

# The Pacific Ocean Neutrino Explorer: P-ONE



Juan-Pablo Yáñez

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**neutrino telescope**

**basics**

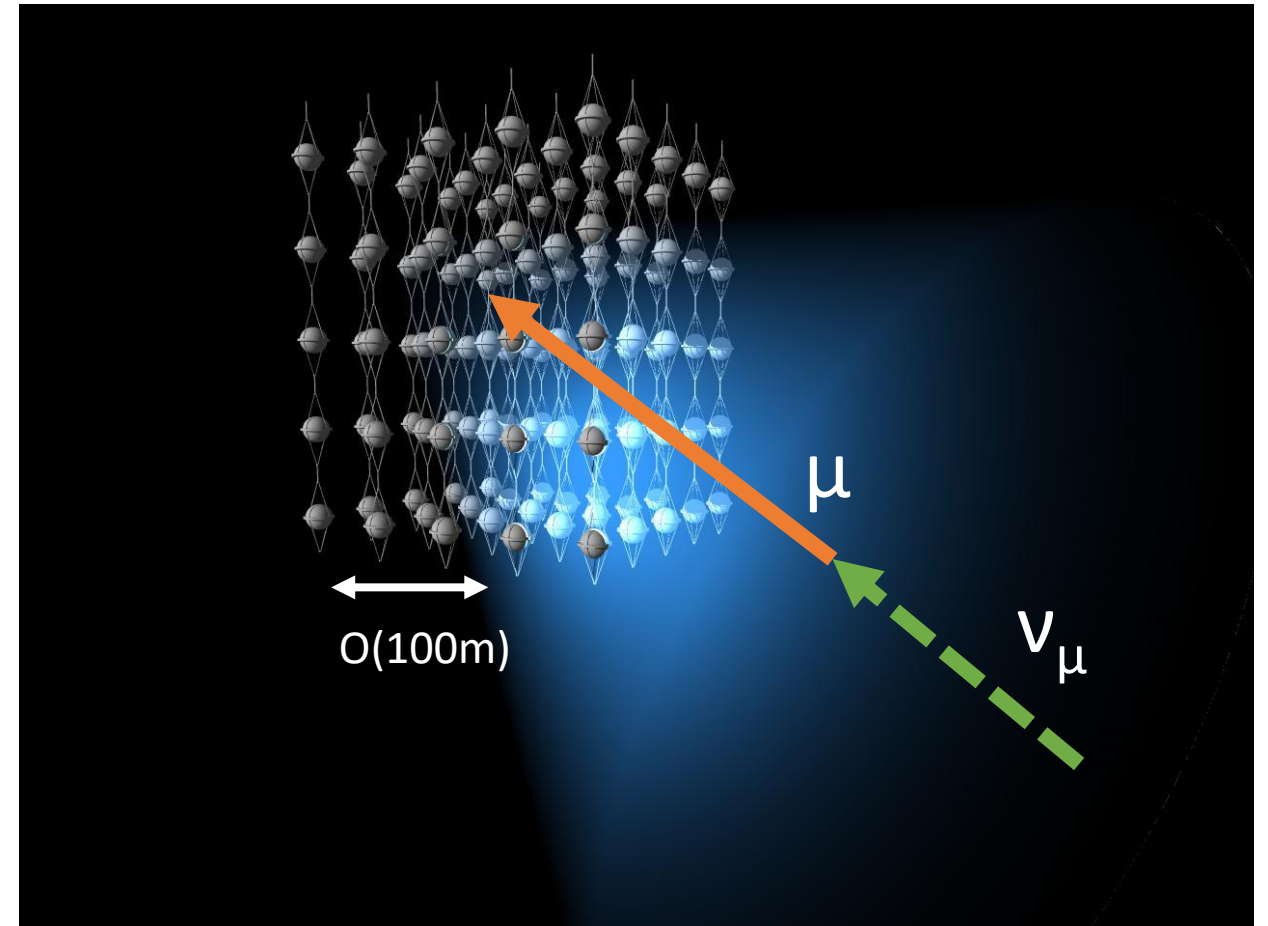
# detection via **Cherenkov** light

-**large**, natural & transparent medium

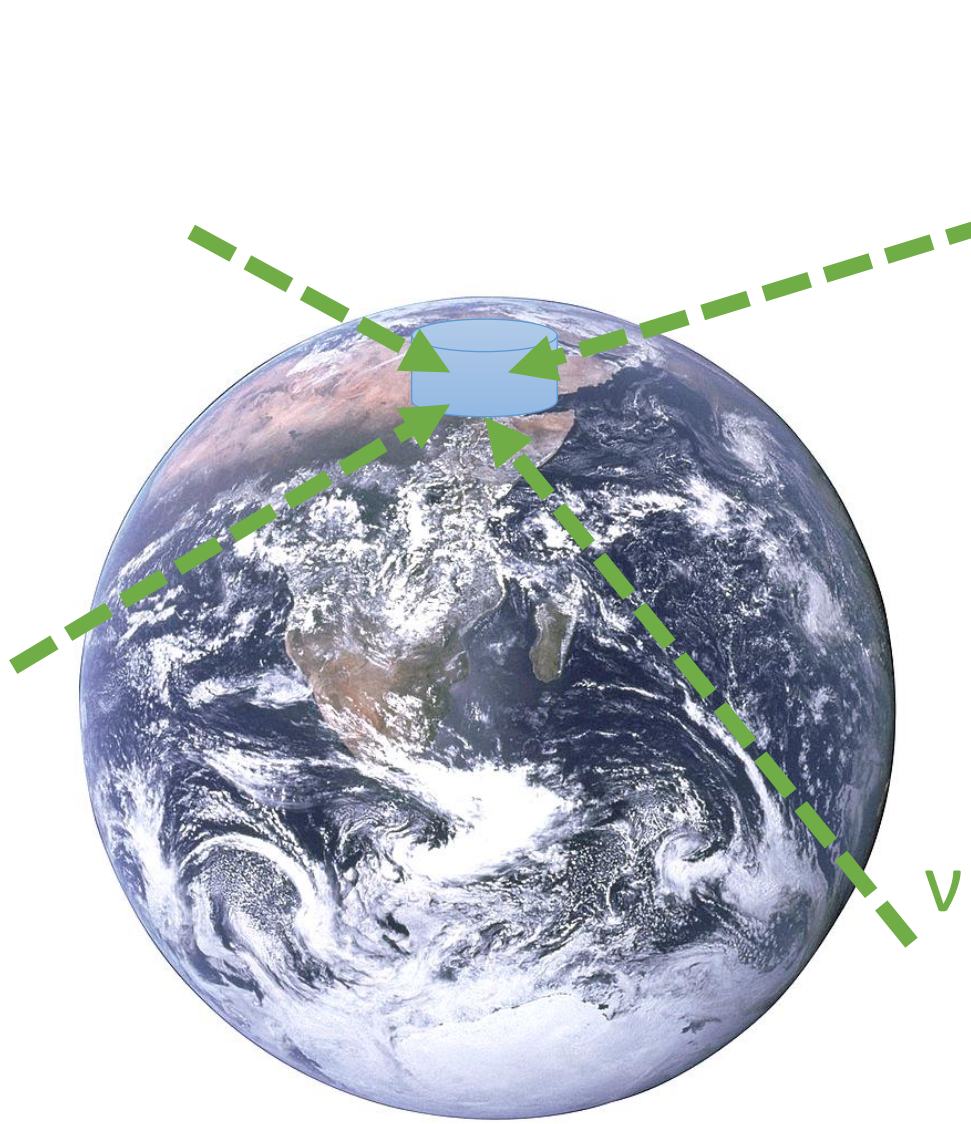
-**3D** array of light sensors

-deep **underground**

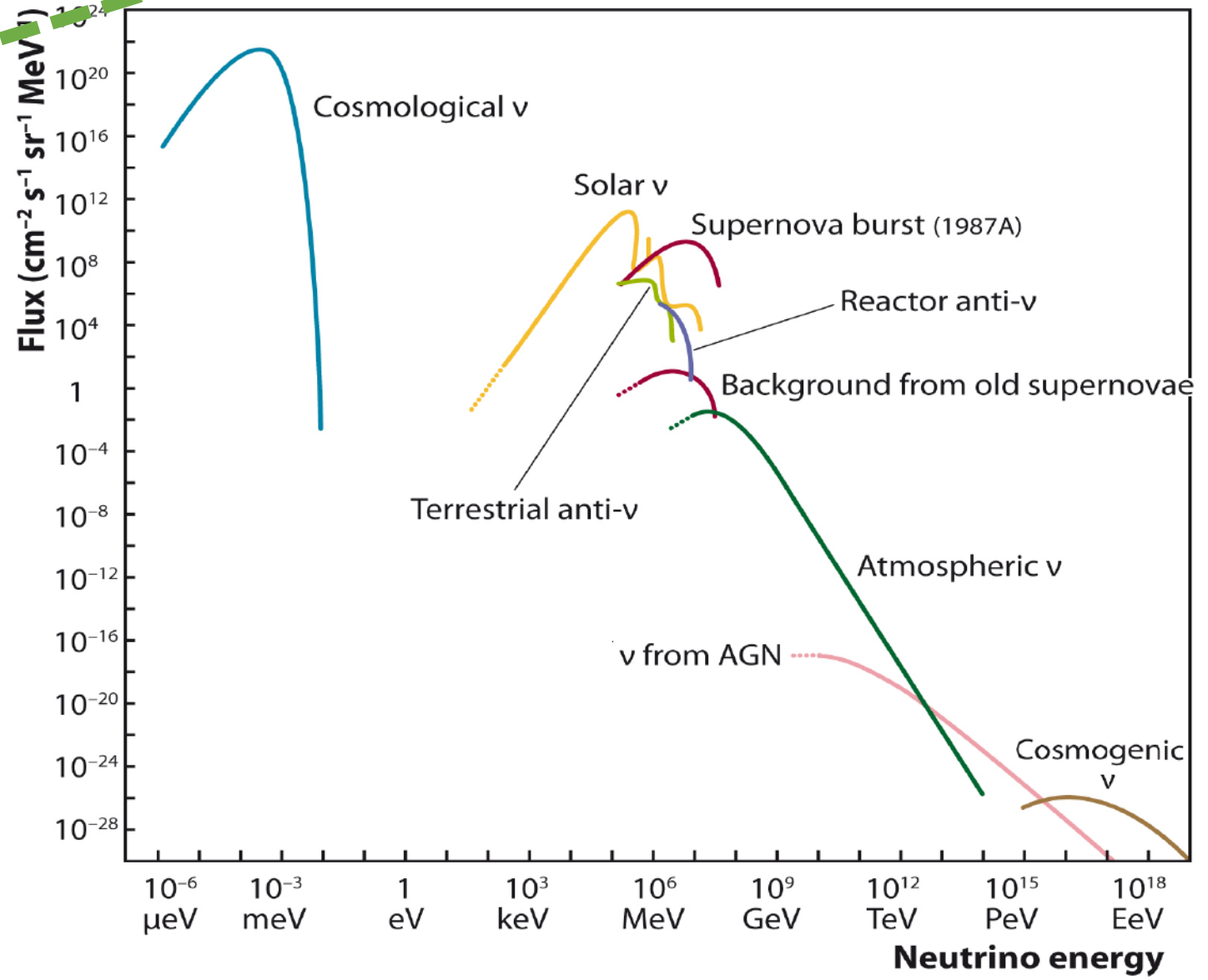
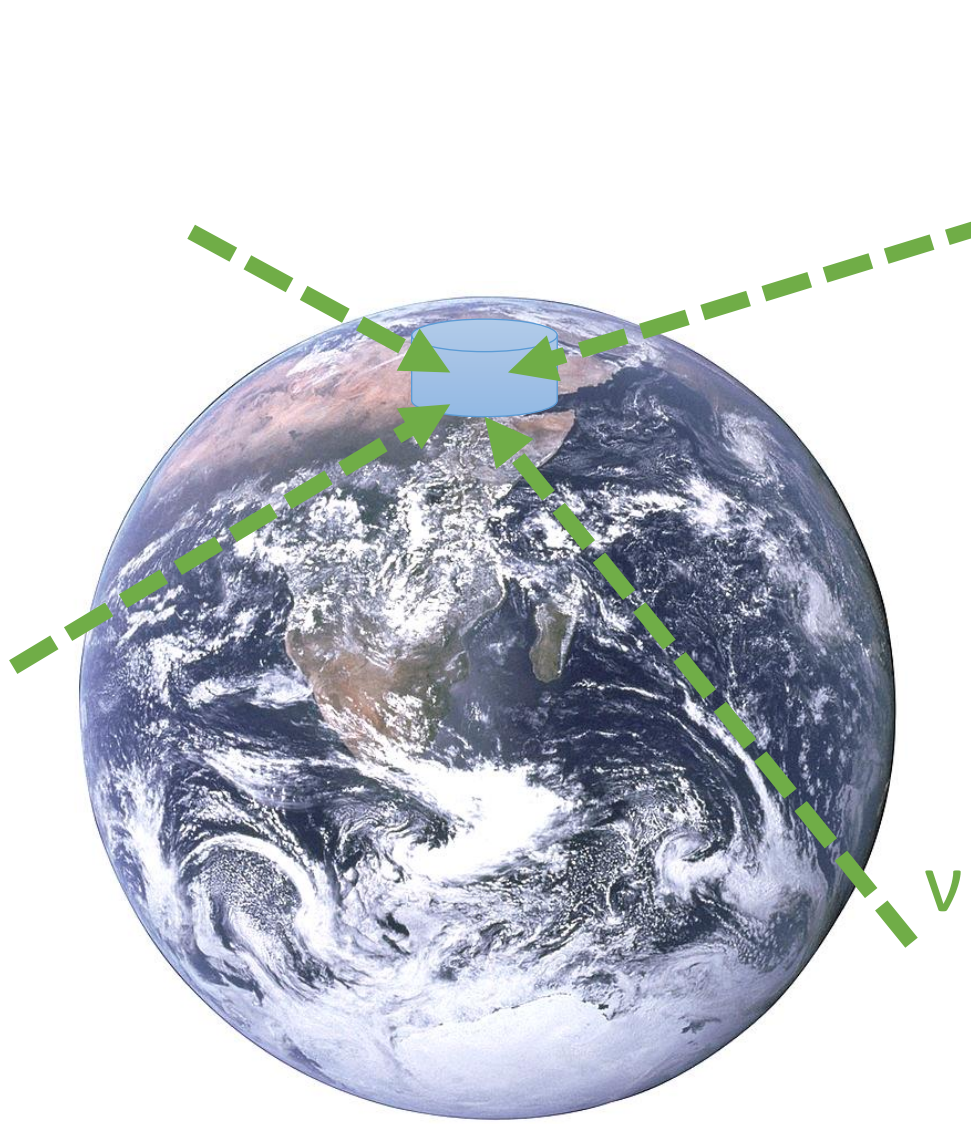
-**sparse** instrumentation







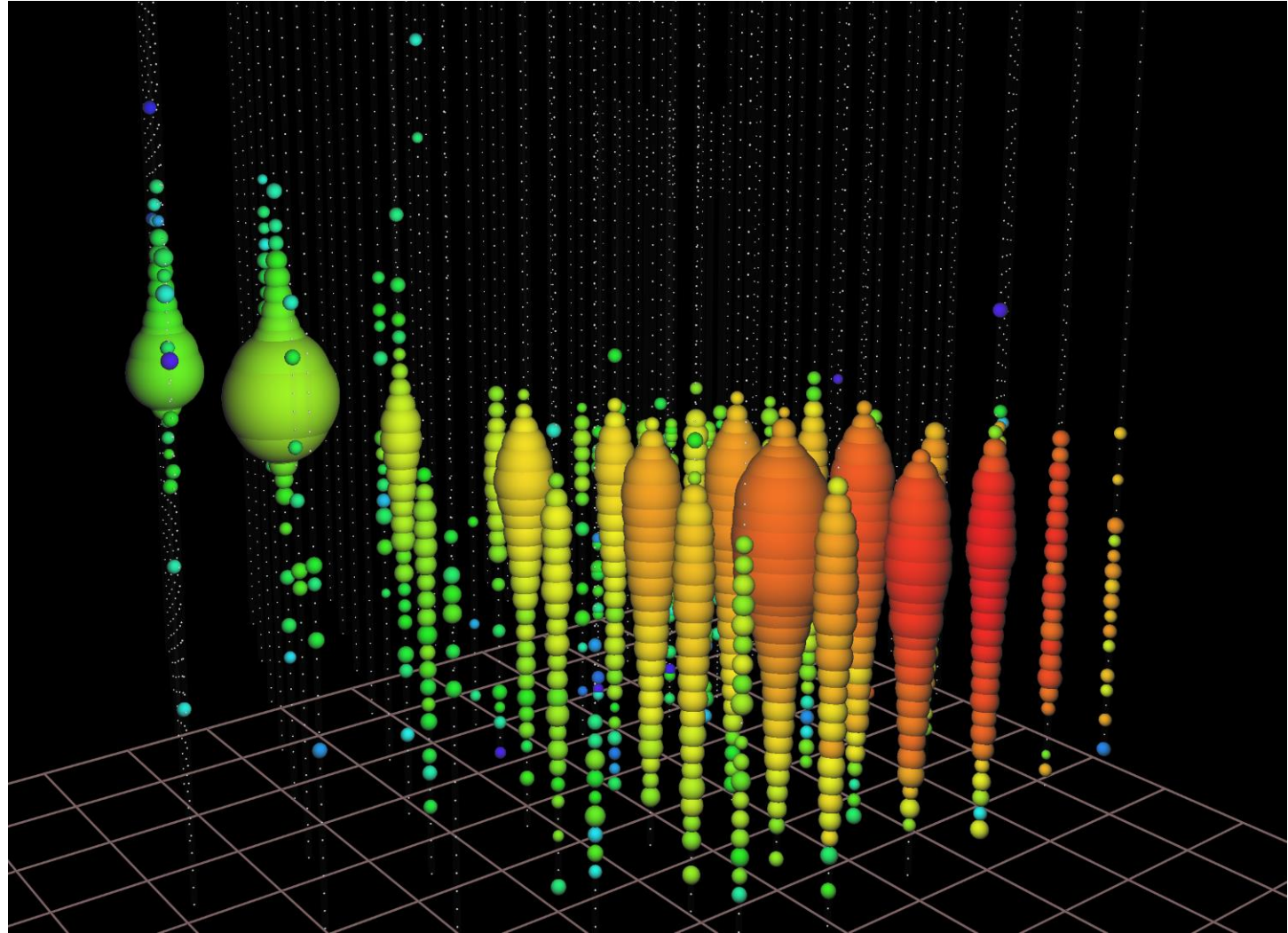
detect **neutrinos** from  
all directions starting  
at a **few GeV**  
-atmospheric  
-astrophysical  
-cosmogenic  
-others



-muons travel from  
tens of meters to  
several **km**

-other particles  
**shower**

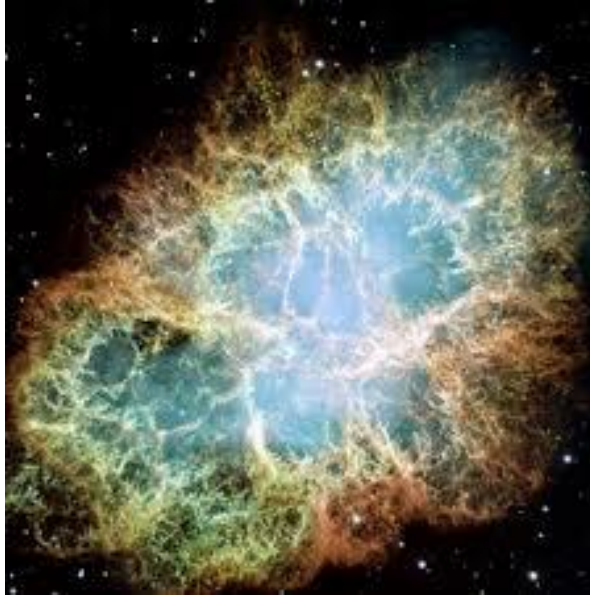
**sparingly  
instrumented  
detectors work**



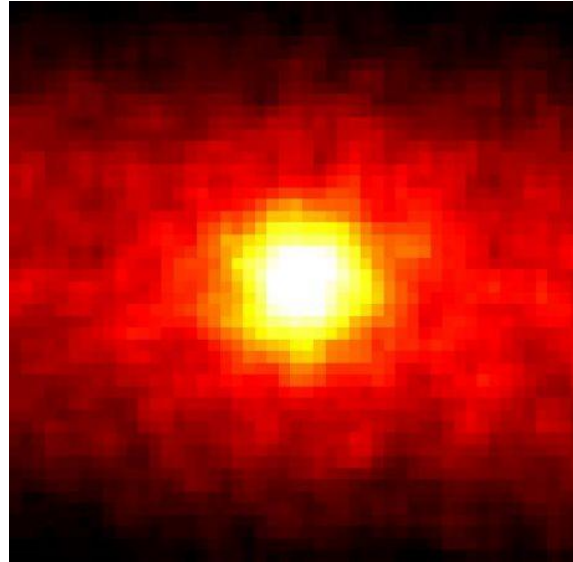


why detecting  
GeV-PeV neutrinos?

# studying their **sources**

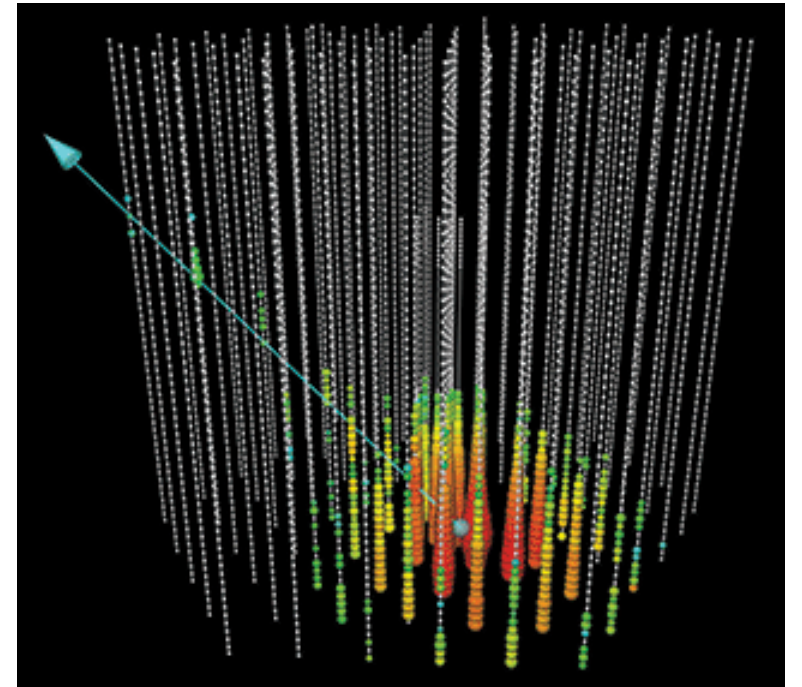


**supernova**  
neutrinos



**solar** neutrinos

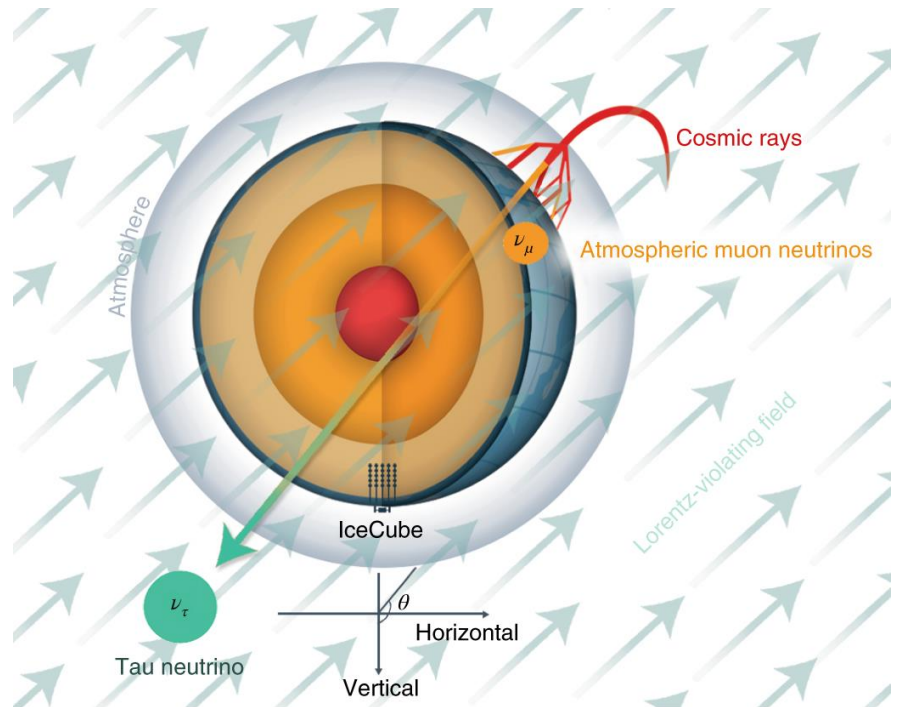
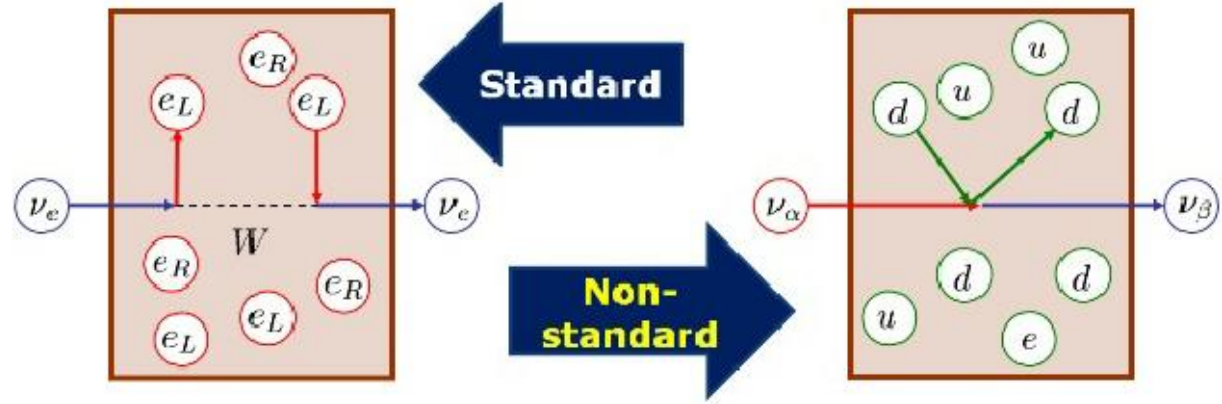
HE neutrinos from  
**violent sources**



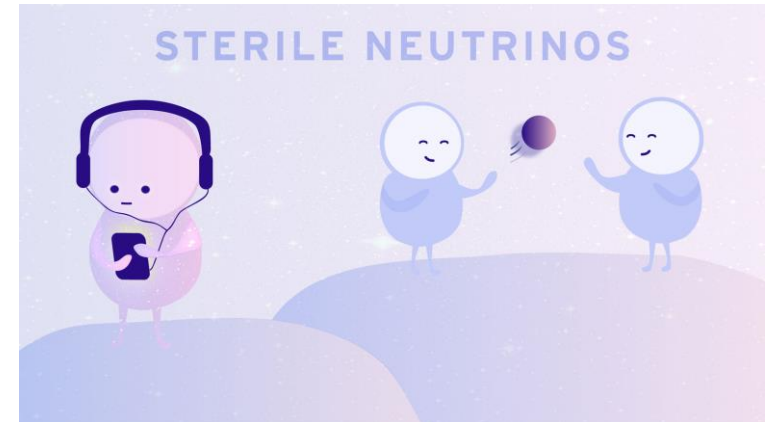


# searching for **exotic physics** with $\nu$

**non-standard interactions**



## Lorentz invariance violation



# **P-ONE: a neutrino detector deep in the Pacific**



**In the deep ocean**

**-light is **minimally** scattered**

**-absorption lengths are tens of meters**

**-sensors can be deployed from a ship**

**-repairs and relocation are possible**

**-logistics should be **relatively simple****



# **Water km<sup>3</sup> scale neutrino telescopes in under construction**

- Km3NeT – Mediterranean sea**
- GVD-Baikal – Lake Baikal**

**serious technical challenges in deployment and operations**  
**– salt water is tough**

# enters Ocean Networks Canada



established in **2007**

operates Ocean observatories

provides **deep sea research infrastructure**



# CANADIAN INFRASTRUCTURE & PARTNERS

Coastal Community Ocean Observers Program

Kugluktuk

Cambridge Bay

Resolute

Grise Fiord

To Cape Herschel, CFS Alert & Thule Research Station

Arctic Research Station

Gascoyne Inlet

Clyde River

Pond Inlet

Qikiqtarjuaq

Arctic Drifter Buoys

Gjoa Haven

Greenland Institute of Natural Resources

Canadian Ranger Ocean Watch Program

Line Papa

Prince Rupert

Kitamaat Village

Churchill

Hudson Bay

SmartBay

Defence Research Hydrophone Experiment

Campbell River

Salish Sea Marine Survival Program

NEPTUNE

Tofino

VENUS

Neutrino Observatory

Mill Bay

Defence Research & Development Canada CODARS

FORCE

OTN/DFO Halifax Line

PACIFIC OCEAN

Great Lakes

University of Waterloo

ATLANTIC OCEAN

**Legend**

- Existing Installation
- Funded Installation
- Potential Installation
- Existing Mobile Asset
- Potential Mobile Asset
- Industry Partner
- Science Partner
- Data Centre
- Ship-based Observing
- Data Transfer Line
- Fibre-optic Cable

Bathymetry (50 m contour lines)  
-3500 m

AN INITIATIVE OF University of Victoria

Data Sources: Smith and Snowball DEM, USGS Cascade DEM, National Geophysical Data Center and NOAA (1999) Great Lakes Bathymetry. Last Updated: 18 September 2018.





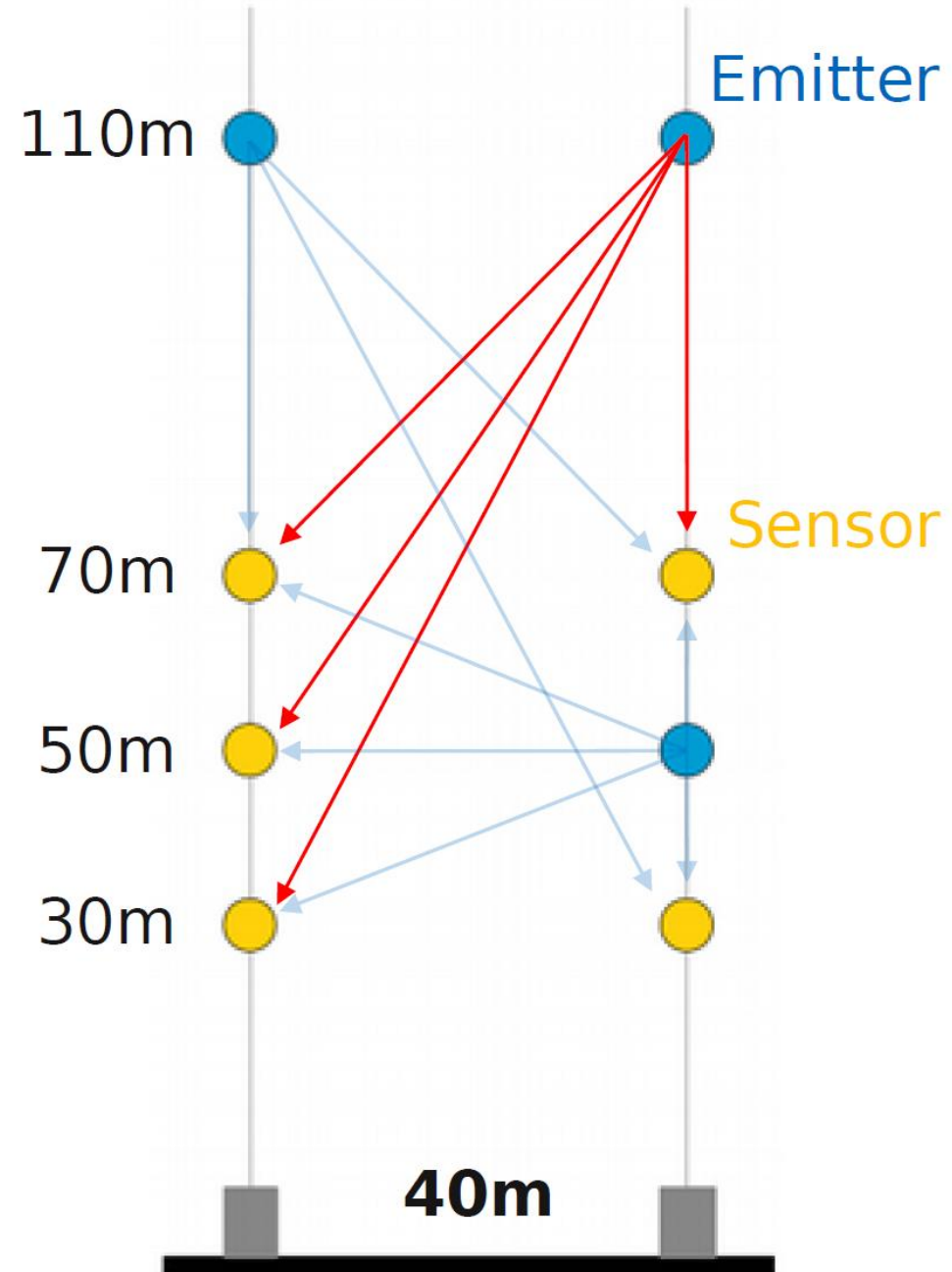
UofA & TUM  
researchers  
established  
**cooperation**  
in 2017

“**potential**  
installation”

**in June 2018,  
STRAW was  
deployed**

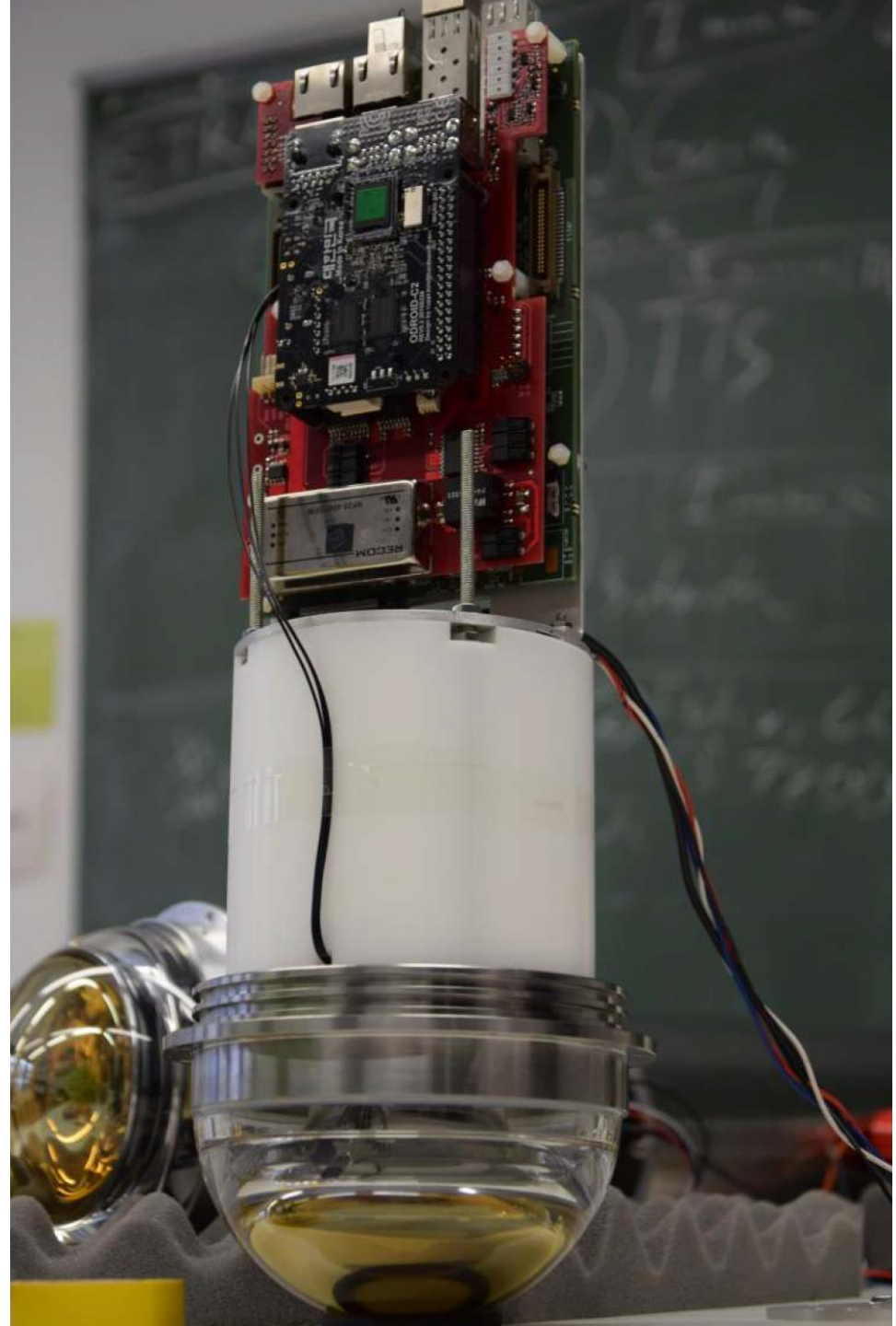
**-deployed over  
a weekend**

**-2.6km depth**

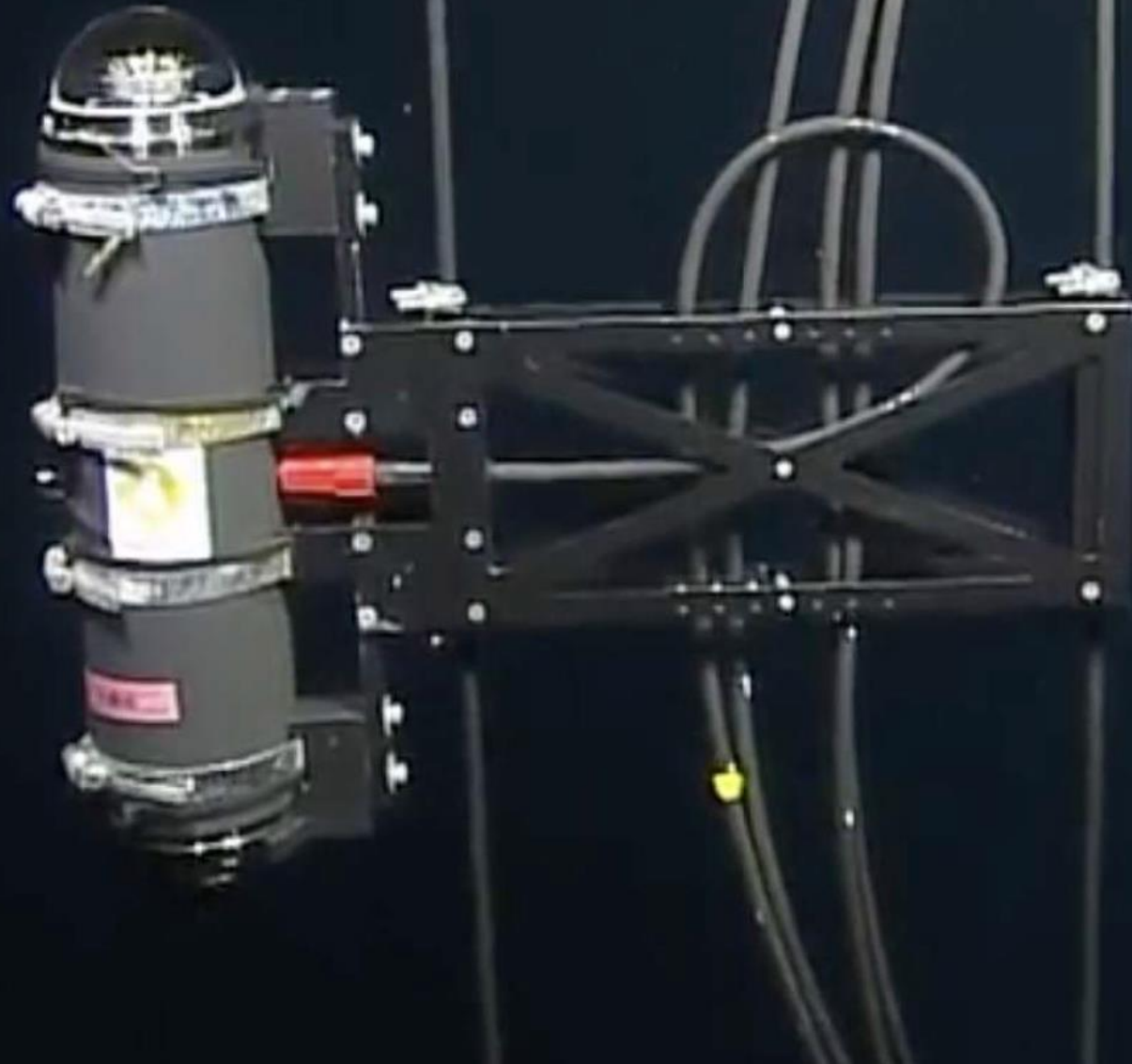




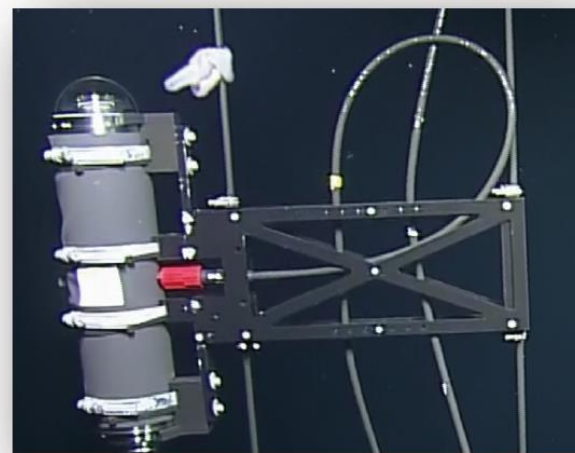
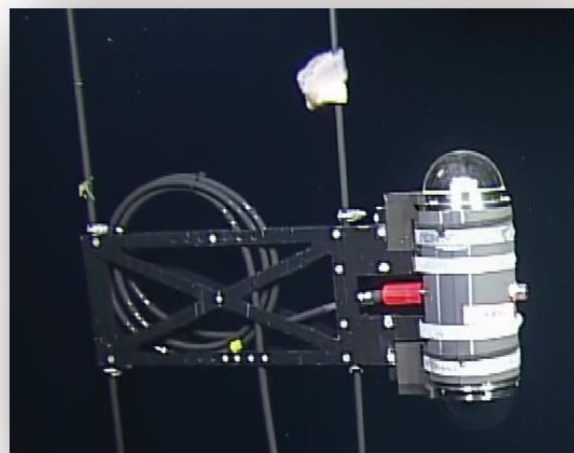
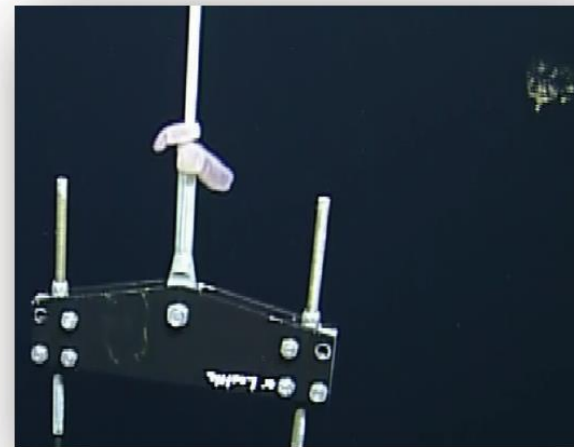
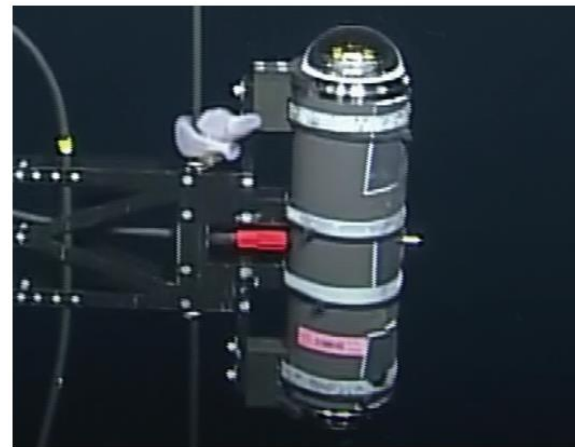
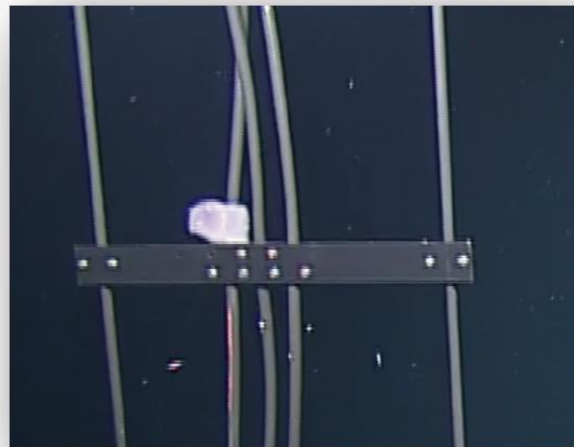
# a handful of light **emitters** and **sensors**







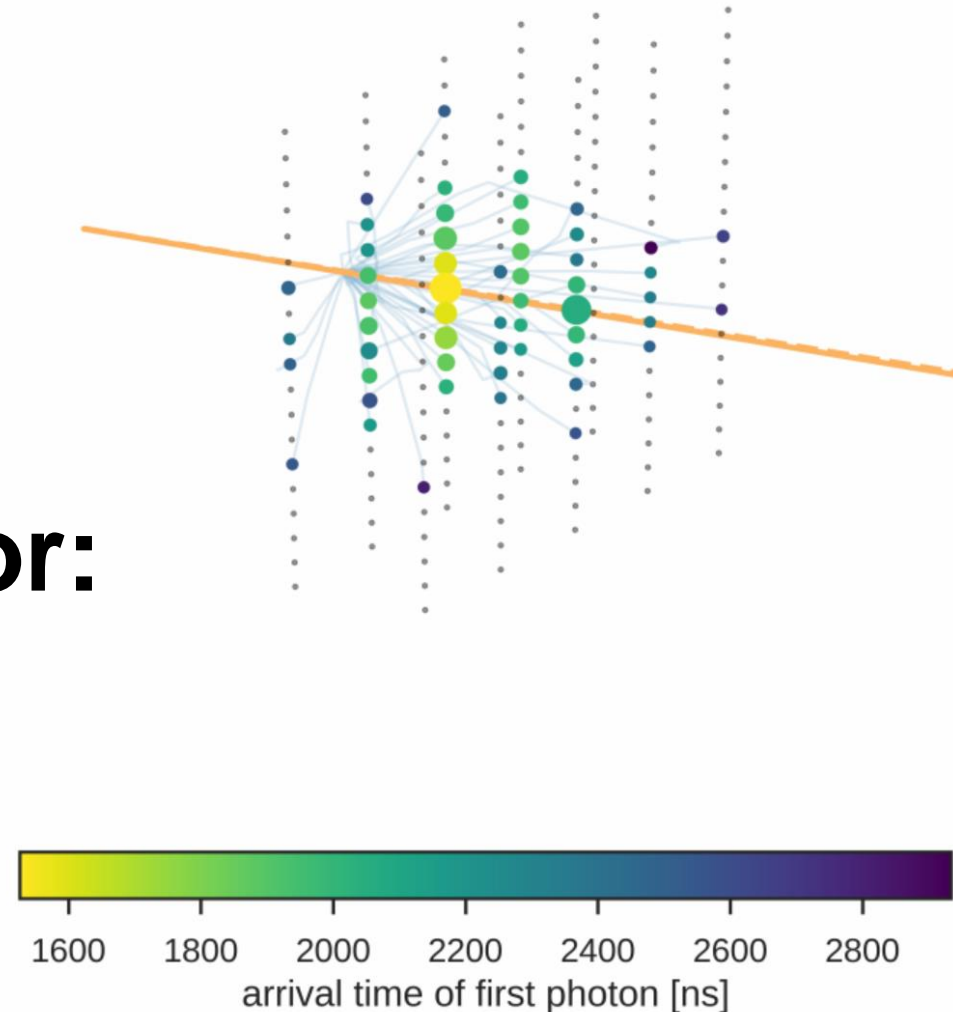
**operating  
without  
problems  
since  
deployment**



**also finding new deep ocean friends**

# first step forward: P-ONE Pacific Ocean Neutrino Explorer

- 200** modules
- 10** strings/lines
- order **100m** spacing
- exploring potential for:
  - tau neutrinos
  - charm production
  - exotic oscillations

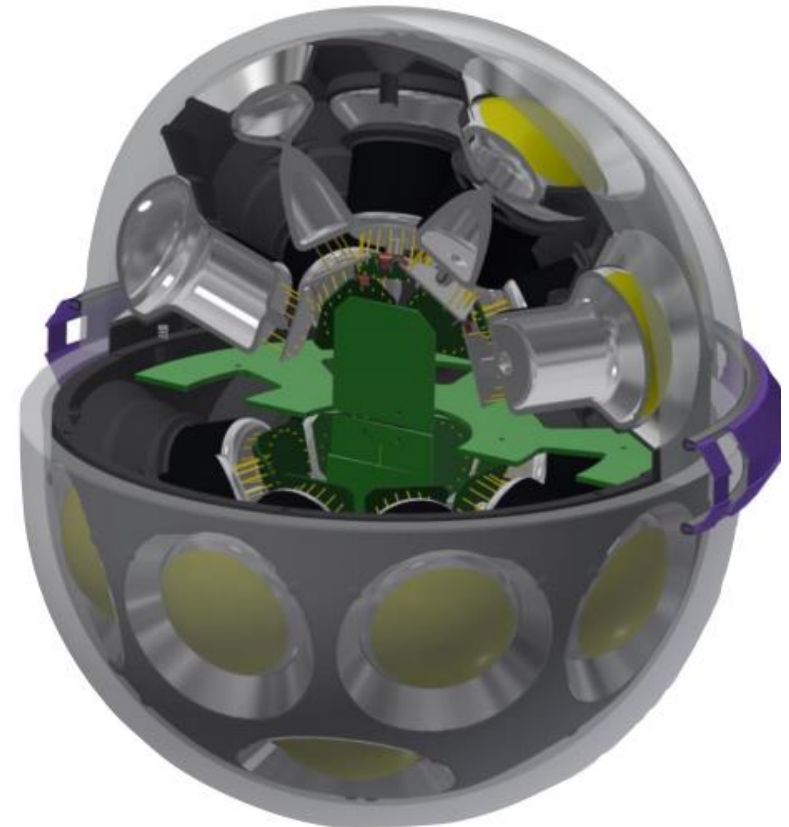


\*Proposal submitted to CFI



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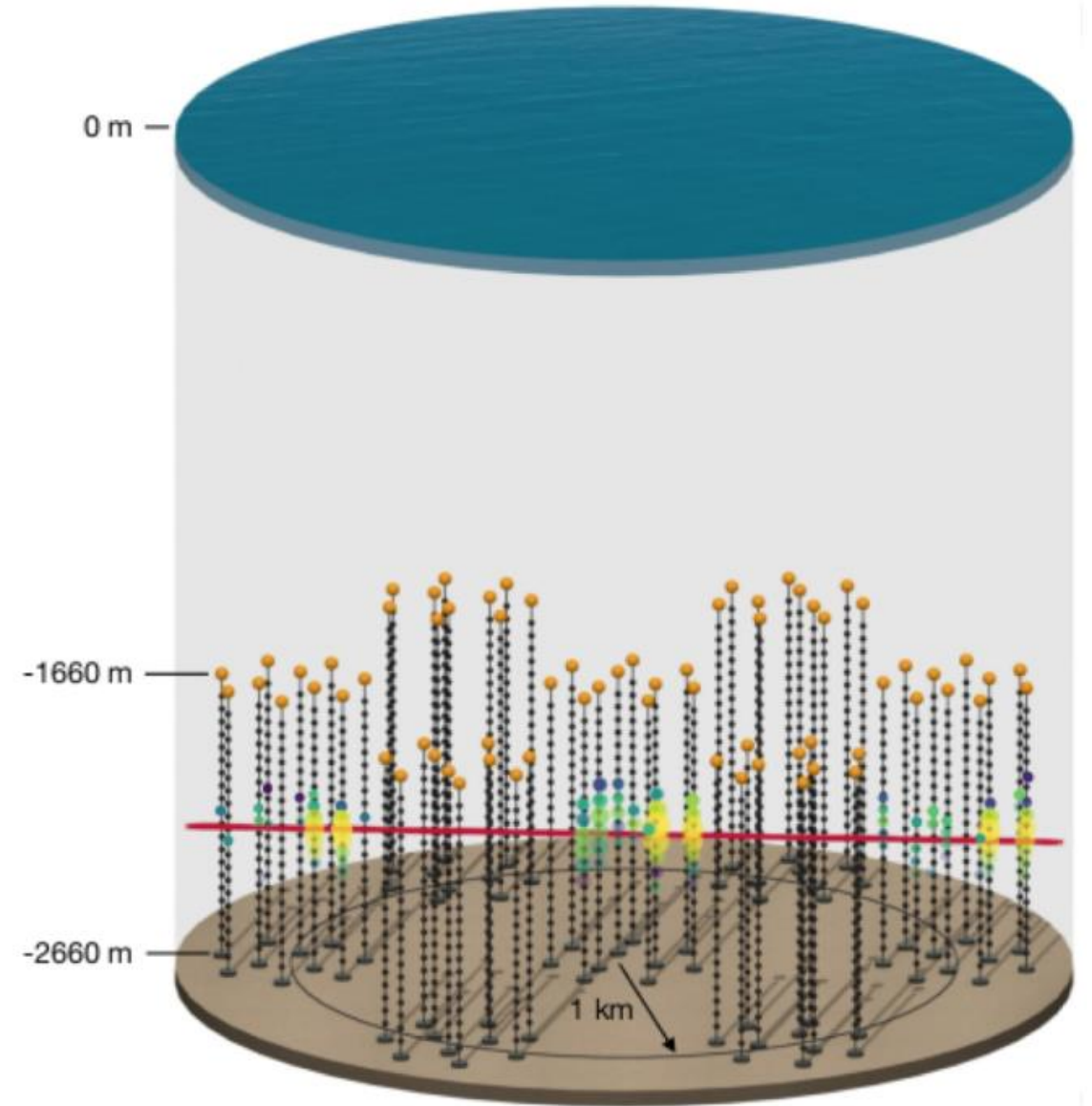


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# and after P-ONE?

an array large enough  
to see TeV-PeV events  
with large statistics:

- do real **neutrino astronomy**
- study **extreme** high energy interactions





To know more, pay us a visit in <http://www.pacific-neutrino.org/>

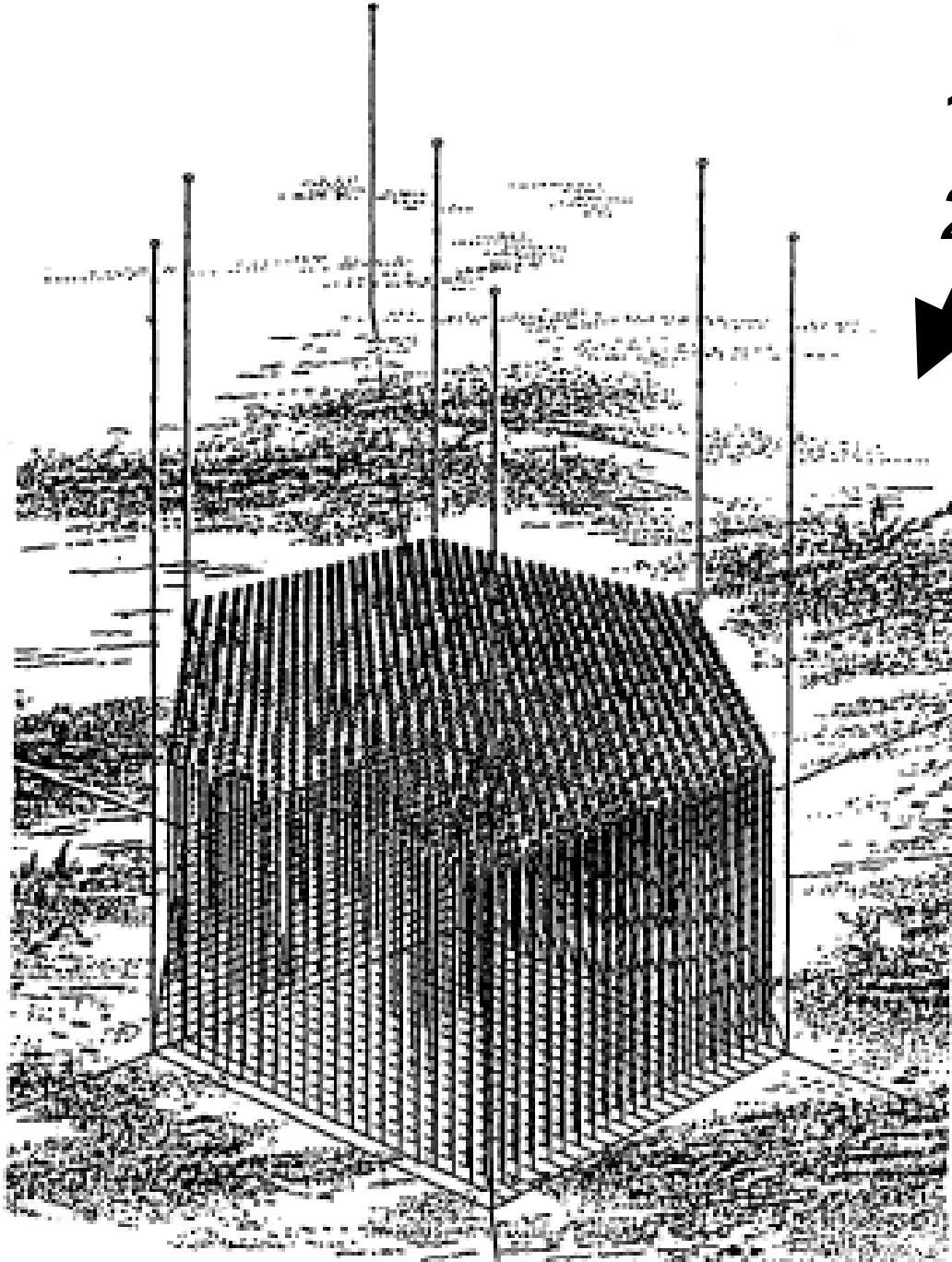
The Pacific Ocean Neutrino Experiment - <https://arxiv.org/abs/2005.09493>

STRAW (STRings for Absorption length in Water) - <https://arxiv.org/abs/1810.13265>

Papers on site characterization and physics potential coming out of Canadian groups soon



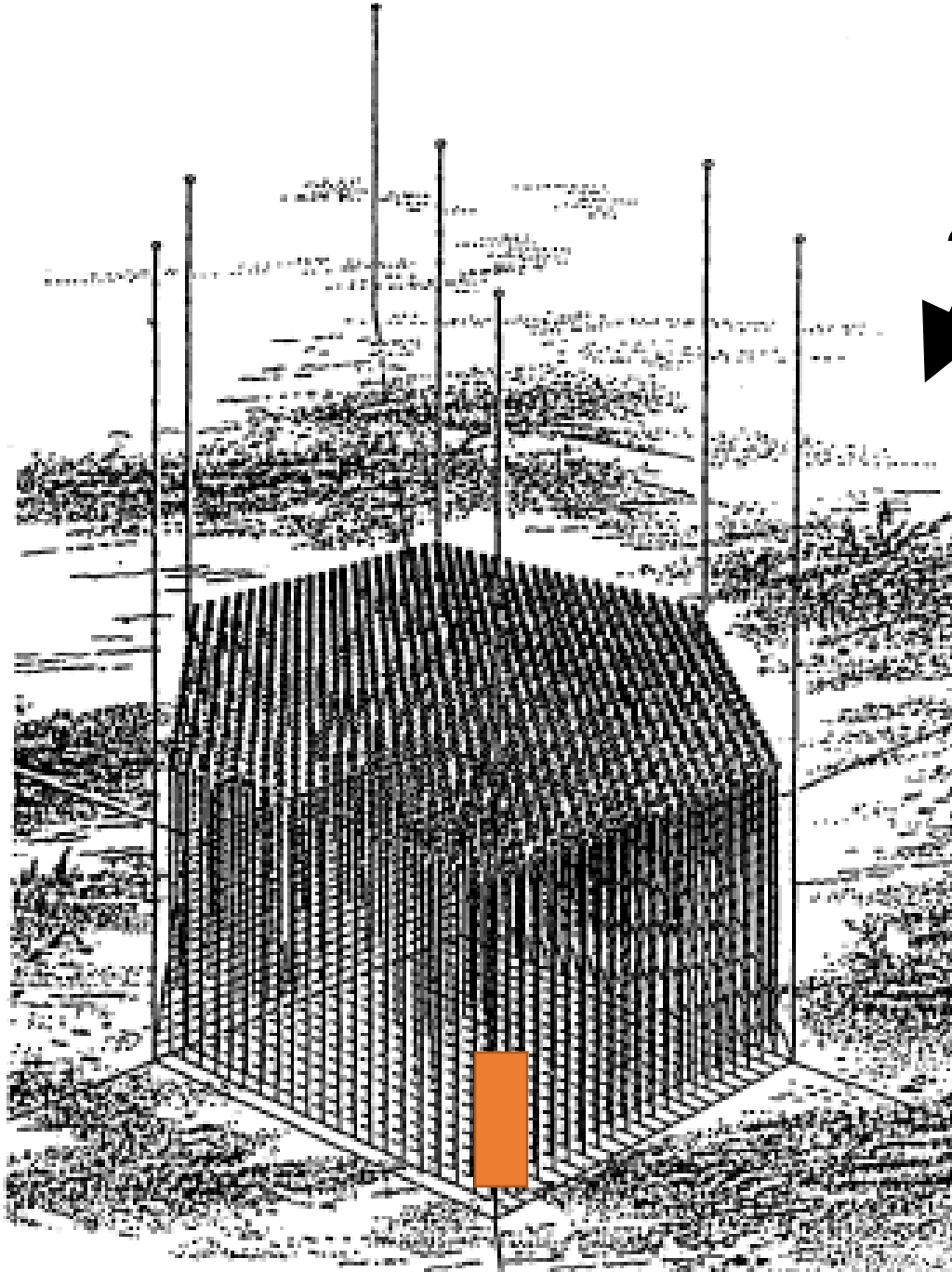
# Backup



1978: 1.26 km<sup>3</sup>  
22,698 OMs



**DUMAND in Hawaii**  
**first proposed in**  
**1973**



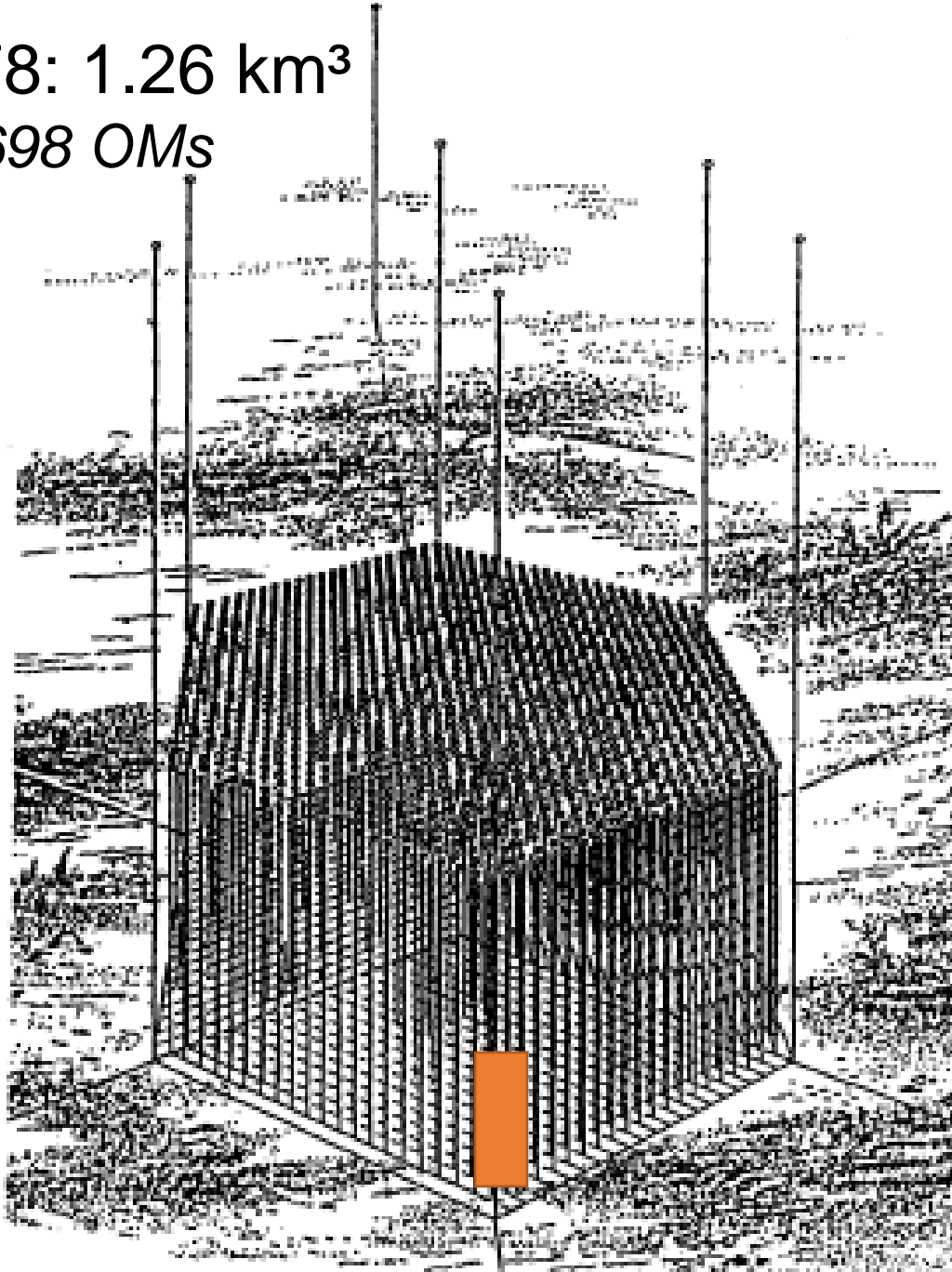
1978: 1.26 km<sup>3</sup>  
22,698 OMs

# DUMAND in Hawaii first proposed in **1973**

1988: reduced DUMAND design  
DUMAND terminated in 1996



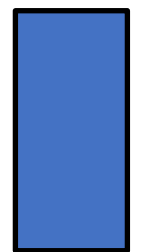
1978: 1.26 km<sup>3</sup>  
22,698 OMs



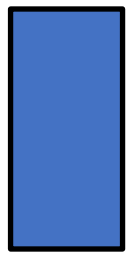
1998  
NT200  
Lake Baikal



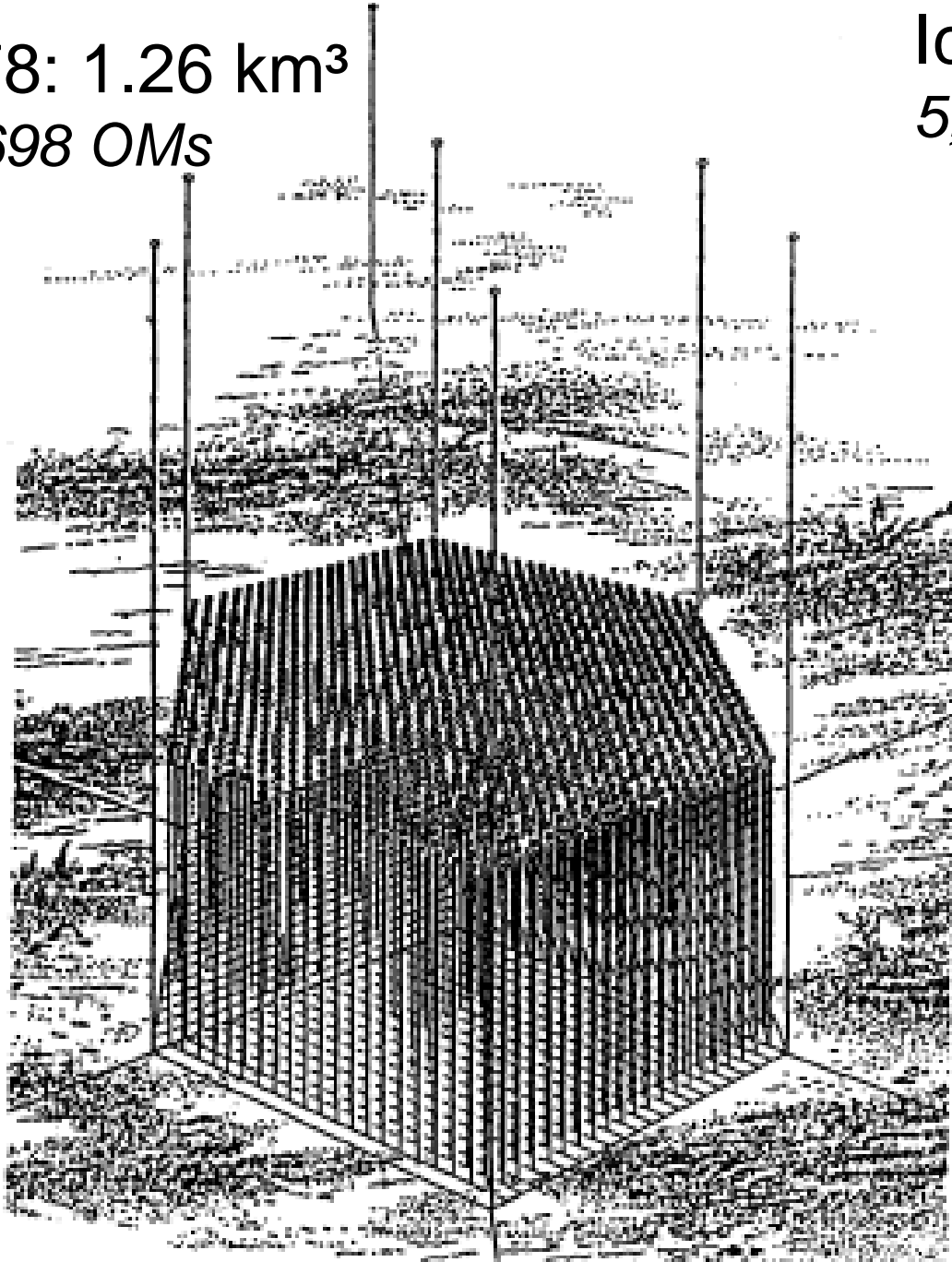
2000  
AMANDA  
South Pole



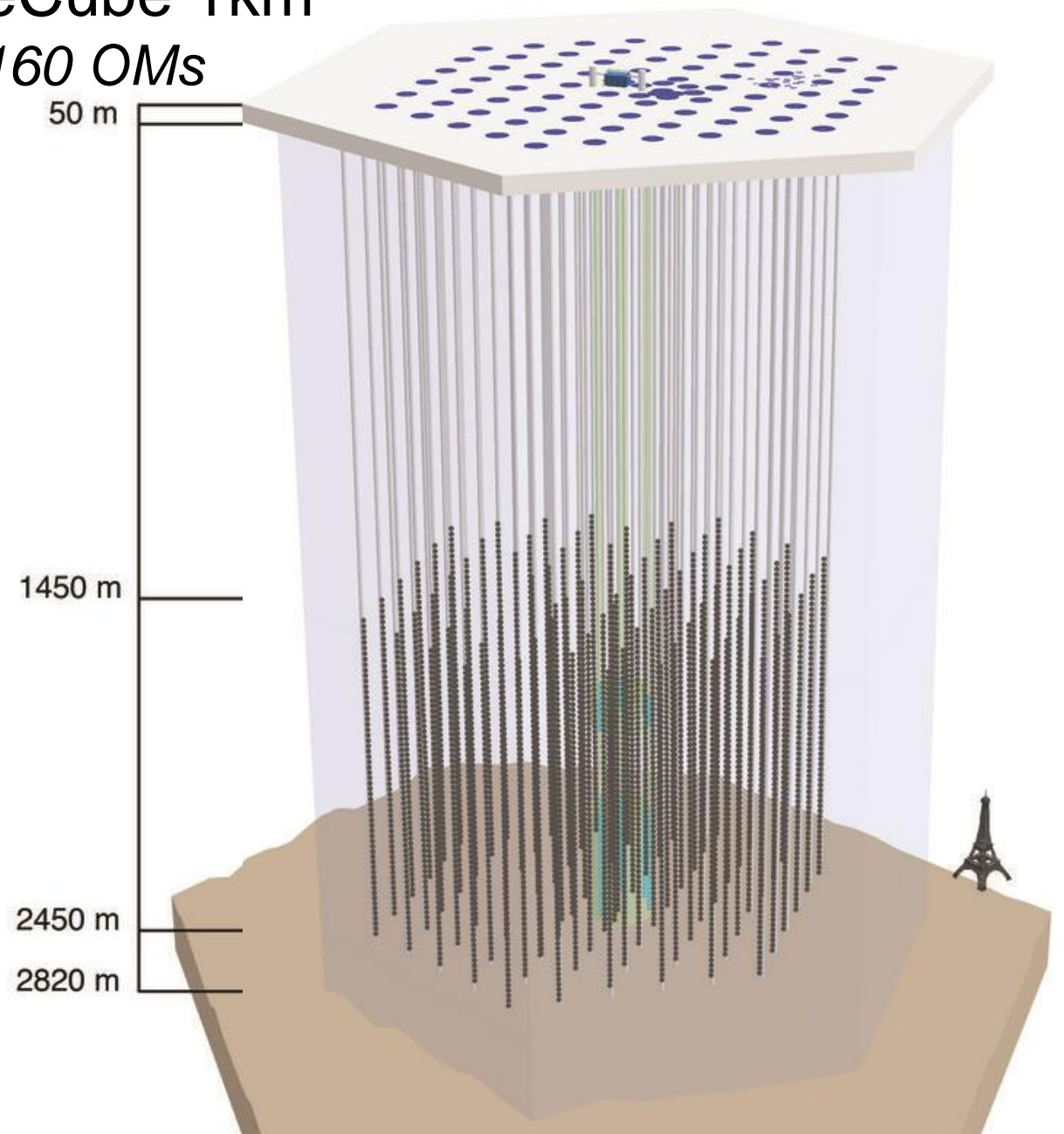
2008  
ANTARES  
Mediterranean



1978: 1.26 km<sup>3</sup>  
22,698 OMs



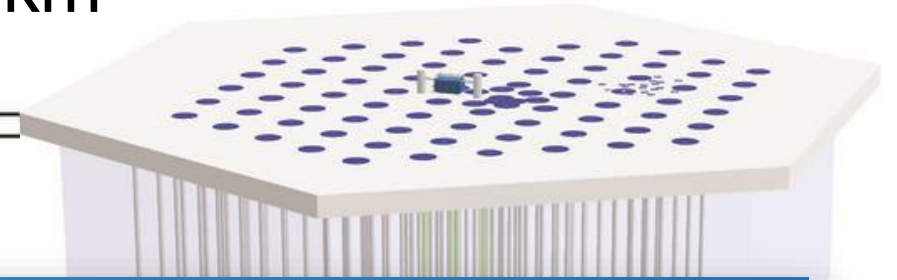
IceCube 1km<sup>3</sup>  
5,160 OMs



1978: 1.26 km<sup>3</sup>  
22,698 OMs

IceCube 1km<sup>3</sup>  
5,160 OMs

50 m

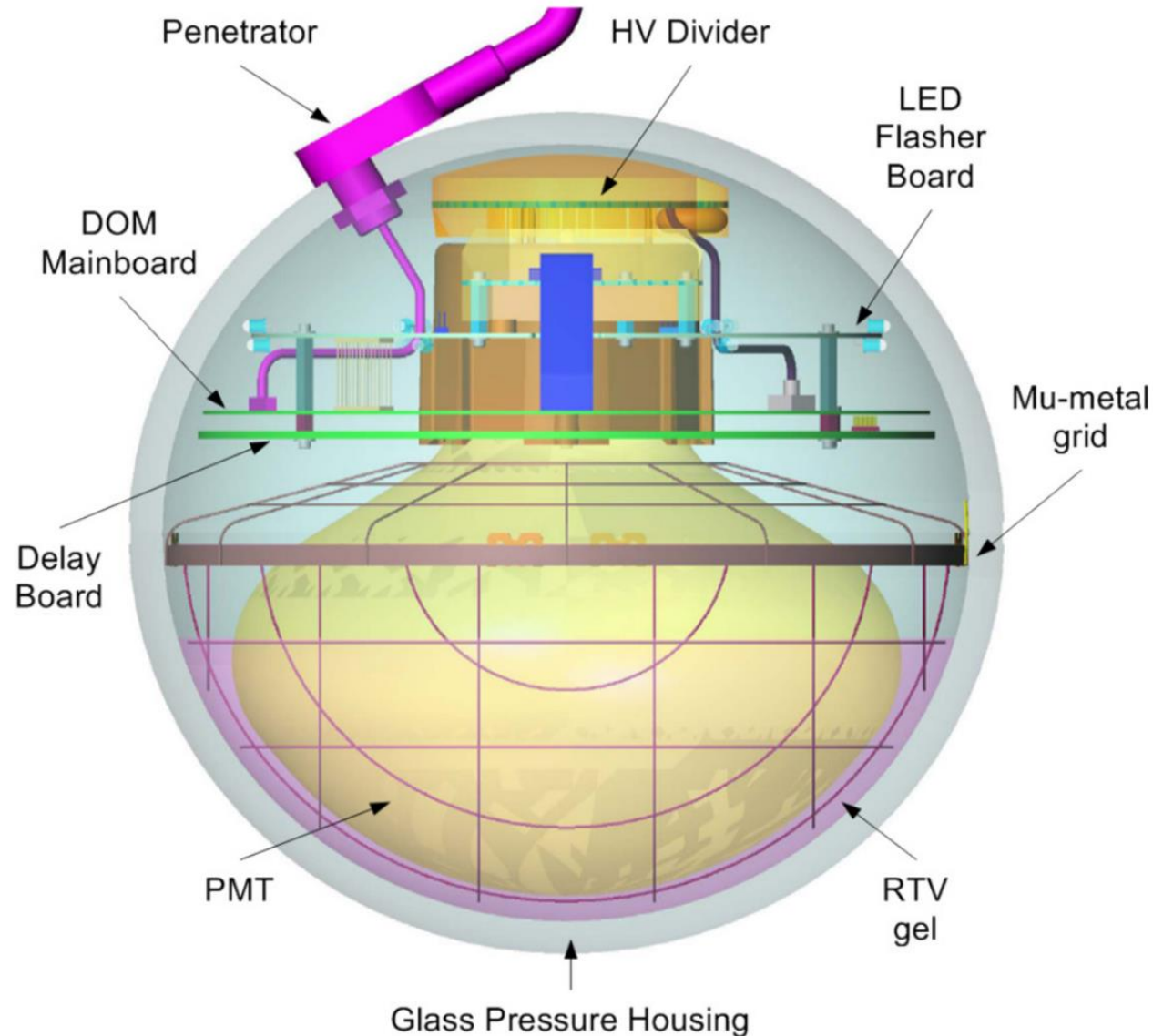




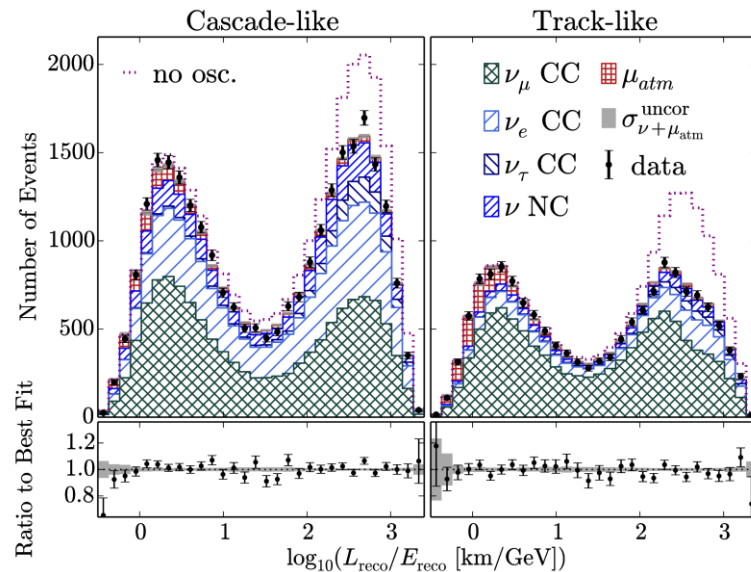
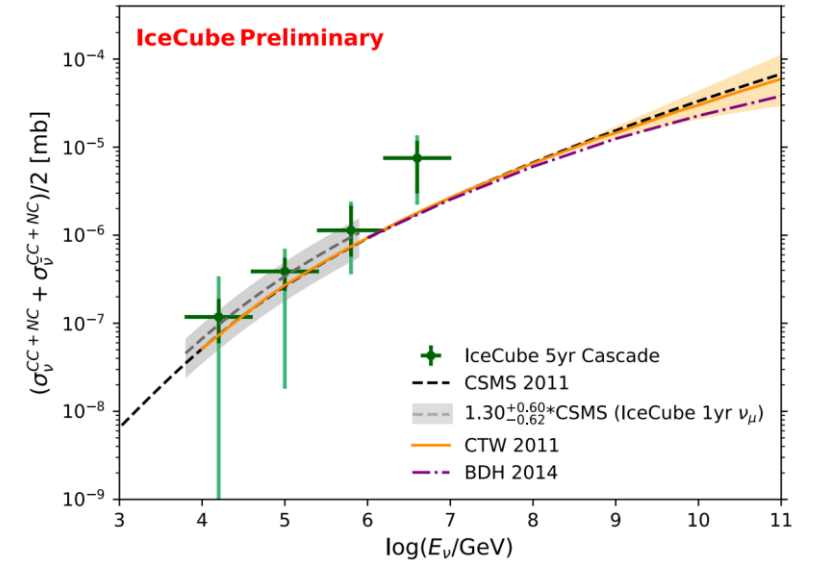
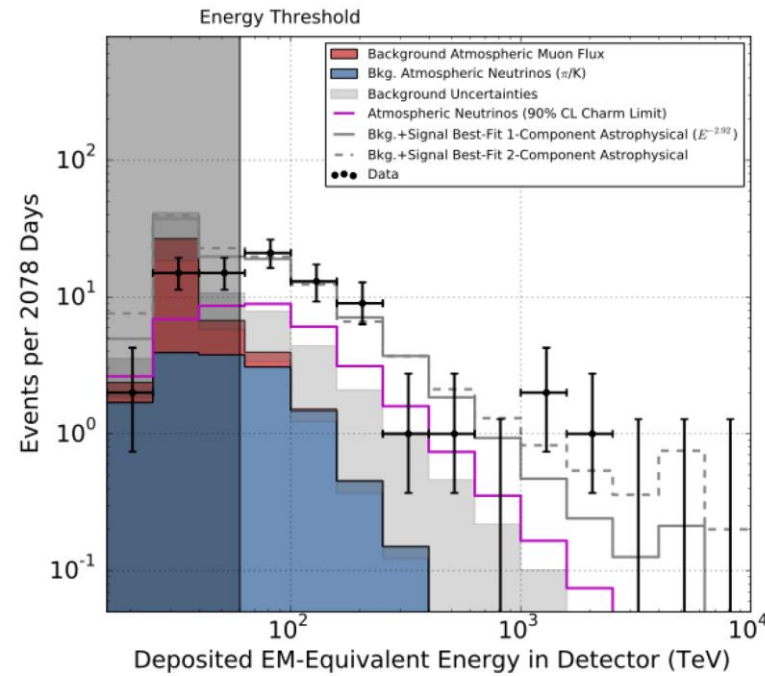
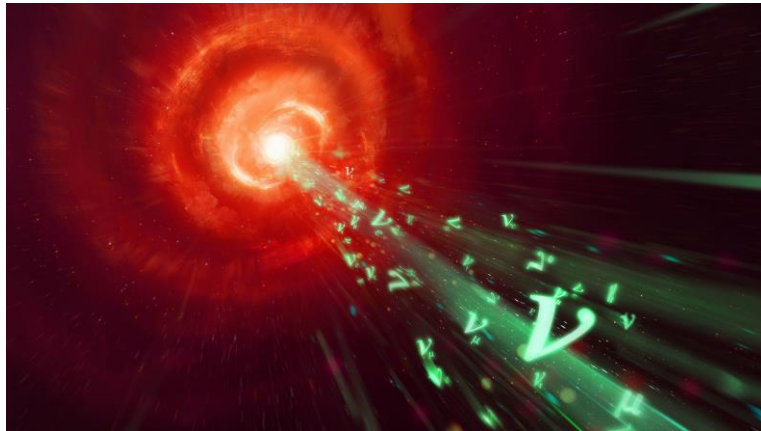
# IceCube has been a great **success**

simple, yet versatile and **reliable** sensors

**less than 1%** failure after 10 years of operation



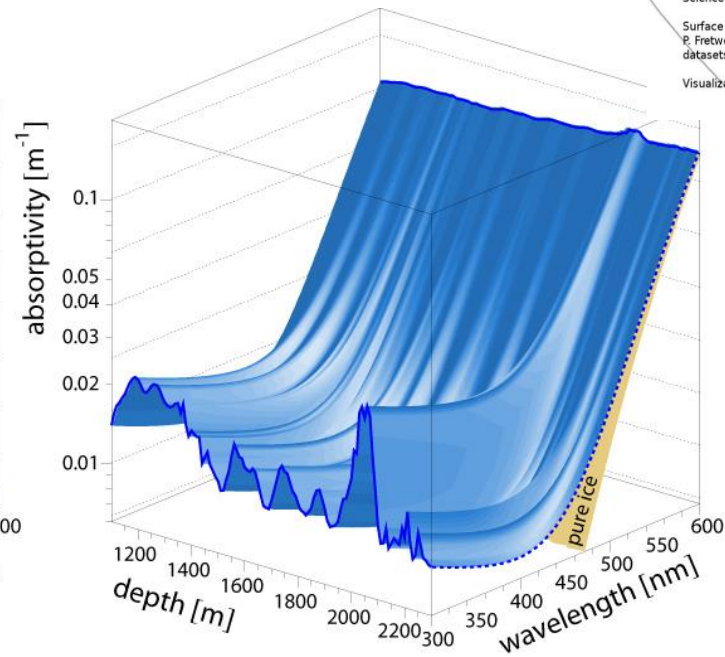
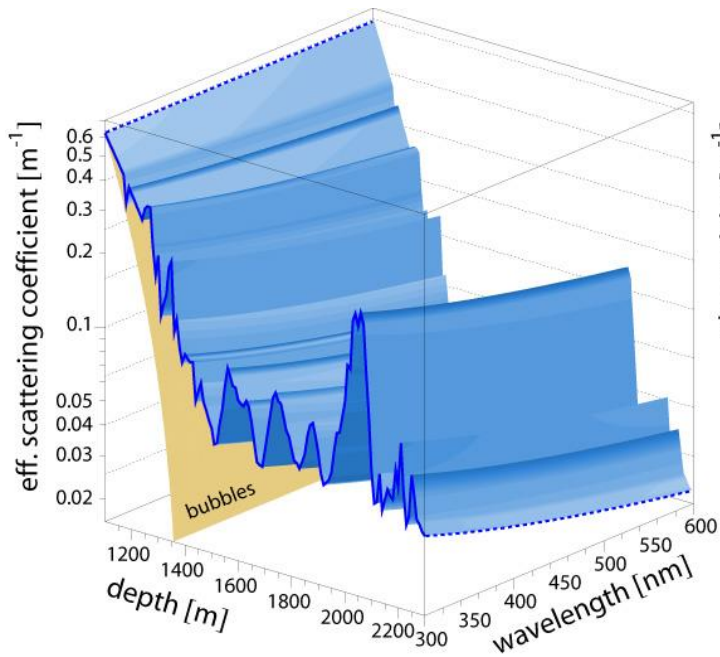
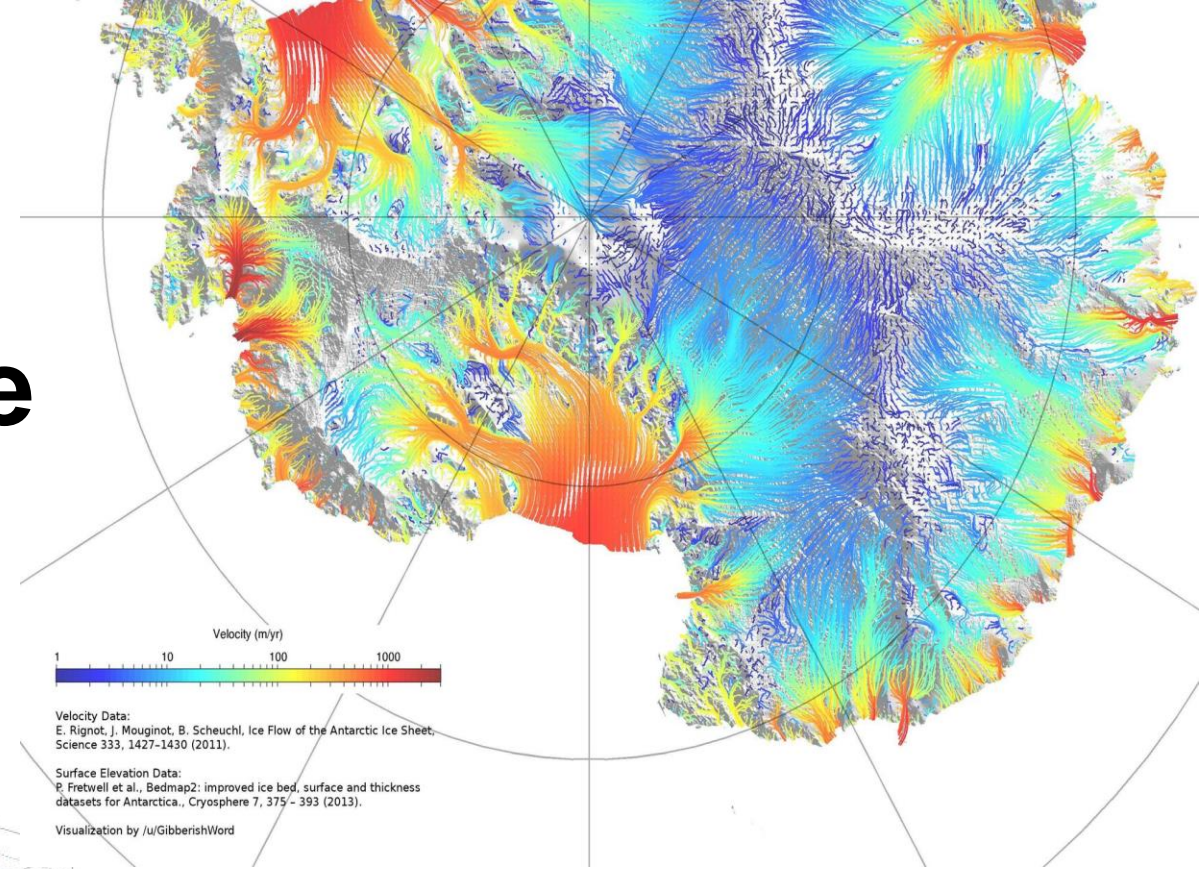
# discovered high energy cosmic neutrinos



does precision measurements of neutrino properties



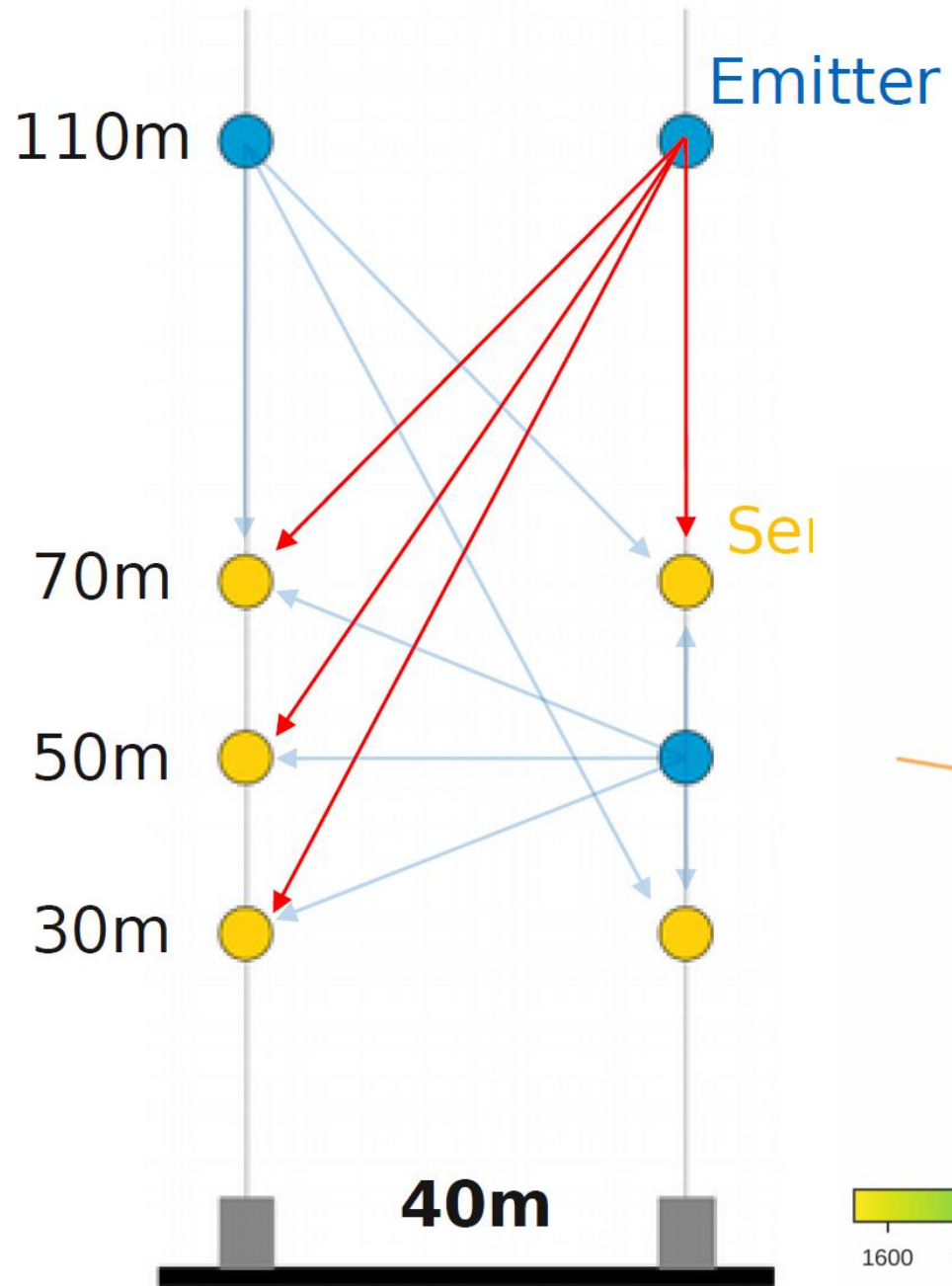
but it is **too small**, the medium is **not ideal**, and construction/logistics are **complicated**





but it is **too small**, the medium is **not ideal**, and construction/logistics are **complicated**





$E_{\nu_l} = 50 \text{ TeV}, E_{l, \text{vertex}} = 28 \text{ TeV}$

