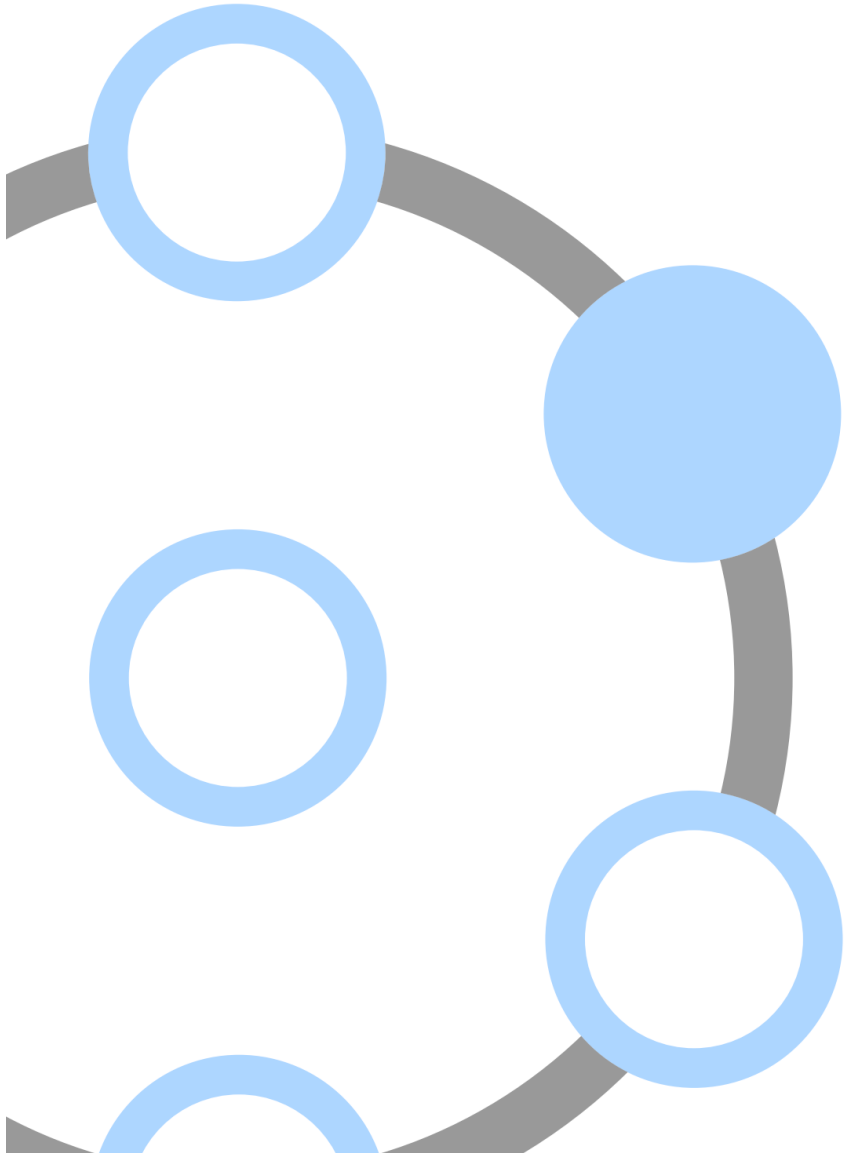
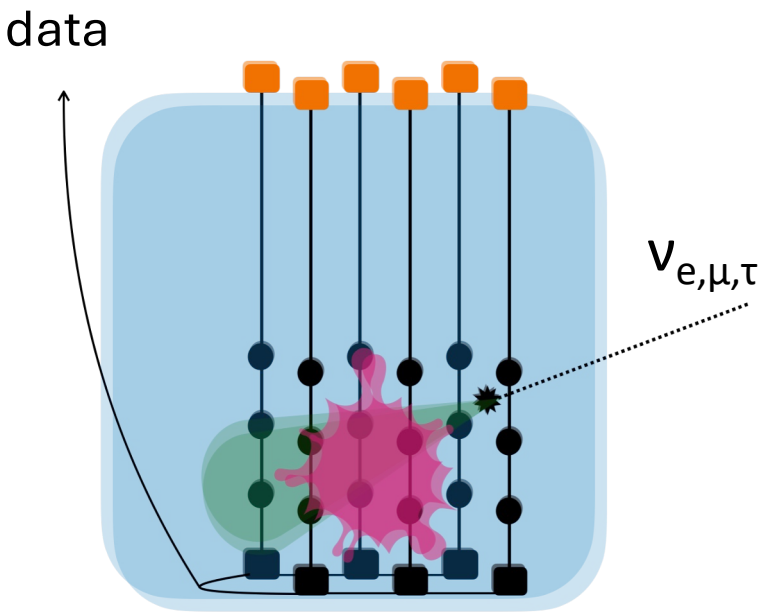


Design and Production of the first P-ONE detector line

Ben Nührenbörger for the P-ONE collaboration

Astrophysical neutrino detectors

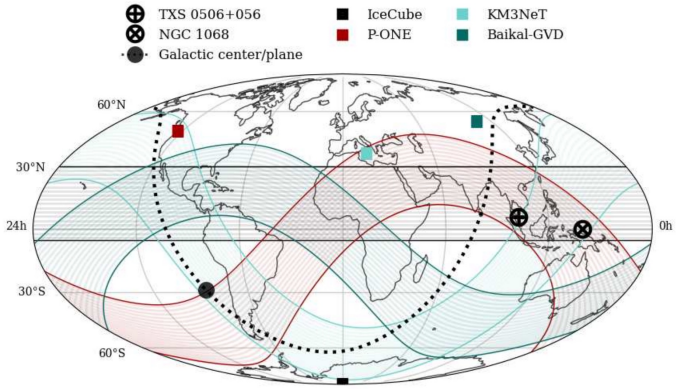
- Astronomical sources emit high-energy neutrinos
- Only interact weakly → good messenger
- Hard to detect
- Secondary particle Cherenkov radiation
- Big volume, low background
  - Our case: deep sea
- Poses calibration challenges
  - Bioluminescence and sedimentation
  - Positioning
  - Optical properties of the water

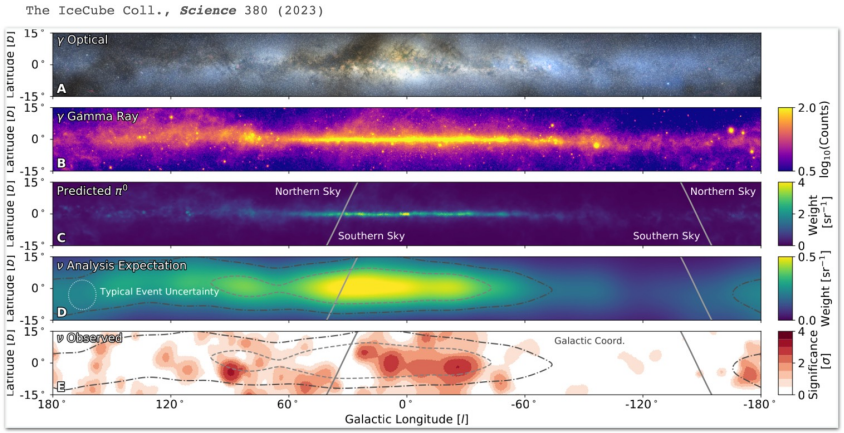


Notable results from other detectors

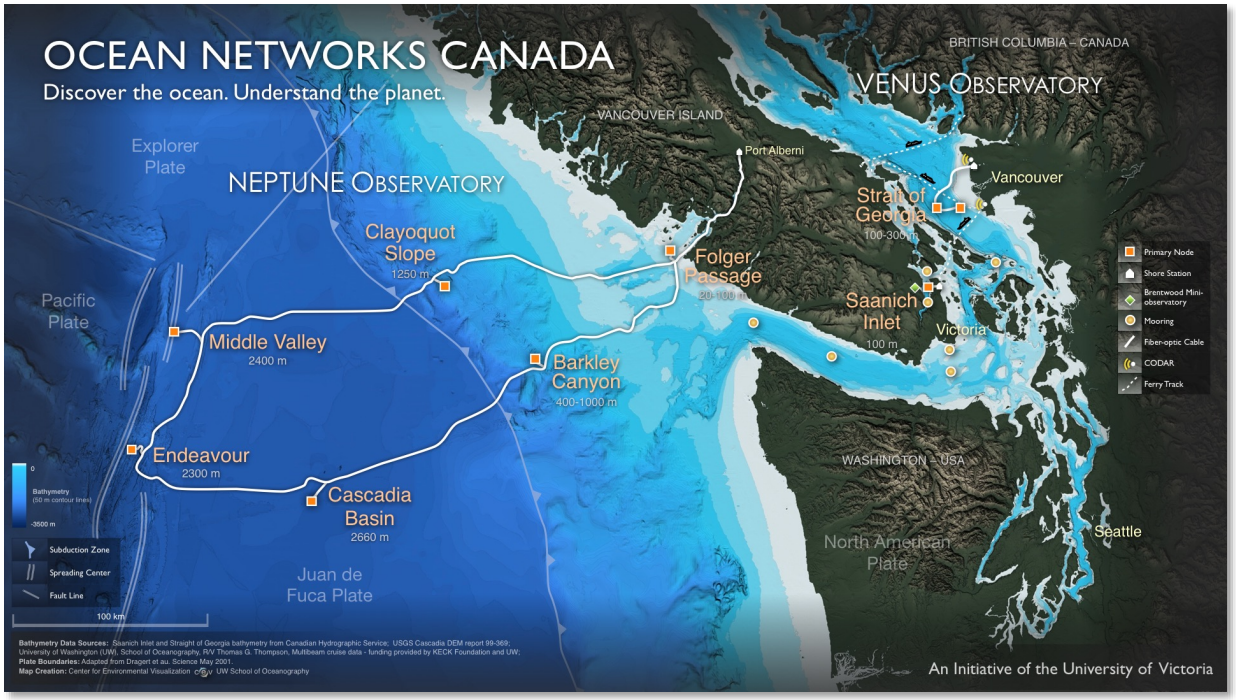
Lisa Schumacher, PLEnuM

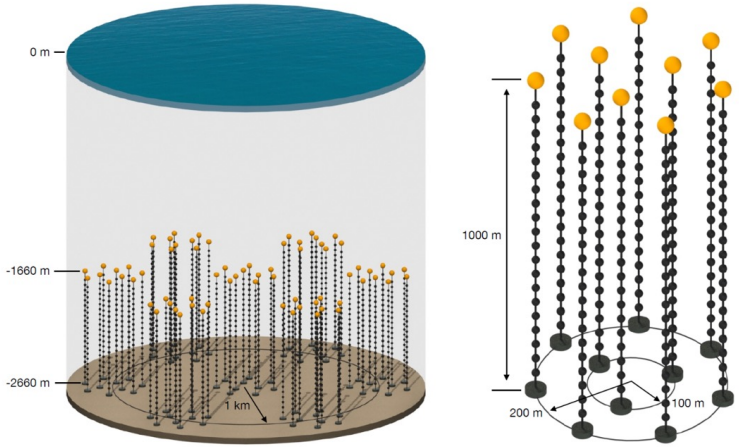
- Evidence for neutrino emission from astrophysical sources found by existing experiments
- Neutrinos from the galactic plane
- Highest energy neutrino 120 PeV discovered from KM3NeT
- Still a lot of space uncovered





Pacific Ocean Neutrino Experiment (P-ONE)



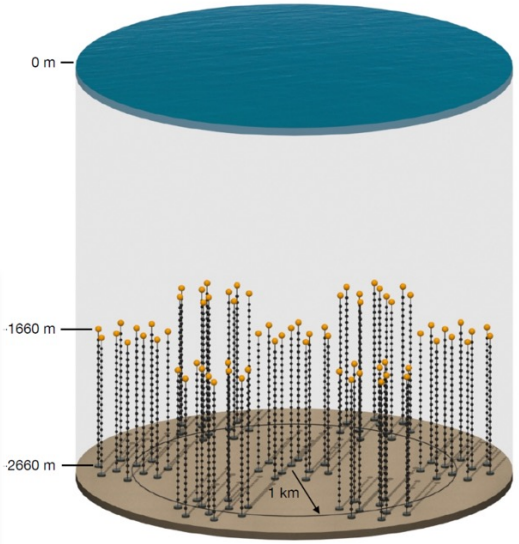


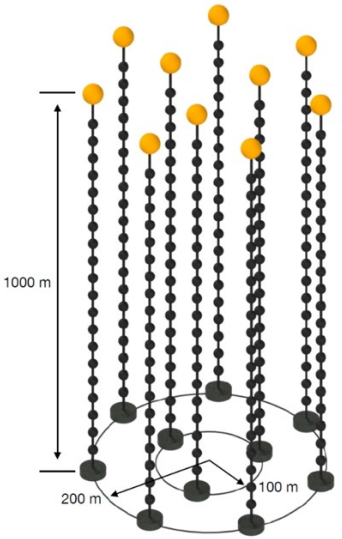
Preliminary

P-ONE

Quick facts:

- Cherenkov Detector
- 2660 m below sea level
- 1000 m detector line length
- Multiple clusters planned
- P-ONE-1 first detector line to be deployed this year
- Supported by ONC

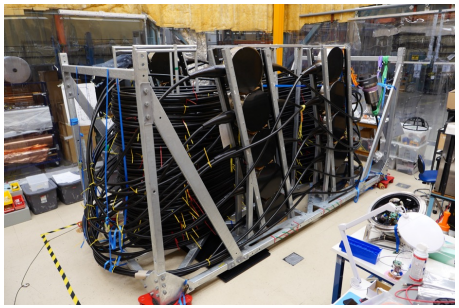


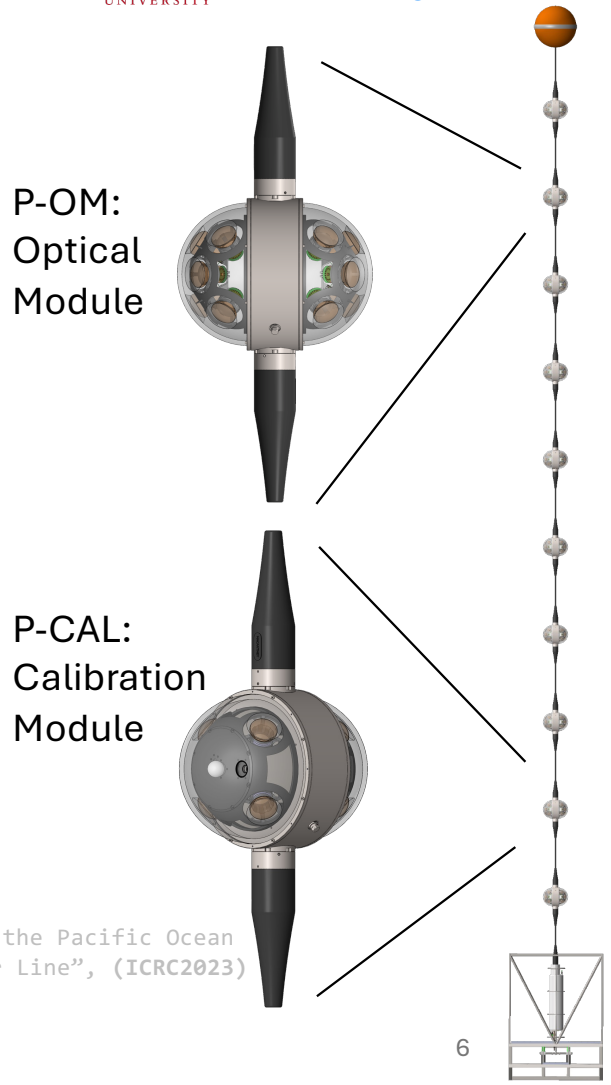


Preliminary

P-ONE-1 Overview and Objectives

- Currently under construction
  - P-OM and P-CAL
  - Distance of 50m between modules
- Collect as much data as possible
- Proof our modular and scalable design
- Proof of deployment concept

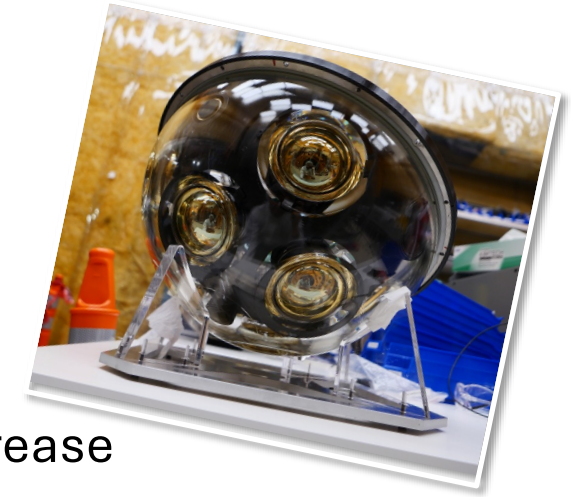


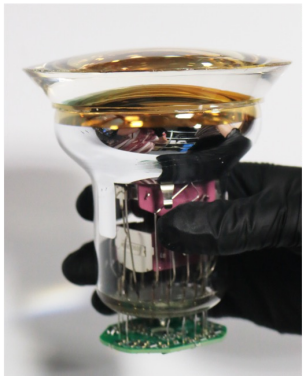


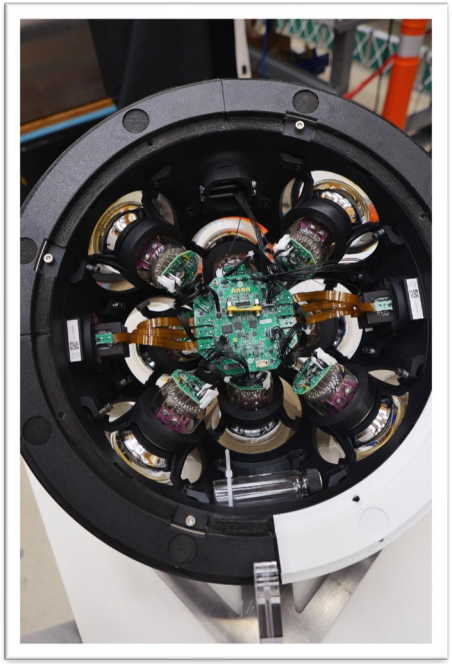
C. Spannfellner, et al., “Design of the Pacific Ocean Neutrino Experiment’s First Detector Line”, (ICRC2023)

Optical Module

- 18 P-OMs in P-ONE-1
- 8 PMTs per hemisphere
- Optical gel reflector pads to increase light yield
- Includes acoustical and optical calibration instruments
- Some hemispheres are coated against sedimentation



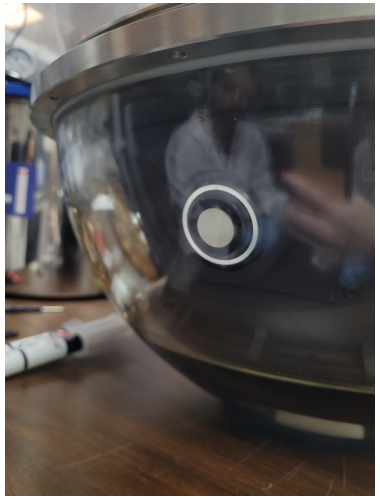


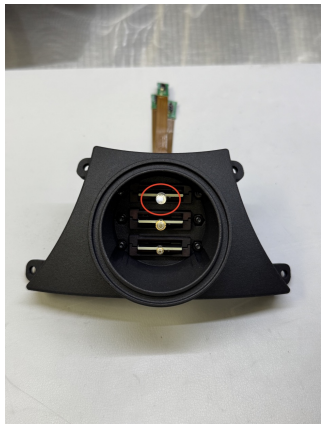


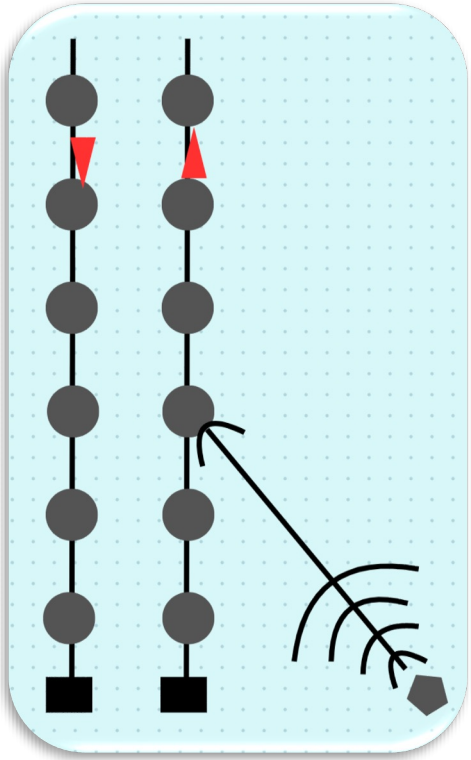
C. Spannfellner, et al., “Design of the Pacific Ocean Neutrino Experiment’s First Detector Line”, (ICRC2023)

Calibration systems

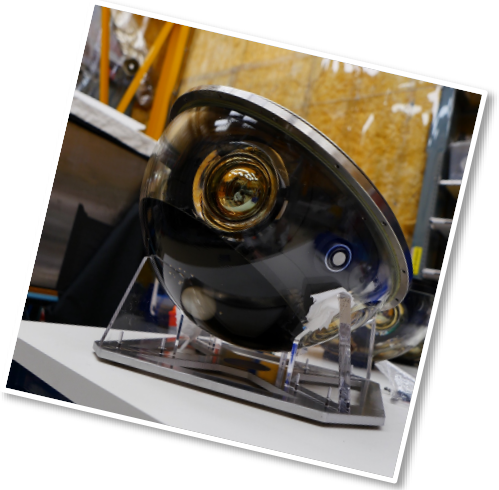
- Optical calibration
  - Monitor water properties
  - Flasher modules in each hemisphere
- Acoustic calibration
  - Positioning of the line in water
  - Acoustic receivers in each module







Calibration Module

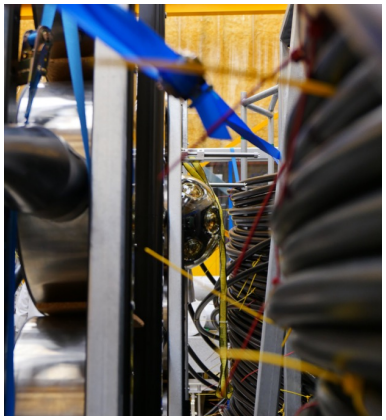


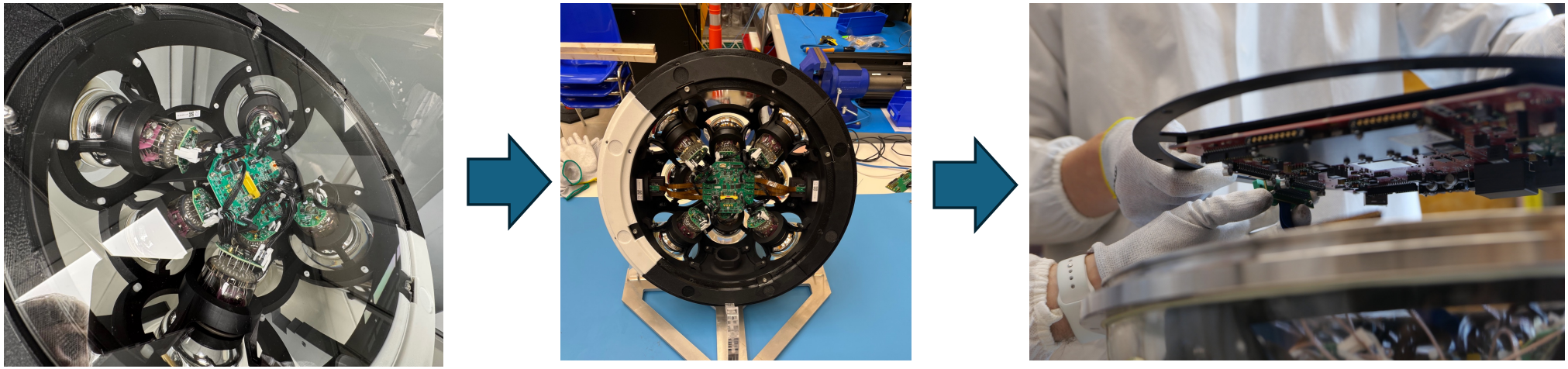
- 2 P-CALs in P-ONE-1
- 4 PMTs per Hemisphere
- Diffuse light source
- In-situ monitoring by a photodiode and a SiPM
- Camera for tracking of bioluminescence and sedimentation

J. Stacho, et al., "Optical Calibration", (ICRC2023)

P-OM Production

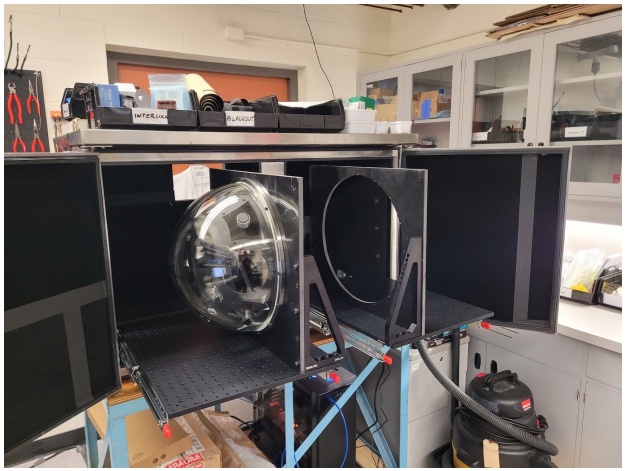
- Arrived with PMTs and PMT control board at TRIUMF
- Integration of optical and acoustic calibration instruments
- Fixation of cabling and noise breaking equipment
- Integration of the mainboard and muon tracker

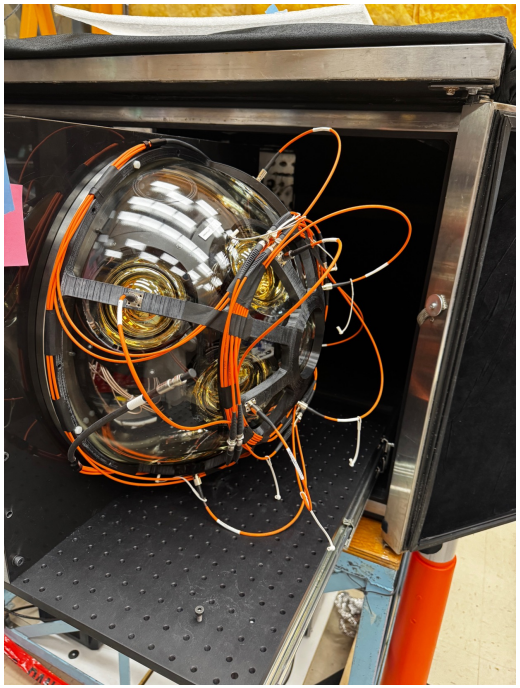




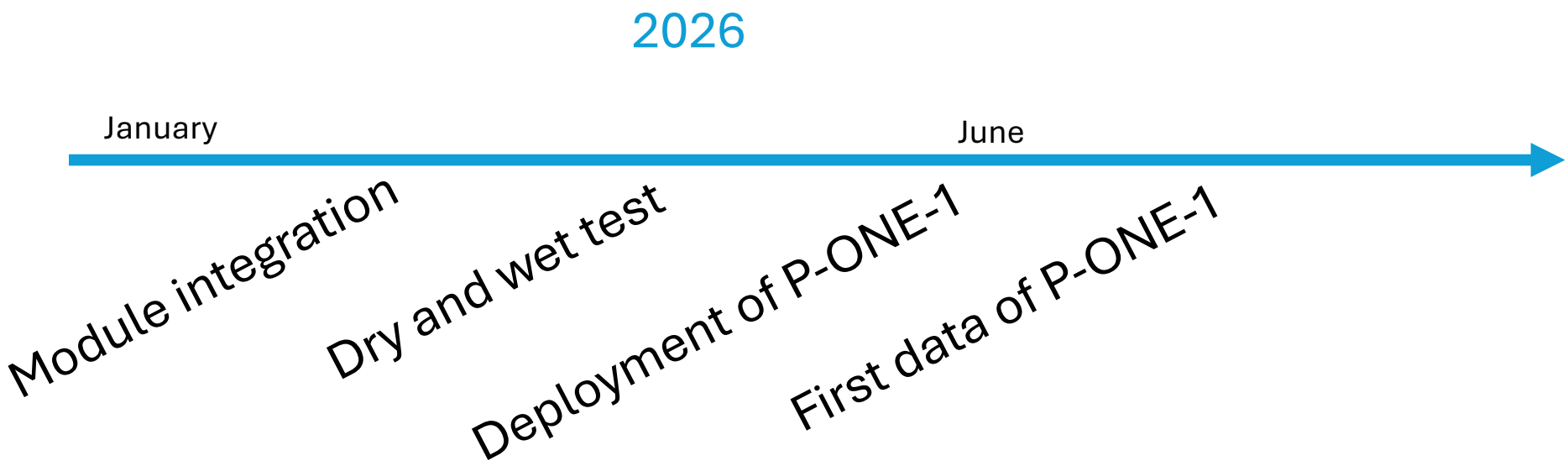
Testing

- Each component is tested before shipment
- Final component test at TRIUMF
  - Check that all components work as intended
- Dry and Wet test of the entire string
  - Testing of all the components on the deployment frame and in water

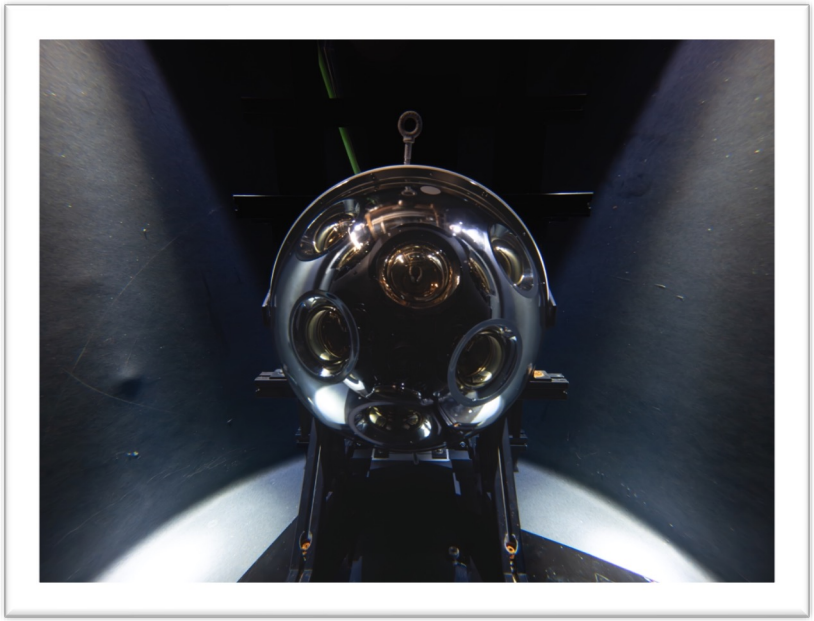




Outlook

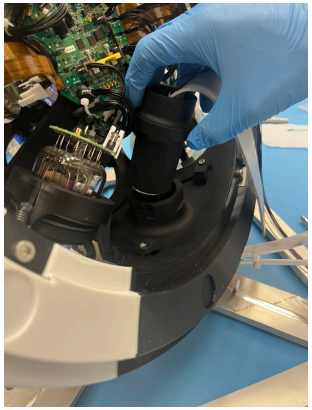


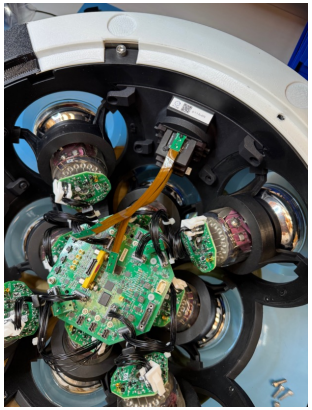
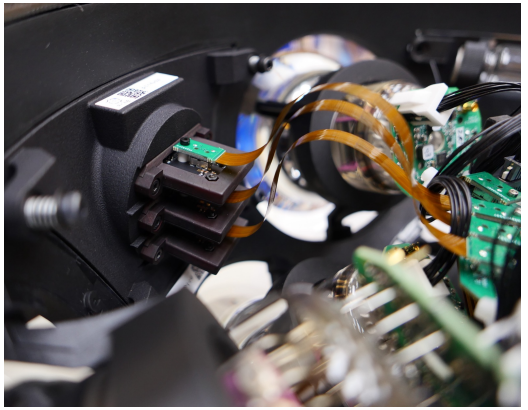
Works on P-ONE-Demonstrator

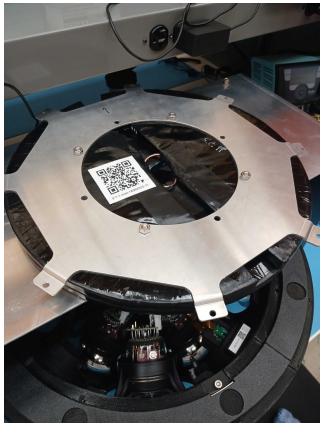
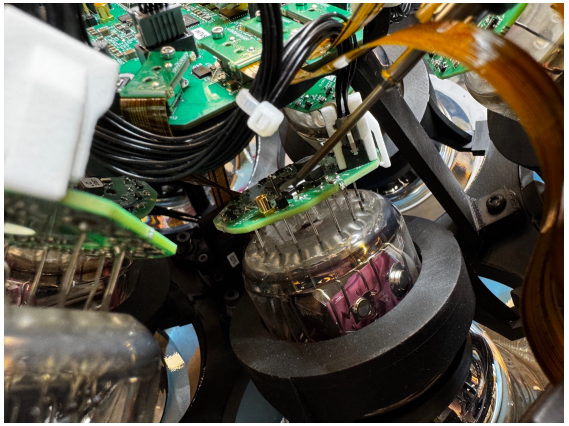
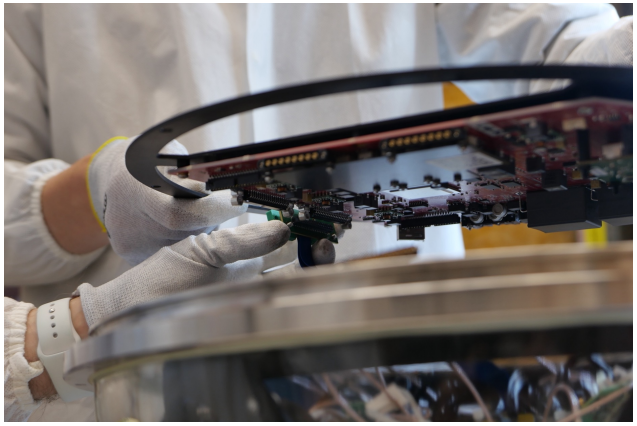


Backup

P-OM Production



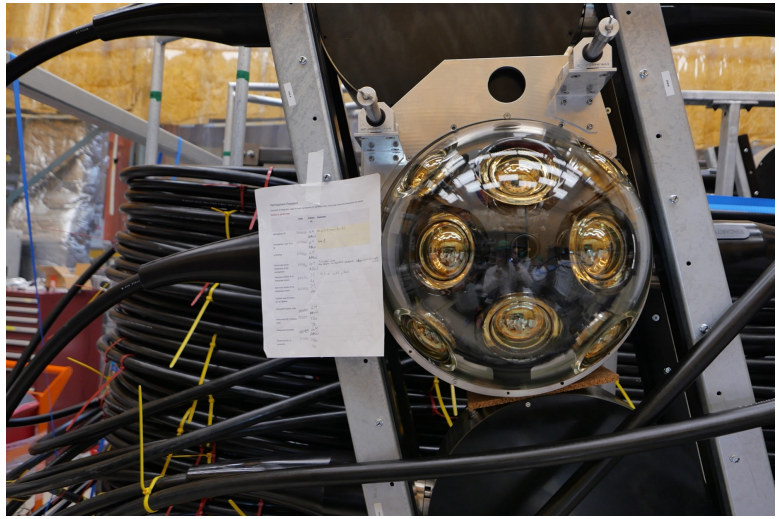




DAQ and Timing

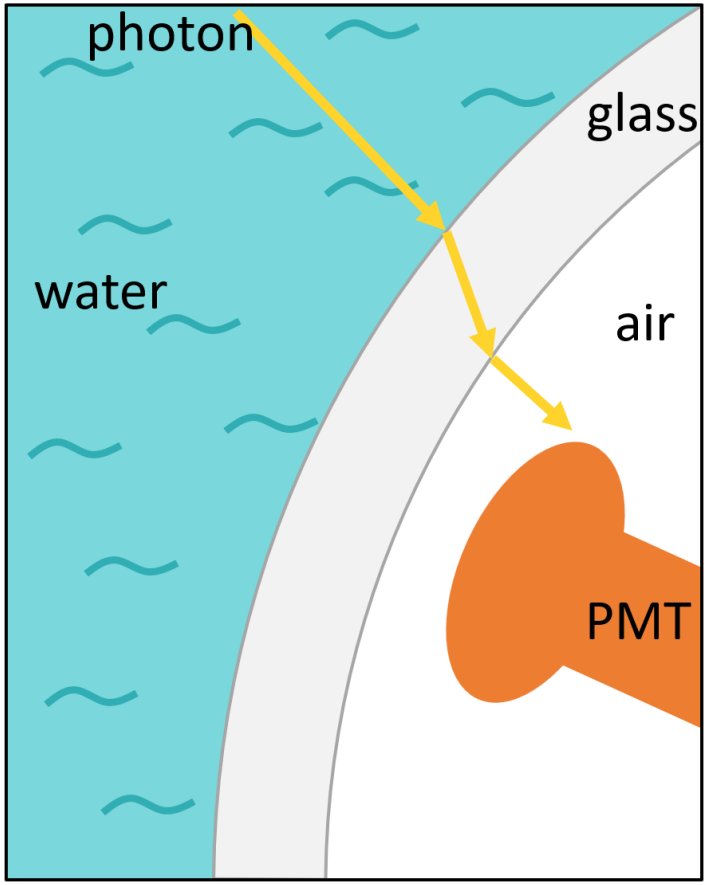
- Use of ONC infrastructure
- Full waveform digitization with 16-channel ADC
- Reconstruction of waveform with 210 MHz sampling rate
- Testing of timing system
- Sub-ns timing synchronization

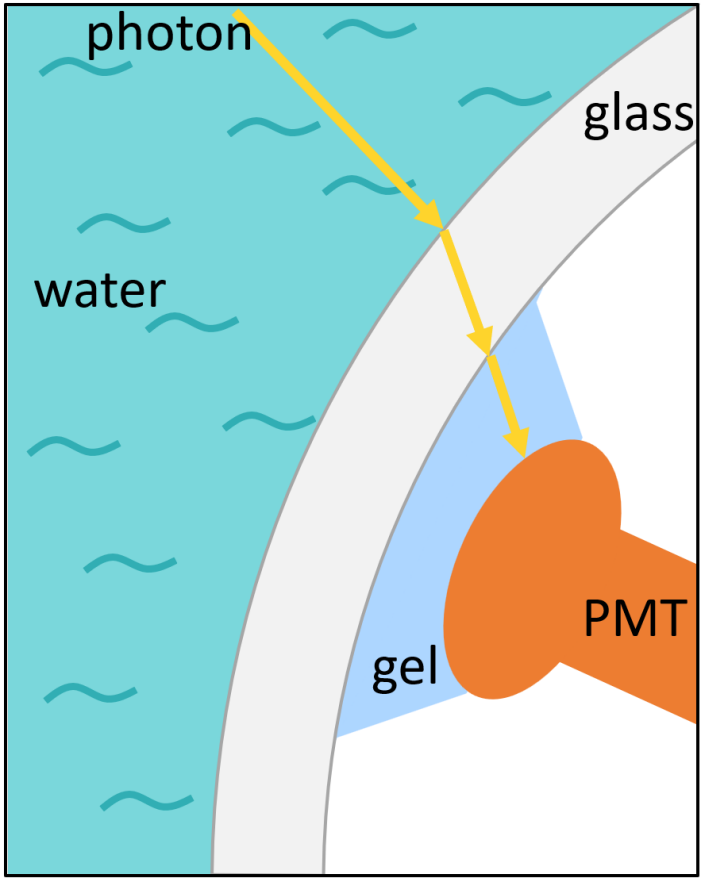
Module installation to frame

- Final step of assembly
- First test of protocols in October 2025
- Full scale installation over the next weeks



Why Gel Pads?

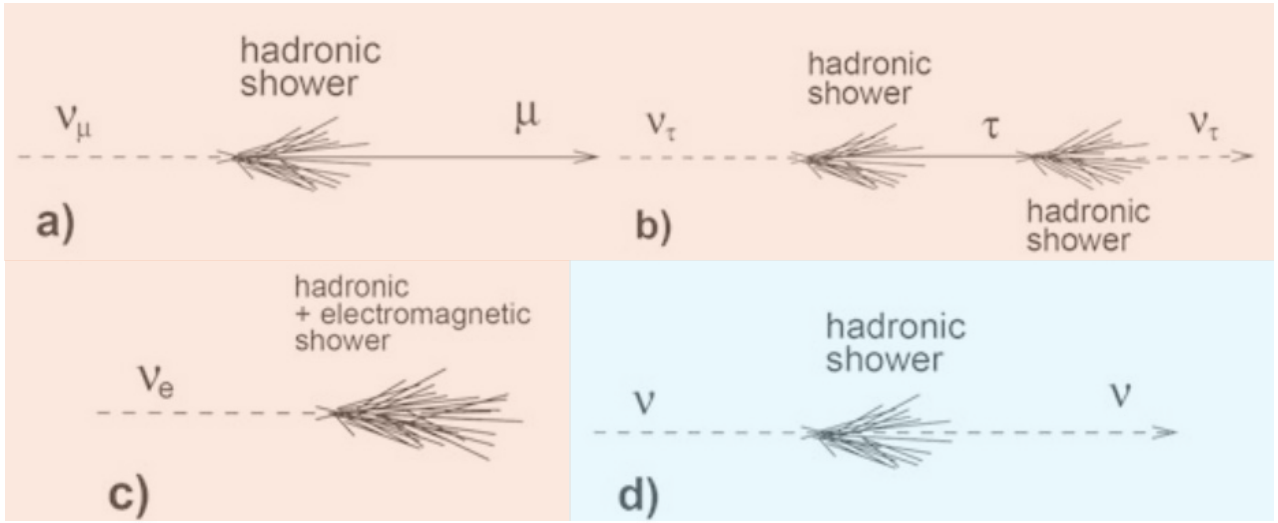


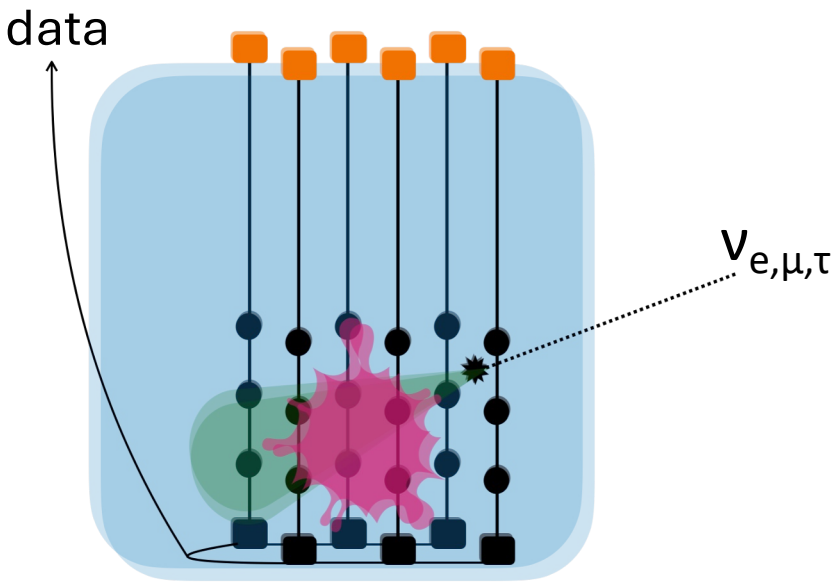


Neutrino Detection Priciple

CC interactions

NC interactions





- Cherenkov light detection via 3-dimensional multi-PMT array
- Large detector volume necessary

P-OM Components

- 2 Glass Hemispheres
- 2 PMT Frames
- 16 PMTs + Gel Pads
- 16 HV Base
- 1 Mainboard
- 2 Interposer
- 1 SMUT
- 16 Optical Flasher

- 2 acoustic receiver
- 1 TOMCat
- 2 Axicones in complete String