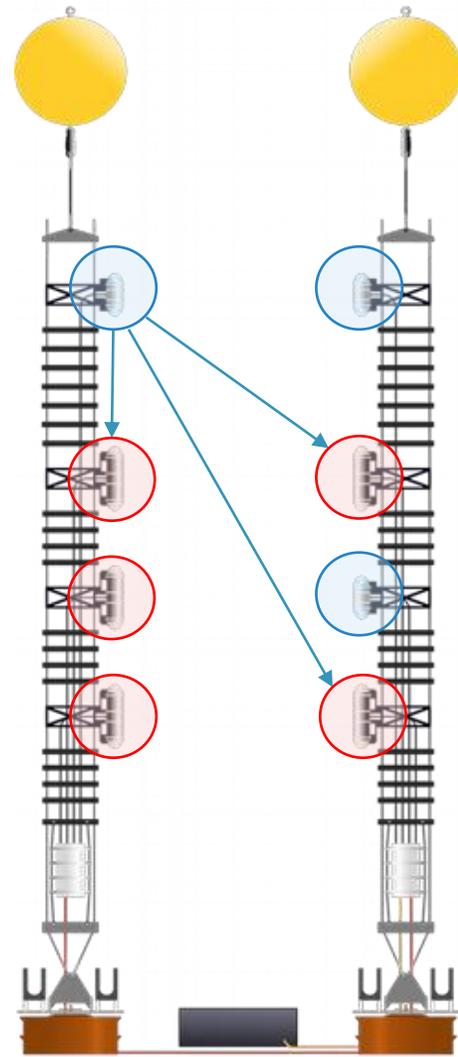
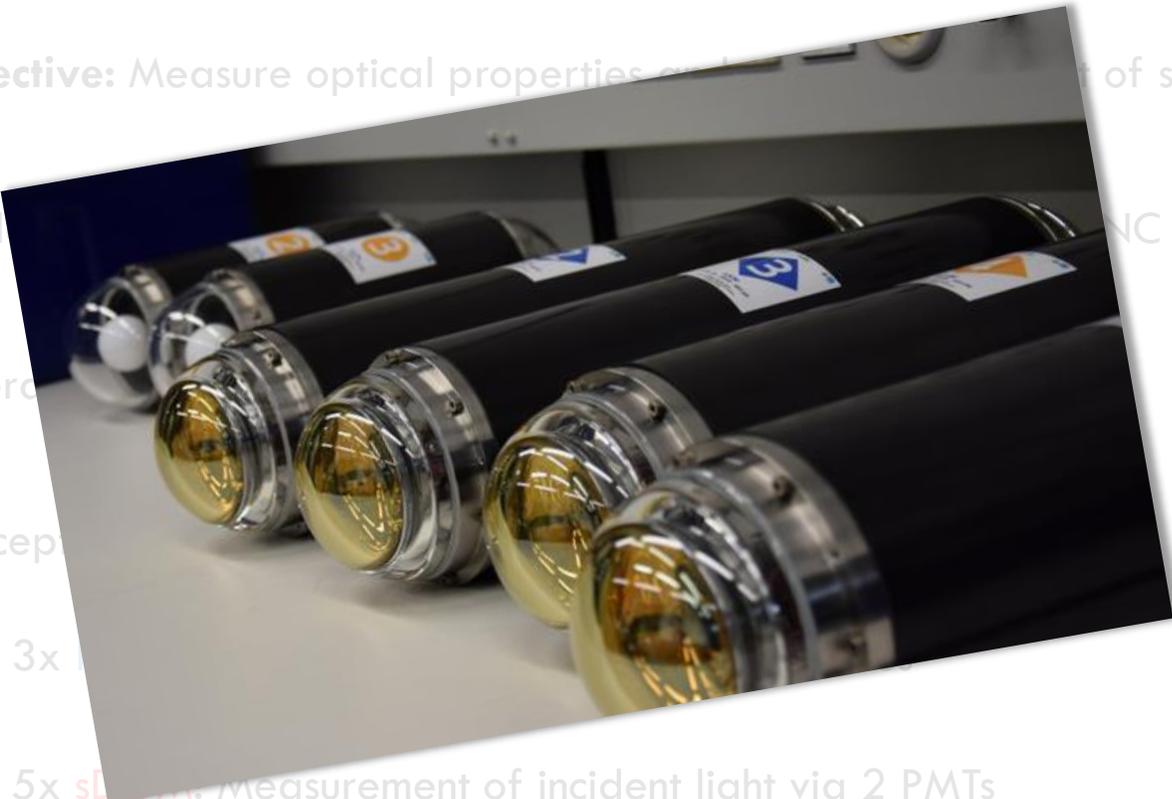


Image: K. Holzappel

STRAW – 1st pathfinder mission

- Objective: Measure
- Depth
- Operation
- Concept
- 3x
- 5x sD...: measur

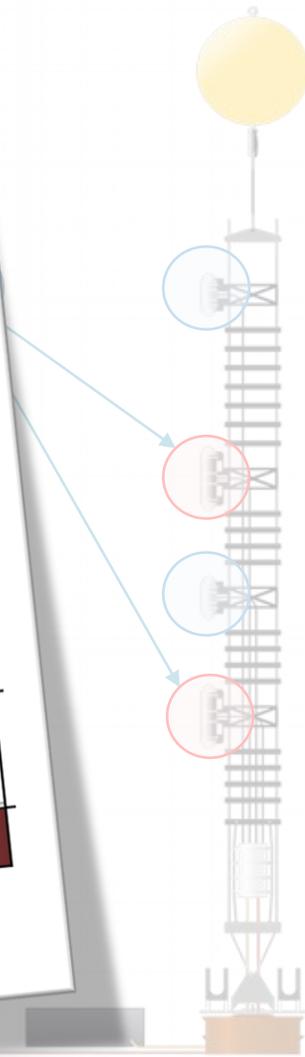
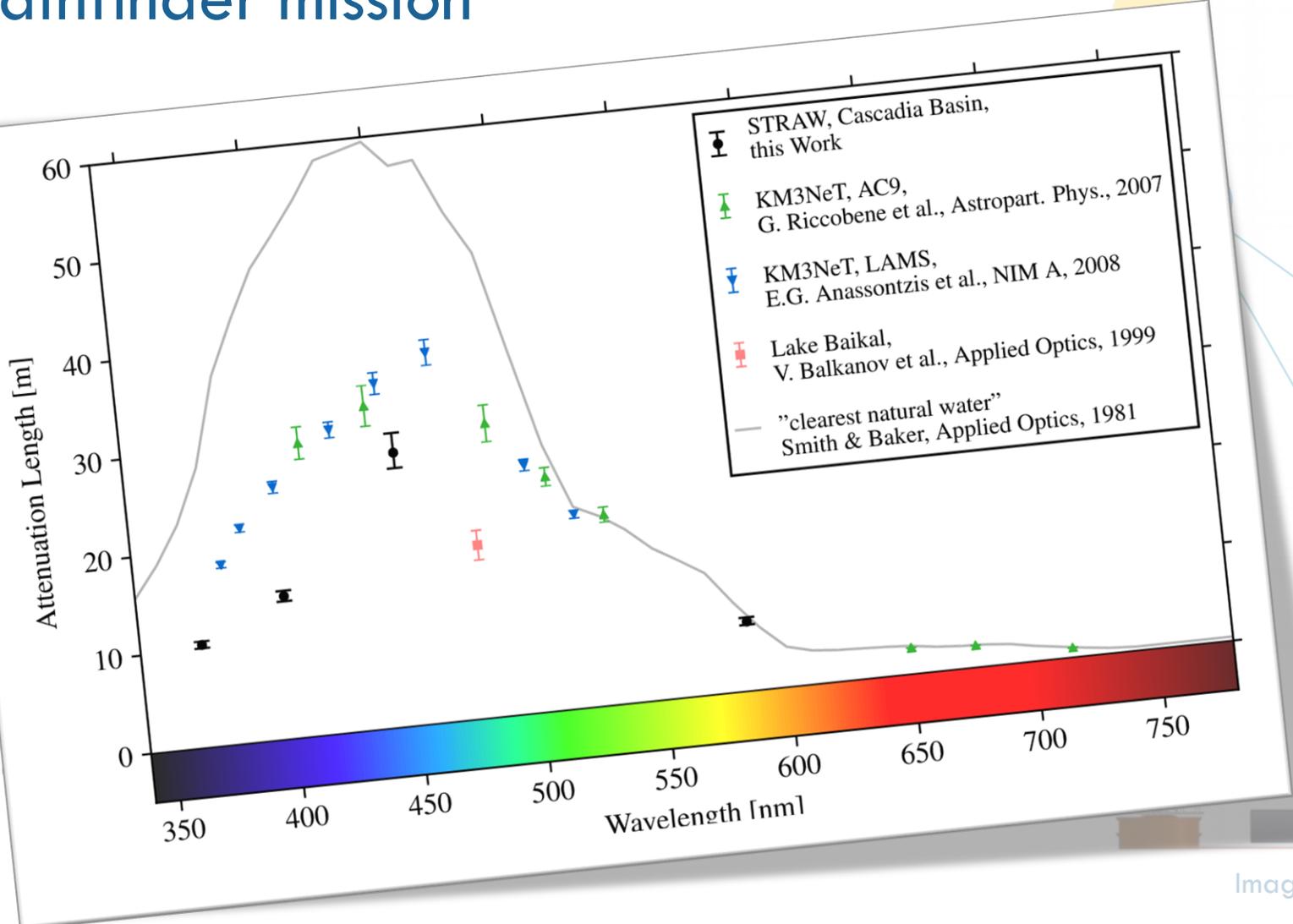
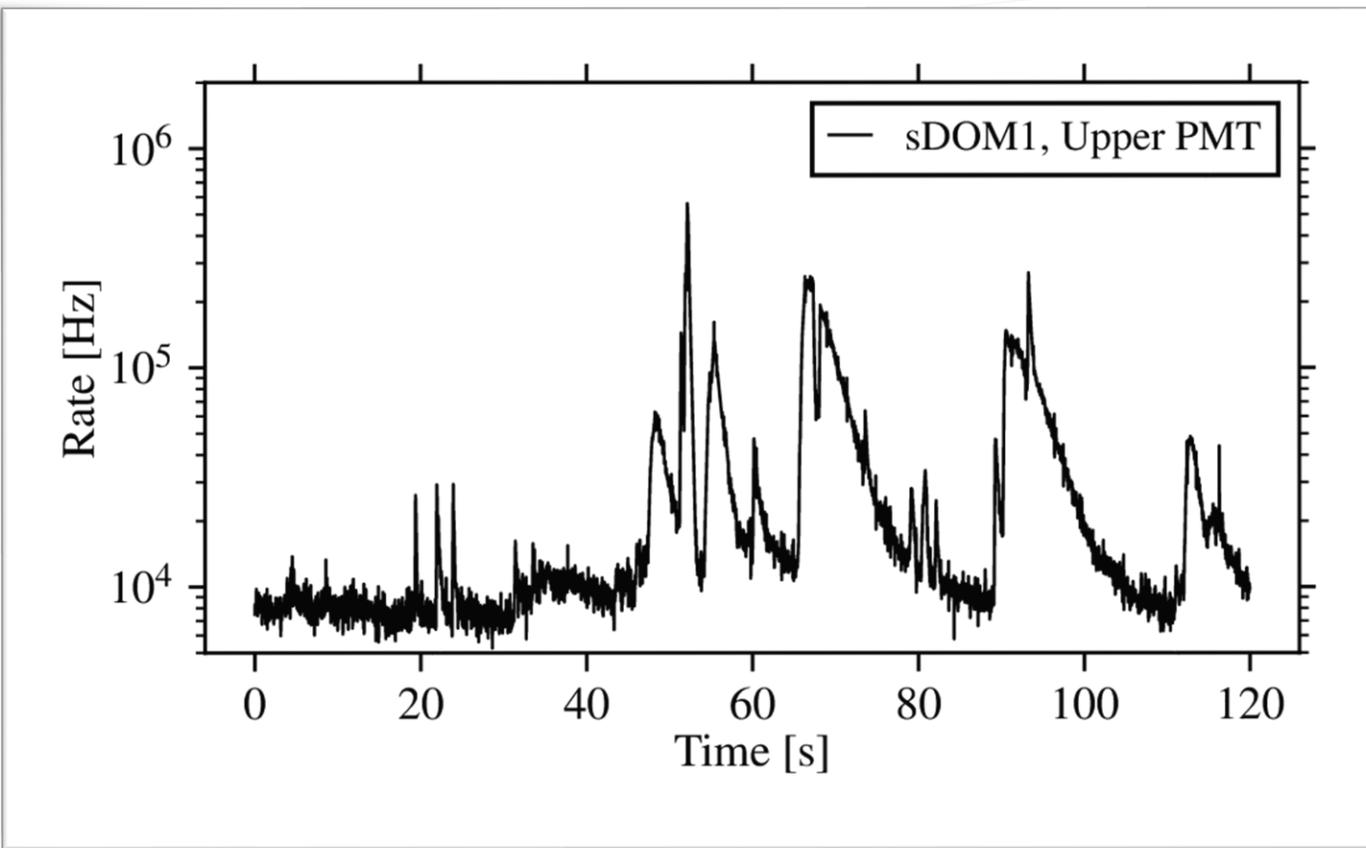


Image: K. Holzapfel

STRAW – 1st pathfinder mission



STRAW, Cascadia Basin, this Work

KM3NeT, AC9, G. Riccobene et al., *Astropart. Phys.*, 2007

KM3NeT, LAMS, E.G. Anassontzis et al., *NIM A*, 2008

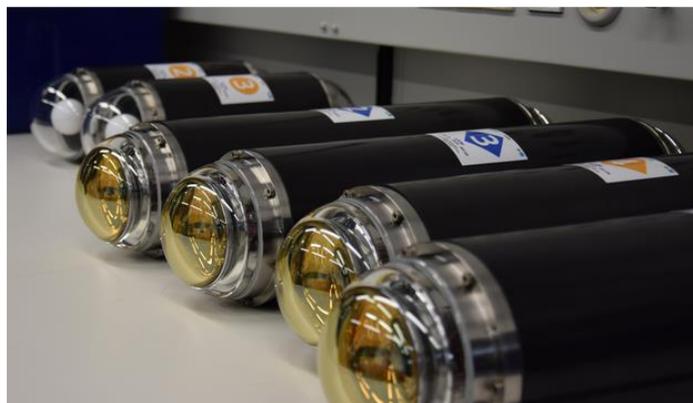
Lake Baikal, V. Balkanov et al., *Applied Optics*, 1999

"clearest natural water" Smith & Baker, *Applied Optics*, 1981

Background at Cascadia Basin

- Baseline component (few kHz)
 - K40 decay
 - Diffuse bioluminescence
- Bioluminescence bursts (MHz)

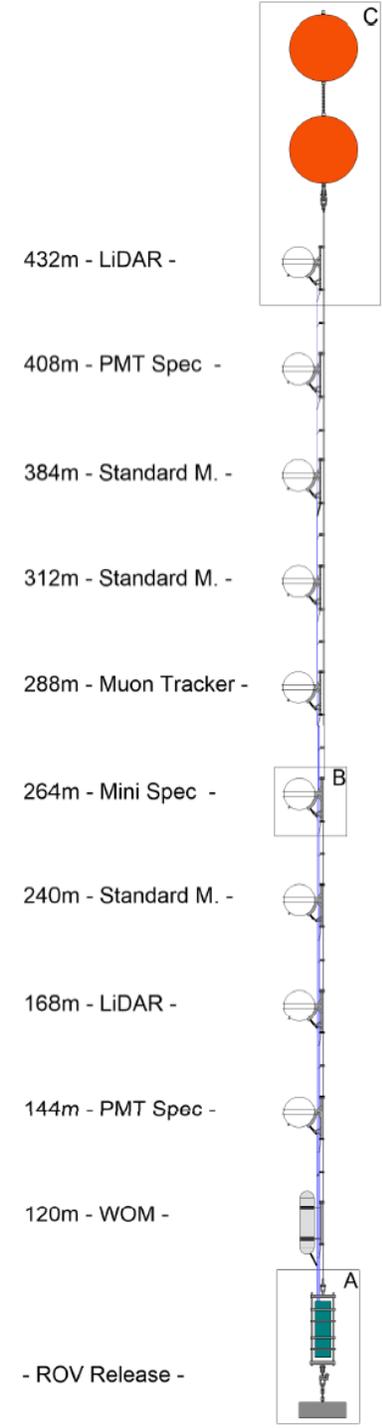
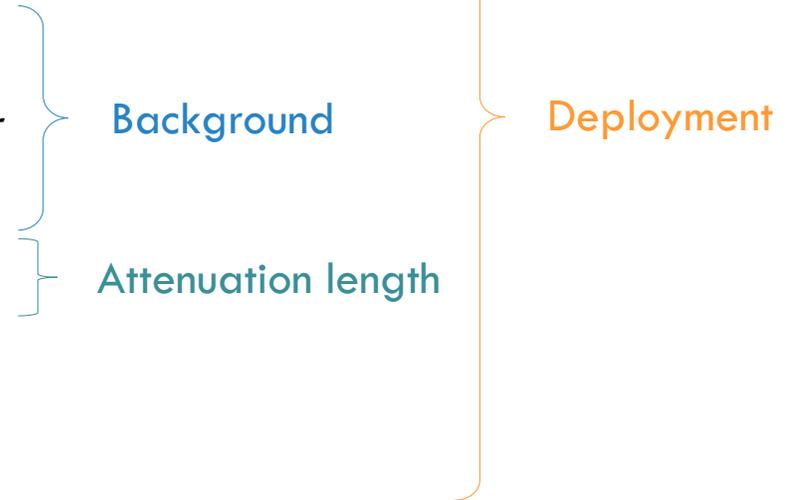
Image: K. Holzapfel

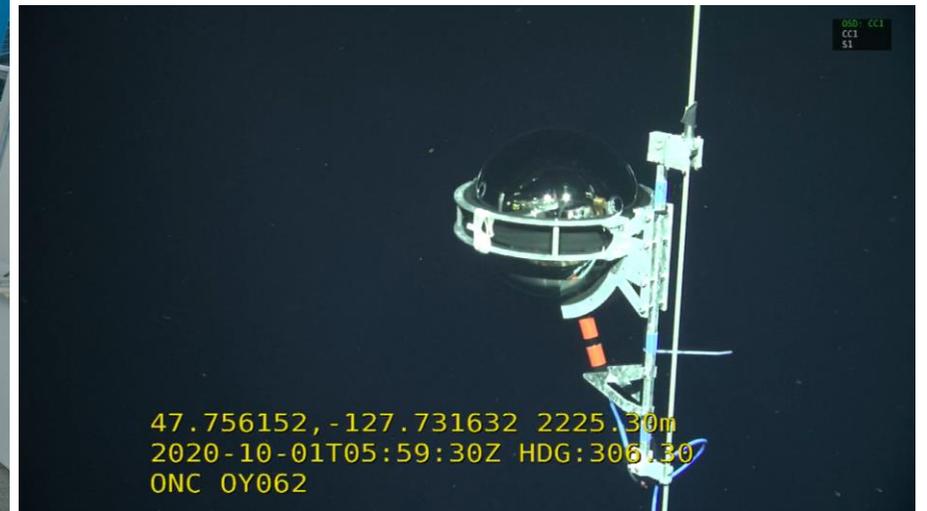
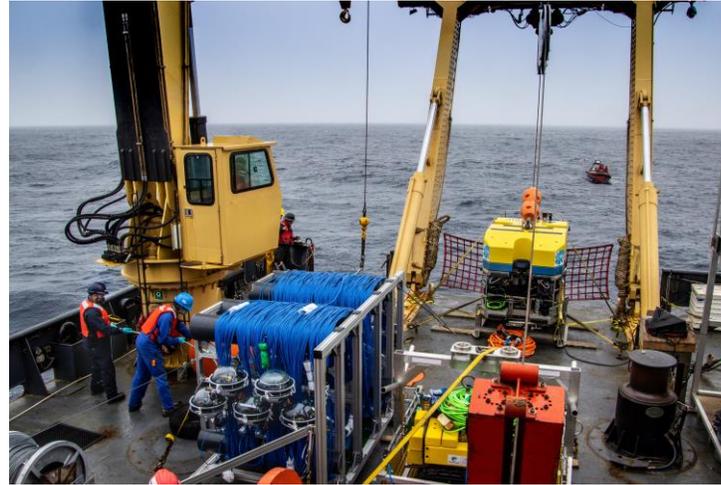


Images: ONC, TUM

STRAW-b – 2nd pathfinder mission

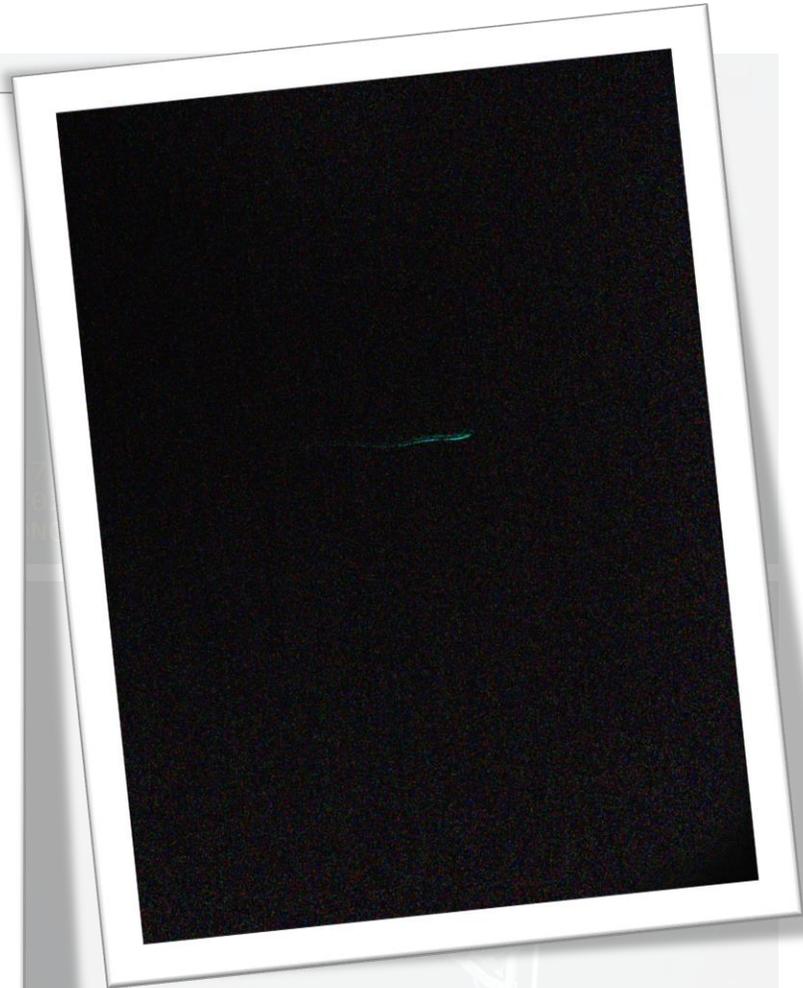
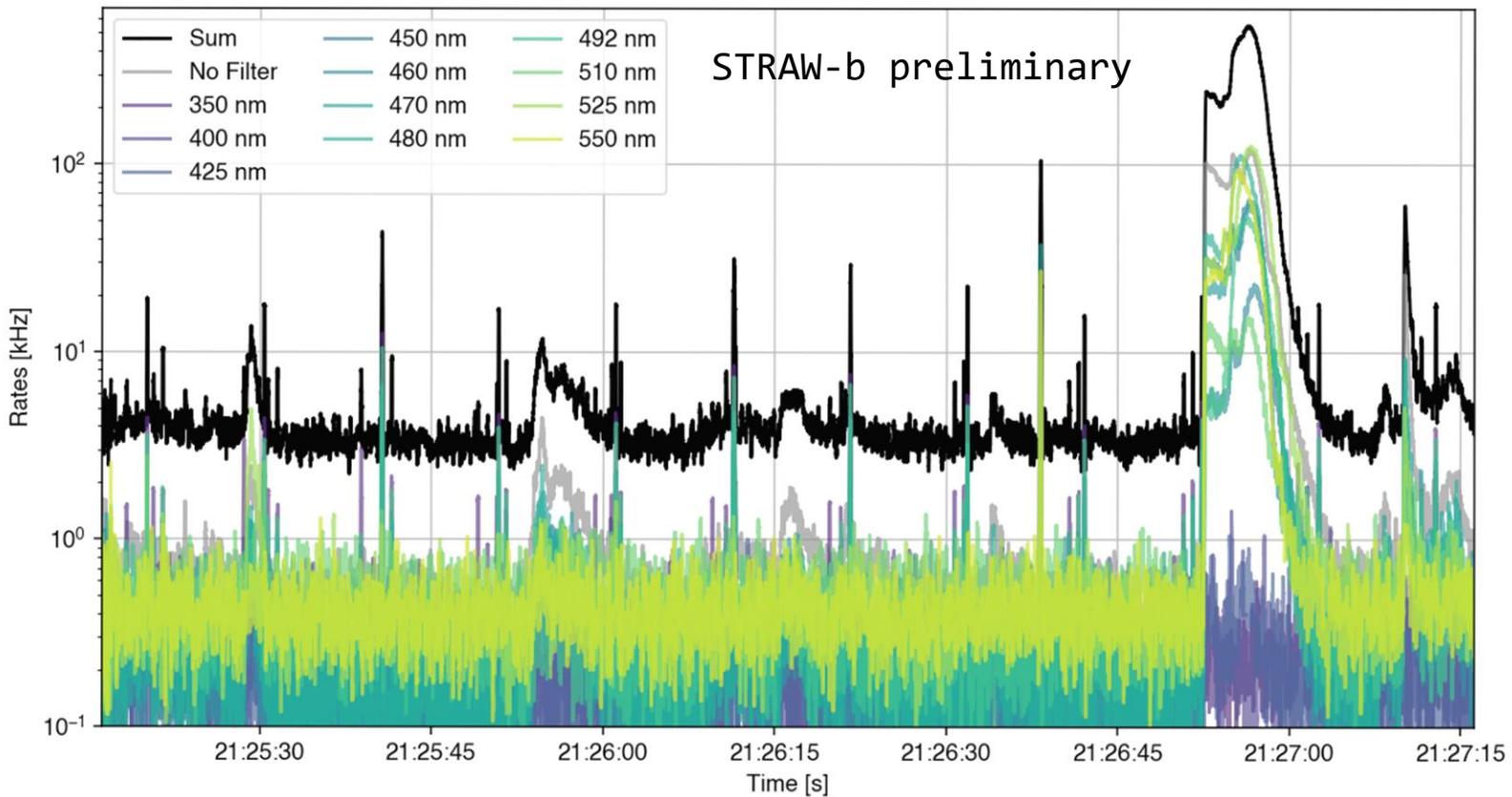
- R&D for P-ONE, further background characterisation, verification of attenuation length
- 3 standard modules with p/T/H ping signal
- 7 specialized modules
 - 2x PMT spectrometers
 - Stand-alone spectrometer
 - Muon Tracker
 - 2x LiDARs
 - External module - WOM





STRAW-b successfully deployed on 27th Sept. 2020, data analysis ongoing

Images: ONC, TUM



STRAW-b successfully deployed on 27th Sept. 2020, data analysis ongoing

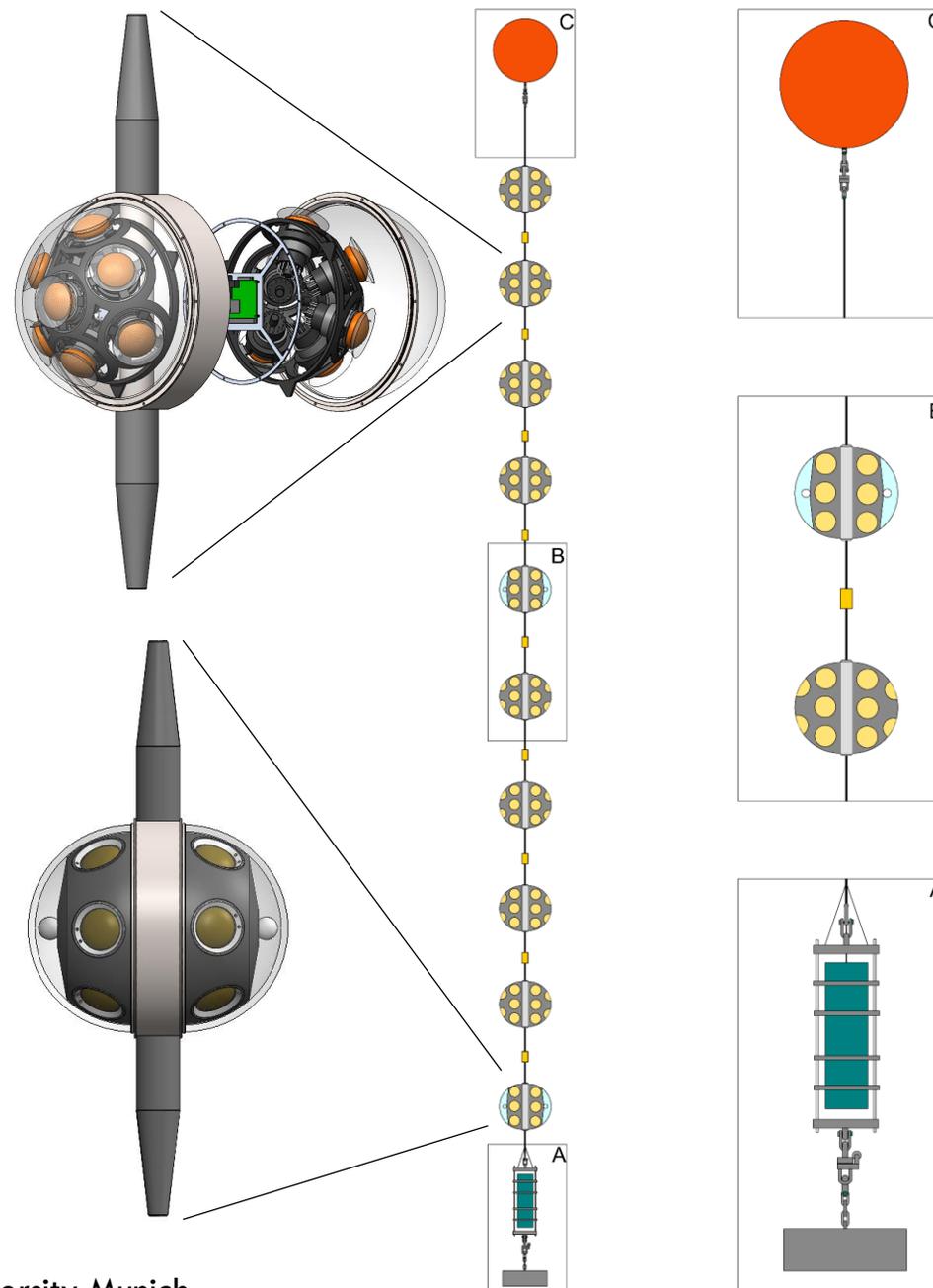
Images: ONC, TUM

P-ONE – pilot phase (prototype line)

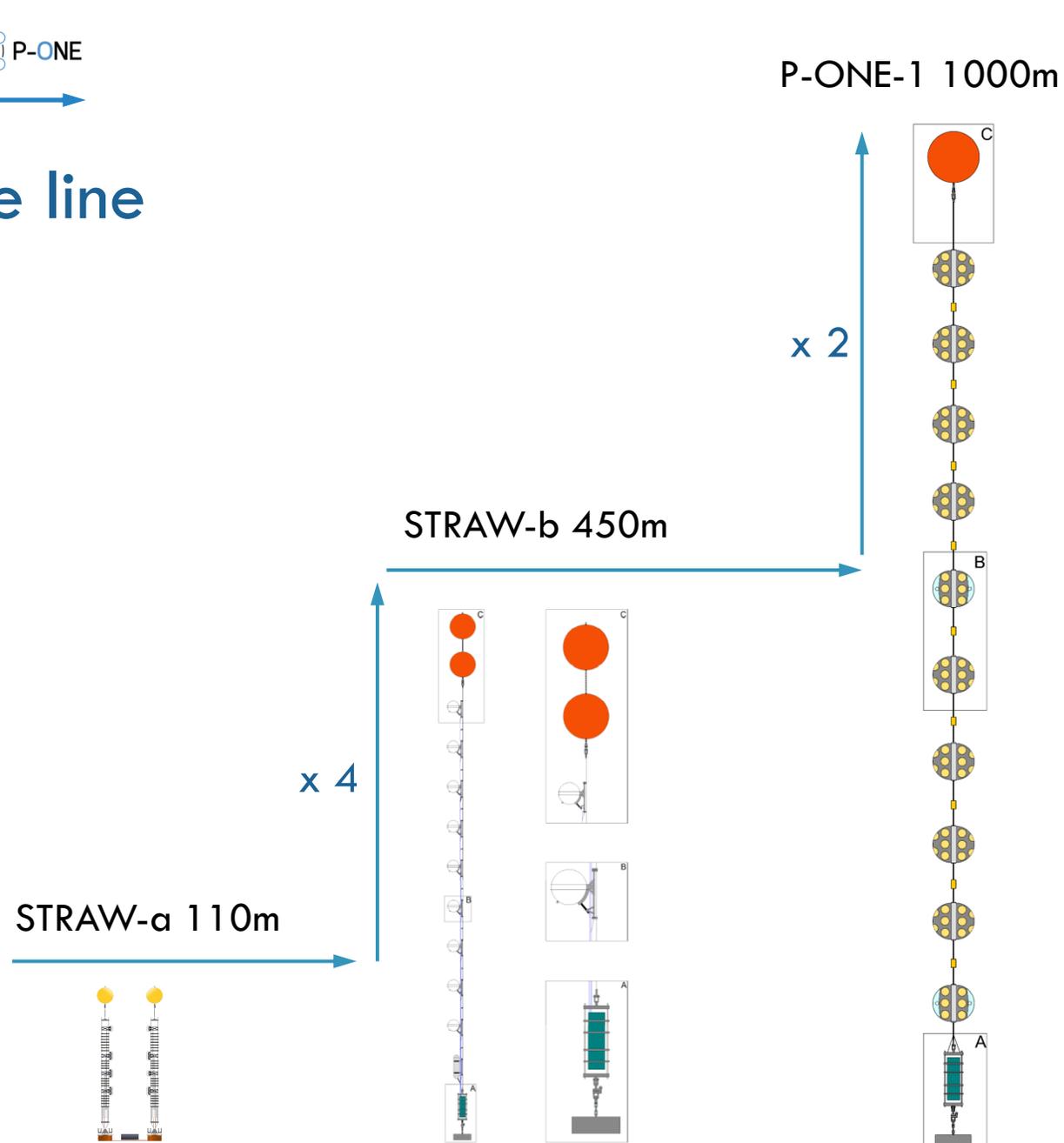
Please note: illustrations are preliminary studies!

P-ONE – prototype line

- 1st step of phase 2 for P-ONE
- **Objectives:**
 - 1) 1st line of P-ONE
 - 2) Proof of deployment concept (scalability)
 - 3) Optical and calibration module development
 - 4) Time synchronisation for mooring line (and full P-ONE)
 - 5) Collect as much data as possible (understand data stream



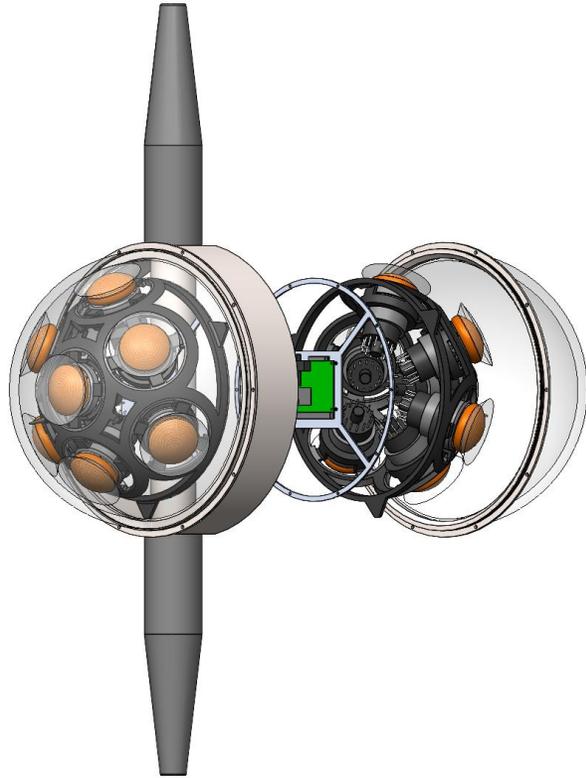
P-ONE – prototype line



Please note: illustrations are preliminary studies!

P-ONE – prototype line

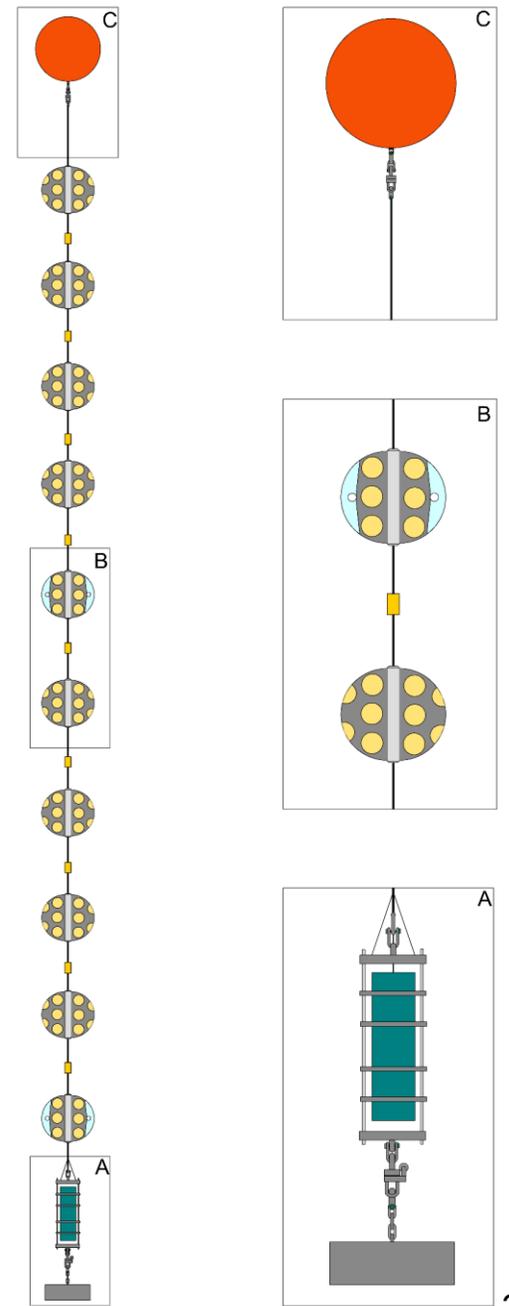
Please note: illustrations are preliminary studies!



Optical Module | In development | 16 pcs



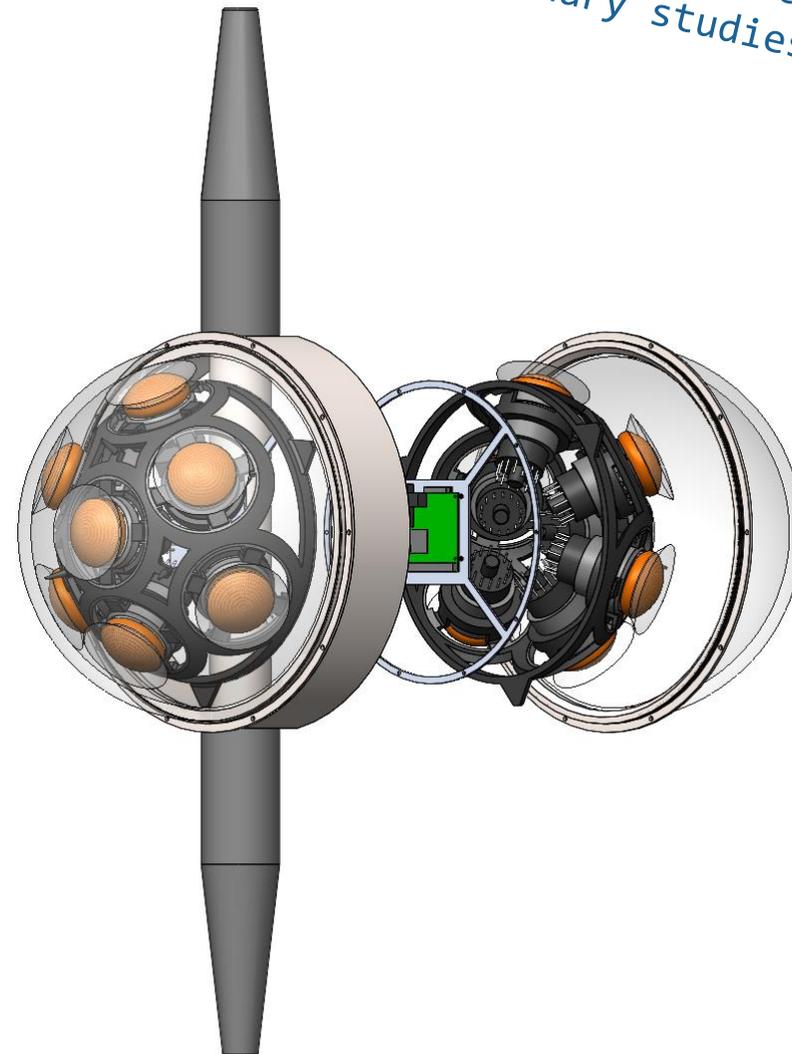
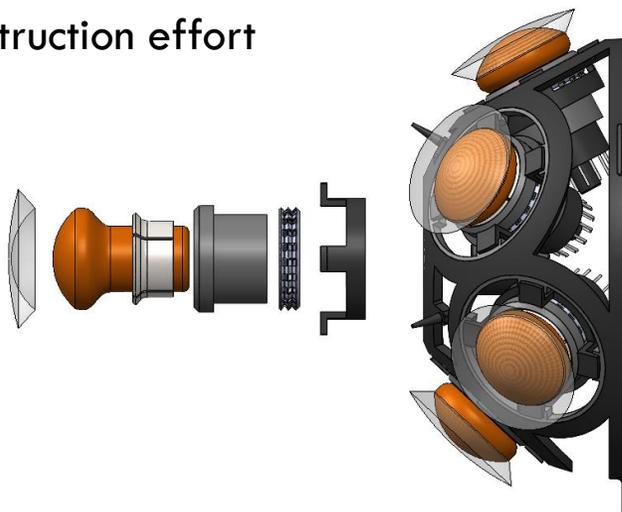
Calibration Module | Adapted POCAM | 4 pcs





P-ONE – optical module

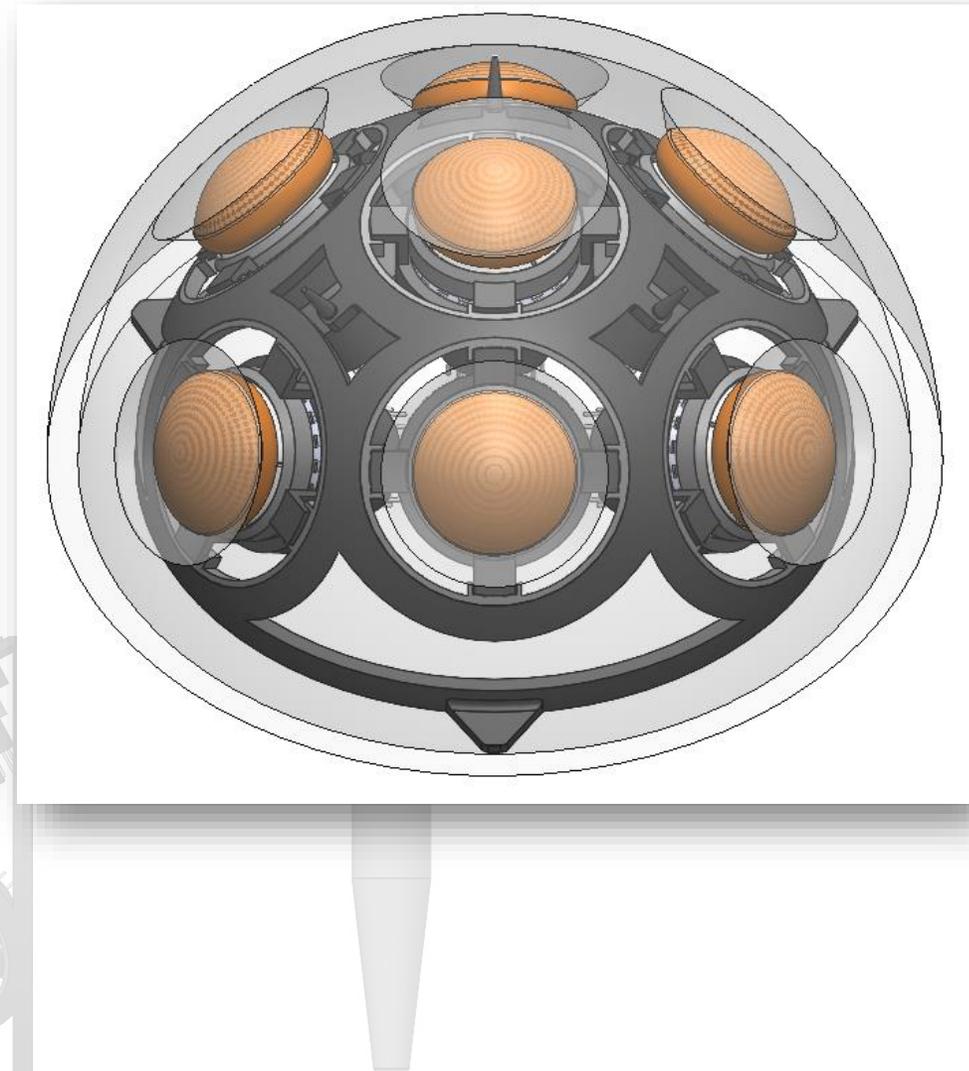
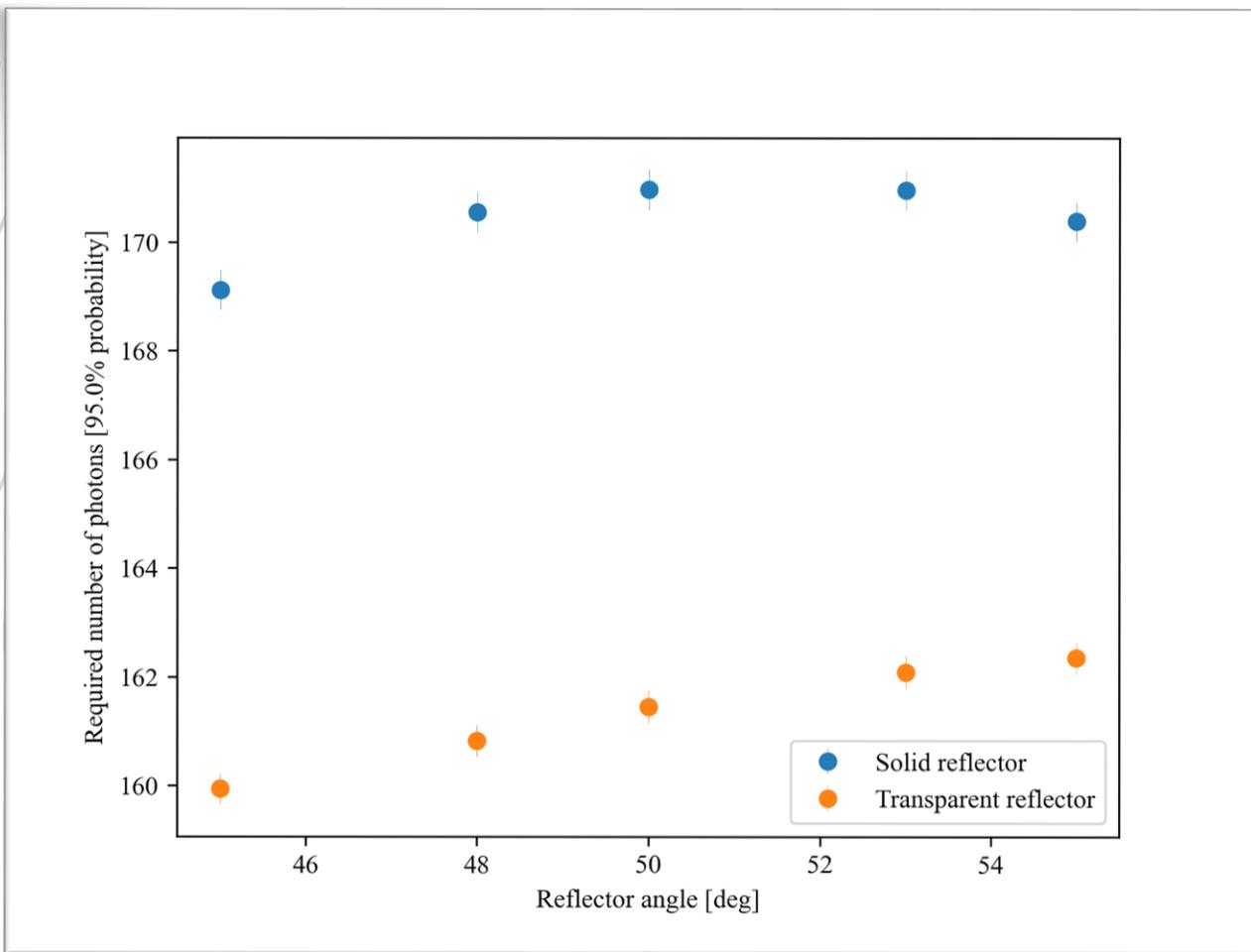
- Photomultiplier tube (PMT) selection in full progress
- Multi-PMT approach
 - Biological processes are slow(er)
 - Suppression of background by requiring coincidence hits on PMTs (ns scale)
- Modular mounting structure to ease construction effort
- Electronics development in progress



Please note: illustrations are preliminary studies!

Please note: illustrations are preliminary studies!

P-ONE – optical module





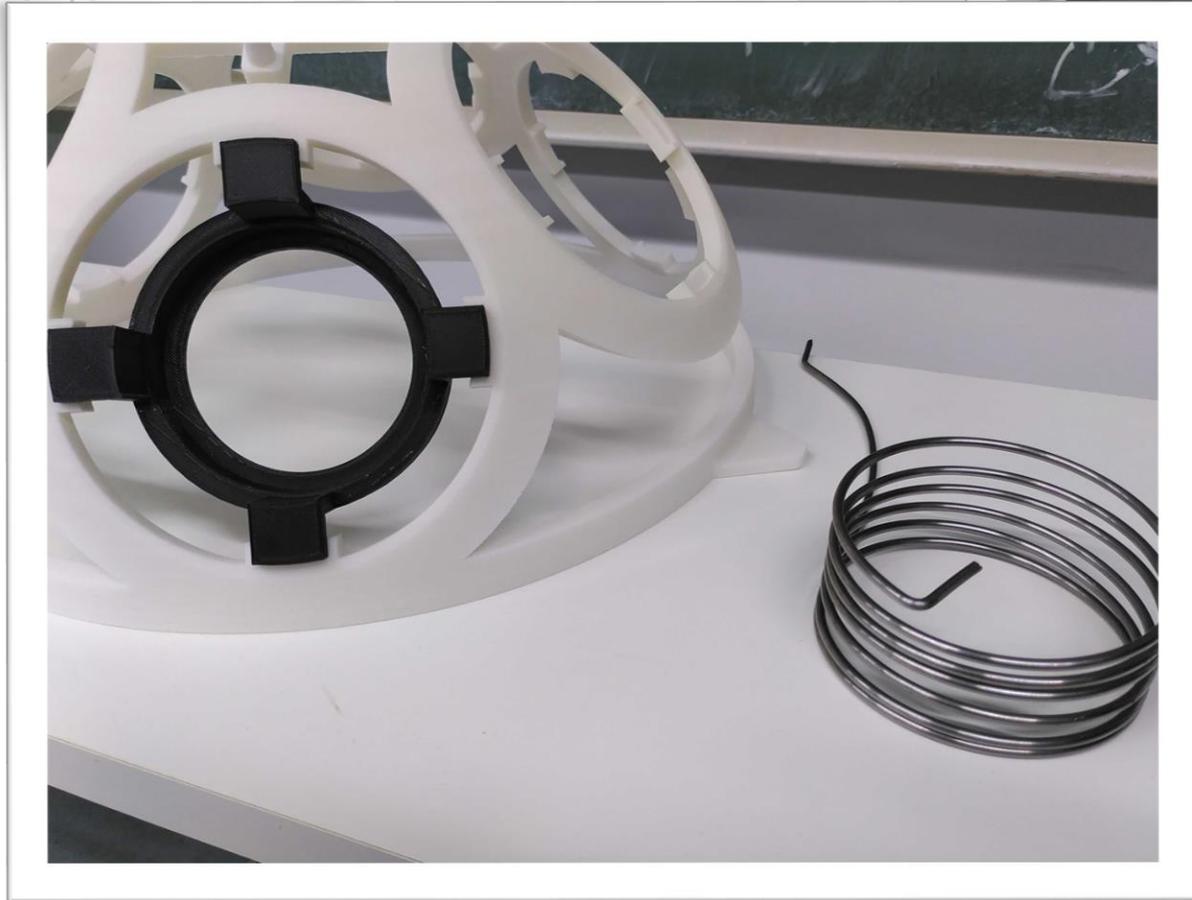
P-ONE – optical module

- P
- M
- M
- E



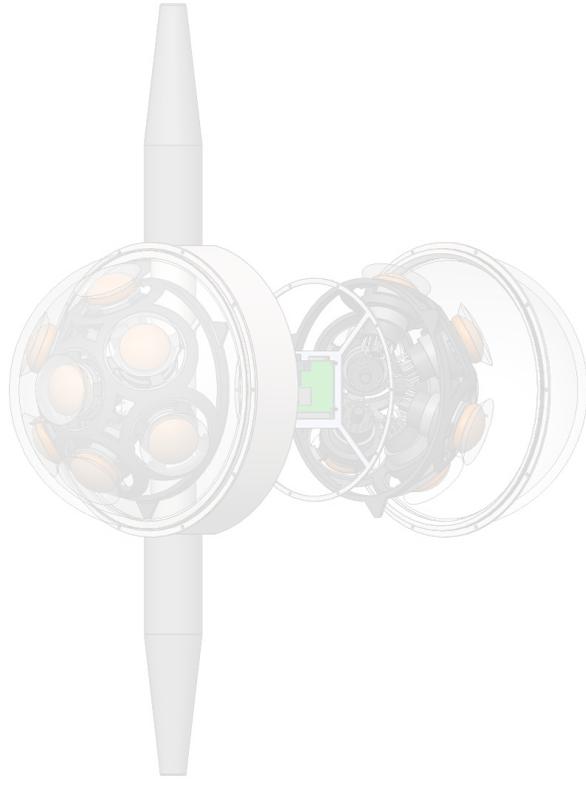


P-ONE – optical module

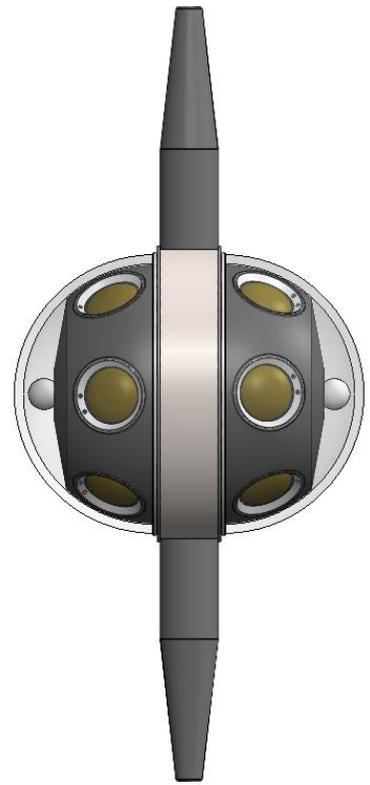


P-ONE – prototype line

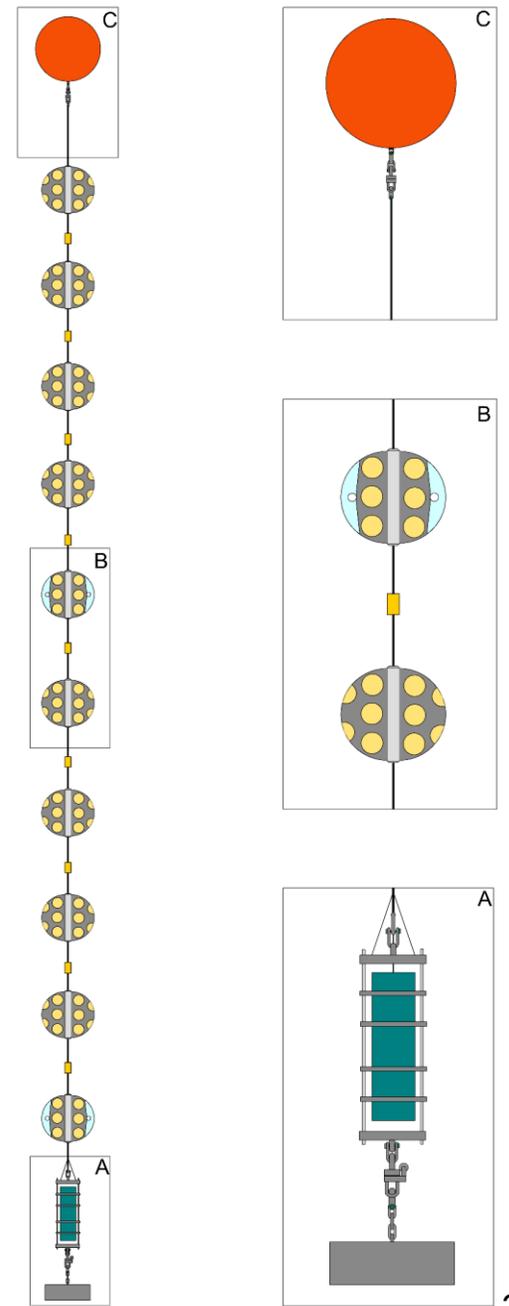
Please note: illustrations are preliminary studies!



Optical Module | In development | 16 pcs

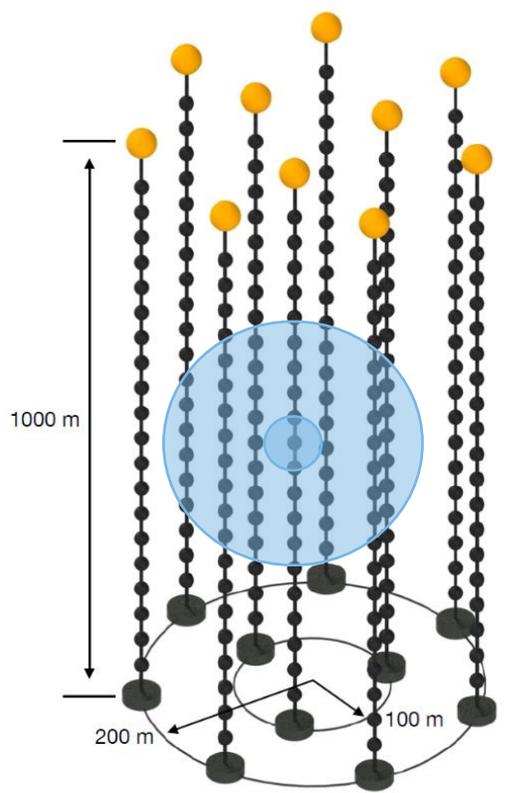
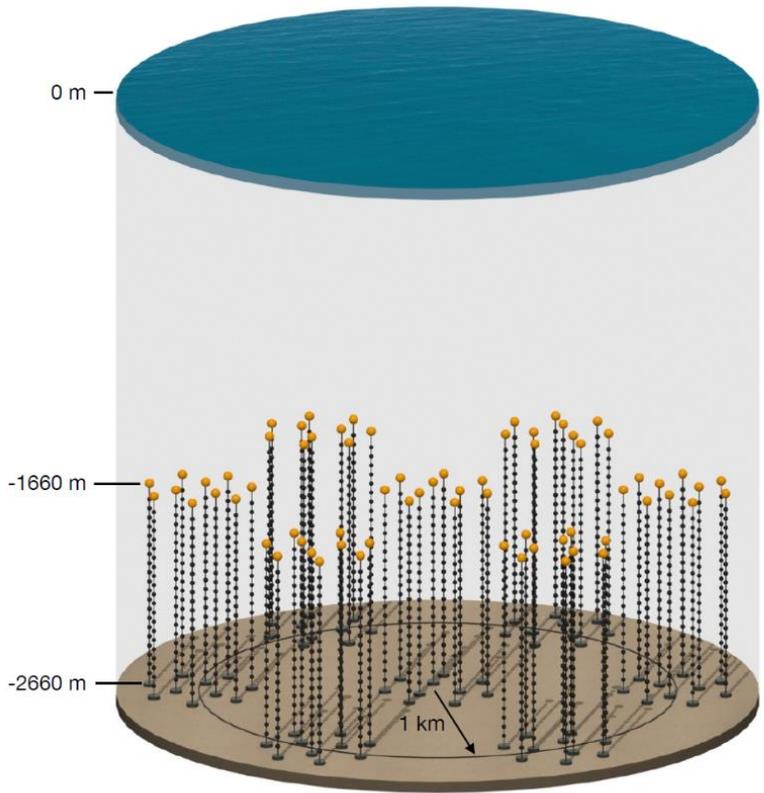


Calibration Module | Adapted POCAM | 4 pcs



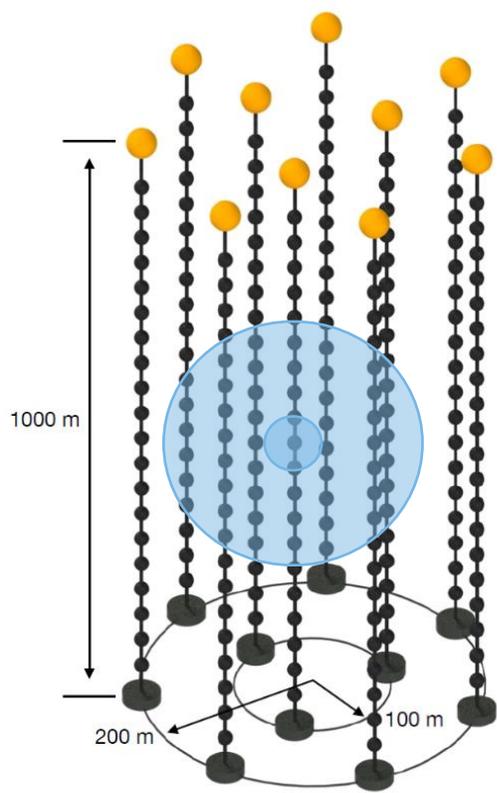
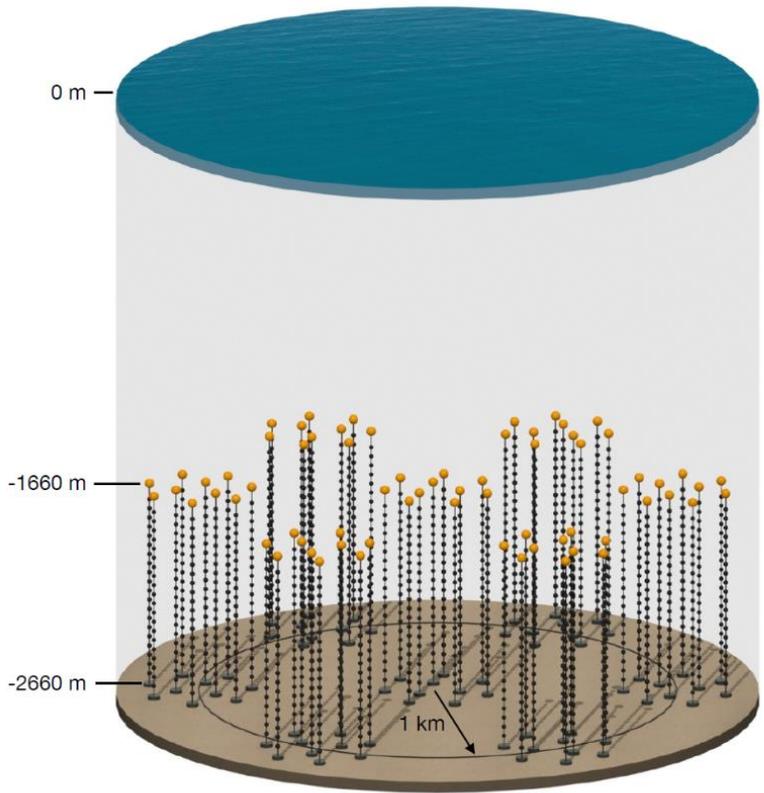
P-ONE – calibration module

Calibration in P-ONE is based on emission of a nano-second light pulse with know characteristics within detector volume.



P-ONE – calibration module

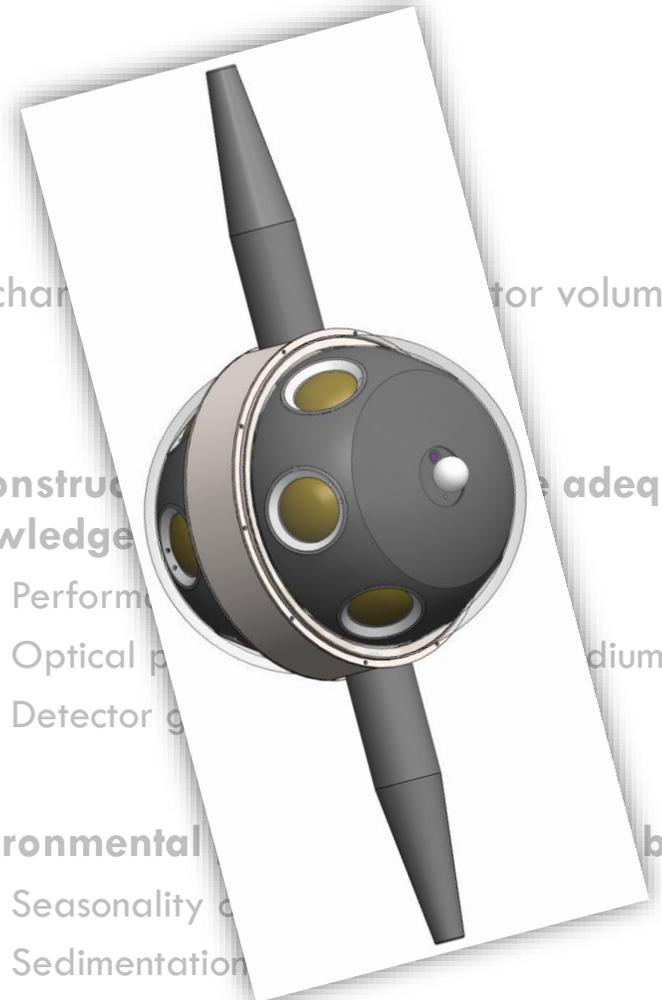
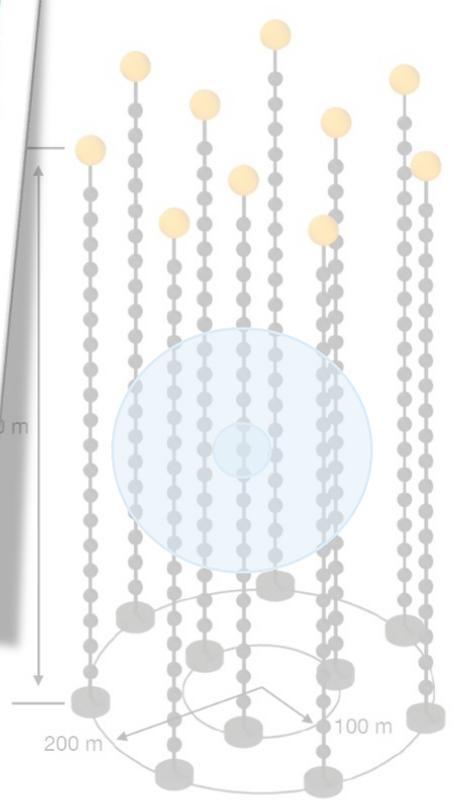
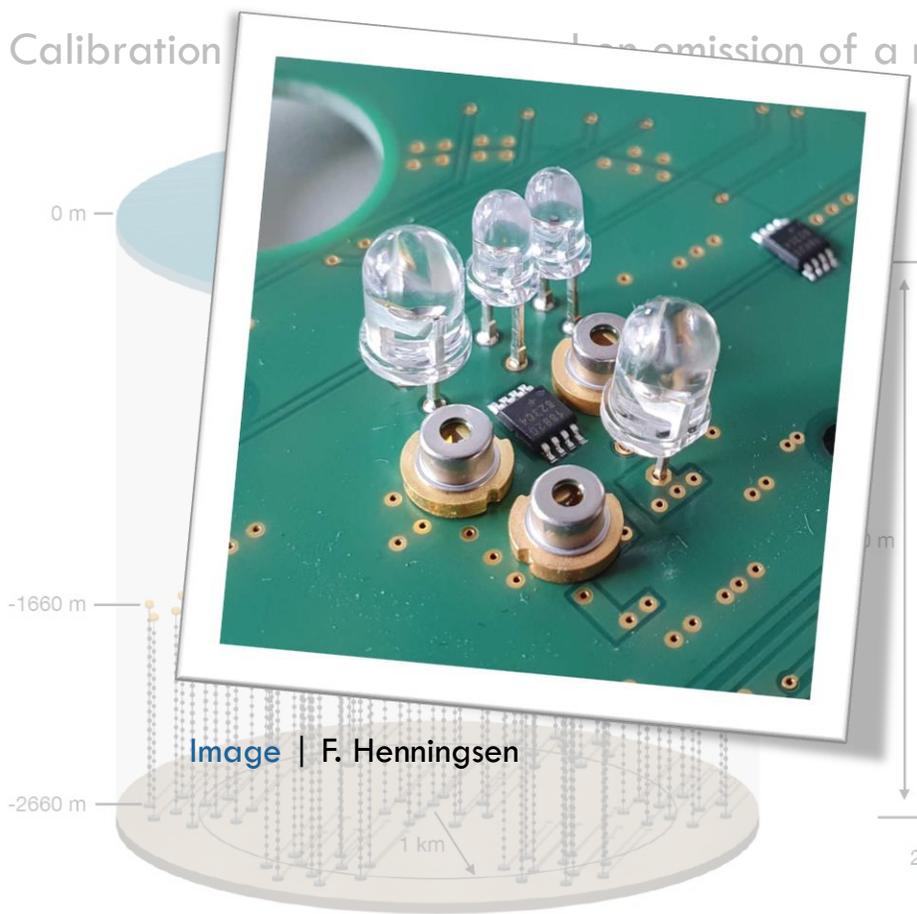
Calibration in P-ONE is based on emission of a nano-second light pulse with know characteristics within detector volume.



- **Reconstruction of events require adequate knowledge of detector**
 - Performance of optical modules
 - Optical properties of detector medium
 - Detector geometry

- **Environmental parameters influence behaviour**
 - Seasonality of bioluminescence
 - Sedimentation
 - Currents

P-ONE – calibration module



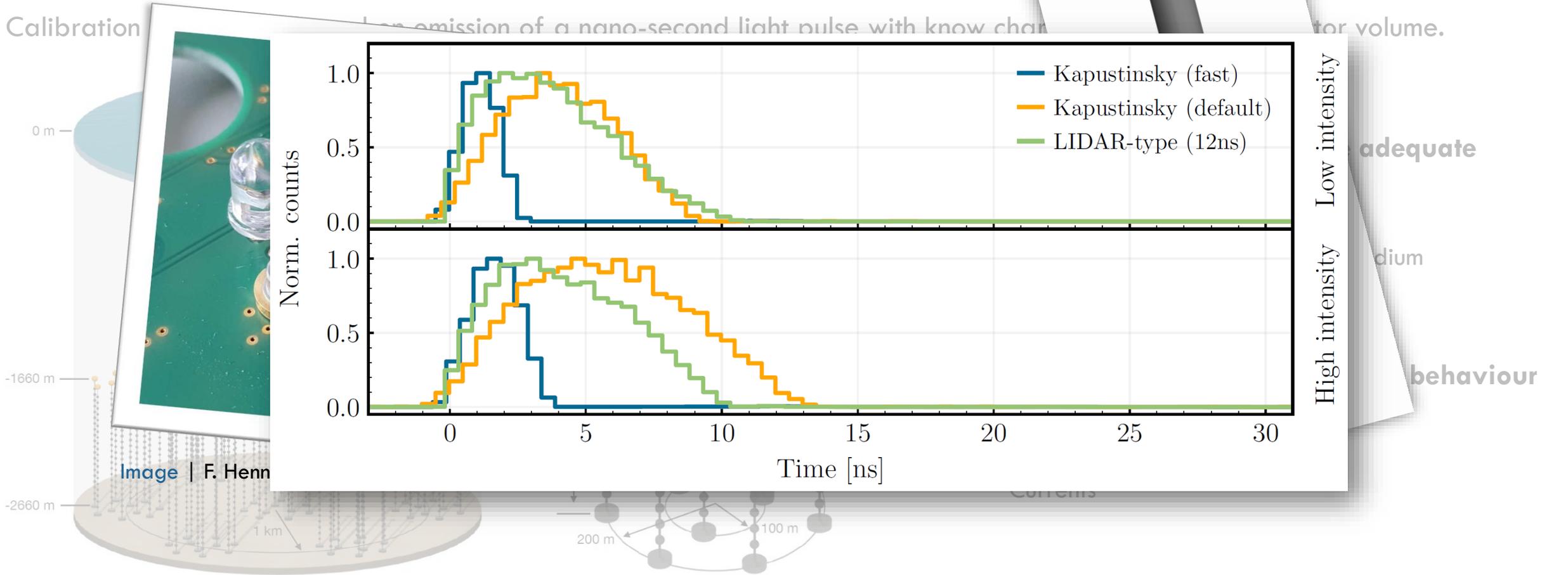
- **Reconstruction of adequate knowledge**
 - Performance
 - Optical properties of medium
 - Detector geometry
- **Environmental behaviour**
 - Seasonality of
 - Sedimentation
 - Currents

P-ONE – calibration module

Calibration

... emission of a nano-second light pulse with know char...

... for volume.



adequate

dium

behaviour

Thank you for the attention! There are many more involved!

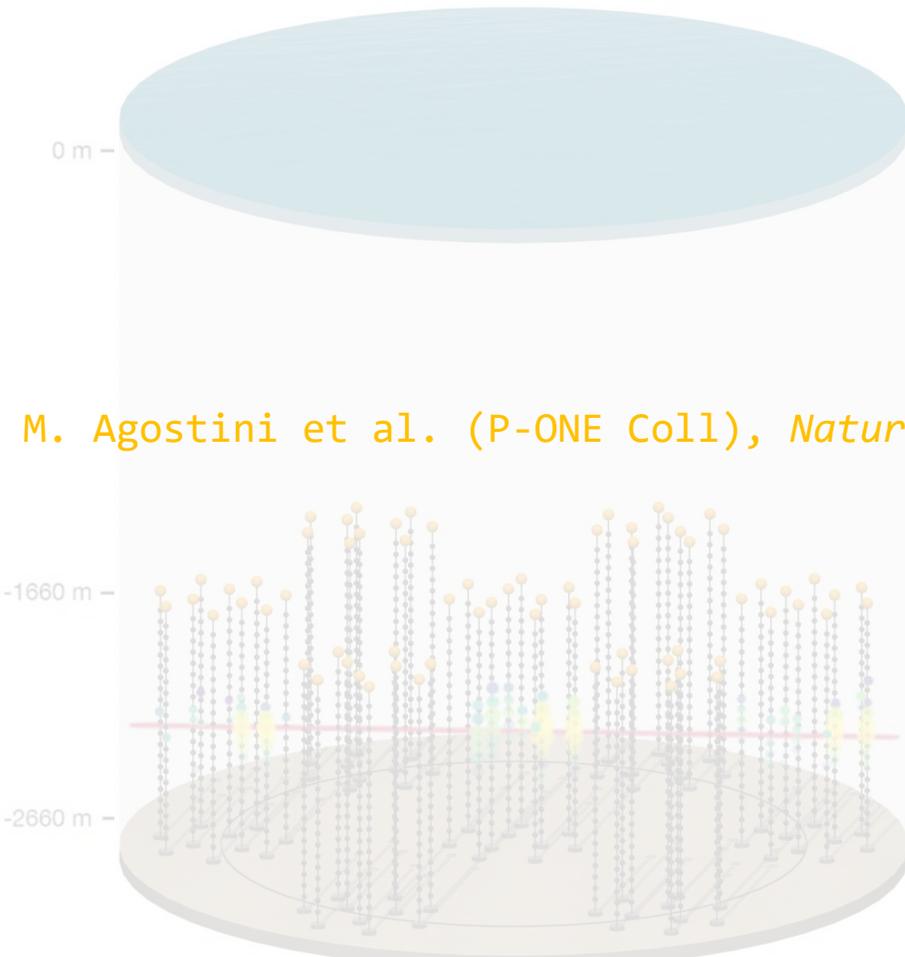


SFB 1258



Backup

P-ONE – detector overview



M. Agostini et al. (P-ONE Coll), *Nature Astronomy* (2020)

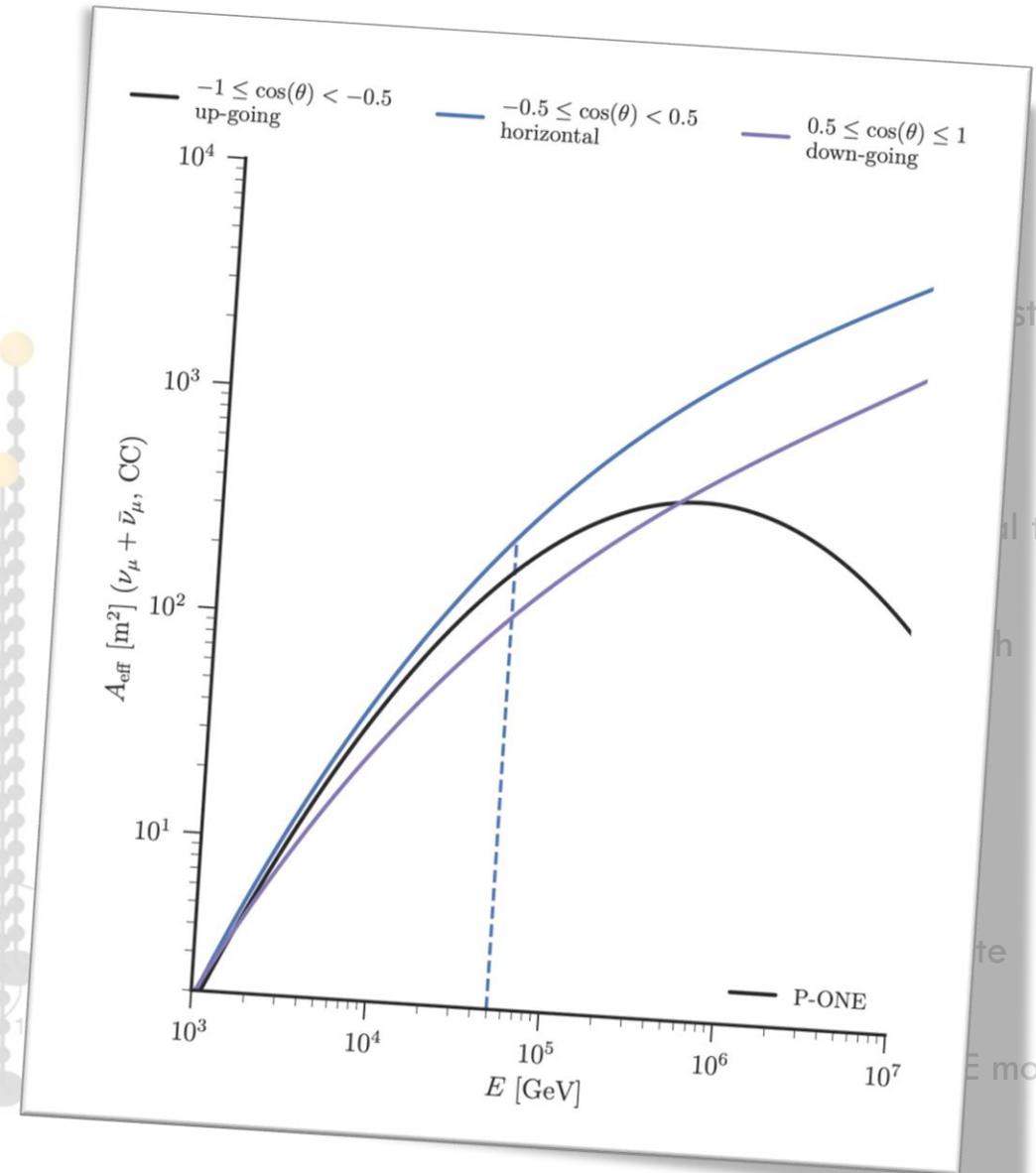
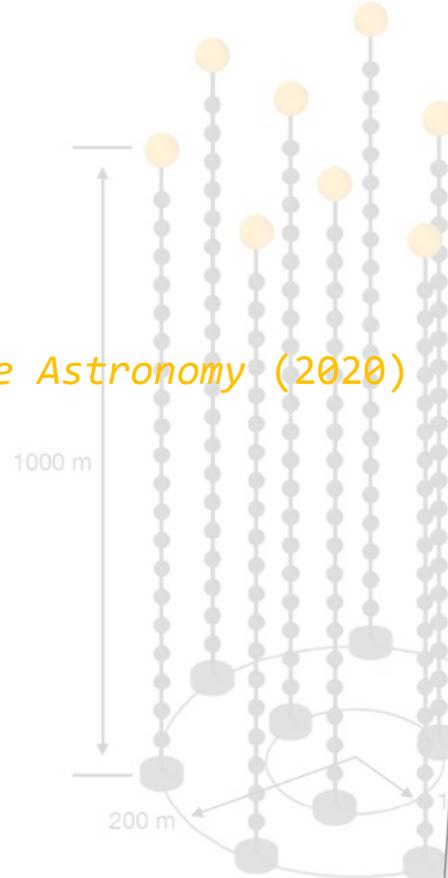


Image: K. Holzapfel

Bailly et al. (P-ONE Coll), *Two-Year Optical Site Characterization for the Pacific Ocean Neutrino Experiment (P-ONE) in the Cascadia Basin (2021)*

STRAW – 1st pathfinder mission

- Objective: Measure optical properties and
- Deployment
- Operation
- Concept
- 3x
- 5x s... measurement of incident light via 2 PMTs

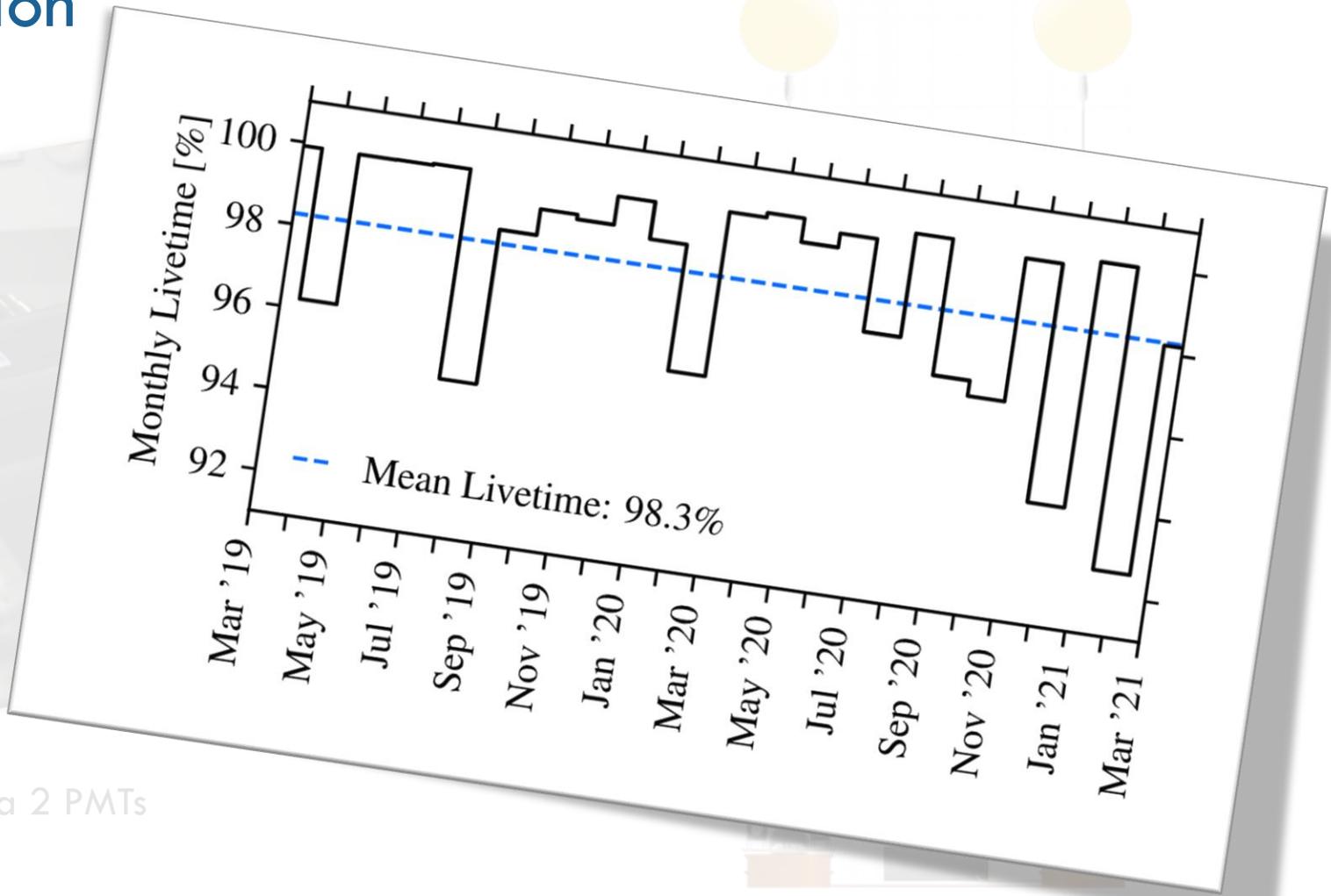
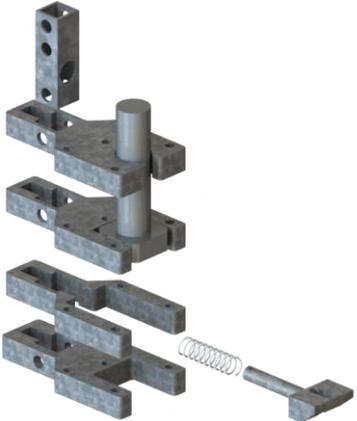
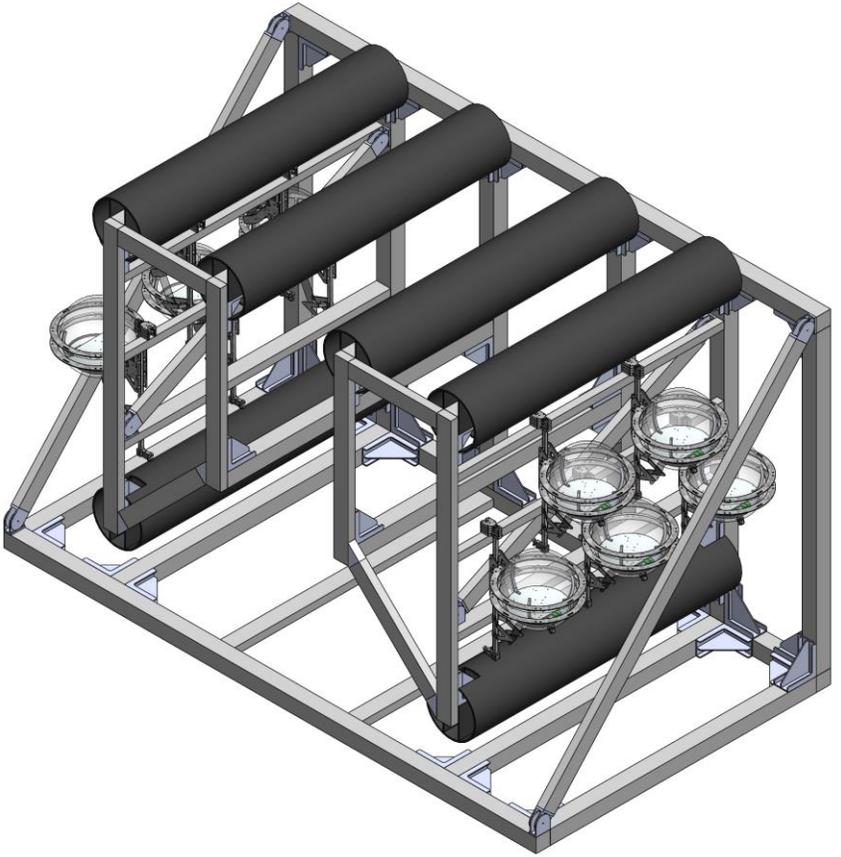


Image: K. Holzapfel

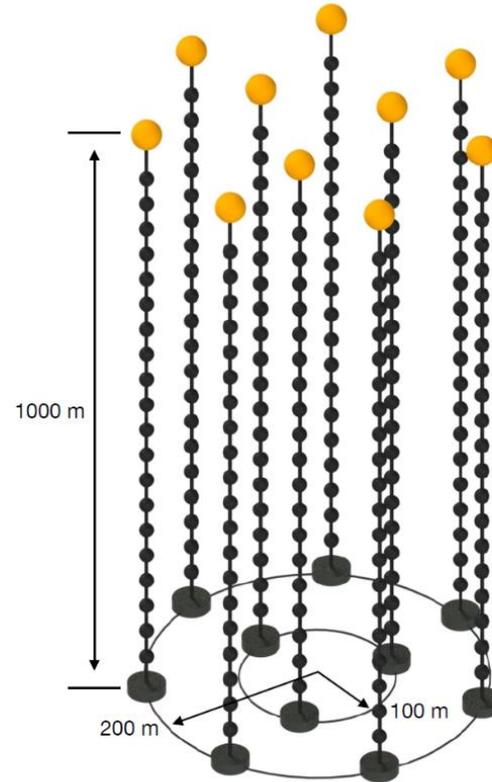
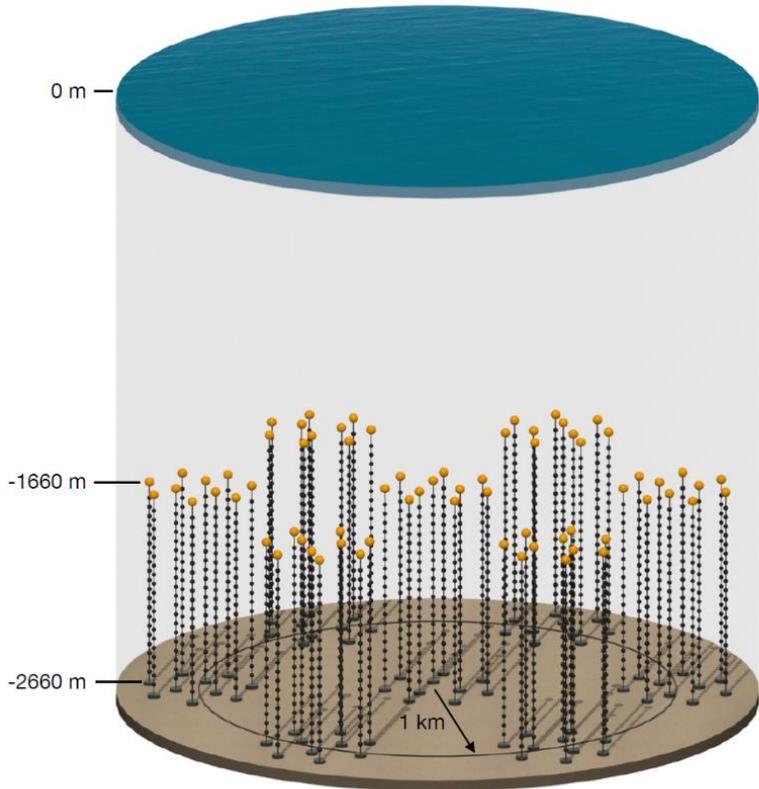


STRAW-b – instrument tray and module mechanics

- Instrument tray
 - Built from aluminum profiles (weight: 1 200kg (equipped))
 - 5 modules can be stored on each side
 - Communication cable (VEOC) is spooled in an eight
- Module mechanics
 - Protection of glass sphere via EPDM rubber layer
 - Click-in mechanism to merge with ferrules on wire rope



P-ONE – external temperature sensors



- External temperature sensors are planned to be incorporated on every module
- Depth-profiling of temperature
 - 1000km height
 - Long-term study (15+ a)



P-ONE – external temperature sensors

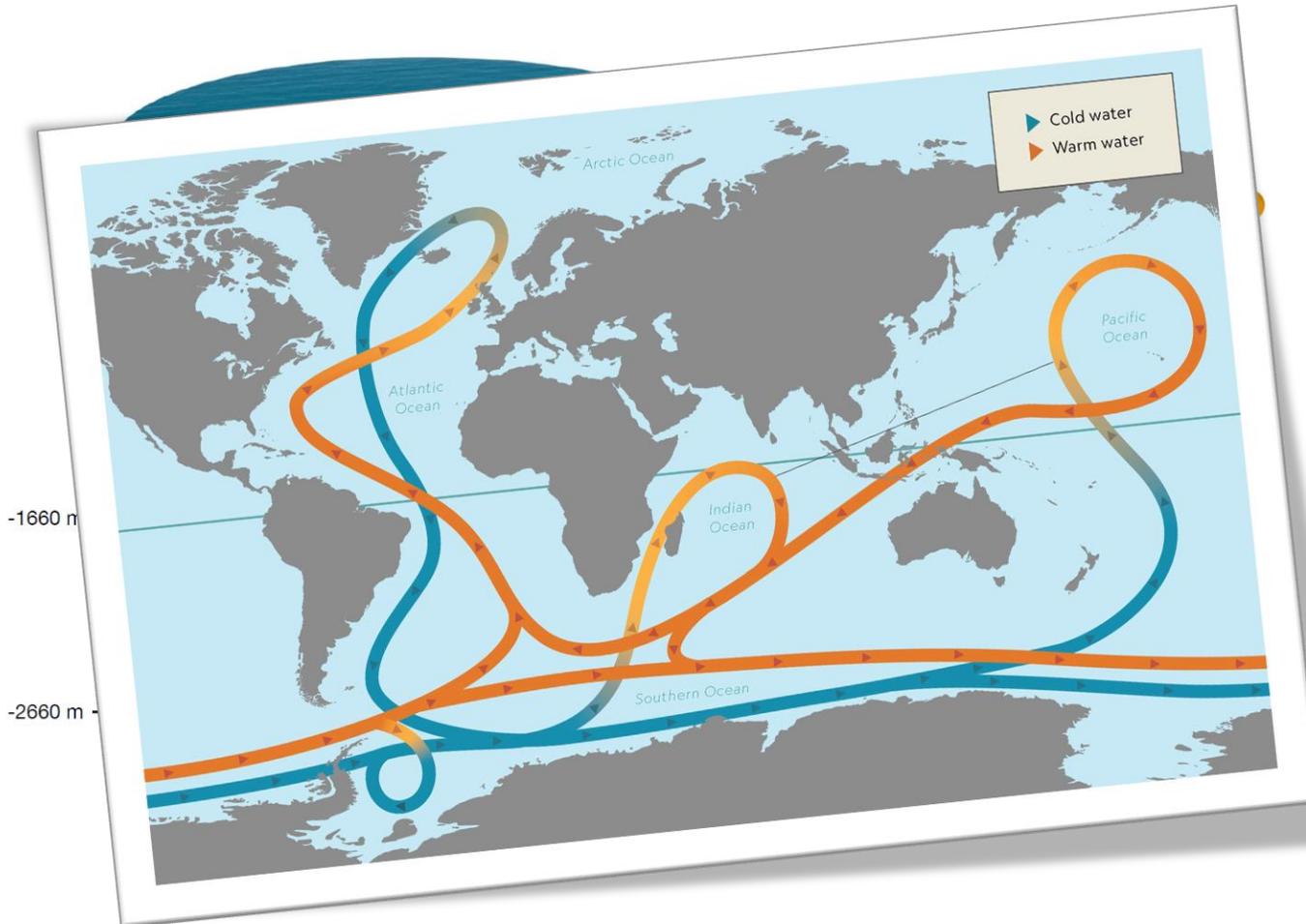


Image | Nat. Geography

- External temperature sensors are planned to be incorporated on every module
- Depth-profiling of temperature
 - 1000km height
 - Long-term study (15+ a)
- **What do we need to know?**

