



The Pacific Ocean Neutrino Experiment

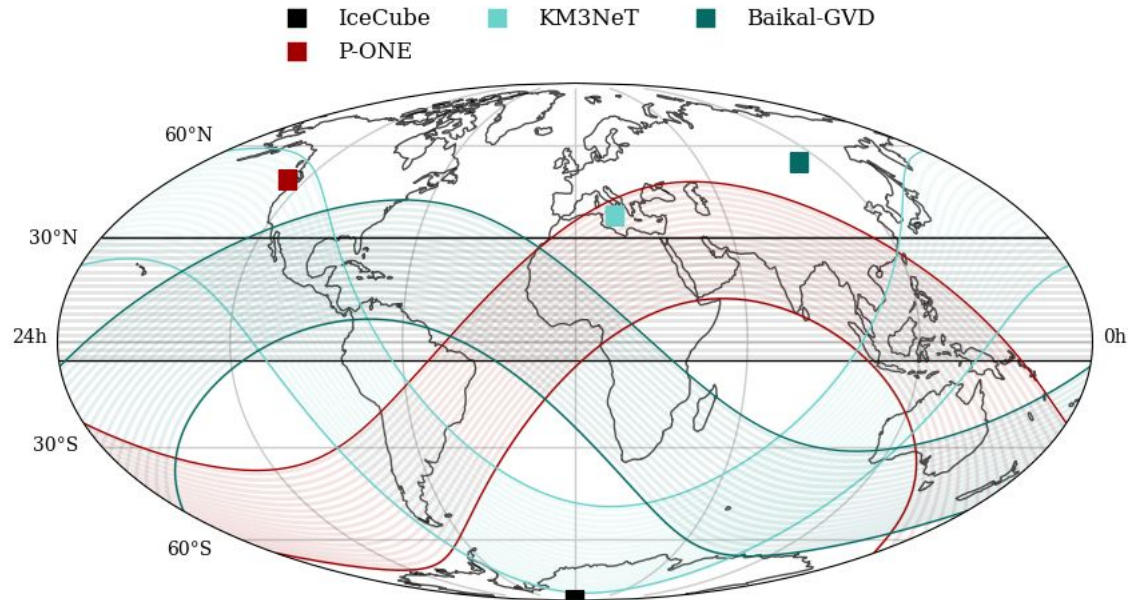
Status Summary

Jakub Stacho
Simon Fraser University (SFU)
July 29, 2026

Neutrino Telescopes

A single neutrino telescope only has a limited band in the sky where it has maximum point source discovery potential

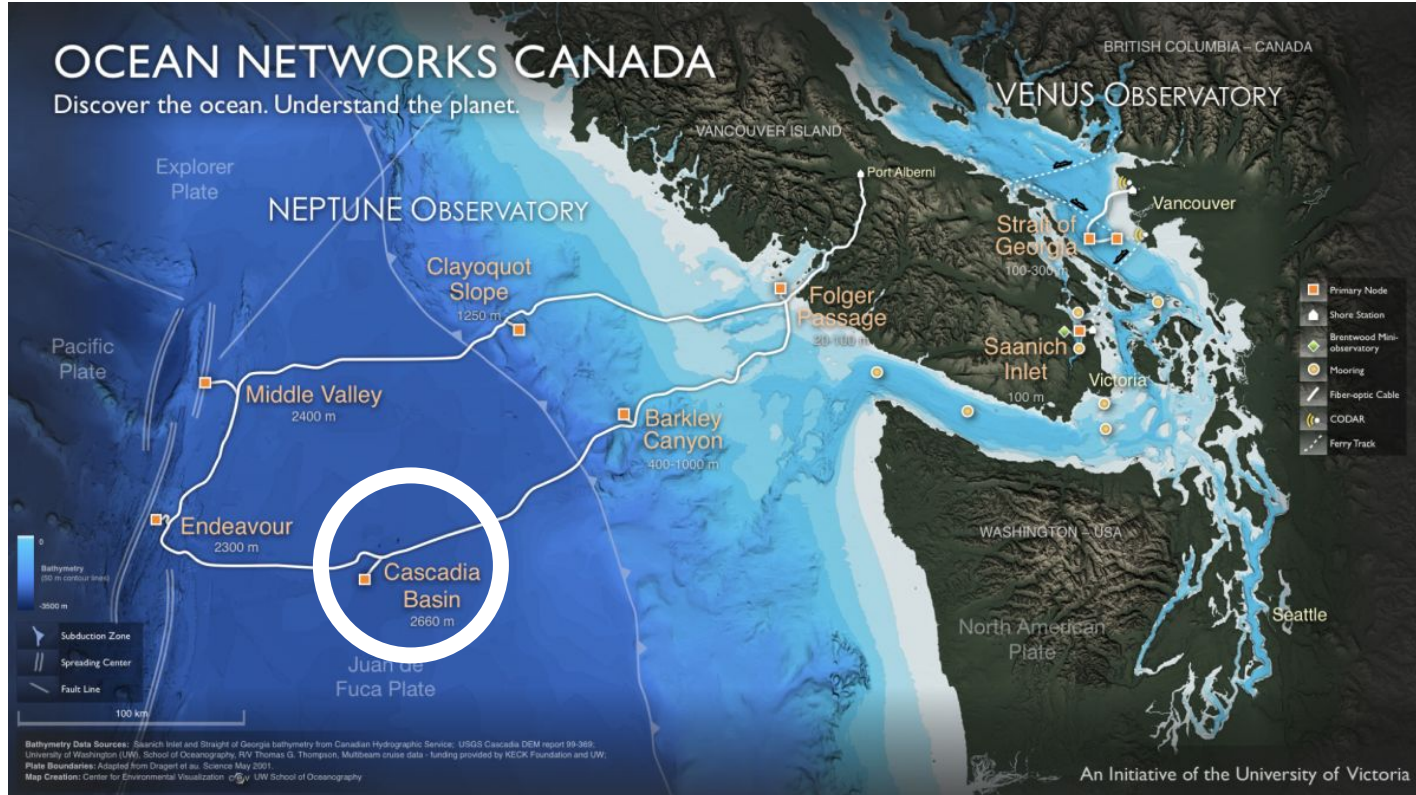
- Need multiple complementary neutrino telescopes around the Earth to boost the source discovery rate



Schumacher, L.J.; Huber, M.; Bustamante, M. PLEnuM Software Tools.
Available online: <https://github.com/PLEnuM-group/Plenum>

The Pacific Ocean Neutrino Experiment (P-ONE)

Planned cubic-kilometre scale neutrino telescope in the Pacific Ocean about 200 km off the coast of Vancouver Island

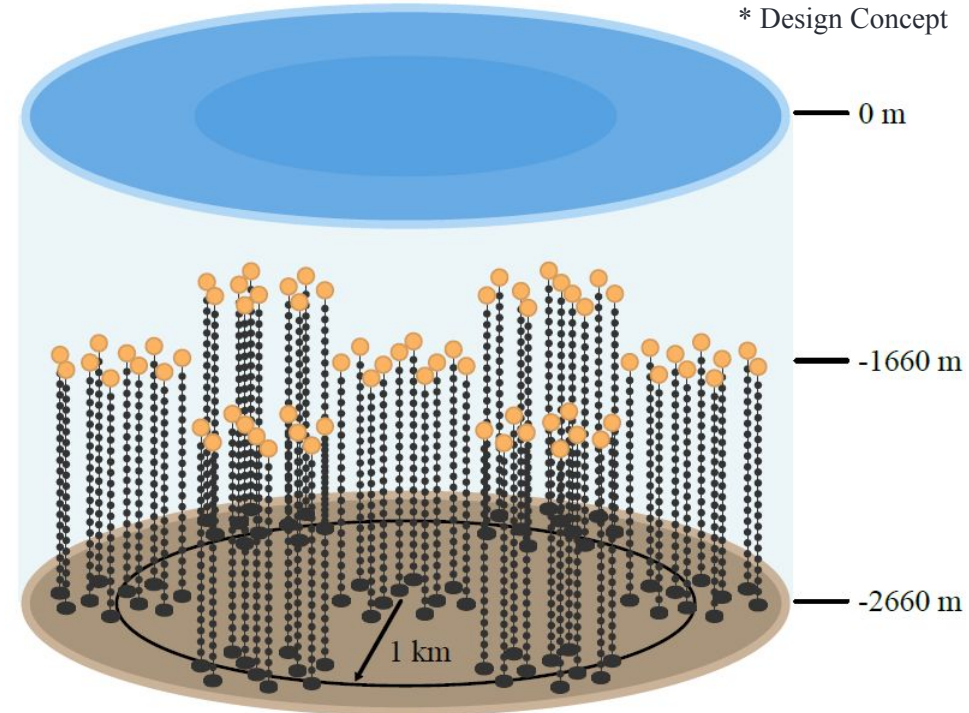


<https://nautiluslive.org/blog/2020/09/04/wiring-abyss-supporting-onca-byss-expedition-british-columbia>

The Pacific Ocean Neutrino Experiment (P-ONE)

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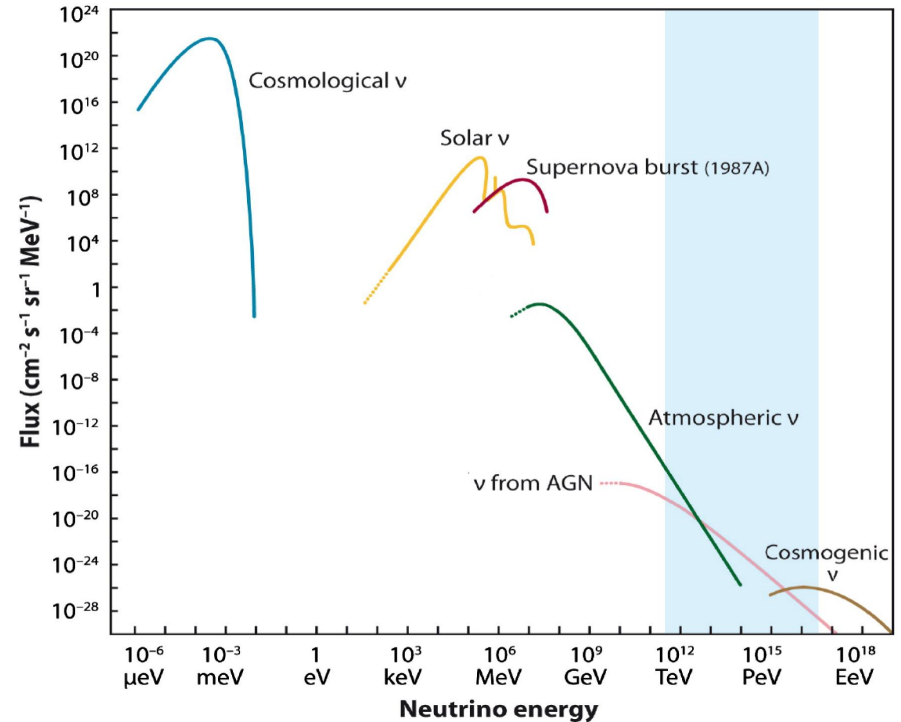
- Lattice of 1,400 optical modules spread across 70 strings



The Pacific Ocean Neutrino Experiment (P-ONE)

Planned cubic-kilometre scale neutrino telescope in the Pacific Ocean about 200 km off the coast of Vancouver Island

- Lattice of 1,400 optical modules spread across 70 strings
- Designed to target neutrinos in the TeV to PeV energy range

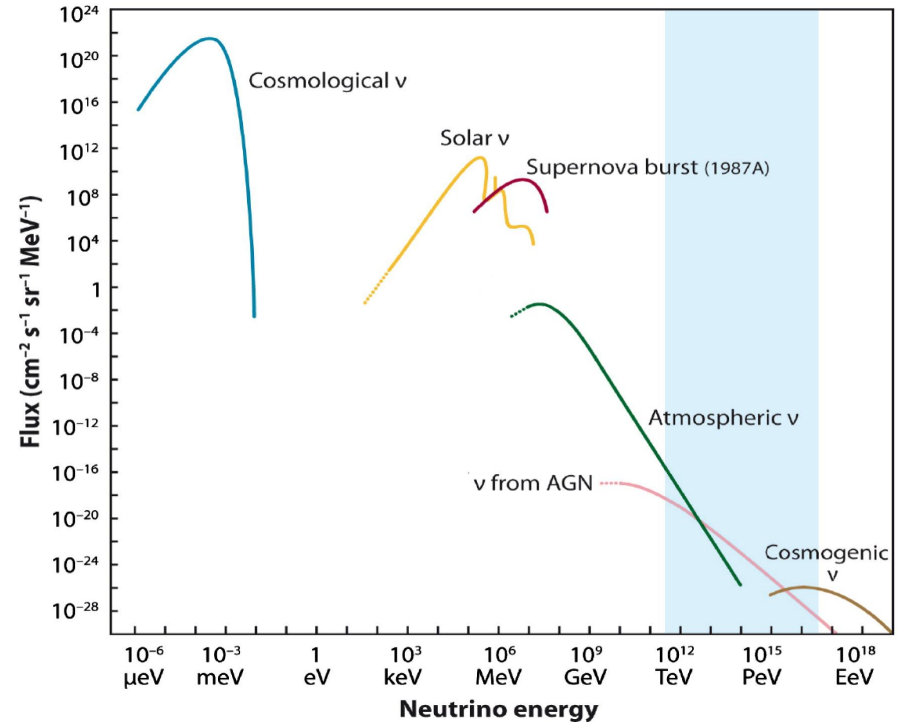


U. F. Katz and C. Spiering. High-energy neutrino astrophysics: Status and perspectives. *Progress in Particle and Nuclear Physics*, 67:651–704, 7 2012.

The Pacific Ocean Neutrino Experiment (P-ONE)

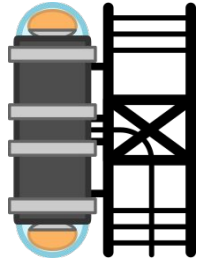
Planned cubic-kilometre scale neutrino telescope in the Pacific Ocean about 200 km off the coast of Vancouver Island

- Lattice of 1,400 optical modules spread across 70 strings
- Designed to target neutrinos in the TeV to PeV energy range
- Focused on precision with a targeted median pointing resolution of 0.4 - 0.05 degrees

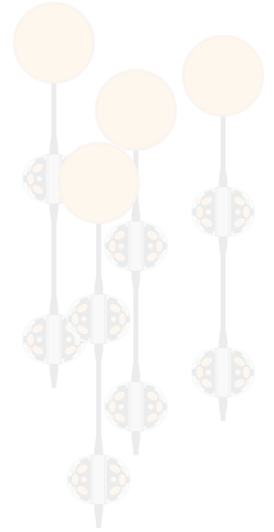
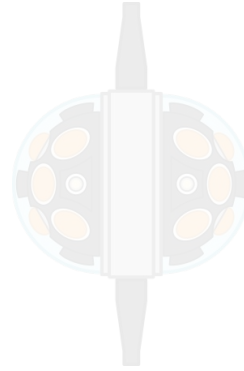


U. F. Katz and C. Spiering. High-energy neutrino astrophysics: Status and perspectives. *Progress in Particle and Nuclear Physics*, 67:651–704, 7 2012.

P-ONE Timeline



2018



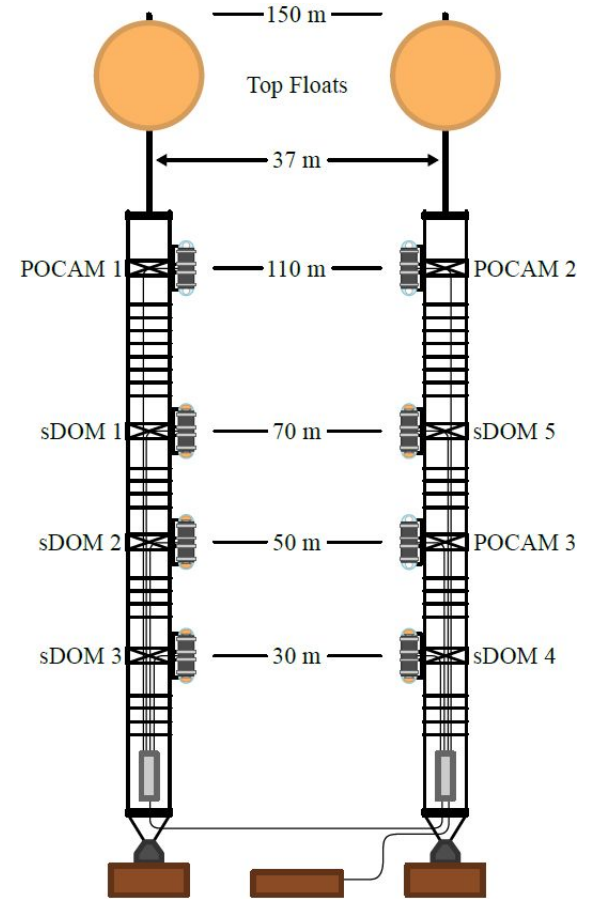
STRAW

First pathfinder

- Strings: 2
- Modules: 8
- Height: 150 m

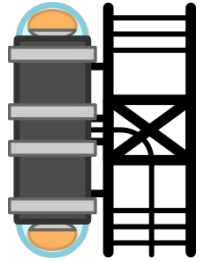
STRAW

Two strings instrumented with simple light emitting and light detecting modules for optical characterization



N. Bailly et al. Two-year optical site characterization for the Pacific Ocean Neutrino Experiment (P-ONE) in the Cascadia Basin. *The European Physical Journal C*, 81(12), December 2021.

P-ONE Timeline

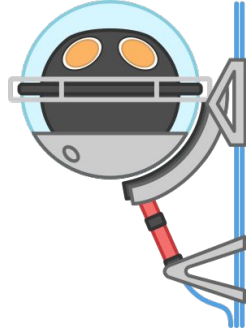


2018

STRAW

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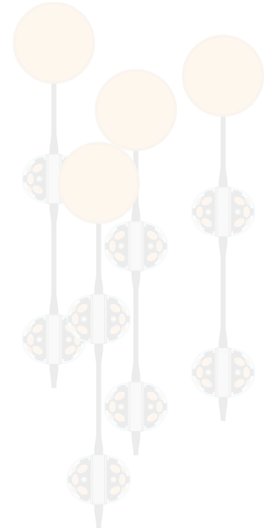
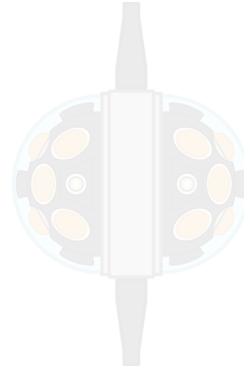


2020

STRAW-b

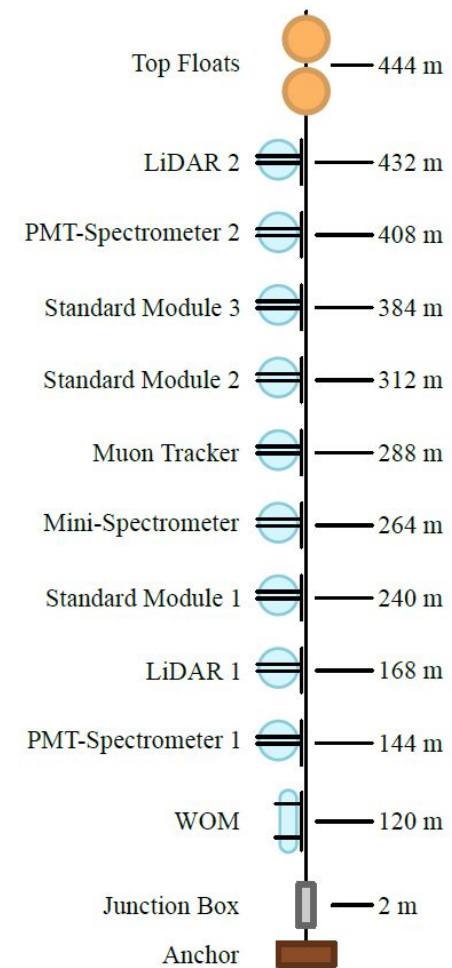
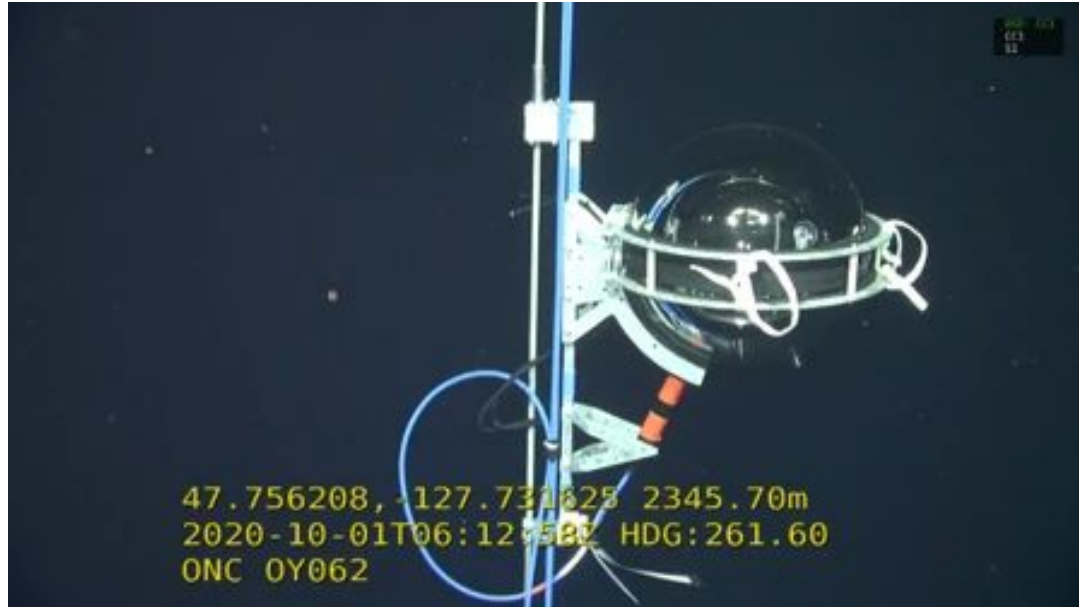
Second pathfinder

- Strings: 1
- Modules: 10
- Height: 450 m

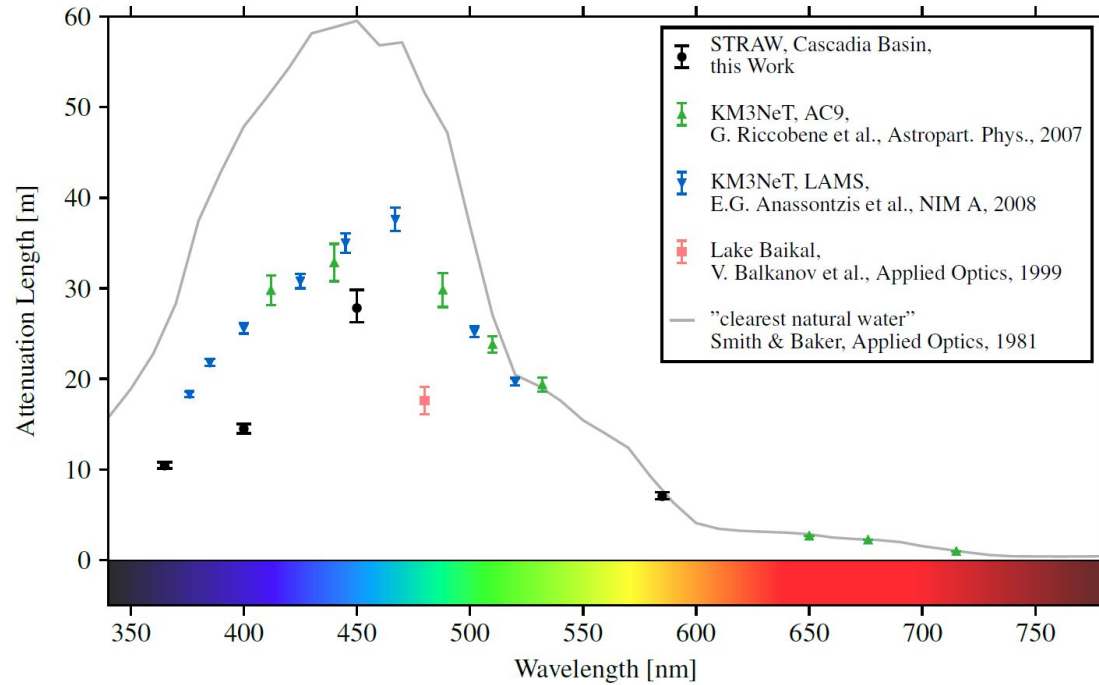


STRAW-b

Single string instrumented with a variety for characterization systems

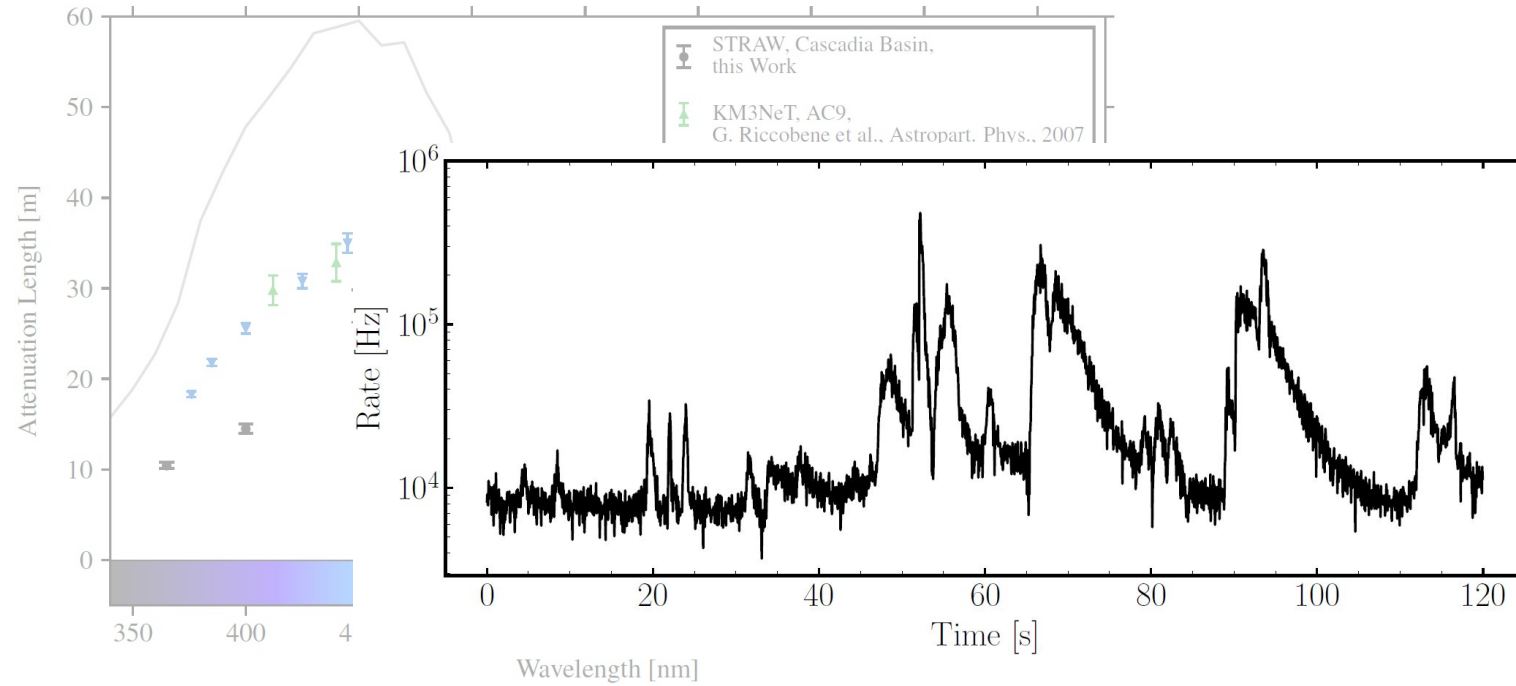


STRAW and STRAW-b Results



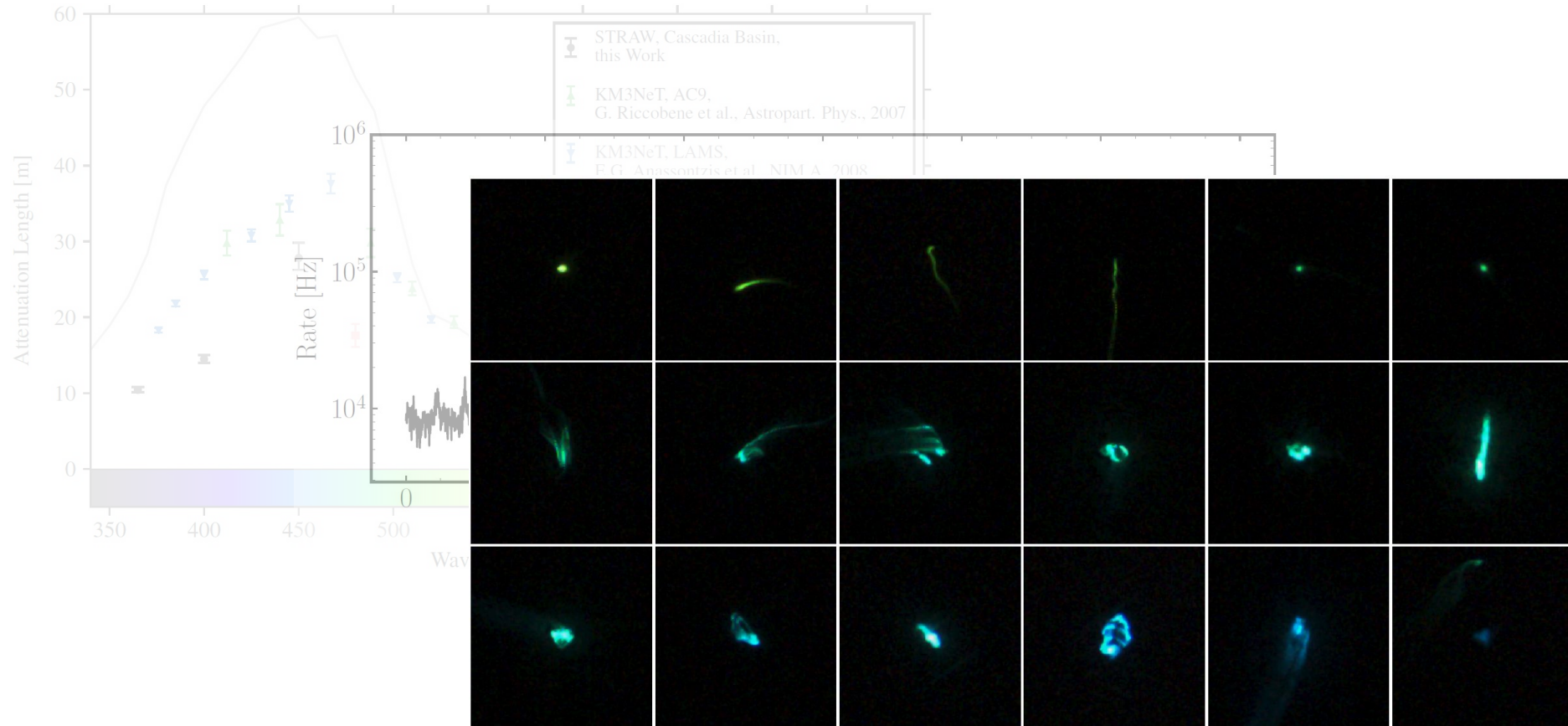
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STRAW and STRAW-b Results

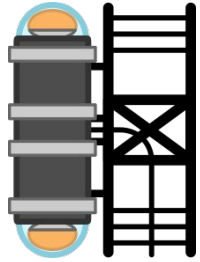


N. Bailly et al. Two-year optical site characterization for the Pacific Ocean Neutrino Experiment (P-ONE) in the Cascadia Basin. *The European Physical Journal C*, 81(12), December 2021.

STRAW and STRAW-b Results



P-ONE Timeline

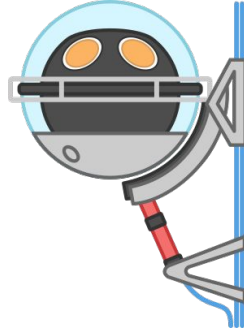


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STRAW

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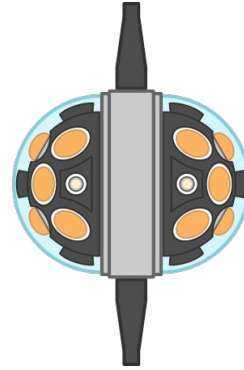


2020

STRAW-b

Second pathfinder

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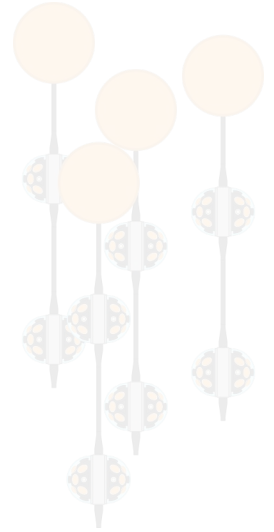


2026

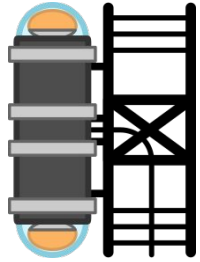
P-ONE-1

First P-ONE string

- Strings: 1
- Modules: 20
- Height: 1 km



P-ONE Timeline

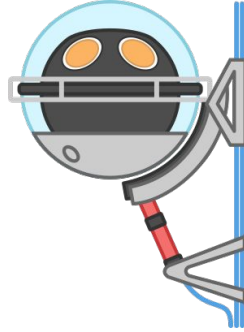


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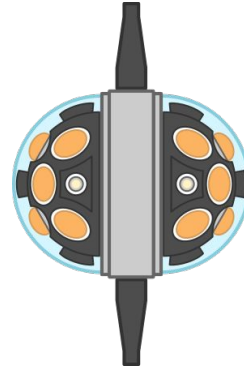


2020

STRAW-b

Second pathfinder

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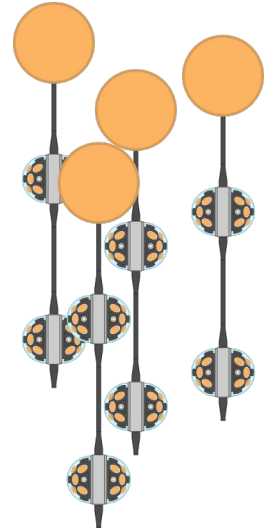


2026

P-ONE-1

First P-ONE string

- Strings: 1
- Modules: 20
- Height: 1 km



2028

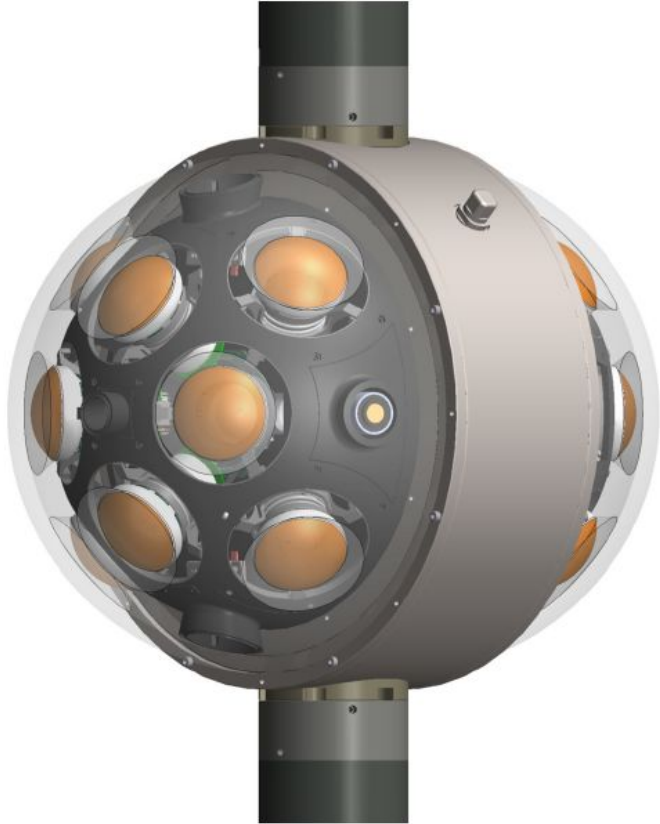
P-ONE-D

Small P-ONE cluster

- Strings: 4
- Modules: 80
- Height: 1 km

P-ONE Optical Module (P-OM)

Two 17" glass hemispheres fastened to a central titanium ring that house 16 PMTs



P-ONE-1 Deployment Procedure

P-ONE-1 is deployed from a steel deployment frame that also acts as the anchor for the string

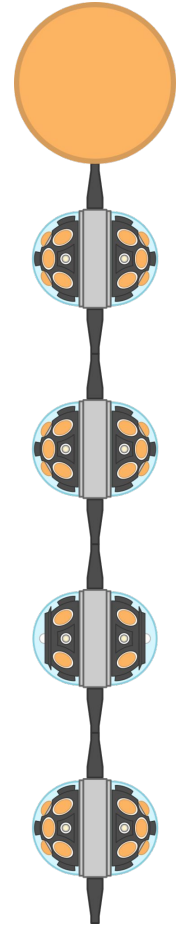
- 1) String spooled onto frame
- 2) Frame lowered to seafloor
- 3) Float released
- 4) String unspools from frame



C. Lagunas Gualda et al. First instrumented line of the Pacific Ocean Neutrino Experiment: status, development and outlook. *Proceedings of 39th International Cosmic Ray Conference*, 1087. December 2025

Environmental Calibration for P-ONE

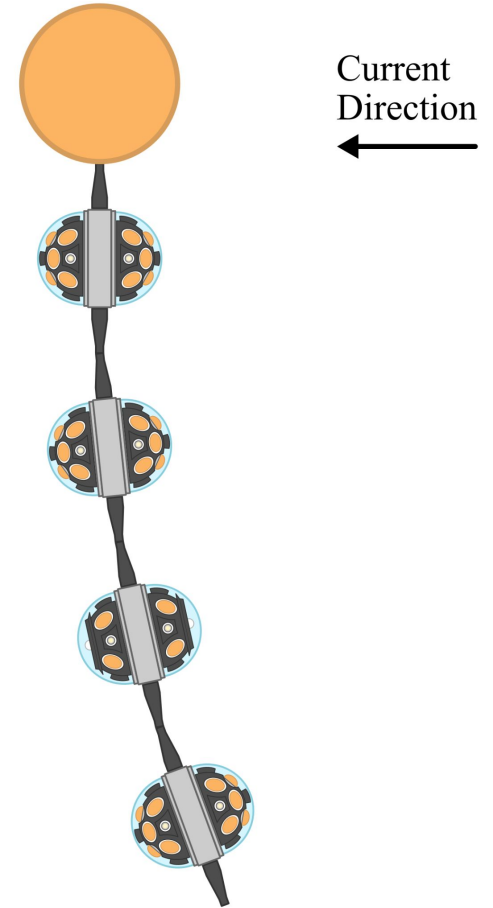
The ocean is a dynamic environment where conditions can continuously be changing



Environmental Calibration for P-ONE

The ocean is a dynamic environment where conditions can continuously be changing

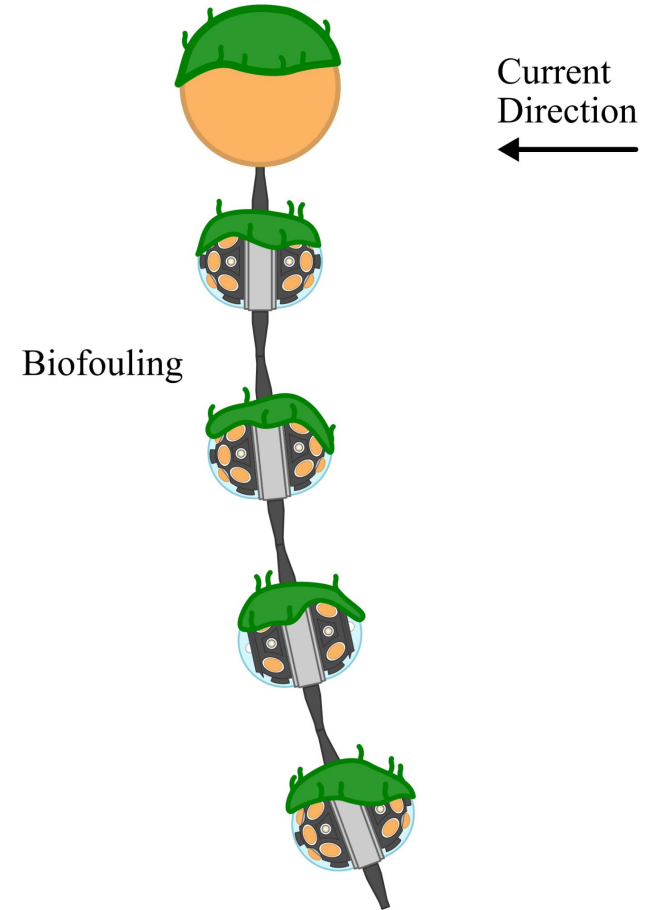
- Modules drift with ocean currents



Environmental Calibration for P-ONE

The ocean is a dynamic environment where conditions can continuously be changing

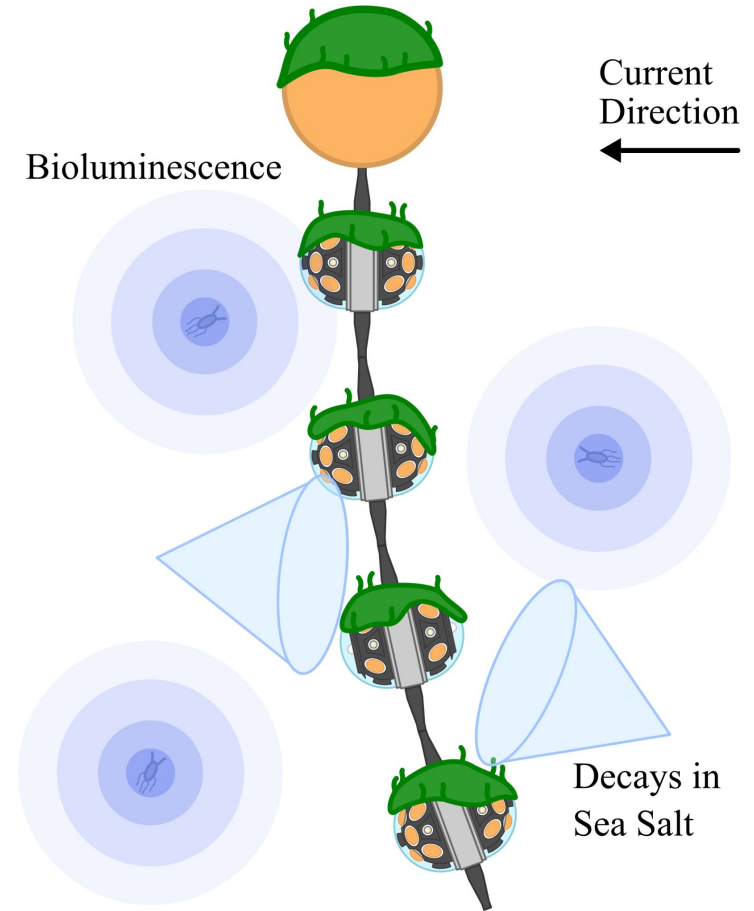
- Modules drift with ocean currents
- Sedimentation settles on top of modules and organisms can grow over time



Environmental Calibration for P-ONE

The ocean is a dynamic environment where conditions can continuously be changing

- Modules drift with ocean currents
- Sedimentation settles on top of modules and organisms can grow over time
- Intrinsic sources of light in the deep sea produce a continuous optical background



Environmental Calibration for P-ONE

P-ONE needs excellent environmental calibration systems to ensure it will meet its precision targets

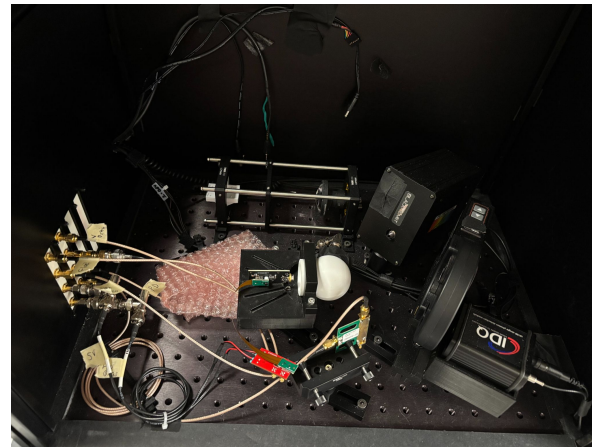
- Simon Fraser University (SFU) focused on developing these environmental calibration systems with HQP funding



SIMON FRASER
UNIVERSITY



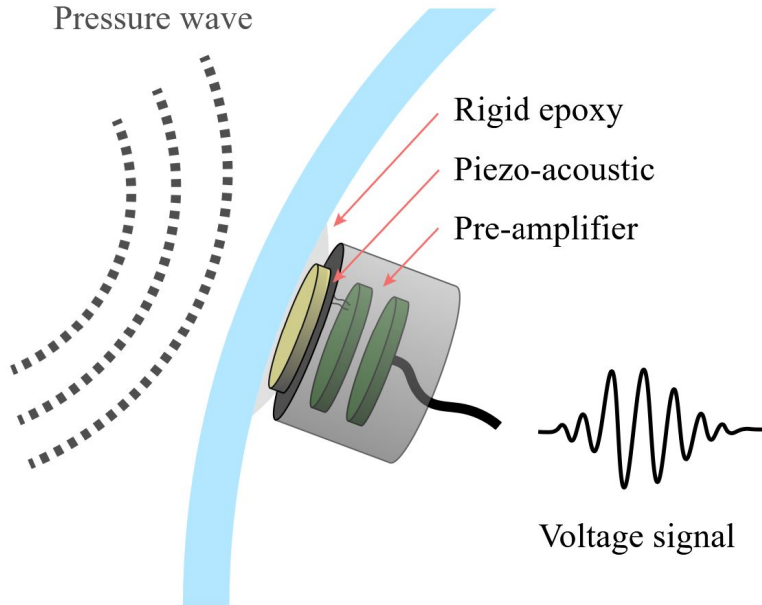
Arthur B. McDonald
Canadian Astroparticle Physics Research Institute



Acoustic Calibration Systems

Piezoelectric acoustic receivers are used in combination with acoustic beacons on the seafloor to triangulate the position of each module. See publication: <https://iopscience.iop.org/article/10.1088/1748-0221/20/07/P07003>

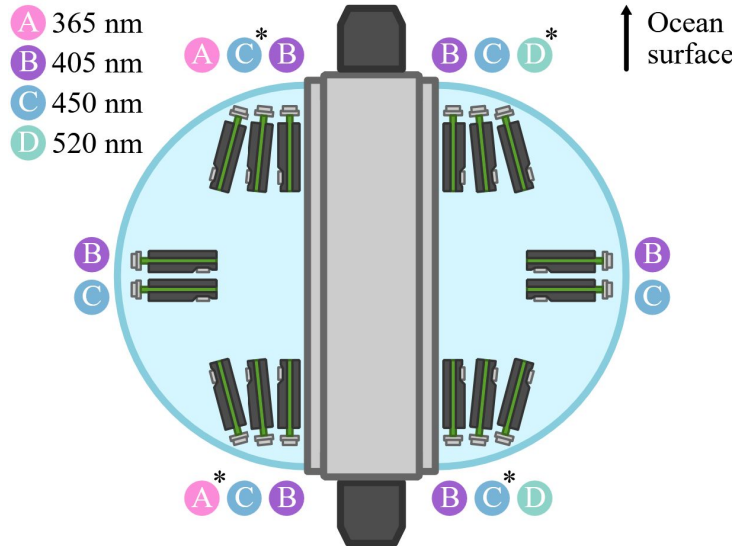
- 2 receivers in each module, 40 in all of P-ONE-1
- Expect a positioning accuracy of 25-30 cm for P-ONE-1



Optical Calibration Systems - Directional Flashers

Directional sub-nanosecond laser diode / LED flashers measure the optical properties of seawater in 50 m segments along the entire water column. See publication: <https://iopscience.iop.org/article/10.1088/1748-0221/21/07/P07029>

- 14 flashers in each module, 296 in all of P-ONE-1

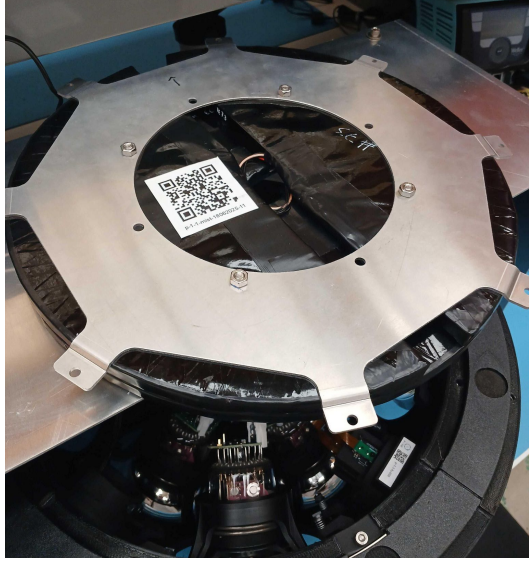


Optical Calibration Systems - P-ONE Calibration Module (P-CAL)

Dedicated calibration module with an isotropic flasher for volumetric optical calibration and camera system for monitoring sedimentation and bioluminescence. See publication: <https://iopscience.iop.org/article/10.1088/1748-0221/21/07/P07029>



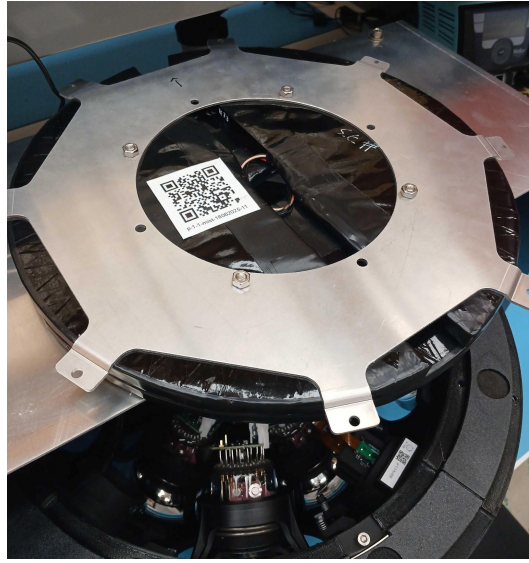
Other Systems in P-ONE



Muon In-Situ Tracker

4 scintillator blocks to tag muons
that pass through a module

Other Systems in P-ONE



Muon In-Situ Tracker

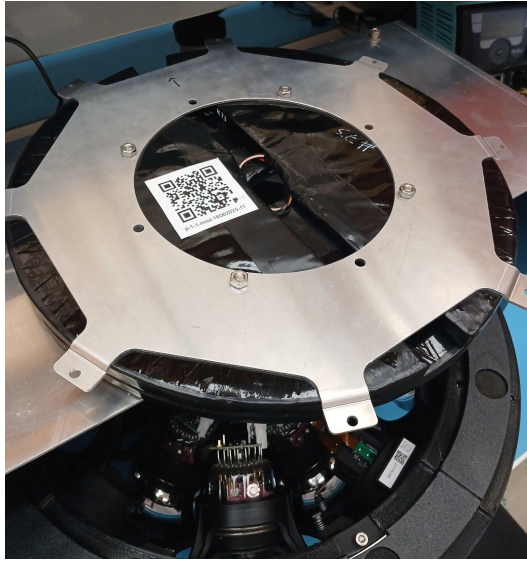
4 scintillator blocks to tag muons
that pass through a module



Axicon

Directional flasher with an axicon
lens to emit a calibration
'Cherenkov ring' of light within the
detector volume

Other Systems in P-ONE



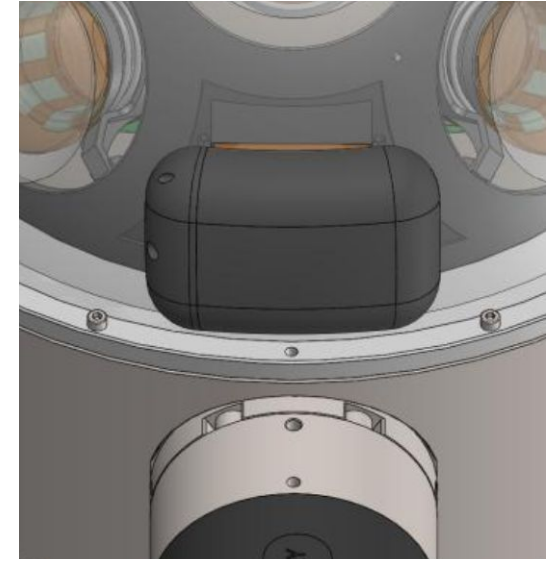
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Directional flasher with an axicon
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detector volume



Barnacle

Oceanography sensor interface for
long term monitoring of
temperature, dissolved oxygen, ...)

* Not in P-ONE-1

P-OM Production for P-ONE-1

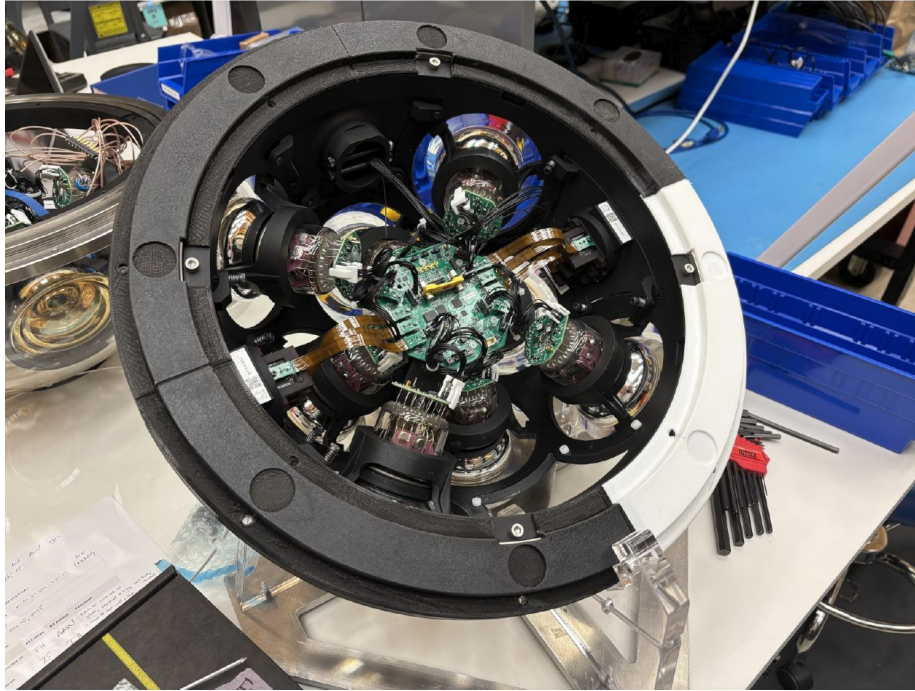
Glass hemispheres were instrumented with PMTs in Munich and then shipped to TRIUMF



C. Lagunas Gualda et al. First instrumented line of the Pacific Ocean Neutrino Experiment: status, development and outlook. *Proceedings of 39th International Cosmic Ray Conference*, 1087. December 2025

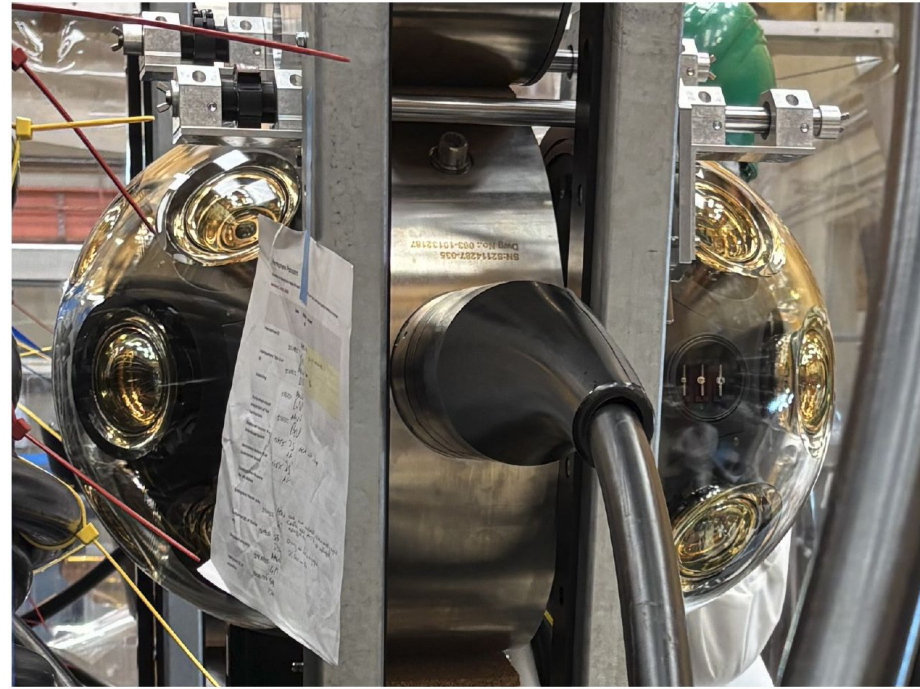
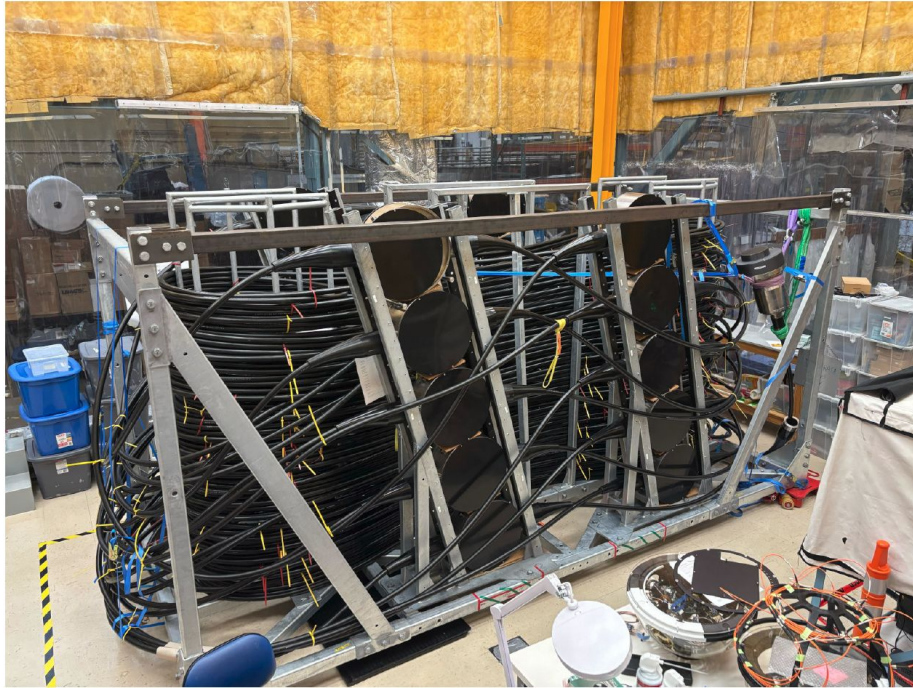
P-ONE-1 Integration

Remaining components integrated at TRIUMF and acceptance test performed to verify functionality of all subsystems



P-ONE-1 Integration

Complete hemispheres mounted to the string on the deployment frame



P-ONE-1 Wet Test

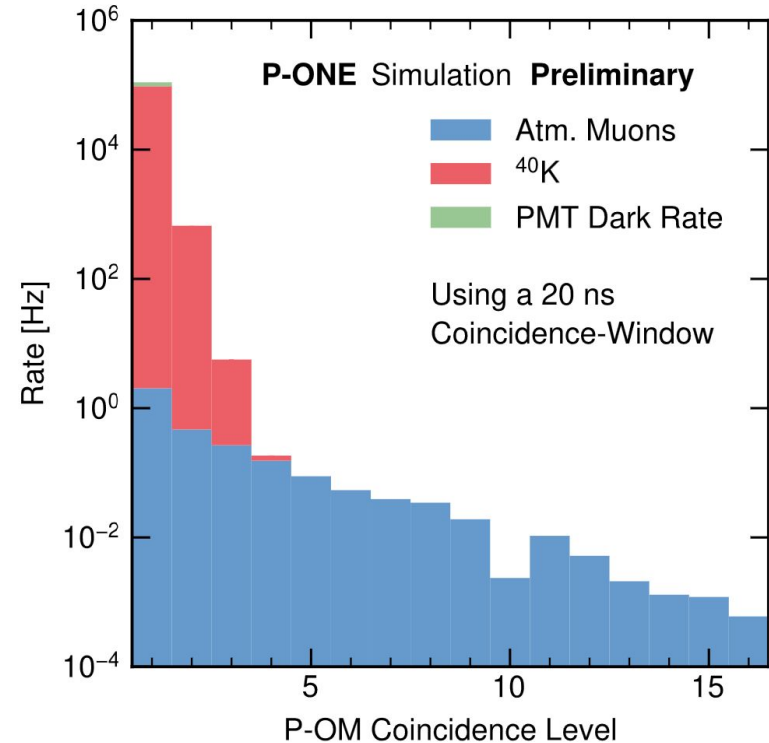
String submerged in Vancouver shipyard to check system function and ensure there are no leaks



P-ONE-1 Goals

P-ONE-1 will be critical to help us understand:

- Detector operation
- Calibration system performance
- Optical background

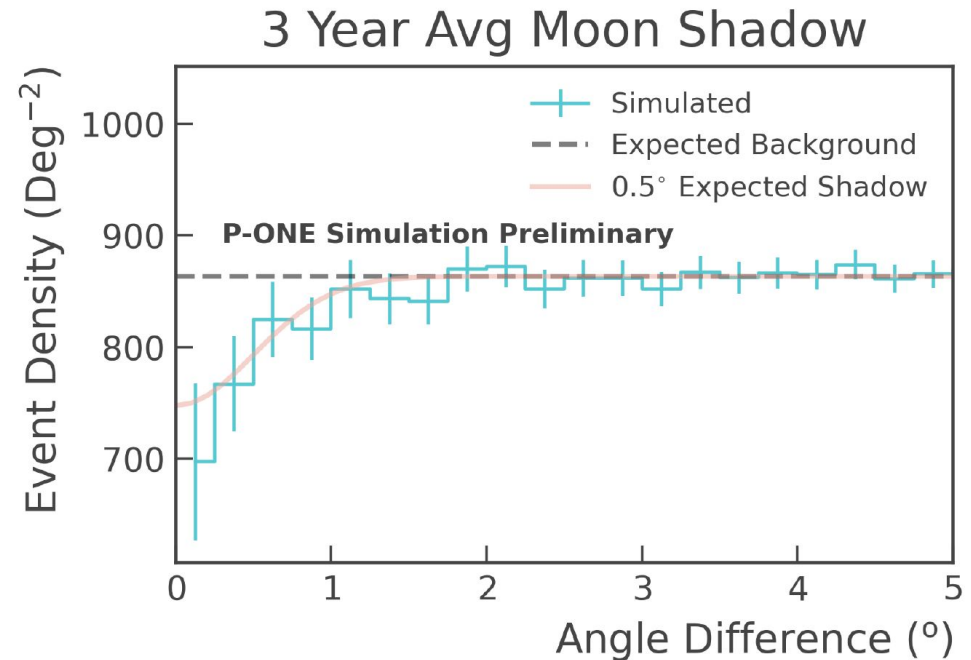


F. Henningsen et al. Pacific Ocean Neutrino Experiment: Expected performance of the first cluster of strings. *Proceedings of 38th International Cosmic Ray Conference*, 1053. July 2023

P-ONE-D Outlook

With more strings in P-ONE-D we will be able to:

- Measure atmospheric neutrino spectrum
- Verify reconstruction techniques using moon and sun shadow analyses



D. Ghuman. Acoustic Positioning Technology for the Underwater Pacific Ocean Neutrino Experiment. *PhD Thesis*, 2026. Simon Fraser University.

Thank You!



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POLSKIEJ AKADEMII NAUK



Deutsche Forschungsgemeinschaft
German Research Foundation

SFB 1258



**Neutrinos
Dark Matter
Messengers**



**INSTITUTE OF
PARTICLE
PHYSICS**
1971 - 2021



Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

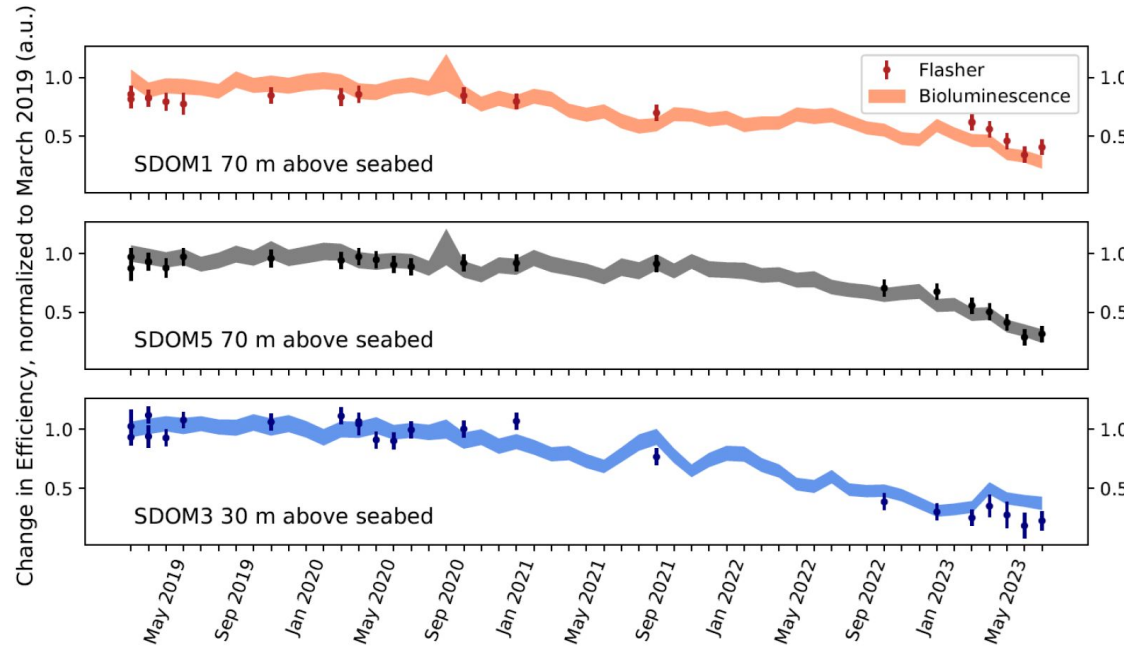


**Science and
Technology
Facilities Council**

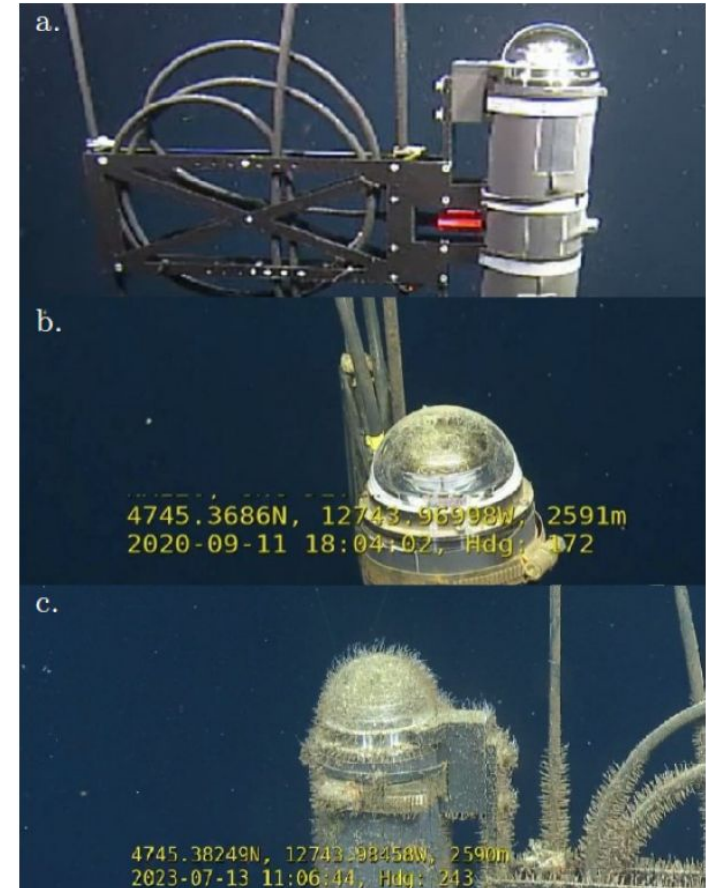


Backup

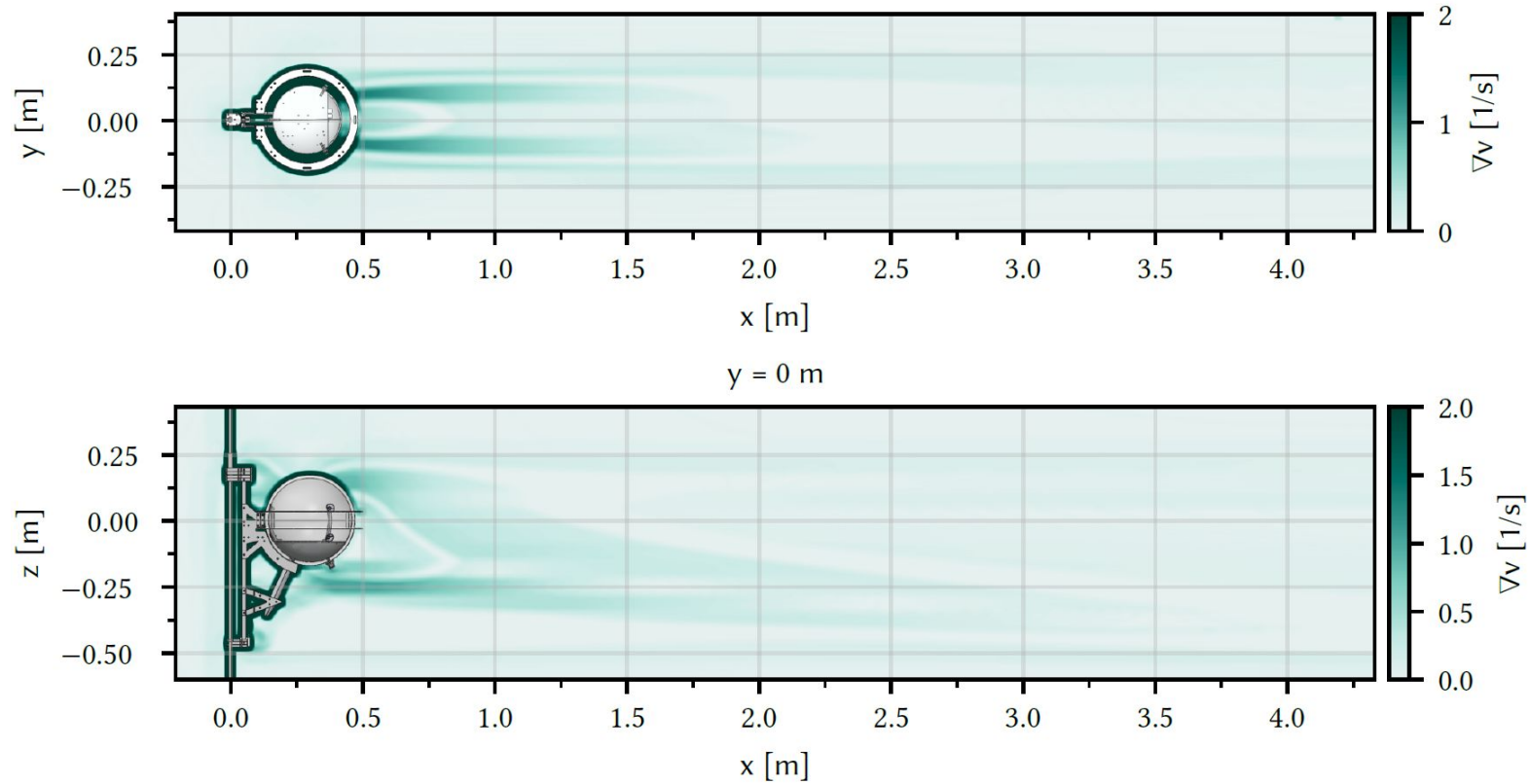
Impact of Biofouling



O. Aghaei et al. Long Term Study of Sedimentation and Biofouling at Cascadia Basin, the Site of the Pacific-Ocean Neutrino Experiment. *The European Physical Journal C*, 2025.

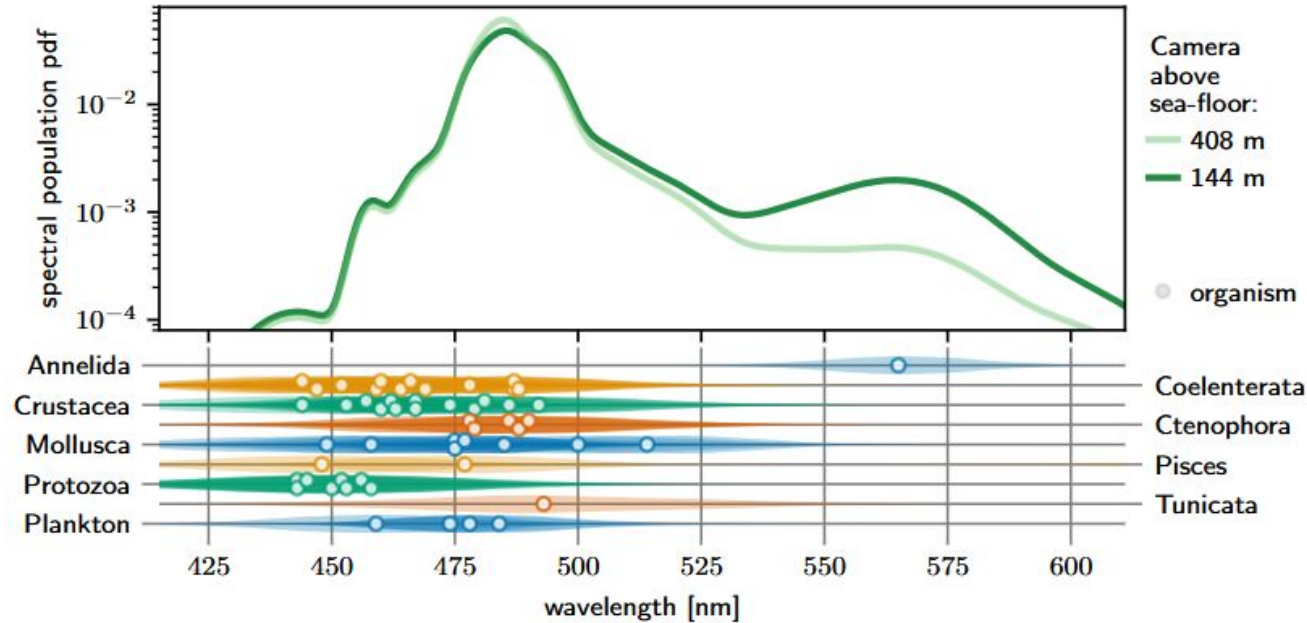


Bioluminescence in the Wake of STRAW-b

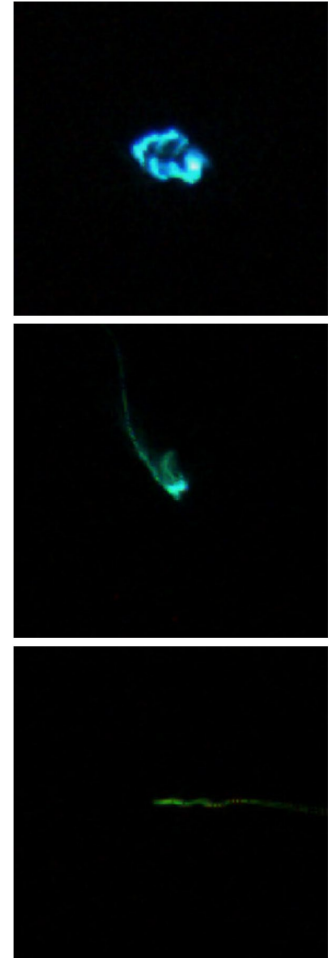


K. Holzapfel. Bioluminescence in the Pacific Ocean Neutrino Experiment: Shedding Light on the Deep Sea. *PhD Thesis*, 2023. Technical University of Munich.

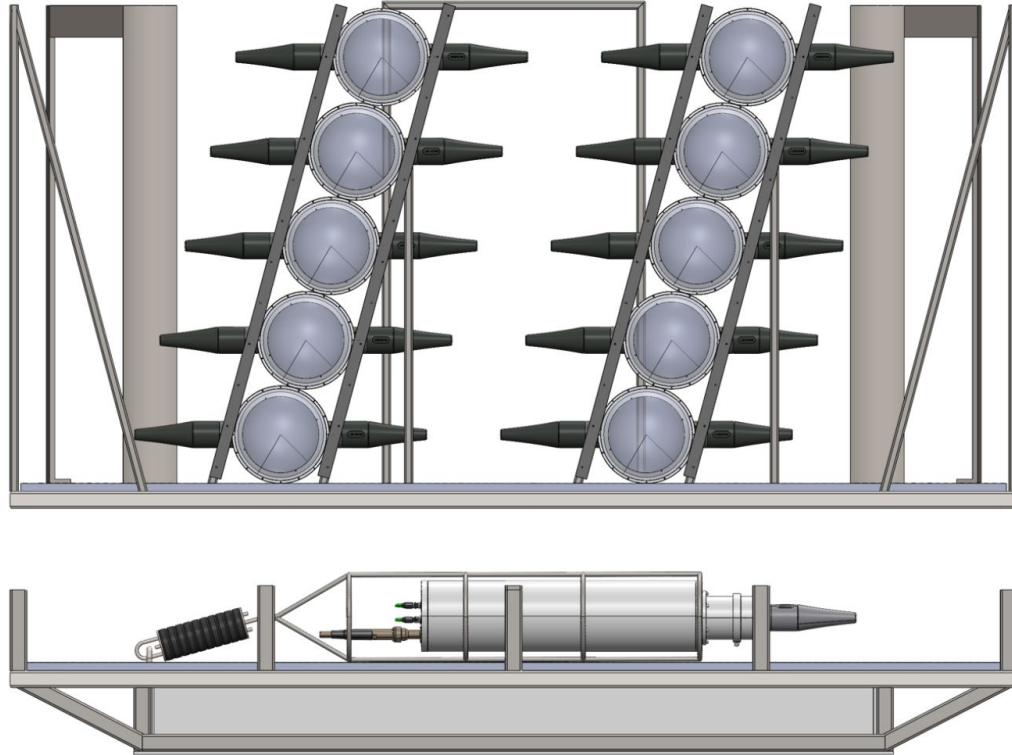
Bioluminescence Analysis in STRAW-b



K. Holzapfel. Bioluminescence in the Pacific Ocean Neutrino Experiment: Shedding Light on the Deep Sea. *PhD Thesis*, 2023. Technical University of Munich.



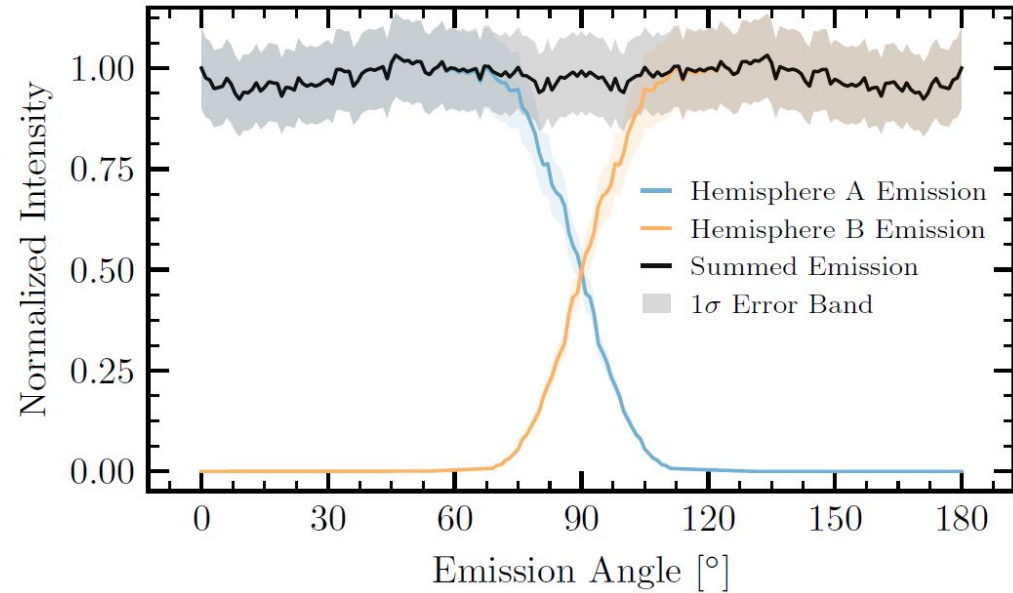
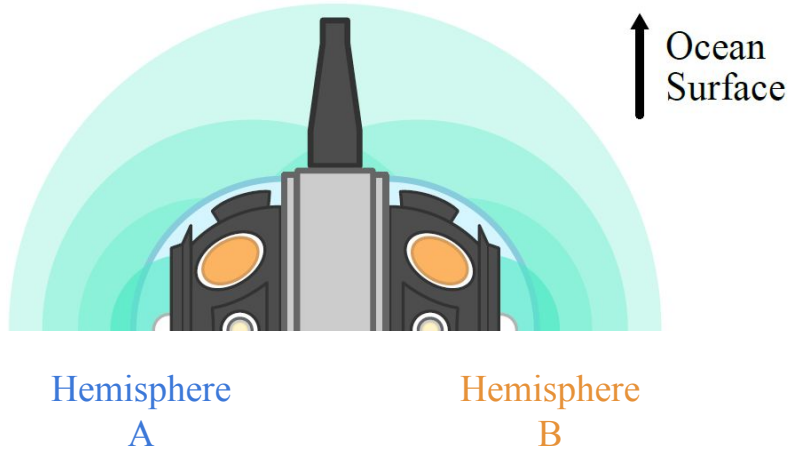
P-ONE-1 Deployment Frame



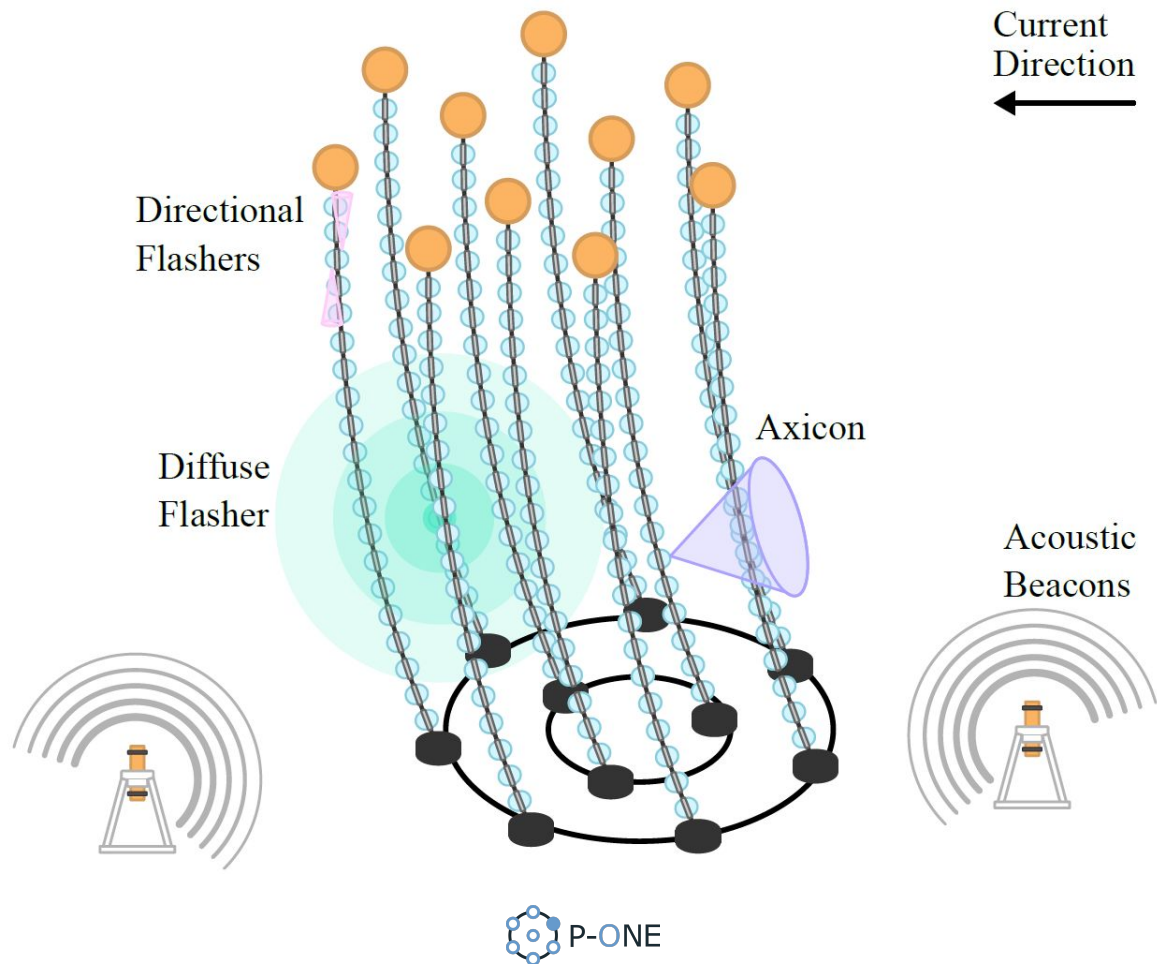
C. Lagunas Gualda et al. First instrumented line of the Pacific Ocean Neutrino Experiment: status, development and outlook. *Proceedings of 39th International Cosmic Ray Conference*, 1087. December 2025

P-CAL Design Methodology

The P-CAL was designed to produce an isotropic emission when both hemispheres are flashed synchronously



P-ONE Calibration Full Picture



M. Agostini et al. Optical calibration systems of the Pacific Ocean Neutrino Experiment, 2026.