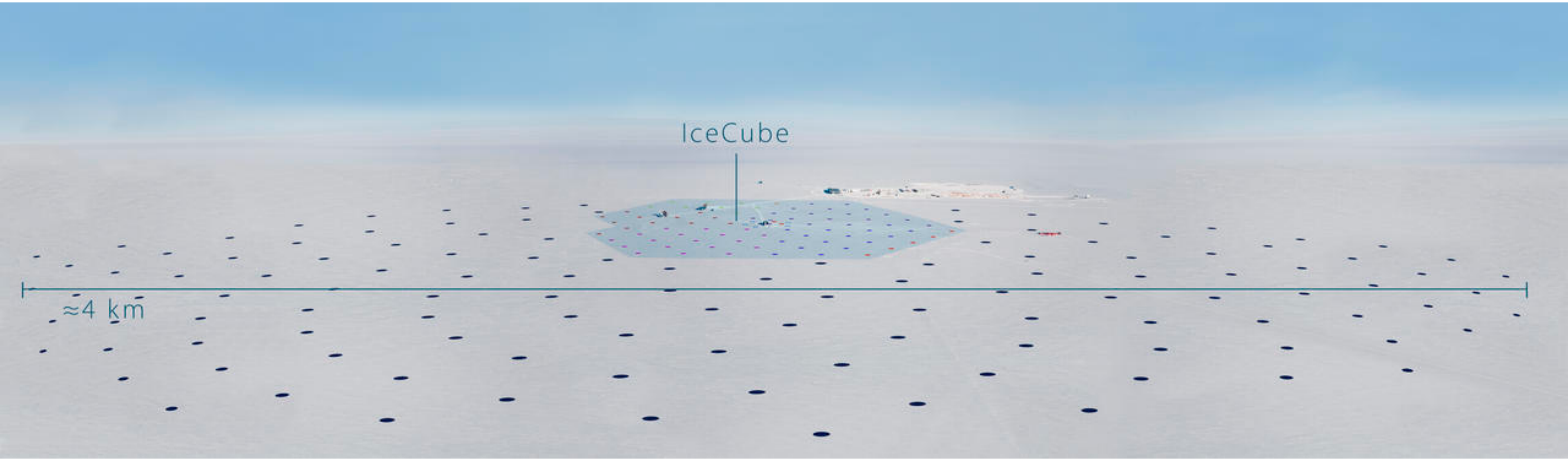


Status of IceCube-Gen2

Tianlu Yuan for the IceCube-Gen2 collaboration

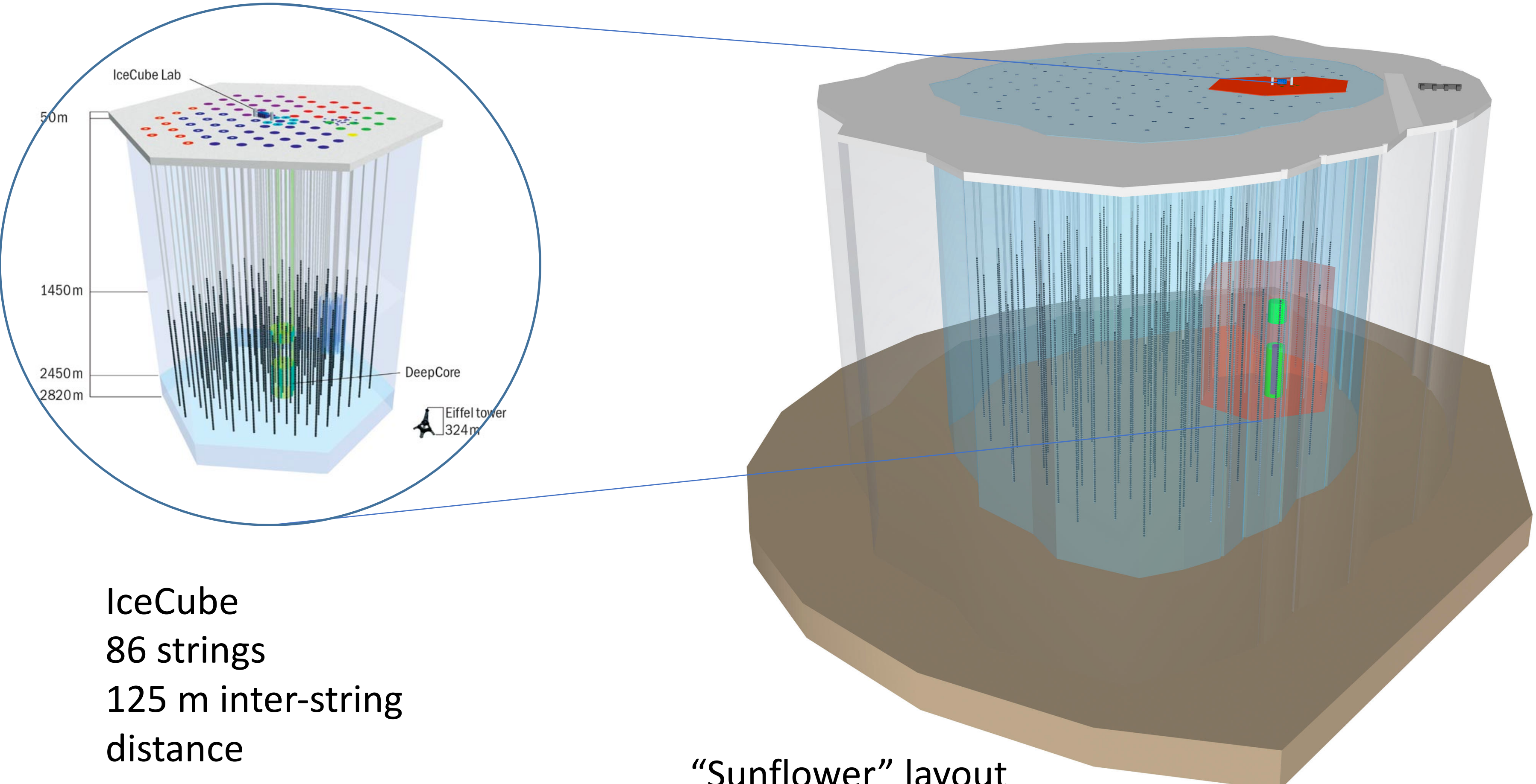
TeVPA, 11 Aug 2017

Columbus, OH, USA

Science goals for IceCube-Gen2

- Discover sources of astrophysical neutrinos
- Identify sources of high energy cosmic rays
- More precise measurements of neutrino properties
- Astrophysical tau-neutrino discovery
- Set limits or discover GZK neutrinos
- BSM physics

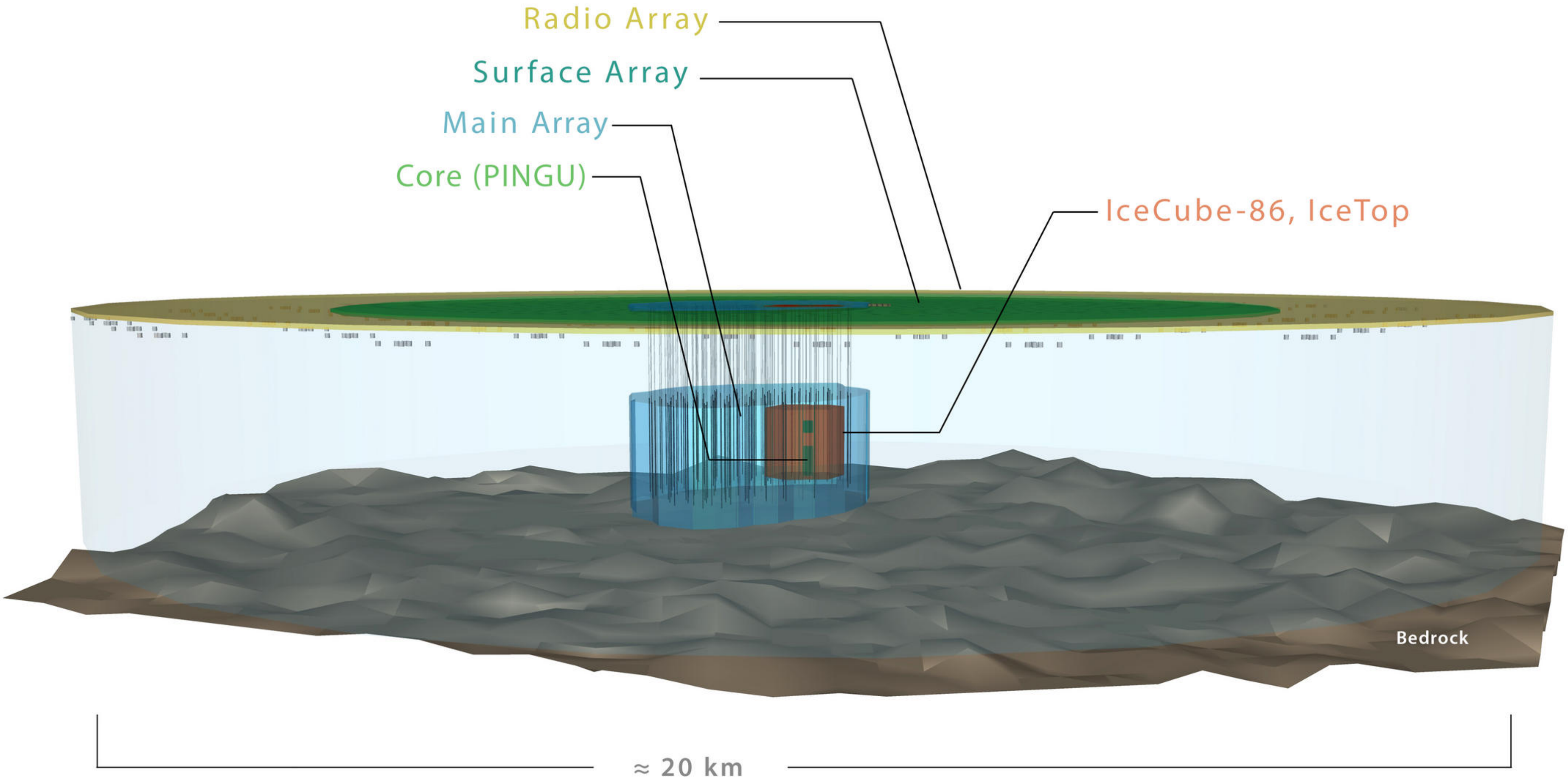
Extending IceCube



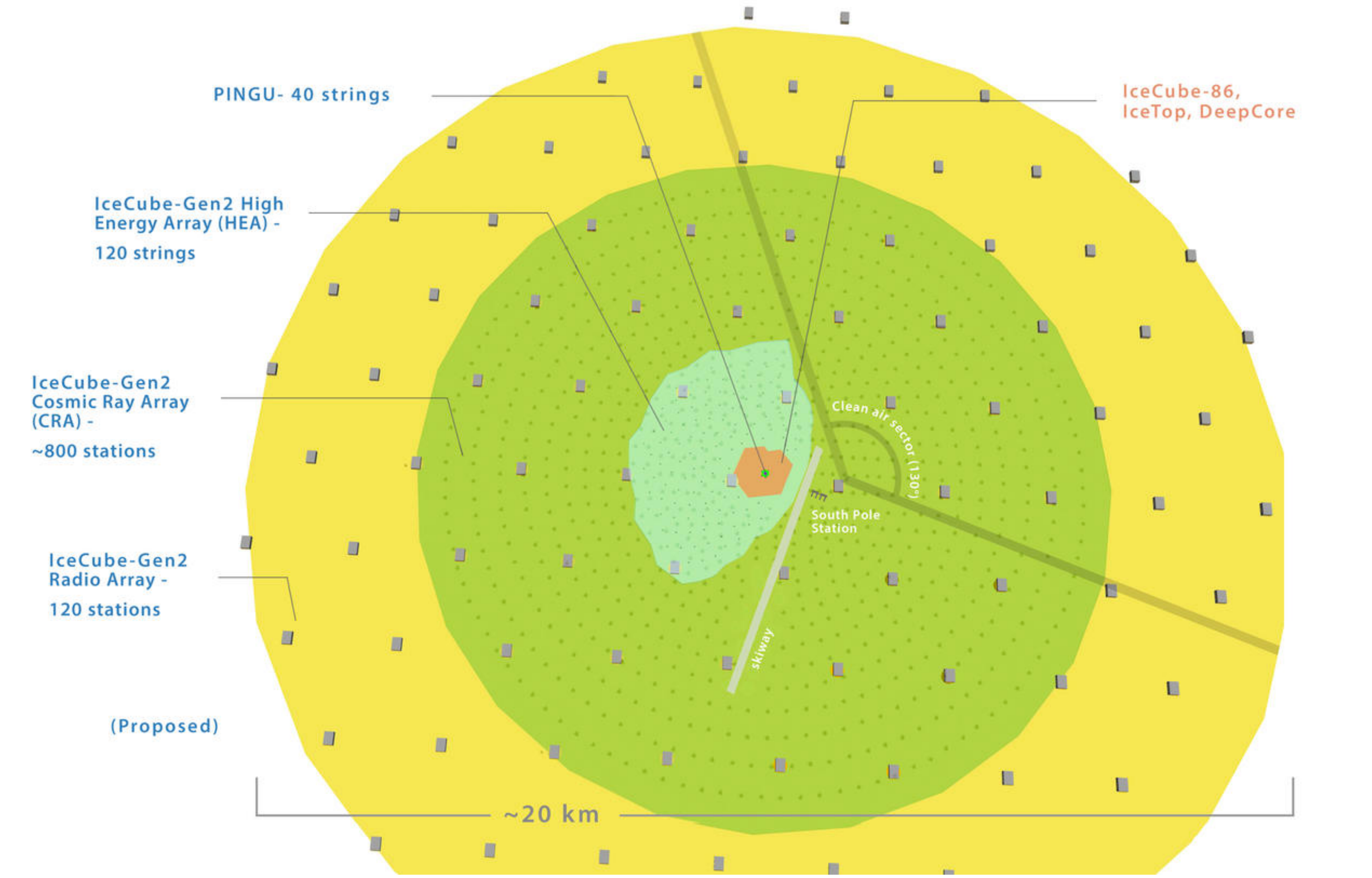
IceCube
86 strings
125 m inter-string
distance
60 OMs per string
0.9 km^3 volume

“Sunflower” layout
120 new strings
240 m inter-string
distance
80 OMs per string
8 km^3 volume

Envisioned IceCube-Gen2 Facility



Envisioned IceCube-Gen2 Facility



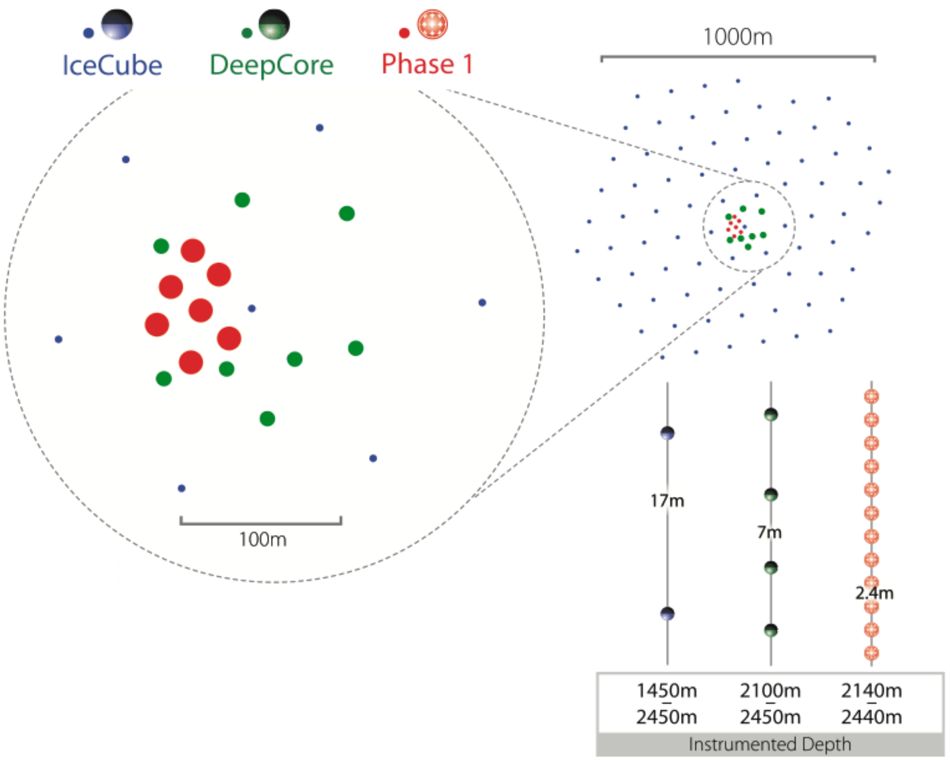
IceCube-Gen2 Phase 1: The next step

Proposal to add 7 additional strings

Instrument with multi-PMT digital optical modules (mDOMs)

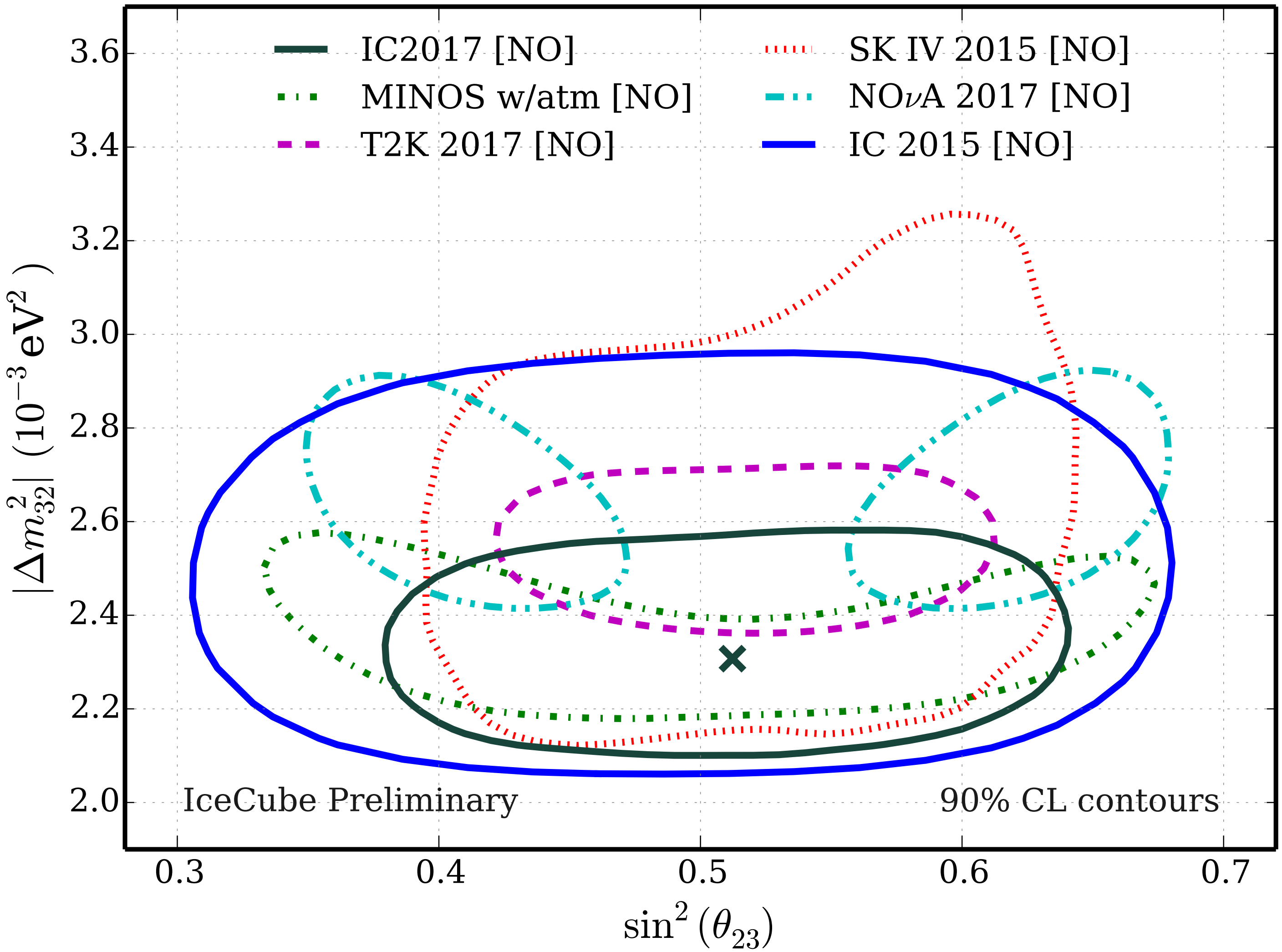
- Better directionality
- Doubles photocathode area

Inline with physics goals of the Precision IceCube Next Generation Upgrade (PINGU)



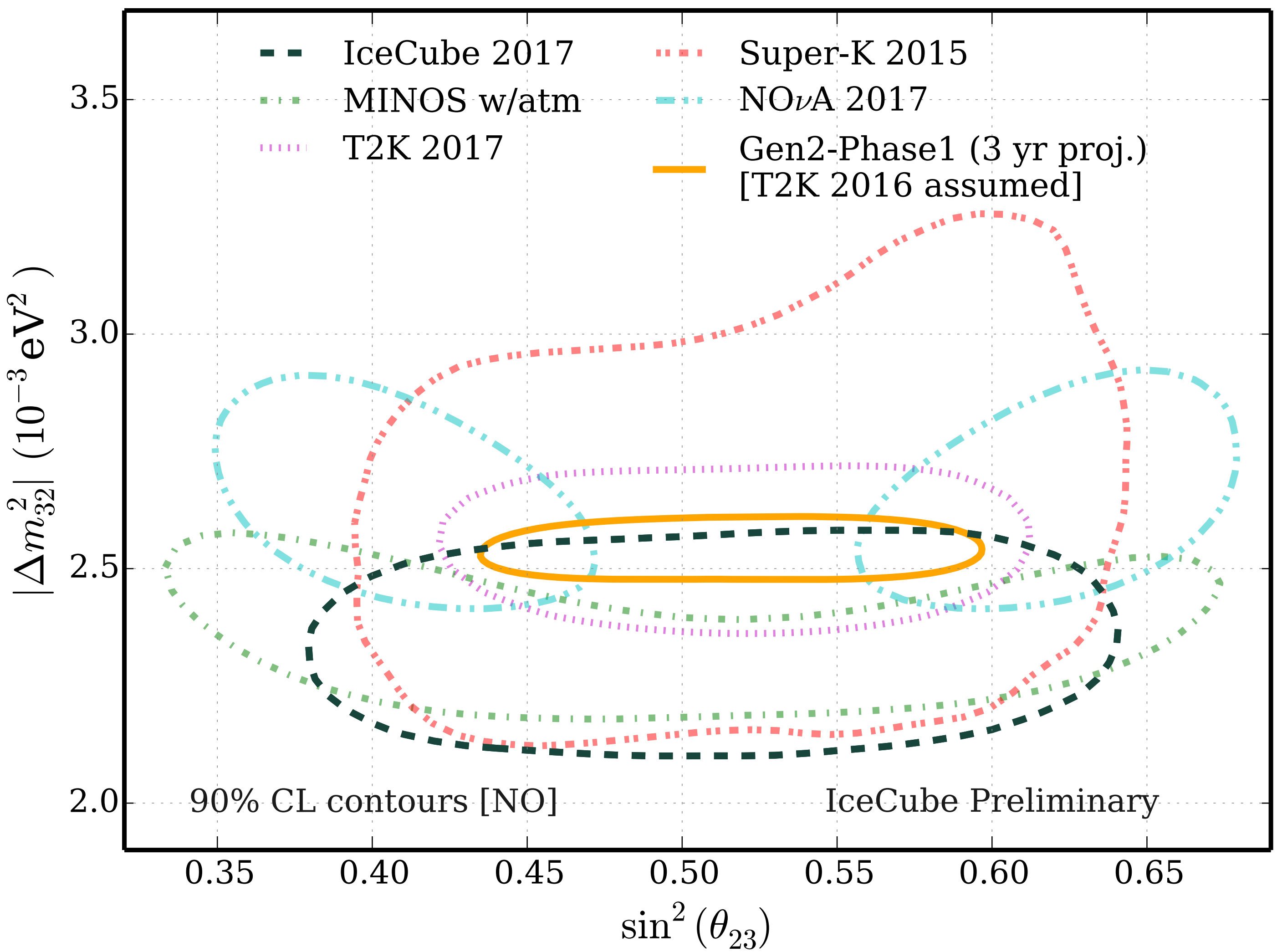
IceCube-Gen2 Phase 1: Oscillation sensitivity

Latest DeepCore result



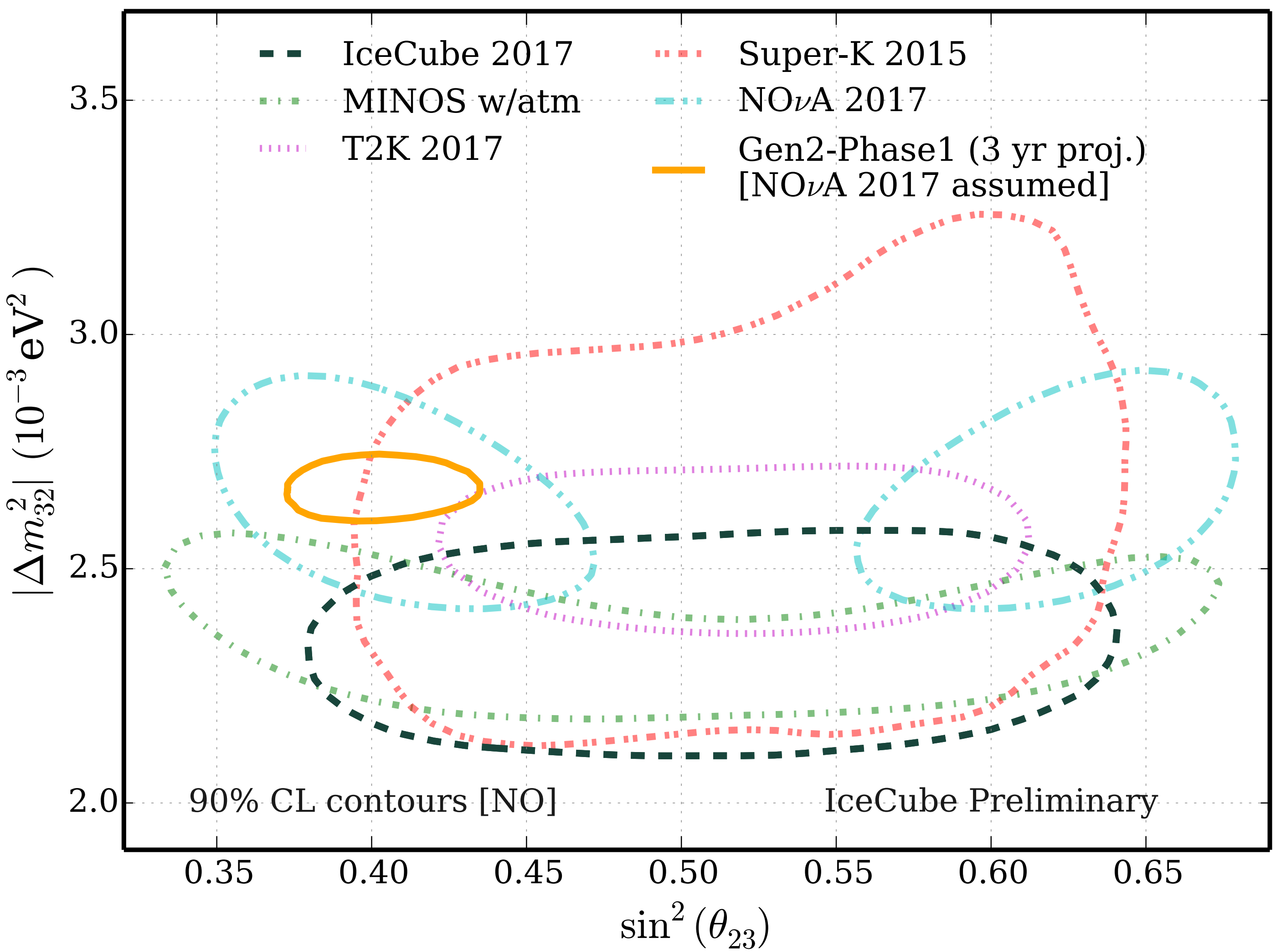
IceCube-Gen2 Phase 1: Oscillation sensitivity

T2K best-fit assumed



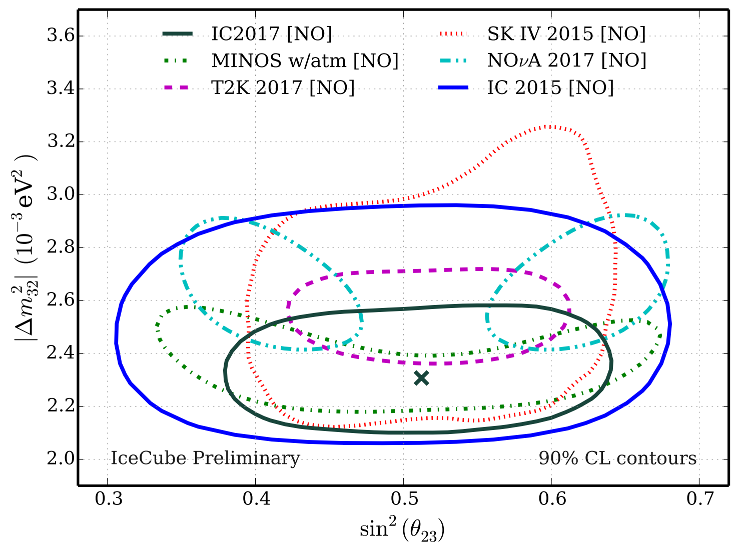
IceCube-Gen2 Phase 1: Oscillation sensitivity

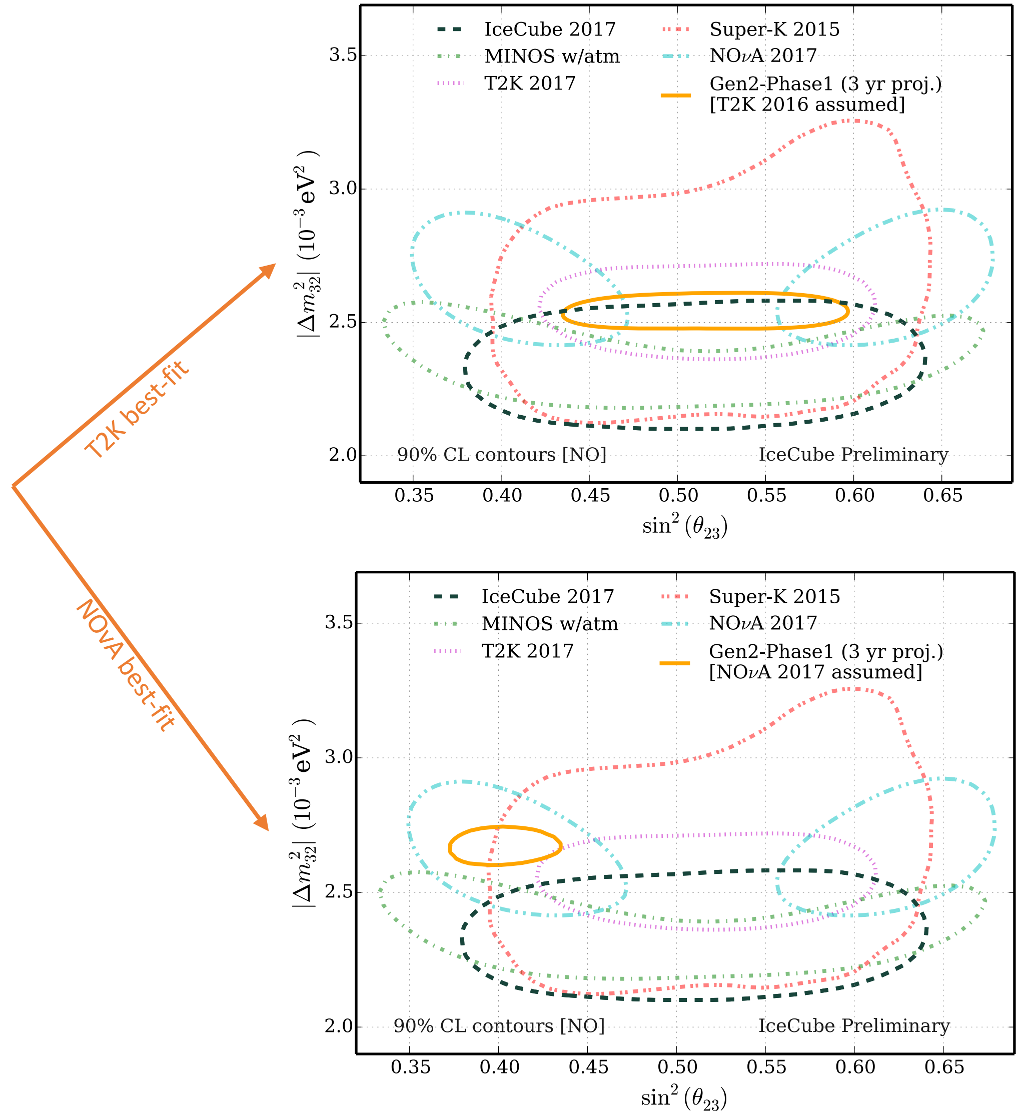
NOvA best-fit assumed



IceCube-Gen2 Phase 1: Oscillation sensitivity

Latest DeepCore result





Ongoing hardware R&D

J. van Santen
(ICRC2017)

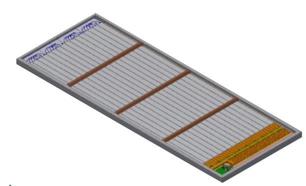
D-Egg: dual-PMT optical module
A. Ishihara, NU073; A. Stoessl, NU111

mDOM: multi-PMT optical module
L. Classen, NU082

WOM: wavelength-shifting optical module
P. Peiffer, NU053

Optical modules: more photons per unit cost, more information per photon

IceTop scintillator upgrade
S. Kunwar, CRI148



IceACT: low-threshold air shower veto
J. Auffenberg, NU041

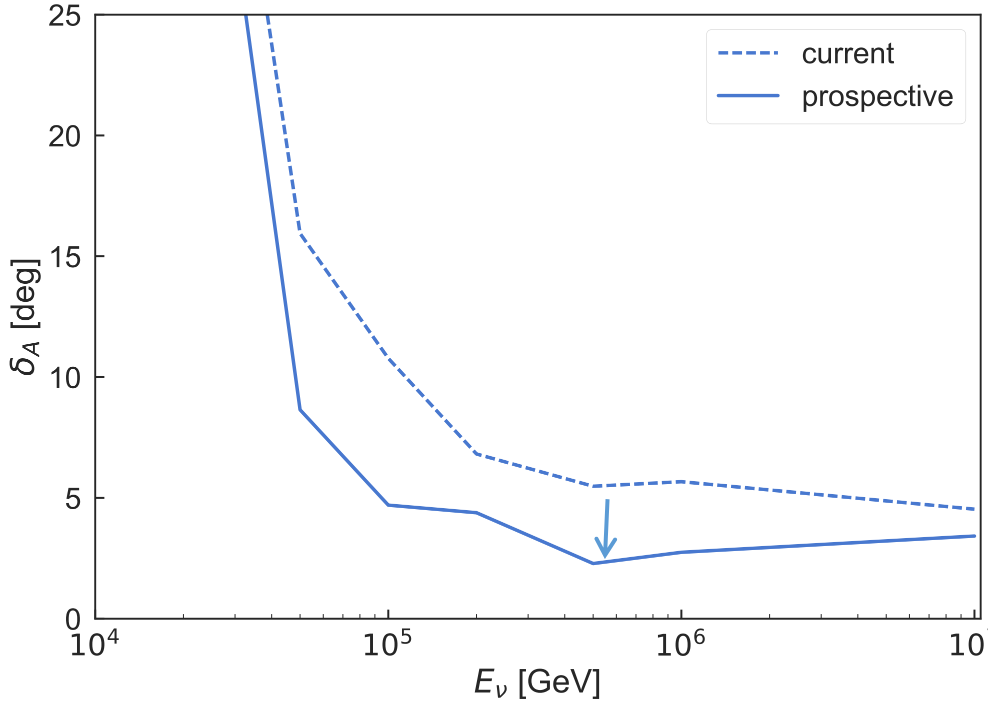
Surface detector: threshold vs. duty cycle

Improved calibration system

Precision Optical CAlibration Module (POCAM) in-situ calibration devices
→ Improve knowledge of ice properties

Prototype deployed within Gigaton Volume Detector in Lake Baikal

Isotropic light source



Can help improve angular resolution
(see my talk from Aug 8)

Looking forwards: A surface veto for IceCube-Gen2

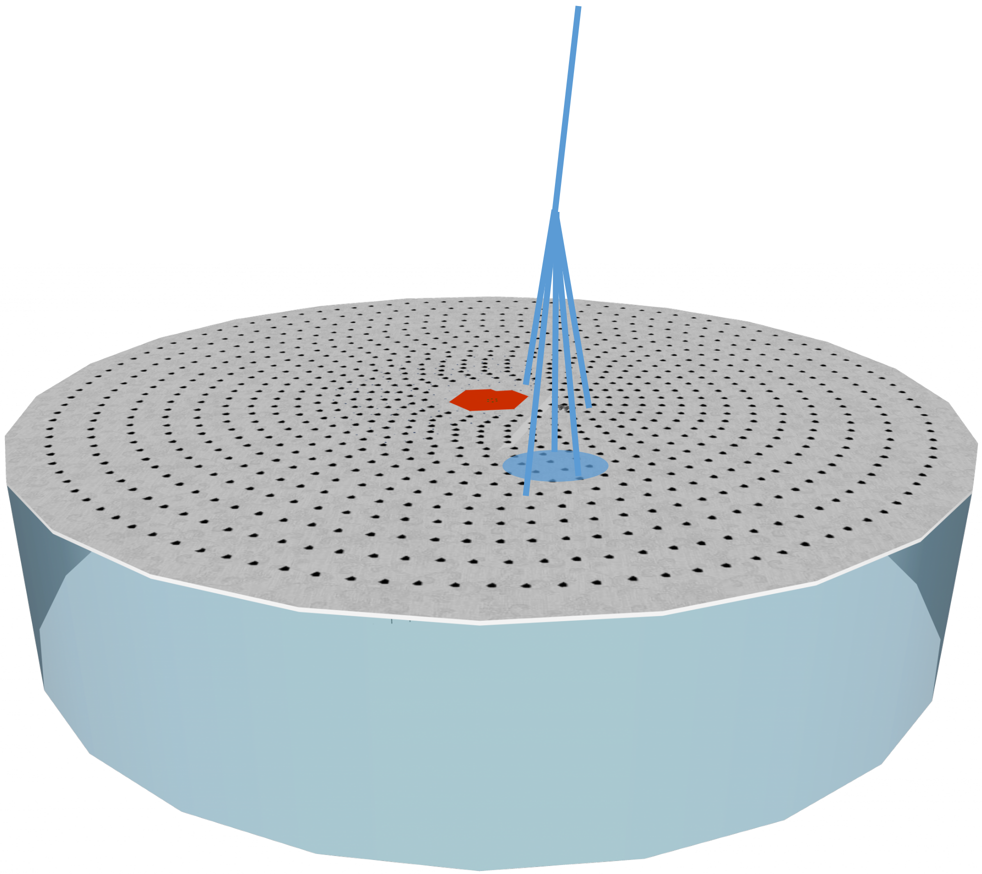
Main background in southern sky are atmospheric muons from cosmic rays

Surface veto can help tag them

Envisioned area of 75 km^2 – compare to IceCube's 1km^2 surface veto IceTop

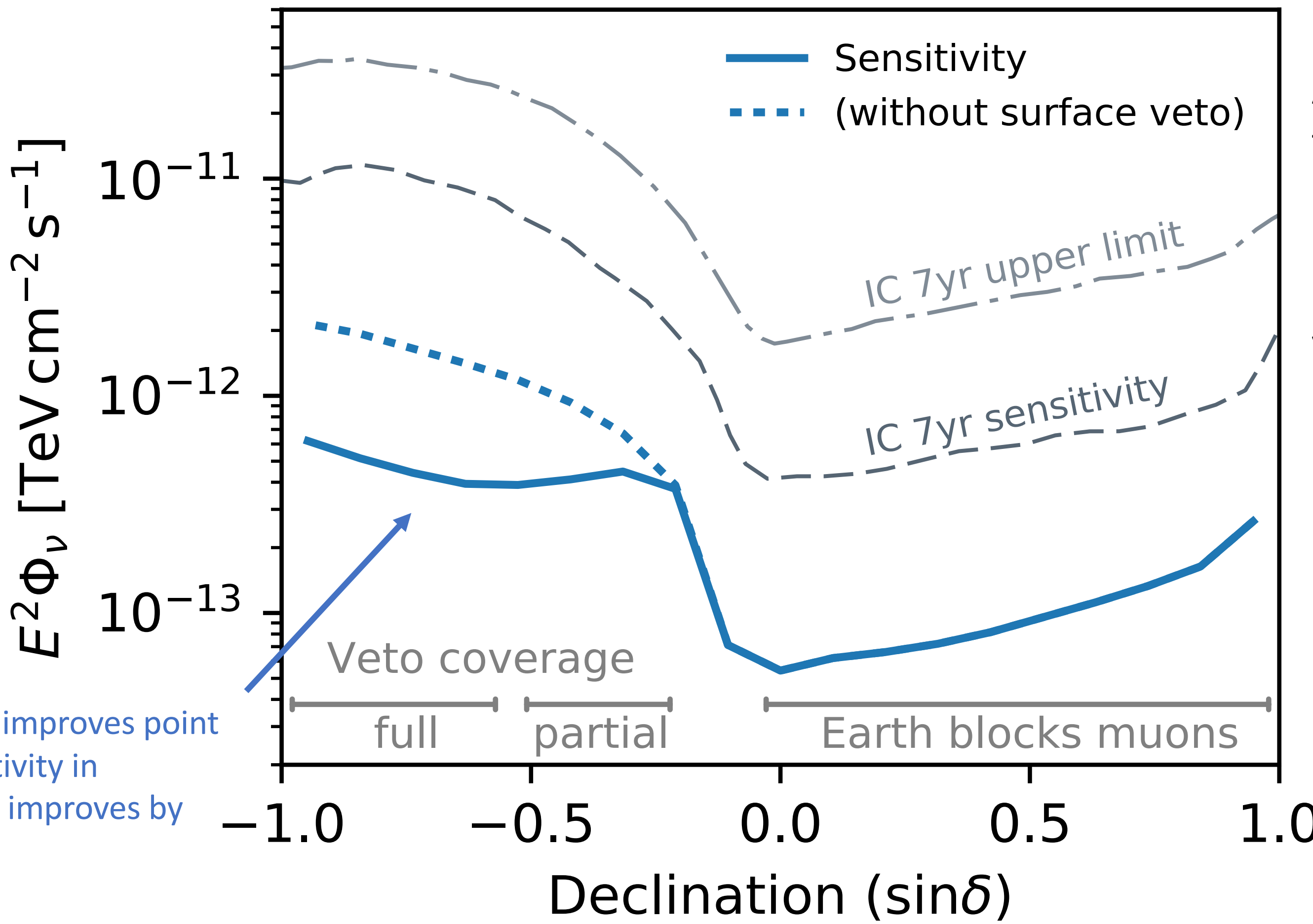
Around 800 stations, covering the entire detector up to zenith of 45˚

Prototype stations under construction



Point source sensitivity

PoS (ICRC2017) J. van Santen



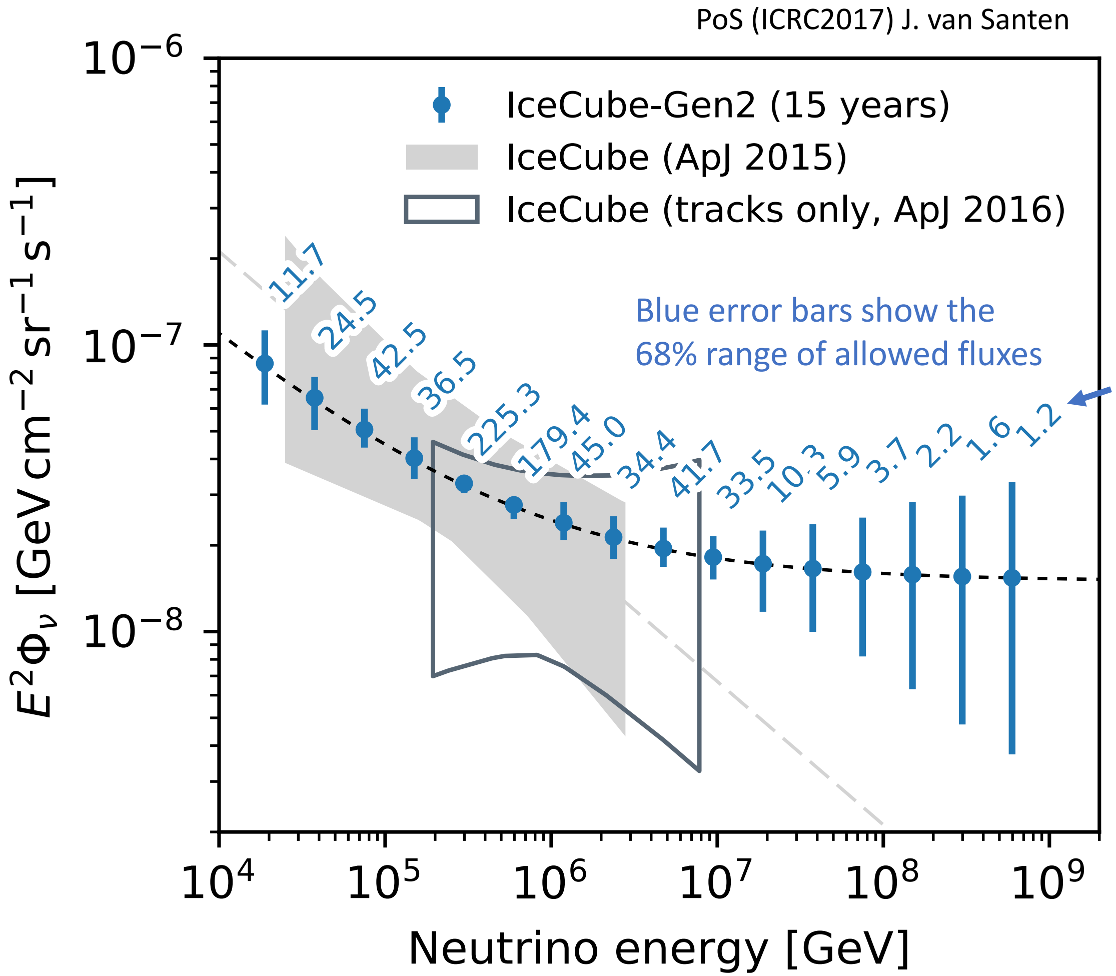
Assuming E^{-2} flux from single source

15 years IC + 15 years IC-Gen2

Surface veto improves point source sensitivity in southern sky improves by factor of > 3

Diffuse sensitivity

Clear distinction of the different spectra possible



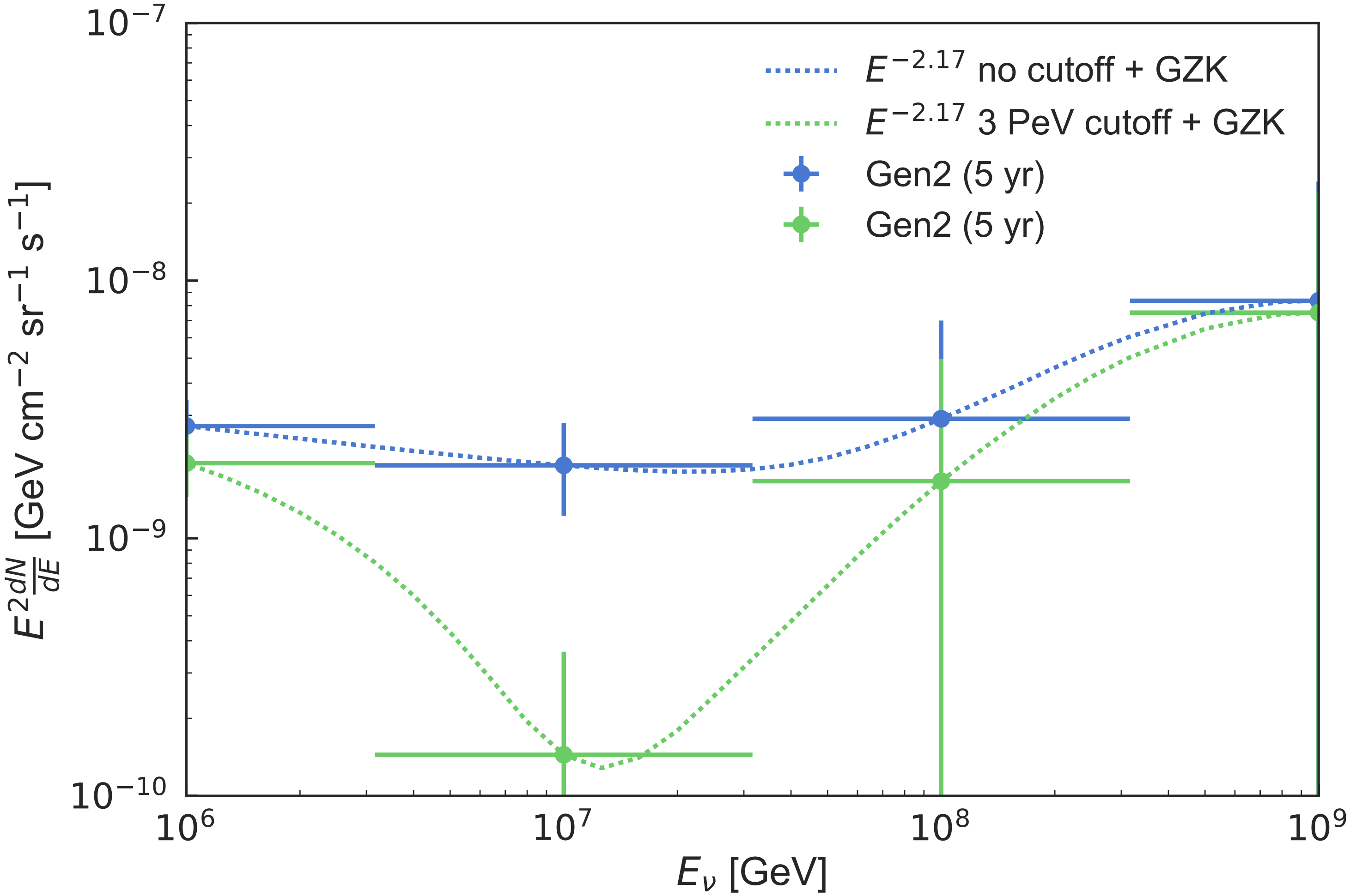
Number of events in each energy range

Double power law $E^{-2} + E^{-2.5}$ injected flux

Cutoff sensitivity, 3 PeV cutoff, γ=2.17

Method: inject astro+GZK neutrino flux and unfold expectations

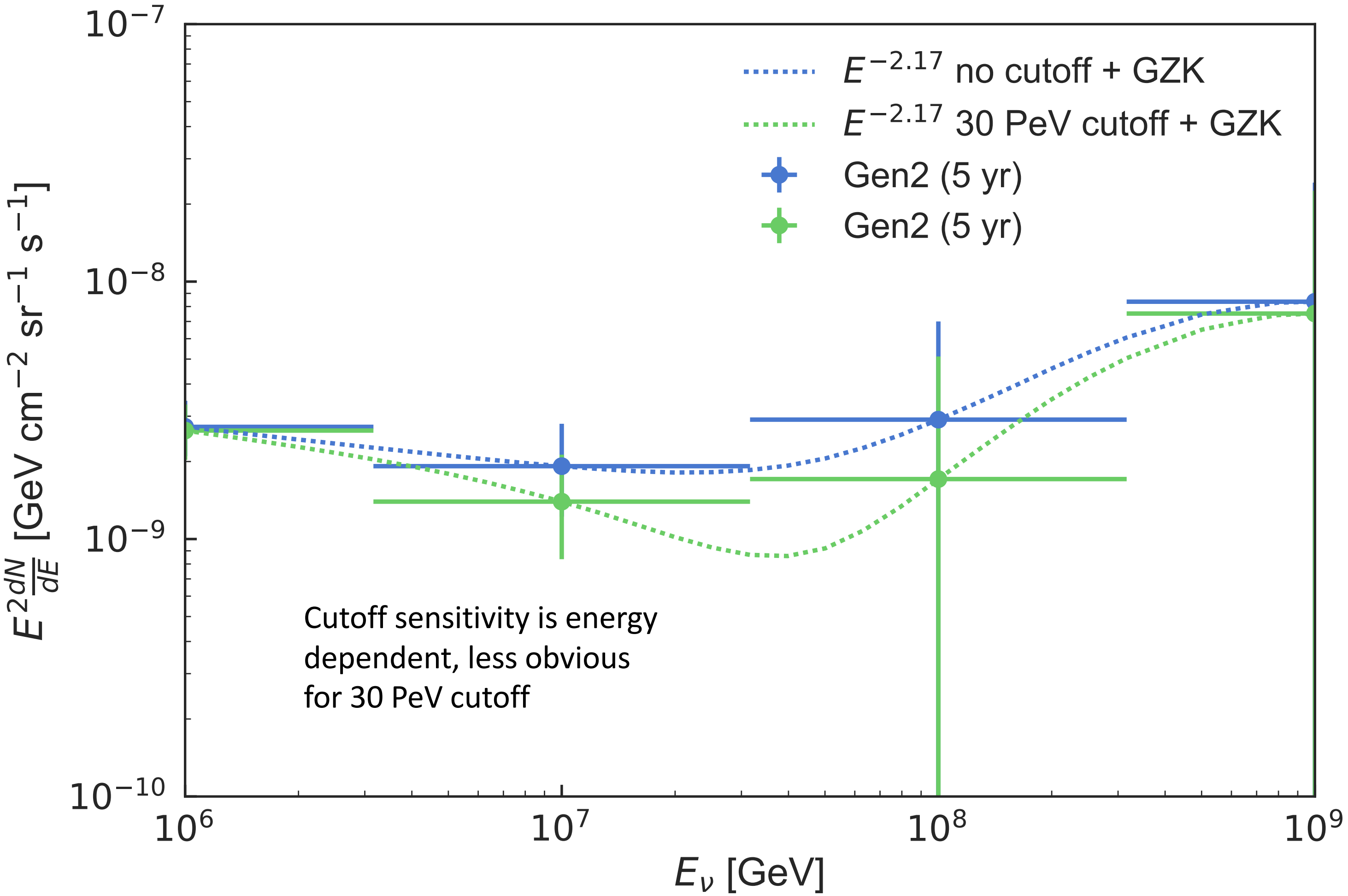
Error bars show 68% range of allowed fluxes



Cutoff sensitivity, 30 PeV cutoff, γ=2.17

Method: inject astro+GZK neutrino flux and unfold expectations

Error bars show 68% range of allowed fluxes



Complementary radio array: ARA

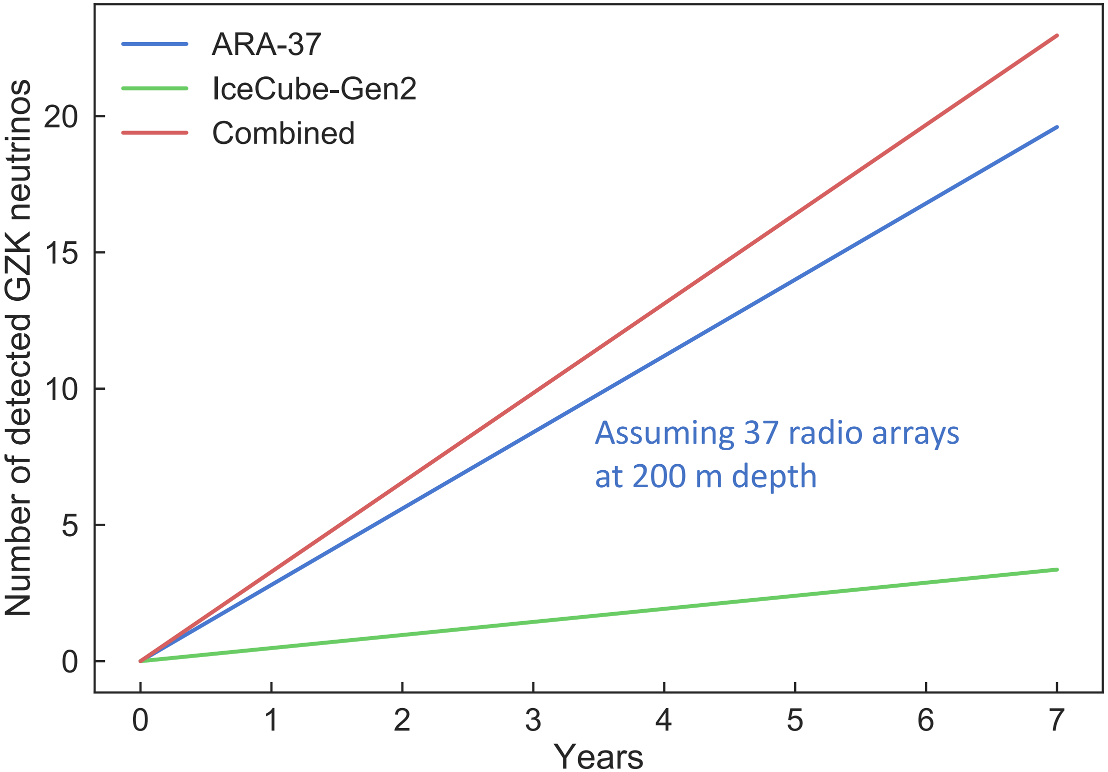
Detection of GZK neutrinos produced off CMB requires sensitivity above 100 PeV

ARA = Askaryan Radio Array

Detect radio waves produced via Askaryan effect on ice

Most optimistic GZK flux scenario

- ARA-37: 2.8 evts/yr
- IceCube-Gen2: 0.5 evts/yr



Summary

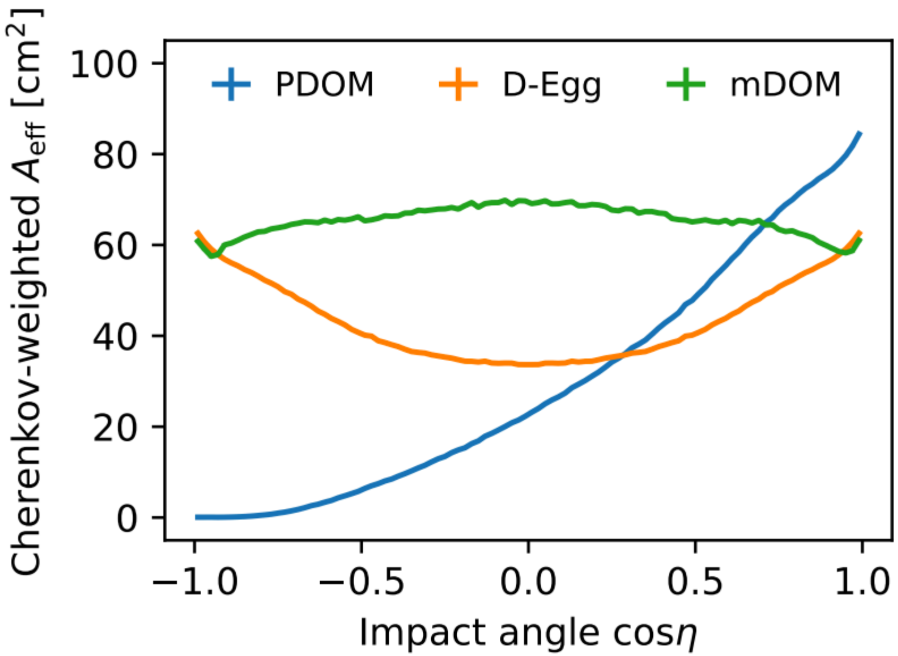
- The future of in-ice neutrino telescopes is IceCube-Gen2
  - Envisioned components include PINGU, large surface array, and complementary radio array
- IceCube-Gen2 Phase 1 is the next step
  - Proposed 7 string expansion with densely-spaced mDOMs
  - Aligns with PINGU science goals → Improved oscillation sensitivity
- Ongoing hardware development to improve DOM design and surface veto detectors
- A lot more left to do and to discover!

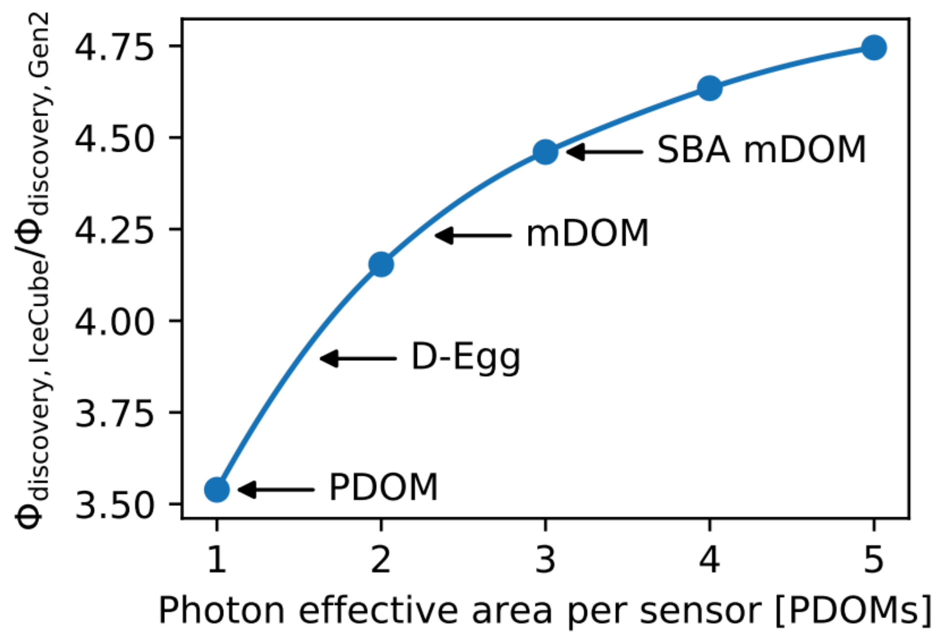
Credit: Martin Wolf, IceCube/NSF

Backups

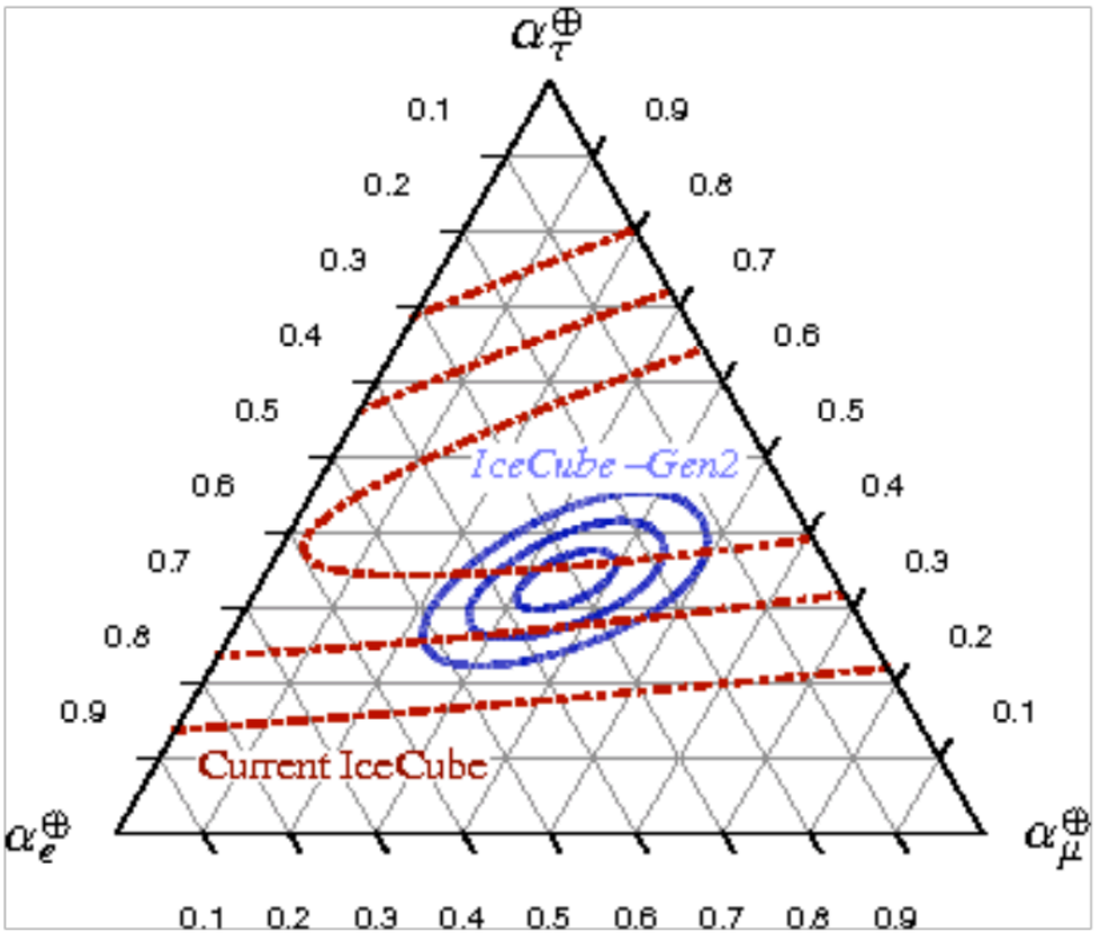
Sensitivity improvements from new DOM designs

PoS (ICRC2017) J. van Santen





Flavor ratio improvement



Shoemaker et al. Phys.Rev. D93 (2016) no.8, 085004