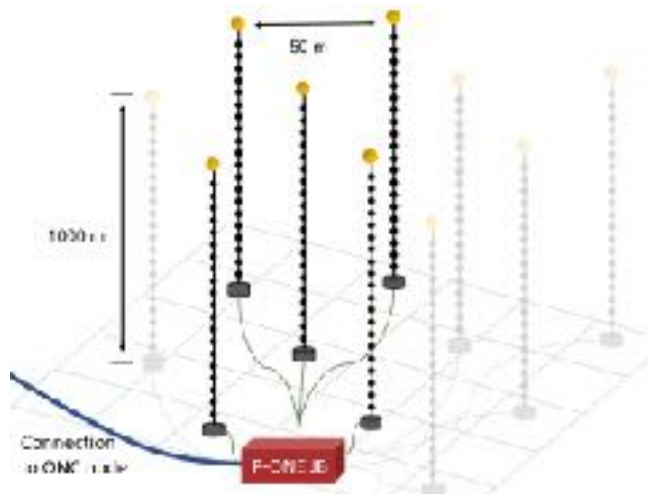


The P-ONE Neutrino Experiment and Prototype

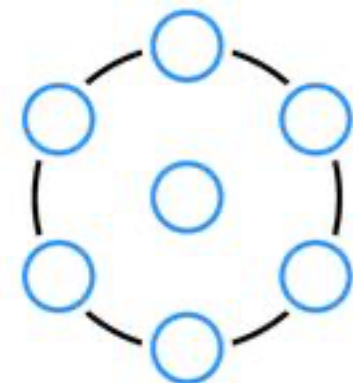
Carsten B Krauss
University of Alberta

June 23, 2023

IPP AGM Fredericton, NB



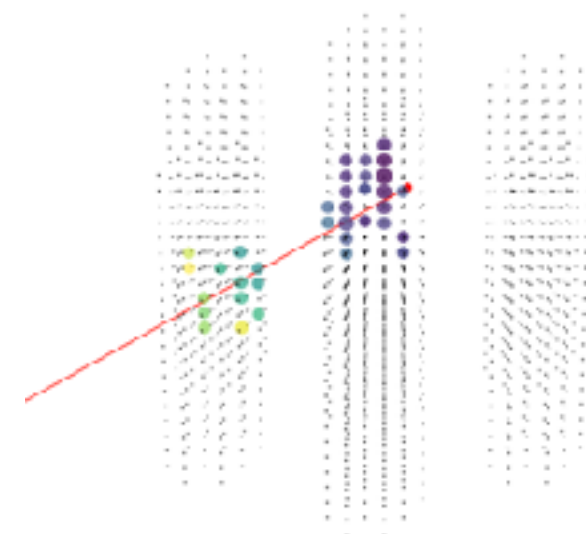
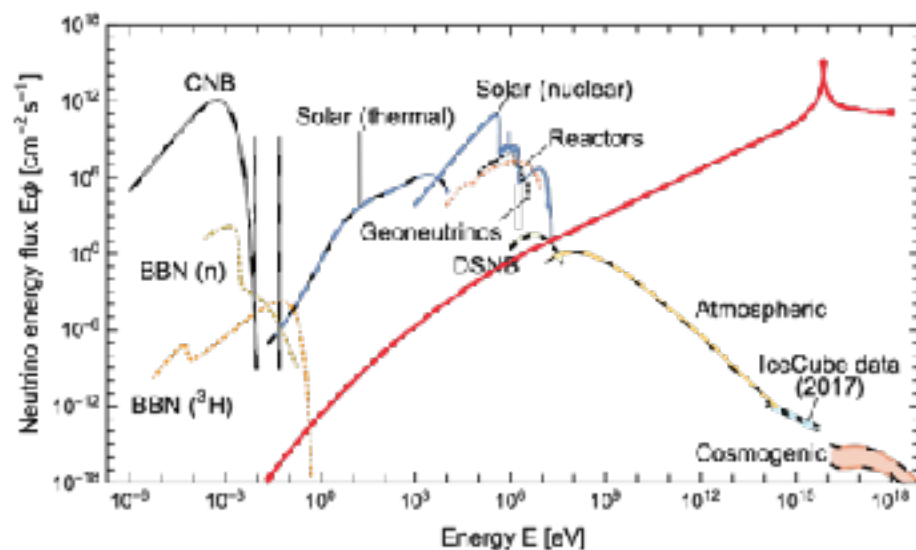
UNIVERSITY OF ALBERTA



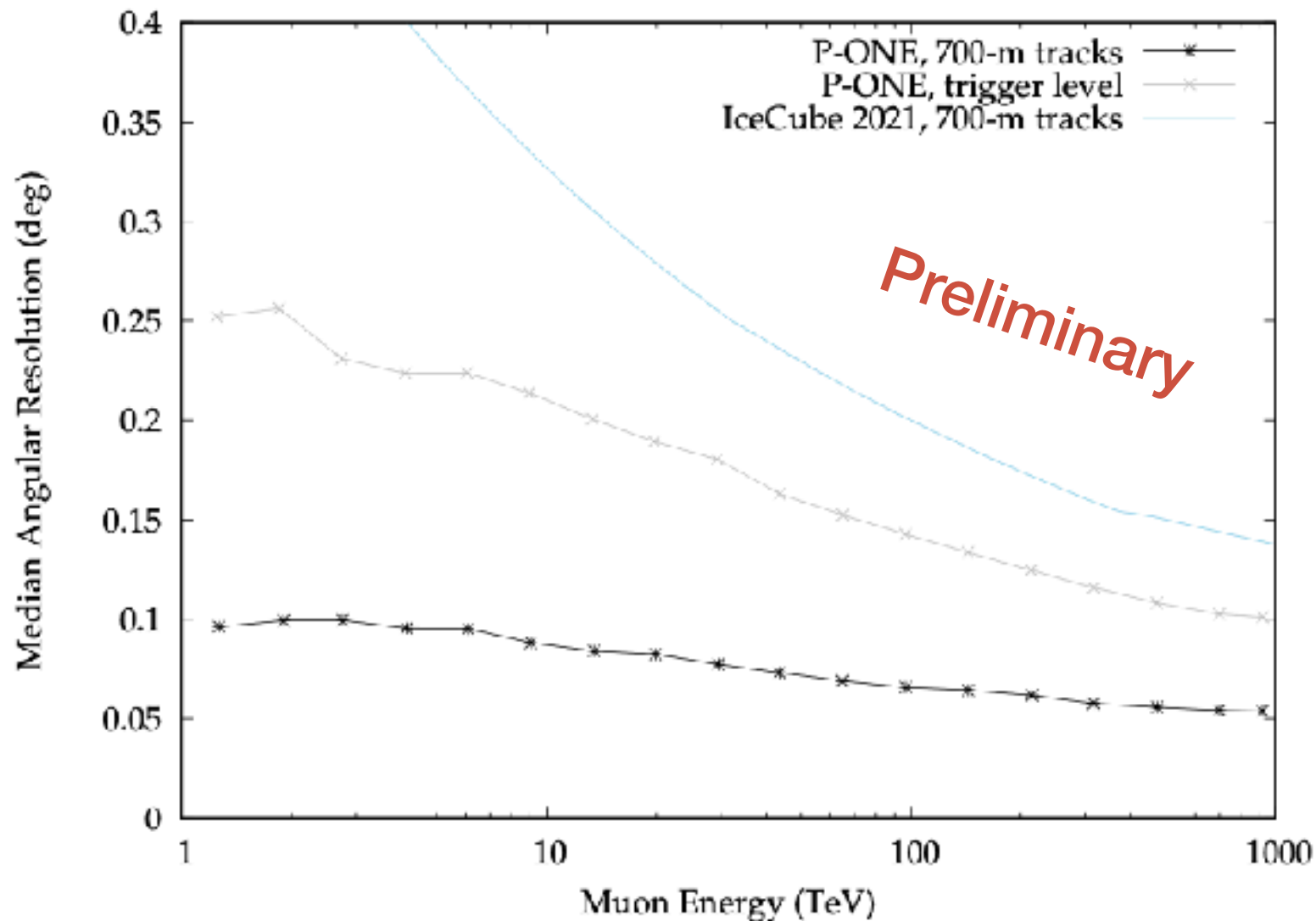
P-ONE

P-ONE Physics

- P-ONE will be optimized for particle identification, making it ideal for high energy neutrino flavour physics. Our system development focuses on the identification of track vs cascade vs double bang signatures, benefiting from the superior scattering properties of ocean water
- With a large P-ONE detector it will be possible to study BSM effects and the Glashow resonance
- Even a ~small detector will be able to join the larger detectors to contribute to point source searches, especially in the sky region not covered by the other detectors in the northern hemisphere and even improve overall sensitivity as the pointing accuracy is so much better in water



The P-ONE Advantage



- Both angular resolution, particle identification ability and sensitivity of P-ONE are designed to be leading in class
- The choices of calibration tools, trigger systems, timing resolution and readout technology are chosen to optimize

P-ONE

- Alberta, Queen's, SFU, TRIUMF, TUM, Erlangen (Germany) and Drexel, Georgia Tech, MSU (USA), Krakow (Poland), UCL (UK) Collaboration
- Started in 2018 with the deployment of a test setup to assess the water quality



The Cascadia Basin Site



Sea spider
(Pycnogonida)

4745.7177N, 12745.72609W, 2659m

2020-09-13 22:52:55, Hdg: 154

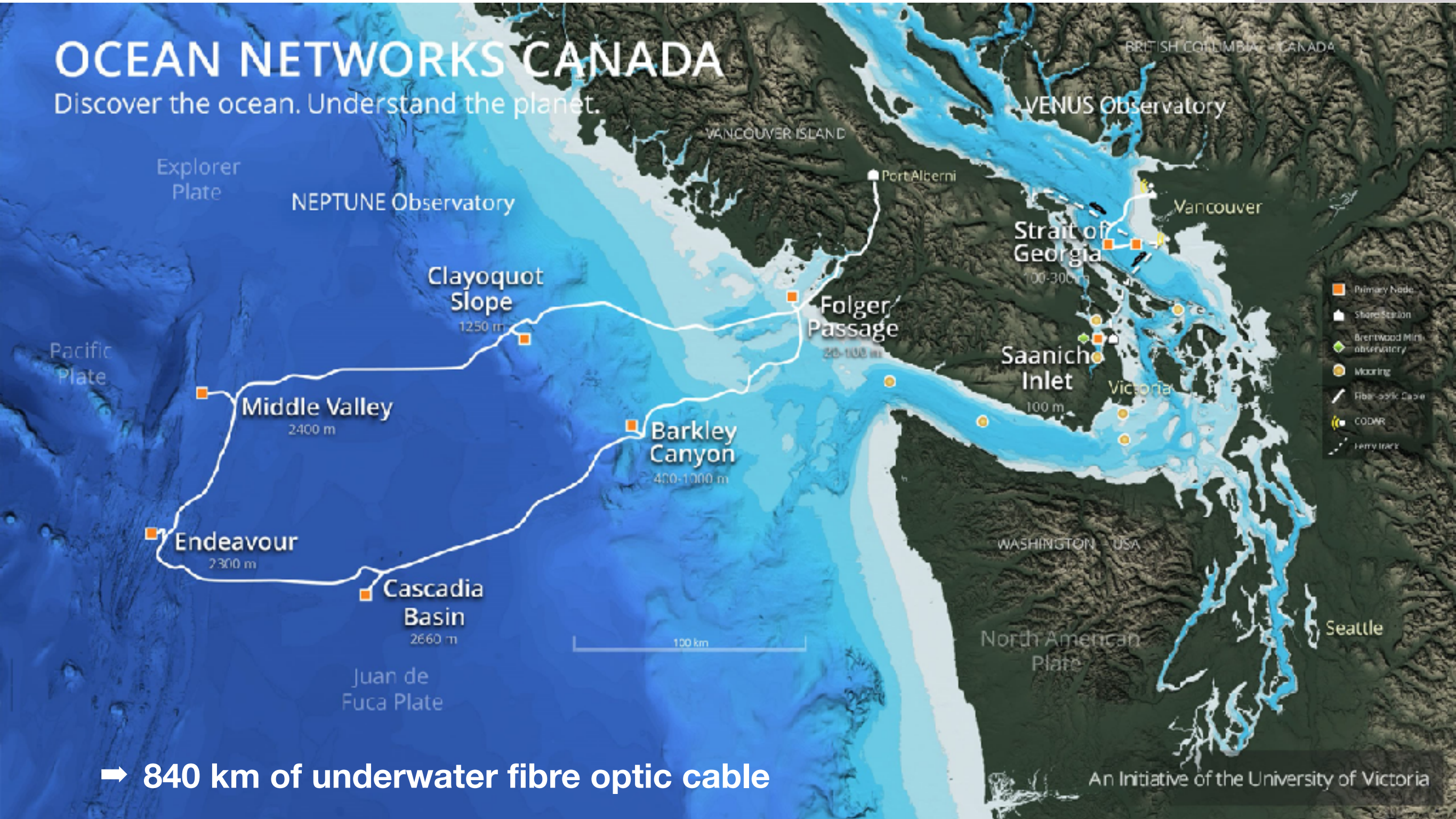
NA120, ONC Dive#: H1807

ONC



OCEAN NETWORKS CANADA

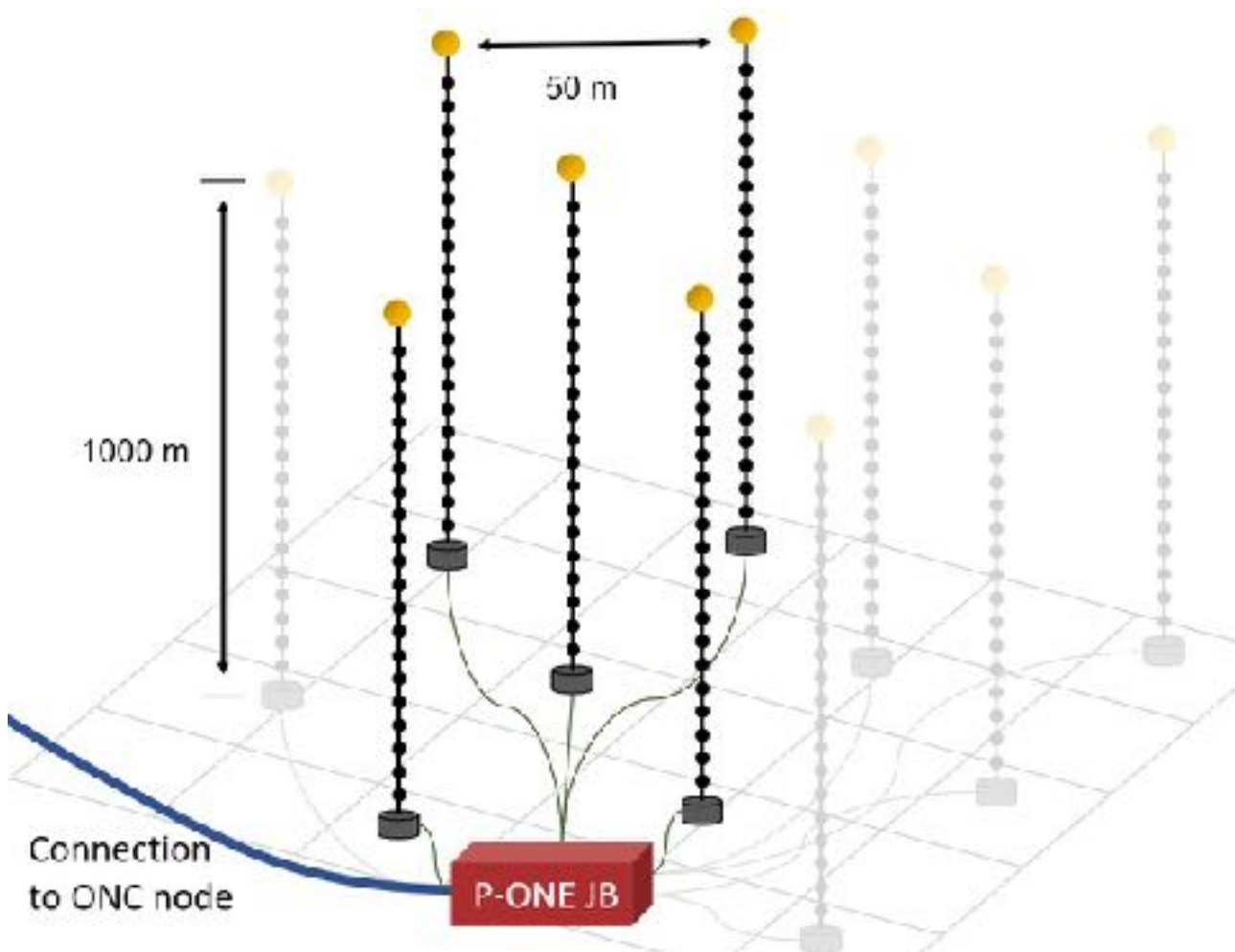
Discover the ocean. Understand the planet.



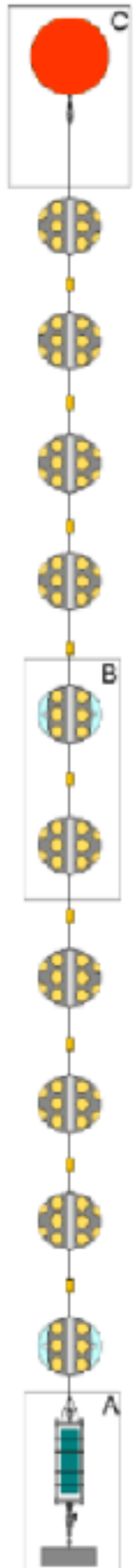
➔ 840 km of underwater fibre optic cable

An Initiative of the University of Victoria

Pacific Ocean Neutrino Experiment (P-ONE) Demonstrator

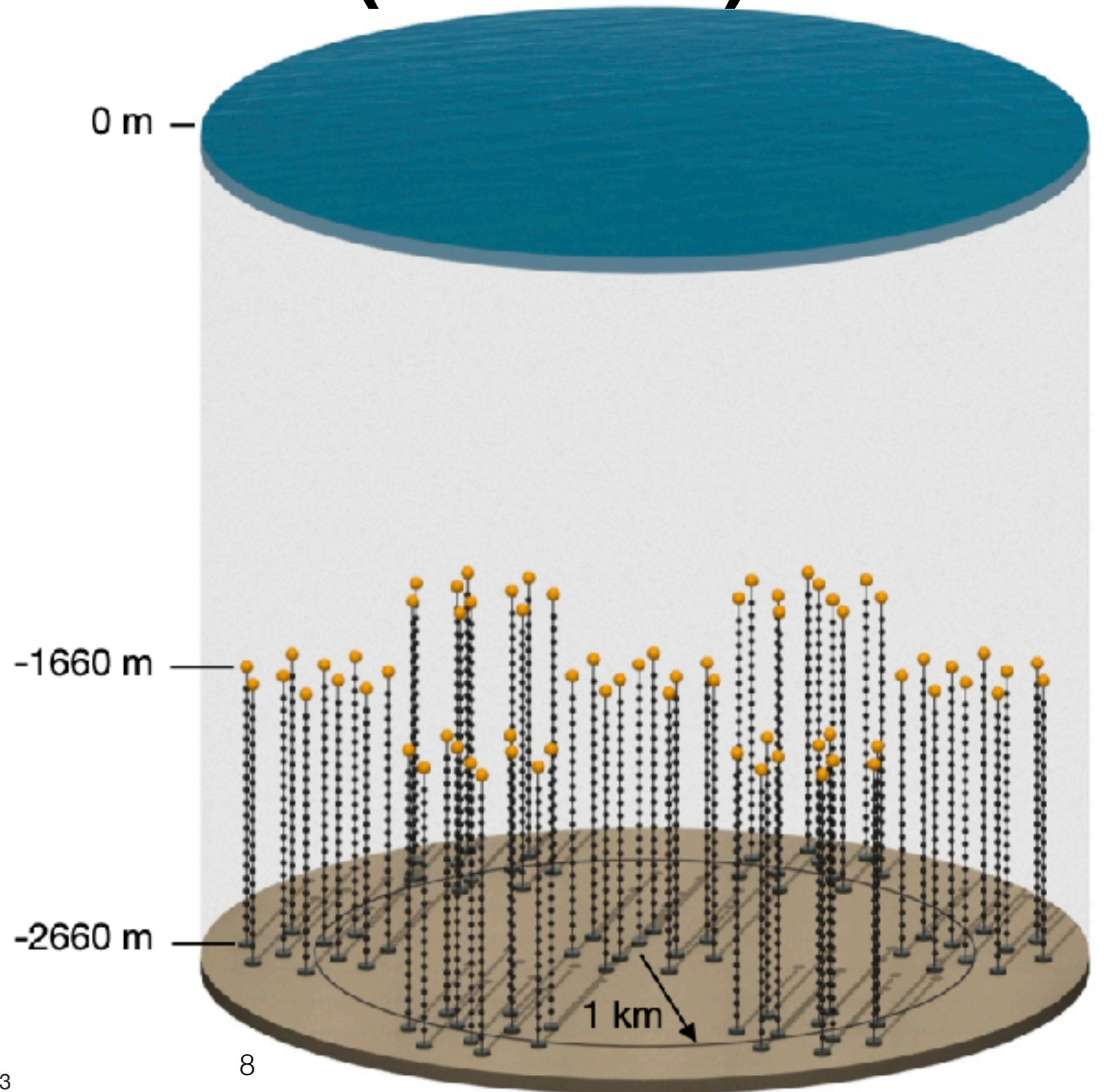


- Time scale for realization: 2024, first mooring line, more in the following years
- Up to 10 strings with 20 optical and calibration modules each
- 1 km long mooring line
- Instrumented volume $>1/8 \text{ km}^3$



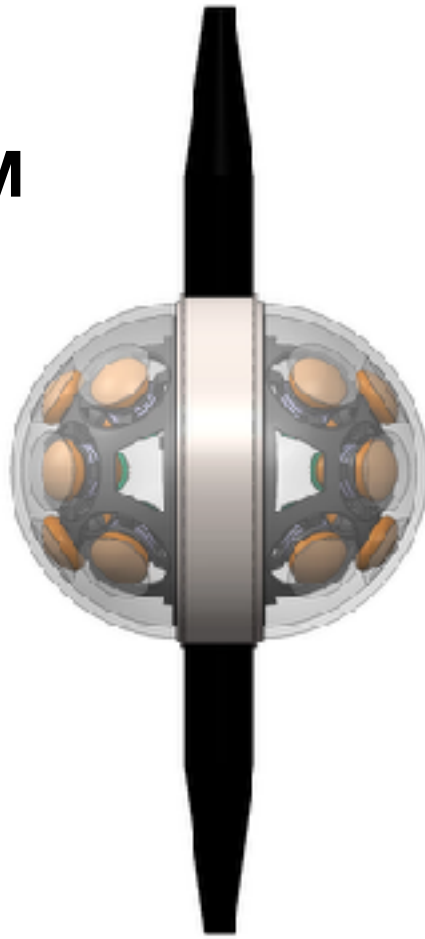
Pacific Ocean Neutrino Experiment (P-ONE)

- The P-ONE collaboration aims to construct a km^3 scale detector by constructing seven identical modules of the *Demonstrator* type
- The optimal final arrangement is currently under study



Large Area Photon Detection

P-OM



P-CAL














- The instrumentation of the ~200 optical modules of P-ONE will use KM3NeT/IceCube-like multi PMT digital optical modules
- 3" PMTs offer a good cost to surface area ratio
- Using a novel, side mounted housing allows obstruction-free observation

Activities In Canada

- Testing of Straw-B modules before deployment
- Biofouling studies and remedies (See talk by B. Veenstra, Wednesday)
- Leadership in the STRAW data taking and analysis to extract optical properties and performance data
- Reconstruction algorithm development
- Development of a new algorithm for tau event identification
- Background simulation (^{40}K and others)
- Trigger algorithm development and implementation
- Hardware development, flasher system, acoustic calibration and positioning system, electronics, calibration systems
- Final assembly and testing at TRIUMF for P-ONE.1, the first string
- Development of an internal muon tracker for reconstruction accuracy calibration
- DAQ development

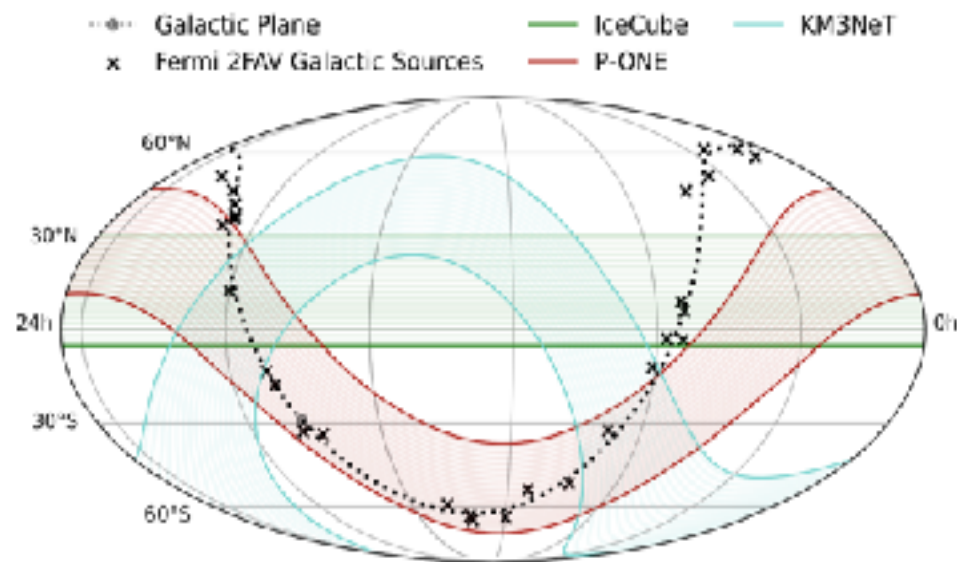


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P-ONE Goals - Demonstrator



COMMISSIONING! PROOF OF CONCEPT,
SUCCESSFUL OPERATION 100% DUTY CYCLE



CALIBRATION! IN-SITU BACKGROUNDS,
DETECTORS, ATMOSPHERIC BACKGROUNDS



PHYSICS GOALS:

- FIRST NEUTRINOS IN PACIFIC OCEAN
- IMPLEMENTATION OF MULTI MESSENGER PROTOCOL
- DEVELOPMENT OF ν -FLAVOUR PARTICLE ID



TRIGGER AN INTERNATIONAL EFFORT (P-ONE)
SYNERGETIC OPERATION ν -TELESCOPES



P-ONE Funding

- Prototype string funded by Origins Cluster of Excellence at TUM (and NSERC RTI)
- ERC funding for the first few strings secured in 2022
- CFI JELF secured for Danninger
- Polish and US seed funding secured in 2022

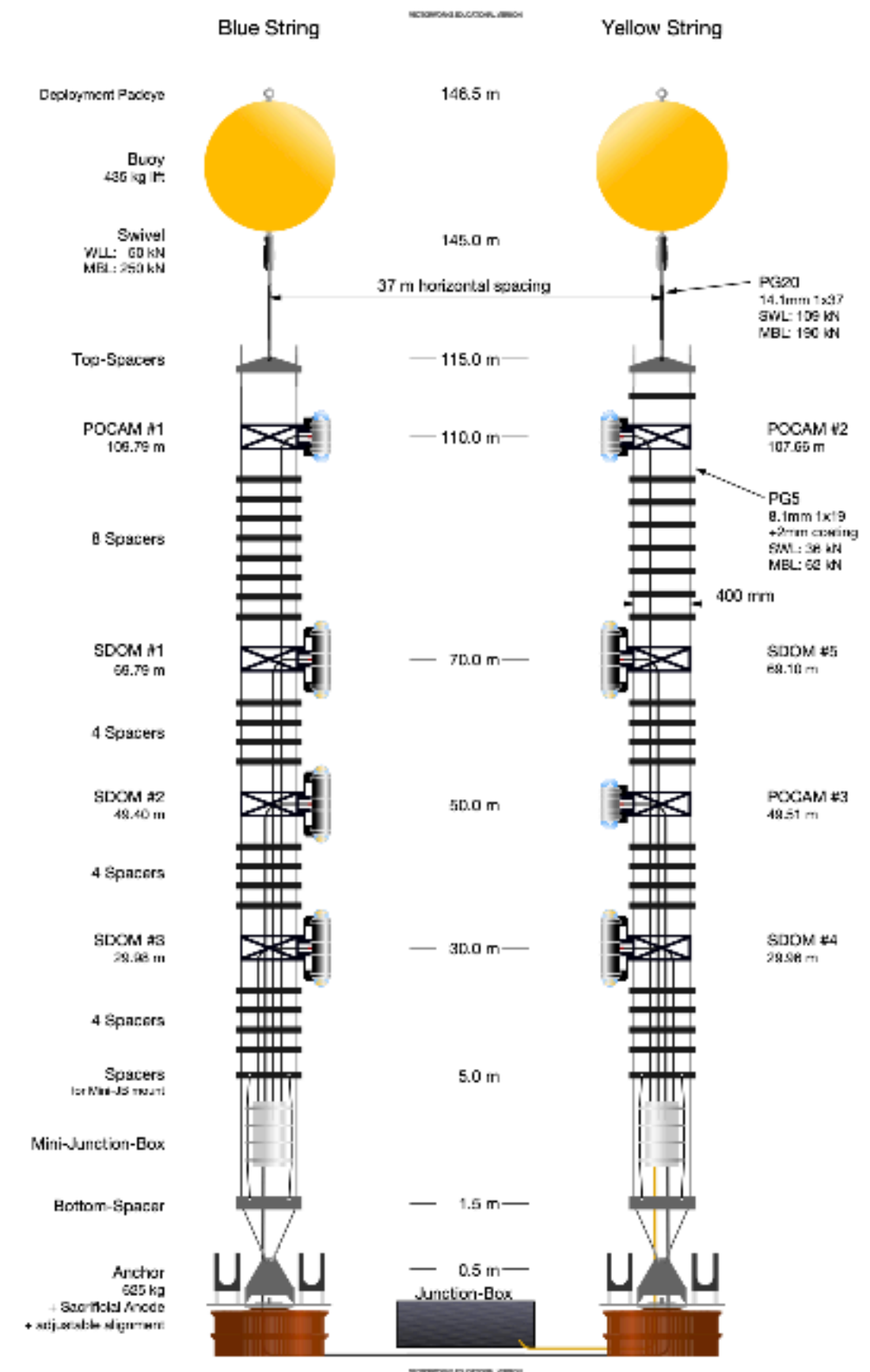
Summary



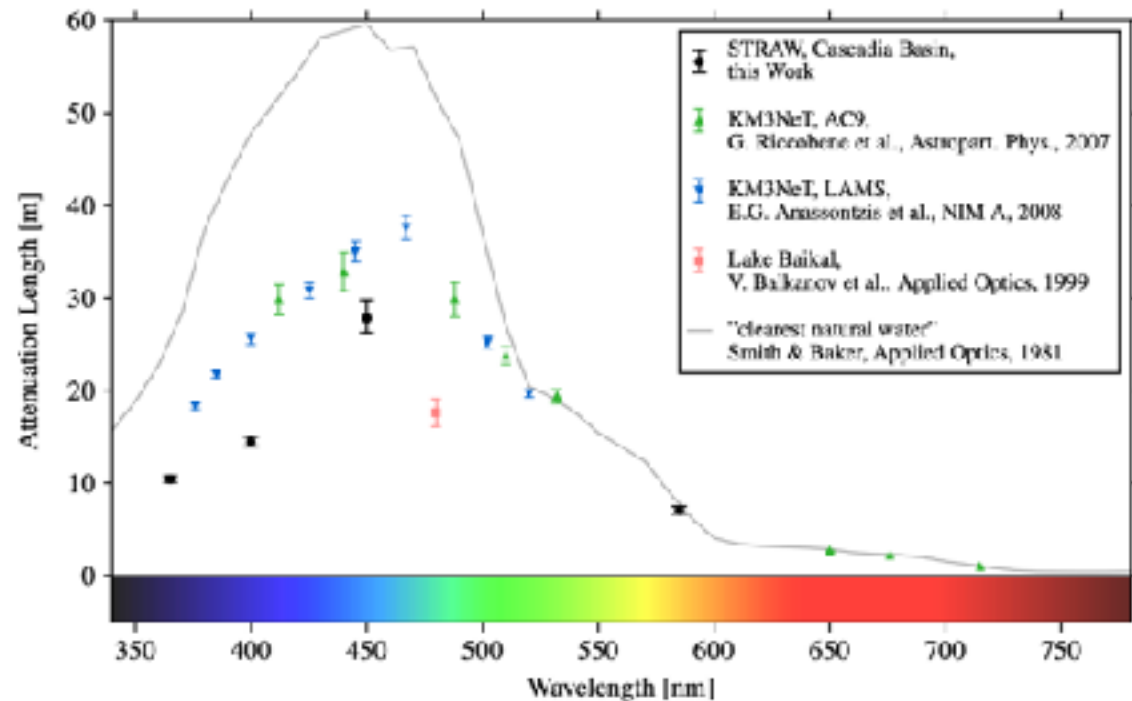
- Neutrino Astronomy will allow new and exciting studies for particle physics - The only thing keeping us from breakthrough discoveries is the small size of the current detectors
- The northern Pacific Ocean is ideally located and already instrumented by ONC for a new observatory to achieve full sky coverage
- Canadian groups haven't taken on major responsibilities for the initial string and are leading calibration systems, trigger systems and final assembly planning efforts towards the P-ONE demonstrator

STRAW

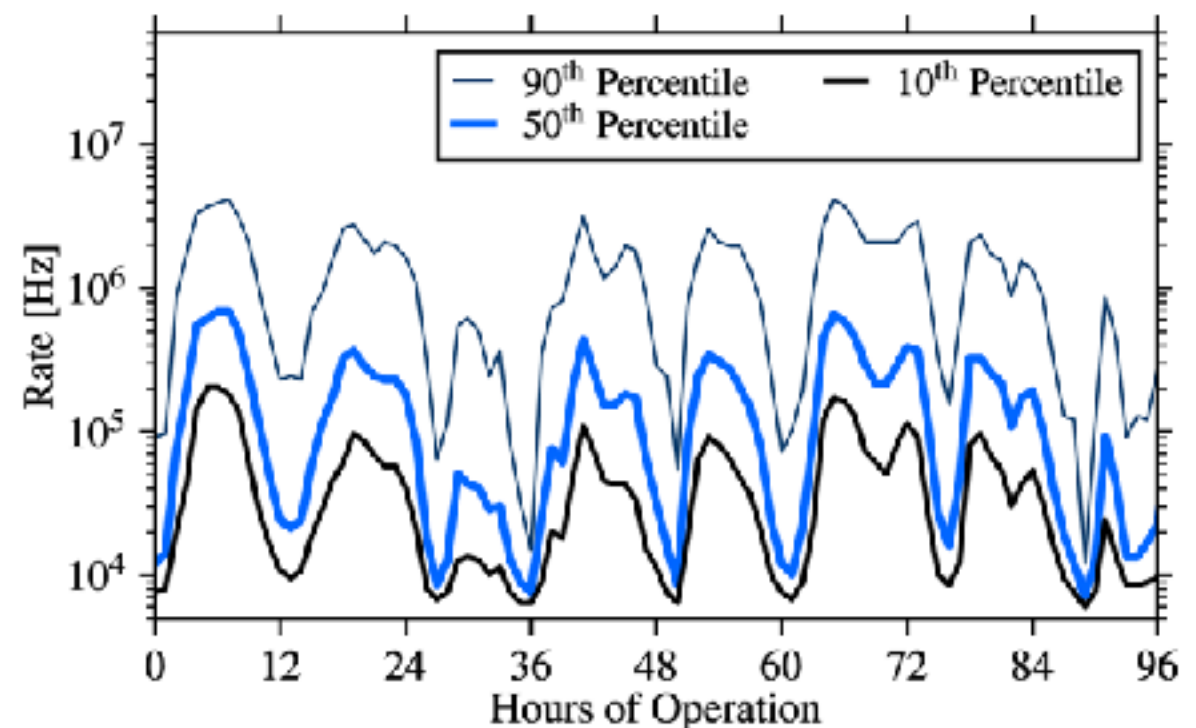
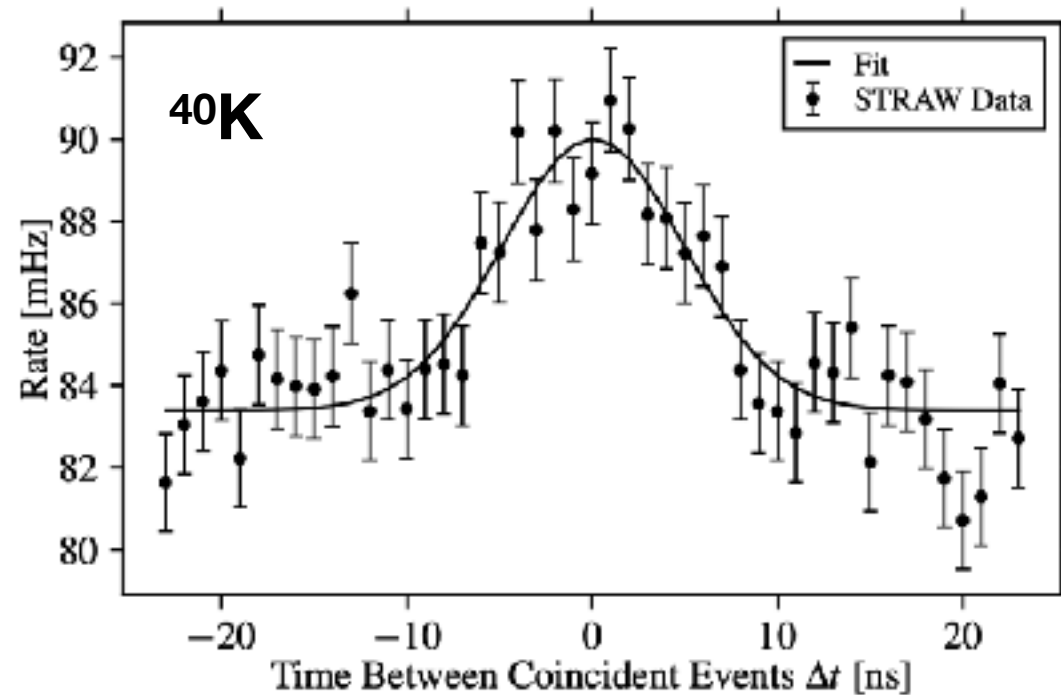
- Strings for Absorption in Water
- Deployed in summer 2018
- All instruments are working
- Absorption and scattering length determined to be similar to other ocean based detector locations



Results: Attenuation Length & Bioluminescence

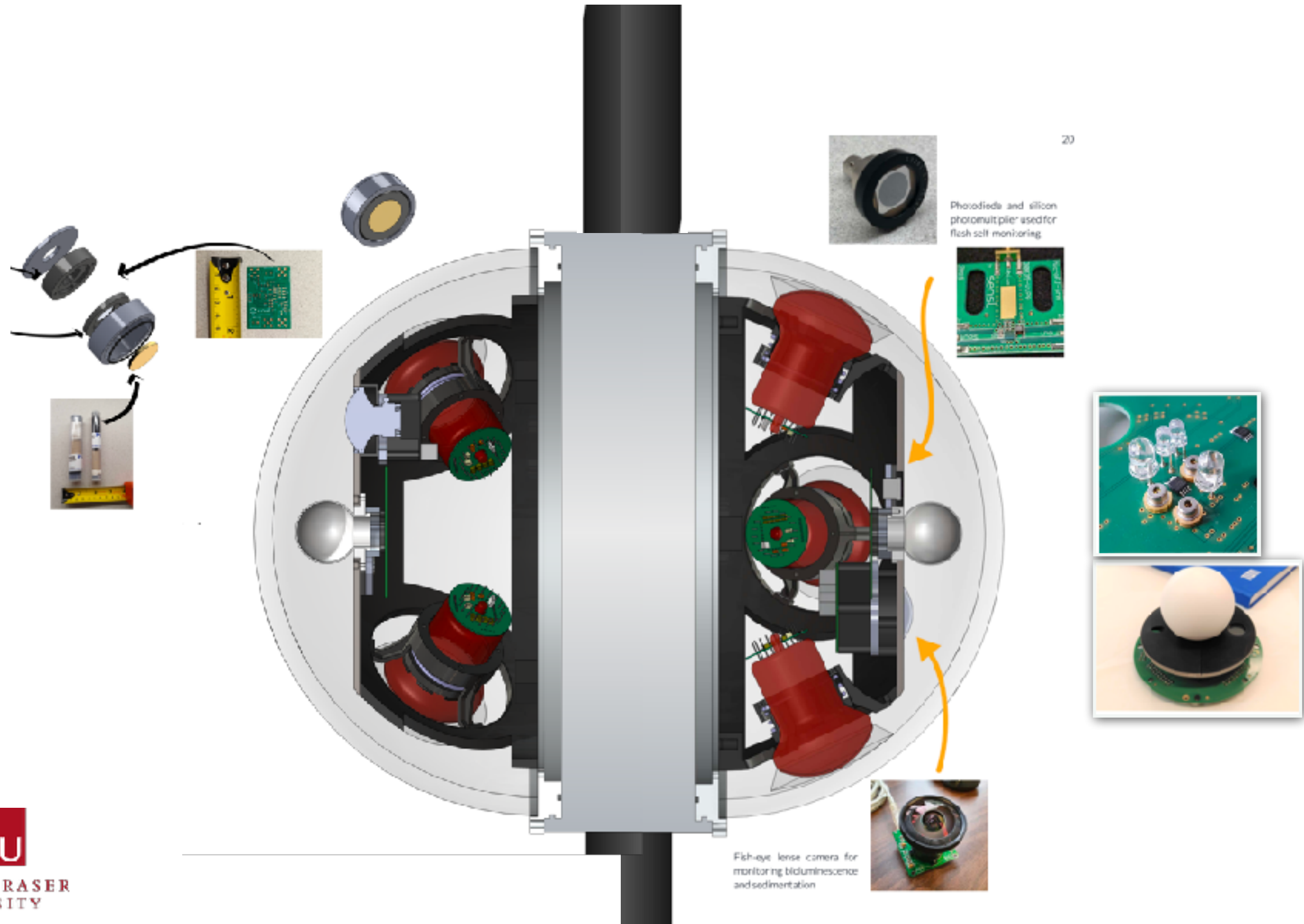


- Full publication with optical parameters:
- Bioluminescence is modulated with the tides
- ^{40}K Rate is consistent with ONC salinity measurements and expectations
- Attenuation length is good enough for a large scale neutrino telescope

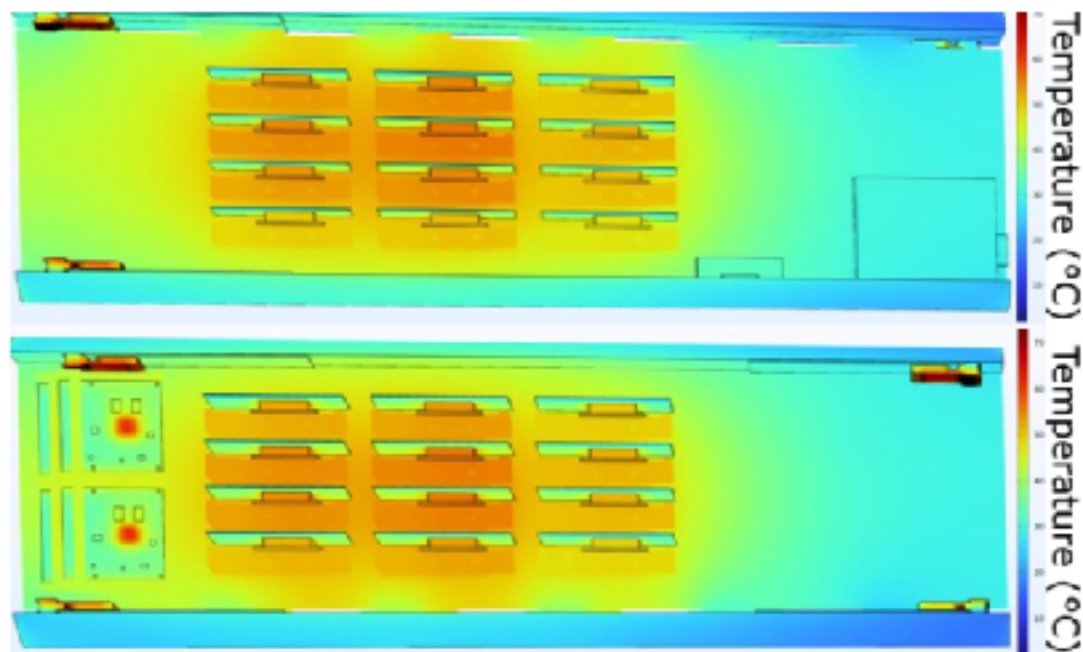




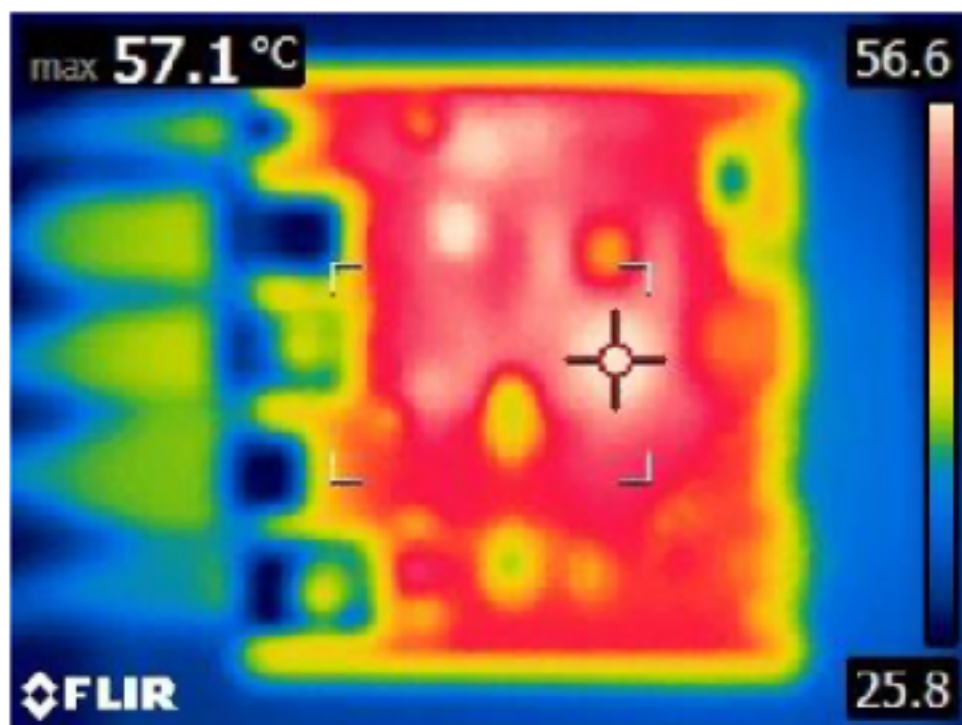
Calibration Module



MiniJunction Box - trigger and mooring line power & data distribution



Simulated temperature on surface of solids in module



- The MiniJunction Box is the primary data and power system hub for each mooring line
- All systems are contained in a titanium pressure housing
- Thermal measurement and FEA simulations have shown that the current design is meeting requirements well