IceCube-Gen2

towards the next generation high-energy neutrino observatory

Darren R Grant — May 2026

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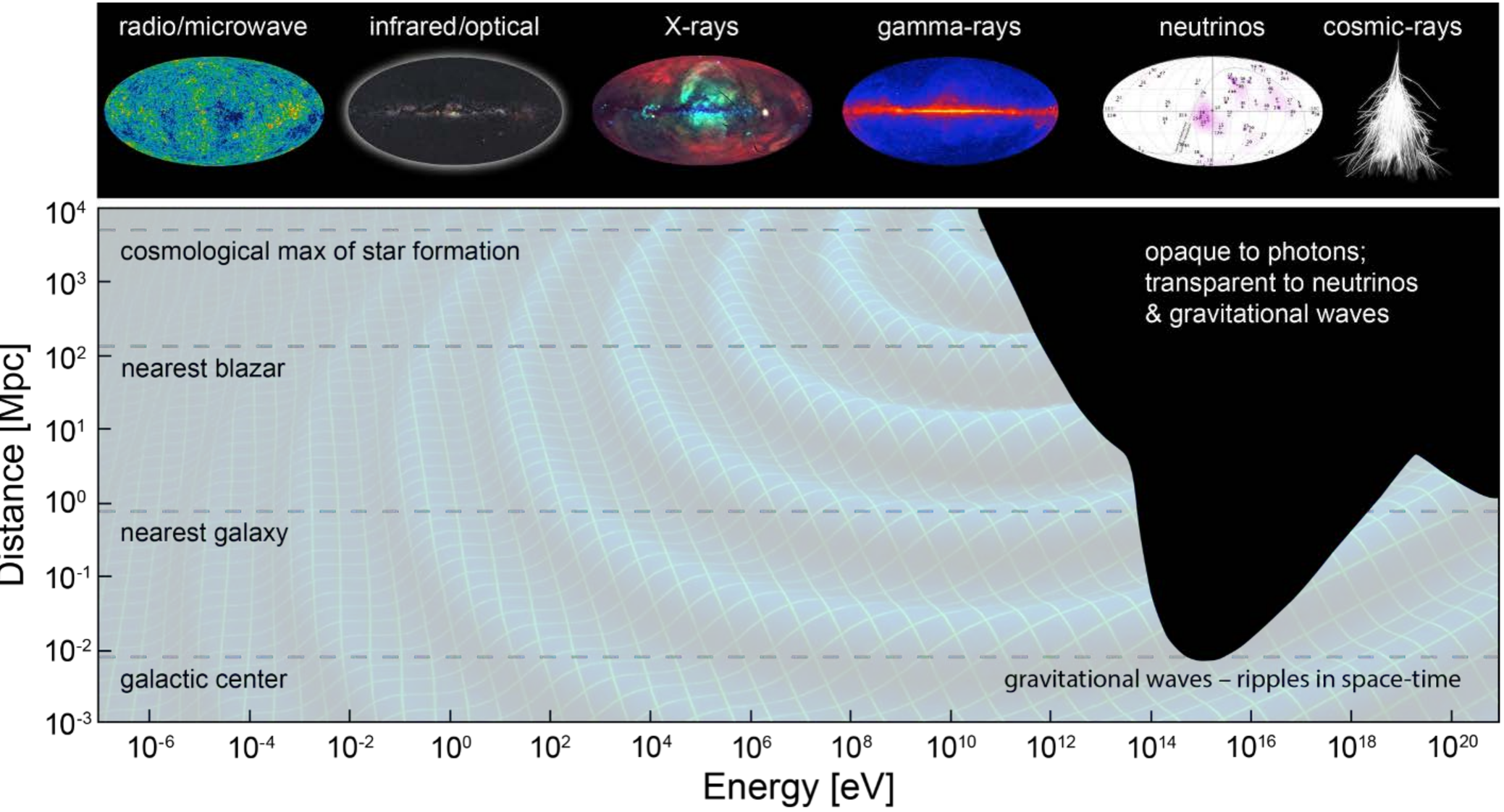
SFU SIMON FRASER UNIVERSITY

Astronomical messengers

Bartos & Kowalski, IOP 2018



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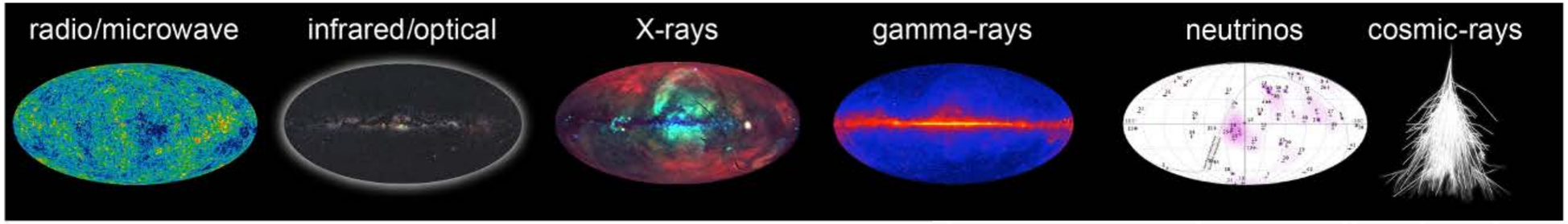

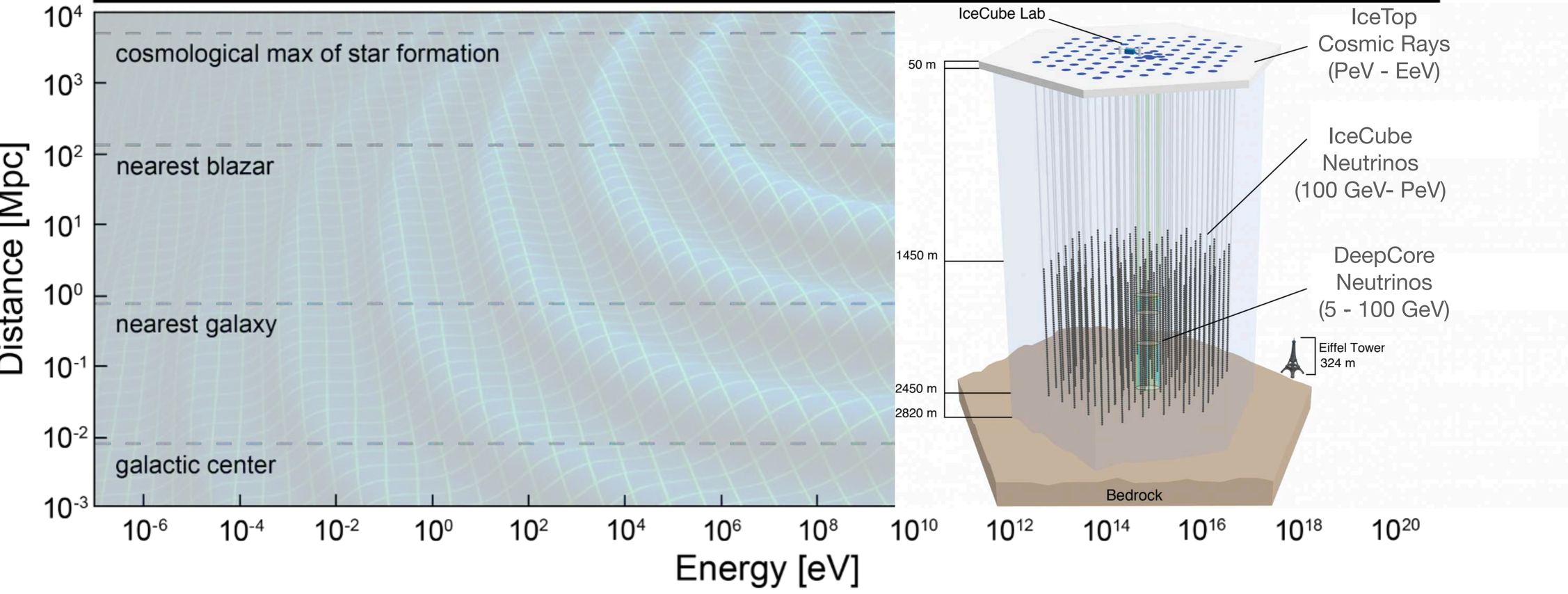

2010 - Cubic-km observatory completed

Astronomical messengers

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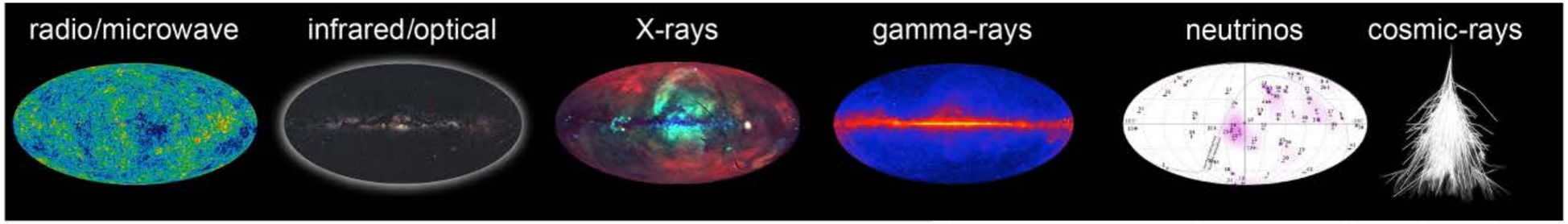
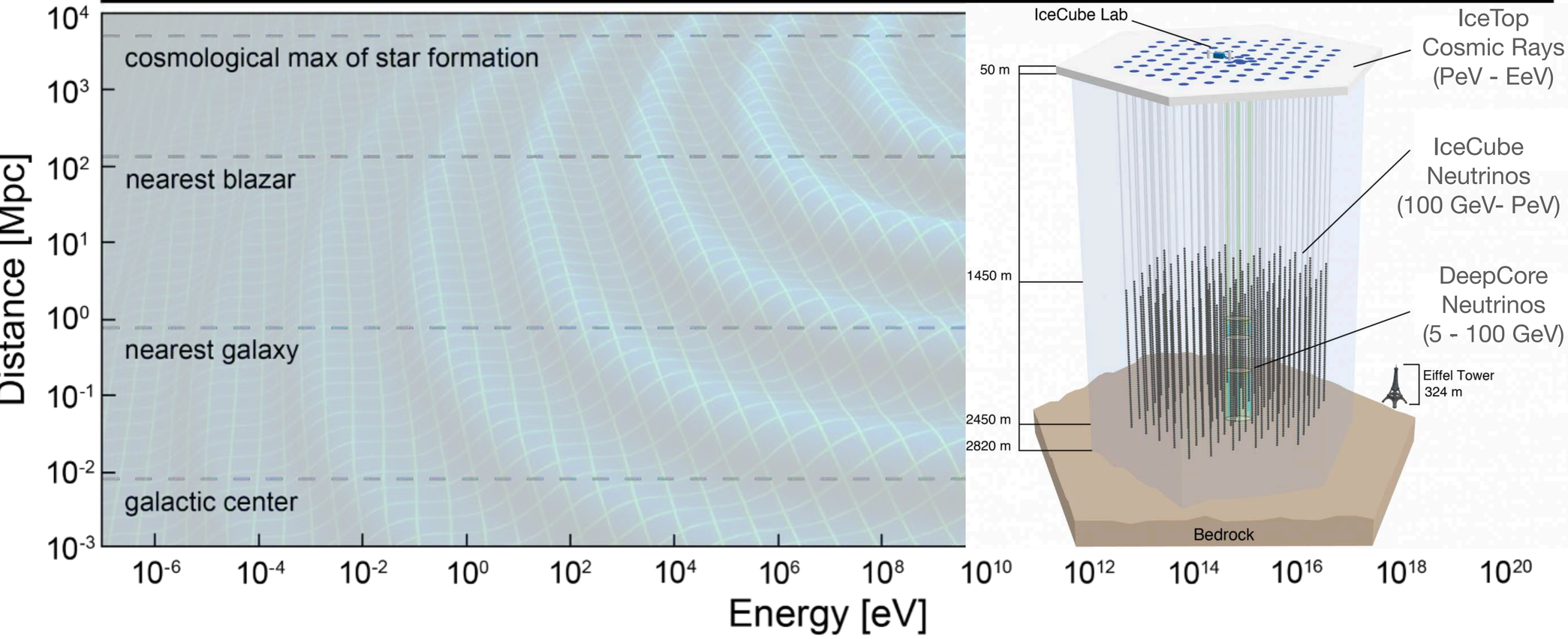
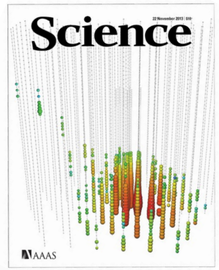




More than 15 years of greater than 99% uptime and less than 1% instrumentation failure

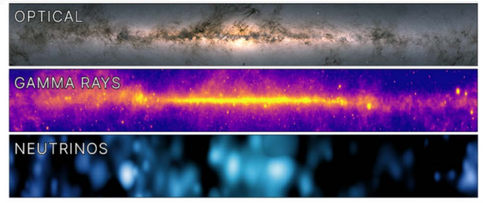
2010 - Cubic-km observatory completed



2013 - Discovery of high-energy astrophysical neutrino flux

2017 - First high-energy neutrino transient multimessenger follow-up

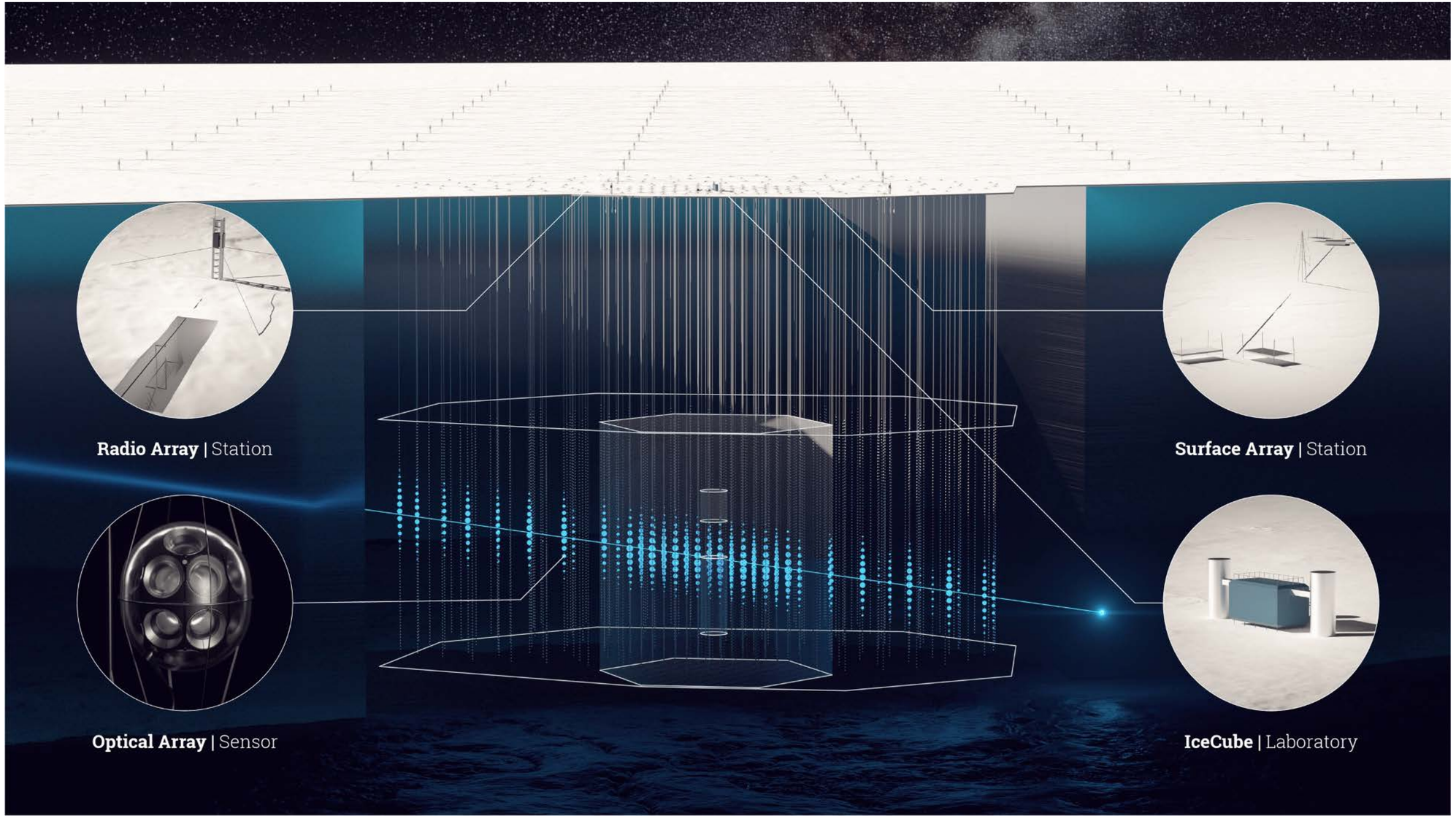
2022 - First evidence of high-energy neutrino sources (NGC 1068)



2024 - High-energy neutrinos observed from the Milky Way

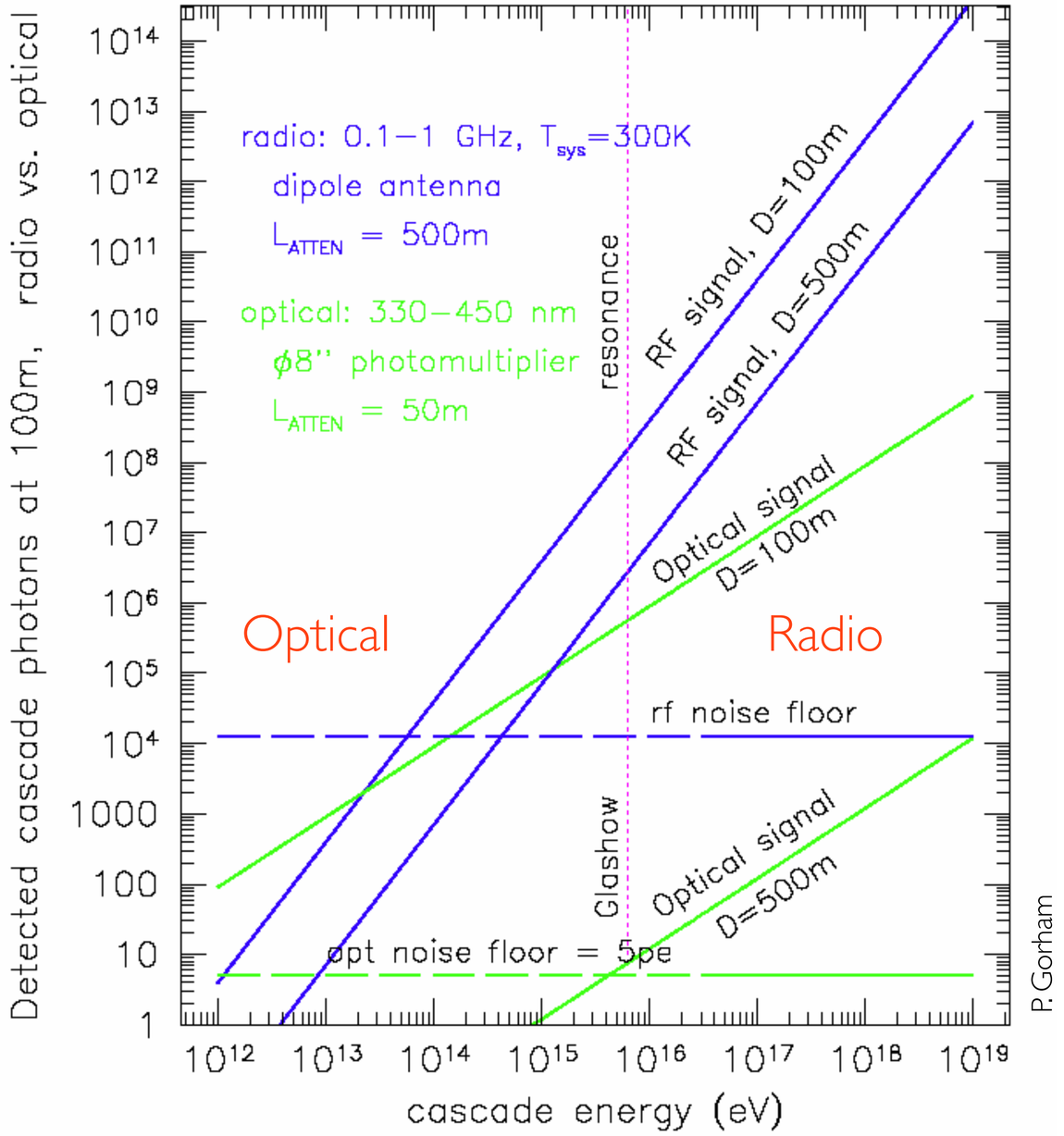
IceCube-Gen2 (envisaged) — beyond the global cubic-km-year scale

IceCube-Gen2 Technical Design Report (TDR, 2024)



- 8x increased instrumented volume
- 5x increased sensitivity to neutrino sources compared to current IceCube
- 500 square-km array designed for radio detection of > 100 PeV neutrinos
- Surface array above optical array footprint designed for cosmic ray science

Principles of high-energy ν detection aside



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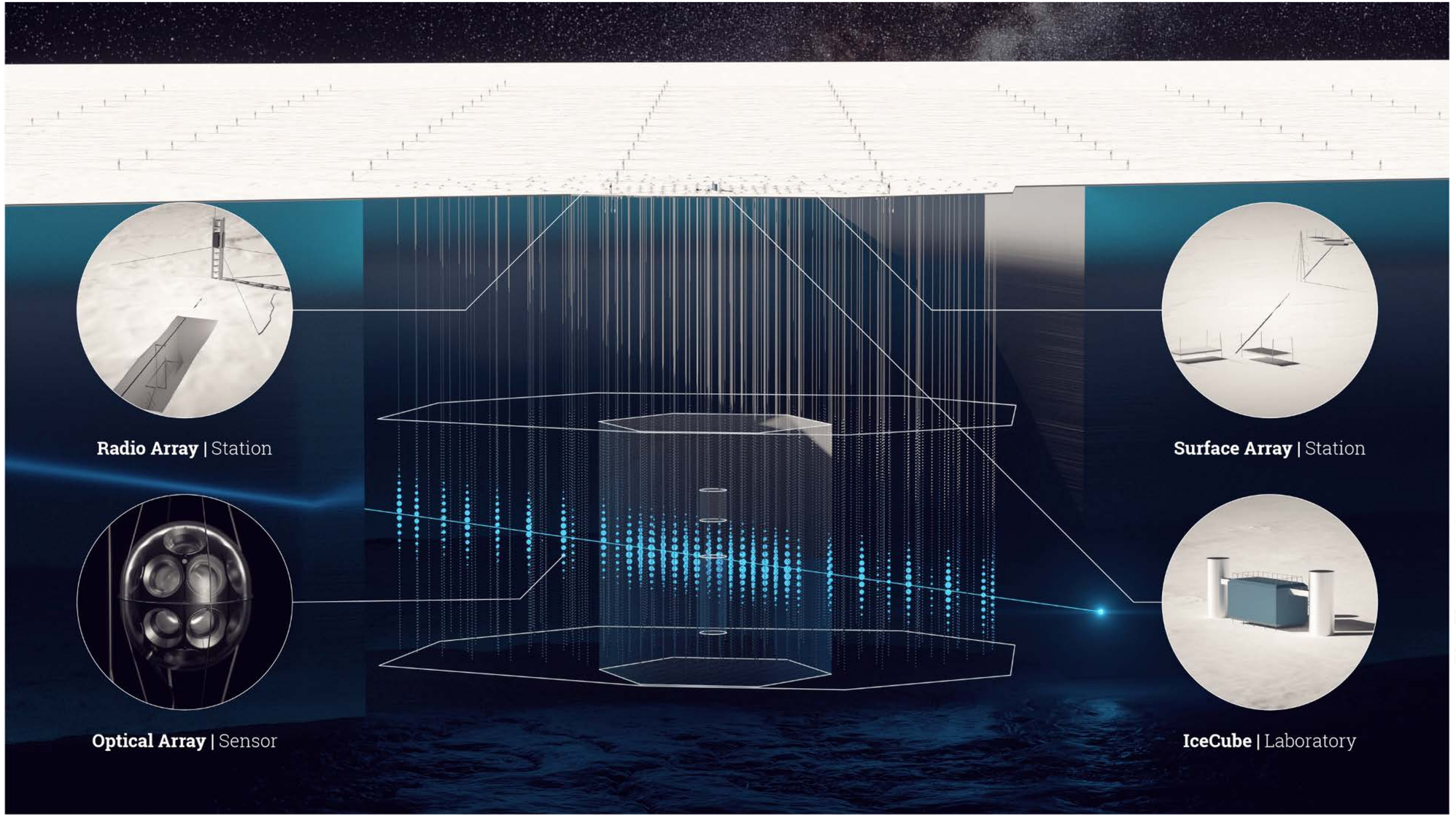

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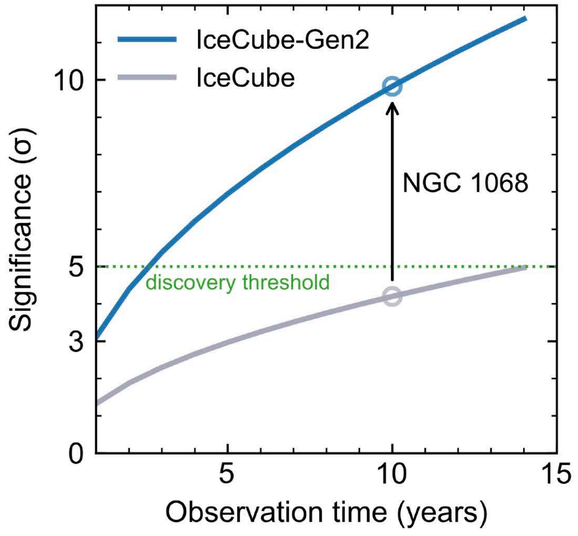

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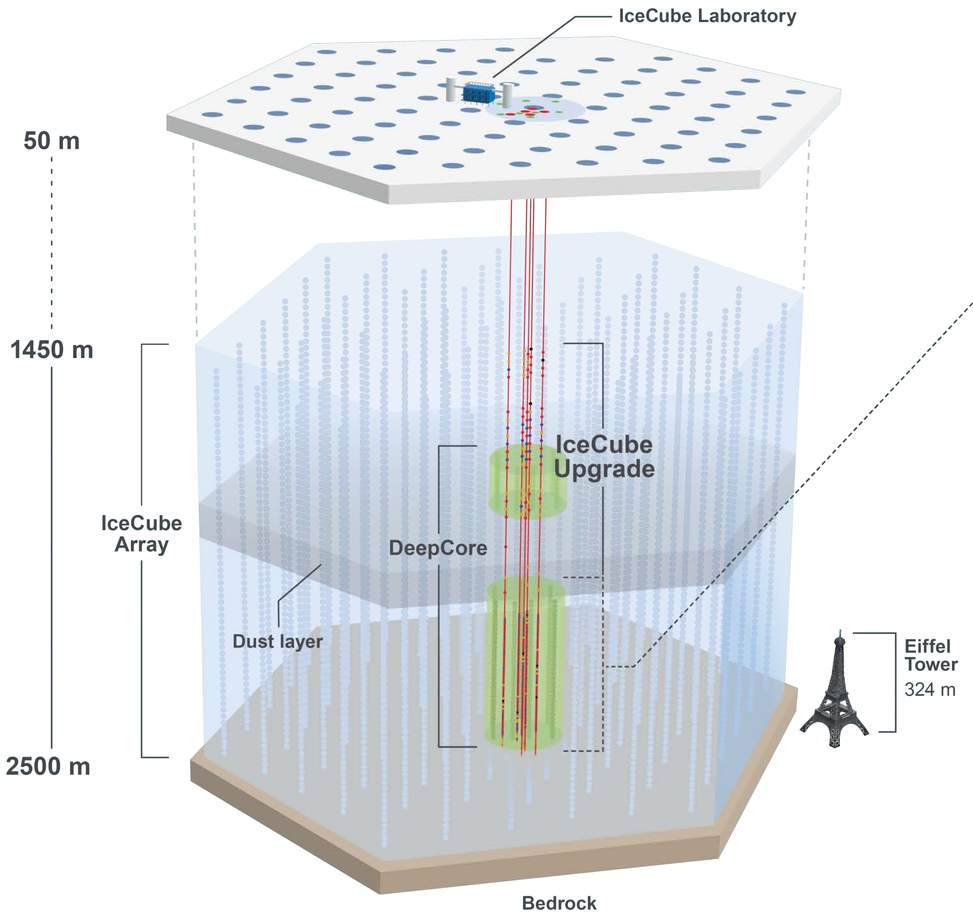
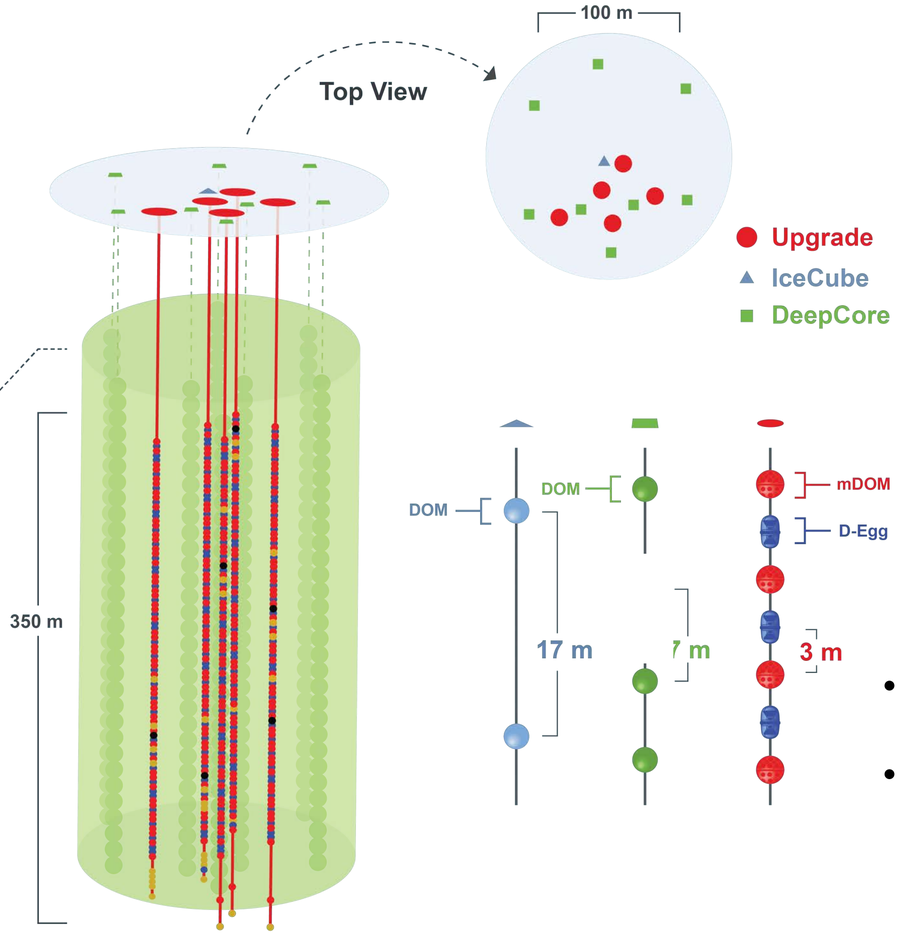
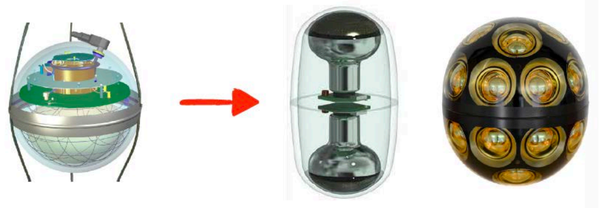
Path to IceCube-Gen2 science



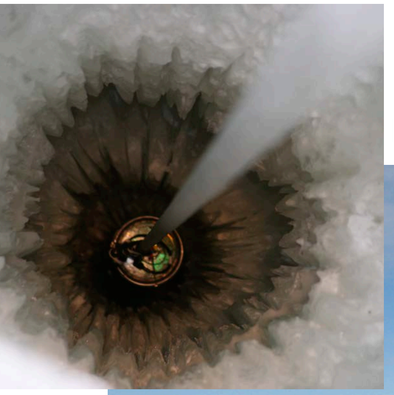


- Construction completed January 2026
- Scientific reach:
  - Precision oscillation measurements
  - Recalibration of the complete IceCube dataset (including high-energy regime); improved angular and energy resolutions and ice model.

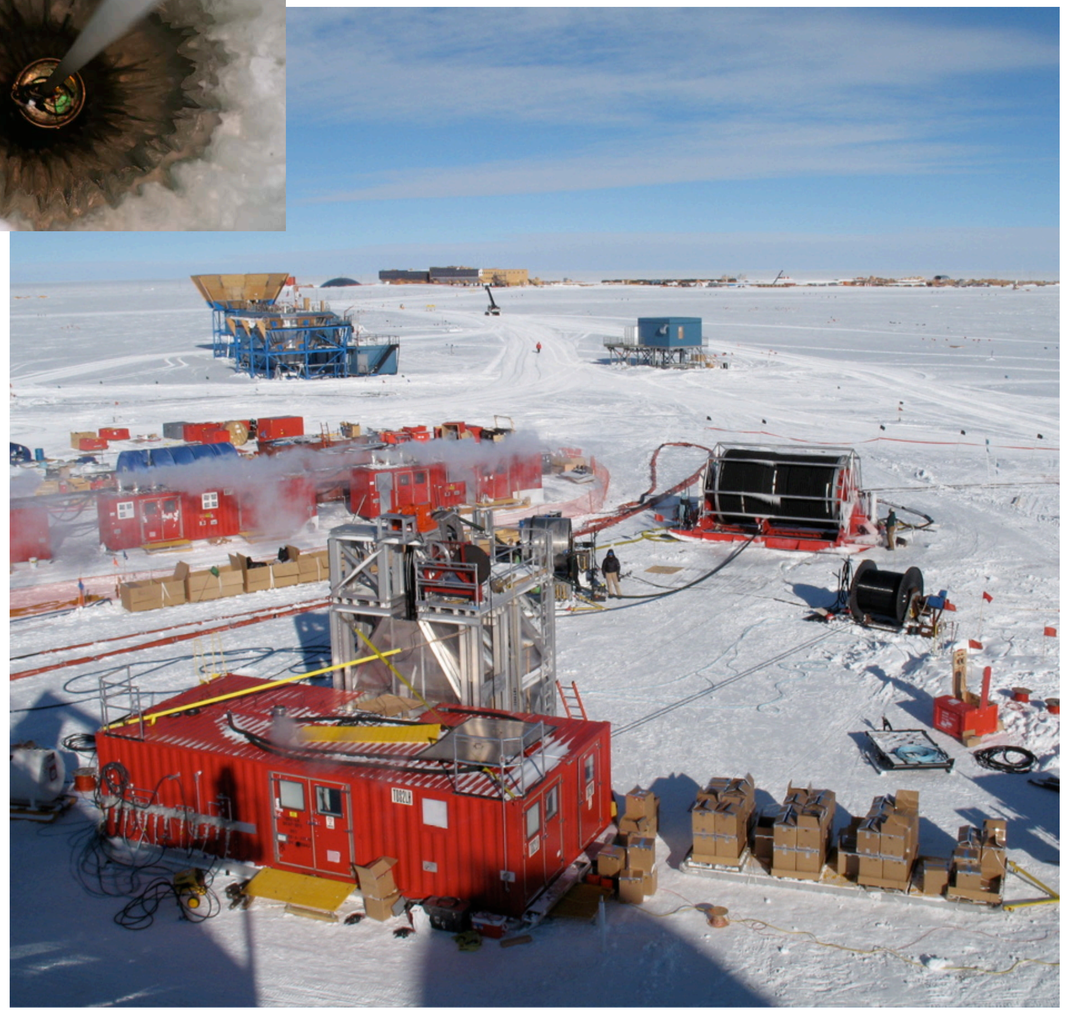


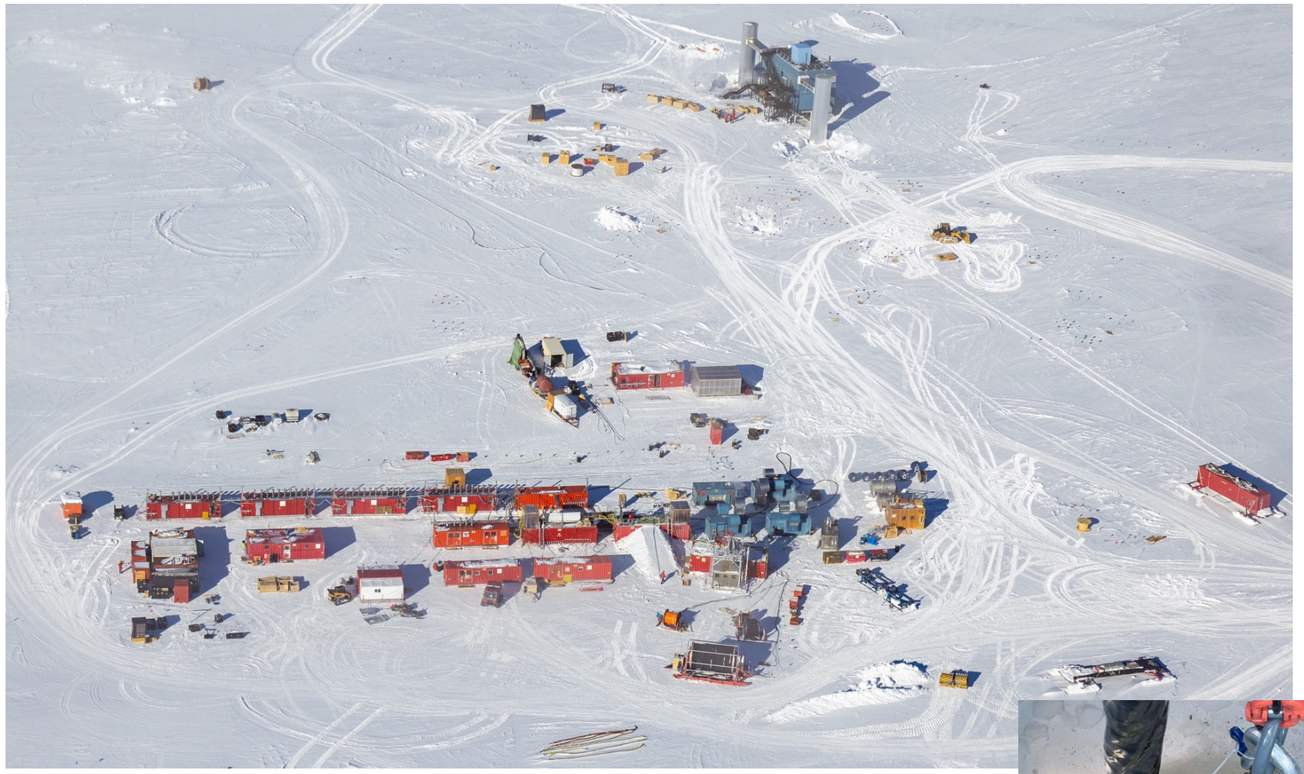
- More than 600 next generation modules (3X sensitivity) and precision calibration devices deployed to depths up to 2600 m

Path to IceCube-Gen2 science

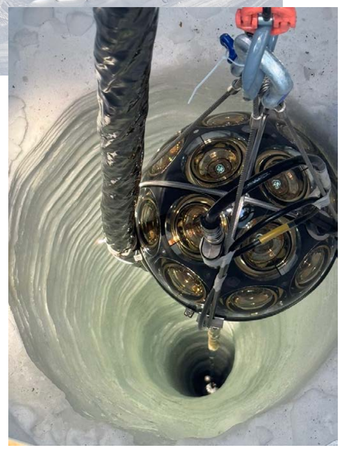


IceCube — 2004-2010





IceCube Upgrade — 2025/6

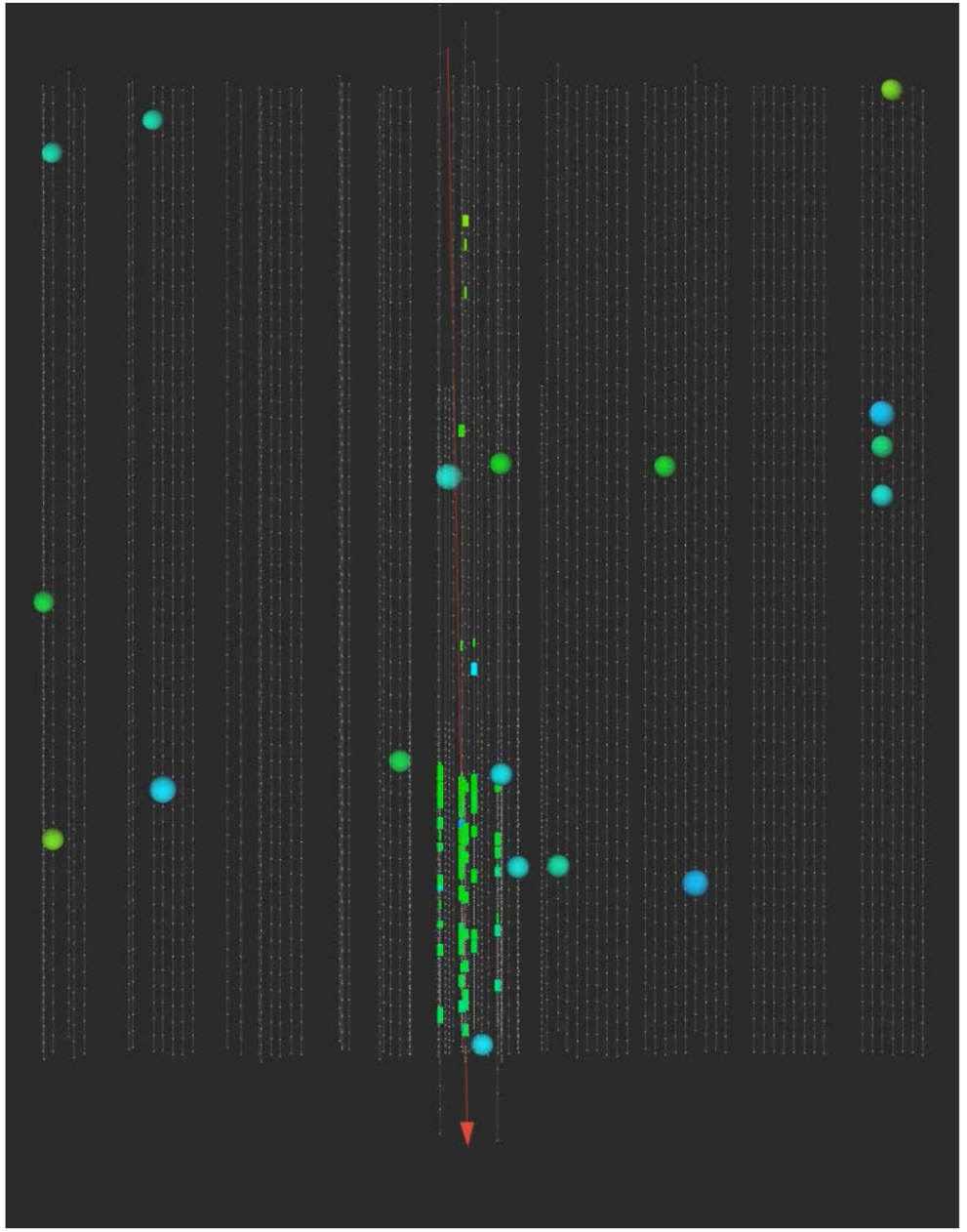


Images: IceCube/NSF

Path to IceCube-Gen2 science

Upgrade deployed Gen2 optical module

Commissioning of new strings well underway



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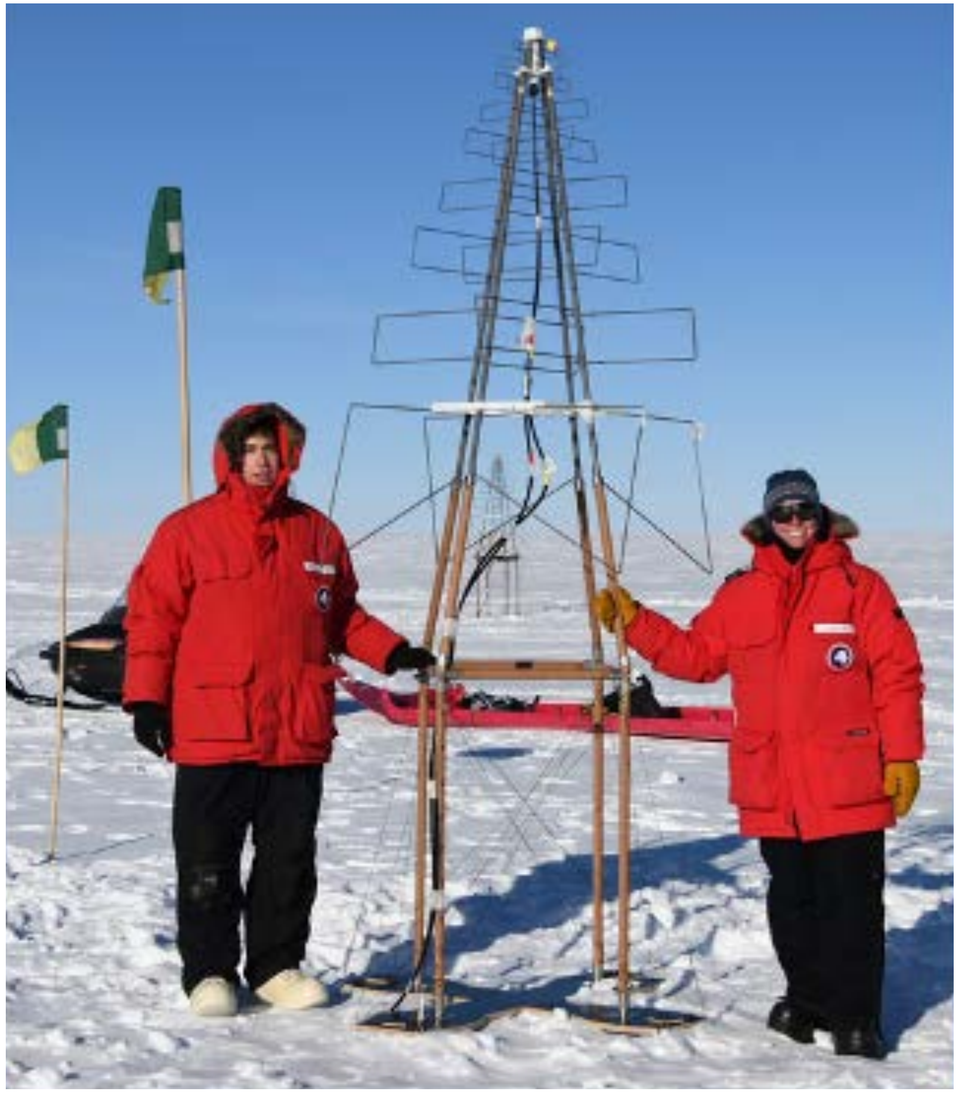
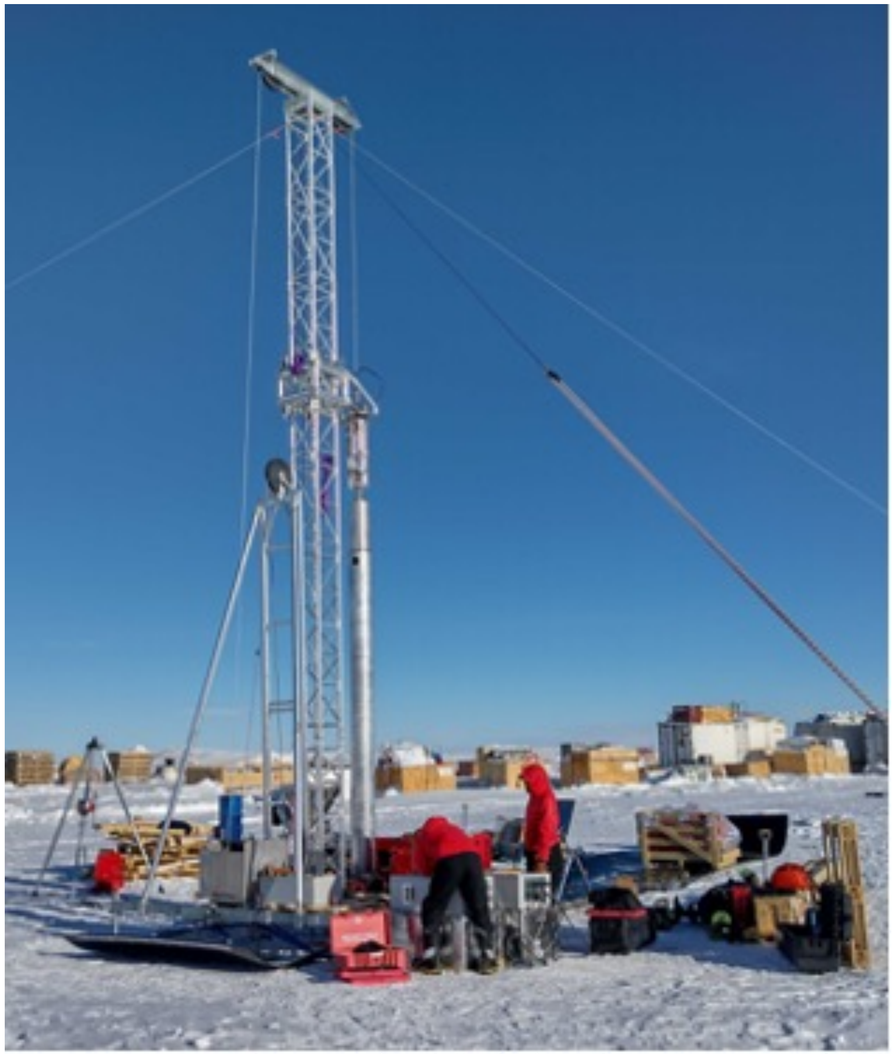
Path to IceCube-Gen2 science

First surface stations in operation at South Pole





RNO-G radio array (pathfinder) underway in Greenland

Images: IceCube/NSF

Paths to IceCube-Gen2 science

More than 400 researchers at 63 institutes in 16 countries

Summary

A remarkable journey from discovery to astronomy

IceCube has been a discovery engine, opening new windows to view and understand our extreme Universe

A global program is rapidly emerging to realize the next generation observatories

IceCube Upgrade construction is completed and delivering first data, setting the stage for an exciting next scientific phase of the leading international program

IceCube-Gen2 primary elements are well understood

Upgrade lessons-learned are incredibly timely as early preparations move towards commencing detector developments.

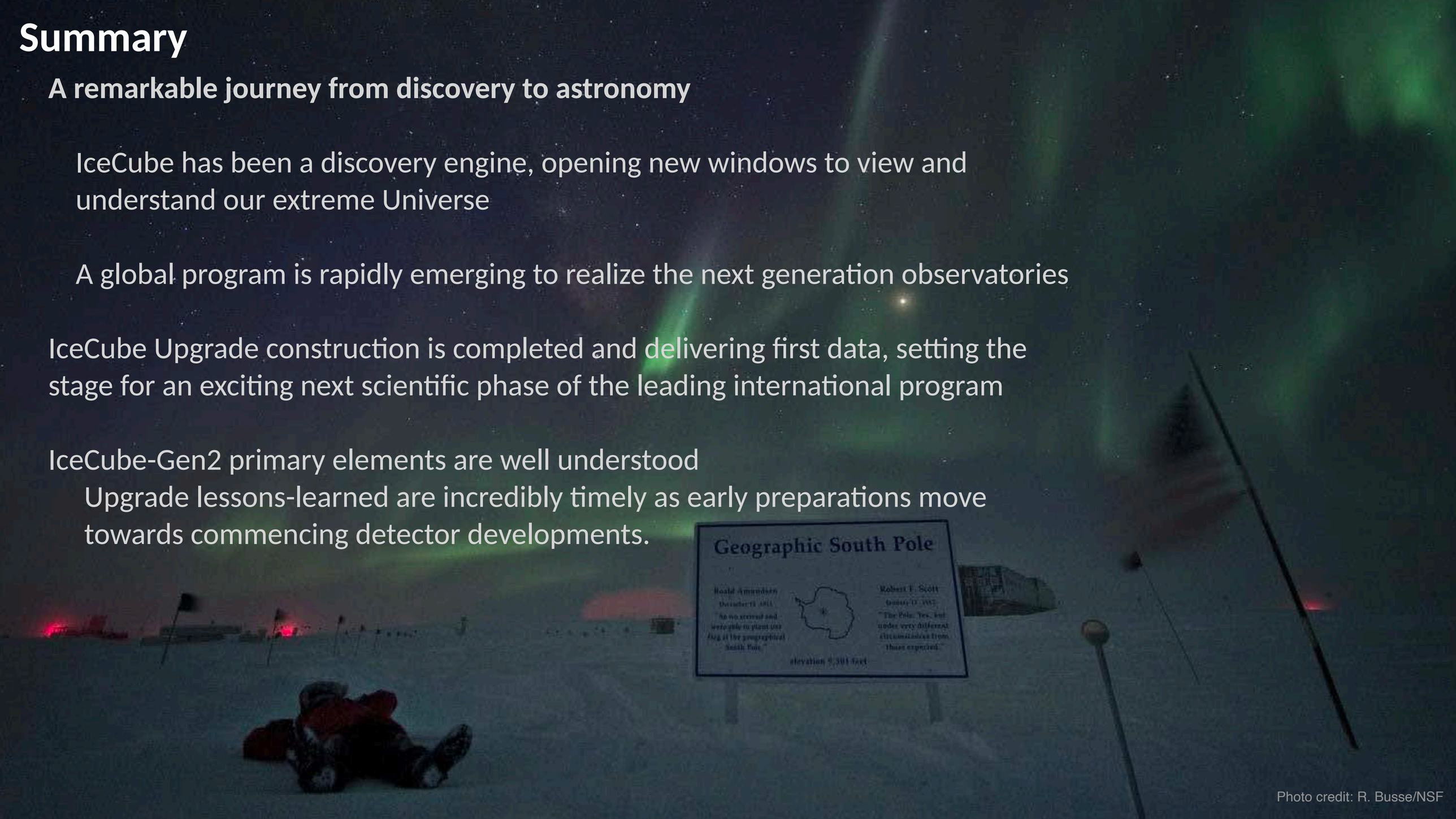
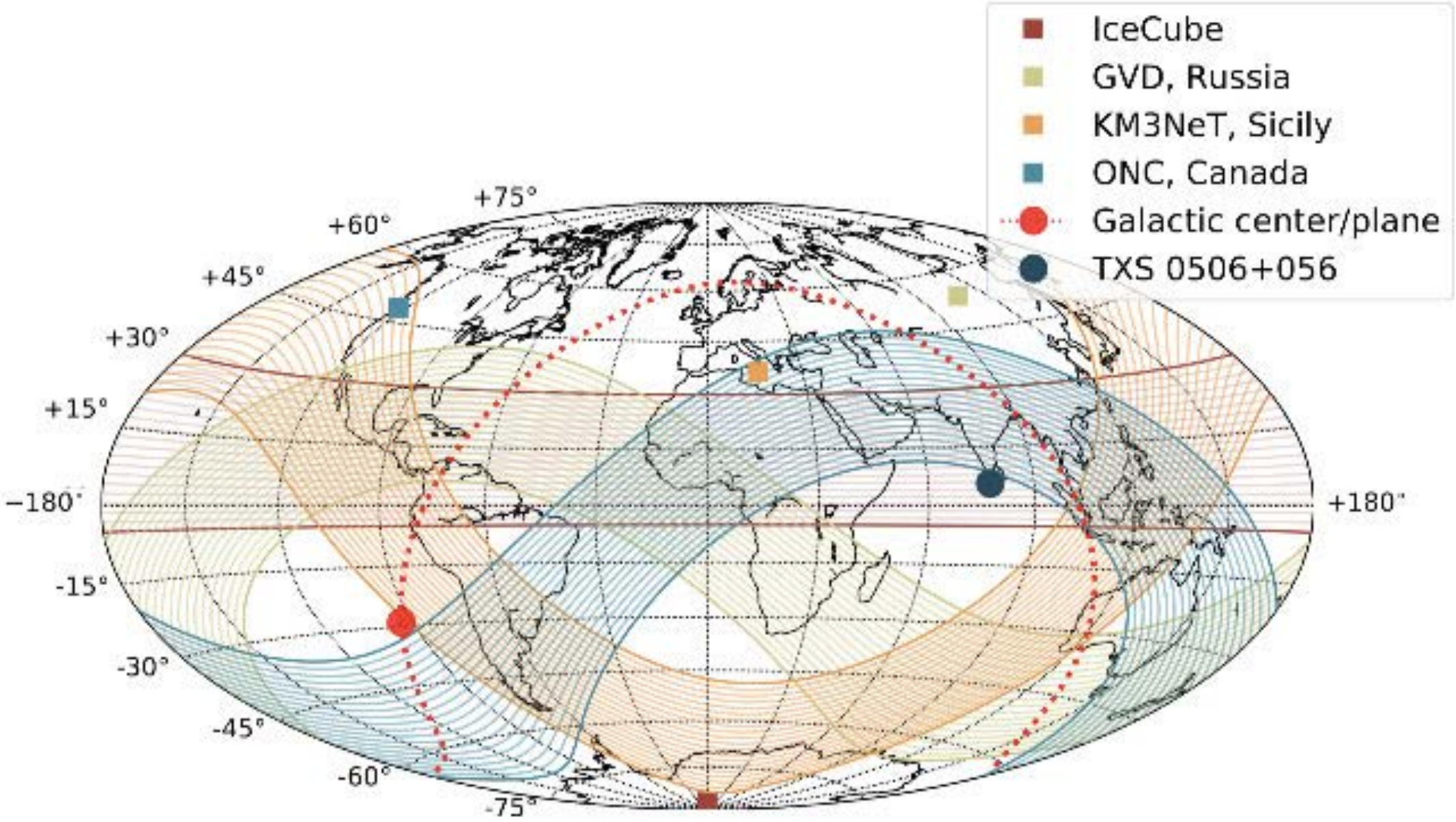


Photo credit: R. Busse/NSF

Backup slides

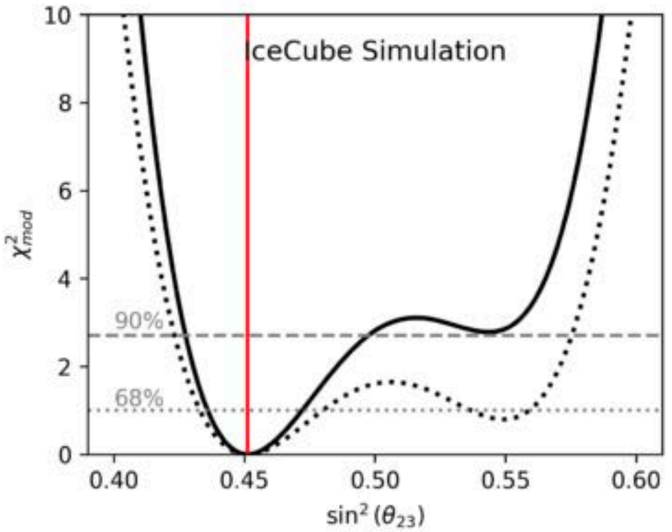
A concerted path toward neutrino astronomy

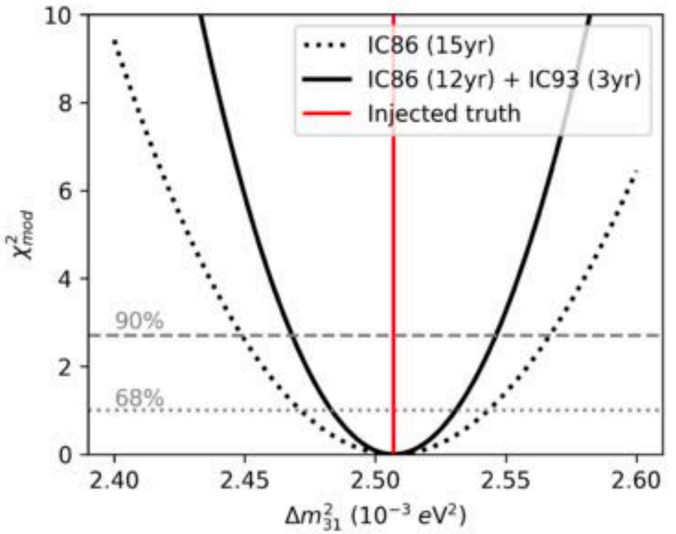
Phys. Rev. D 112, 083027

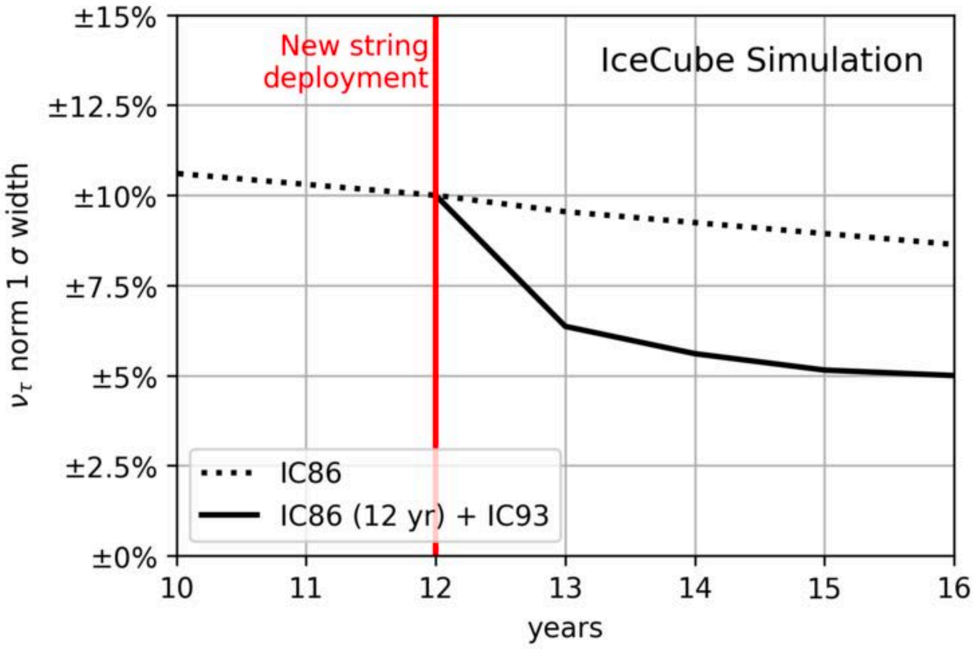


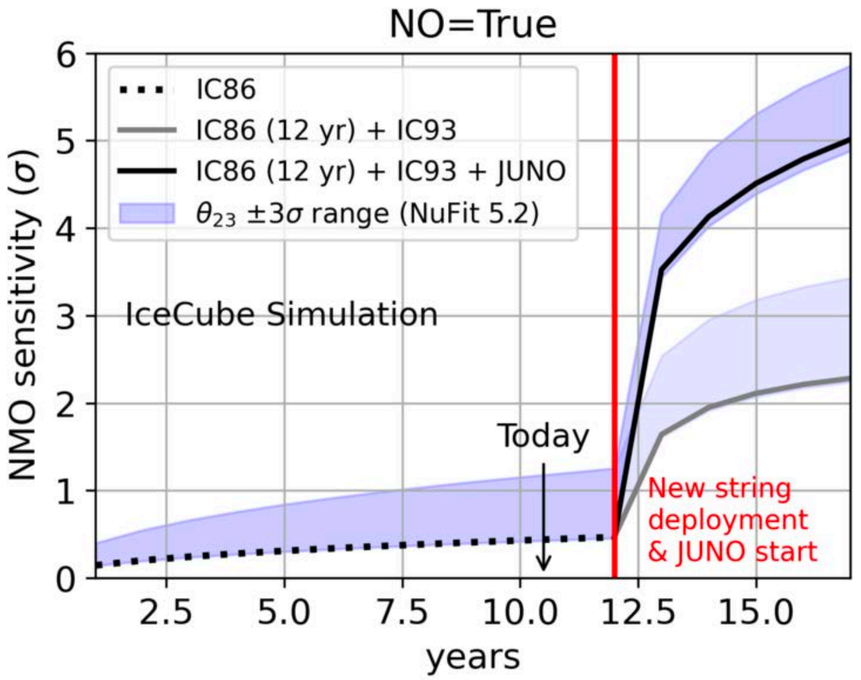
IceCube Upgrade Atmospheric Neutrinos

- 3-year sensitivity estimates
  - Improved sensitivity to the atmospheric mixing angle, including octant, and mass splitting
  - 5% uncertainty on the normalization of the tau neutrino normalization and test of PMNS unitarity
  - 3σ determination of the mass ordering (5σ with JUNO)









	2022	2023	2024	2025	2026	PY 1	PY 2	PY 3	PY 4	PY 5	PY 6	PY 7	PY 8	PY 9	PY 10
IceCube Upgrade	★ IceCube Upgrade Rebaseline				■ Install 7 Upgrade Strings										
Detector Construction					▨	■ Optical Module Production									
					▨	■ Radio Station Construction									
String Installation						Prepare Drill	3 Strings	4	16	20	21	21	21	14	
Surface Array Installation						5 Stations	6	16	22	23	21	23	14		
Radio Installation						20 Stations		50	58	67	67	69	30