

ICECUBE



PRECISION ICECUBE NEXT
GENERATION UPGRADE

IceCube and future detectors

IPP AGM/Town Hall Meeting
May 2017

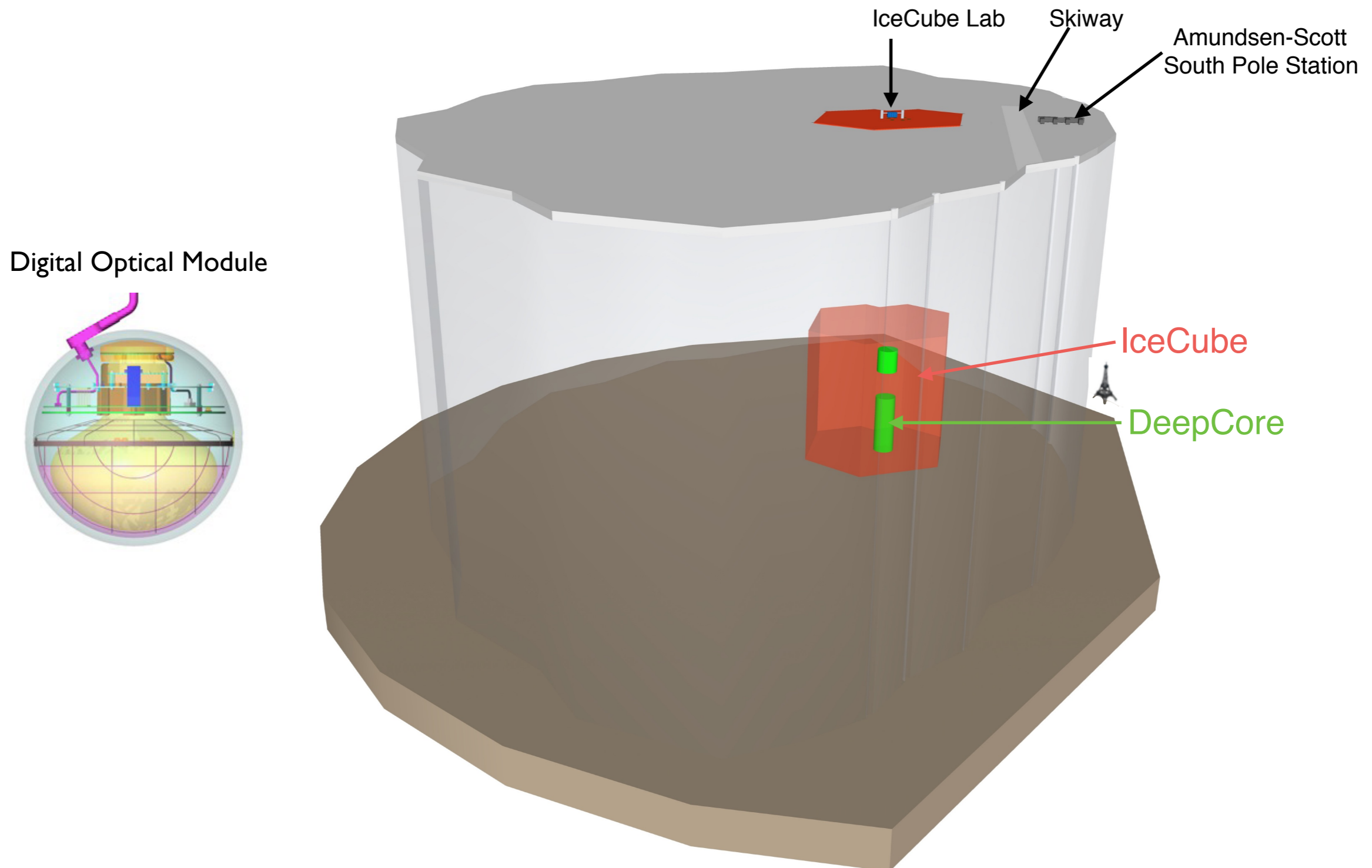


ICECUBE
GEN2

The IceCube Canada research program

Core analysis efforts:

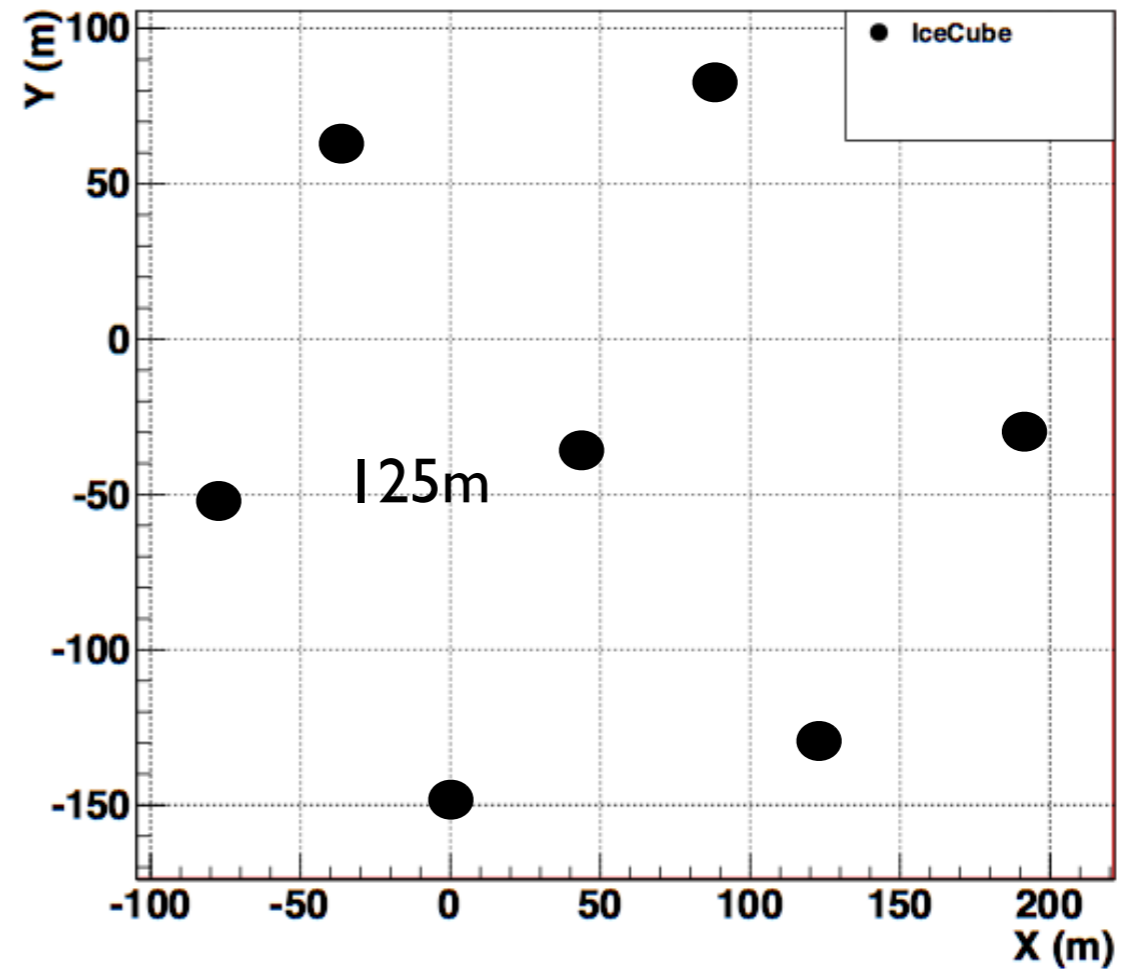
- measurements of “low-energy” neutrinos including precision extraction of the atmospheric neutrino flux, atmospheric neutrino oscillations, indirect dark matter searches
- studies of the “high-energy” diffuse neutrino flux



IceCube

- 78 Strings
- 125m string spacing
- 17m DOM spacing

IceCube (top centre view)



10 MeV

100 MeV

1 GeV

10 GeV

100 GeV

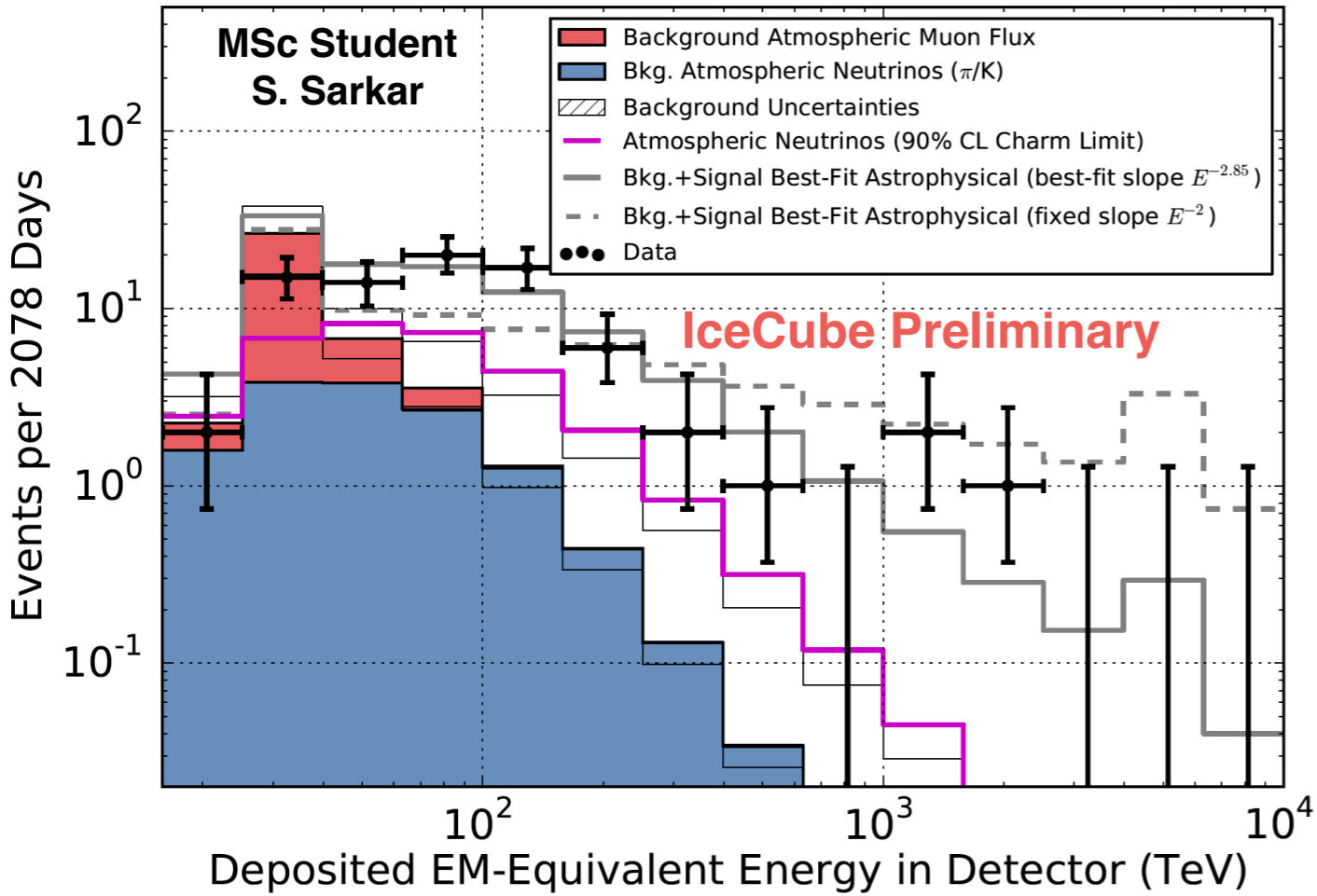
1 TeV

10 TeV

1 EeV

IceCube

Starting Event Spectrum



IceCube diffuse working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada

10 MeV

100 MeV

1 GeV

10 GeV

100 GeV

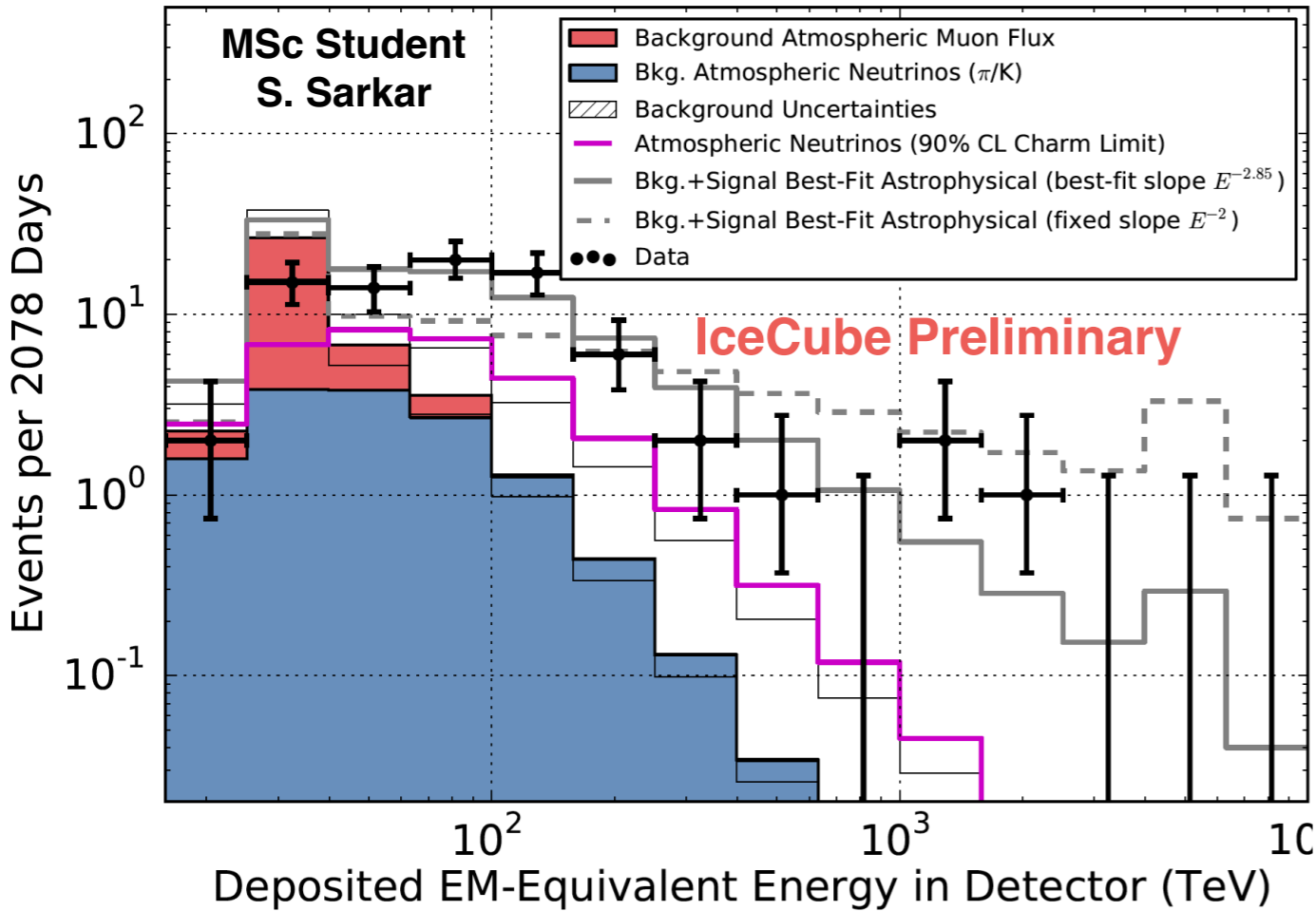
1 TeV

10 TeV

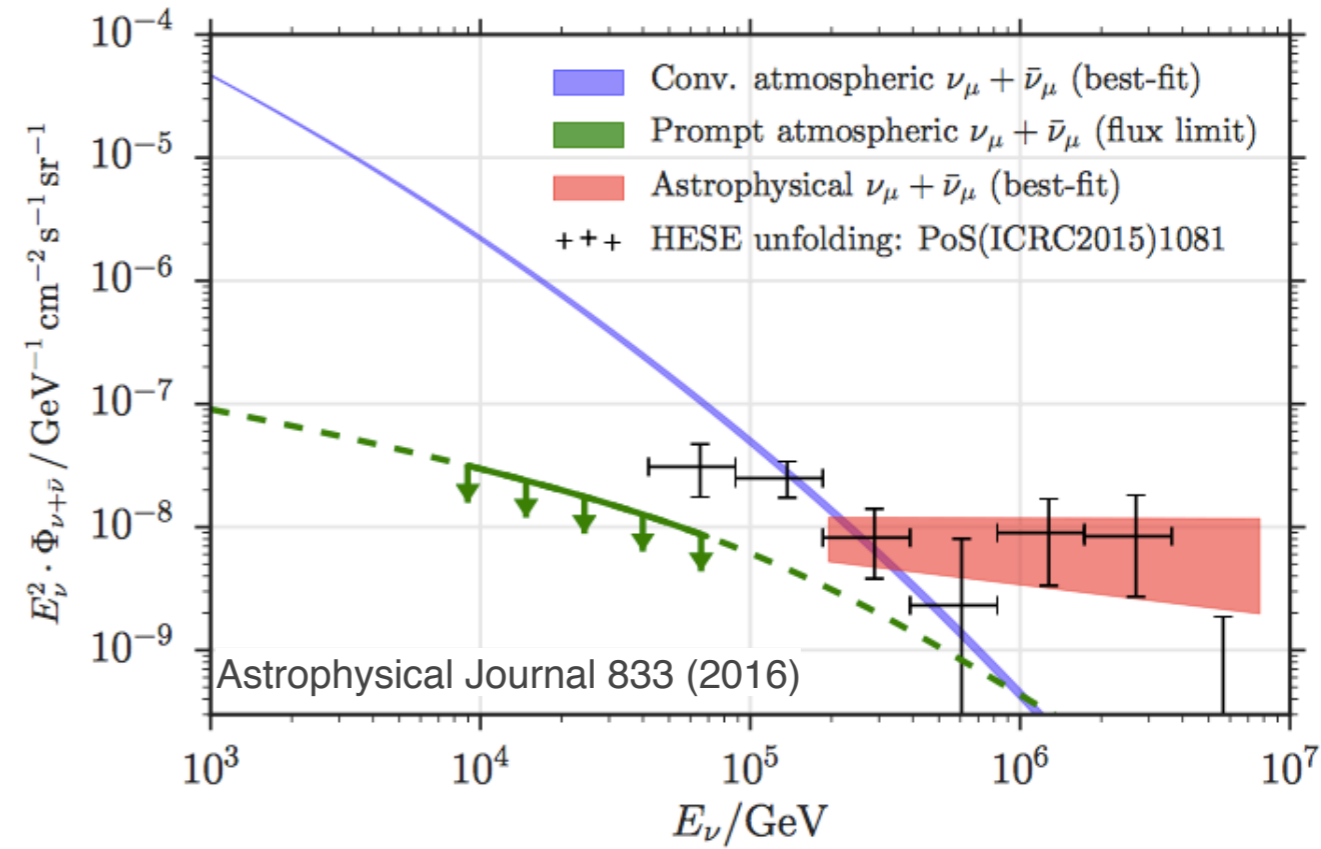
1 EeV

IceCube

Starting Event Spectrum



Astrophysical Muon Neutrinos (northern sky)



IceCube diffuse working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada

10 MeV

100 MeV

1 GeV

10 GeV

100 GeV

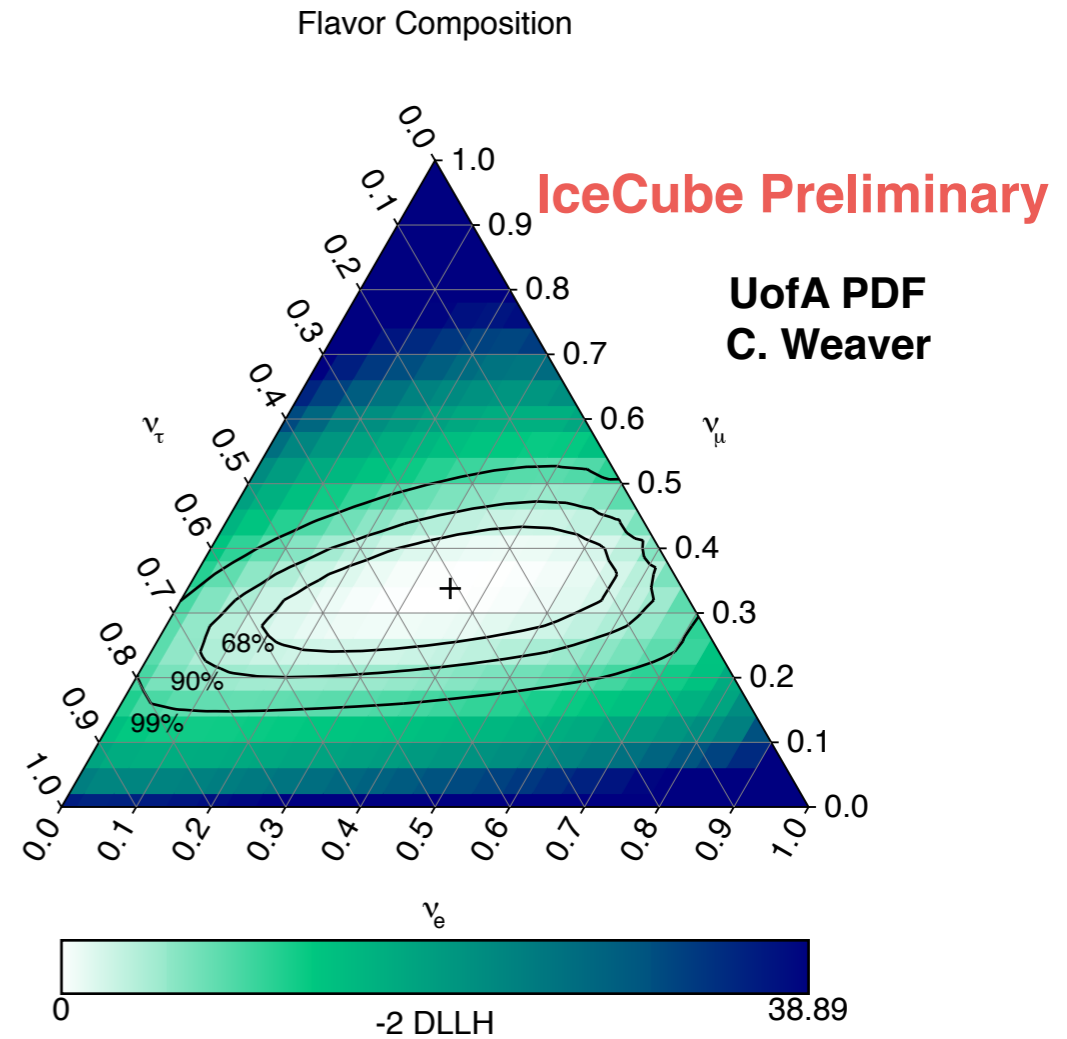
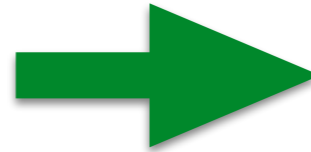
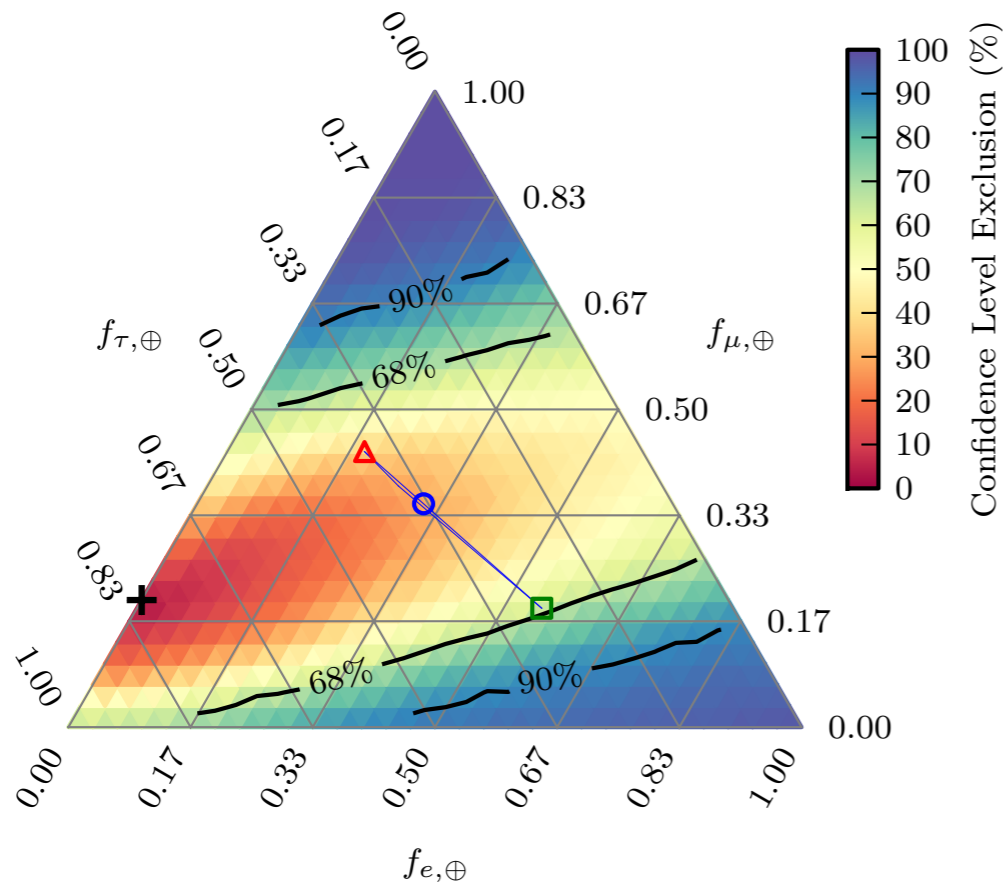
1 TeV

10 TeV

1 EeV

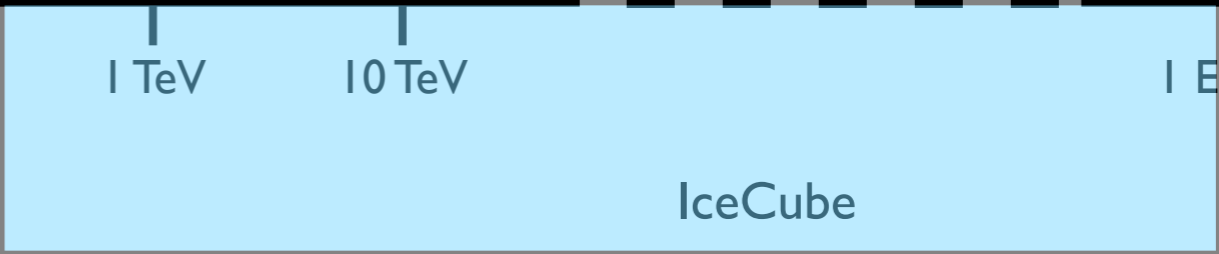
IceCube

IceCube



IceCube diffuse working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada

10 MeV 100 MeV 1 GeV 10 GeV 100 GeV 1 TeV 10 TeV 1 EeV

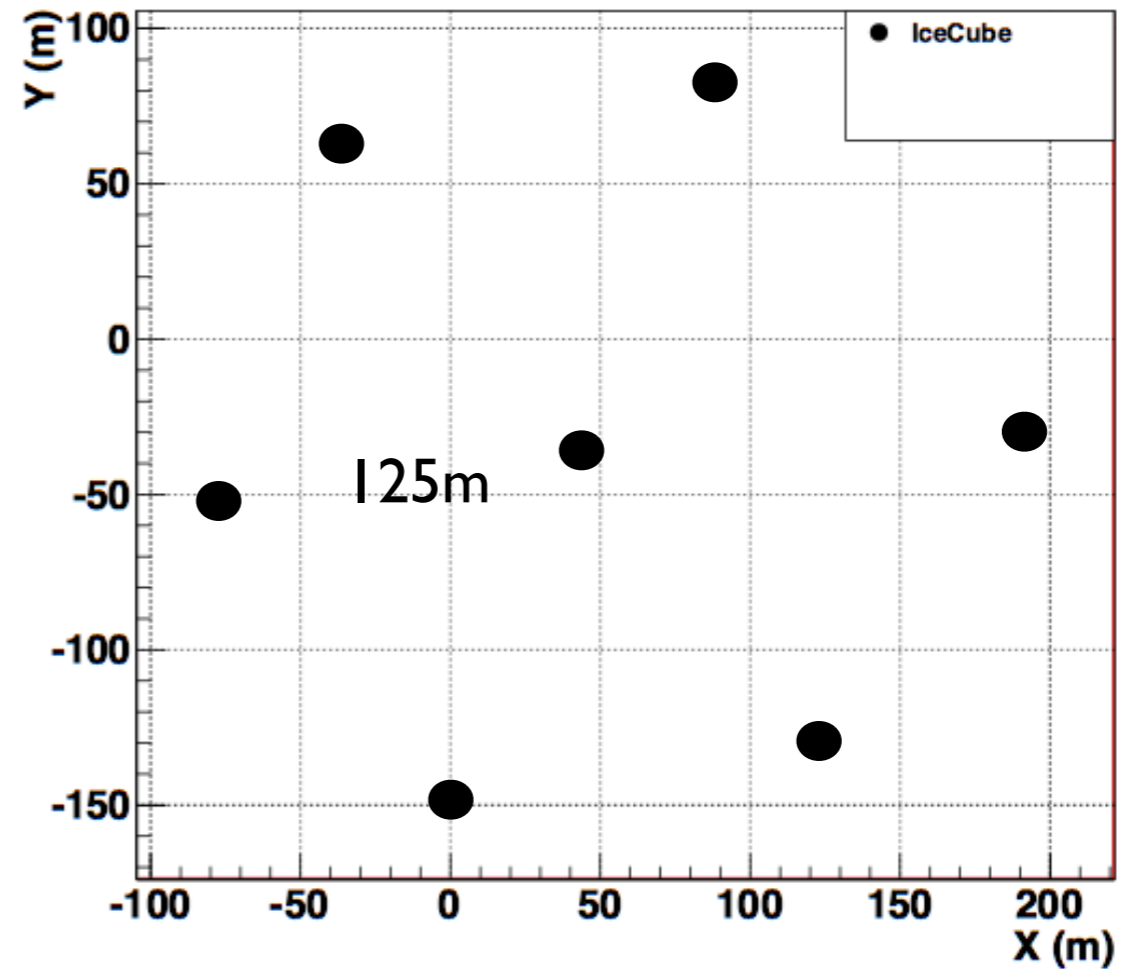


IceCube

IceCube

- 78 Strings
- 125m string spacing
- 17m DOM spacing

IceCube (top centre view)



10 MeV

100 MeV

1 GeV

10 GeV

100 GeV

1 TeV

10 TeV

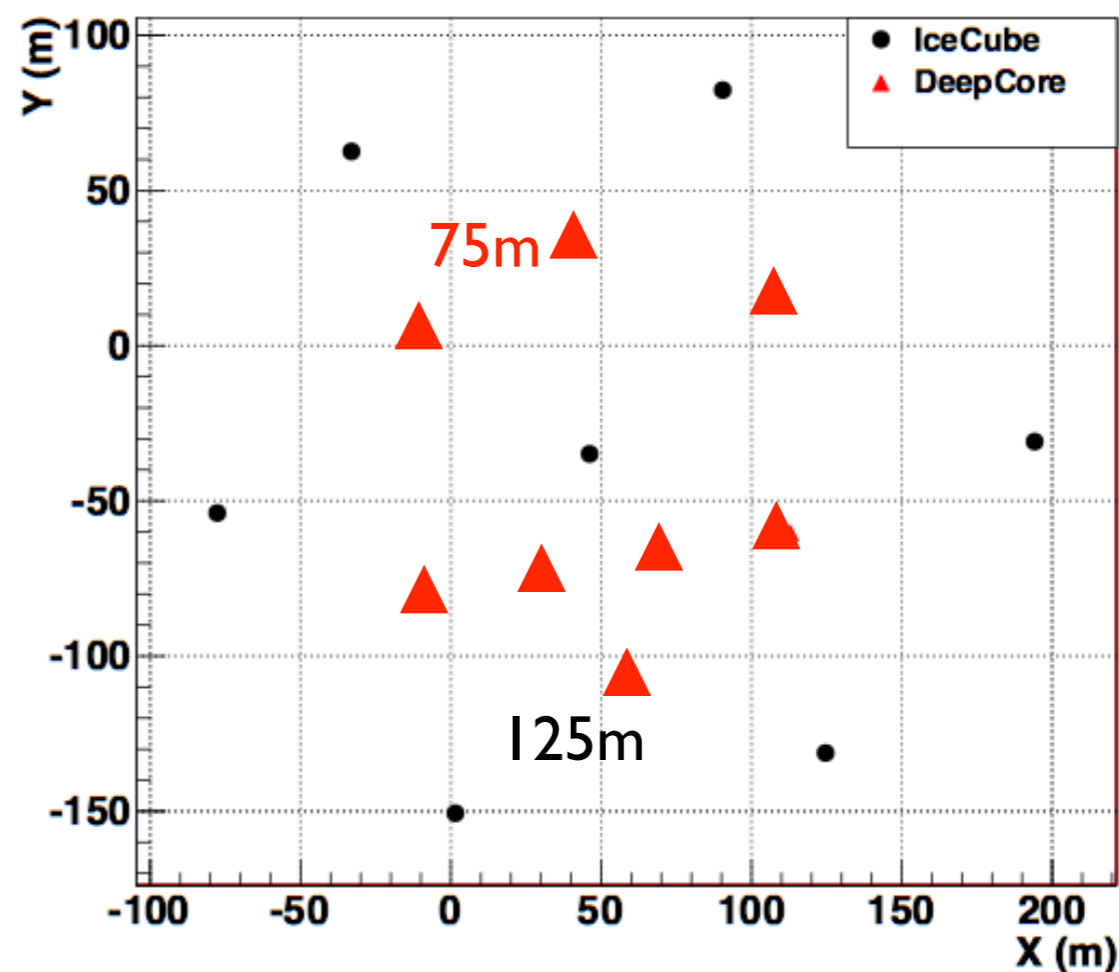
1 EeV

IceCube

IceCube-DeepCore

- 78 Strings
- 125m string spacing
- 17m DOM spacing
- Add 8 strings
- 75m string spacing
- 7m DOM spacing

IceCube-DeepCore top view



10 MeV

100 MeV

1 GeV

10 GeV

100 GeV

1 TeV

10 TeV

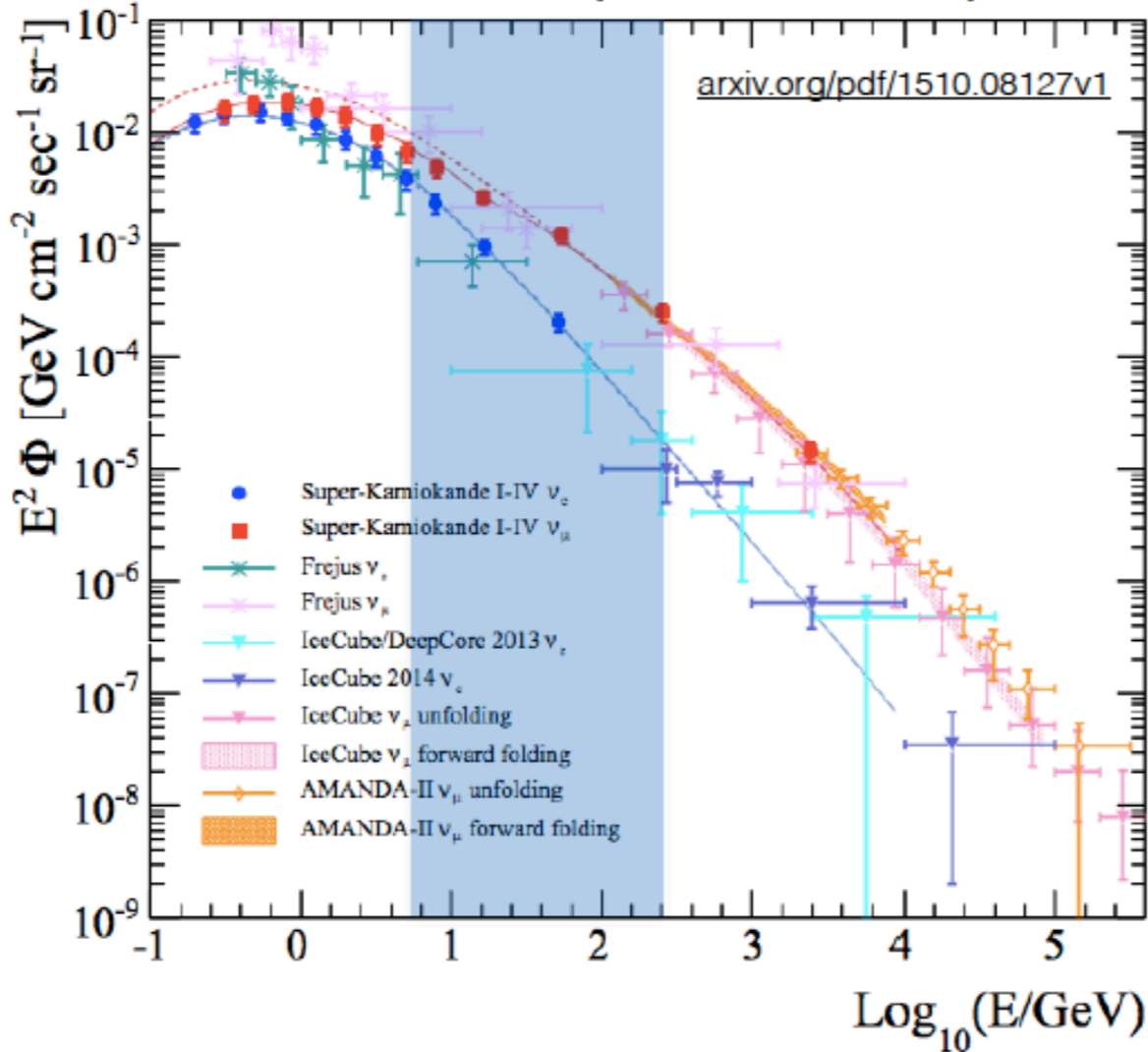
1 EeV

DeepCore

IceCube

IceCube-DeepCore

Precision atmospheric neutrino measurements



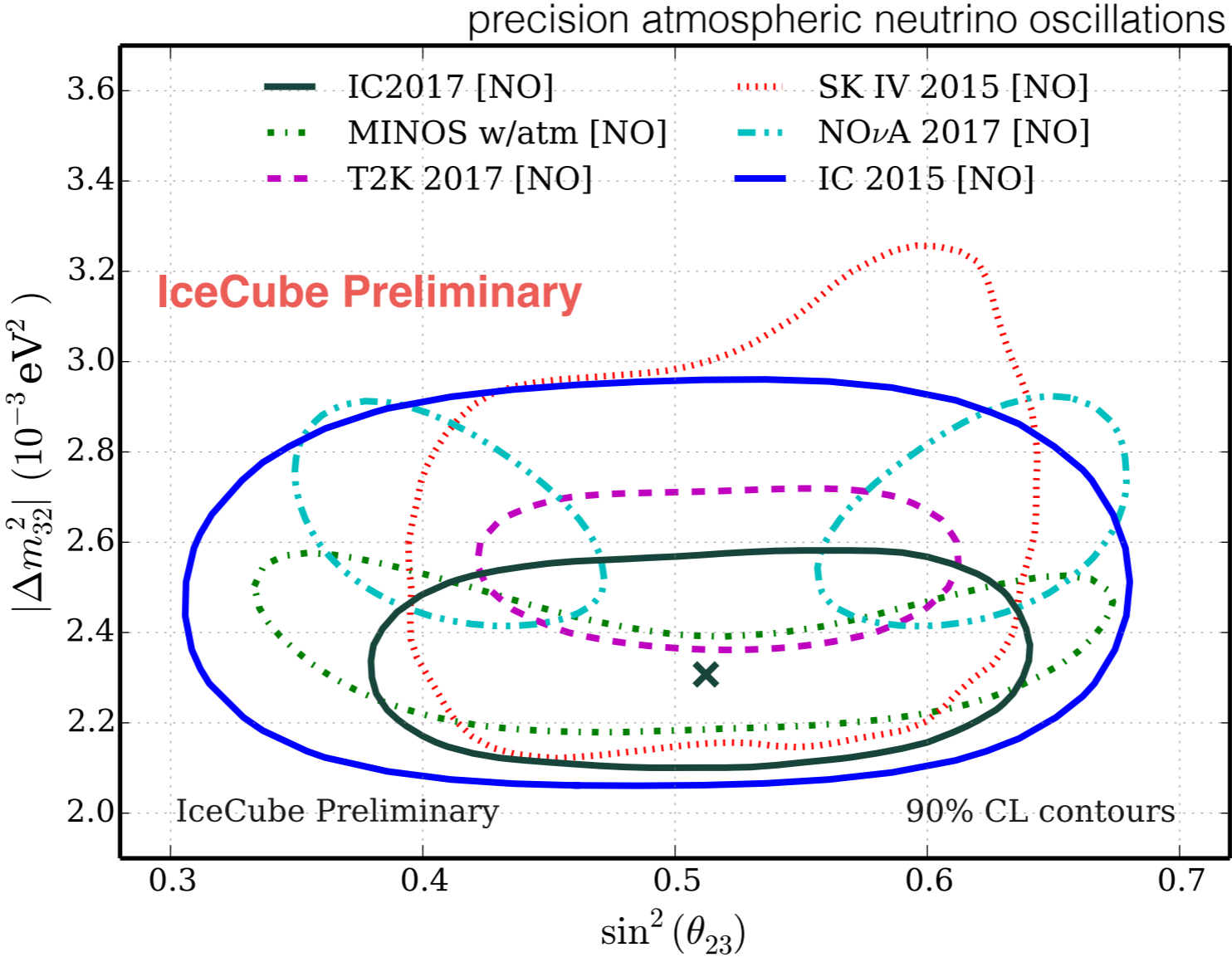
PhD Student
T. Wood;
Banting
Fellow J. P.
Yanez



IceCube oscillations working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada



IceCube-DeepCore



PhD Student
S. Nowicki

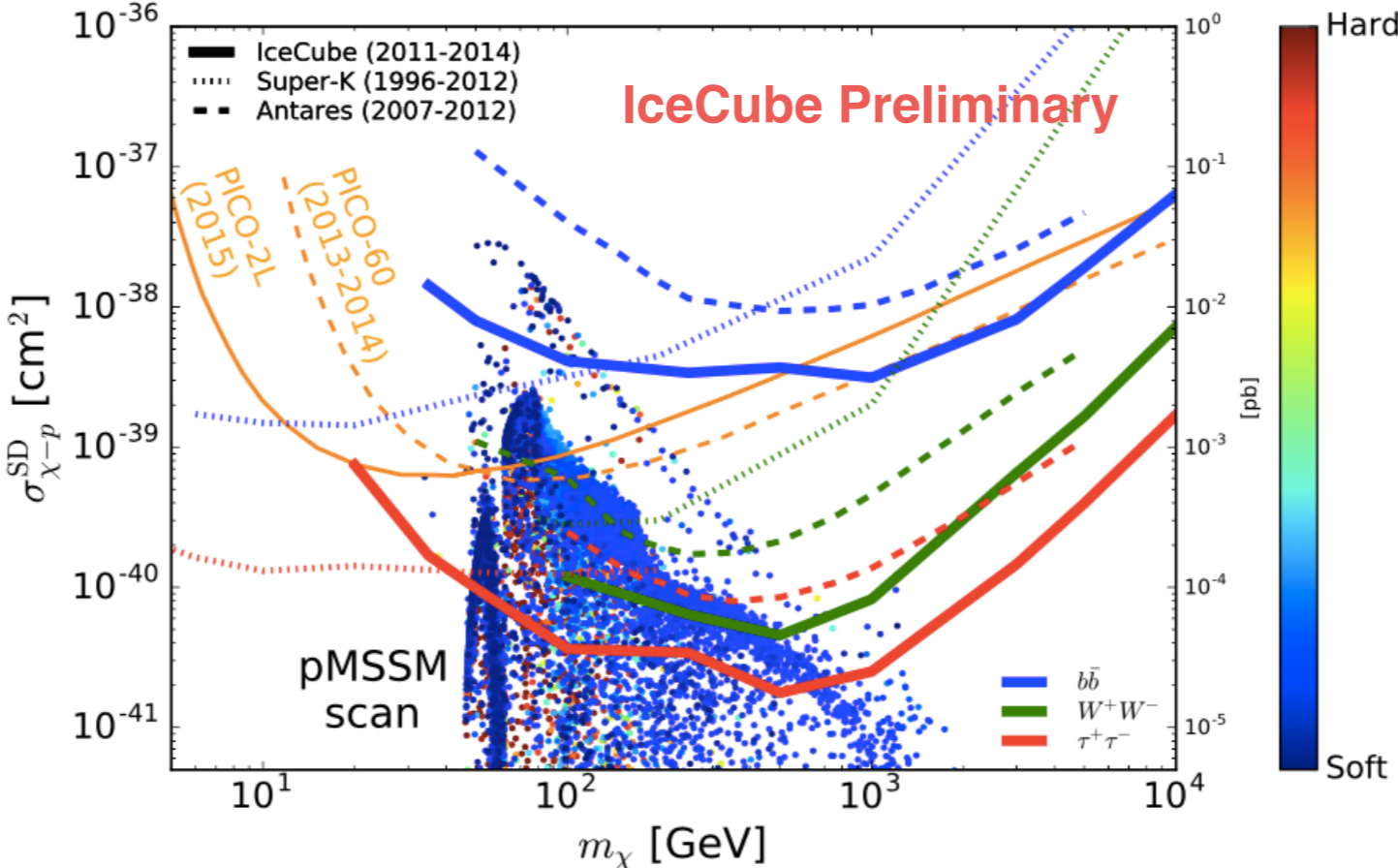


IceCube oscillations working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada



IceCube-DeepCore

Indirect Dark Matter Searches

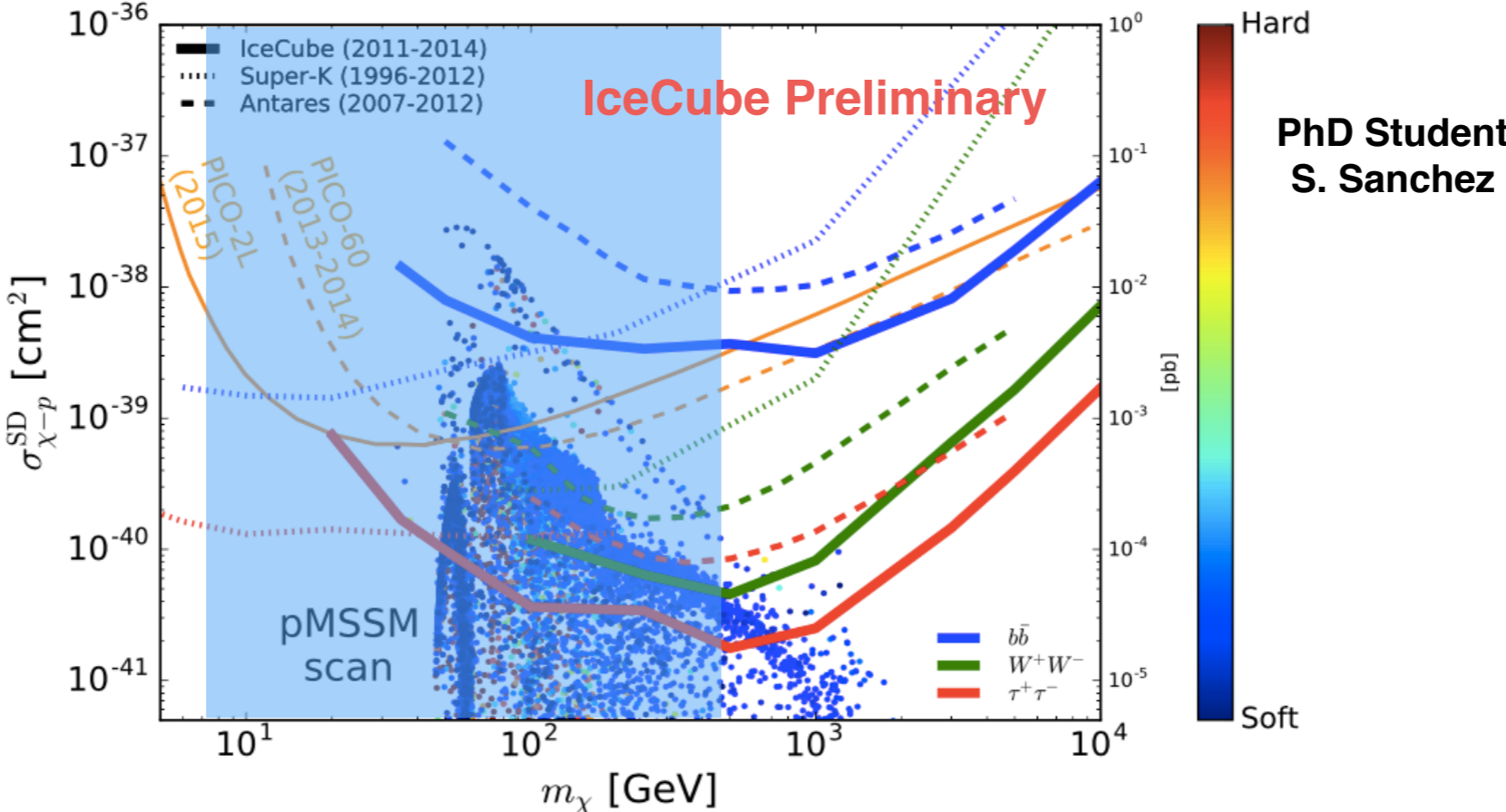


IceCube oscillations working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada



IceCube-DeepCore

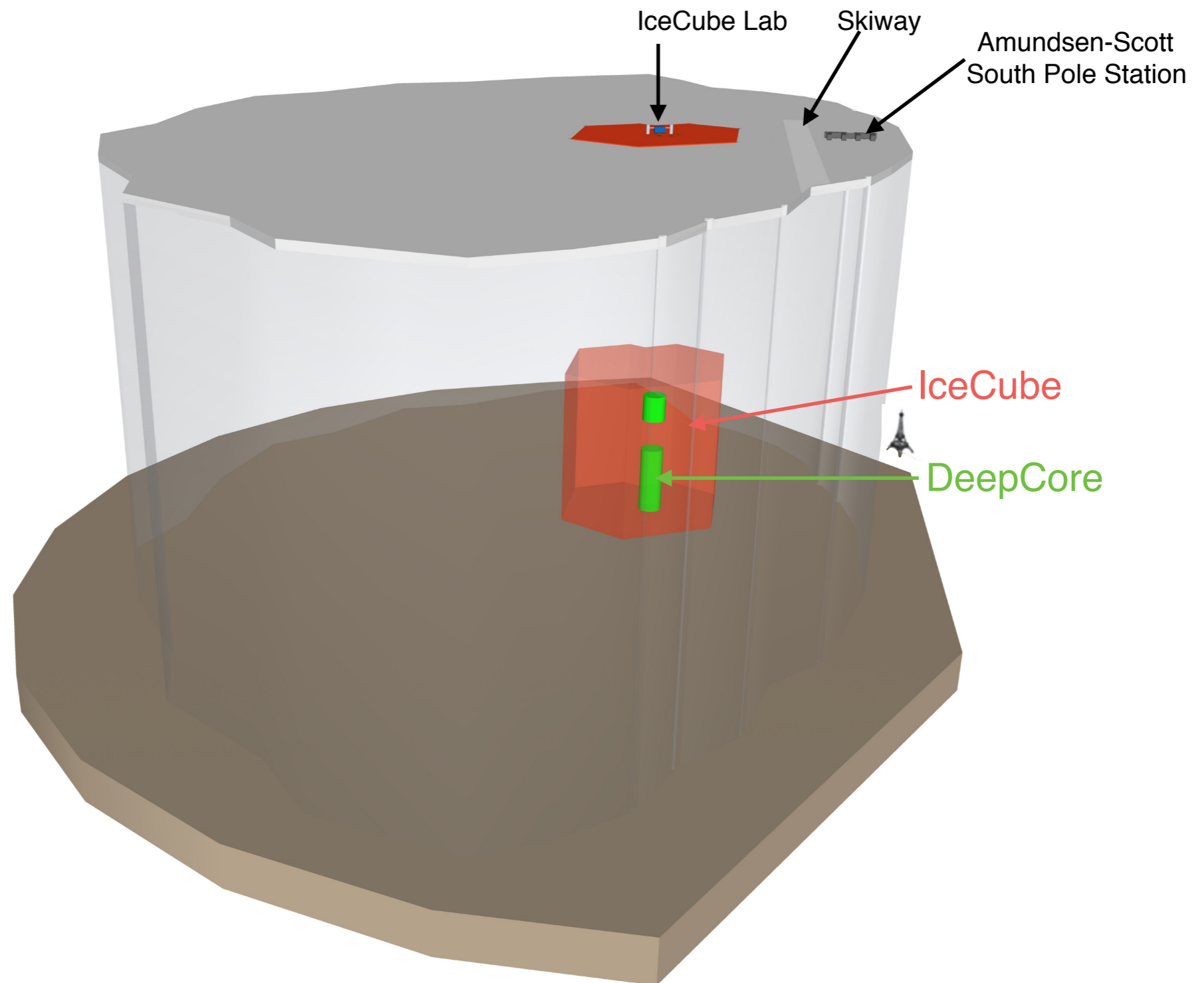
Indirect Dark Matter Searches



IceCube oscillations working group convened @ U. Alberta; Simulations and analyses completed on Compute Canada

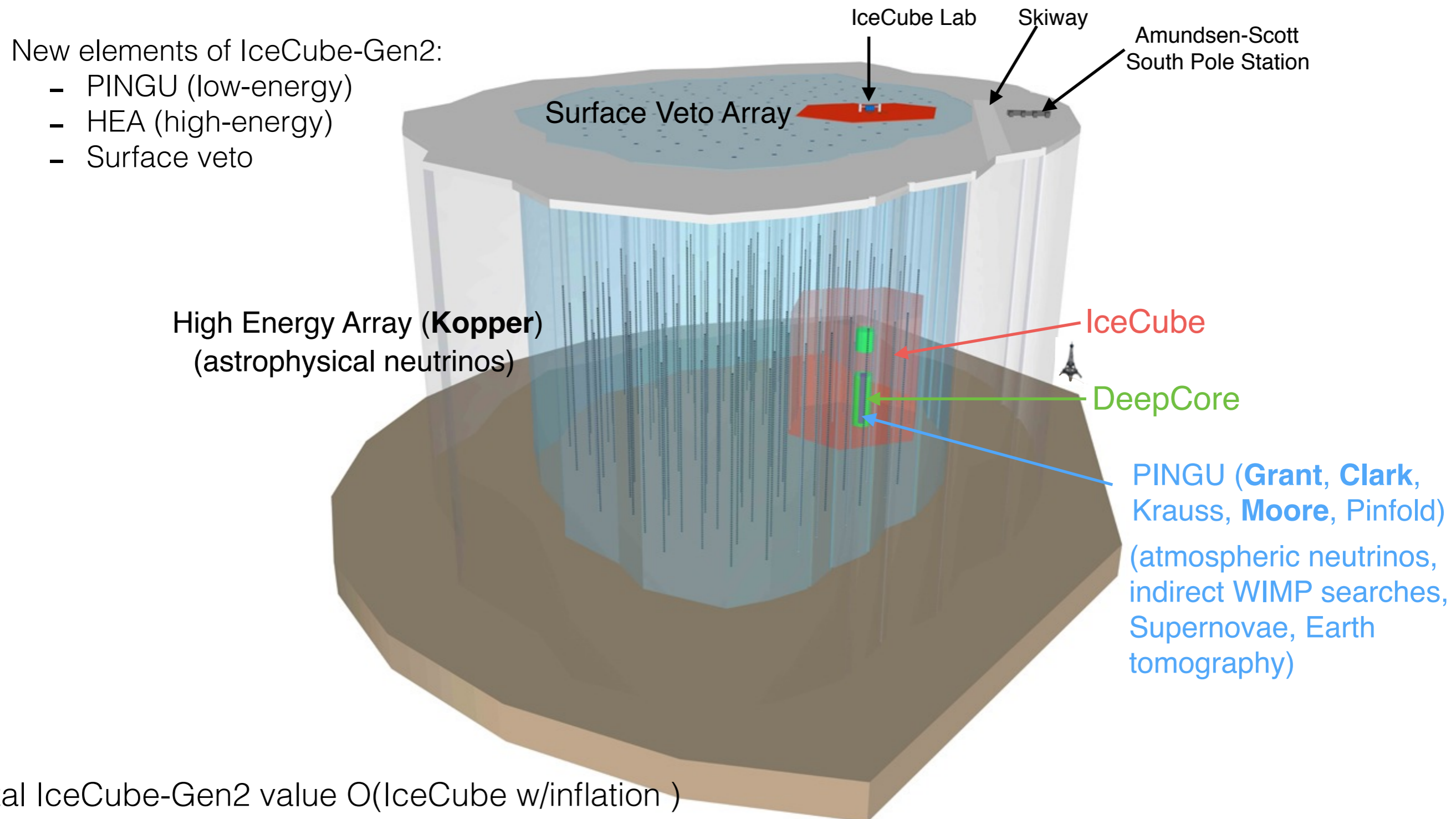


IceCube



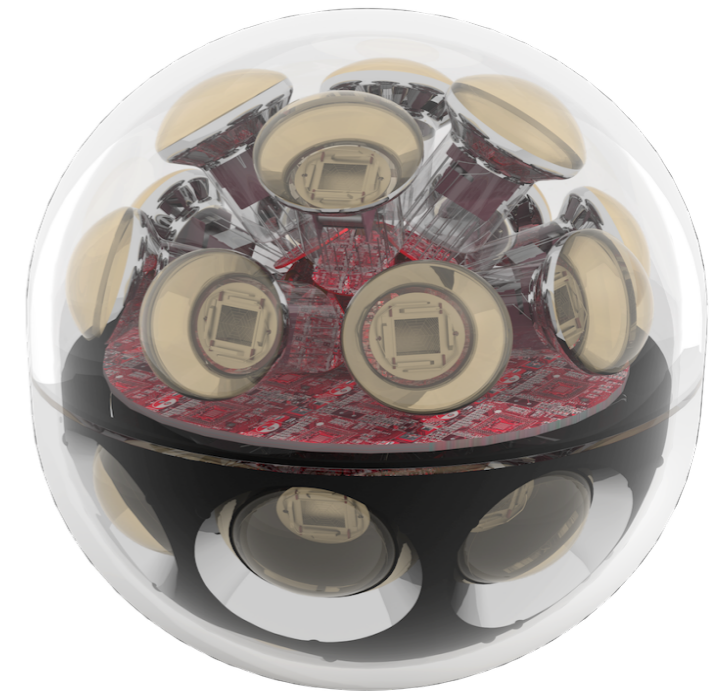
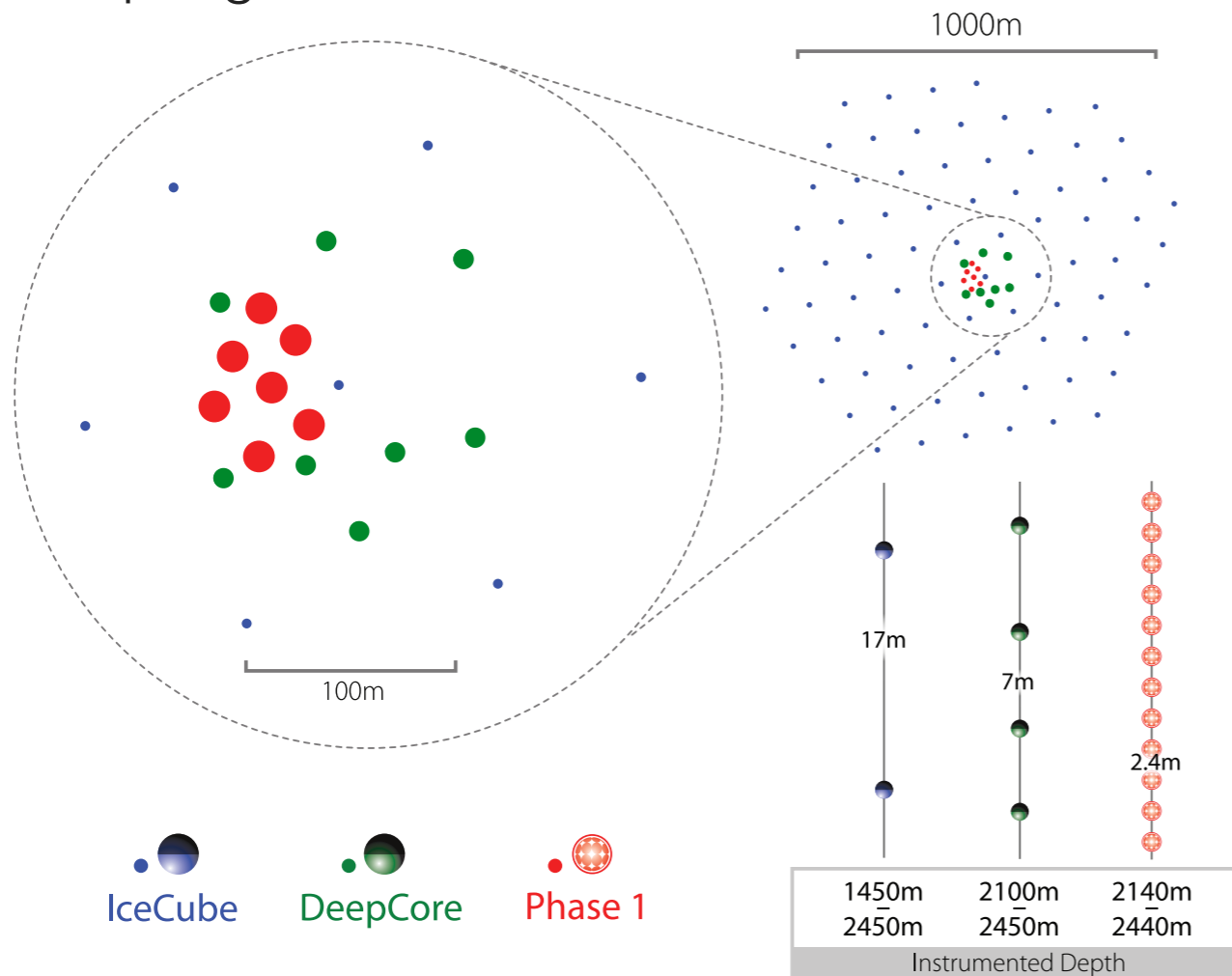
IceCube-Gen2

In addition to the core IceCube analyses, Canada has established leadership in the next generation (Gen2) developments of the IceCube facility.



IceCube-Gen2 developments

- Gen2 Phase 1 proposal submitted to CFI, NSF and BMBF Fall 2016. Results expected Spring/Summer 2017.

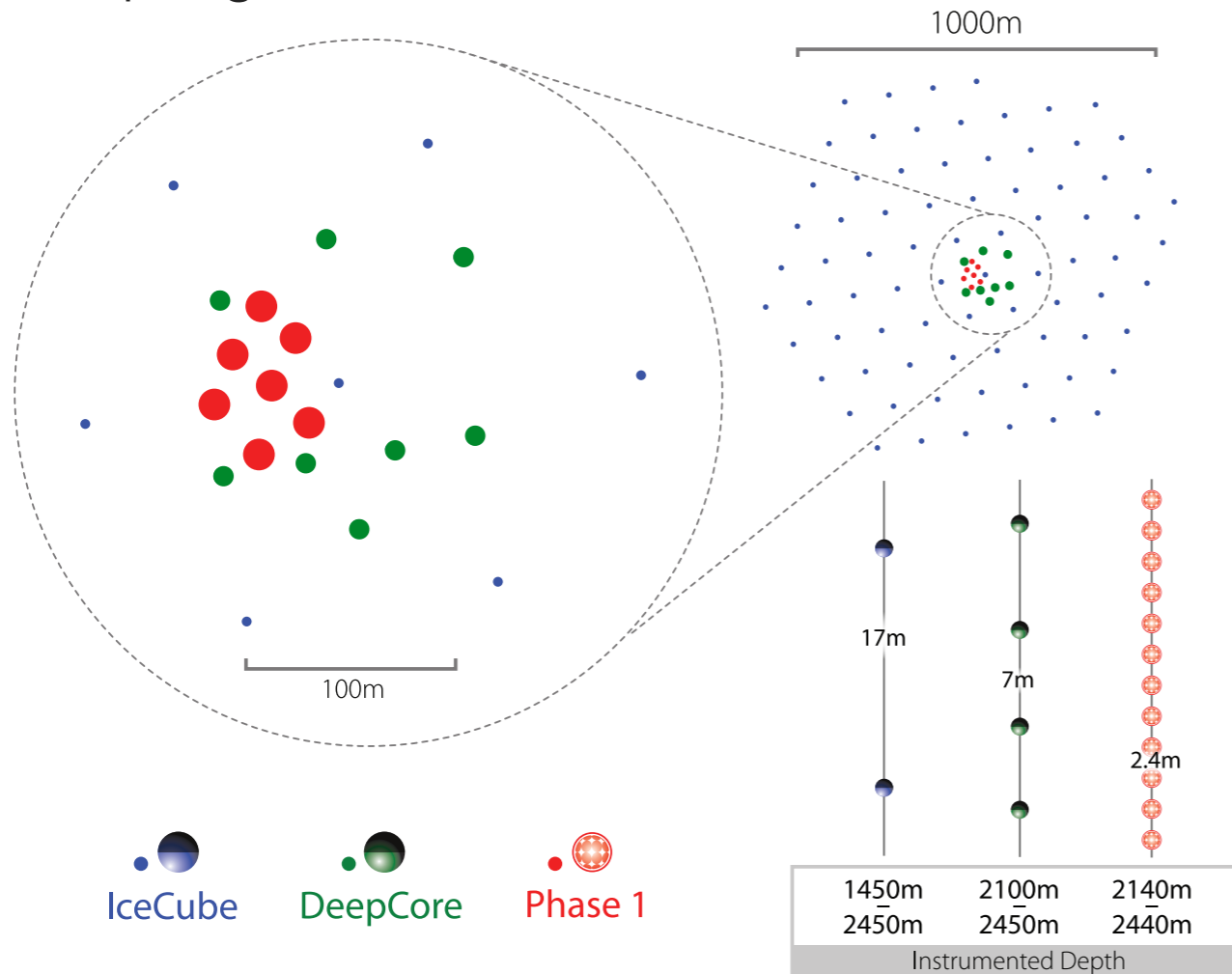


- 25 x 3" PMTs
- Uniform angular coverage
- Digital photon counting
- All data to surface; satellite transfer

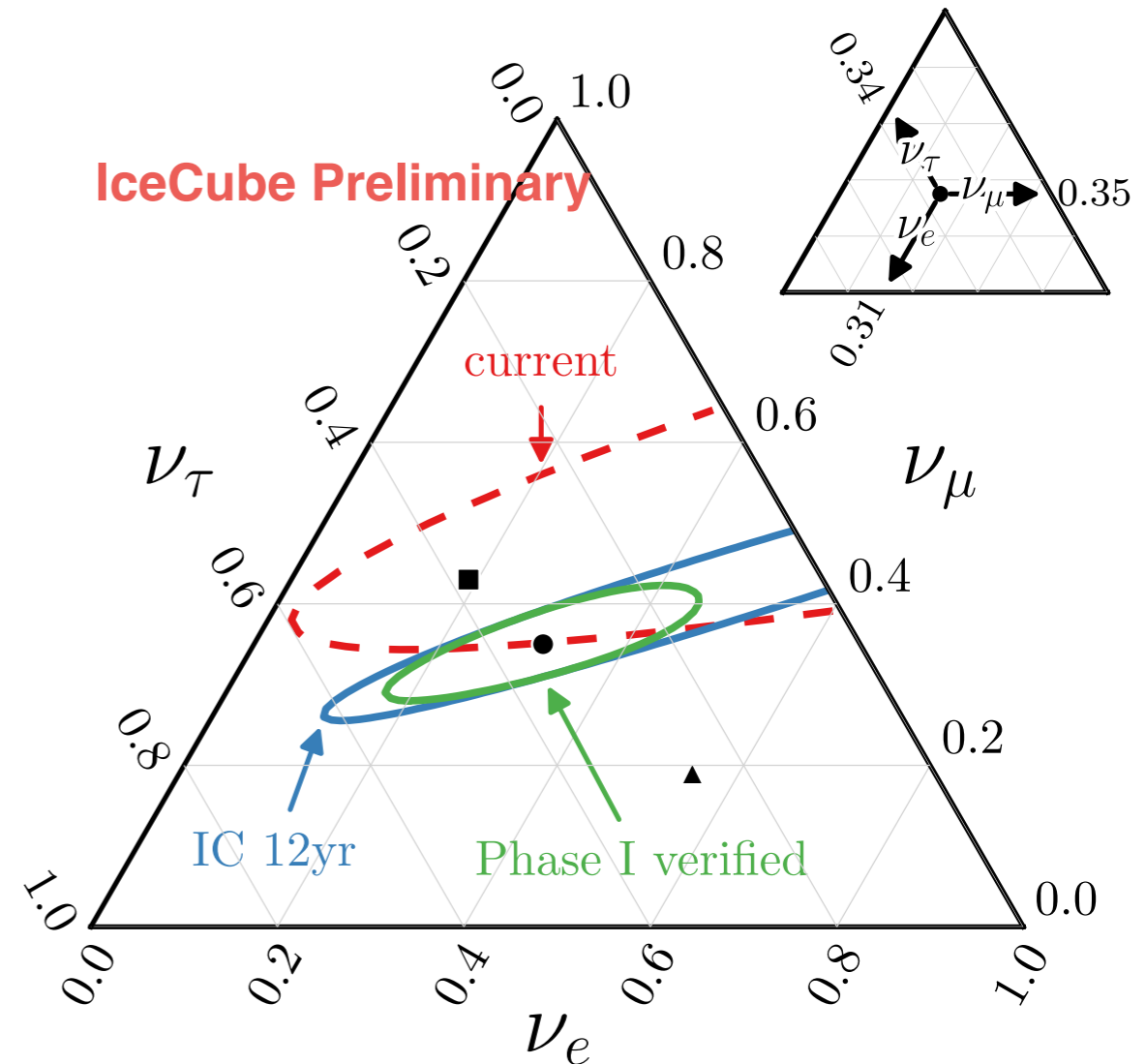
- CAPSTONE CFI (\$23.2M, under review) provides the collaboration's first large-scale facilities to design, develop, produce and test multi-PMT modules for the initial strings of Phase 1 and for NuPRISM

IceCube-Gen2 developments

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precision tests of the astrophysical neutrino flavour ratio

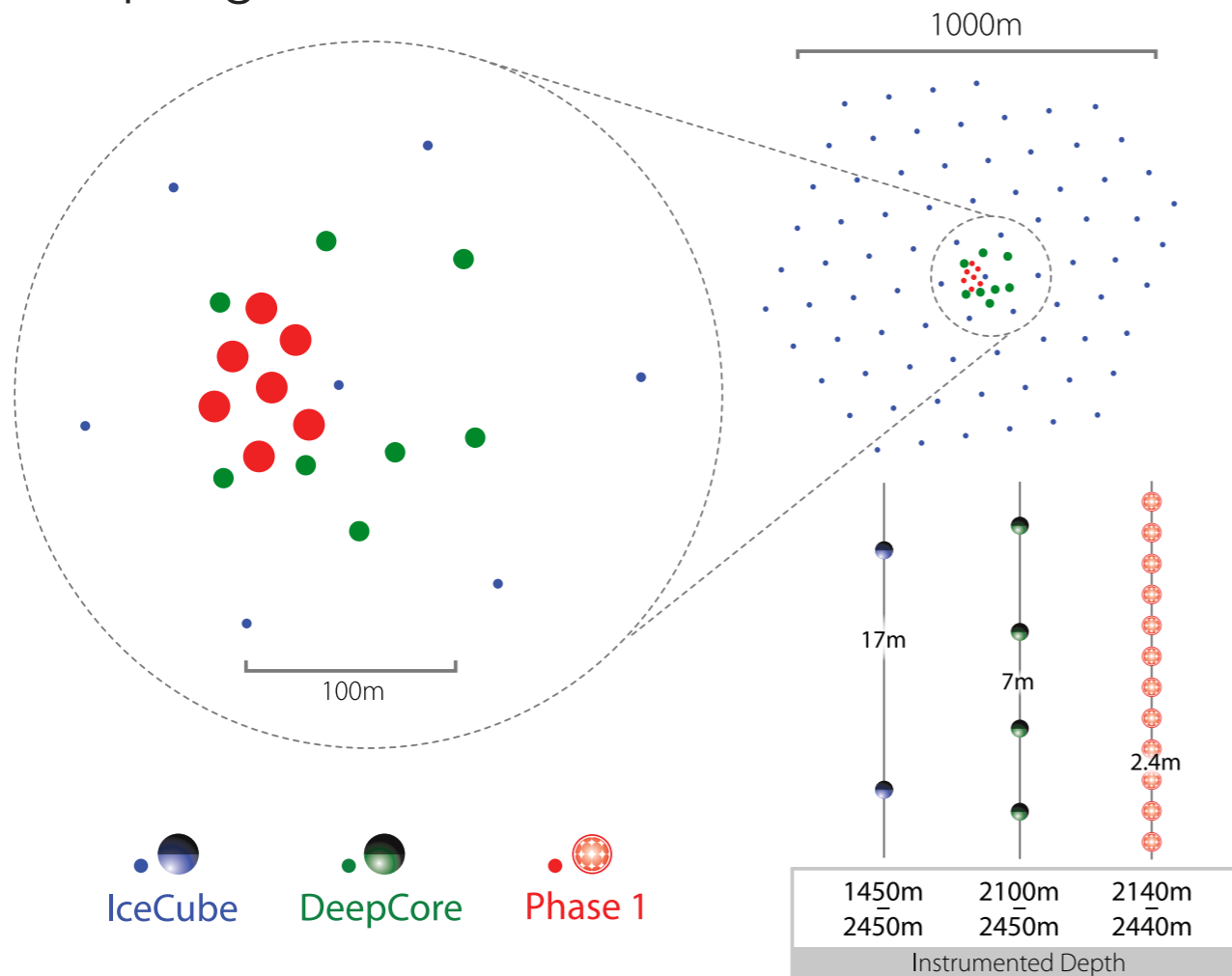


- 25 x 3" PMTs
- Uniform angular coverage
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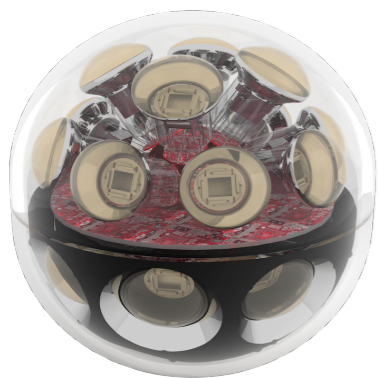
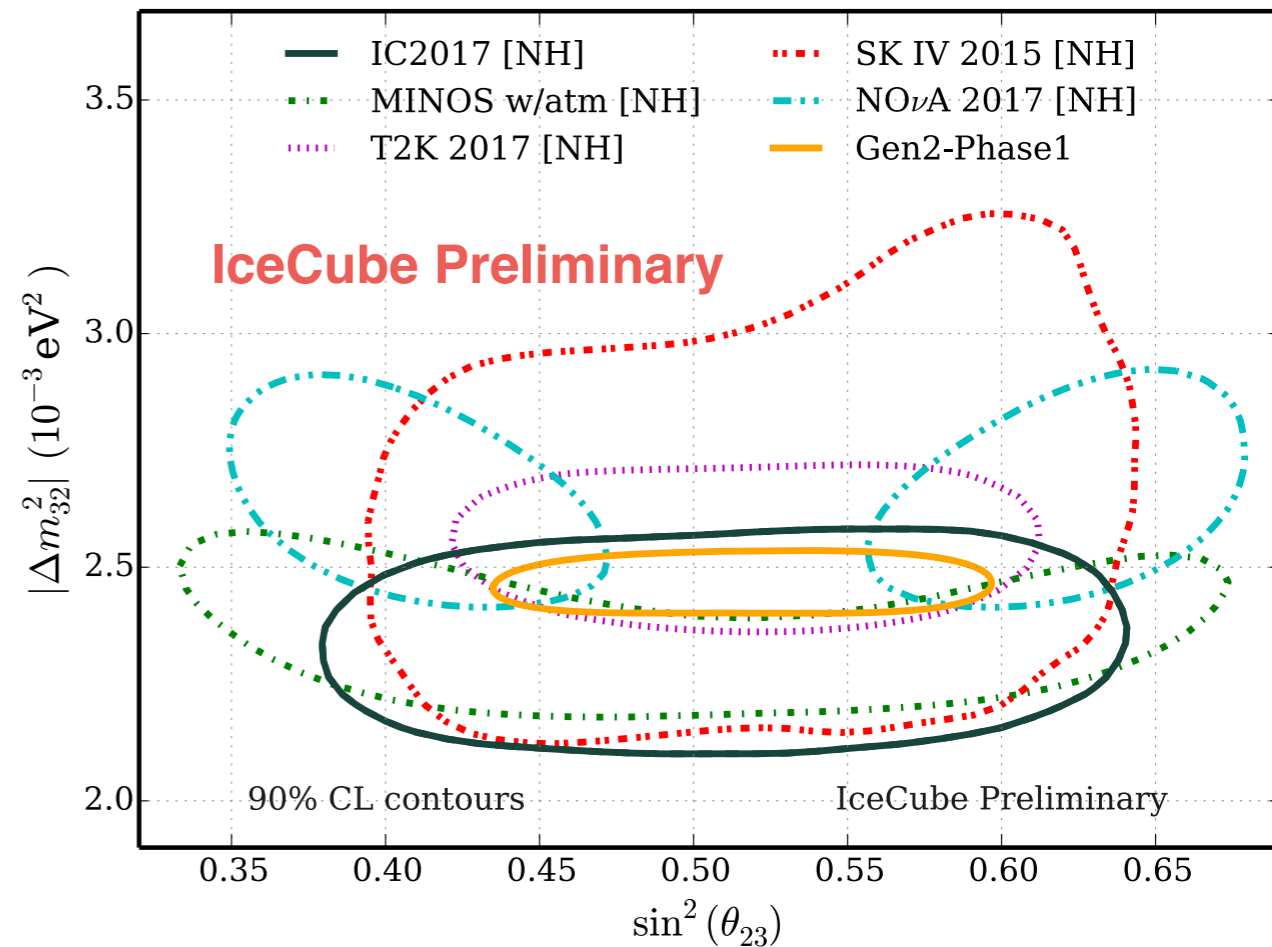
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IceCube-Gen2 developments

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precision measurements of muon neutrino appearance

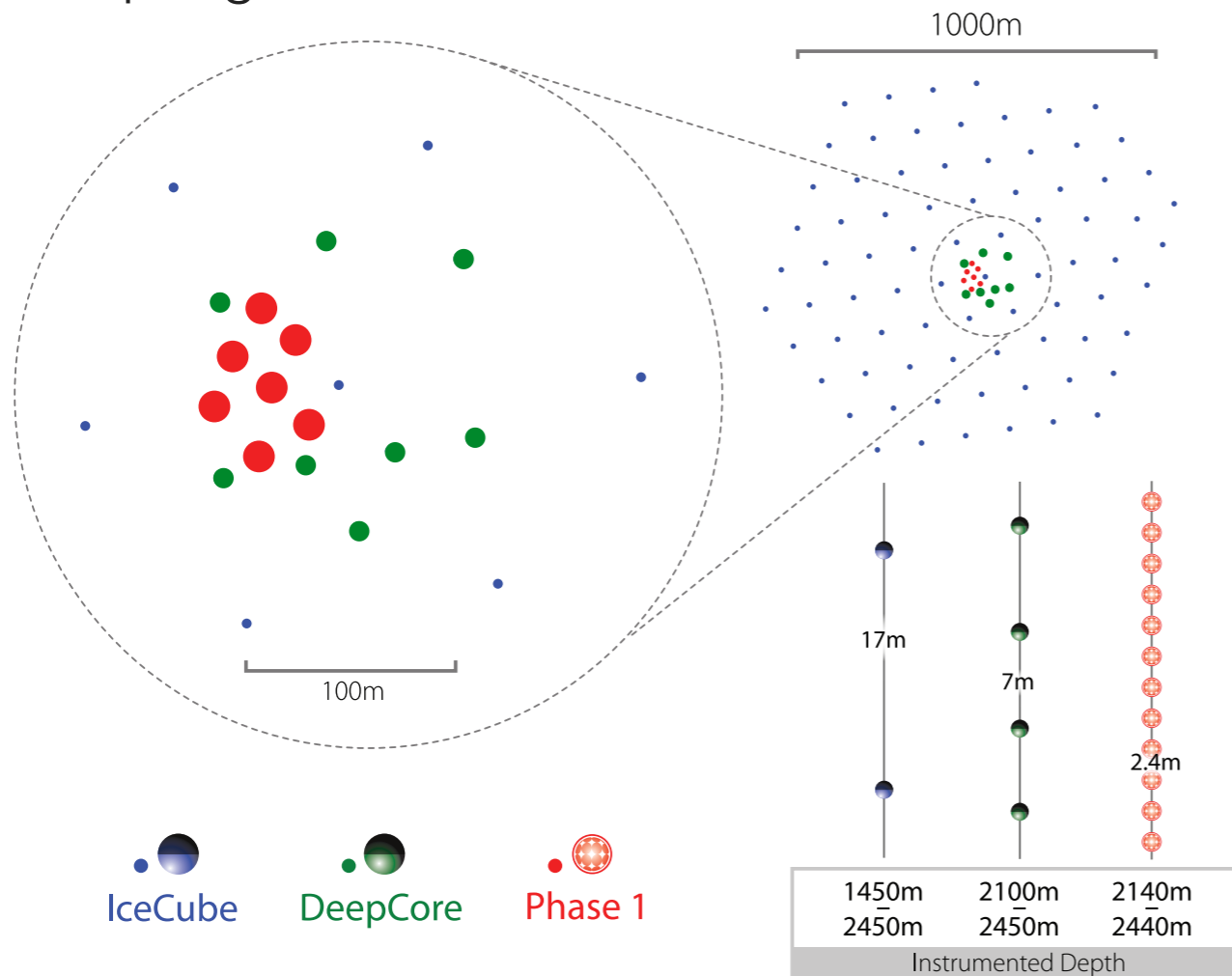


- 25 x 3" PMTs
- Uniform angular coverage
- Digital photon counting
- All data to surface; satellite transfer

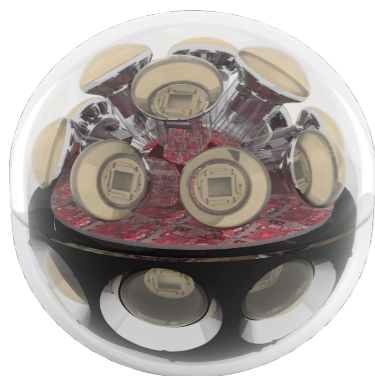
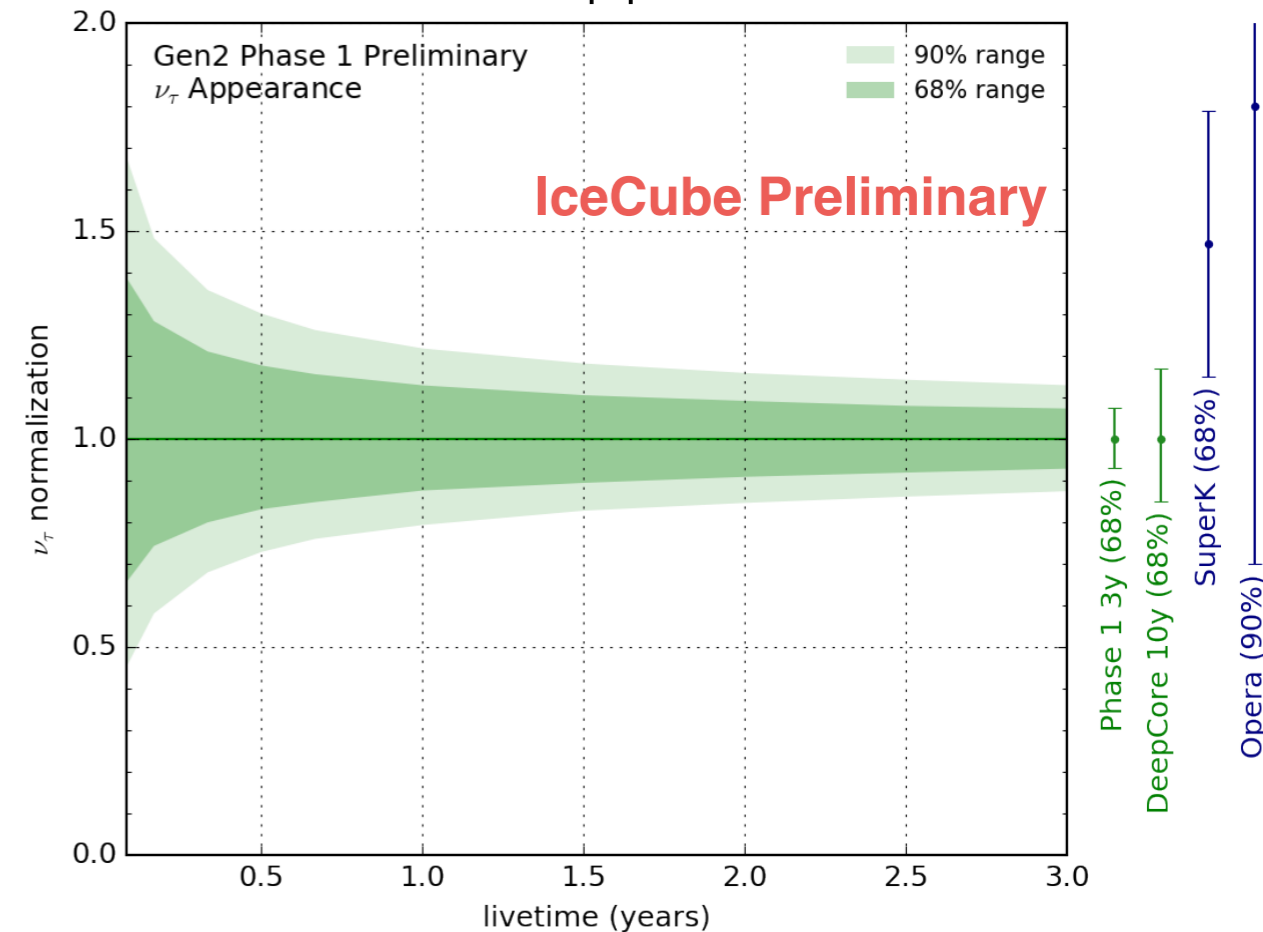
- CAPSTONE CFI (\$23.2M, under review) provides the collaboration's first large-scale facilities to design, develop, produce and test multi-PMT modules for the initial strings of Phase 1 and for NuPRISM

IceCube-Gen2 developments

- Gen2 Phase 1 proposal submitted to CFI, NSF and BMBF Fall 2016. Results expected Spring/Summer 2017.



precision measurements of tau neutrino appearance



- 25 x 3" PMTs
- Uniform angular coverage
- Digital photon counting
- All data to surface; satellite transfer

- CAPSTONE CFI (\$23.2M, under review) provides the collaboration's first large-scale facilities to design, develop, produce and test multi-PMT modules for the initial strings of Phase 1 and for NuPRISM


IceCube-DeepCore-Gen2 and Canada

- The program continues growing
 - Currently 6 faculty (Alberta, SNOLAB) @ 3.7 FTE, 2 PDFs, 1 Banting Fellow, 3 PhD students, 2 MSc student, 5 summer students
 - **See talks by Sarah Nowicki, Chris Weaver and Tania Wood this week**
- Some group highlights since 2015
 - PhD Student **Sarah Nowicki** (2015/6) and PDF **Chris Weaver** (2016/7) selected as 1 of 5 austral summer on-site leads (South Pole Station).
 - **Kopper** awarded **IUAPP Young Scientists Prize** in Astroparticle Physics (August 2015)
 - **Kopper** awarded CFI JELF for the *illum* GPGPU cluster (\$500,000 total value, March 2016)
 - **Grant** and **Krauss** awarded share of **2016 Breakthrough Prize** in Fundamental Physics (November 2015)
 - **Grant** awarded University of Alberta **Faculty of Science Research Prize** (April 2016)
 - **Yanez** awarded **NSERC Banting Fellowship** (February 2016)
 - **Grant** awarded **NSERC E. W. R. Steacie Memorial Fellowship** (February 2017)

IceCube-DeepCore-Gen2 and Canada

- collaboration leadership appointments (since 2015)
 - **co-lead** future detectors (**Grant**) (2012 - present)
 - **co-convener** Diffuse neutrino working group (**Kopper**) (May 2015 - present)
 - **co-convener** Low-energy/oscillations working group (**Clark**) (March 2015 - May 2016)
 - **PINGU analysis coordinator** (**Clark**) (March 2015 - present)
 - **chair** Publications Committee (**Grant**) (May 2015 - May 2017)
 - IceCube-Gen2 in-ice detector **design lead** (**Kopper**) (June 2015 - present)
 - **co-convener** Low-energy/oscillations working group (**Yanez**) (January 2017 - present)
 - **Collaboration Spokesperson** (**Grant**) (May 2017-present, 2-year renewable term)

Summary

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- Continued growth of the IceCube Canada program; new initiatives are gaining traction
 - Canadian researchers are having impact at the highest levels in the international collaboration
 - We remain at the centre of some of the most exciting IceCube discovery analyses. Longterm leadership in the future PINGU and Gen2 projects is firmly established including Phase 1 (NSF reviewer results were excellent; CFI and BMBF proposal results pending)
 - Interested in the program? Please contact us!