

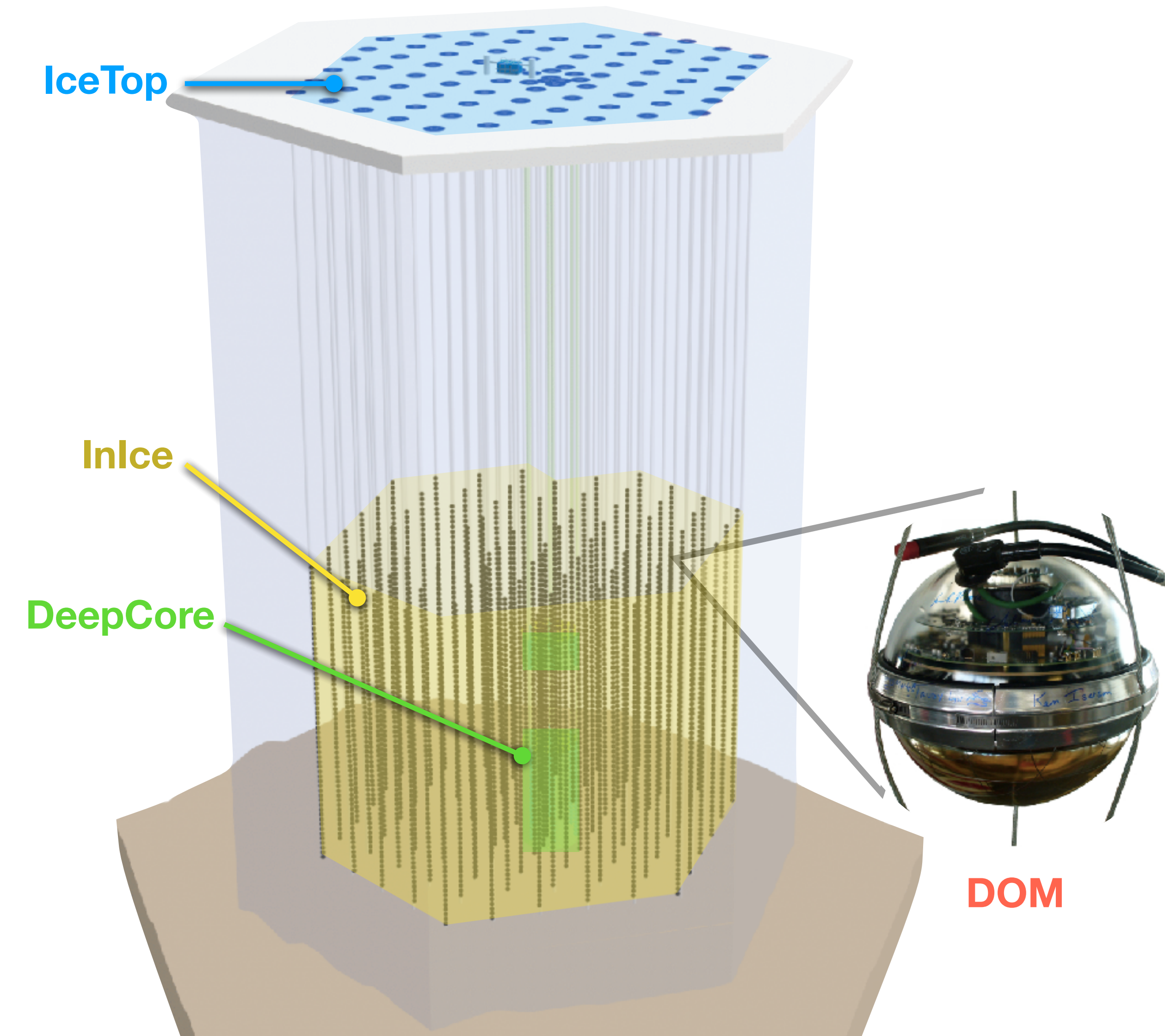
IceCube Upgrade DOM test at SNOLAB

Nahee Park



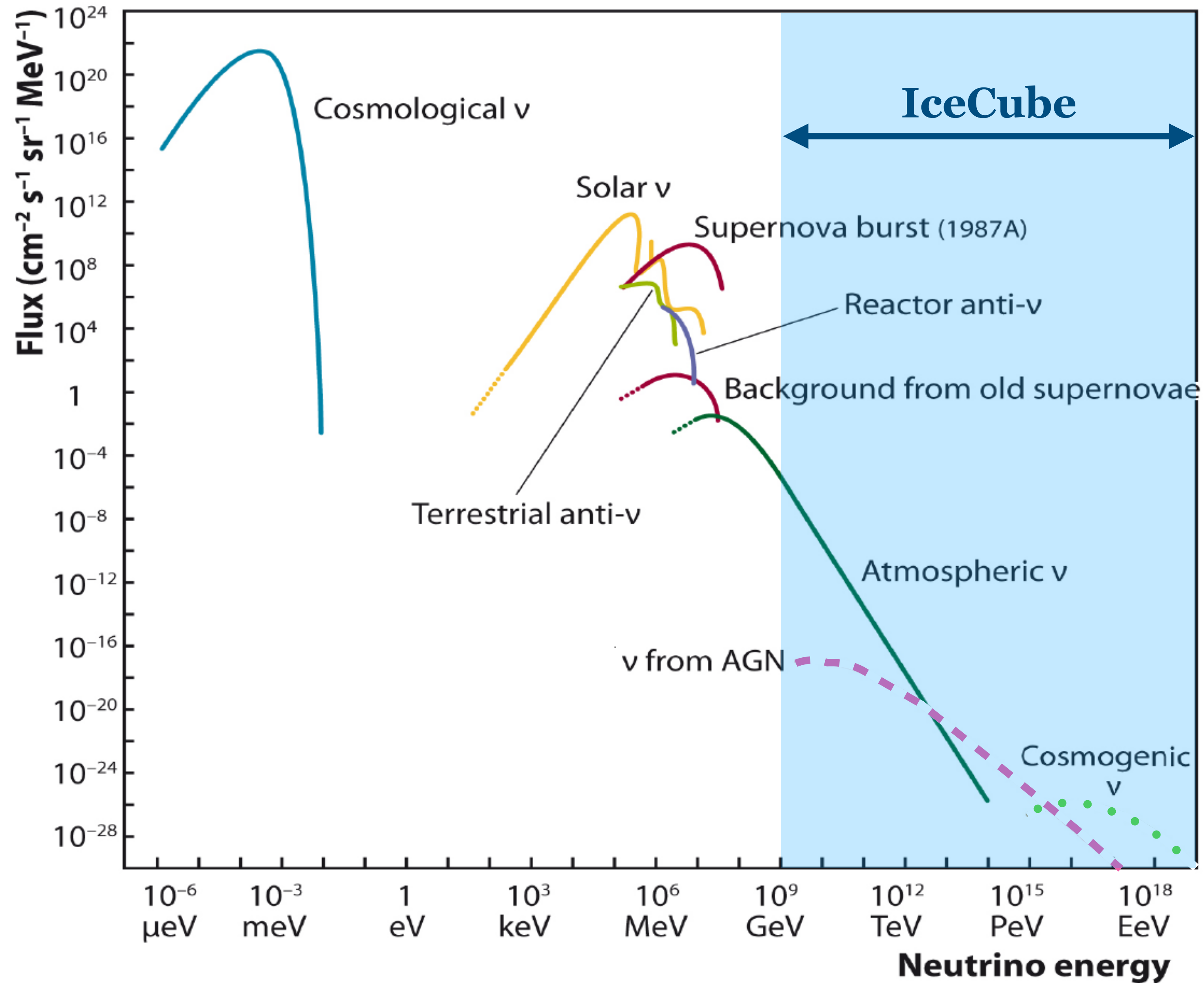
The IceCube Neutrino Observatory

- First km³ -scale neutrino detector
- 5160 digital optical modules (DOMs) deployed at depths between ~1.5-2.5 km
- Denser in-fill for O(10) GeV neutrinos (DeepCore)
- Surface air shower array (IceTop)
- Construction finished in Dec 2010



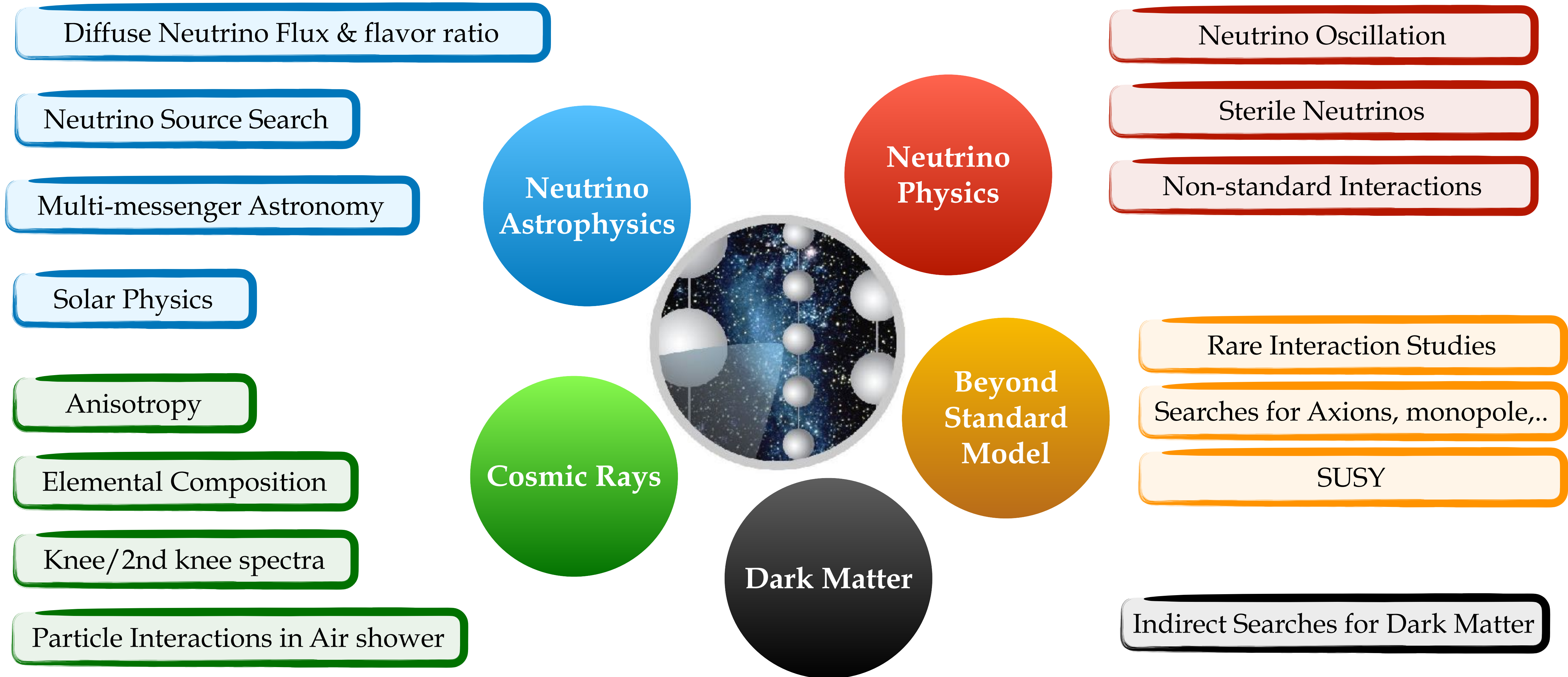


Neutrino Measurements of IceCube



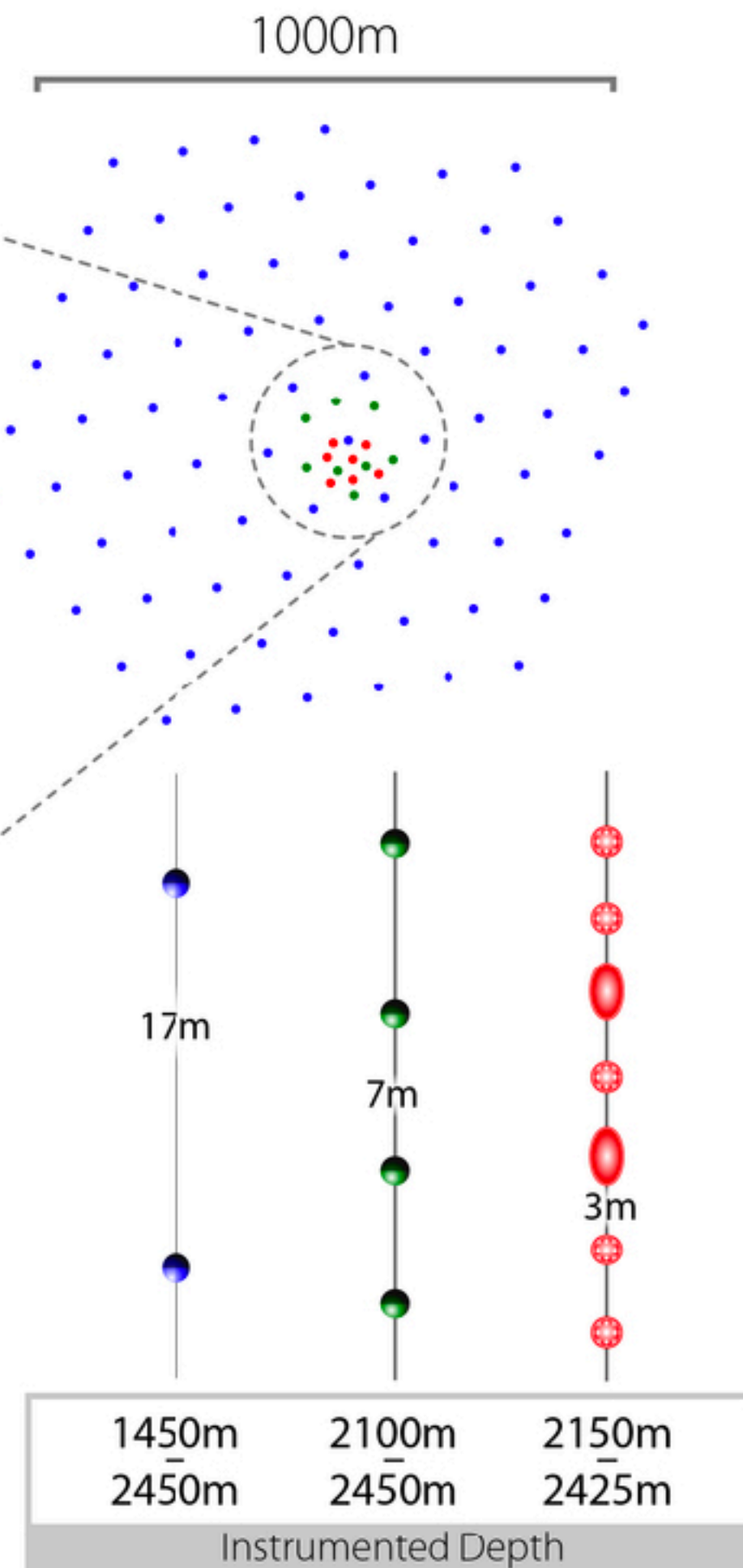
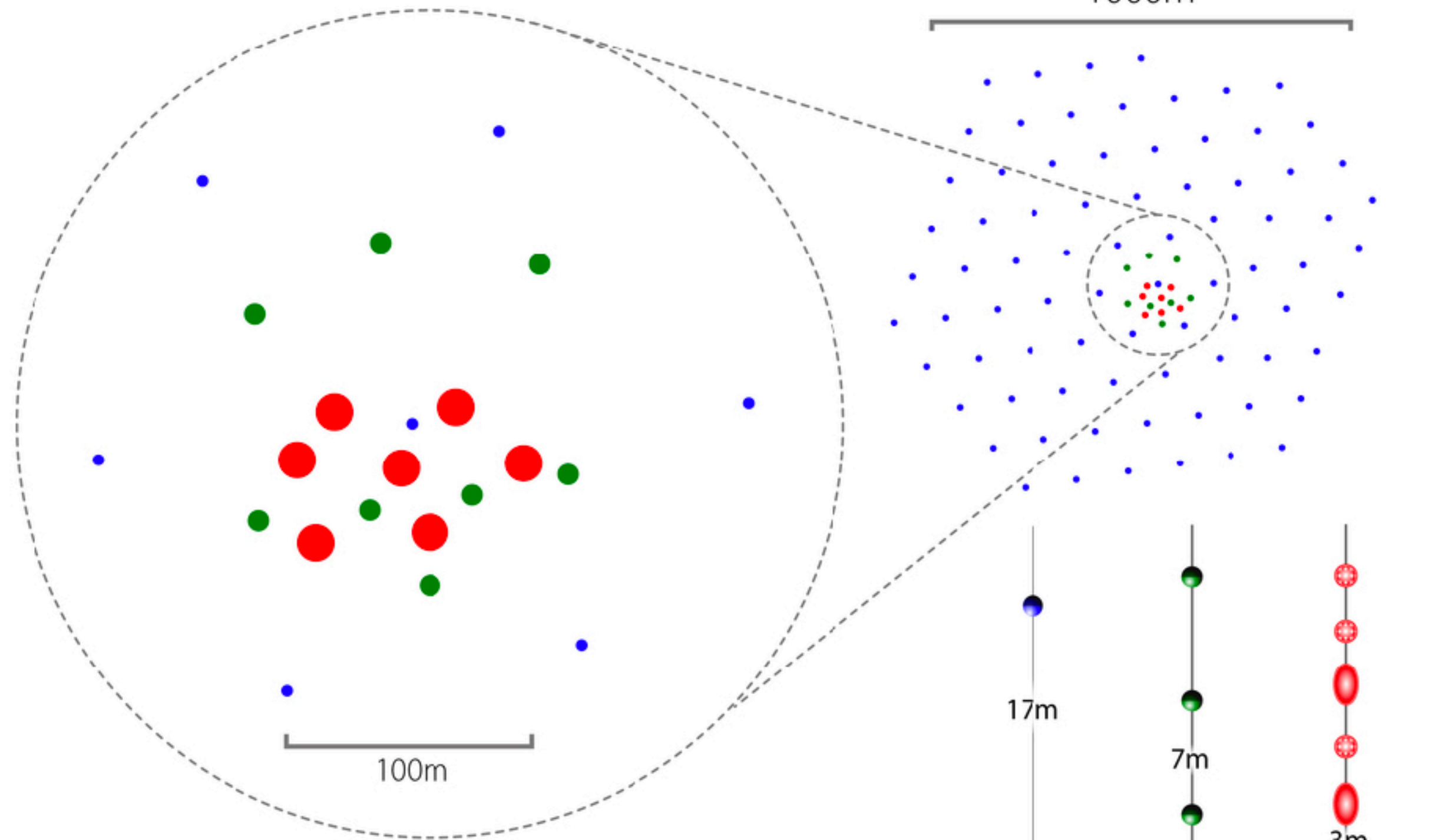


IceCube Science





IceCube Upgrade: near future



Ref: Duvernois 20190222

Goals

- Precision oscillation measurements
- Improved detector calibration
- R&D for IceCube-Gen2

Key features

- > 800 new devices
- Reduced spacing between modules
- Explore deep ice down to 2.6 km

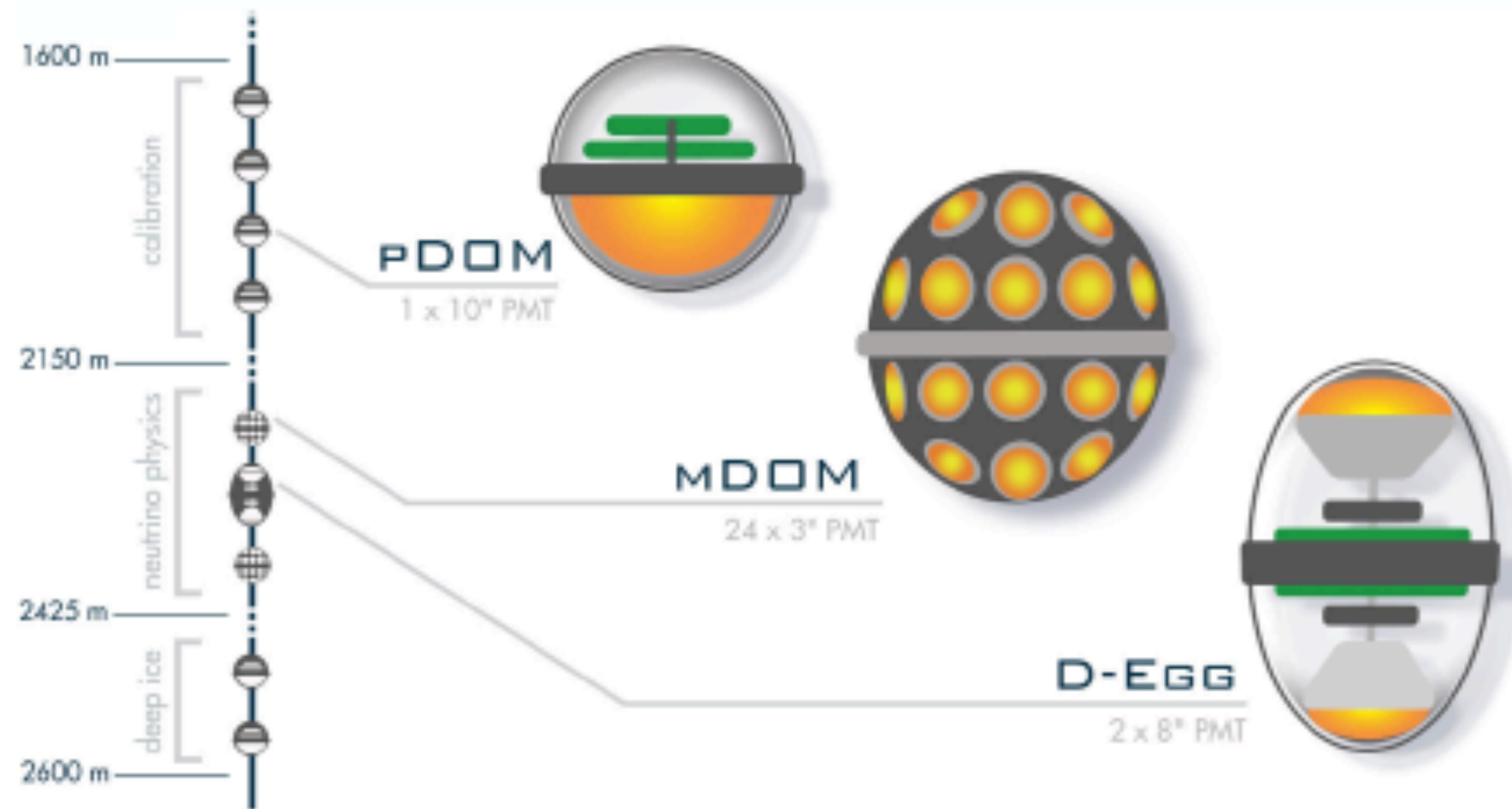
Status

- Scheduled to start string deployment in 2025-26!

IceCube Upgrade: new DOMs

New Optical module design

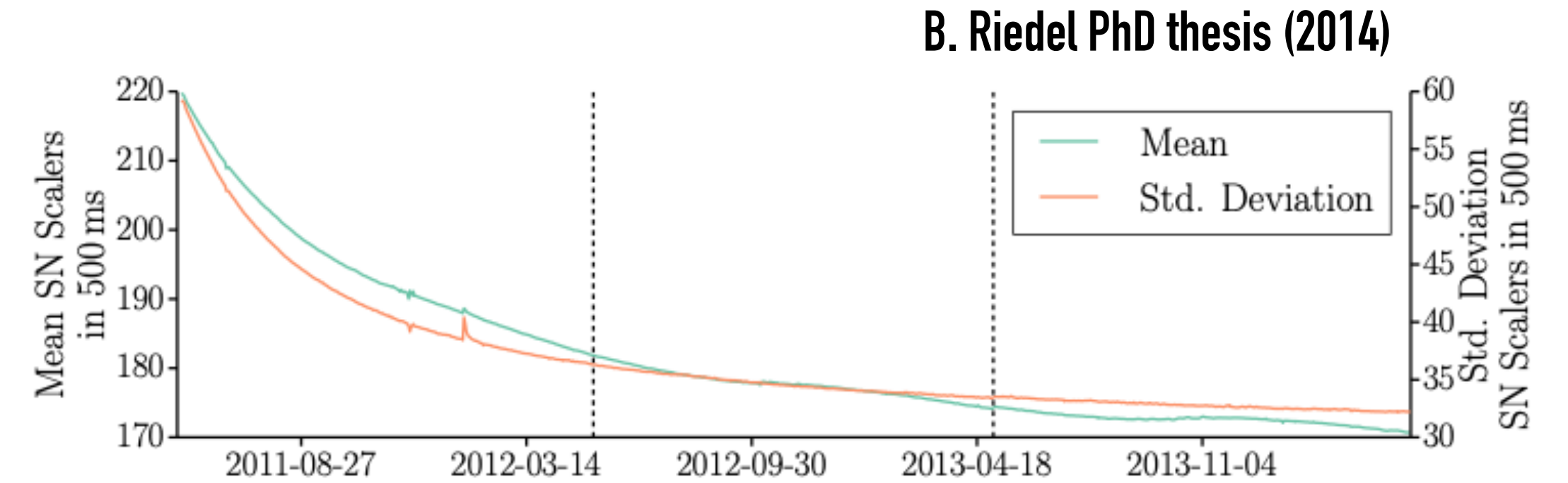
- Multi-PMTs per modules
 - Larger photocathode area
 - Increased angular acceptance



Motivations for SNOLAB tests

Understanding of noise profile and stability of IceCube Upgrade DOMs

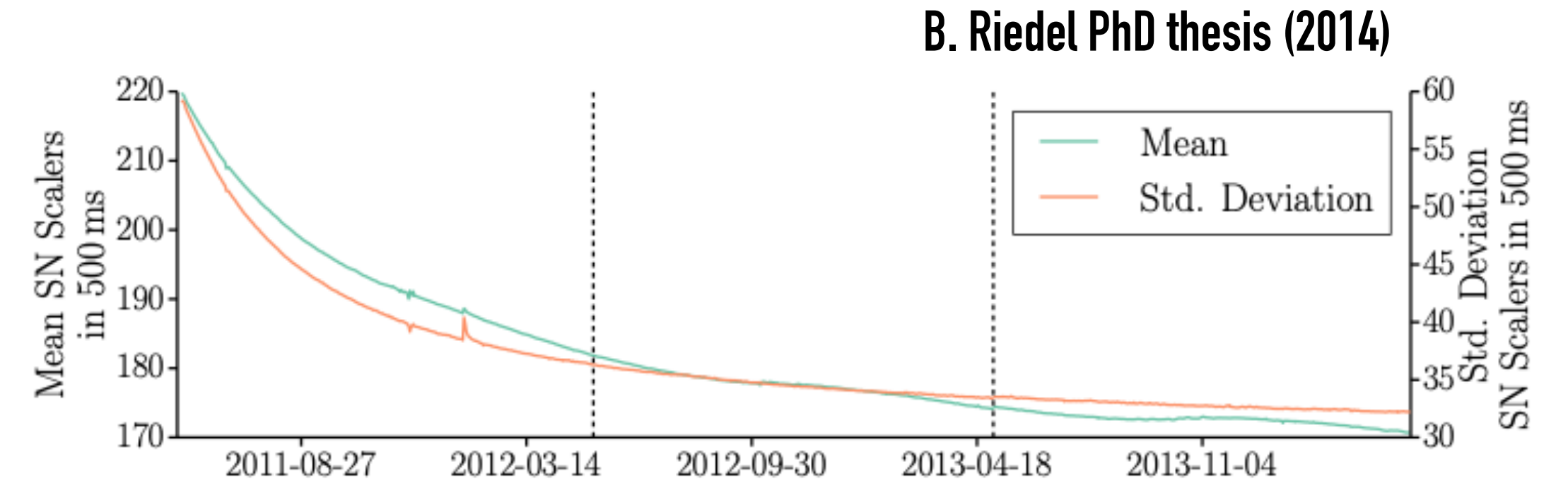
- IceCube DOM dark noise (IceCube DOM)
 - Uncorrelated PMT dark noise
 - Radioactive decay of glass material (e.g. ^{40}K , ^{238}U , ...)
 - Decay of triboluminescence from initial “freeze-in”
 - Impurities introduced from the drilling process



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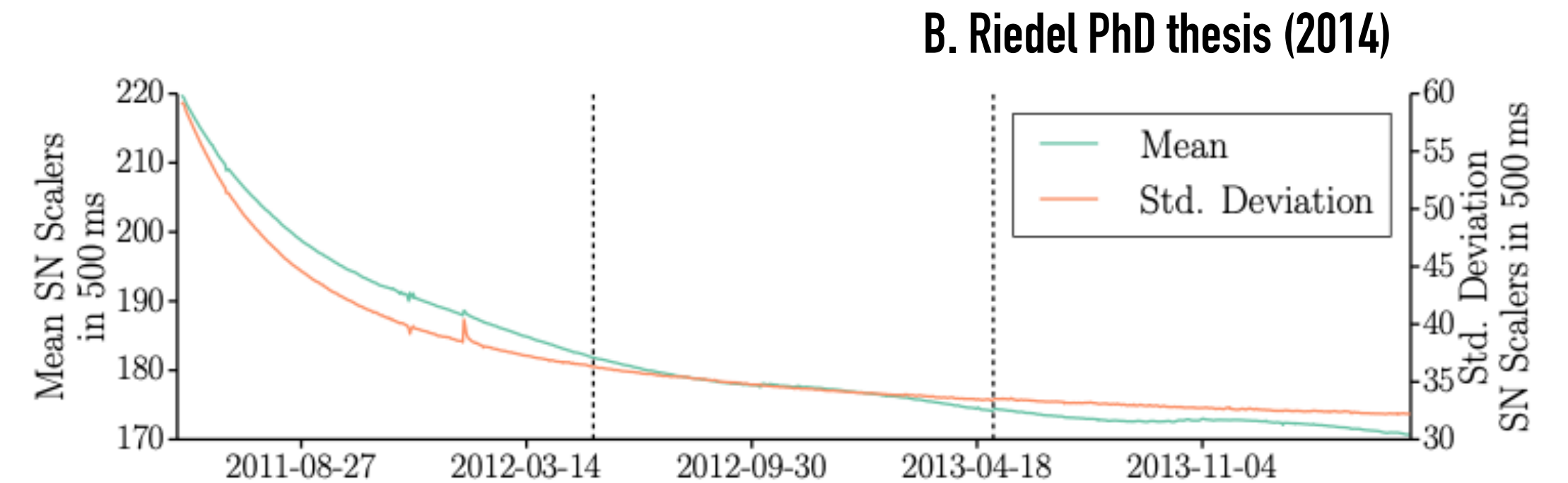


- The nature of the dark rate and contribution from different sources are not well-quantified.
- We expect different properties for Upgrade DOMs as they use different glass housings.
- Upgrade DOMs have multi-PMTs, thus we need to study the correlated background rates and its changes

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➡ ***Long-term measurements at SNOLAB provide an ideal condition for the study.***

This will provide timely information to develop background models for the IceCube Upgrade.

Also, great opportunity for the Canadian HQPs to have hands-on experience with new DOMs.

(Expected) Setups at SNOLAB

Setup will be simple

- A refrigerator: exterior size 77 cm × 184 cm × 121 cm
- A desk where we can put a mini field hub, a computer, and potentially a small controller for LED



Timeline (tentative)

2024

- September: D-Egg delivery to Queen's
- October-December: Measuring D-Egg at the ground level and training HQPs at Queen's
Potential delivery of P-DOM to Queen's

2025

- Early 2025 (tentative)
 - Ready to deliver the equipment to SNOLAB (refrigerator, DOM, mini FH, ...)
 - Start measuring D-Egg & P-DOM at SNOLAB
- Middle 2025 (tentative)
 - Delivery of mDOM to Queen's & ground-level test
 - Delivery of mDOM to SNOLAB

We will update the timeline as the delivery time becomes clearer.



THE ICECUBE COLLABORATION

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Université libre de Bruxelles
Universiteit Gent
Vrije Universiteit Brussel

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University of Alberta-Edmonton

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Ruhr-Universität Bochum
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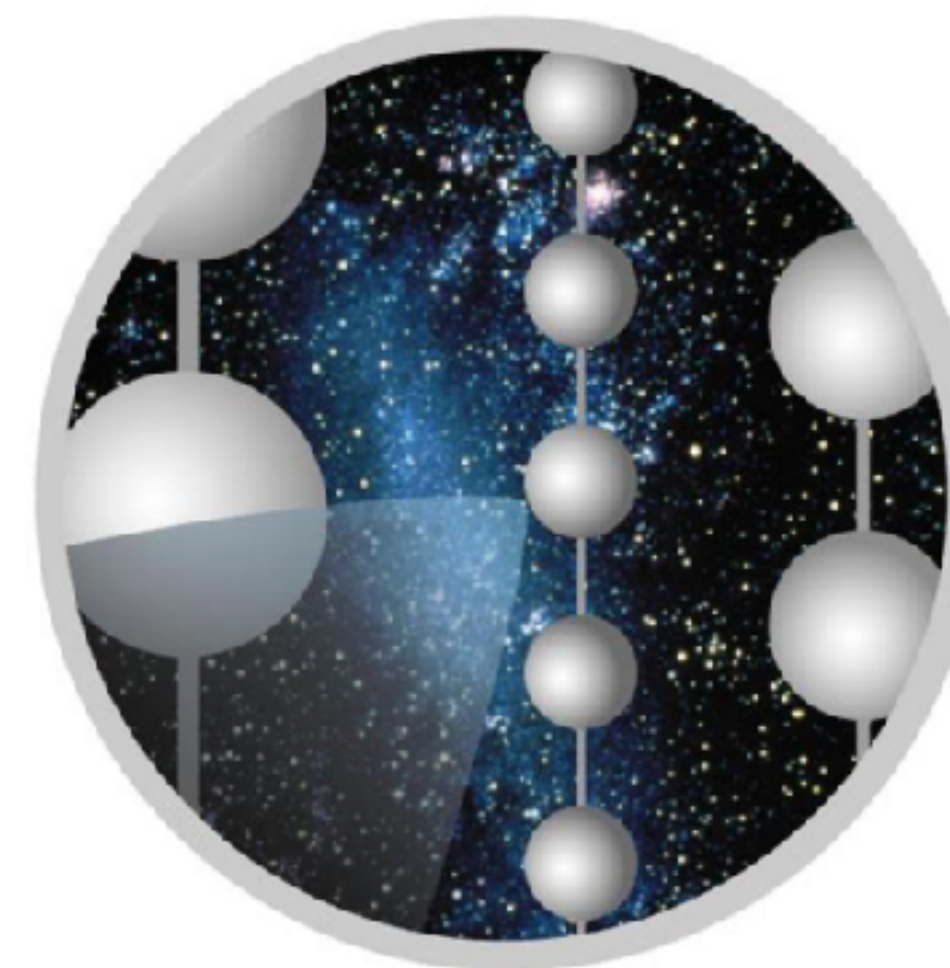
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ICECUBE

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