

A NOBL Experiment

Neutrino Geoscience Kingston, 27-30th Oct. 2025

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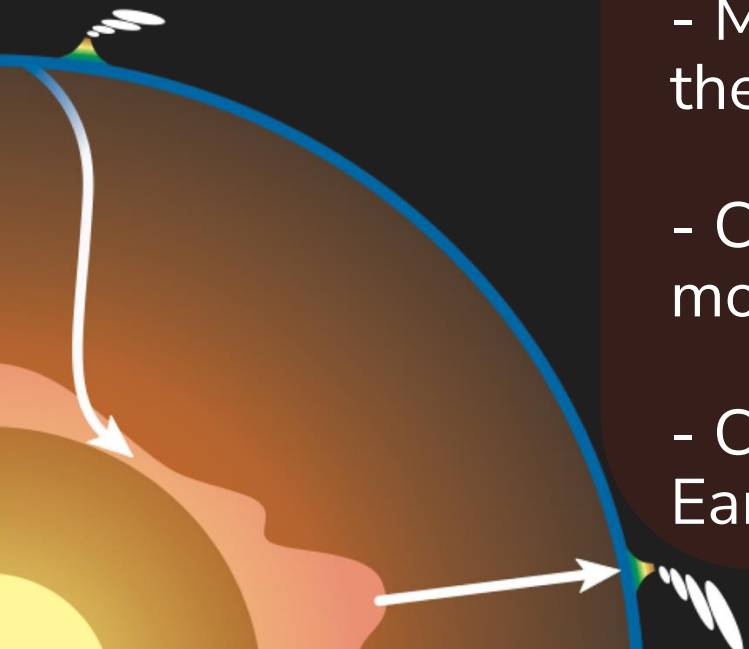
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Scientific Motivation

- Quantifying the amount and distribution of heat producing elements in the Earth
- Mapping the compositional variation in the mantle
- Critically testing compositional models of the Earth
- Constraining the cooling history of the Earth

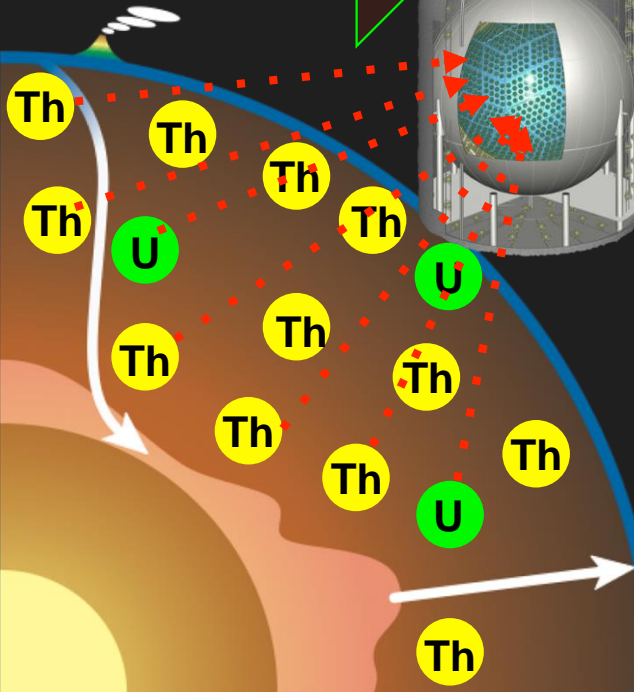
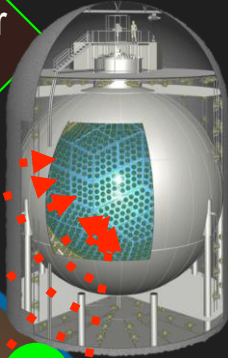


Scientific Motivation

Electron-antineutrinos from natural radioactive decays

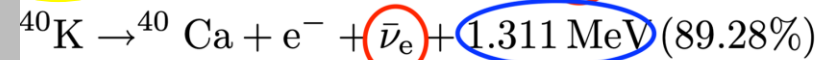
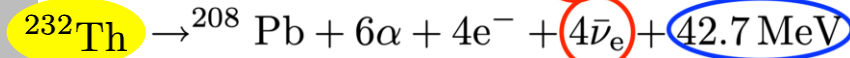
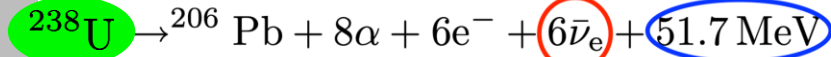
$$\bar{\nu}_e \ 9.5 \times 10^6 / \text{cm}^2 / \text{sec}$$

Anti-neutrino Detector
(e.g. KamLAND)

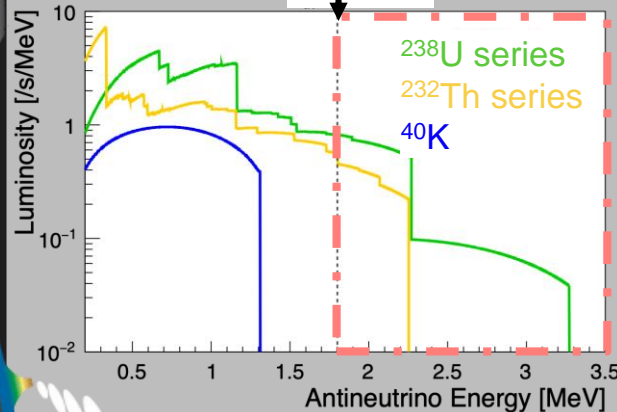


β -decay

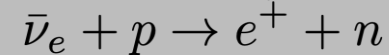
geo-neutrinos



Energy threshold, 1.8 MeV



inverse β -decay



* Only geo-neutrinos from **U** and **Th** are detectable right now

* ^{40}K geo-neutrino detection needs another technology.

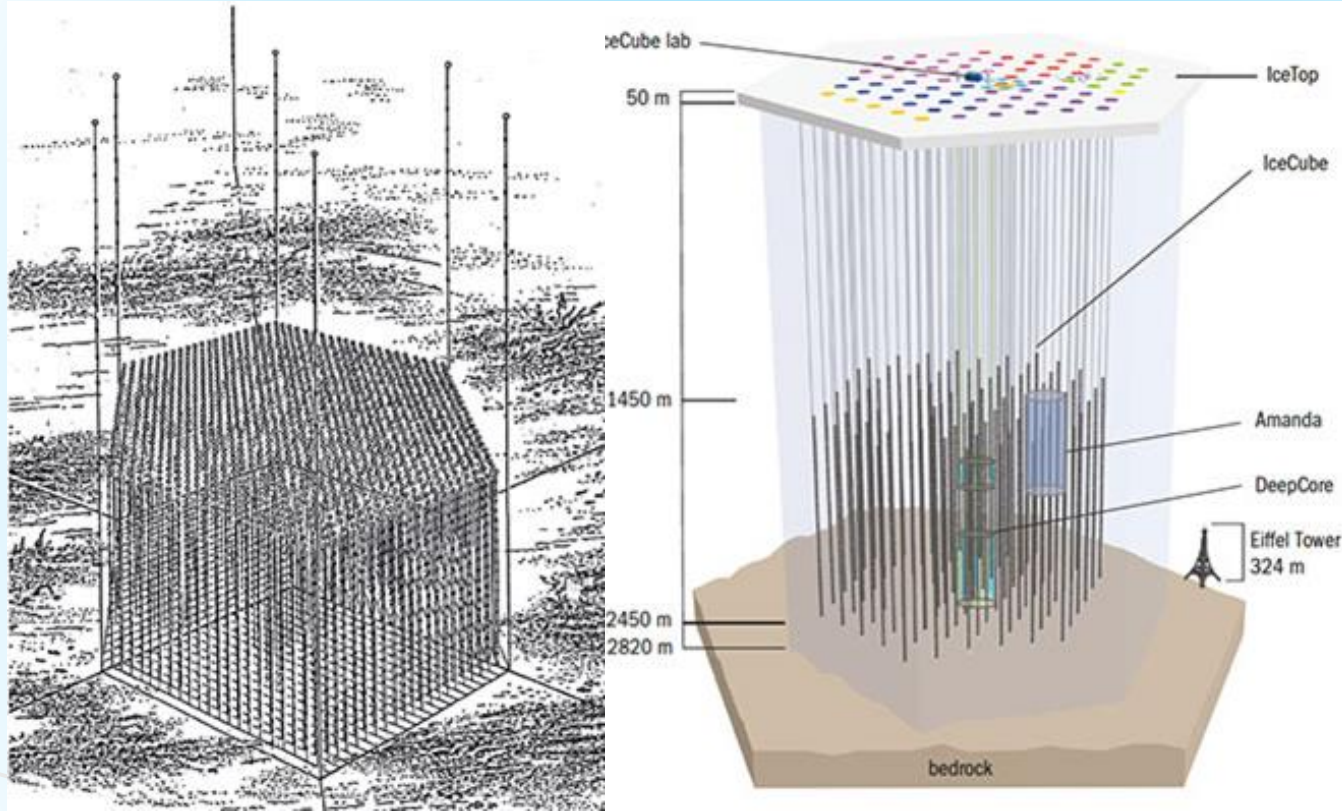
Number of geo $\bar{\nu}_e \propto$ amount of **U** **Th**, radiogenic heat

History of Sub-Surface neutrino detection

- Homestake mine (1968-70)
 - Solar neutrino problem
 - “missing” neutrinos! (conservation not until SNO 2003)
- **DUMAND workshop (1976)**
 - Neutrino detectors made at UH
 - leading to
 - IMB - [Irvine-Michigan-Brookhaven \(detector\)](#)
 - HPW - Harvard-Purdue-Wisconsin
 - Kamioka
 - DUMAND - Deep Underwater Muon and Neutrino Detection
 - ultimately:
 - AMANDA, IceCube, Antares, Nestor and KM3

□ [Bruce T. Cleveland et al 1998 ApJ 496 505](#) /

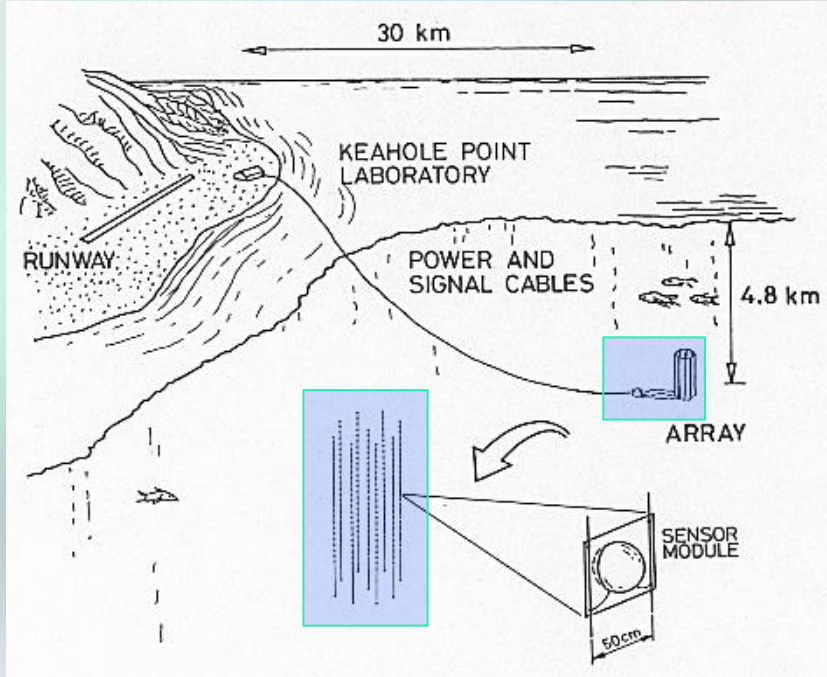
DUMAND



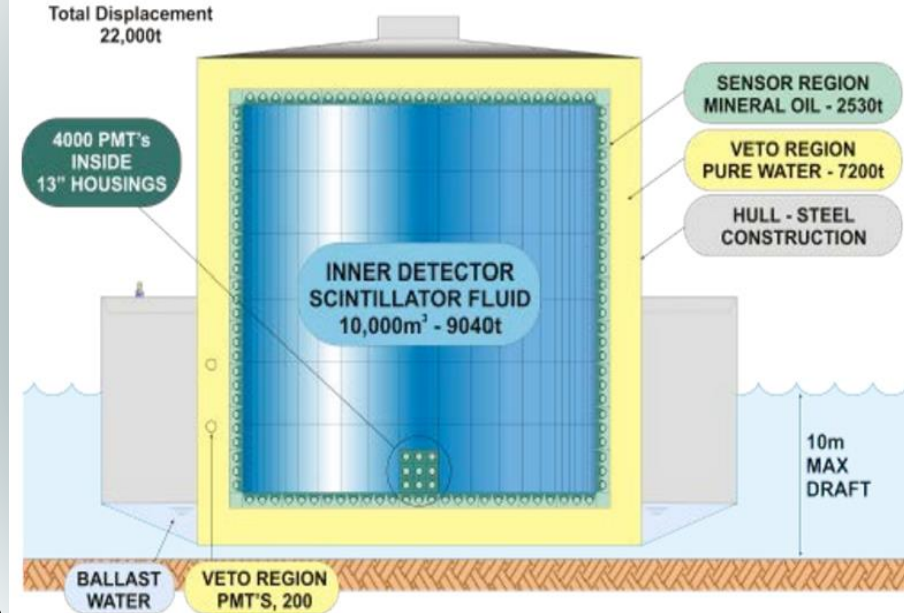
The original DUMAND project (left), cancelled in 1995, and IceCube located at the South Pole (right). Although there are no formal links between the two experiments, their configurations bear strong similarities.

DUMAND and HanoHano

DUMAND



HanoHano

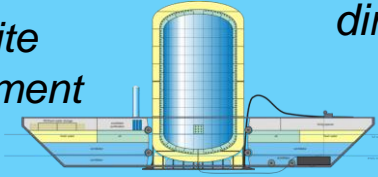


Neutrino Geoscience: Current and Future

what we need

improved accuracy of measurement & modelling

multi-site measurement



directional sensitive detector

new type detector

An Ocean Bottom

current generation

Detector

next generation

what we learn

total radiogenic heat in the Earth

• Measuring

resolving vertical and horizontal flux differences

Th/U ratio

• Measuring

Next Target!

distinguishing mantle contribution

• Measuring

detecting K geo-neutrino



OBD: breakthrough beyond modern land-based detector transforming our vision of deep Earth

first measurement in **2005**

OBD Present & Future



Technical demonstration & environment measurement in the sea
 deep sea neutrino & muon flux, ocean water density & temperature, radioactivity
 → input parameters for ~1.5 kt detector design

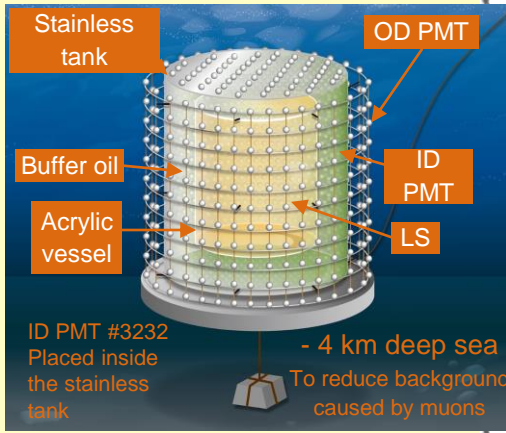
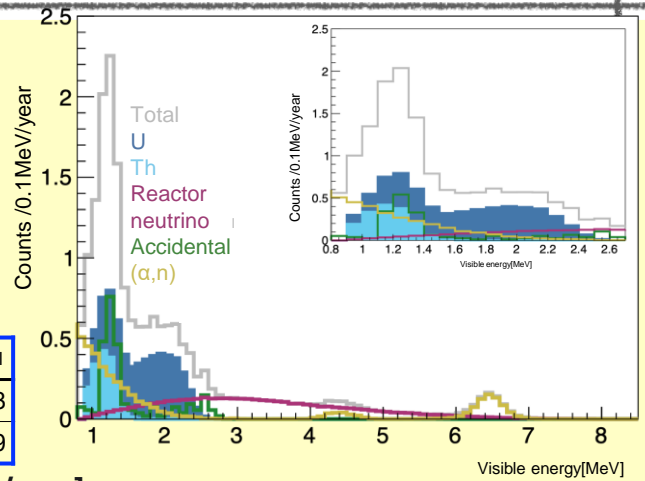
First clear mantle signal

- * Detector simulation study is in progress.
- * Hawaii is possible position.
- * Detector should be installed at ~4km deep sea to shield muons **Low T 2-4°C High P 40MPa**

E region	Signal			Backgrounds					
	U	Th	Total	Reactor	Acci.	(α ,n)	He-Li	Fast-neutron	Total
All	6.59	1.64	8.23	4.13	1.92	3.88	0	<2.42	9.93
Geo-nu	(4.61)	(1.15)	(5.76)	1.53	1.90	2.96	0	<0.58	6.39

(mantle)

[Events/year]

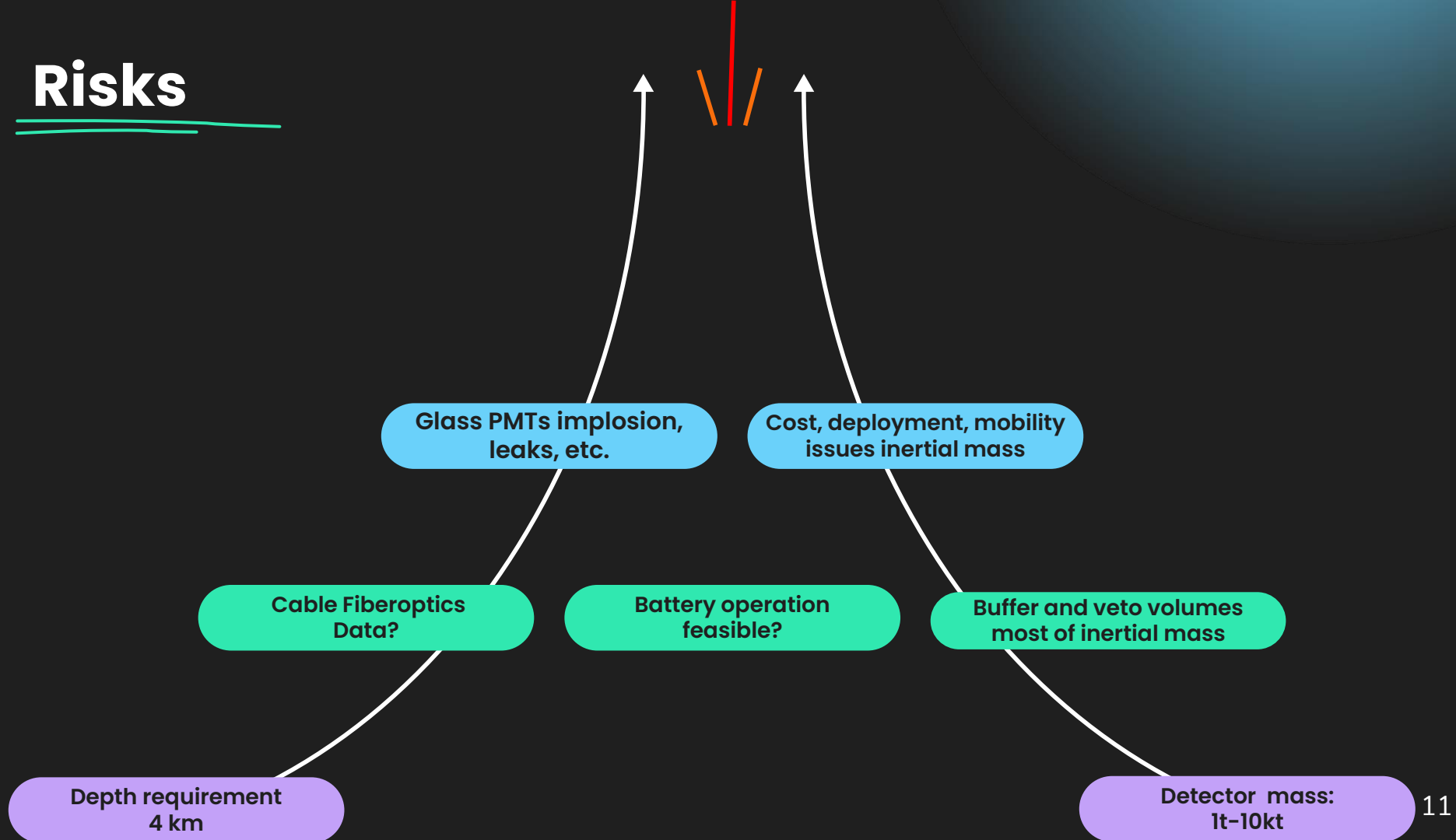


*** Mantle geoneutrino sensitivity**

highQ model:	1 year → 3.7 σ	1 month → 4.1 σ
middleQ model:	3 year → 3.5 σ	3 month → 3.9 σ
lowQ model:	10 year → 2.5 σ	1 year → 3.0 σ

*** 17 kt detector case**

Risks



UH Meeting Station Aloha

Who? Blue Eisen (Marine Research Engineer)

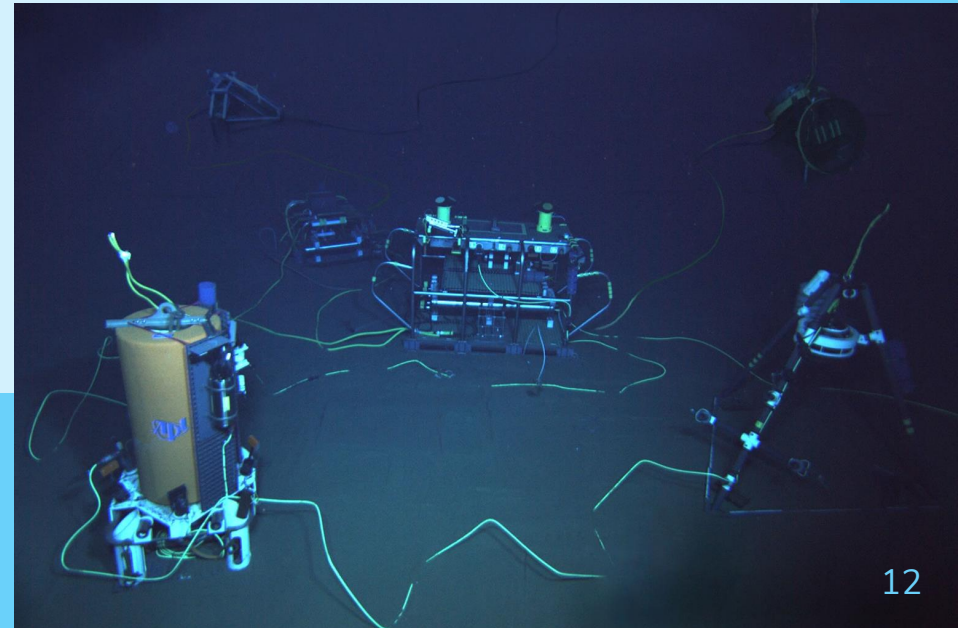
What? Station ALOHA's ALOHA Cabled Observatory (ACO)

When? Sept. 2025.

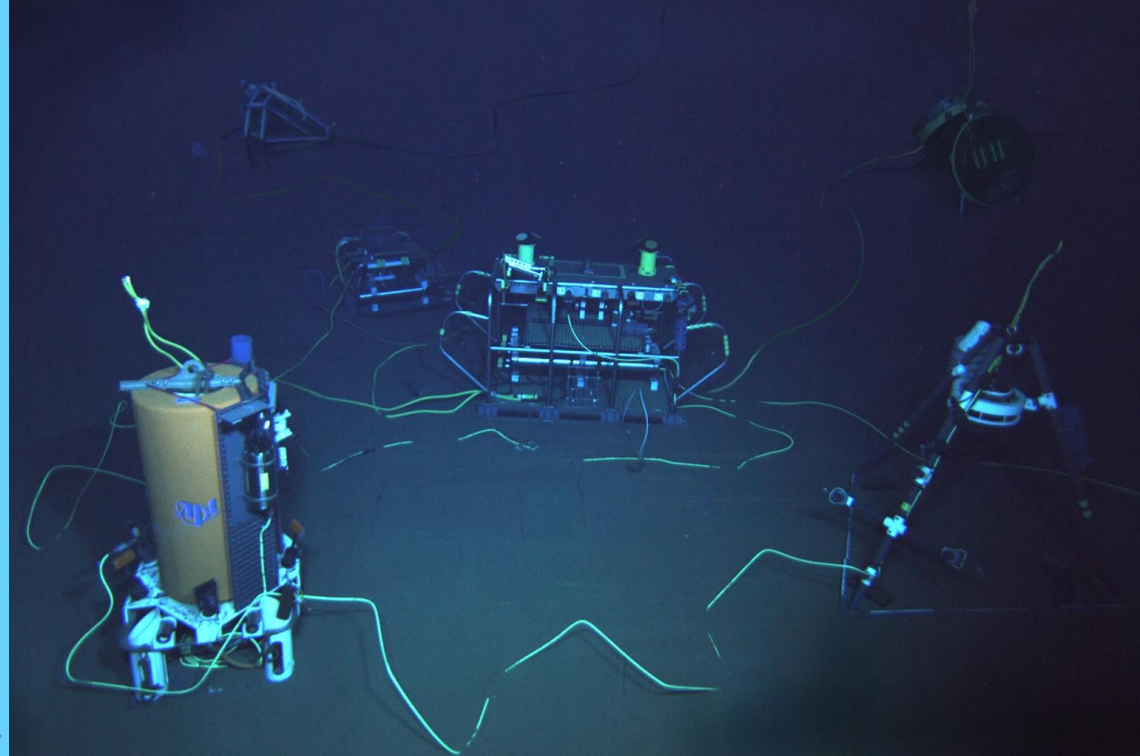
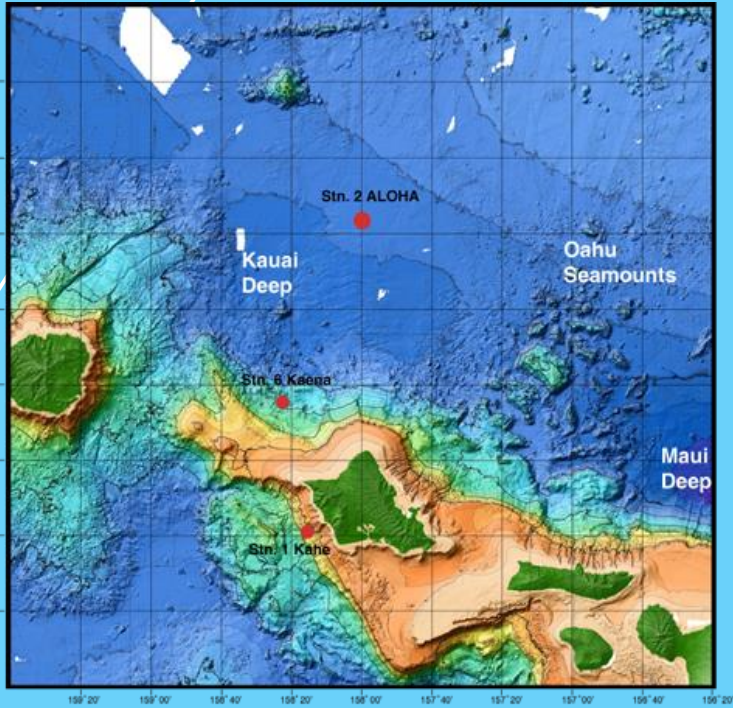
Where? 5km below the surface,
100km north of Oahu.

Why? Three methods to do
ocean bottom deployments,
SiPMs, etc.

<https://aco-ssds.soest.hawaii.edu/>



Station Aloha - ACO



Blue Eisen
thus suggested
the **mineral oil method**
for pressure tolerance.

1atm with nitrogen or air, cool old air

- Expensive bulky heavy casing

Submerge in oil (40MPa)

- Pressure balanced

Epoxy (40MPa)

- Deep camera (Deep Sea Eye)
- 3d printed box, filled with epoxy
- Will experience compression
 - Even matrix with chop fibers

Next steps

Step 1

Talk to other ocean bottom experiments (KM3NeT, etc.)

Step 2

Synergize with Tohoku U. on testing components for possible use in OBD.

Step 3

Work with national labs to facilitate next steps for both research and career.

Summary

1. Measure Radiogenic Heat and the Core-Mantle Boundary: Unique composition measurement via geo-neutrinos.
2. Testing of Q models and $\bar{\nu}_e$ flux via an Ocean Bottom Detector project lead by Tohoku U. Specifically, professors **Hiroko Watanabe and Bill McDonough**.
3. Risk white paper, input from Blue Eisen (UH Station Aloha).
4. Test SiPMs, coordinate with other deep ocean technology projects (many have military implications).

Thank you!

