

Pacific Ocean Neutrino Experiment

Towards the first detector lines

Felix Henningsen for the P-ONE Collaboration

July 18, 2023



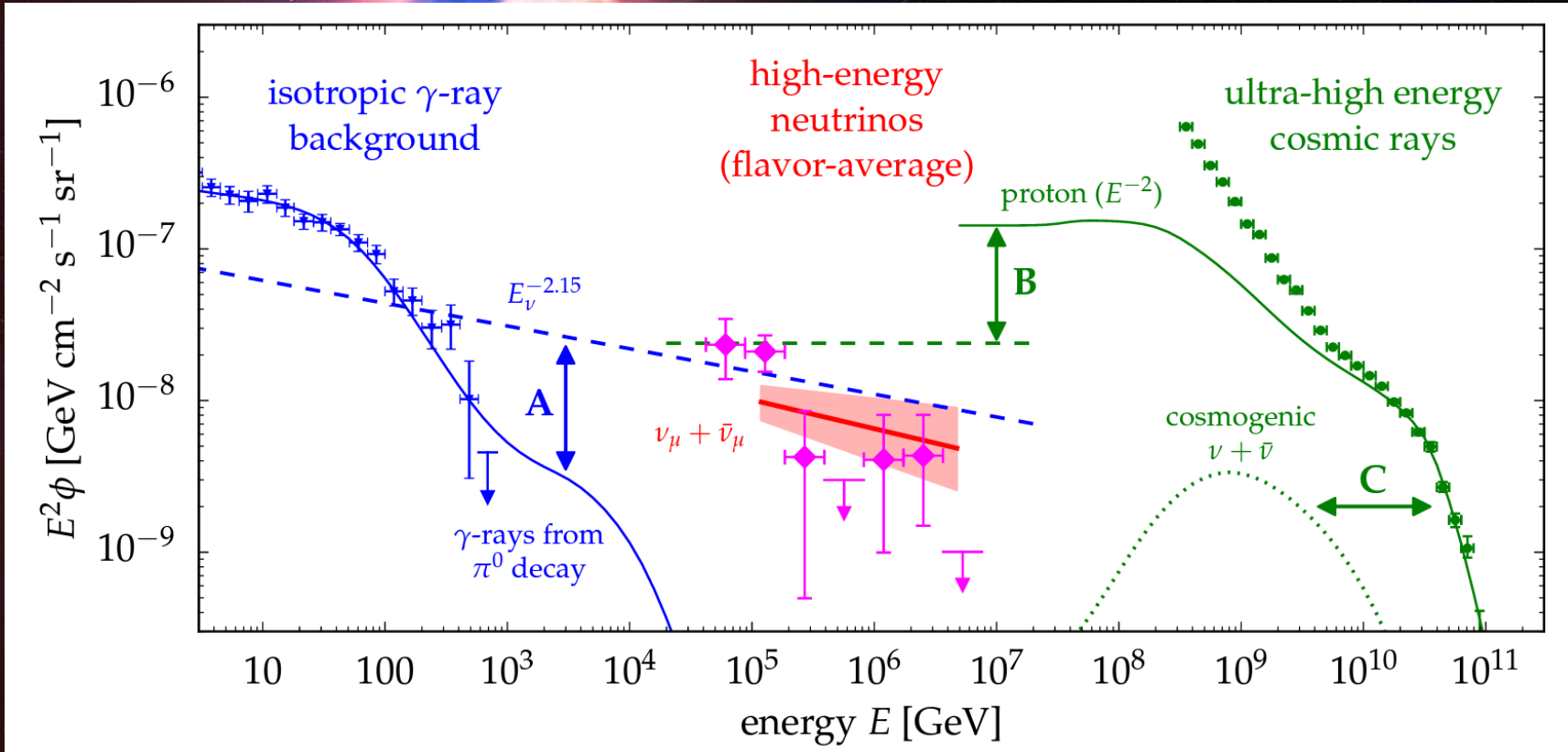
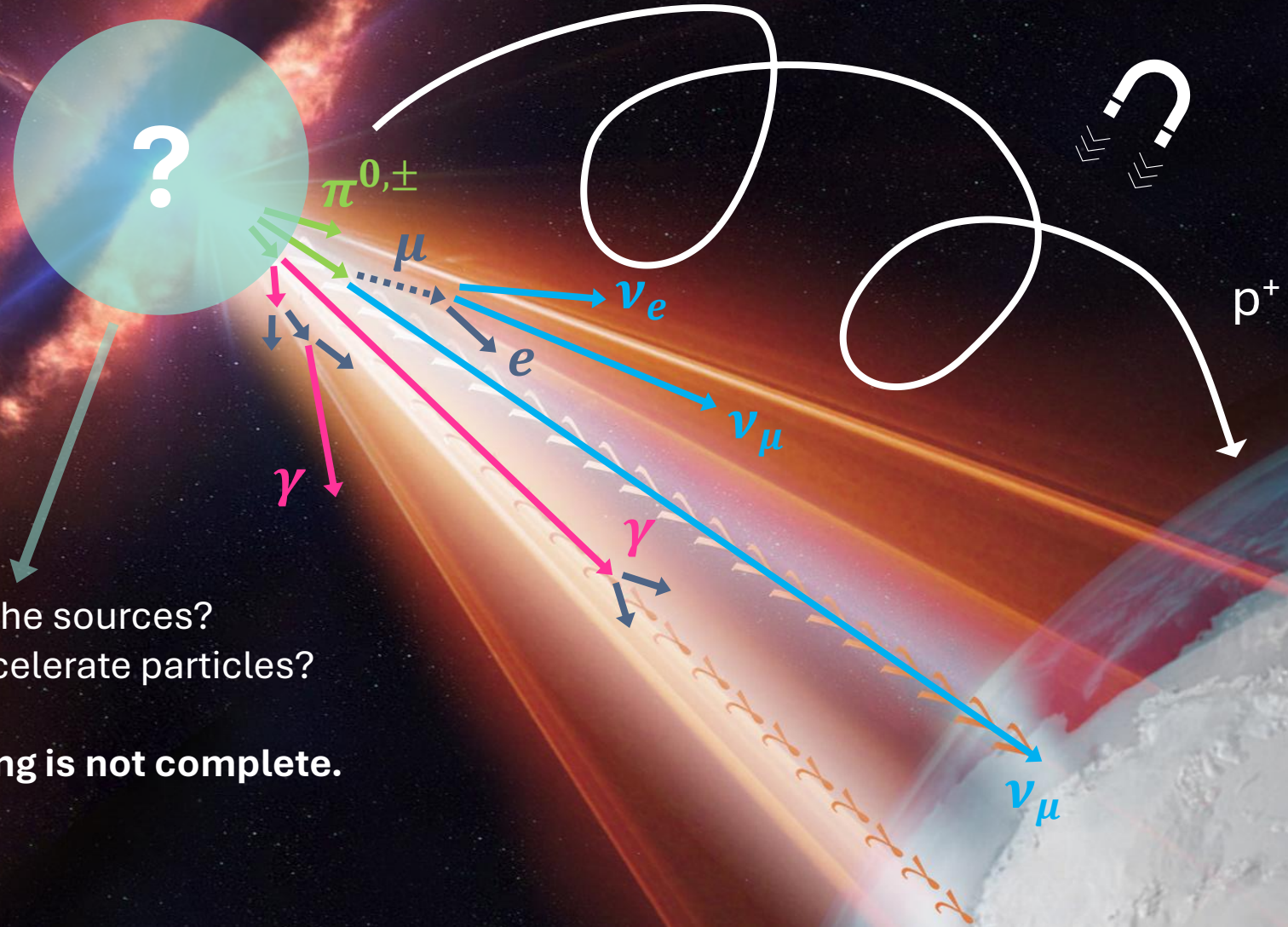


Image arXiv:1903.04334

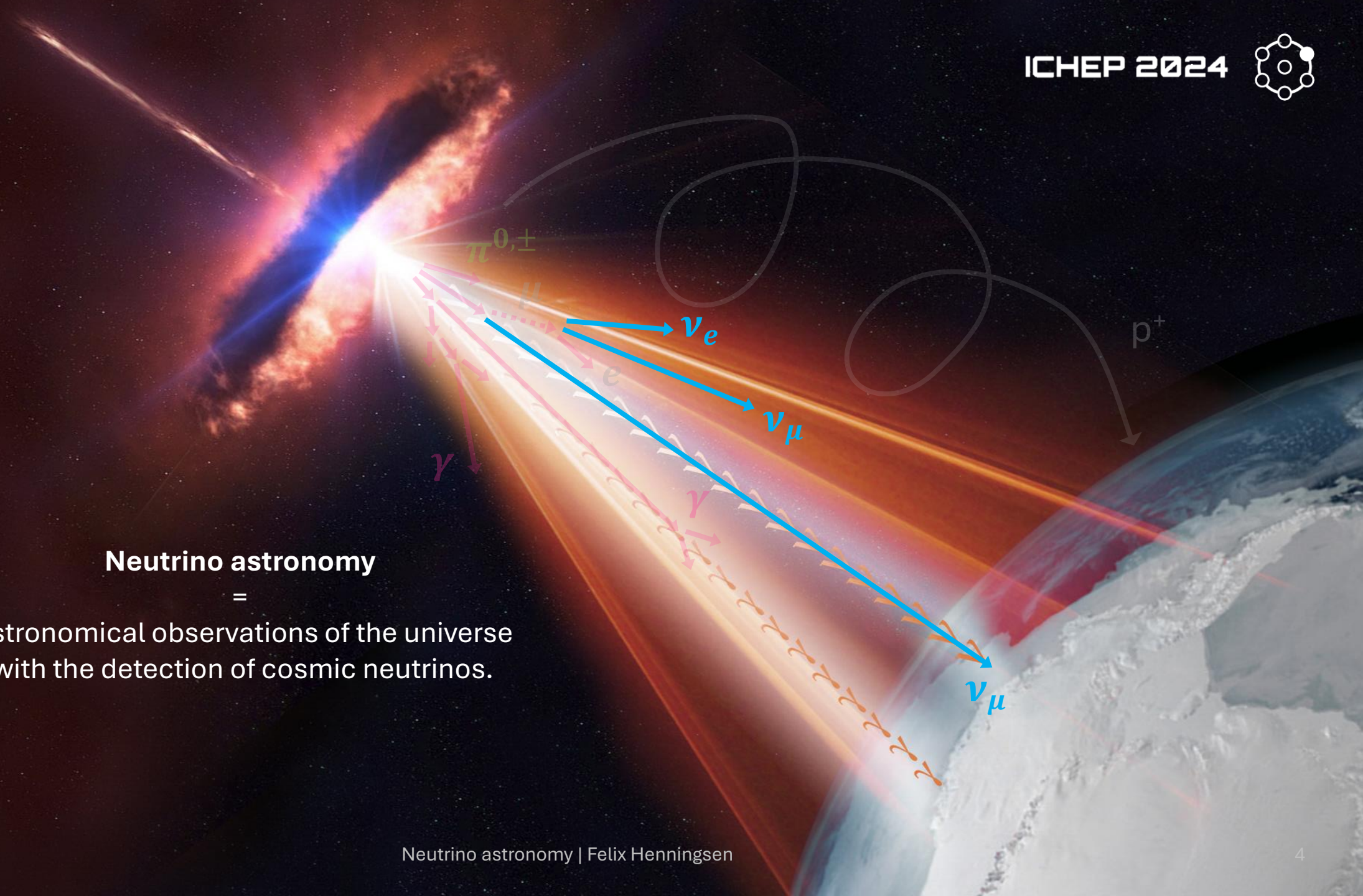


What are the sources?
How do they accelerate particles?

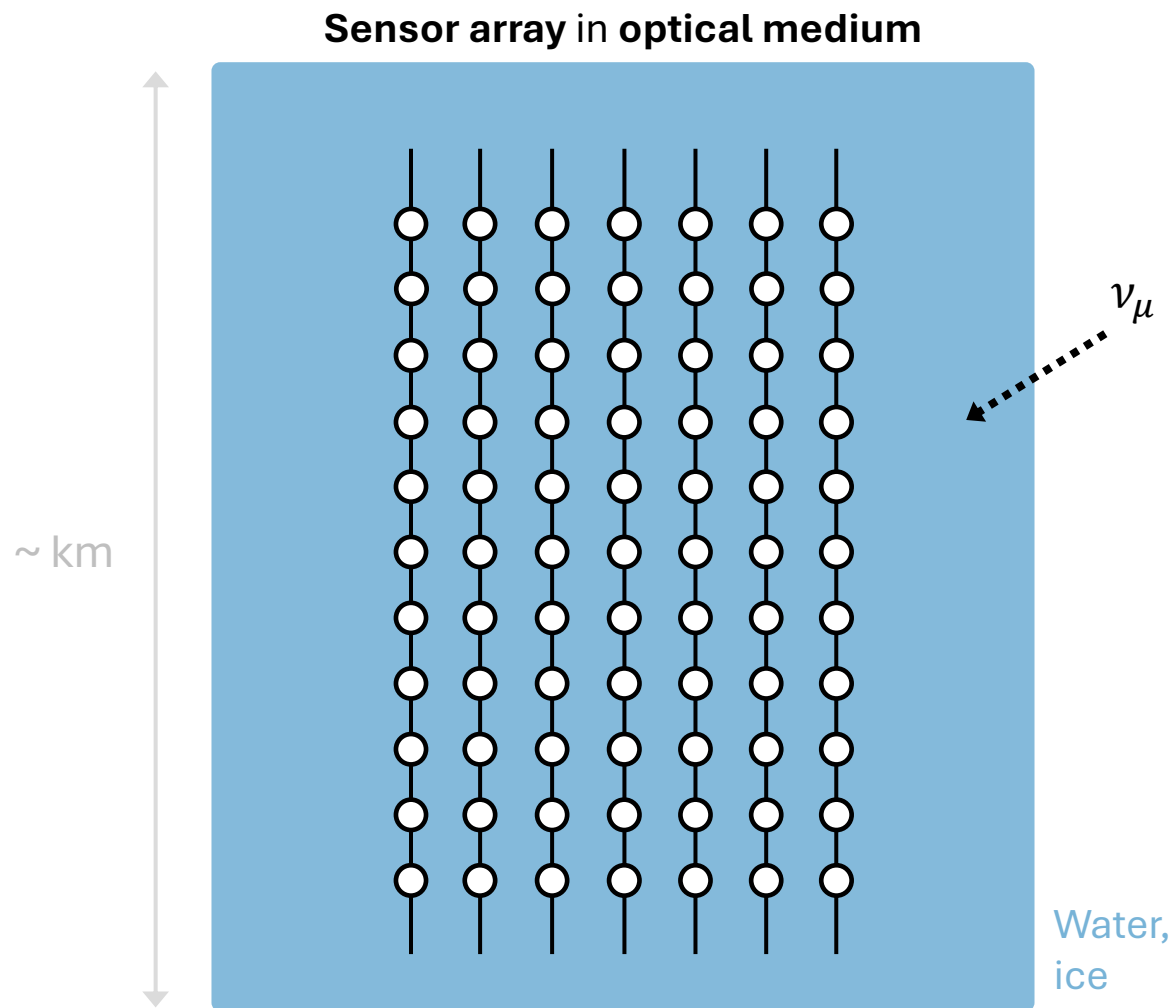
Our understanding is not complete.



Neutrino astronomy
 =
 Astronomical observations of the universe
 with the detection of cosmic neutrinos.

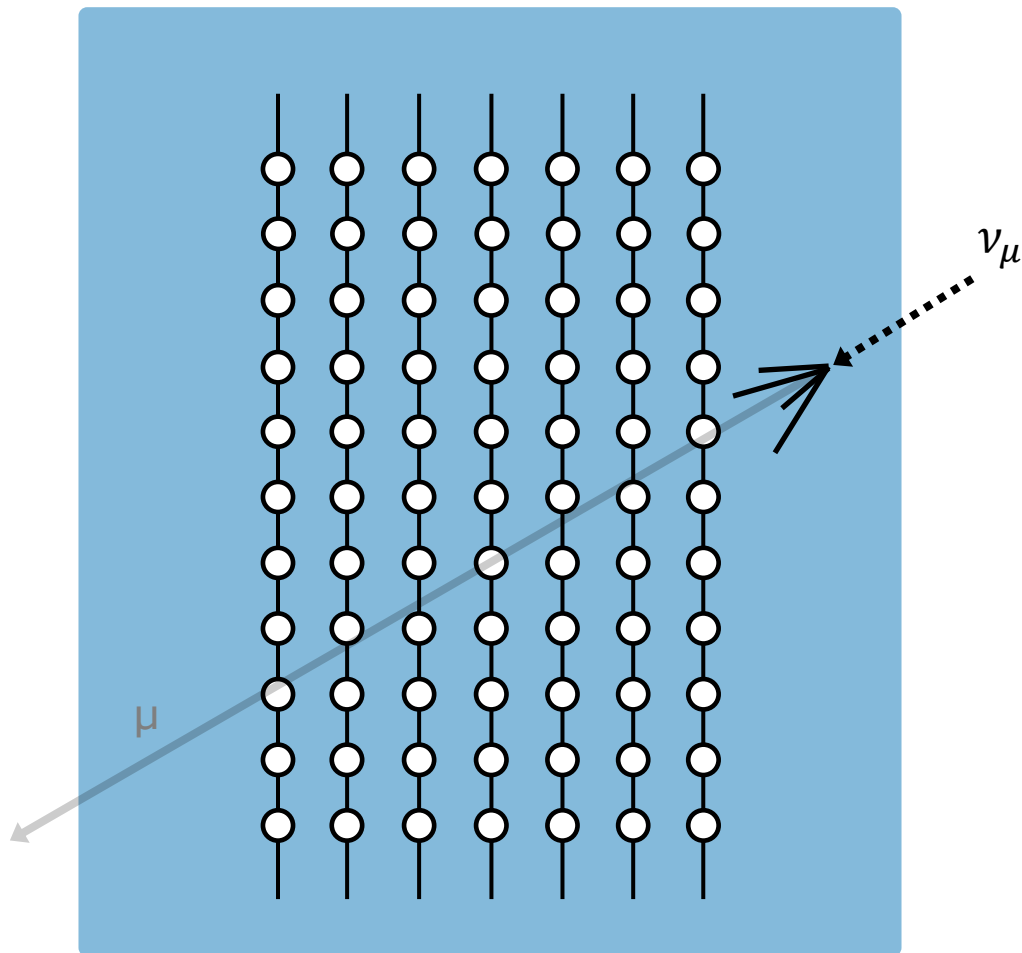


Neutrino detection

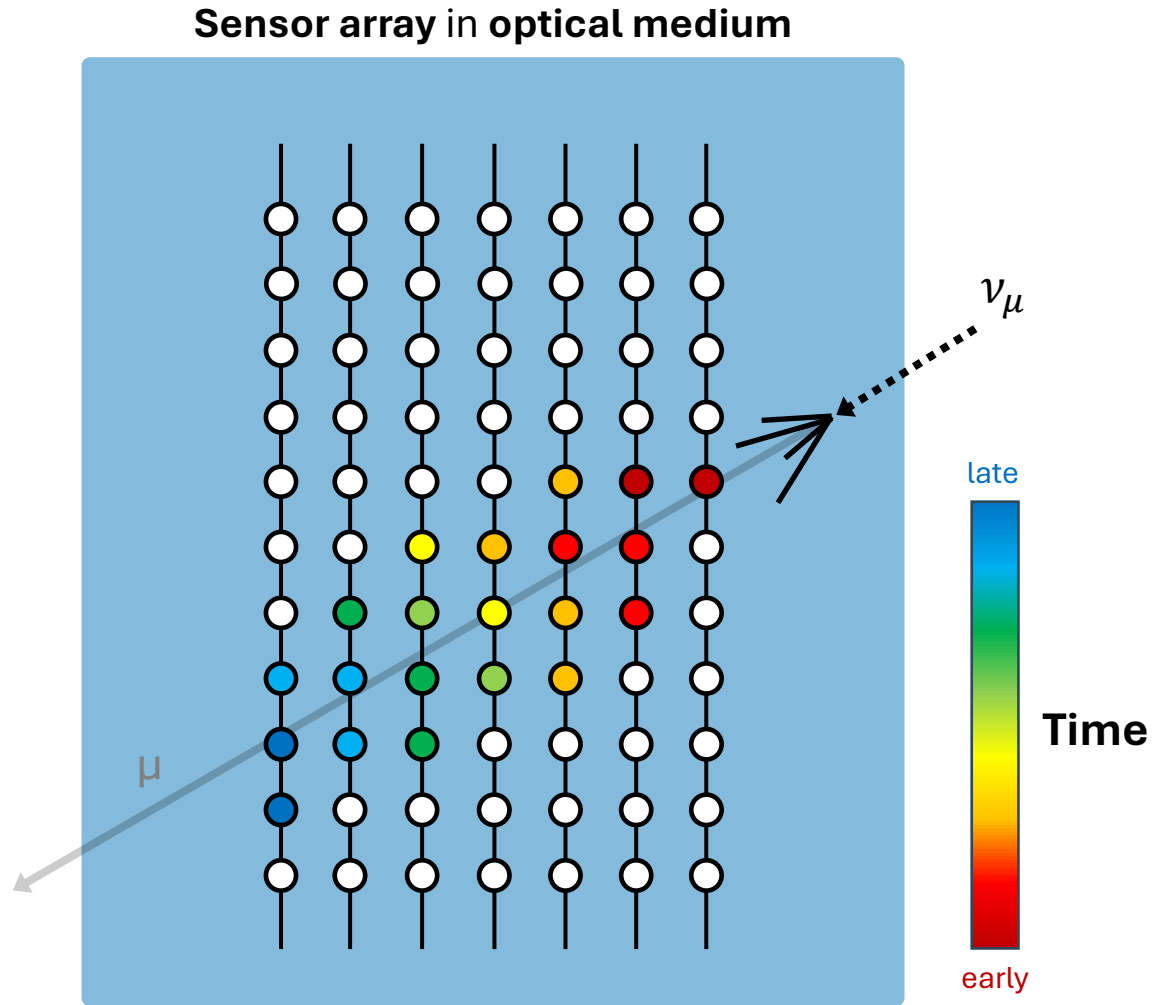


Neutrino detection

Sensor array in optical medium

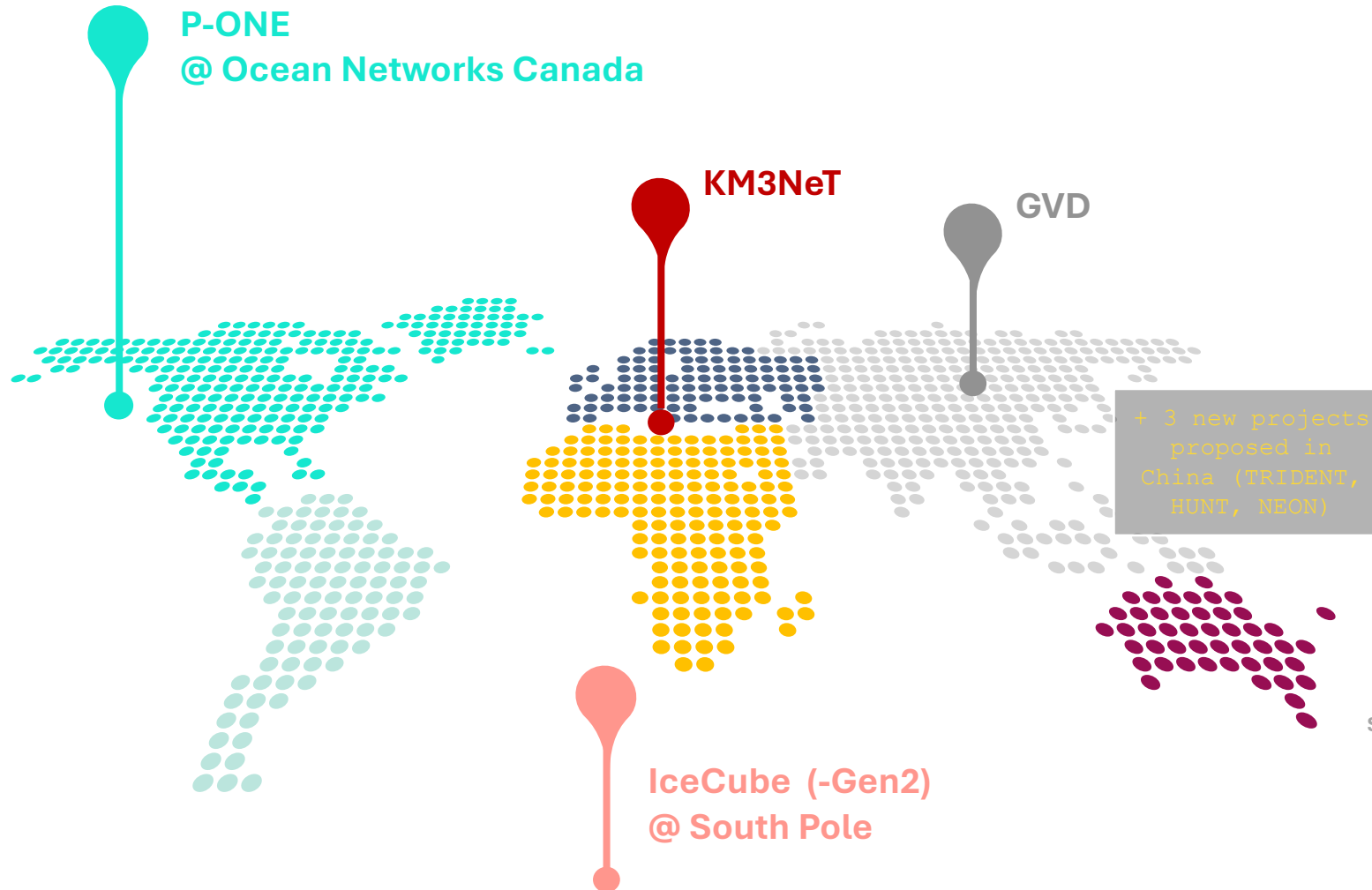


Neutrino detection





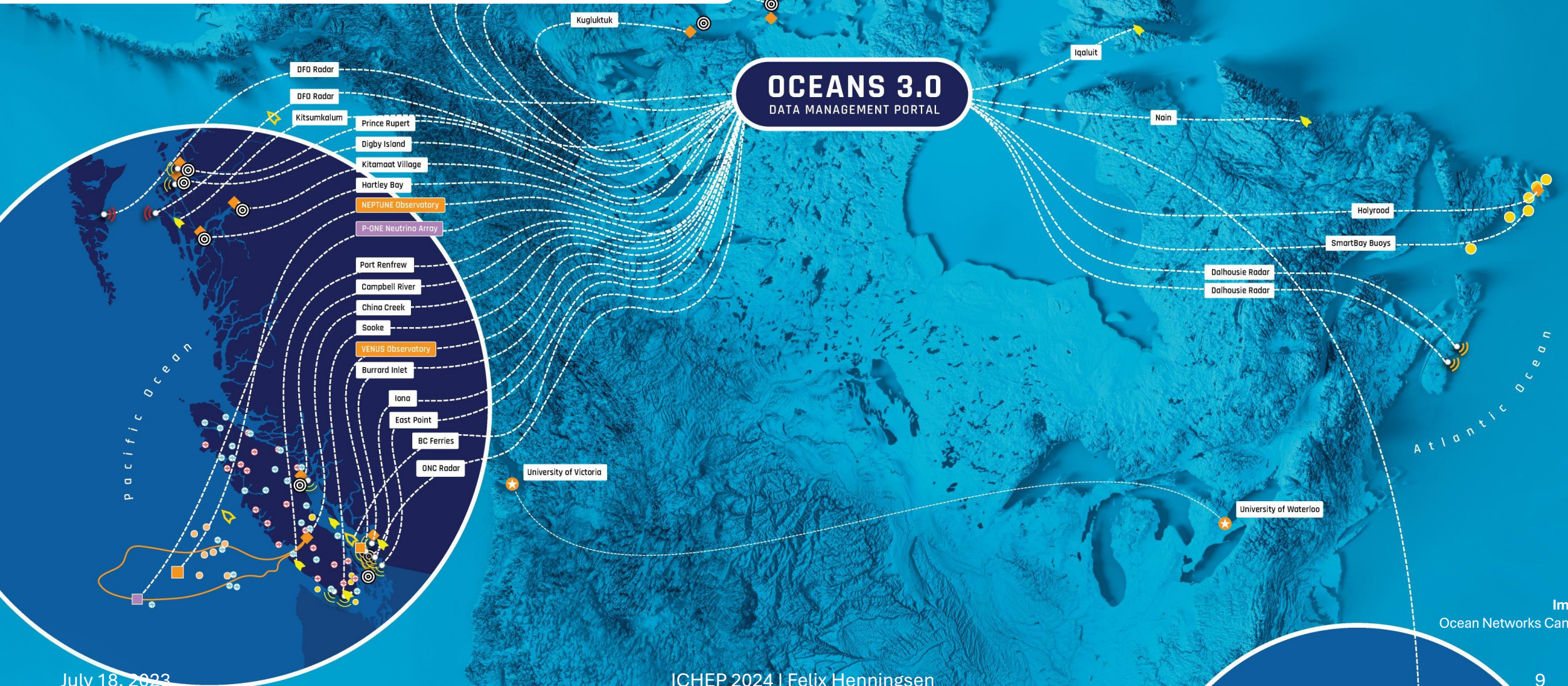
Global detector network



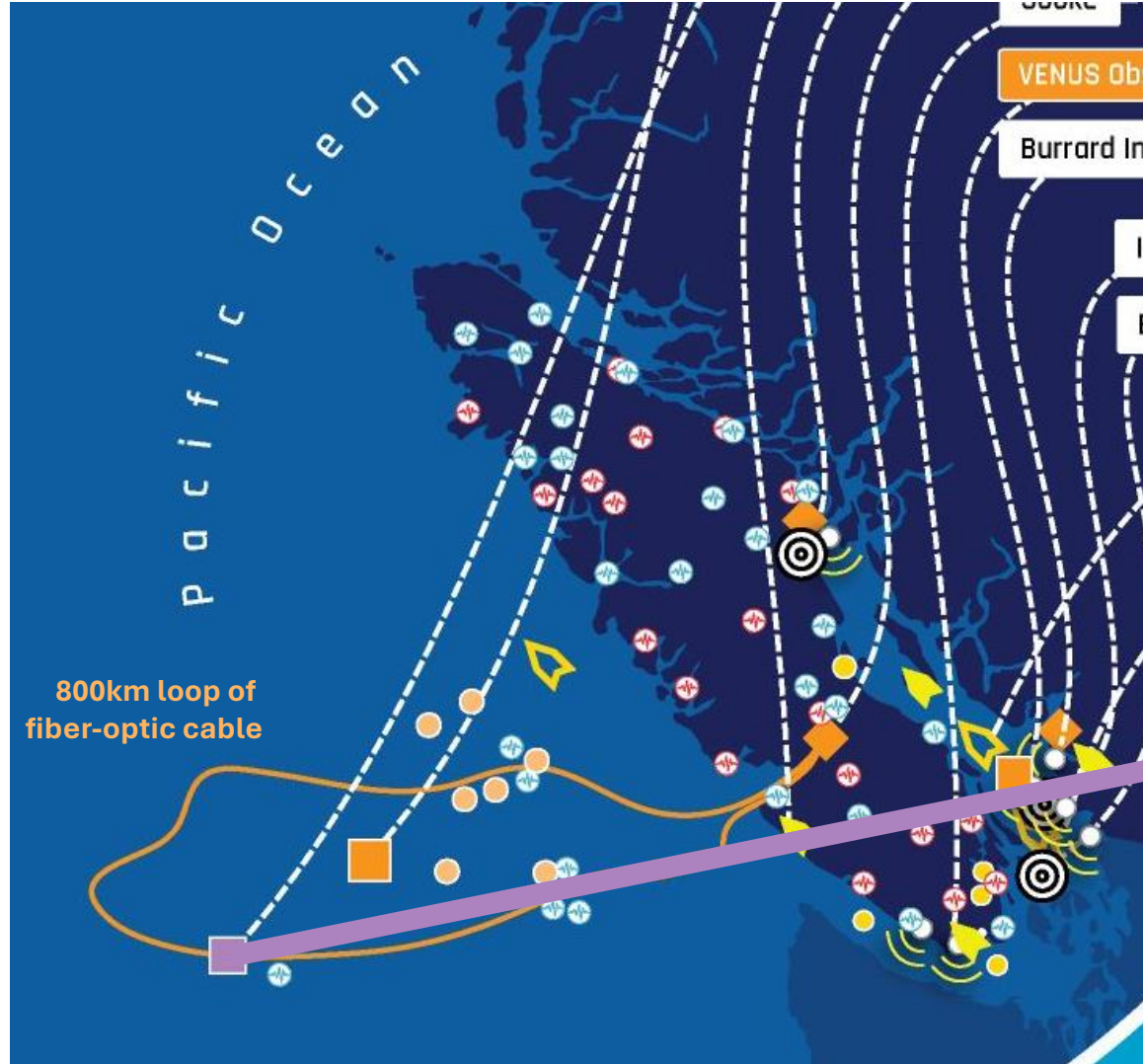
Slide credit E. Resconi



Ocean Networks Canada



Ocean Networks Canada



Partnering with **Ocean Networks Canada** for **deep-sea infrastructure + expertise**

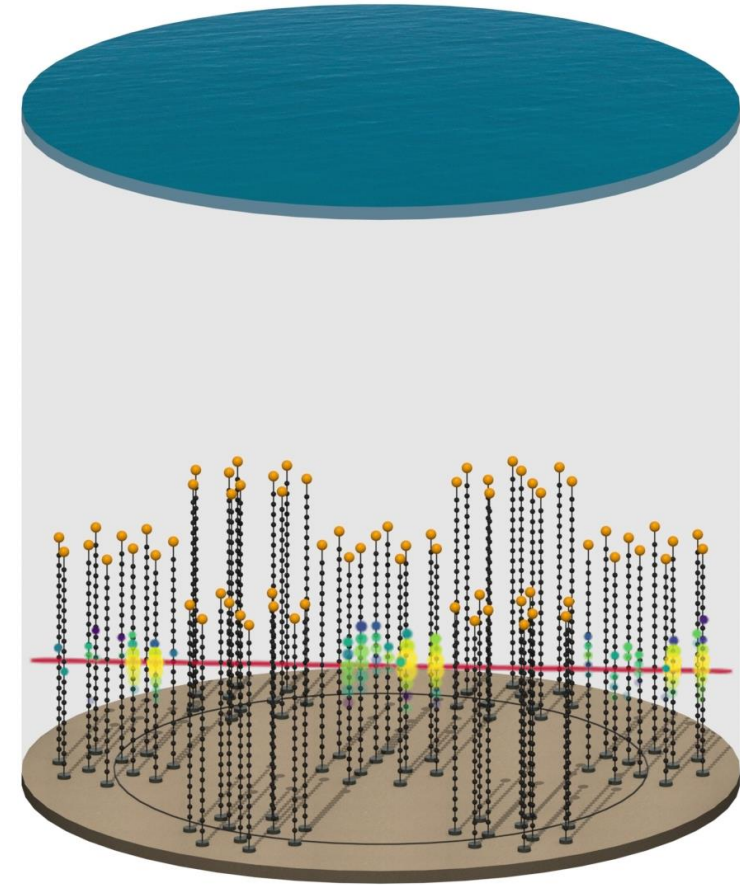
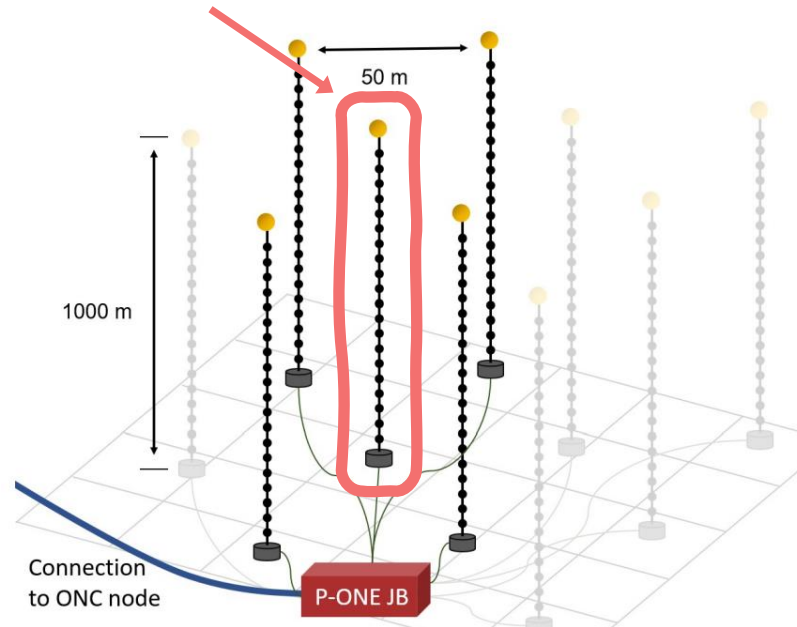
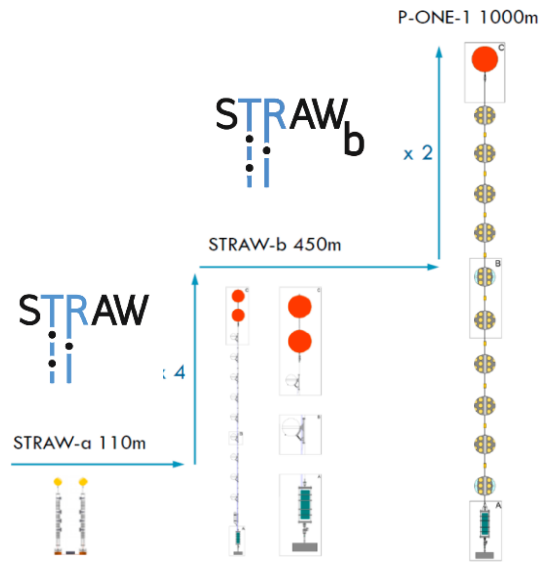


Image Nat Astron 4, 913–915 (2020)



Project status

P-ONE-1 deployment in 2025

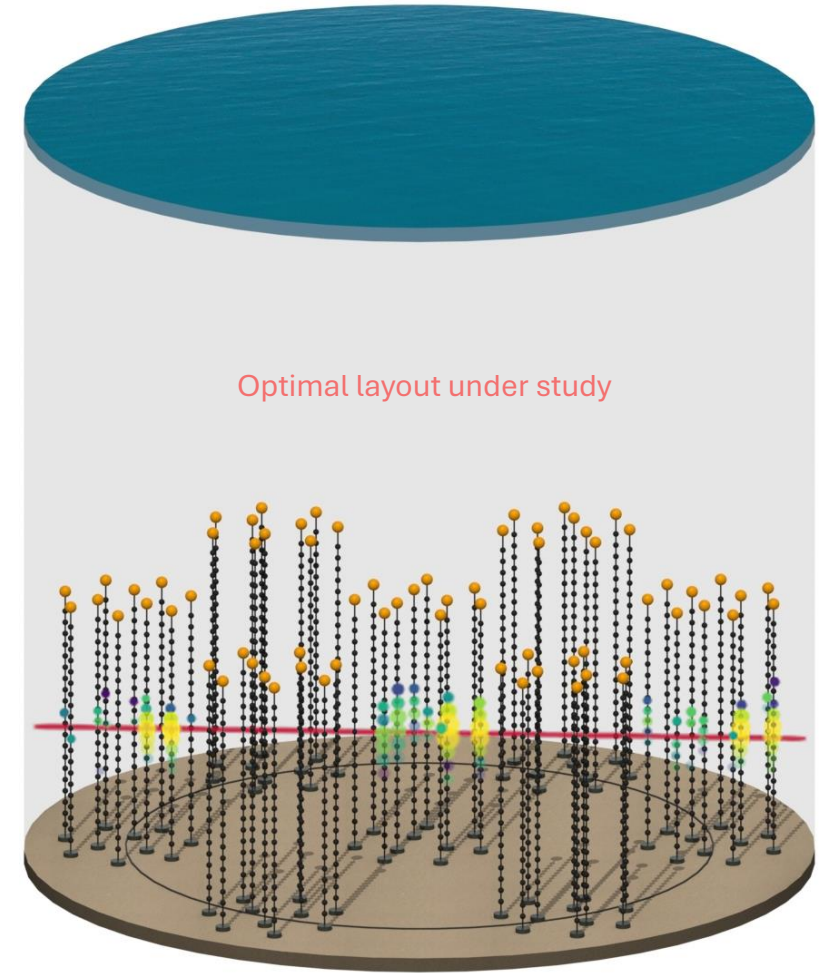


Pathfinders
2018 – 2023

Eur. Phys. J. C 81, 1071 (2021)
JINST 19 P05072 (2024)

Demonstrator (6-10 lines)
2023 – 2028

Funded

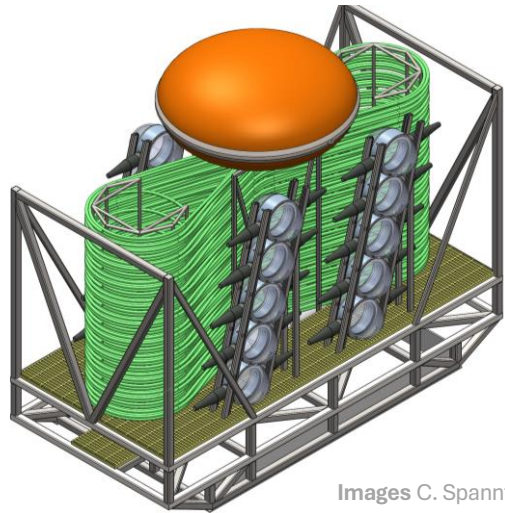


Array
2028+

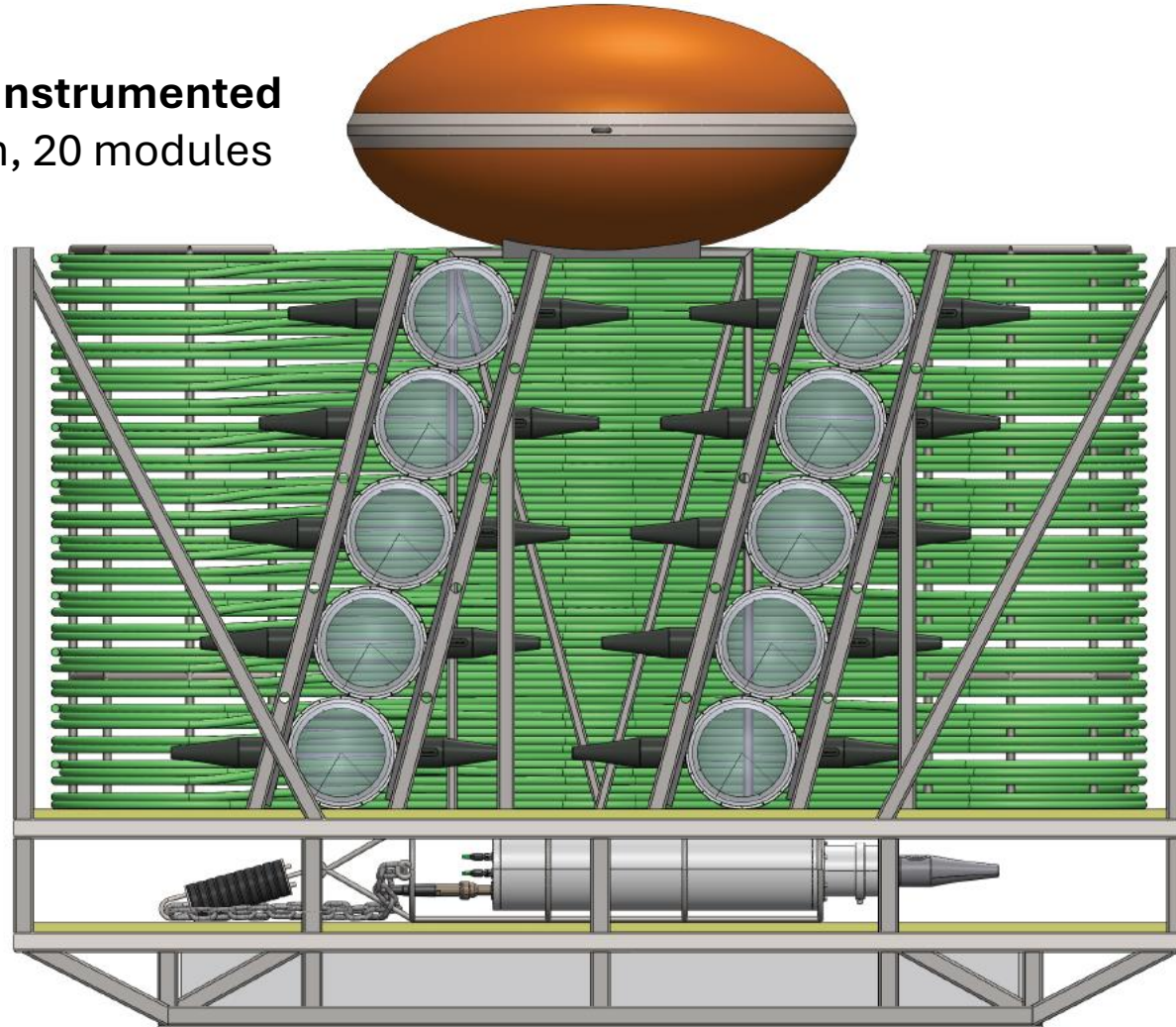


Detection line

**Pre-packaged, fully-instrumented
detection line – 1km, 20 modules**



Images C. Spannfellner



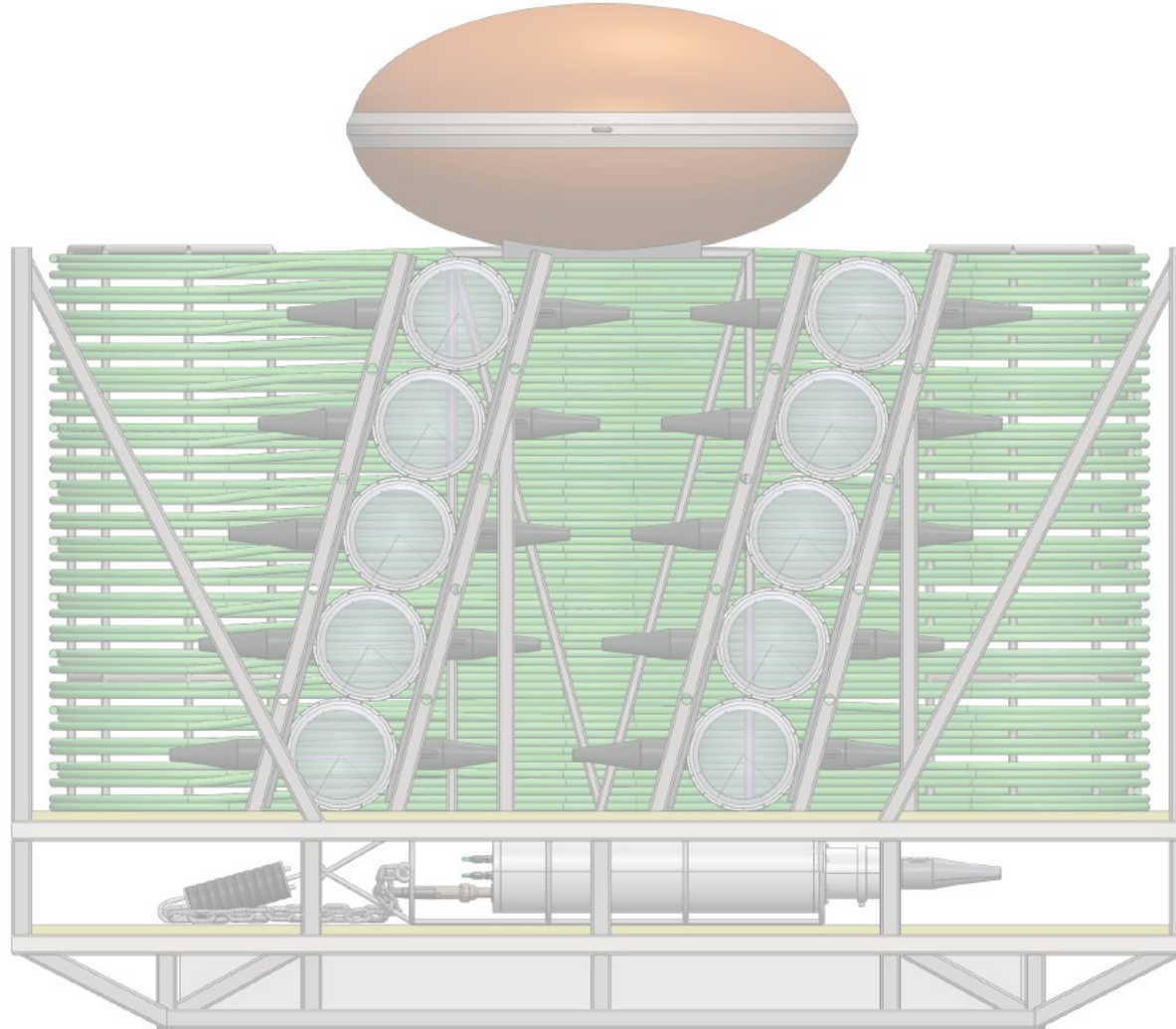
~ 3 meters

Detection line

**Optical module
(P-OM)**

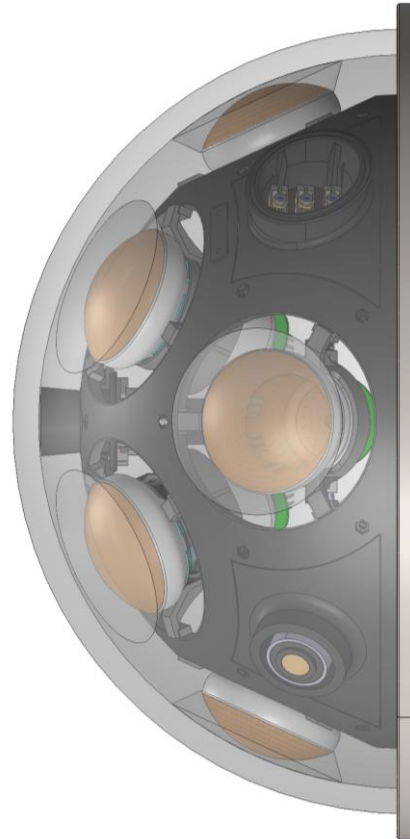


**Calibration module
(P-CAL)**





P-ONE Optical Module (P-OM)



Key facts

16x PMTs with full-waveform digitization

16x Optical flashers

2x Piezo-acoustic sensors

Sub-ns time synchronization

-

Full optical instrument simulation

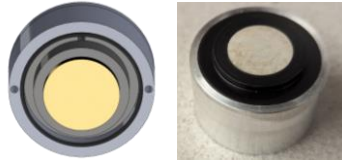
For details PoS (ICRC2023) 1219



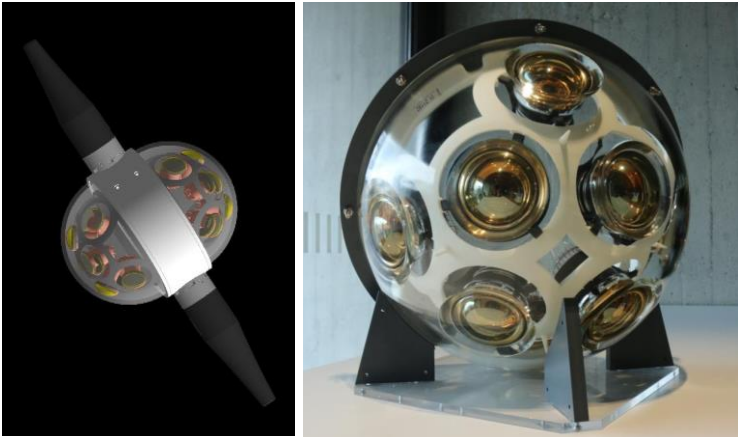
Instrumentation

Piezo-acoustic receivers

D. Ghuman *et al* *PoS(ICRC2023)* 1112



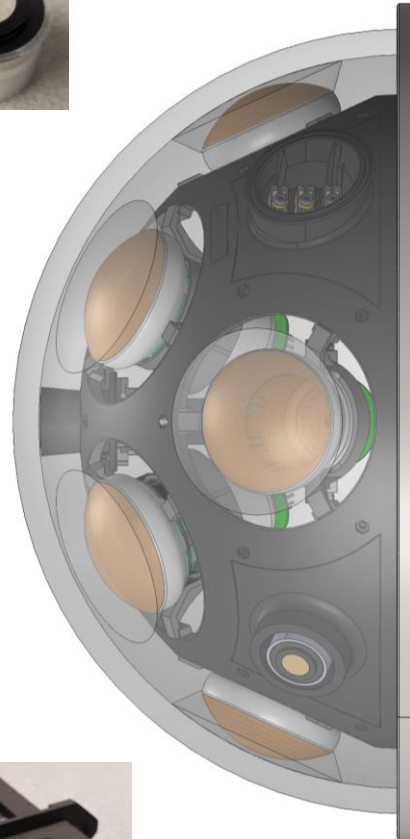
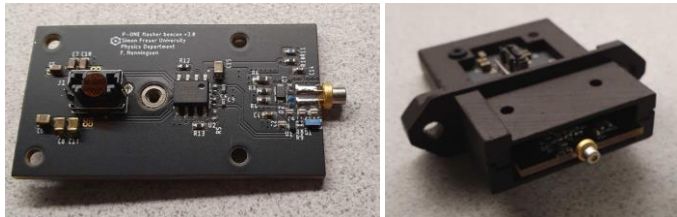
Opto-mechanical integration



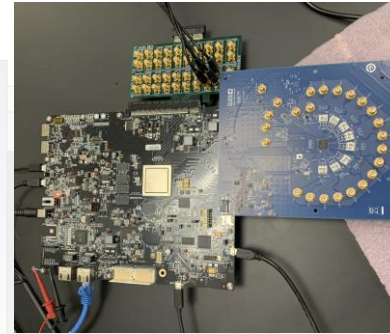
Images V. Gousy-Leblanc (left), *PoS(ICRC2023)* 1219 (right)

Optical flashers

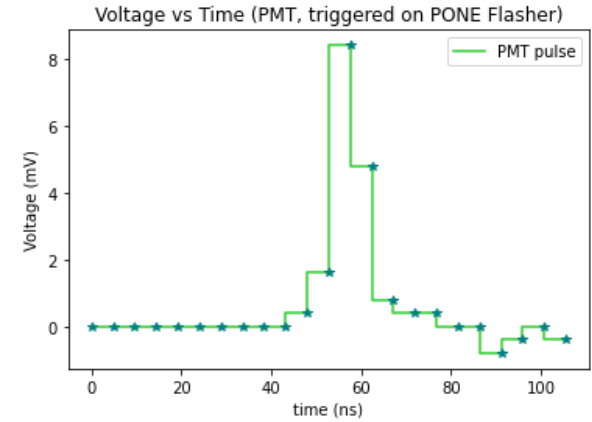
F. Henningsen *et al* *JINST* **18** P10010 (2023)



Full waveform read-out



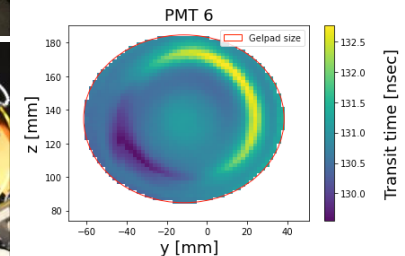
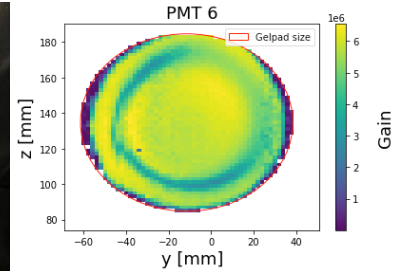
Images J. Garriz



Production and testing



Images V. Gousy-Leblanc





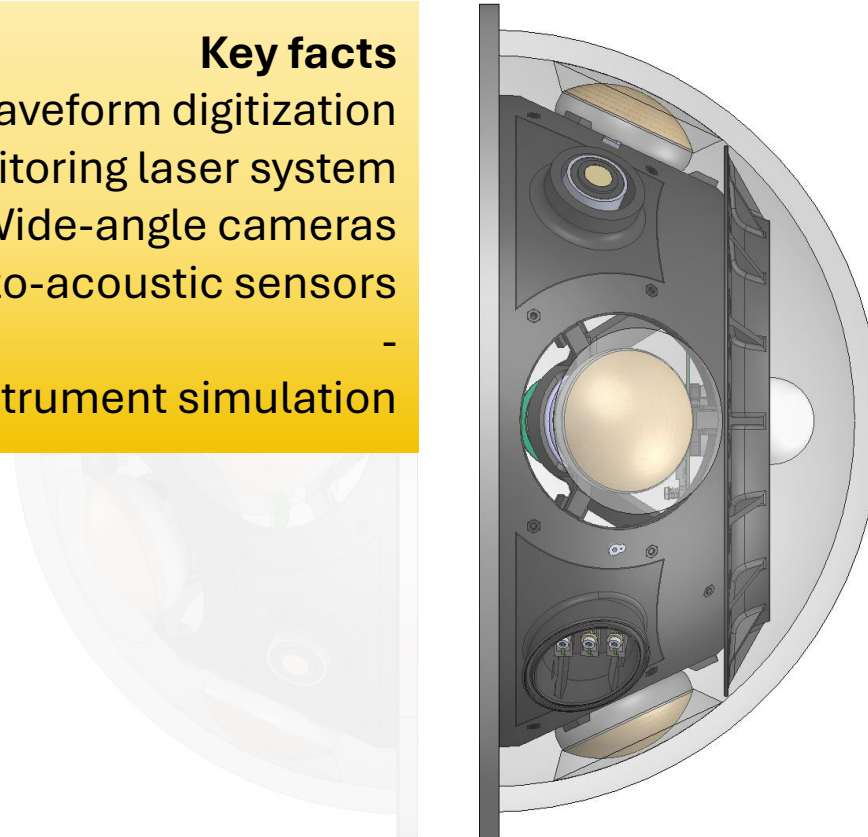
Instrumentation

P-ONE Calibration Module (P-CAL)

Key facts

- 8x** PMTs with full-waveform digitization
- 2x** Isotropic, self-monitoring laser system
- 2x** Wide-angle cameras
- 2x** Piezo-acoustic sensors
-
- Full optical instrument simulation

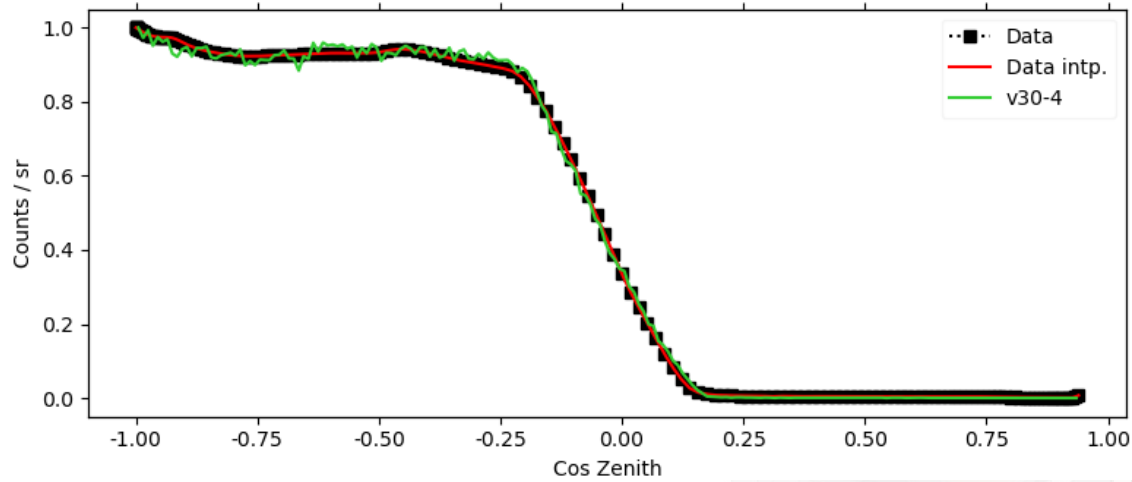
For details PoS (ICRC2023) 1113



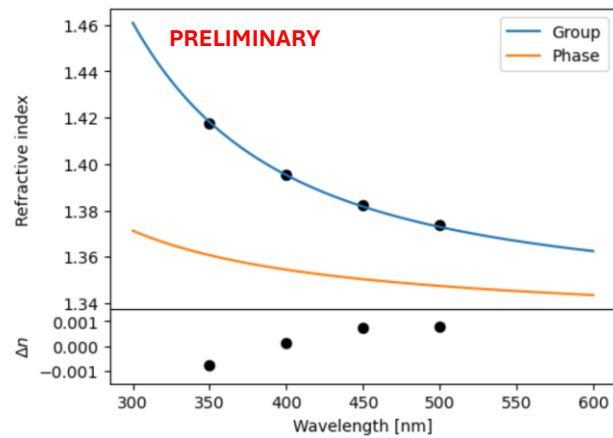
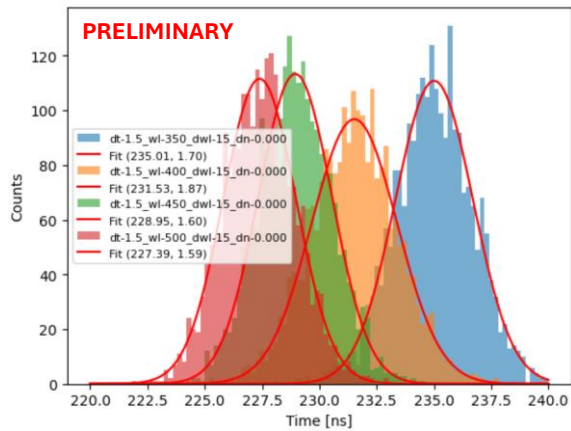


Instrumentation

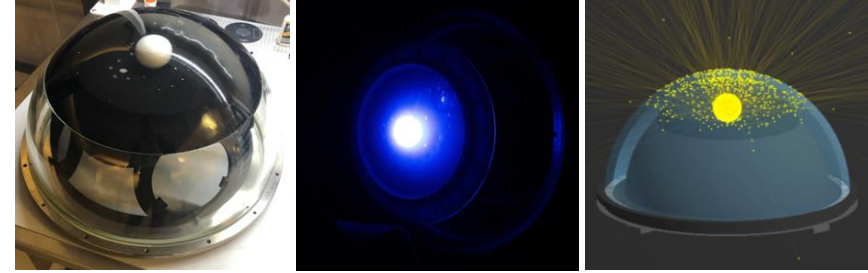
Instrument calibration, simulation



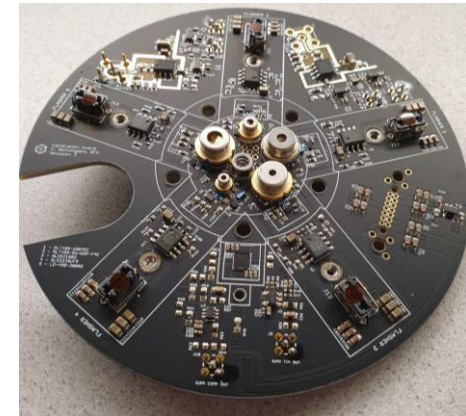
Calibration simulation studies



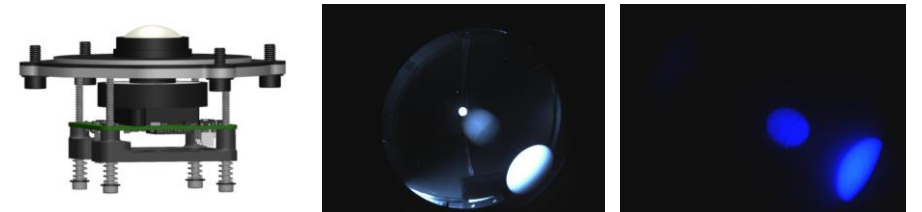
Diffuse optics



Self-monitoring lasers



Camera system





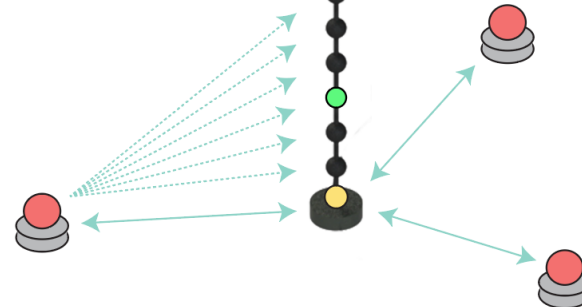
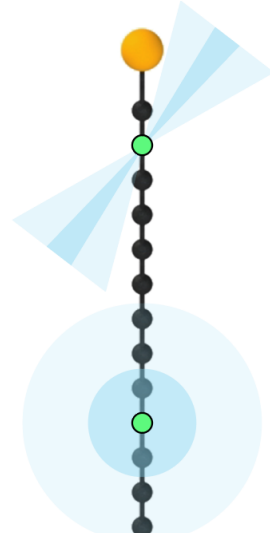
Acoustic positioning system

Seafloor positioning and GNSS



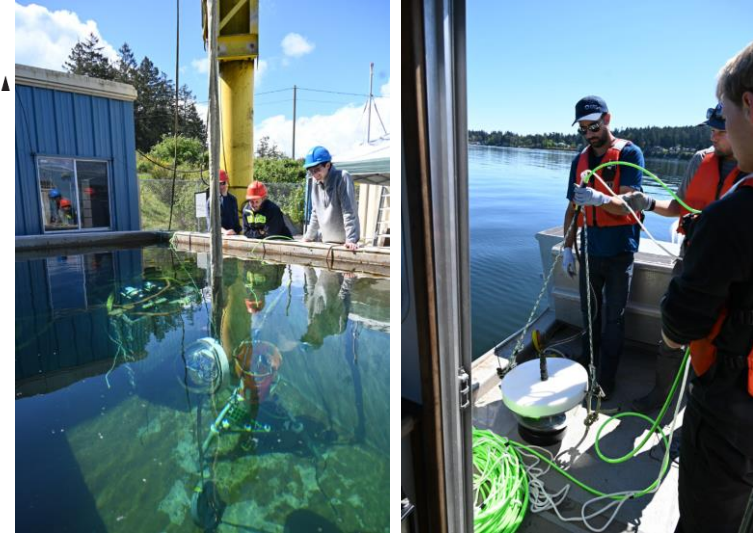
Images M. Heesemann (left), Sonardyne Int. Ltd. "Fetch" (right)

- Top float ●
- P-OM ●
- P-CAL ●
- Light ■
- Interrogator ●
- Pinger ●

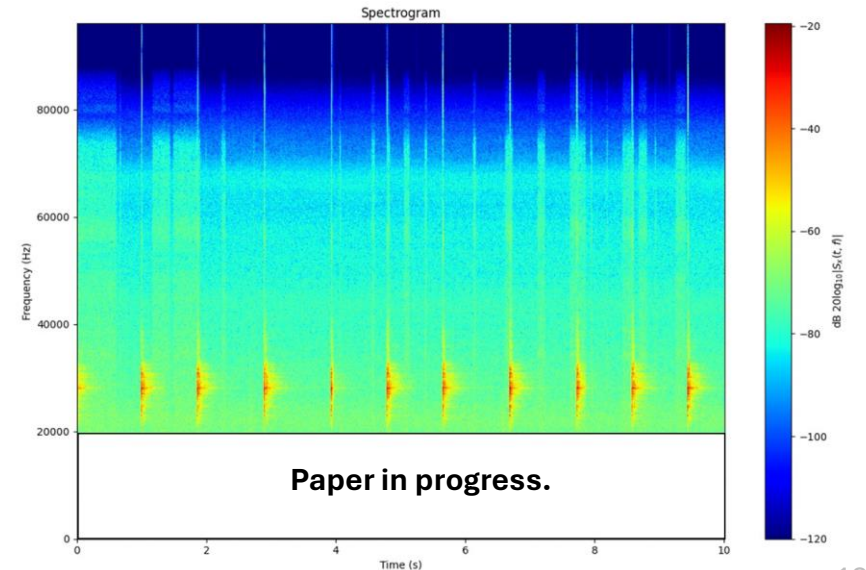
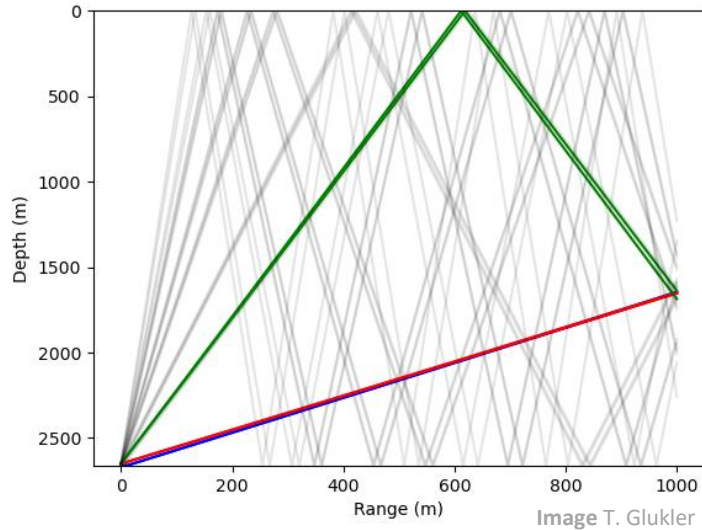


For more details: PoS (ICRC2023) 1112

Water field tests



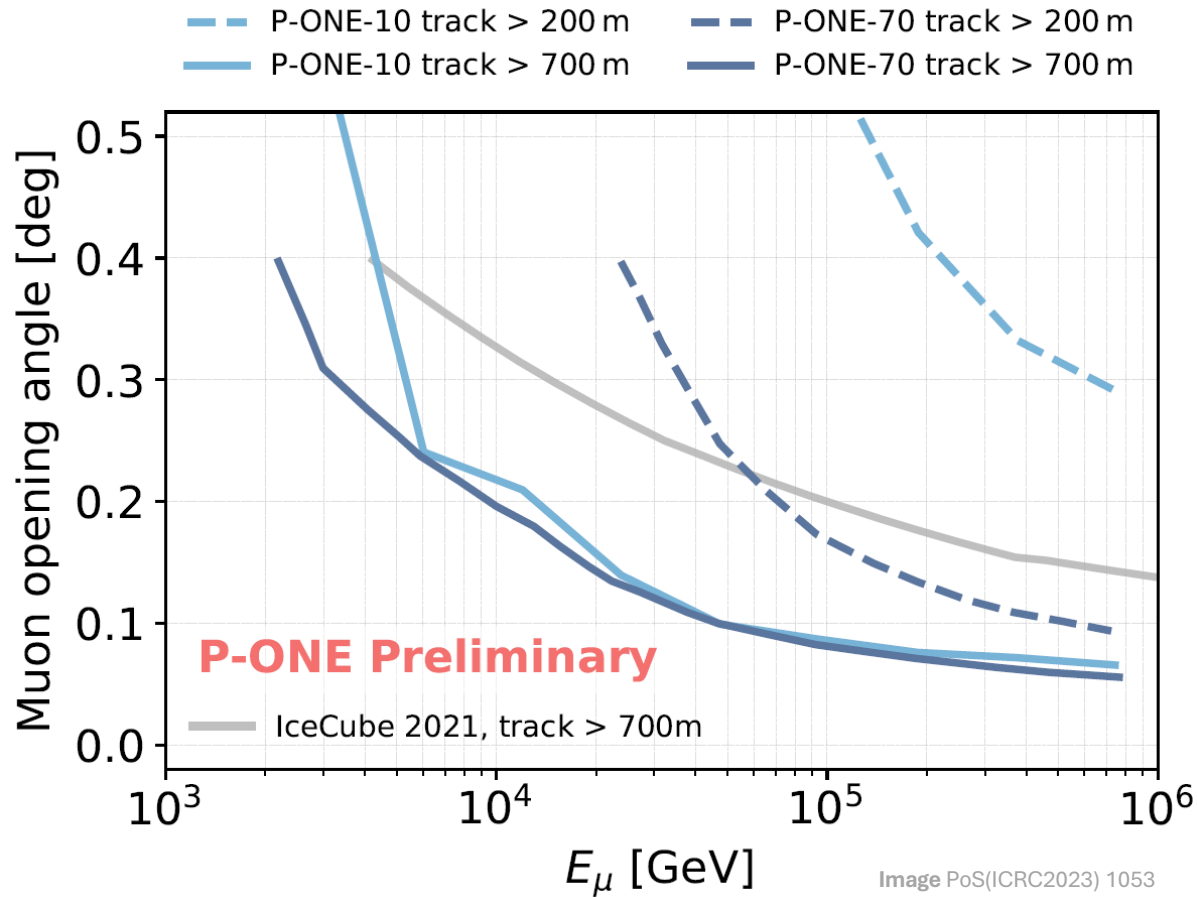
Acoustic ray-tracing simulation





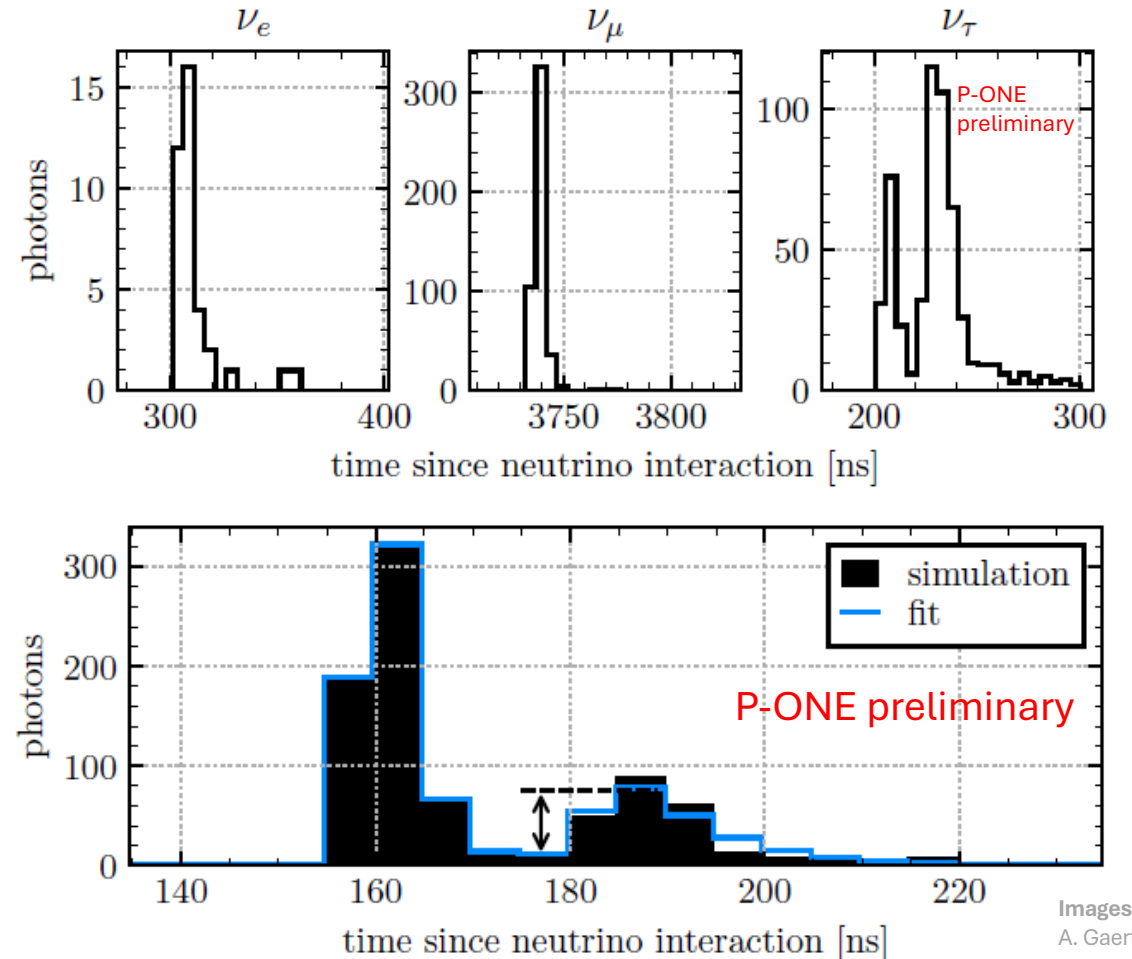
Science potential

Track reconstruction



For details PoS (ICRC2023) 1175

Tau identification





Summary

Excellent progression of the P-ONE project

First goal: Test deployment / detector concept and operation

- Full, detailed in-situ calibration and measurement of backgrounds
- Ultra-fast, high-bandwidth detector readout
- Particle identification
- Study atmospheric muons and neutrinos

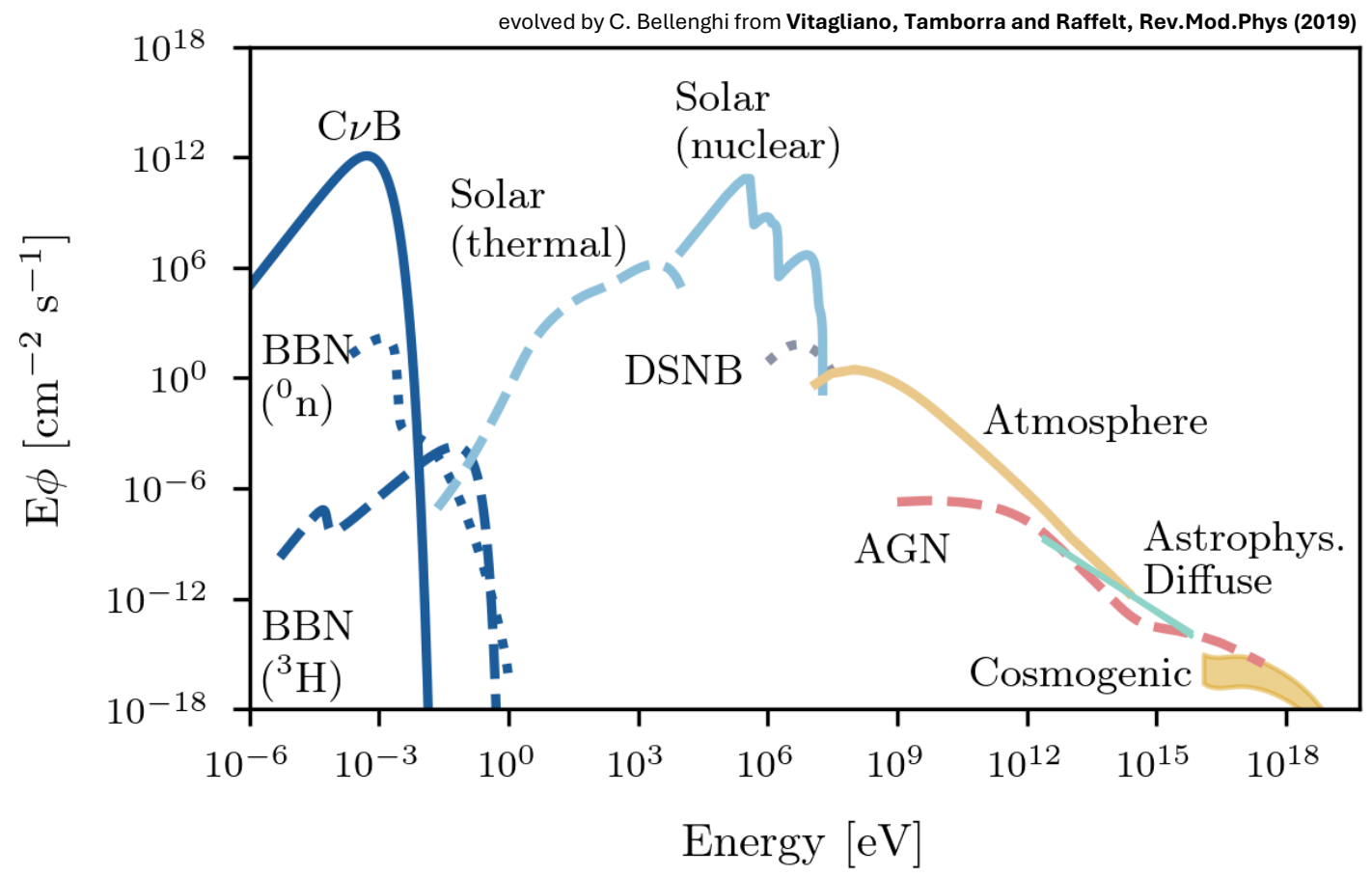
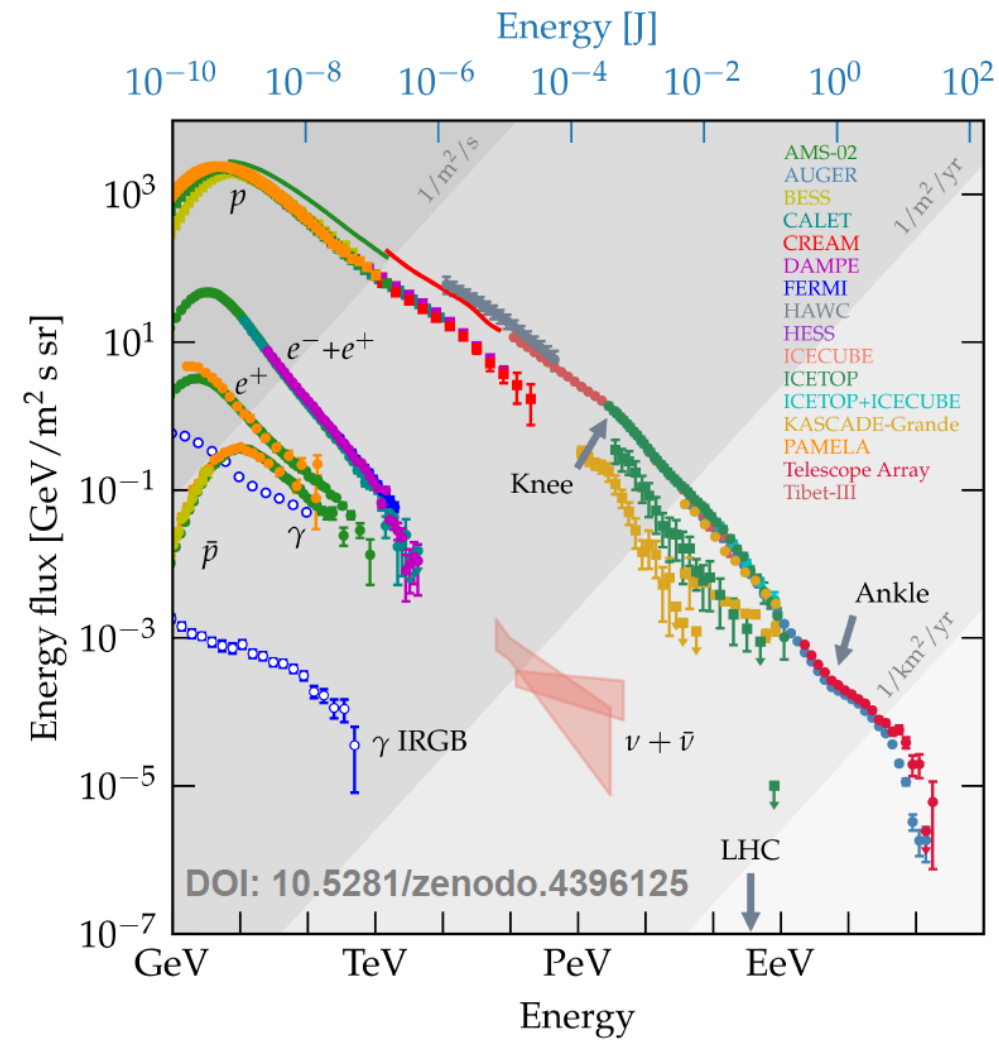
P-ONE-1 is a crucial milestone for a future km^3 array in the Pacific Ocean





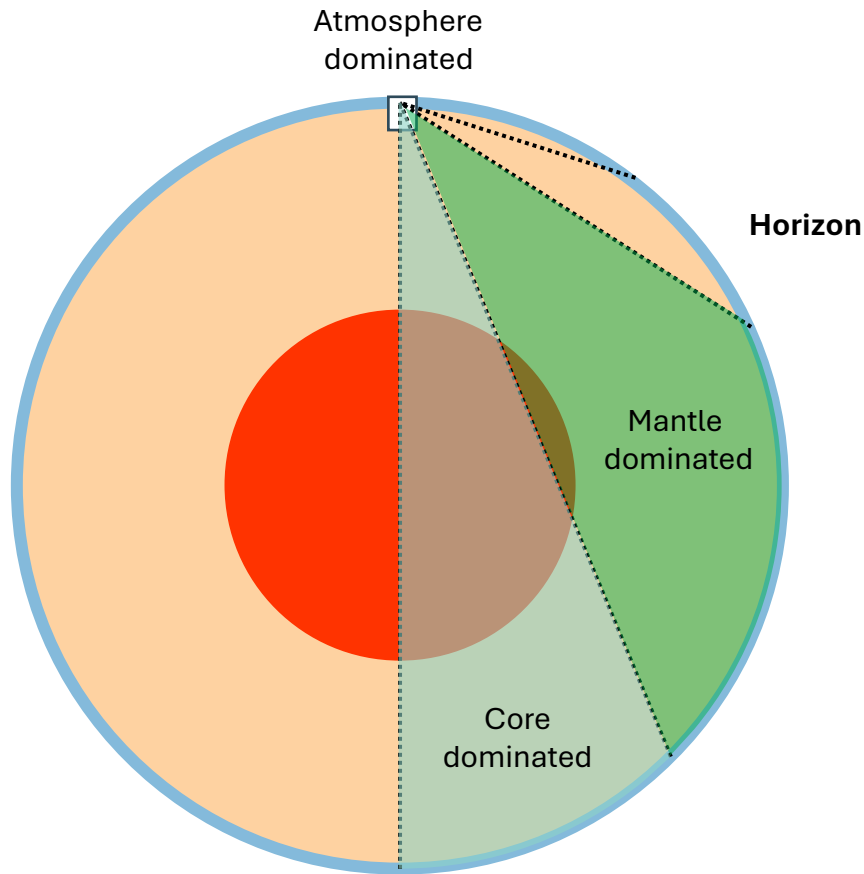
Backup

Neutrino astronomy





Neutrino detectors



Sensor array in optical medium

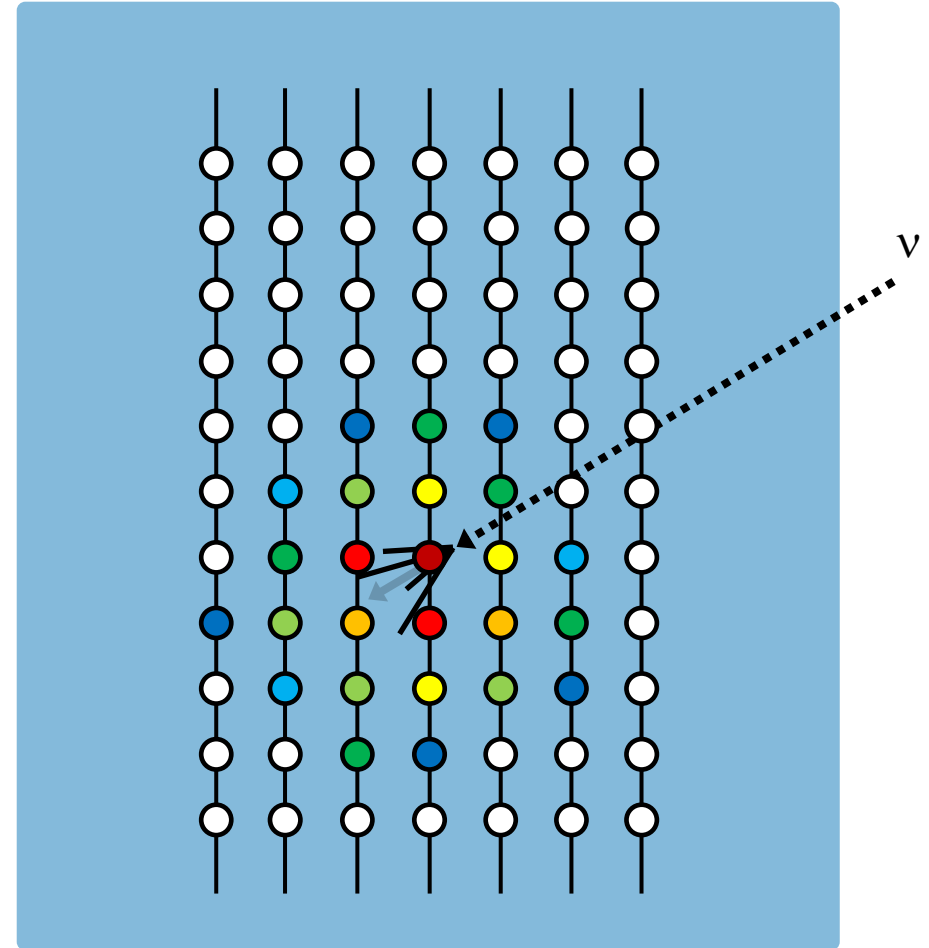
late



early

Time

Cascade





Global detector network

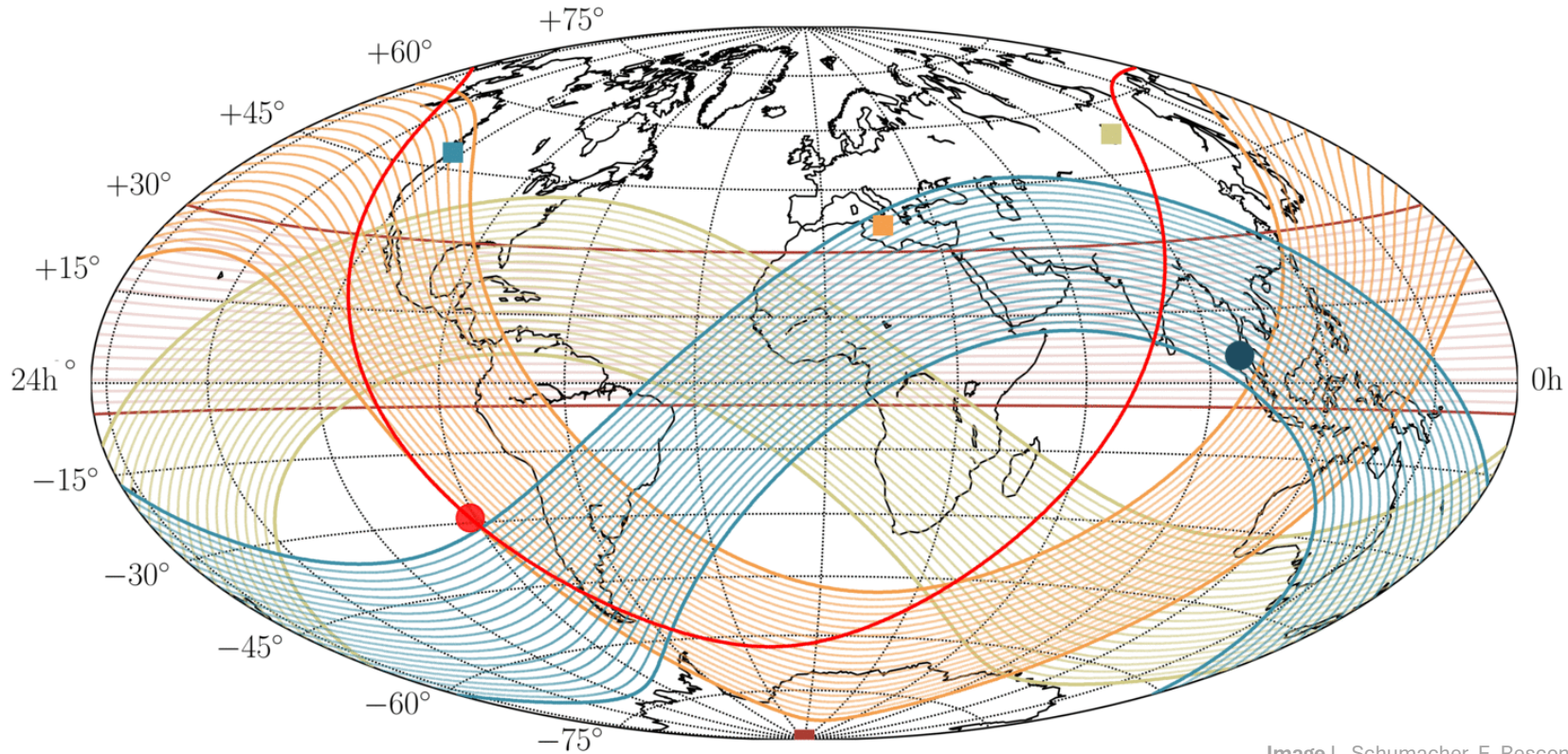


Image L. Schumacher, E. Resconi

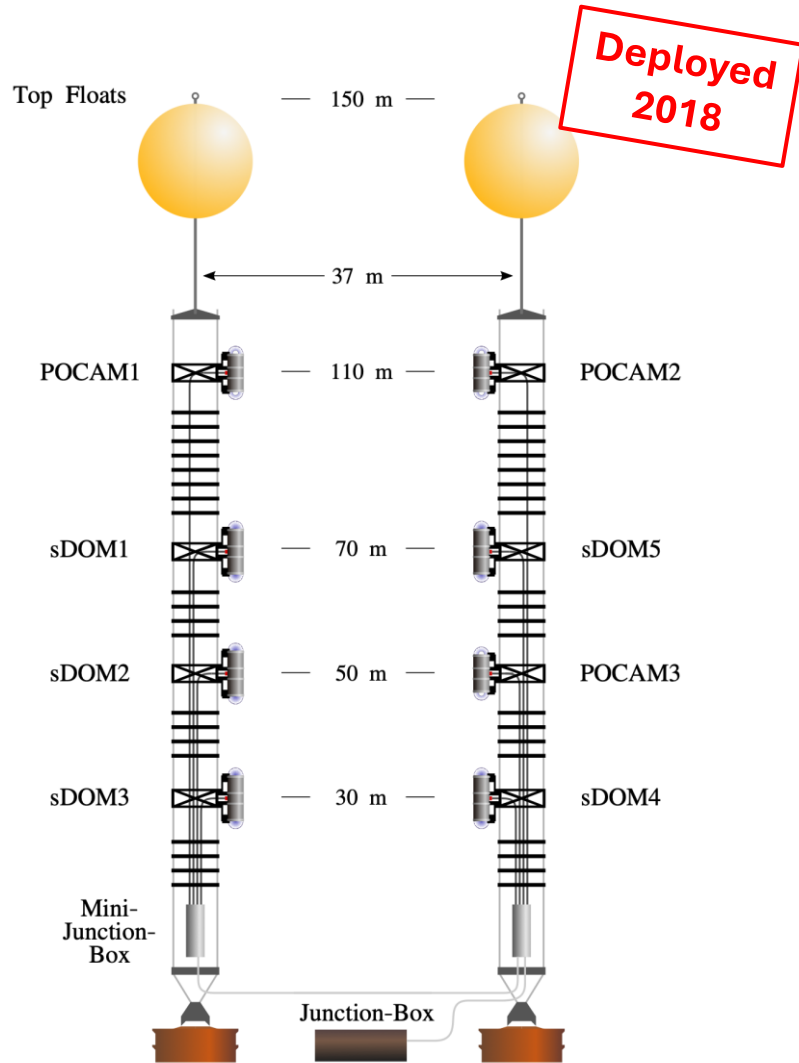
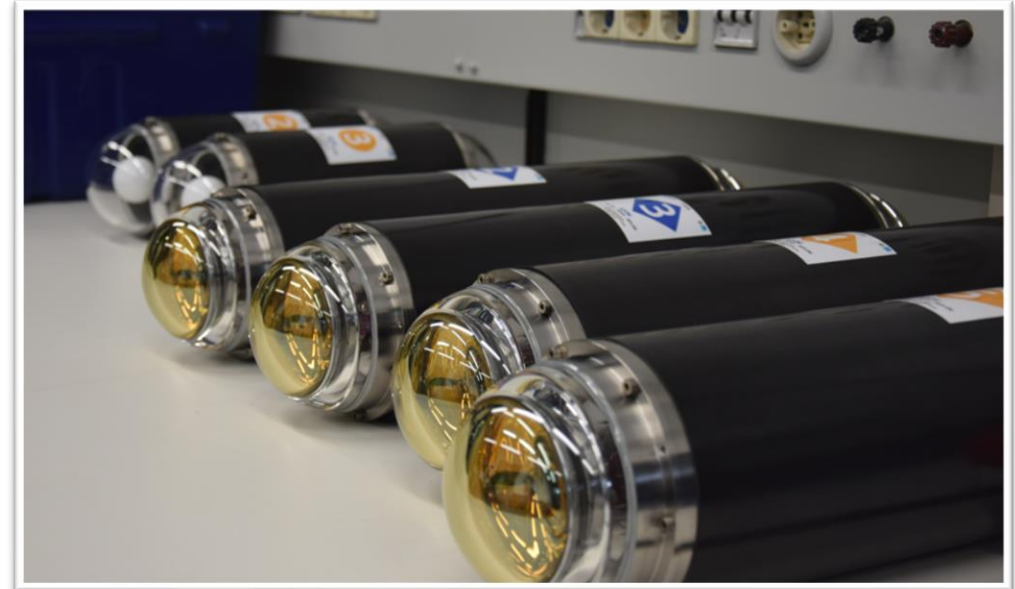
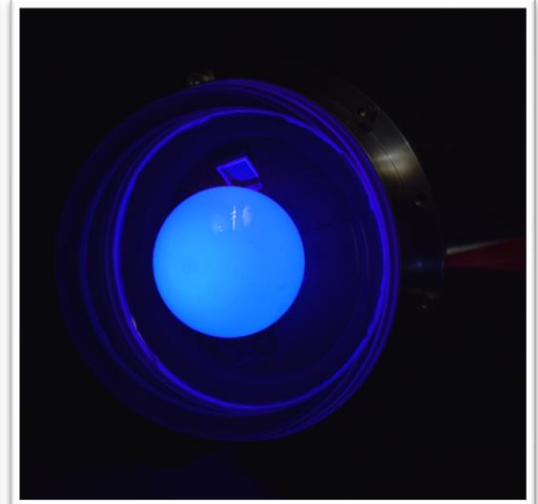
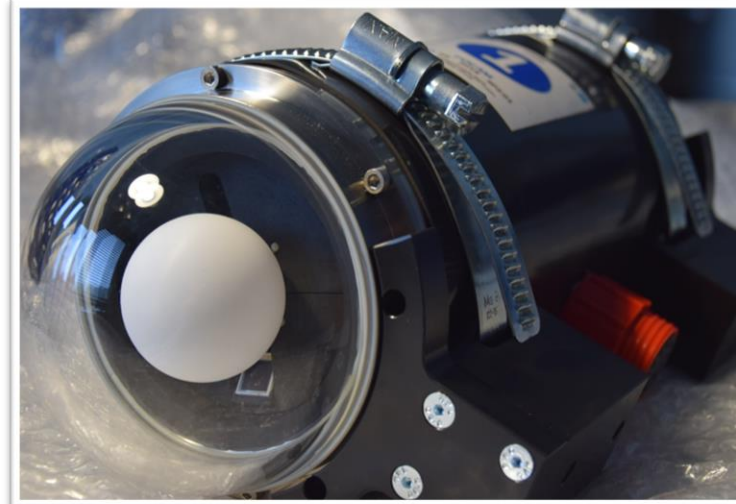
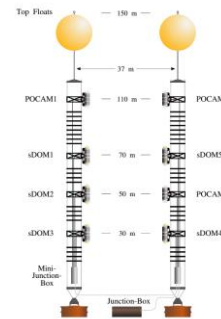
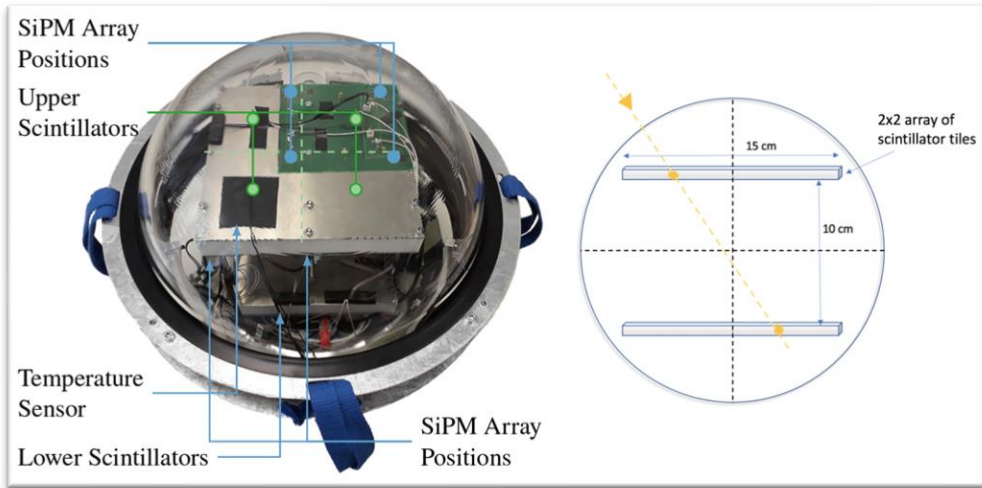
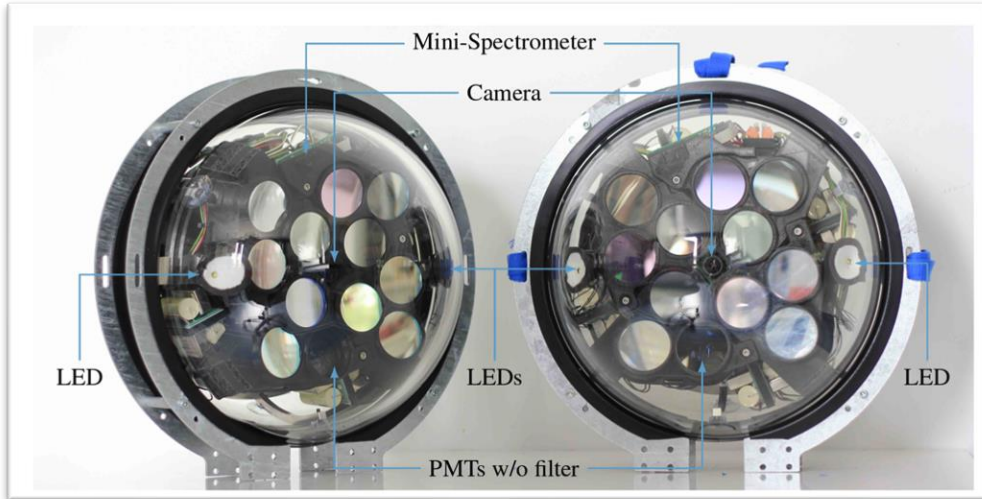


Image Eur. Phys. J. C 81, 1071 (2021)

Images F. Henningsen, PhD thesis (2021)





2 Floats
-2216 m | 444 m
(surface | seafloor)

LiDAR 2
-2228 m | 432 m

PMT-Spectrometer 2
-2252 m | 408 m

Standard Module 3
-2276 m | 384 m

Standard Module 2
-2348 m | 312 m

Muon Tracker
-2372 m | 288 m

Mini-Spectrometer
-2396 m | 264 m

Standard Module 1
-2420 m | 240 m

LiDAR 1
-2492 m | 168 m

PMT-Spectrometer 1
-2516 m | 144 m

WOM
-2540 m | 120 m

Junction box
-2658 m | 2 m

Anchor
-2660 m | 0 m

