Pacific Ocean Neutrino Experiment (P-ONE): prototype line development

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The Pacific Ocean Neutrino Experiment (P-ONE) (1) collaboration, among which are institutes distributed around Europe and North America, endeavours the construction of an astrophysical neutrino telescope in the Pacific Ocean off the coast of British Columbia, Canada. Following the successful deployment of two pathfinder missions, STRAW and STRAW-b, the next milestone in form of the P-ONE prototype line is being pursued. Its objectives are threefold:

1) The development of the optical and calibration modules and the verfication of their working principle.
2) The refinement of the deployment strategy to allow an efficient deployment of several mooring lines.
3) The initial deployment of the very first instrumented mooring line of the P-ONE detector.

P-ONE prototype line concept

The prototype line shall be the blueprint for the final P-ONE moorings. As such, it has the same key features to allow an efficient construction of the P-ONE detector:

- Mooring length of 750-1000 m with evenly spaced modules
- 20 modules per line: 16-17 optical and 3-4 calibration modules
- Combined backbone structure in form of an electric-optical cable with incorporated strain members

P-ONE optical module

The optical module follows a multi-PMT approach, allowing the differentiation of background events induced by bioluminescent activity and the decay of potassium-40.

- PMT candidates with a photocathode area between 3-3.5 inch are currently under investigation
- Modular internal structure, effectively allowing the replacement of individual components
- Transparent reflector pads to increase the overall light detection efficiency

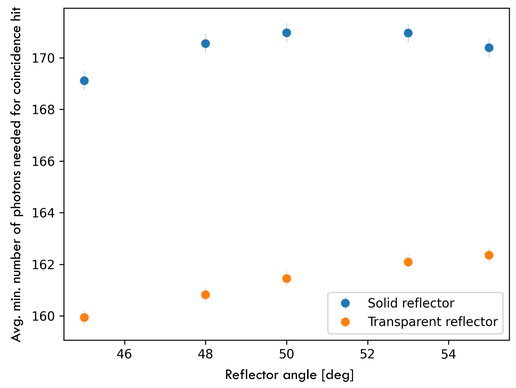
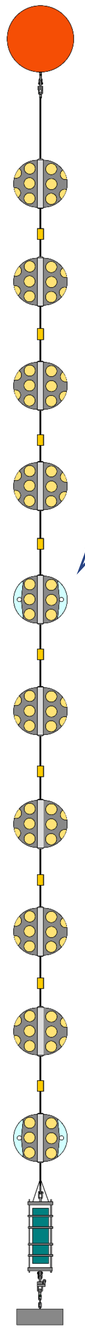


Fig. 1: The plot shows the averaged minimum number of photons for a given direction which are needed for the optical module to have at least three PMTs detecting one or more photons. Averaged over all reflector angles, the transparent reflector performs 5.7% better than the solid reflector



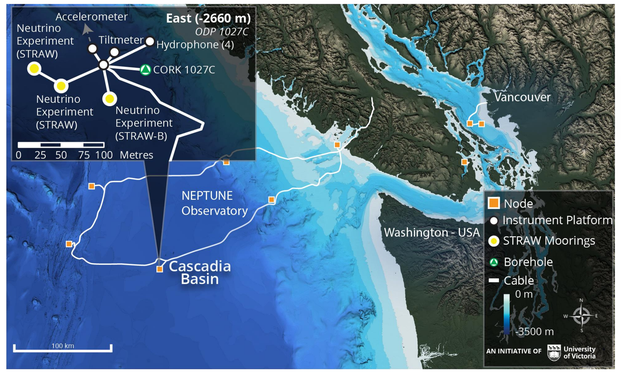
P-ONE calibration module

The concept of the calibration module is based on the isotropic emission of an in-situ monitored nano-second light pulse with high dynamic range within the detector volume to calibrate the surrounding optical modules and has been successfully proven by the Precision Optical Calibration Module (POCAM) (2). The P-ONE calibration module will adapt many of its core features but integrate it in an enclosure identical to the optical modules, reducing the overall complexity of the mooring line.

- Emission of nano-second light-pulses with variable intensity
- In-situ monitoring by a photodiode and SiPM
- Identical form-factor to the optical modules
- Option to integrate PMTs is under investigation
- Measures to ensure an isotropic emission profile are currently studied and will be proven in a dark chamber

Ocean Networks Canada (ONC)

A key strength for P-ONE is the already existing deep sea infrastructure in form of the North East Pacific Time-series Underwater Networked Experiment (NEPTUNE) observatory, established by Ocean Networks Canada (ONC) in 2009, allowing the connection of various experiments on a plug-and-play basis. The Cacadia Basin node in a depth of 2660 m has been selected as a suitable site for the P-ONE neutrino detector by its pathfinder experiments (3).



References

(1) M. Agostini, M. Böhmer, J. Bosma, K. Clark, M. Danninger, C. Fruck et al., The pacific ocean neutrino experiment, Nature Astronomy 4 (2020) 913.
(2) F. Henningsen, M. Böhmer, A. Gärtner, L. Geilen, R. Gernhäuser et al., A self-monitoring precision calibration light source for large-volume neutrino telescopes, Journal of Instrumentation 15 (2020) P07031. | ICRC2021 #578
(3) ICRC2021 proceedings: #594, #1138, #1183, #1270, #1272

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Shortcut to contribution