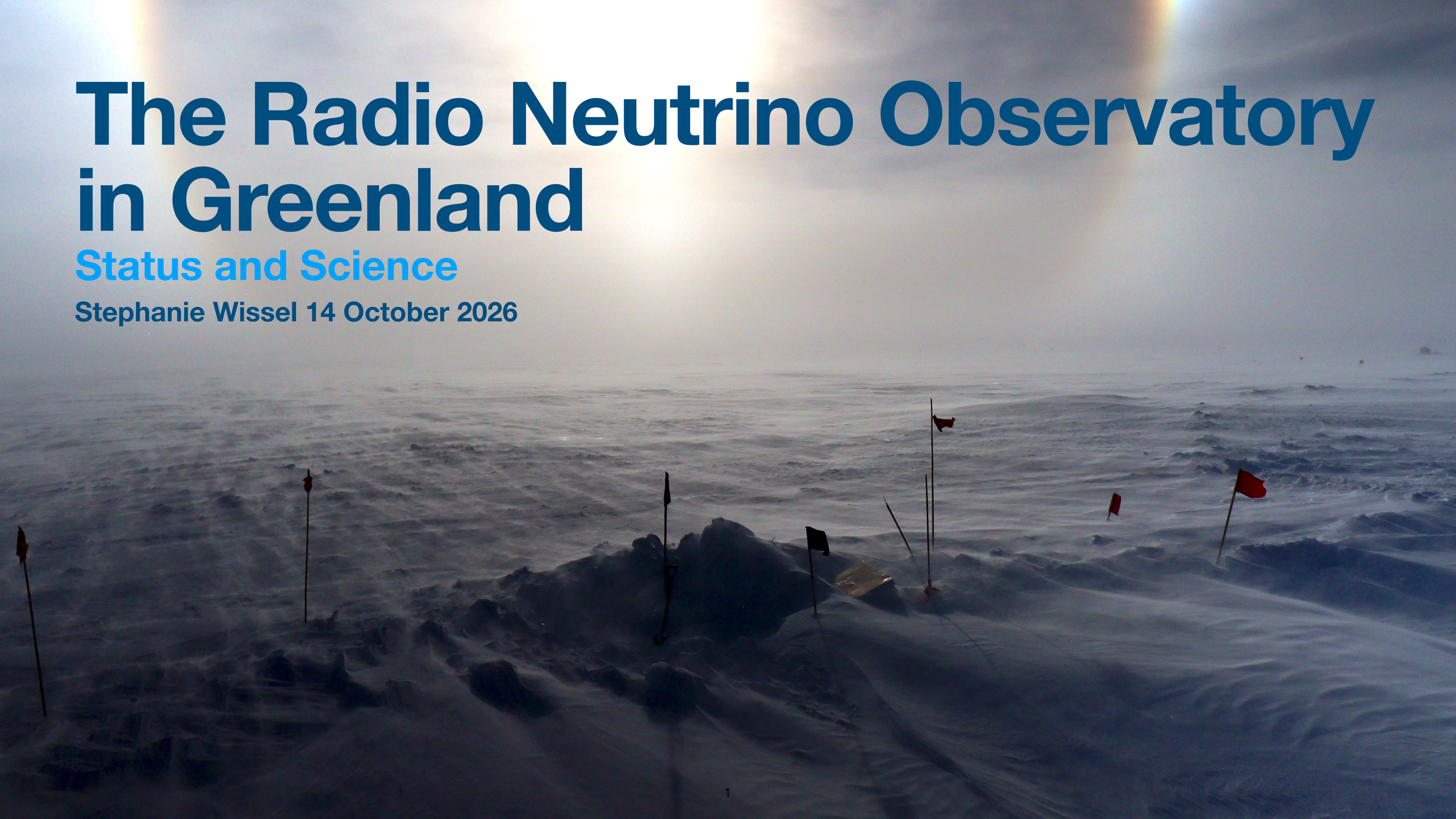
The Radio Neutrino Observatory in Greenland

Status and Science

Stephanie Wissel 14 October 2026



18 Institutes in 5 countries

~80 scientists

Whittier College

Summit Station

Uppsala University

DESY-Zeuthen

TU Dortmund

FAU-Erlangen

Radboud University

Wuppertal University

Université Libre de Bruxelles

Vrije Universiteit Brussels

Ghent University

University of Nebraska-Lincoln

University of Kansas

University of Wisconsin-Madison

University of Chicago

The Ohio State University

Pennsylvania State University

University of Alabama

University of Delaware

University of Maryland



RNO-G Collaboration meeting Fall 2025

RNO-G Collaboration April 2024

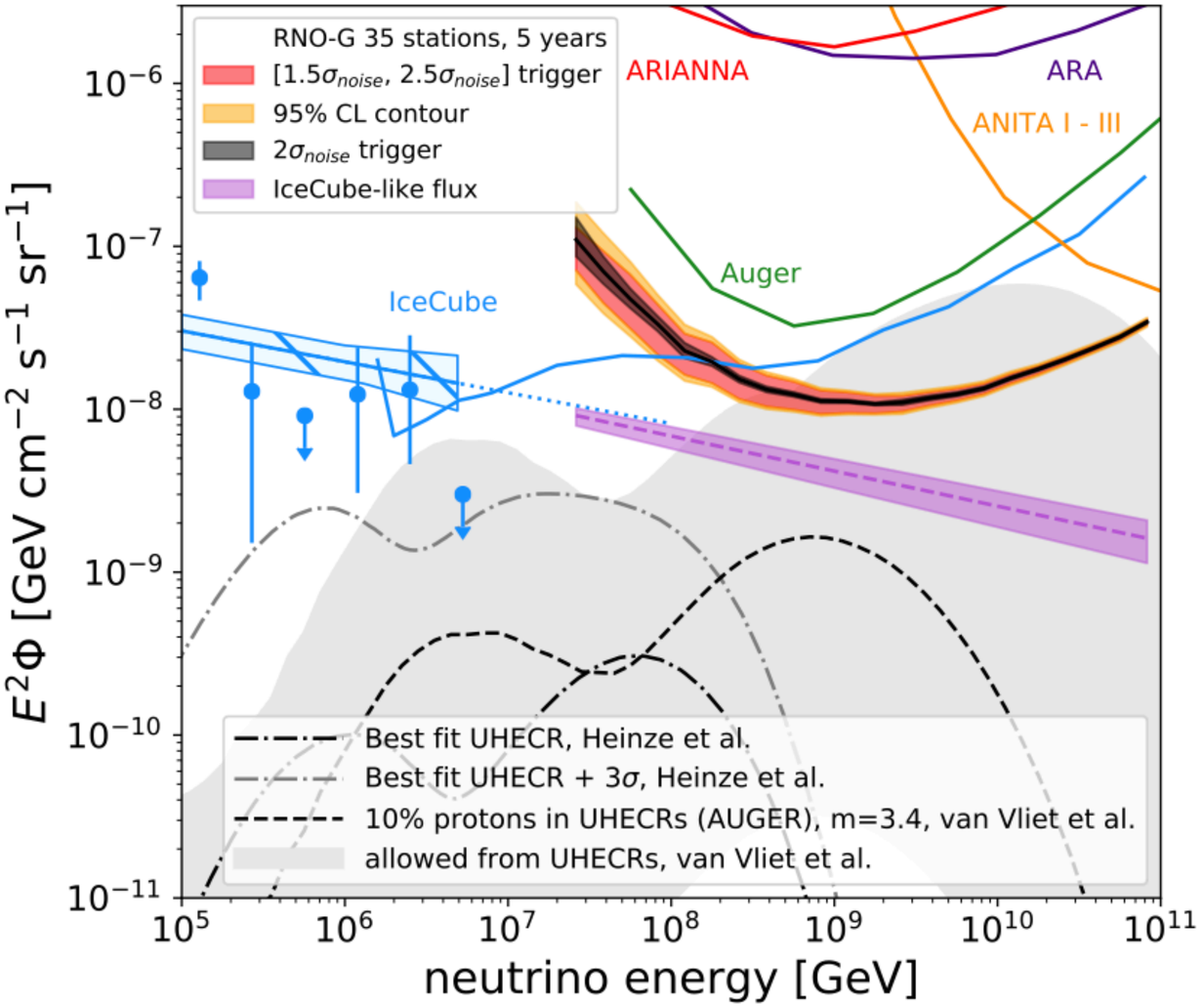
UPPSALA UNIVERSITET

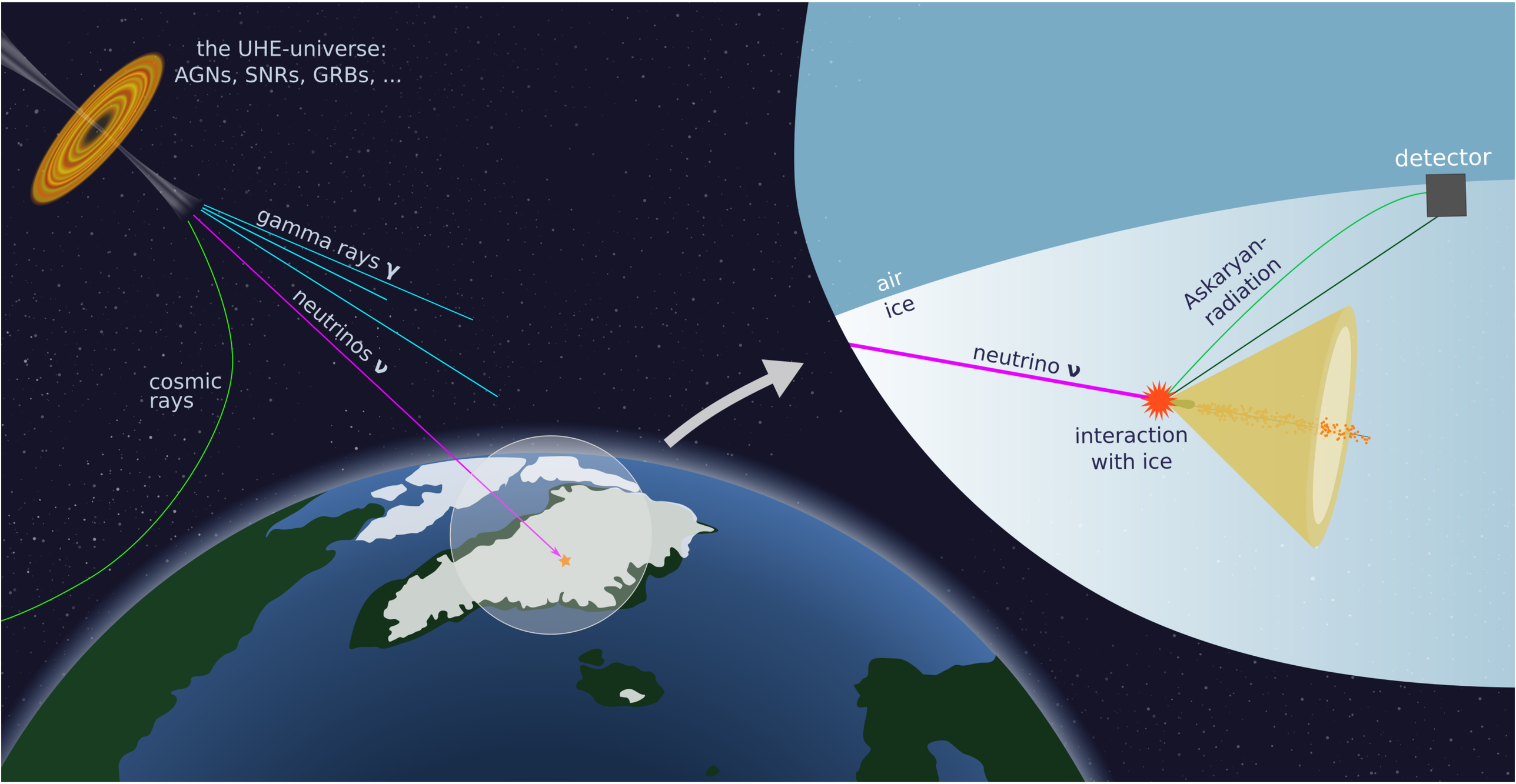
Ultrahigh Energy Neutrinos

Current Status

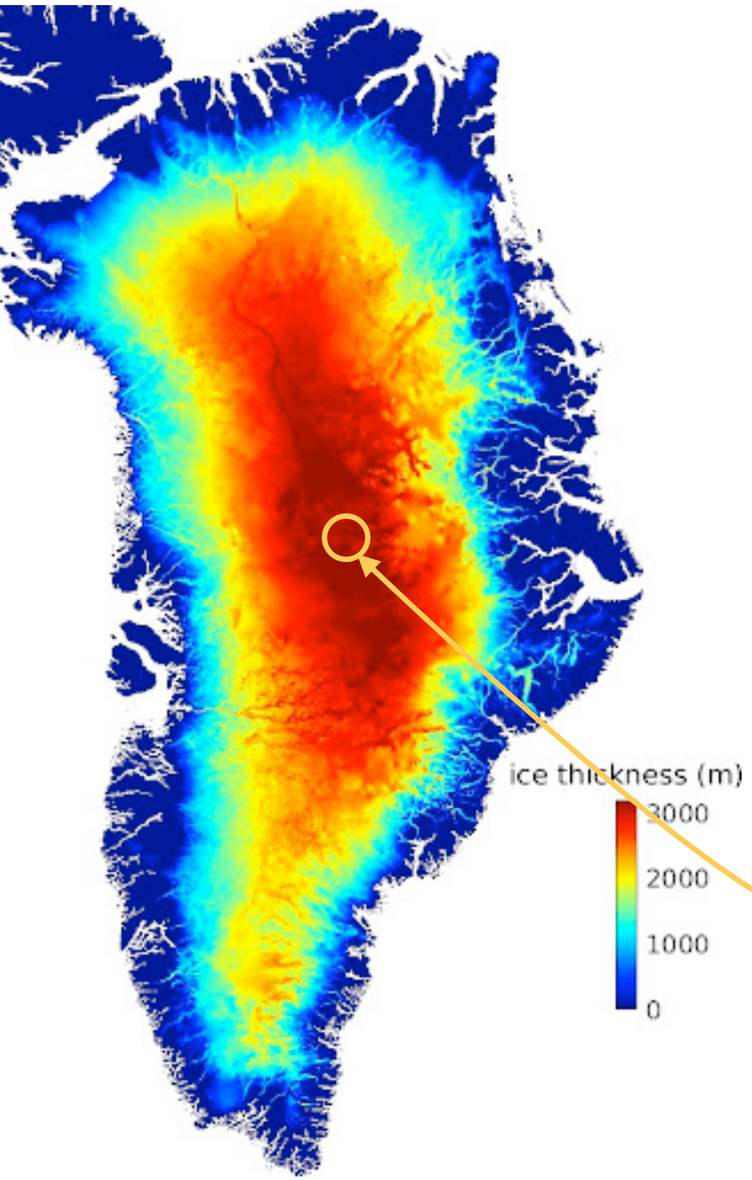
- What is the nature of comic accelerators the highest energies?
  - Astrophysical neutrinos at UHE
  - Cosmogenic neutrinos from UHECR interactions with background photons
  - Highest energy neutrinos observed: KM3-230213A (220 PeV)
  - Most competitive limits from IceCube, Pierre Auger Observatory, ANITA
- Radio arrays like RNO-G can push effecti areas towards the EeV scale

J. A. Aguilar et al (RNO-G Coll.) JINST 16 P03025 2021




the UHE-universe:
AGNs, SNRs, GRBs, ...
gamma rays γ
neutrinos ν
cosmic
rays
detector
air
ice
Askaryan-
radiation
neutrino ν
interaction
with ice

RNO-G Site: Summit Station in Greenland

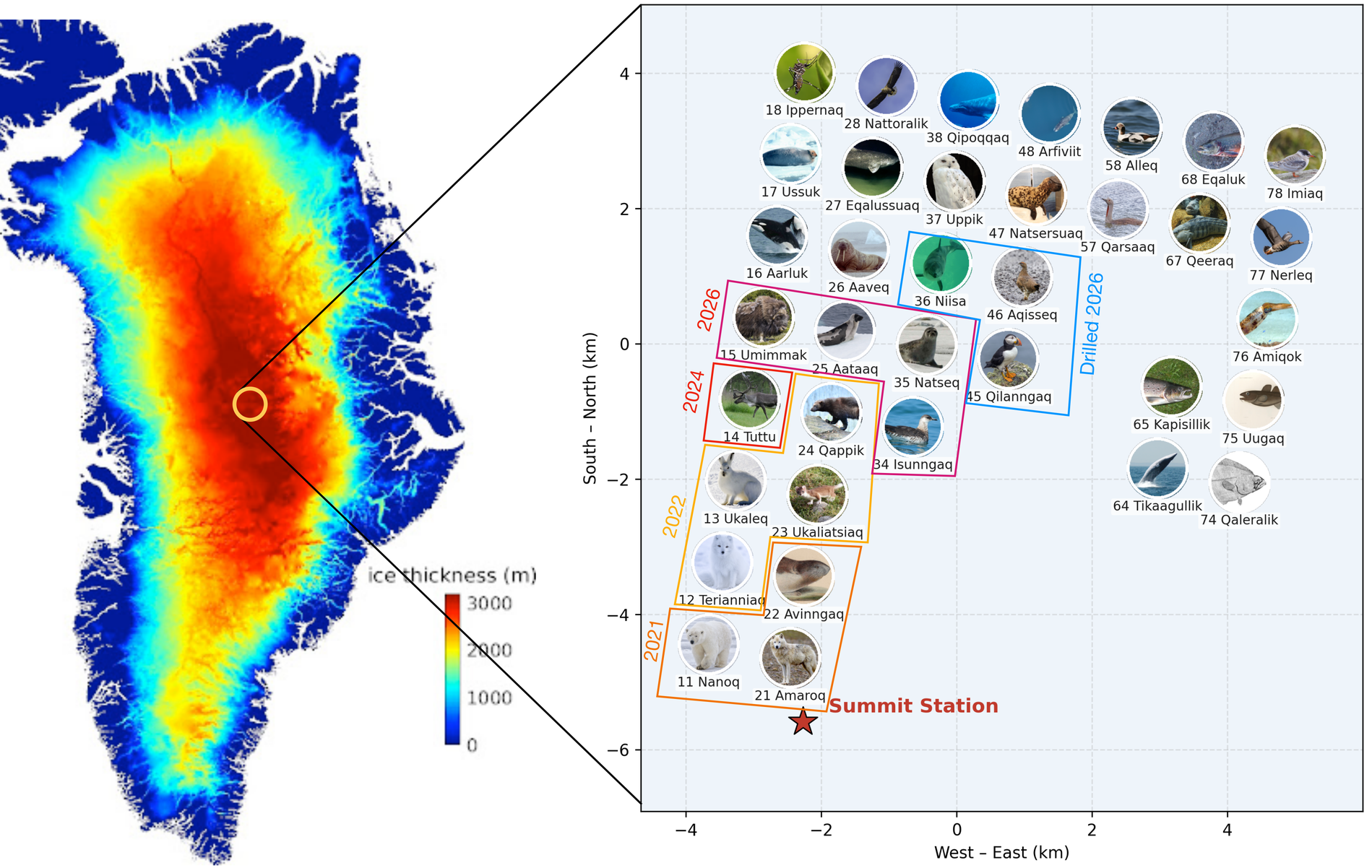


- One of the biggest volume of radio transparent medium on Earth
  - 3 km thick ice at Summit Station.
  - Attenuation length
- Good infrastructure
  - Summit Station NSF-operated.
- Sunlight 10 months/year
  - Solar power



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RNO-G Array



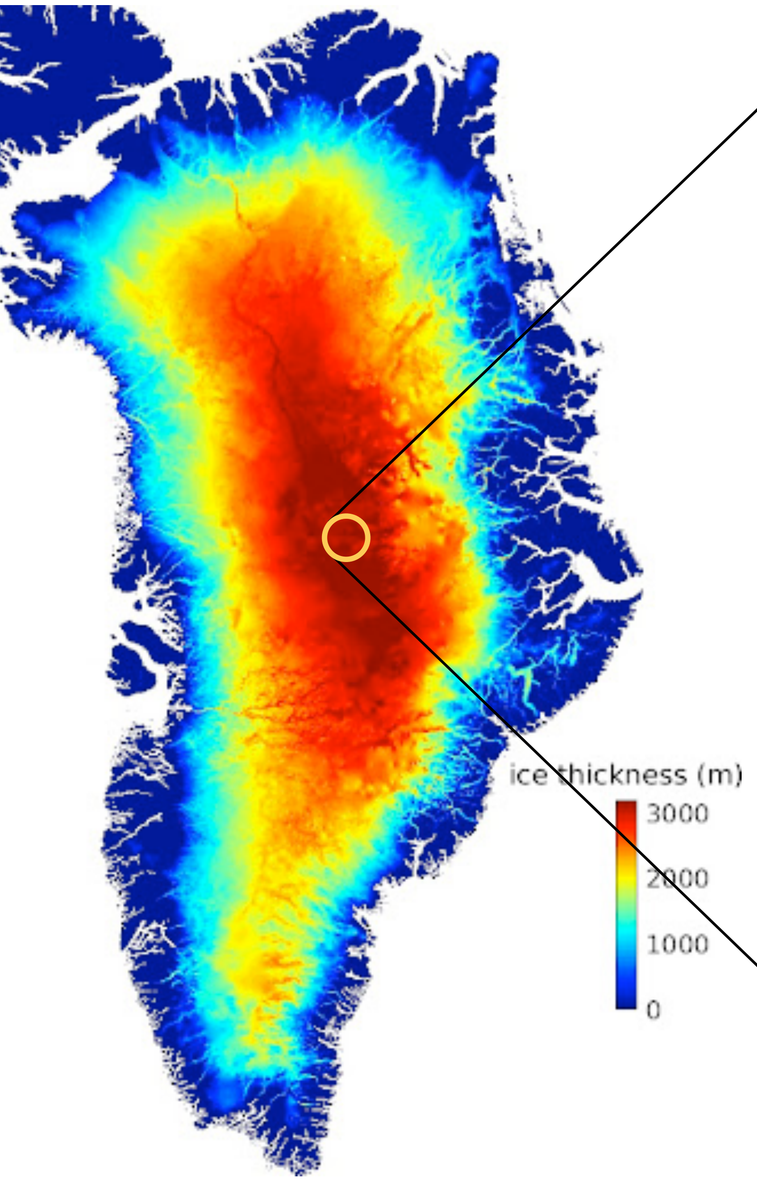
Progress

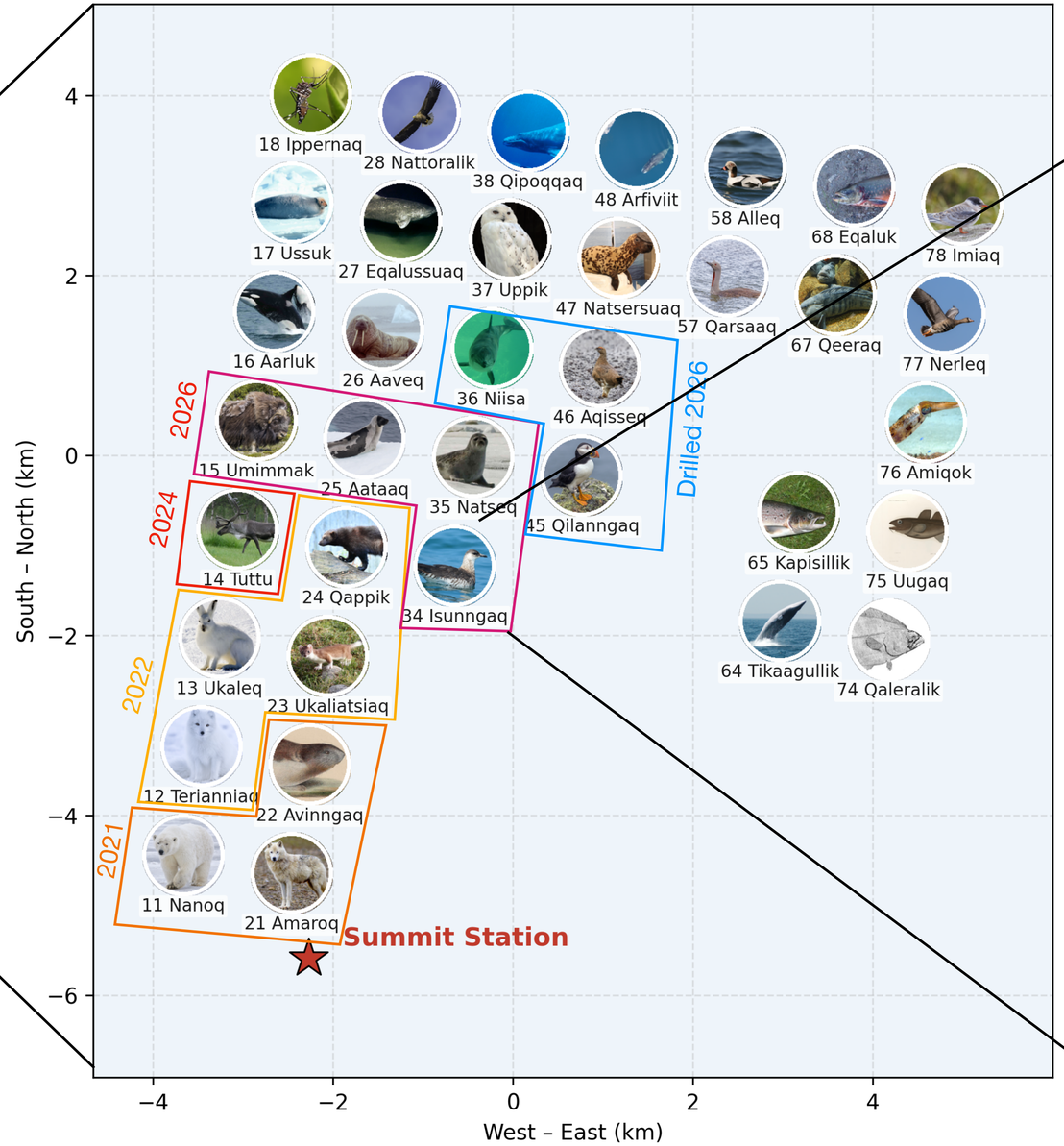
- Planned 35 stations on 1.25 km grid
- 12/35 stations operating
- Hardware for full array is fully funded
- Autonomous operation with solar power and LTE network

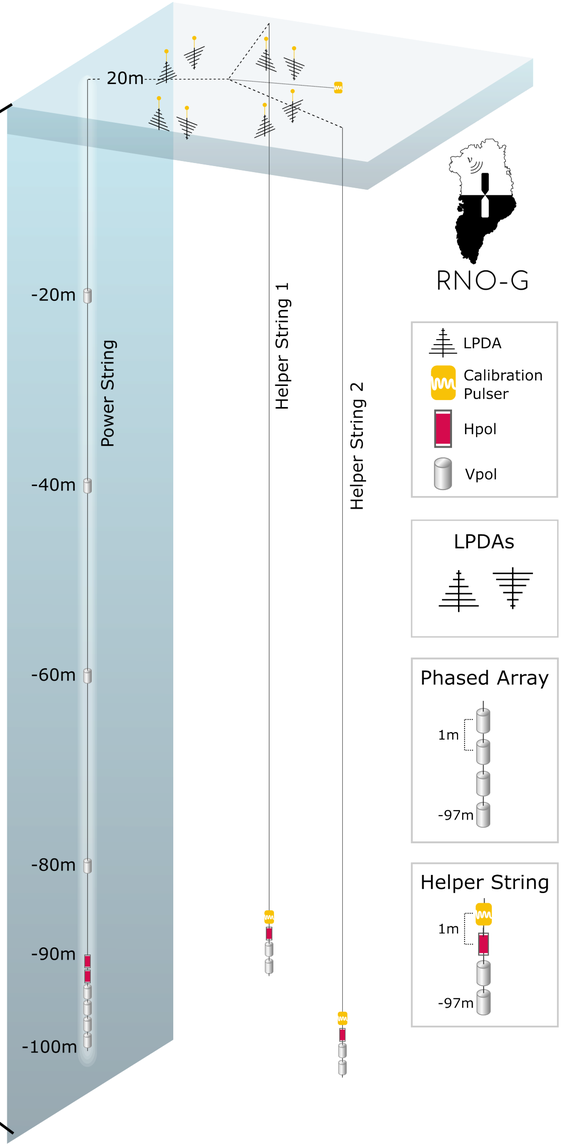
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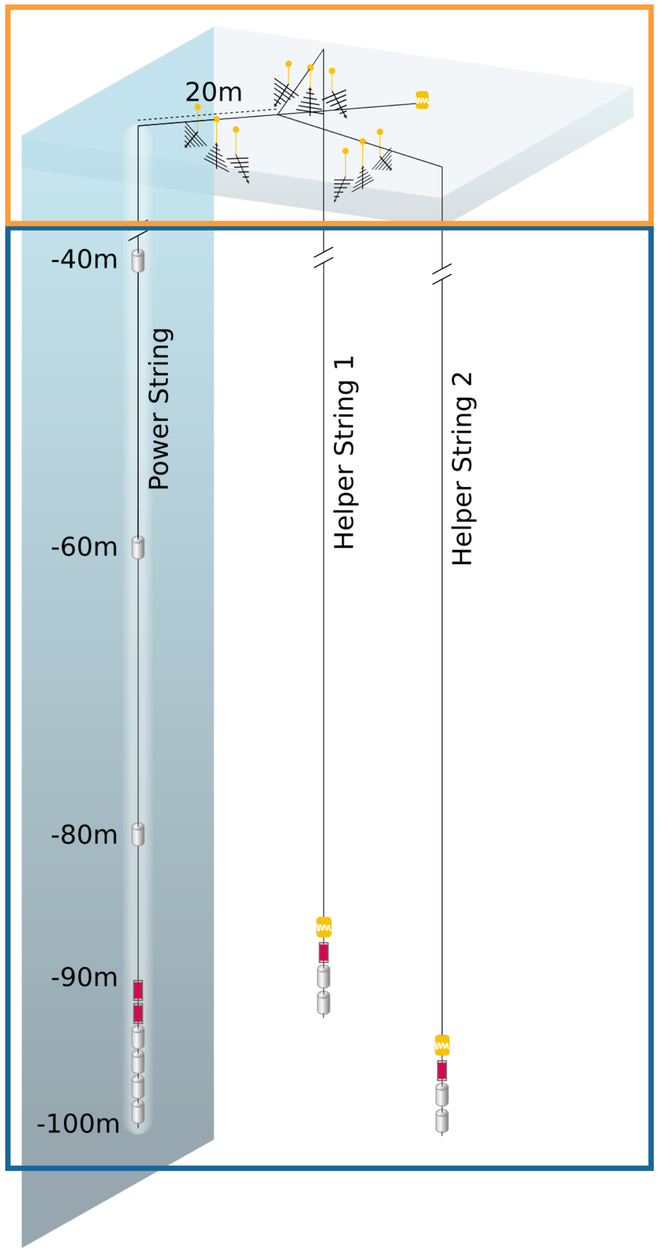
RNO-G Array & Station

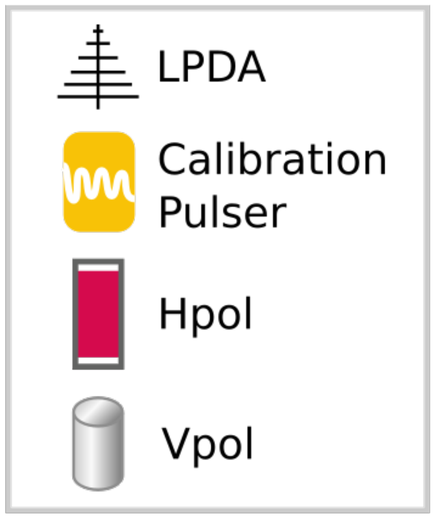






RNO-G Stations: Hybrid Design





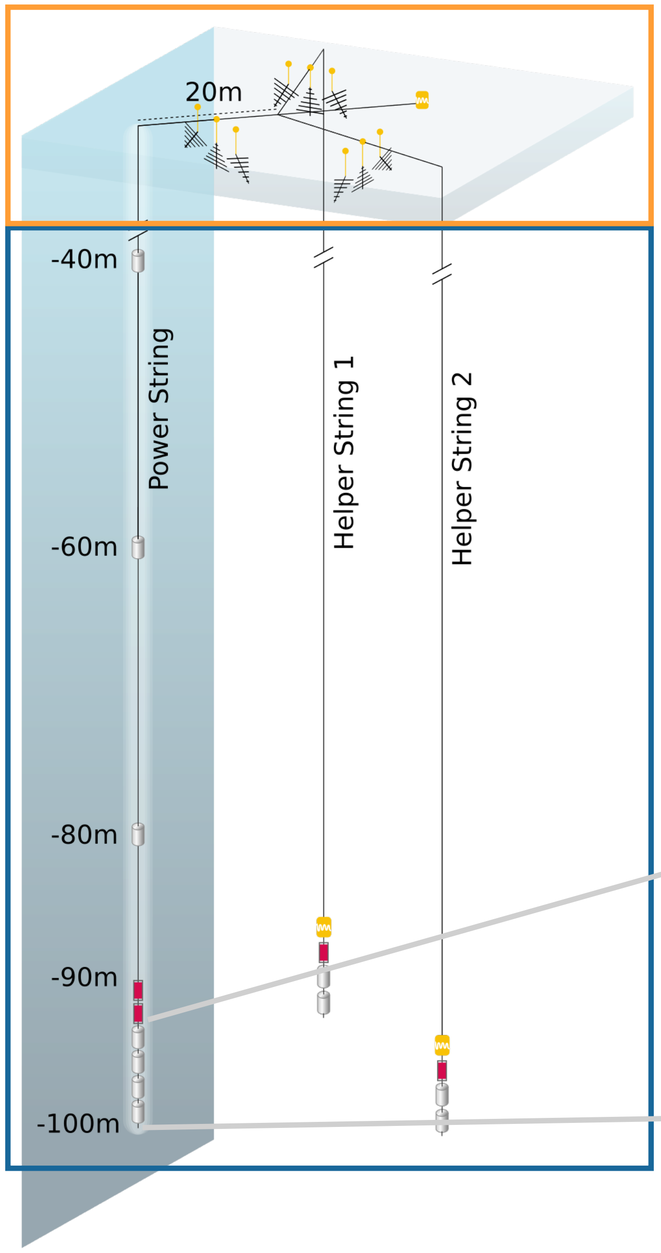
Three different antenna types:

- Log-Periodic Dipole Antenna (LPDA)
- Vertically-polarized (Vpol)
- Horizontally-Polarized (Hpol)



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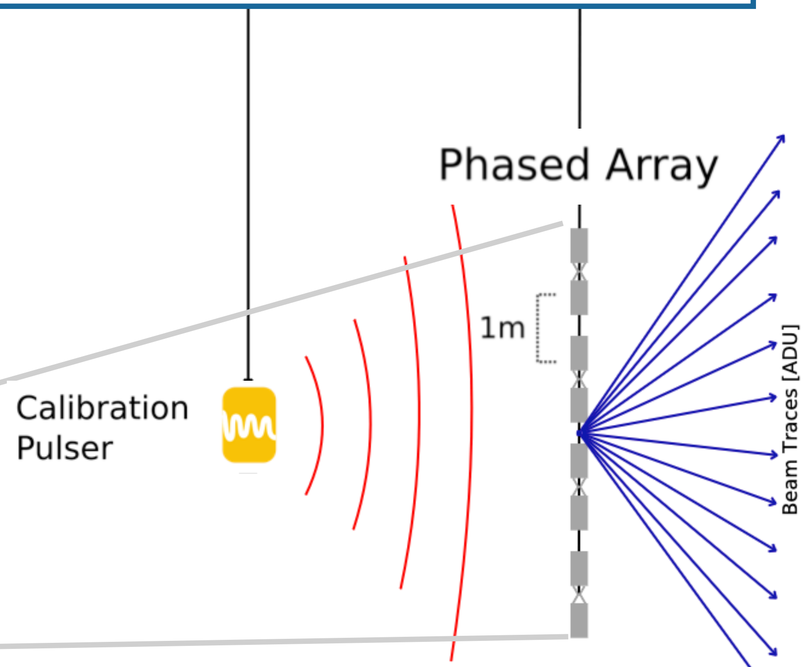
Trigger from Deep Phased Array



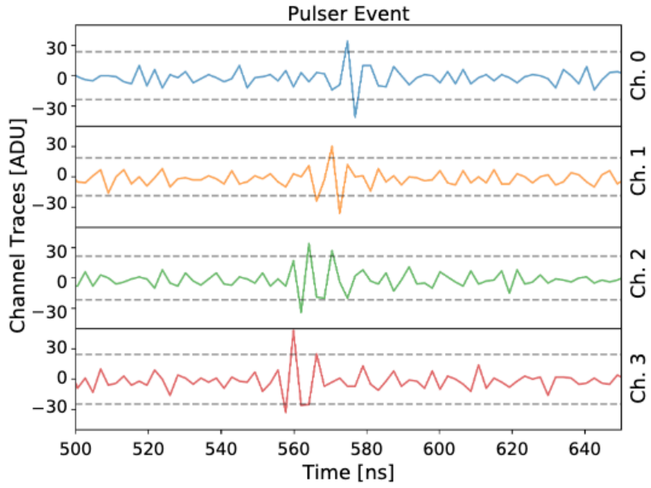
Low threshold trigger:
Densely packed Phased-Array of Vpols

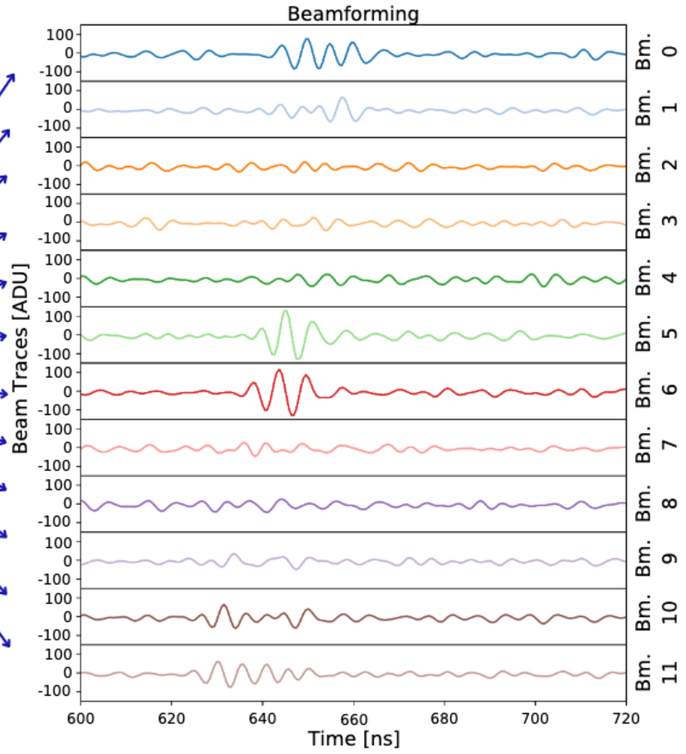
- digital interferometer forms 12 beams over the full volume

- trigger runs on each beamformed trace



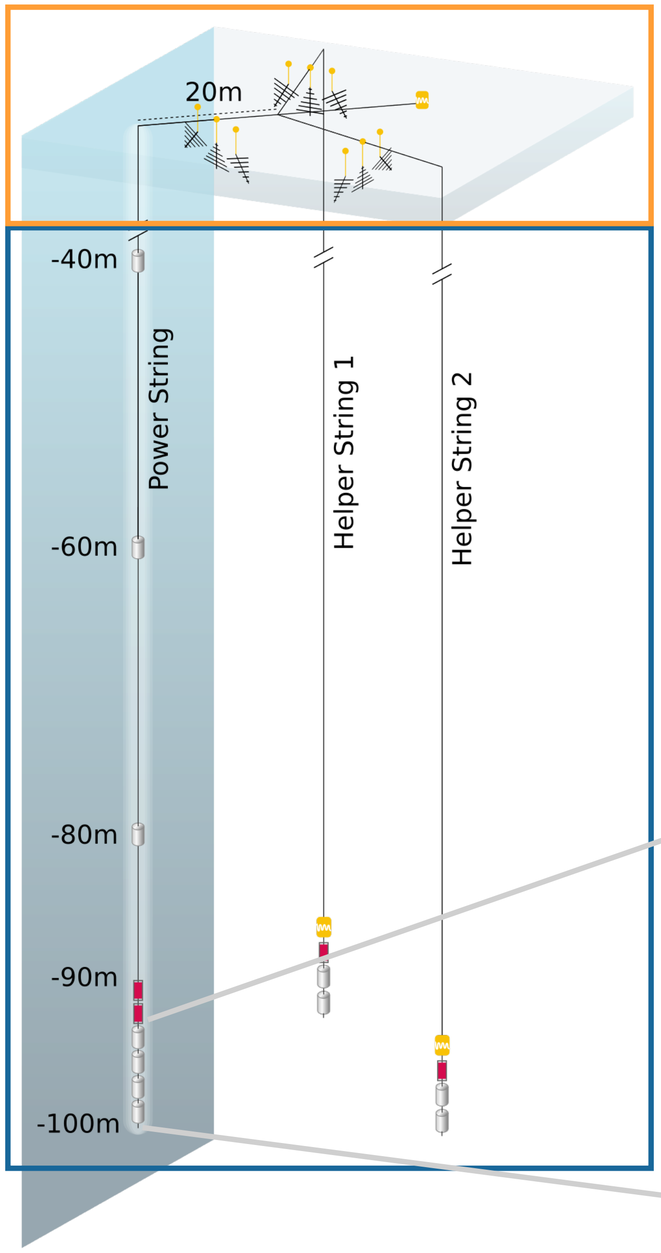
JINST 29 09 P09029 2026 (R. Krebs, PSU)





cience

Trigger from Deep Phased Array



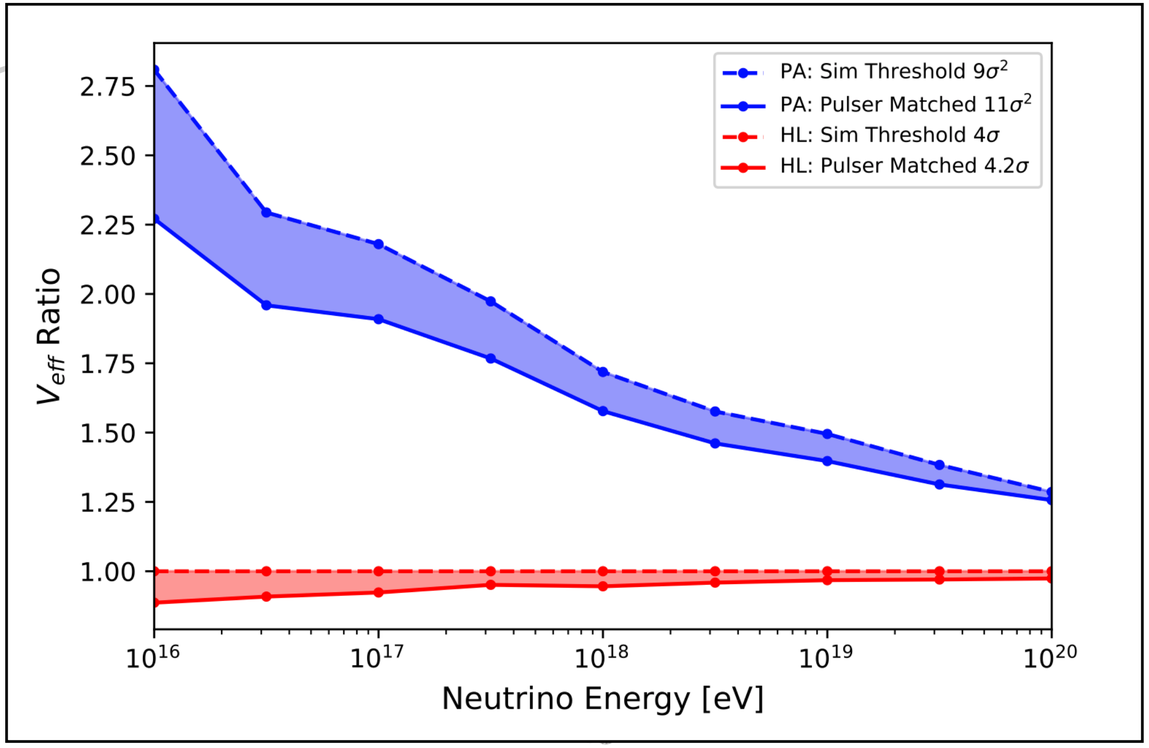
Low threshold trigger:
Densely packed Phased-Array of Vpols

- digital interferometer forms 12 beams over the full volume

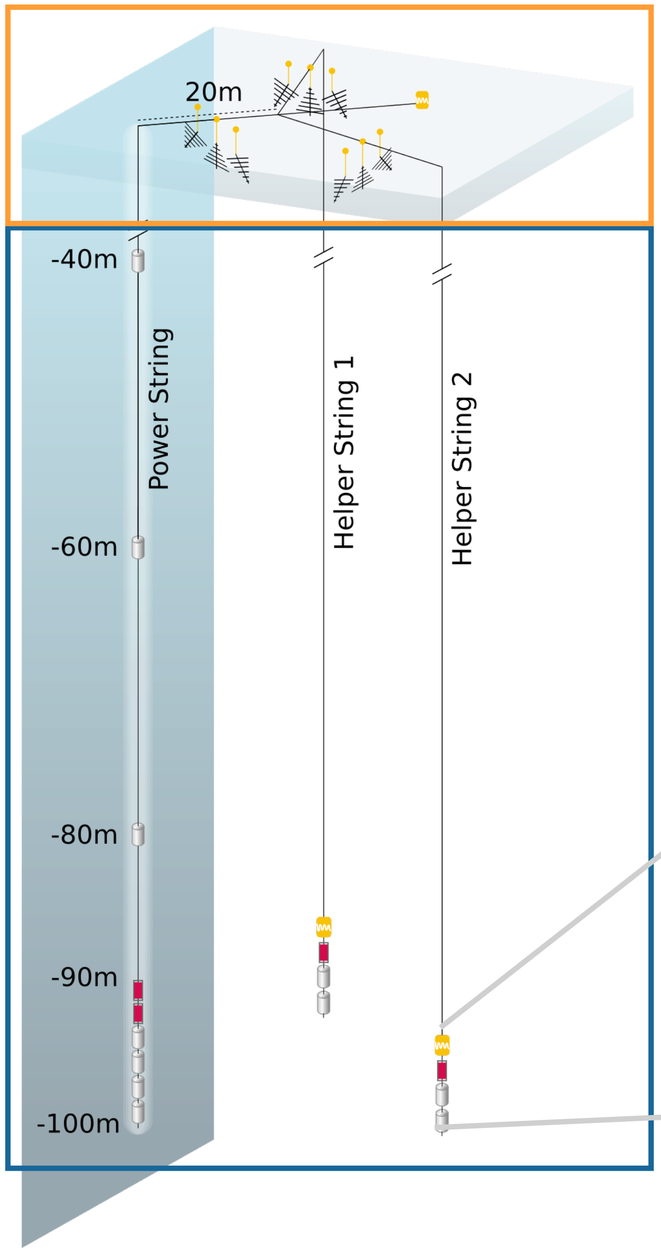
- trigger runs on each beamformed trace

2024 Trigger upgrades lead to up improved neutrino volume

JINST 29 09 P09029 2026 (R. Krebs, PSU)

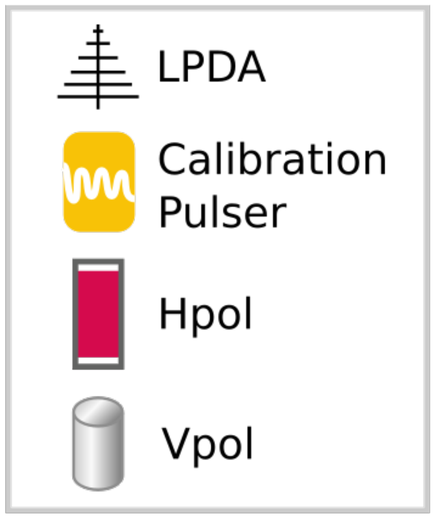


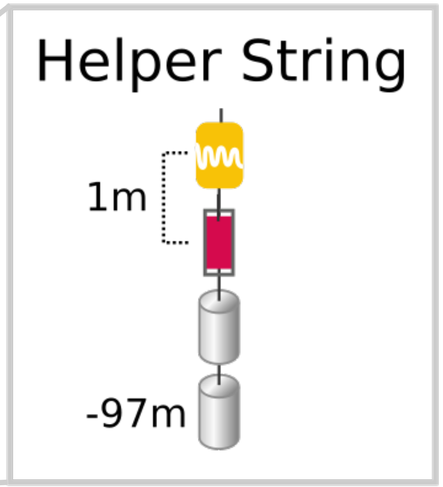
Reconstruction from Helper Strings



Surface component

Deep component





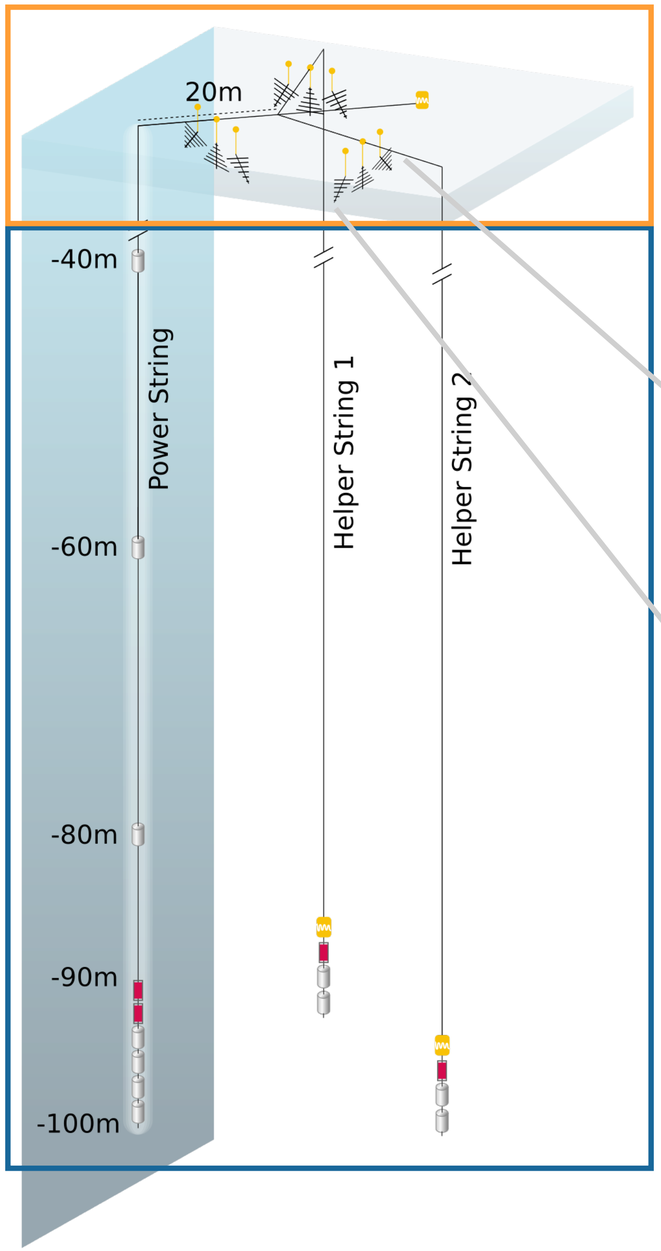
Three different antenna type:

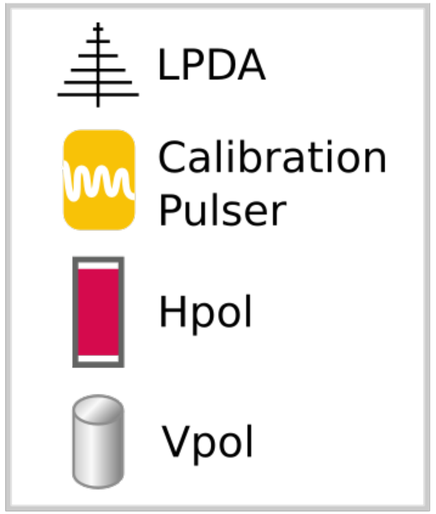
- Log-Periodic Dipole Antenna (LPDA)
- Vertically-polarized (Vpol)
- Horizontally-Polarized (Hpol)

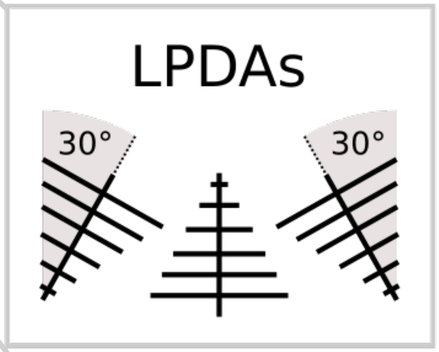
Helper strings include Vpol and Hpol antennas for signal reconstruction, as well as calibration pulsers that transmit signals as needed.

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Surface LPDAs







Three different antenna type:

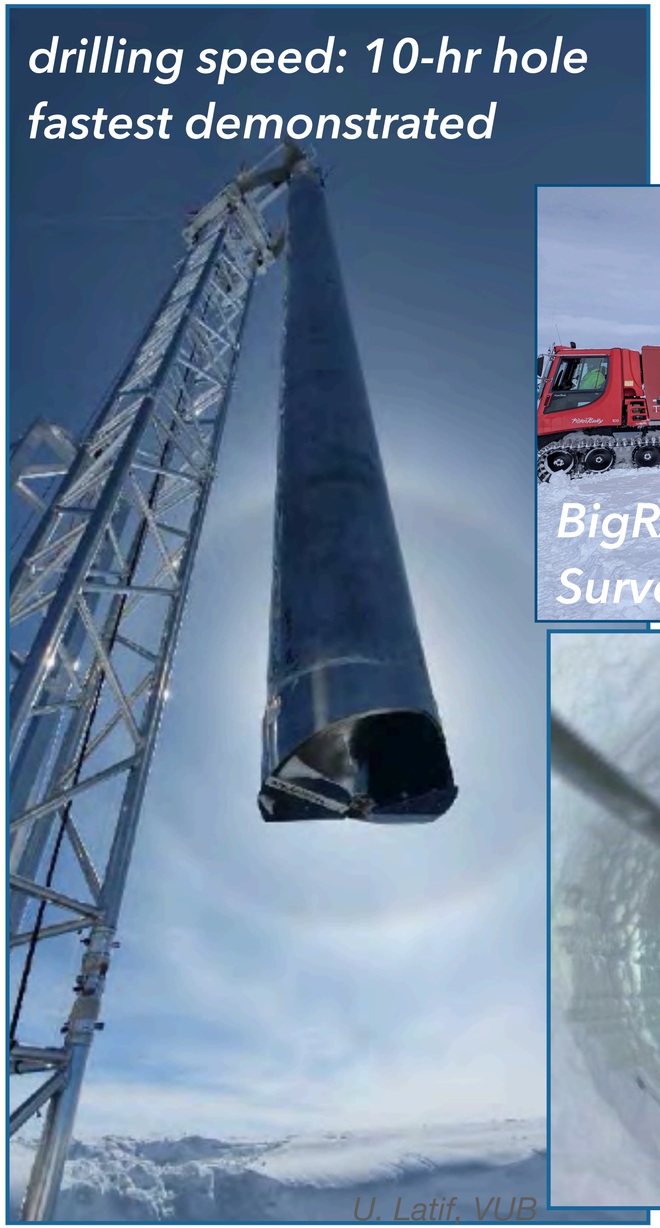
- Log-Periodic Dipole Antenna (LPDA)
- Vertically-polarized (Vpol)
- Horizontally-Polarized (Hpol)

LPDAs at the surface help with signal reconstruction and act as a surface veto.

They also contribute a small amount to neutrino effective volume.

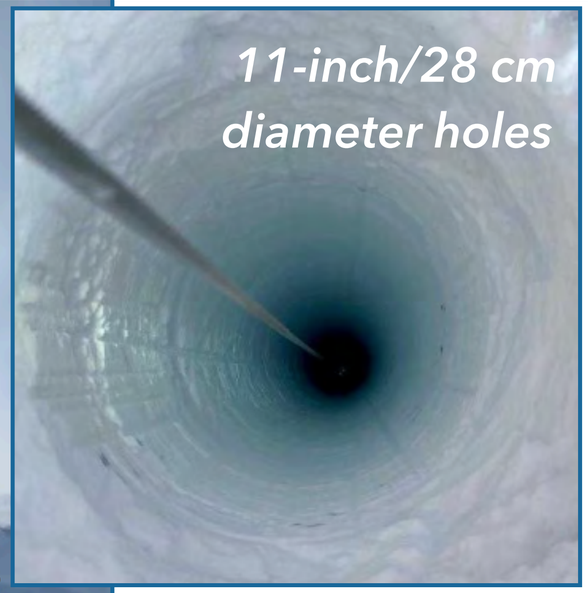
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Drilling



J. Tutt, PSU



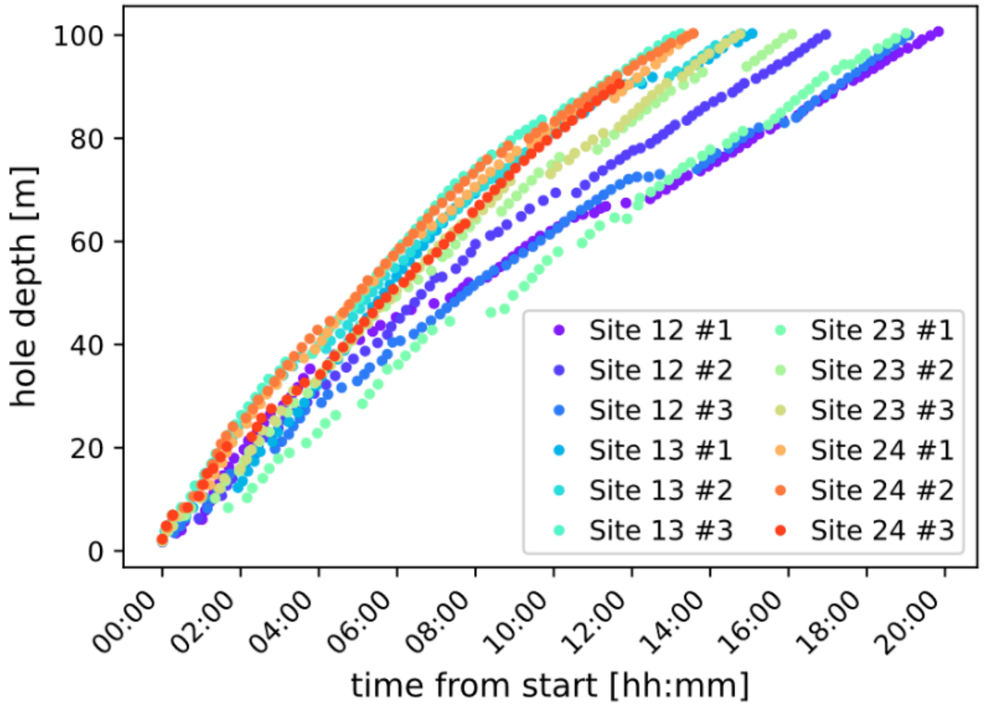


D. Tosi, PSU

Station design relies on **3 holes of a depth of 100m** per stations

- World's largest mechanical drill designed by British Arctic Survey and managed by WIPAC
- Significant effort to enhance speed & de-icing from 2023-2025
- Drill performance much improved in 2025 and fastest holes ever in 2026

S. Agarwal et al (RNO-G Coll.) 2025 JINST 20 P04015



Installation

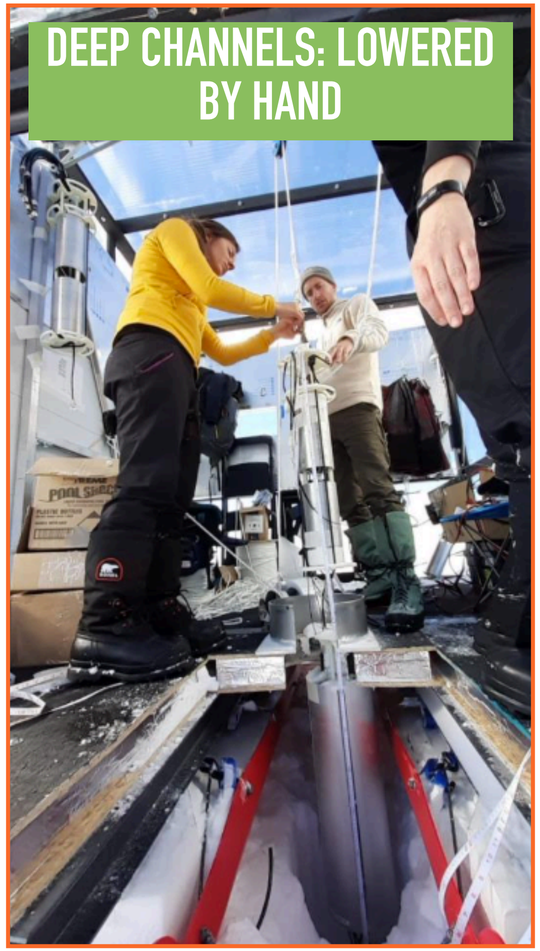




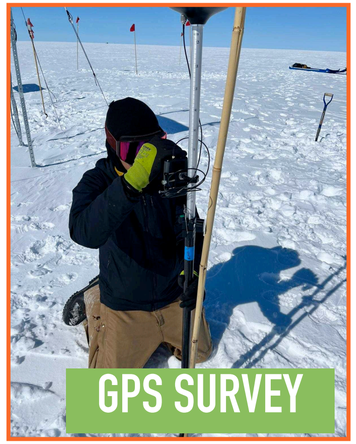






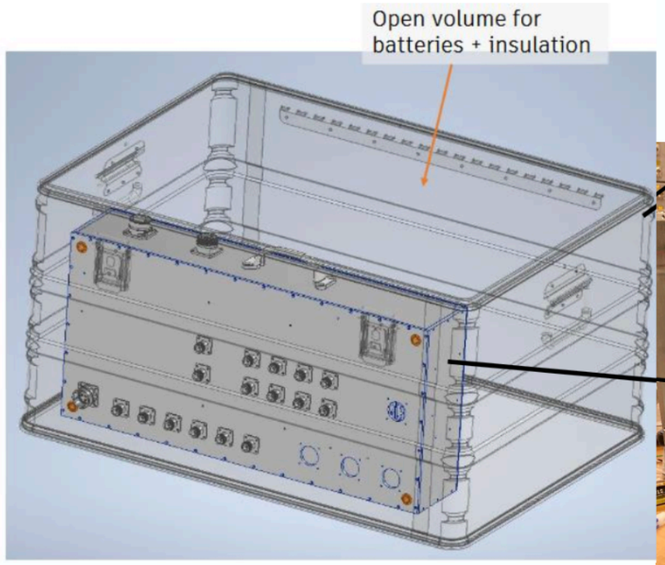


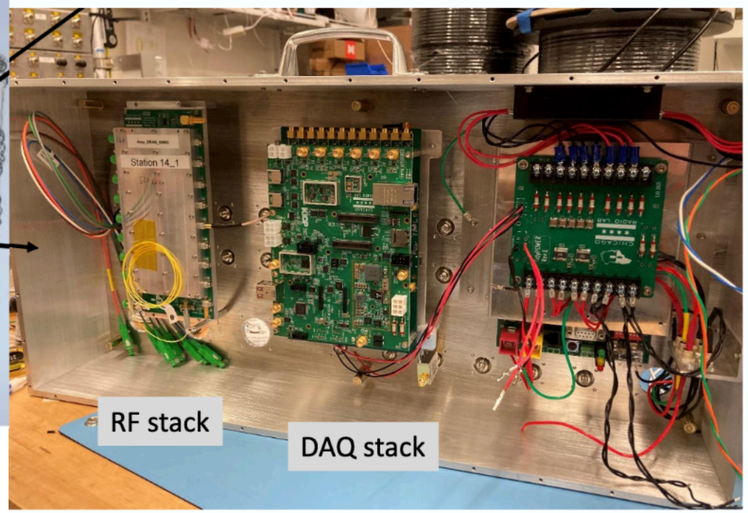


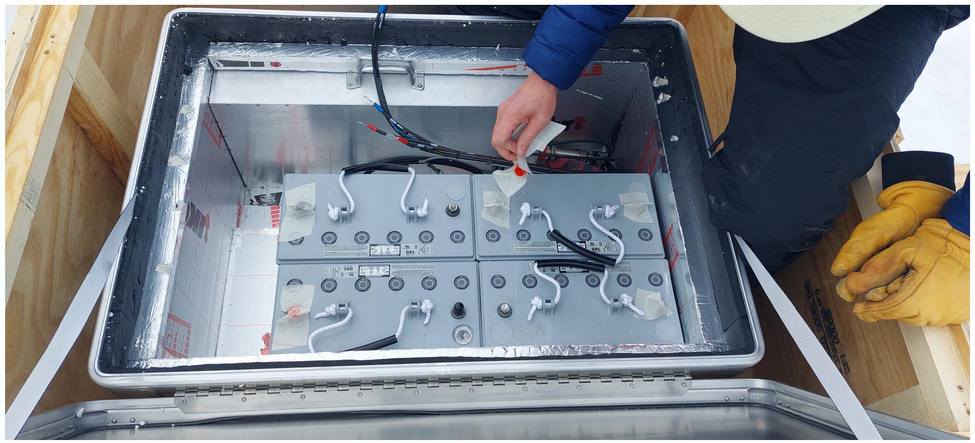




Season 2026 - Major upgrade with new DAQ



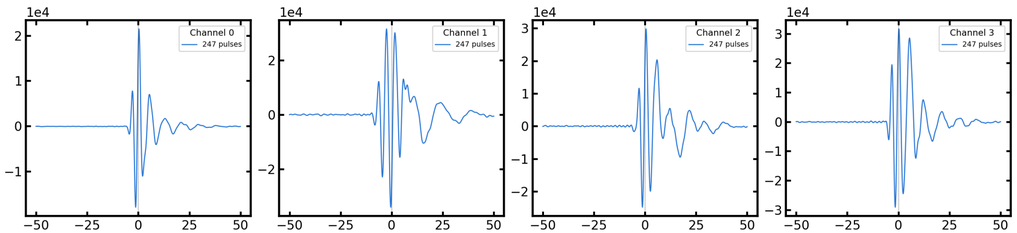




E. Oberla (Chicago), M. Schust (DESY)

- DiDAQ: All digital 24-channel system
- Robust (lower maintenance), modest power increase compared with prior design

All-Digital DiDAQ during commissioning



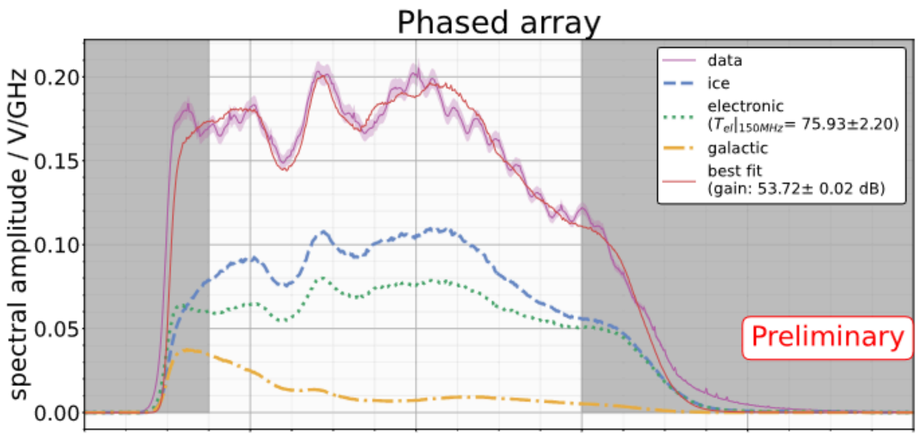
Calpulser run on Phased Array channels

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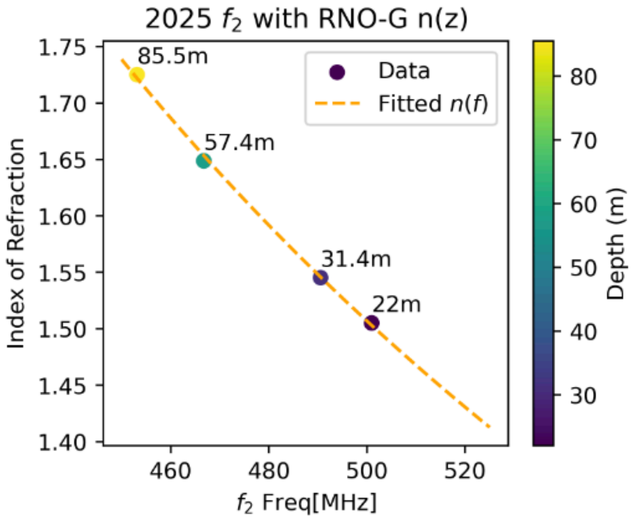
Detector Commissioning

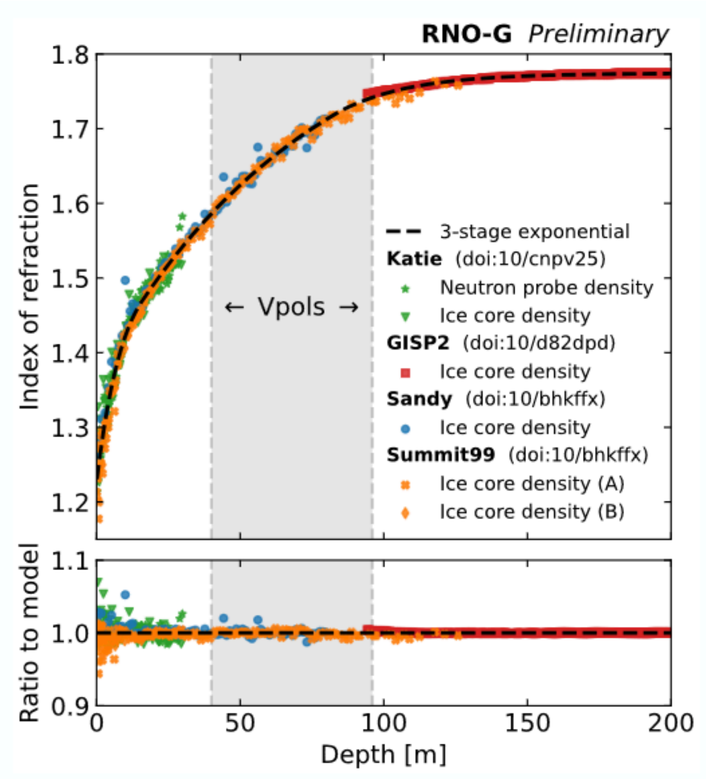
Calibration

- **Signal amplitude calibration**: for event energy estimation
- **Absolute positioning of antennas**: for direction estimation
- **Antenna alignment and relative calibration**: for signal polarization, needed for neutrino identification and reconstruction
- **In-situ ice properties**: for accurate description of signal propagation.



Full simulation chain for prediction of absolute signal amplitude





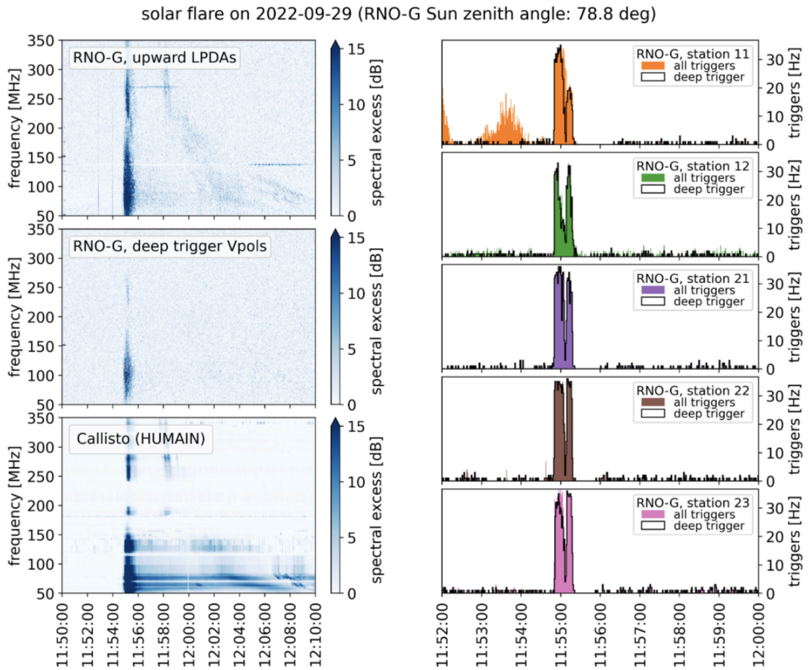
Refractive index: via dedicated measurements in-situ

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Natural Sources of Radio

Calibration or Backgrounds?

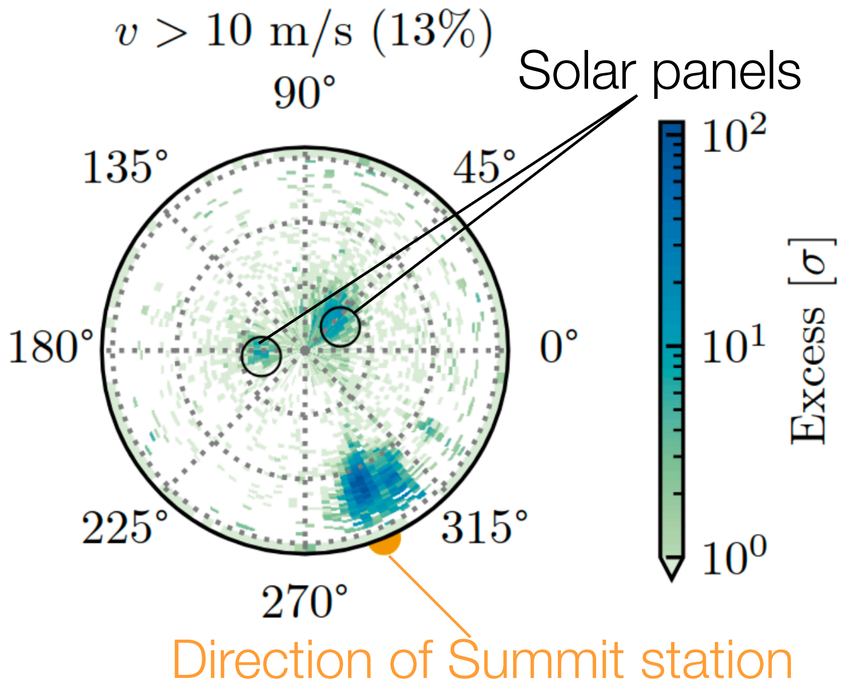
- RNO-G detects solar flares in the 100-500 MHz range
- Distant source for **absolute pointing calibration** and solar science



S. Agarwal et al (RNO-G Coll.) Astroparticle Physics 164 (2025) 103024, ISSN 0927-6505

- Triboelectric charging due to wind

Wind events reconstruct to large metal structures

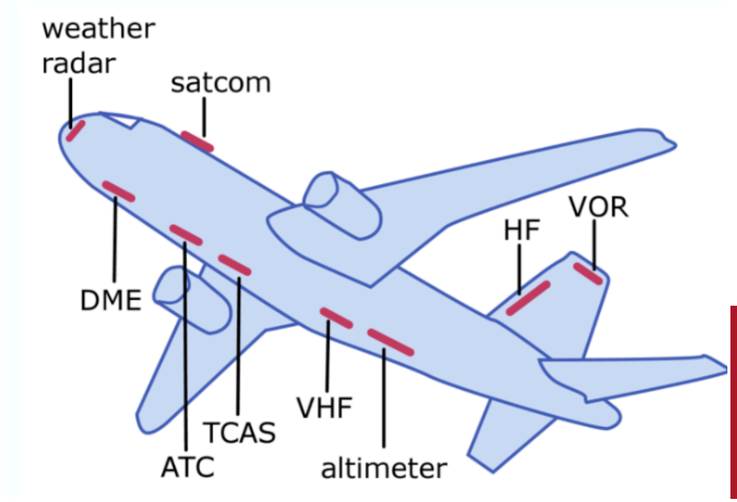


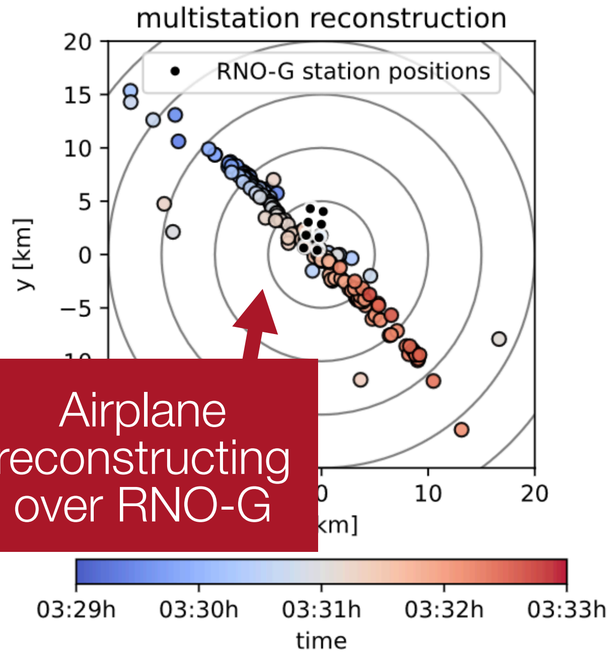
Work presented at ARENA 2026 (P. Schriefer, ECAP)

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Humanmade Backgrounds? Calibration Sources?

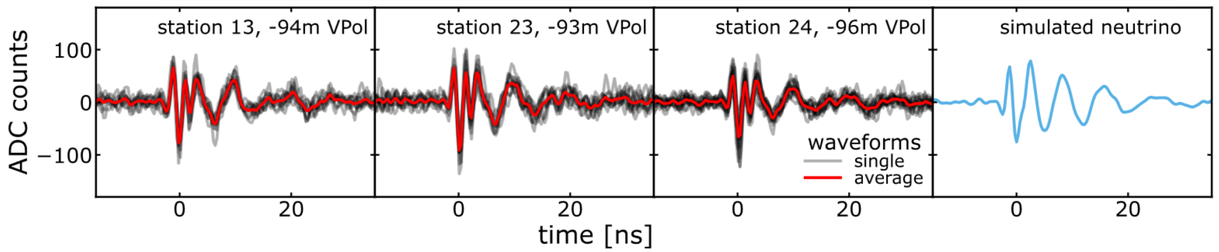
Airplanes





Airplane reconstructing over RNO-G

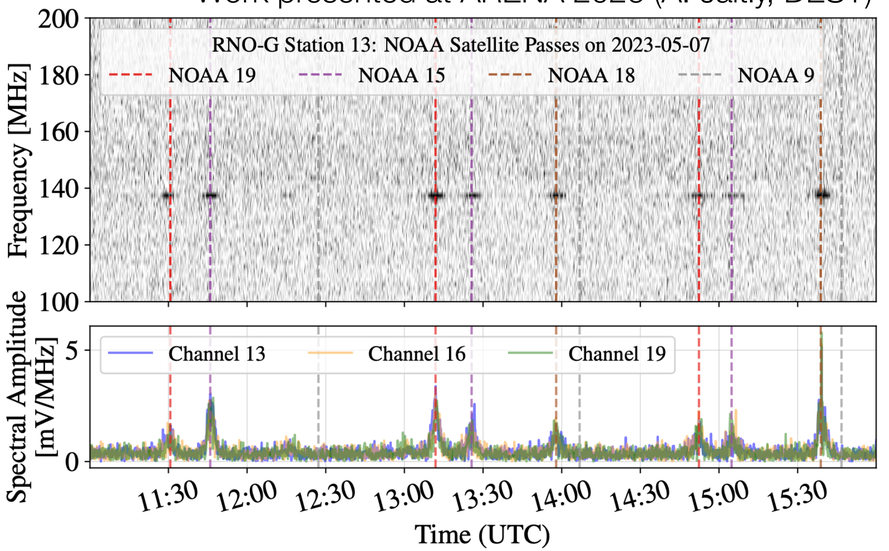
Signal from airplane similar to neutrino



S. Agarwal et al (RNO-G Coll.) 2025 JINST 20 P11015

Continuous wave signals from satellites in a few hours of data

Work presented at ARENA 2026 (A. Jaitly, DESY)



NOAA satellites passes

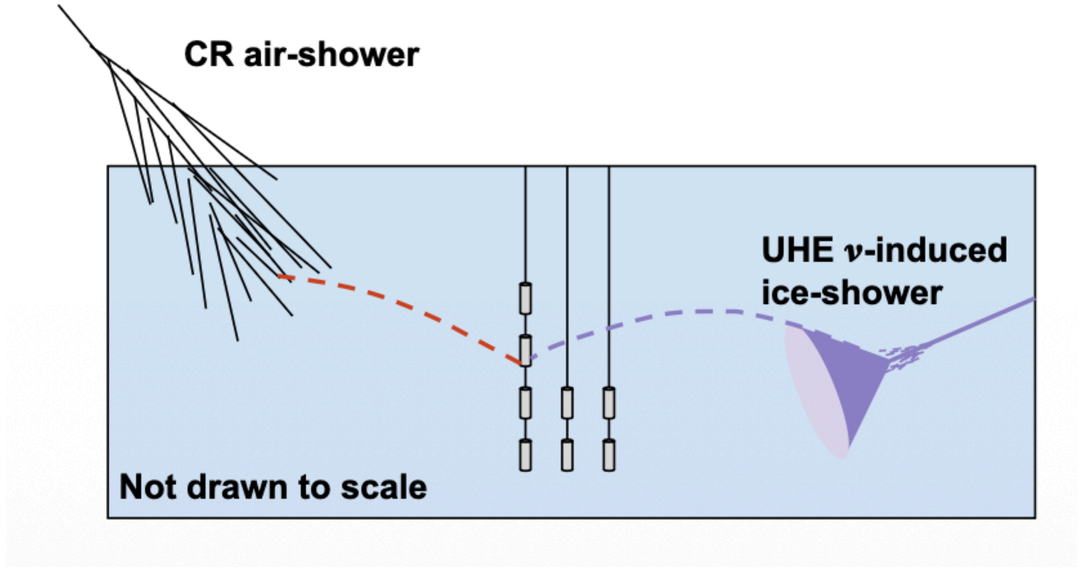
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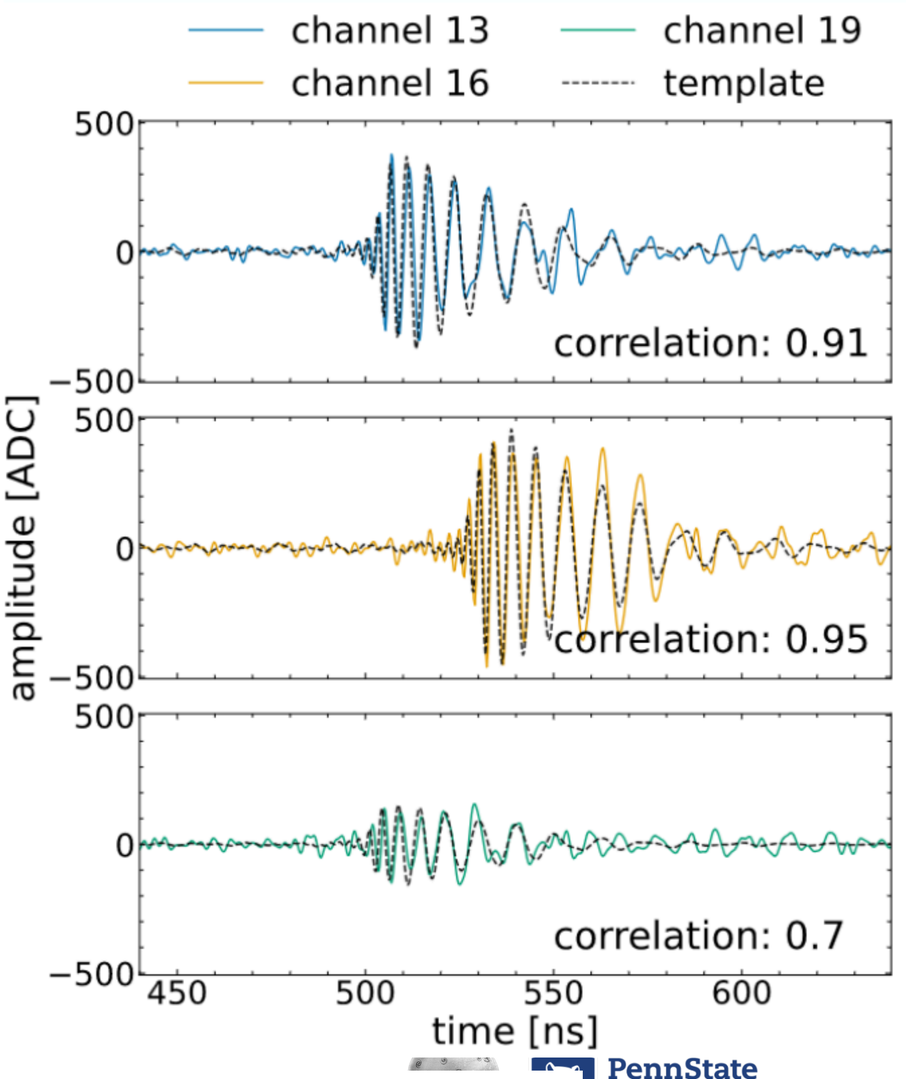
Cosmic Rays – first astroparticle channel

in surface channels

Work submitted to EPJ-C (J. Henrichs, DESY)

- Cosmic ray air showers generate radio emission in air (geomagnetic) and in ice (Askaryan)
- Several CR candidates identified in two years of data in upward facing surface channels
- Important to understand detector response and systematics
- Number and reconstructed properties consistent with expectation.





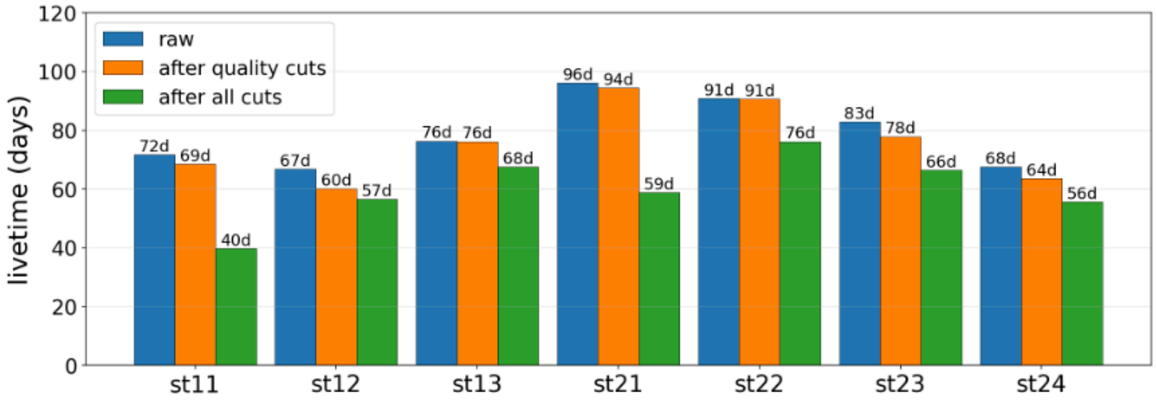


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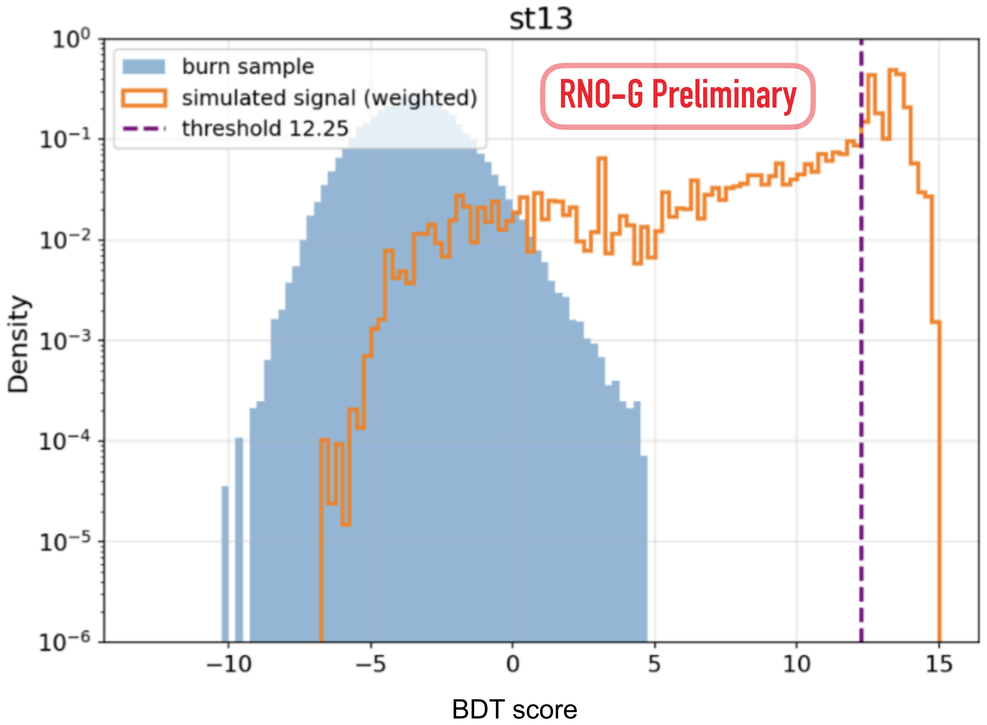
Cosmic Rays – first astroparticle channel

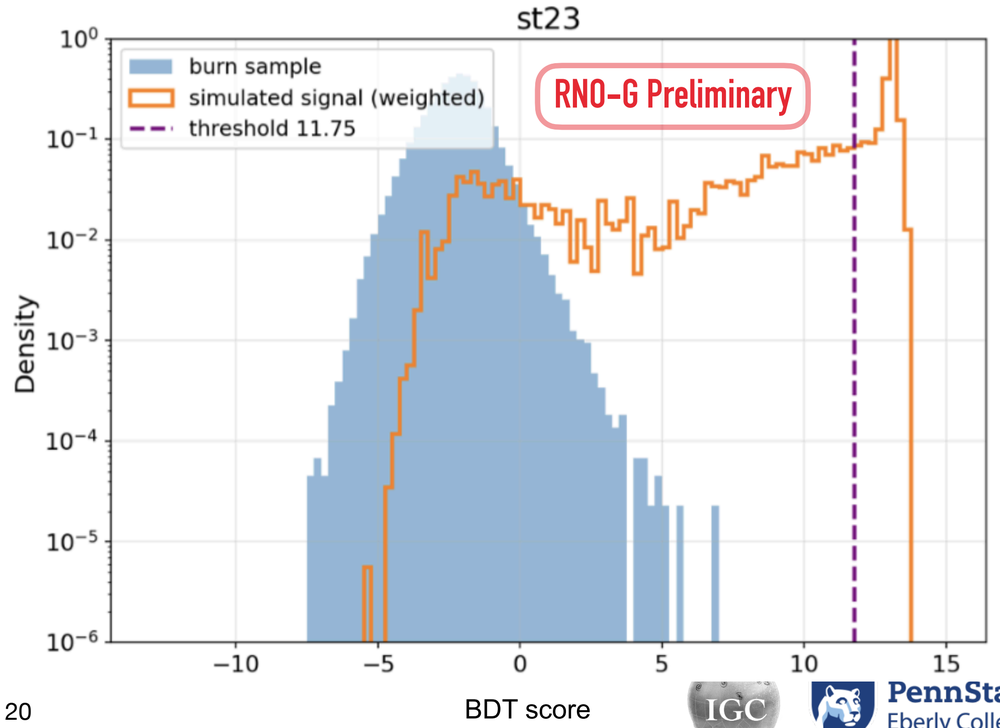
in deep channels

Work presented at ARENA 2026 (B. Hendricks, PSU)



- Search in **deep channels** of early data for in-ice Askaryan emission ARA PRL 2026
- Represents first detailed study of backgrounds (dominant thermal and more rare non-thermal backgrounds)





PennState Eberly College of Science

Conclusions

RNO-G targets neutrinos >10 PeV

- Expect to complete 35-station array in early 2030s (hardware fully funded)
- 1/3 of the array currently operating, several drilling and instrument upgrades in progress.
- Cosmic ray searches in progress: first astroparticle signatures which are crucial for detector validation
- First diffuse neutrino search coming soon
- RNO-G well-positioned (Northern sky, UHE sensitivity) for following up KM3NeT event.



2026 field team going home

Sensitivity to KM3NeT event. Expect O(1) event in one summer with RNO-G-35

