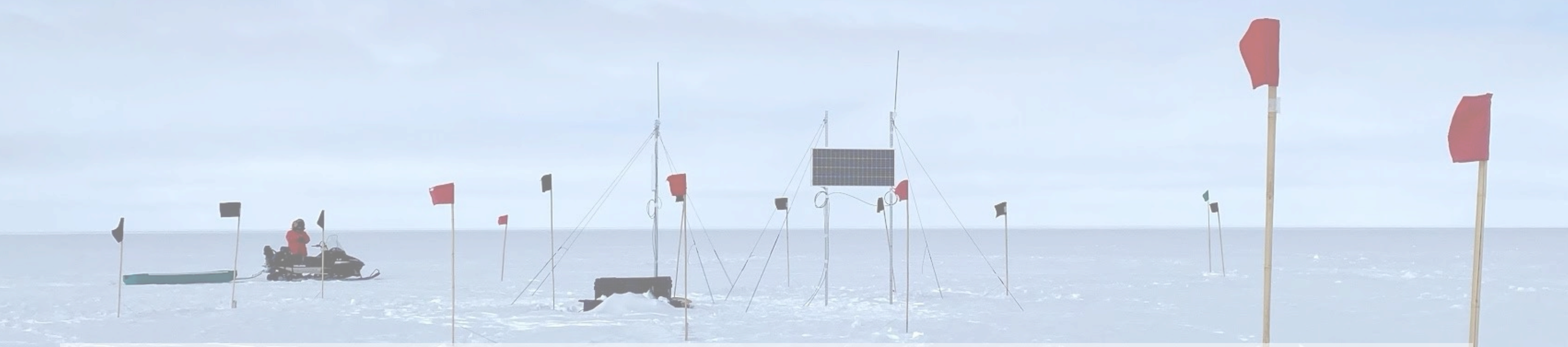


The Radio Neutrino Observatory in Greenland (RNO-G): Overview and Status

Kaeli Hughes, for the RNO-G Collaboration

June 11, 2024

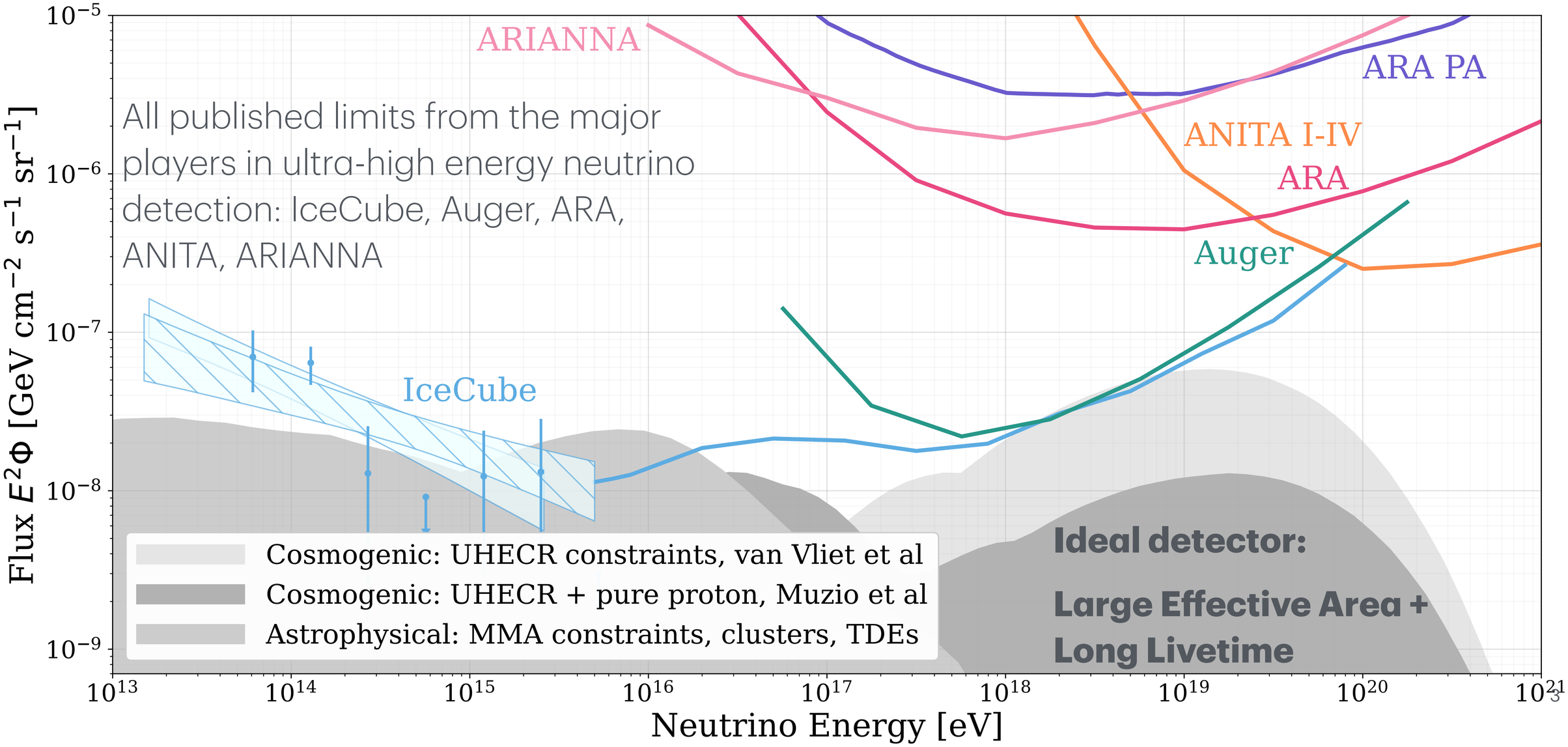
RNO-G CHICAGO 2024

THE OHIO STATE UNIVERSITY

The RNO-G Collaboration

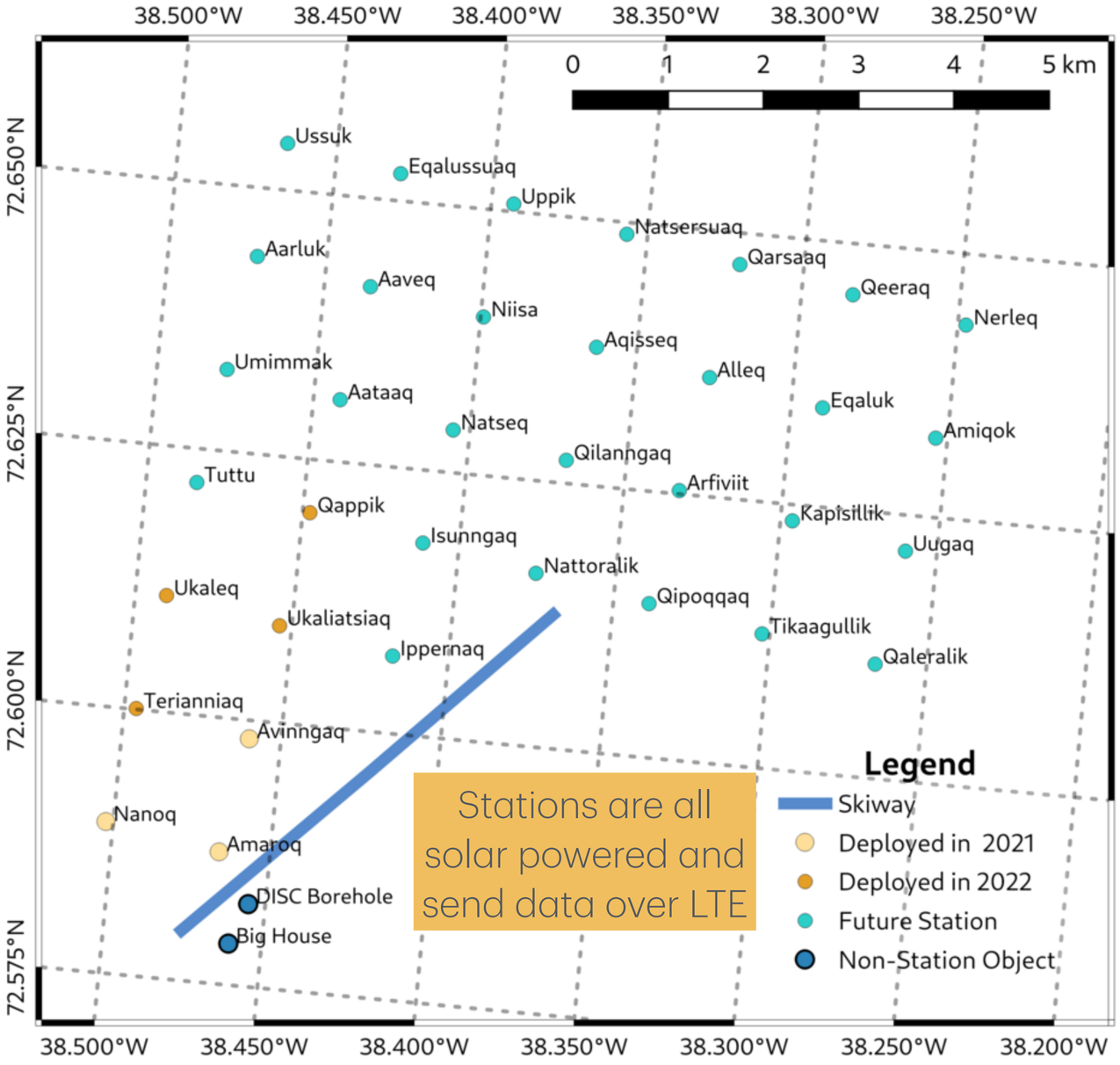
RNO-G Collaboration February 2023

The state of the field: June 2024

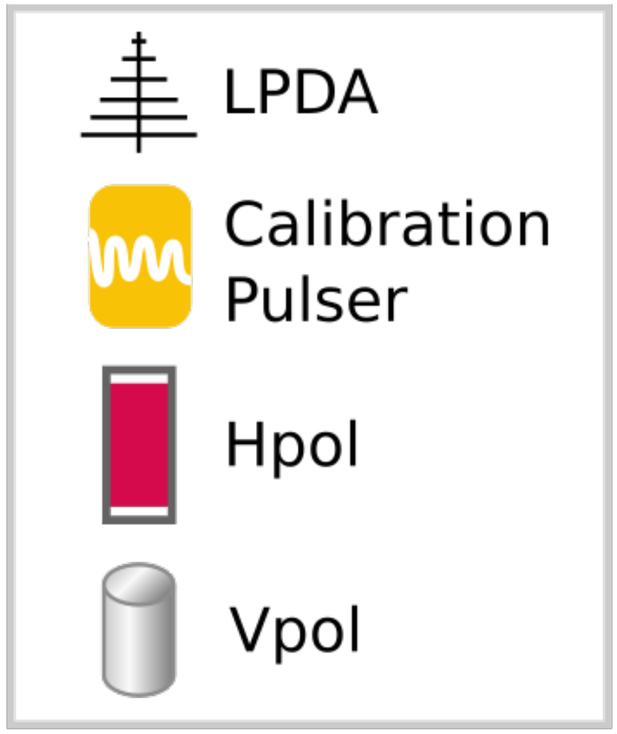


RNO-G: a new experimental effort

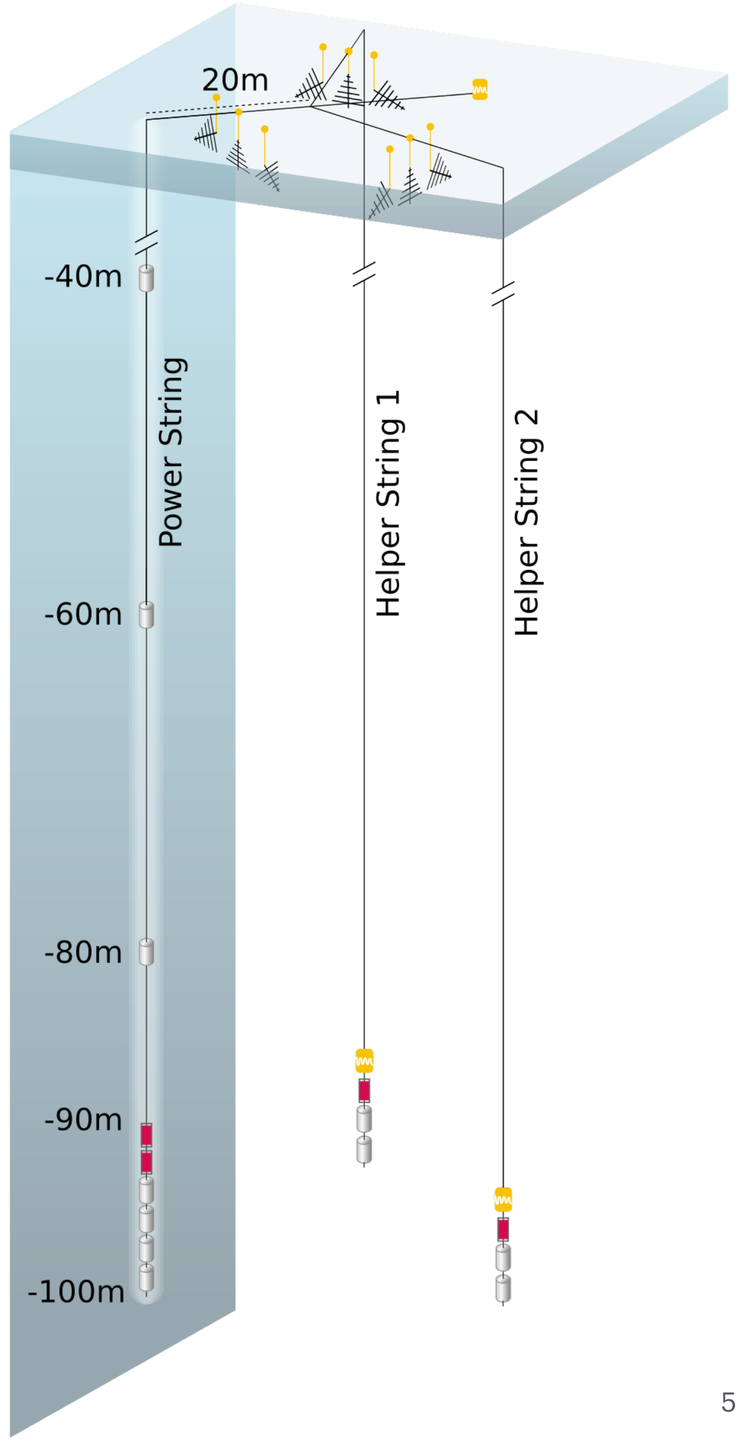
- Deployed near Summit Station, Greenland
- Hardware is fully funded to reach 35(+) stations: already the largest in-ice radio neutrino detector by area!
- Currently in building phase: holes for 7 more stations are being drilled this year, with DAQs installed next year
- Science team is also working on calibration, simulation, instrument performance- see following talks from RNO-G team members!



A single RNO-G Station



Antennas types: Log-periodic dipole antenna (LPDA), Horizontally-polarized (Hpol), and Vertically-polarized (Vpol)



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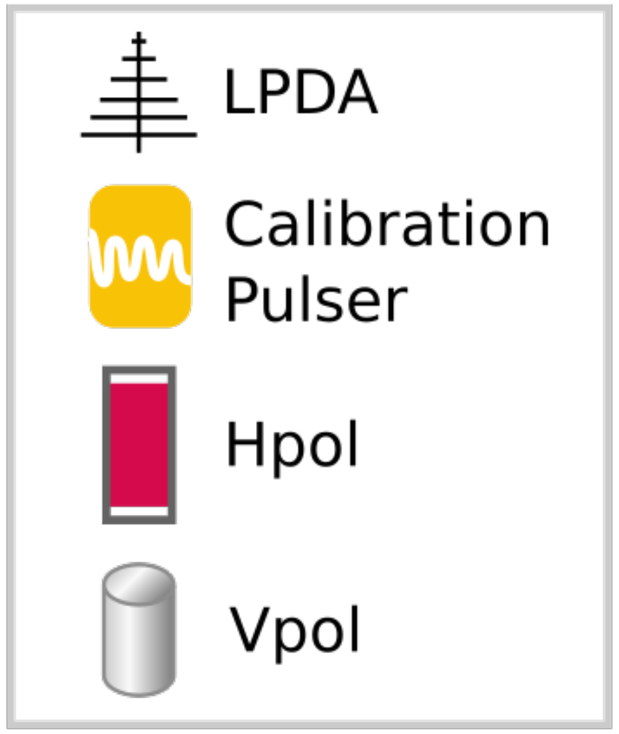

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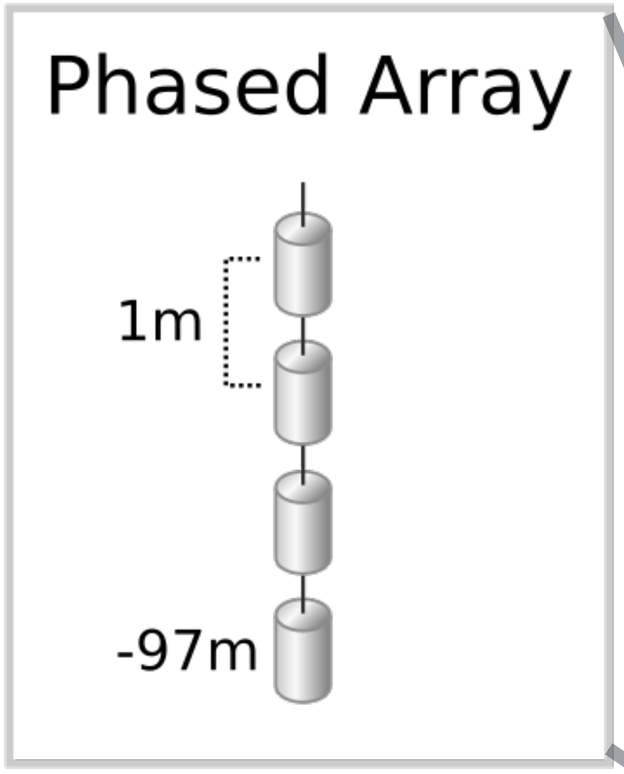
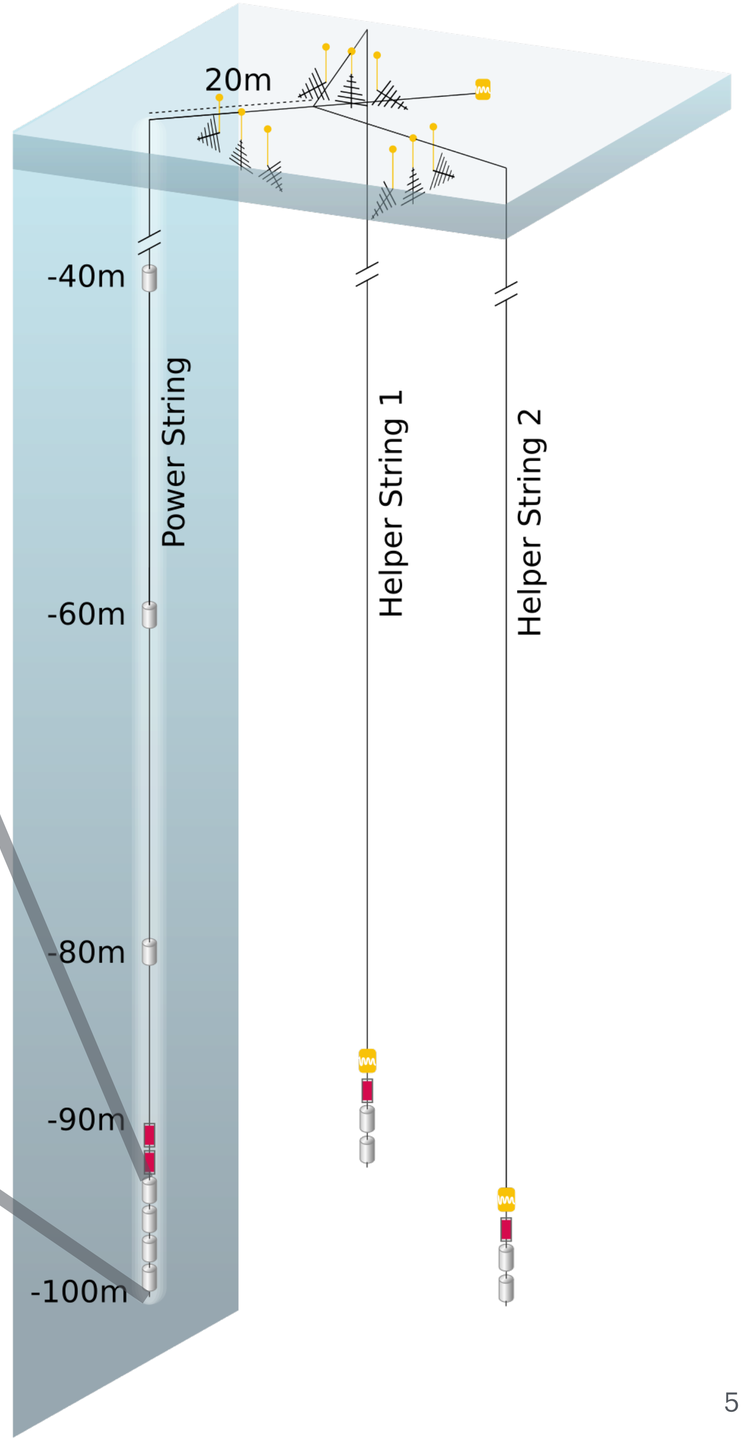
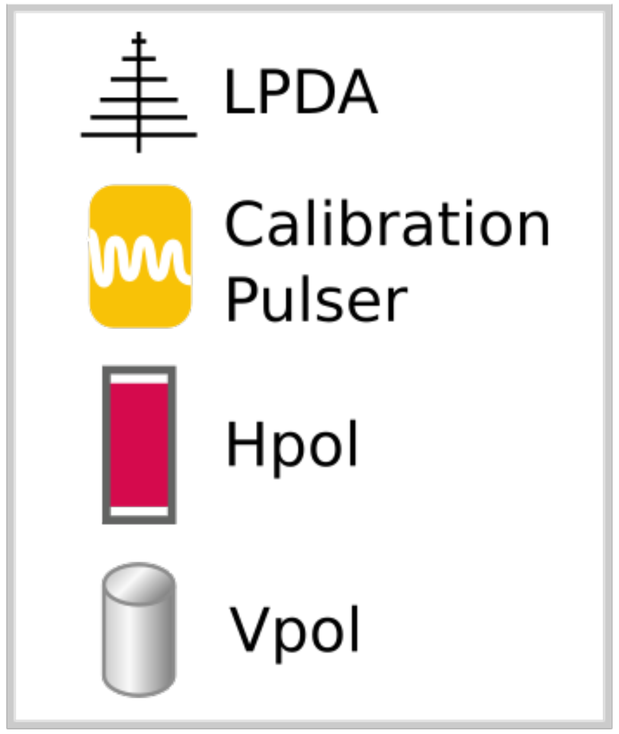
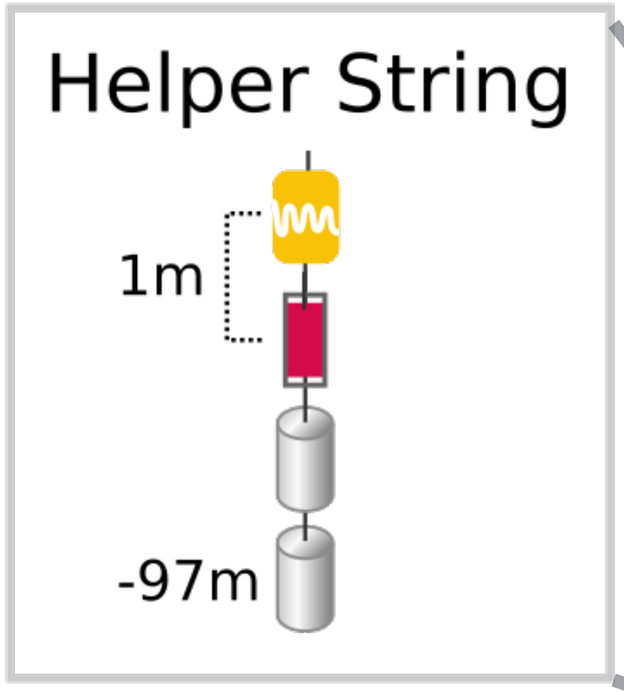


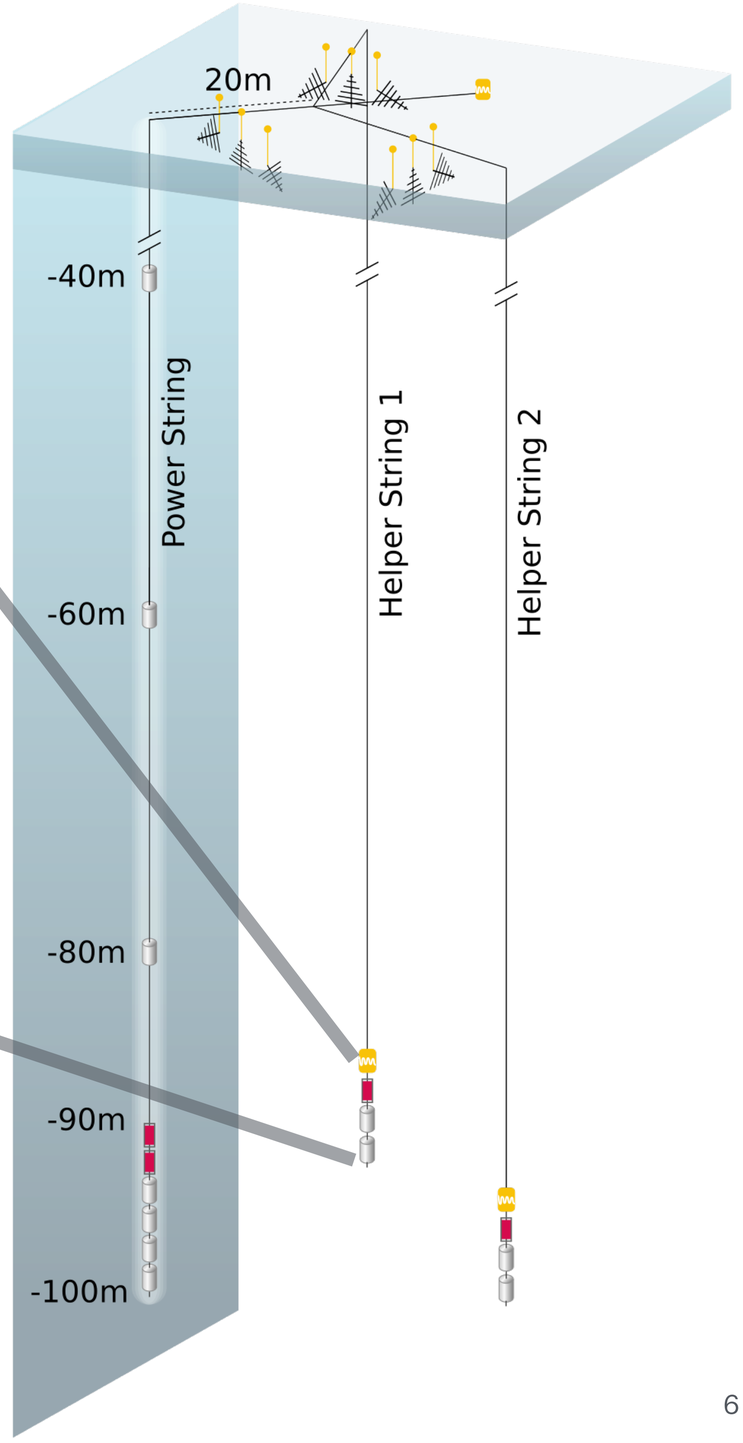
Densely packed phased array of vertically polarized (Vpol) antennas will make up our most sensitive trigger.



A single RNO-G Station



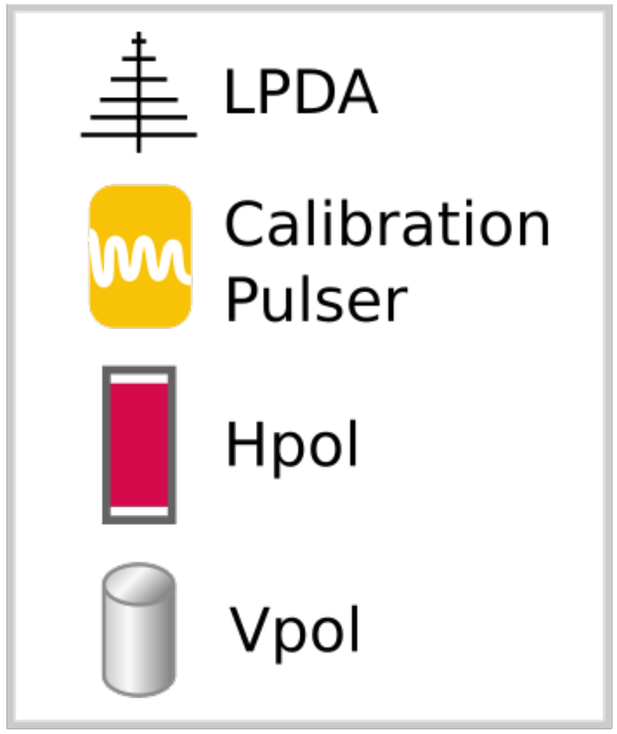




Antennas types: Log-periodic dipole antenna (LPDA), Horizontally-polarized (Hpol), and Vertically-polarized (Vpol)

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

A single RNO-G Station



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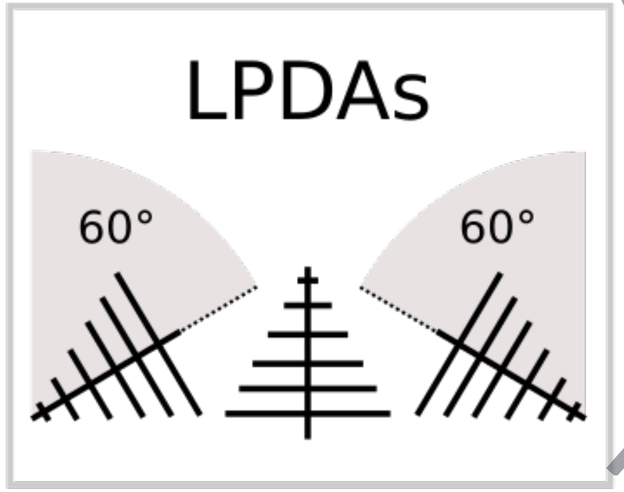
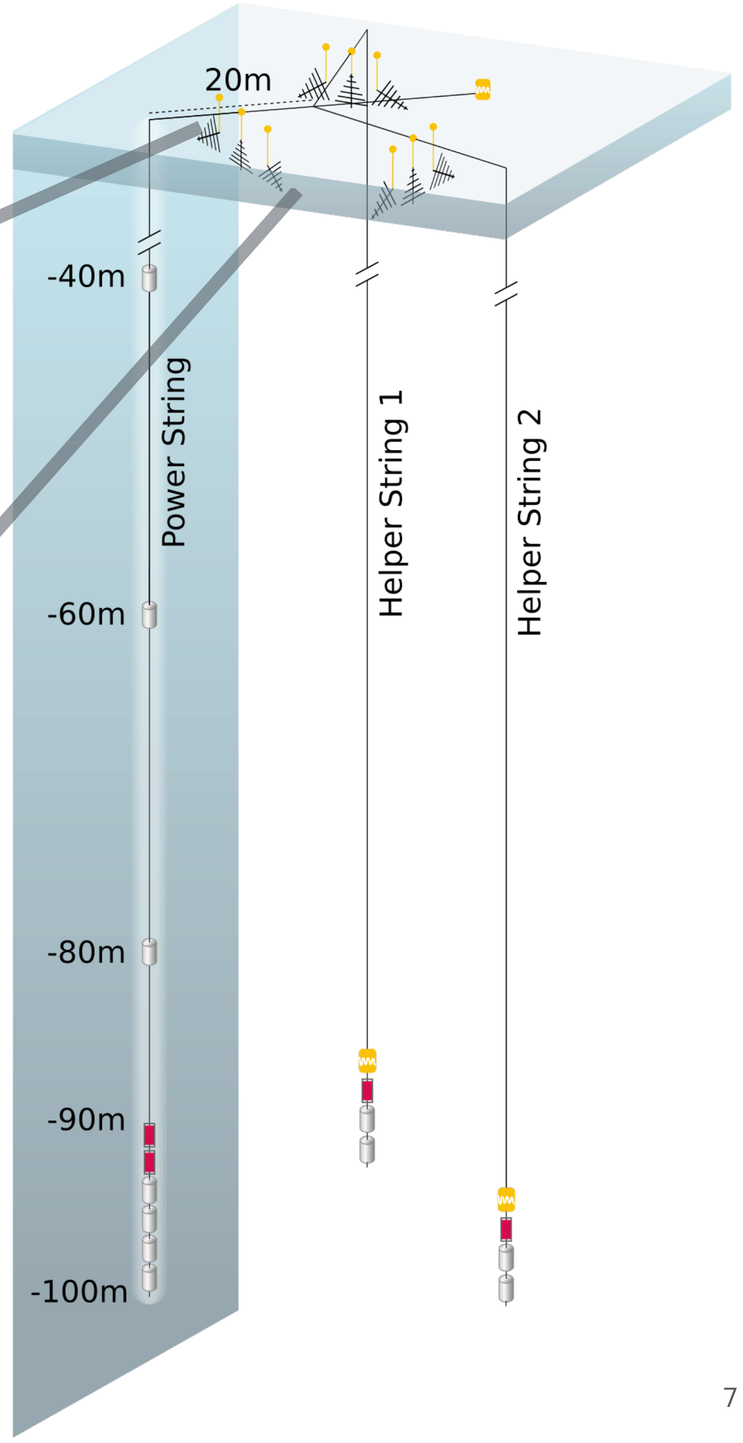


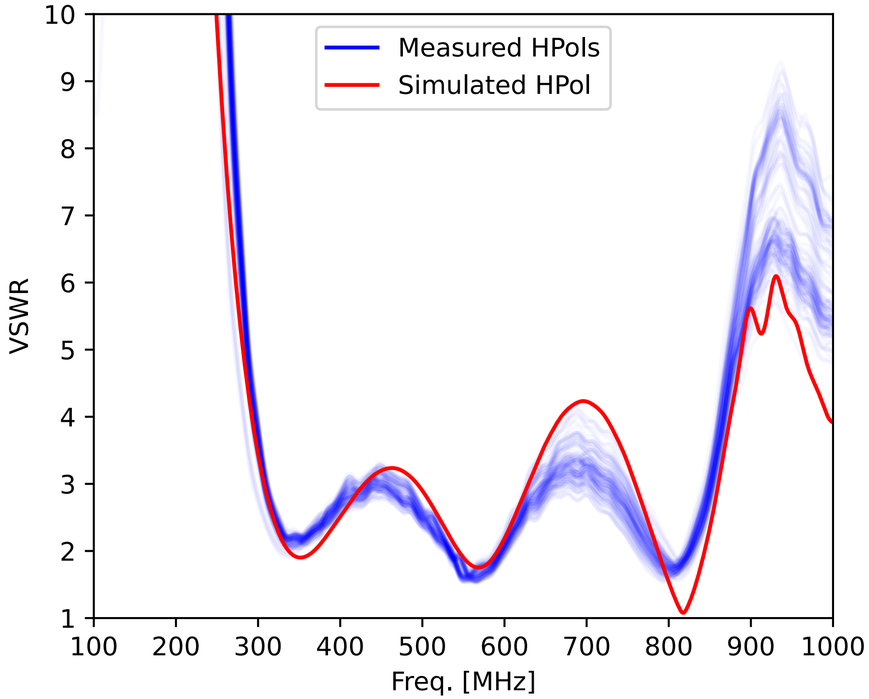
LPDAs at the surface help with signal reconstruction and act as a surface veto. They also contribute a small amount to neutrino effective volume.



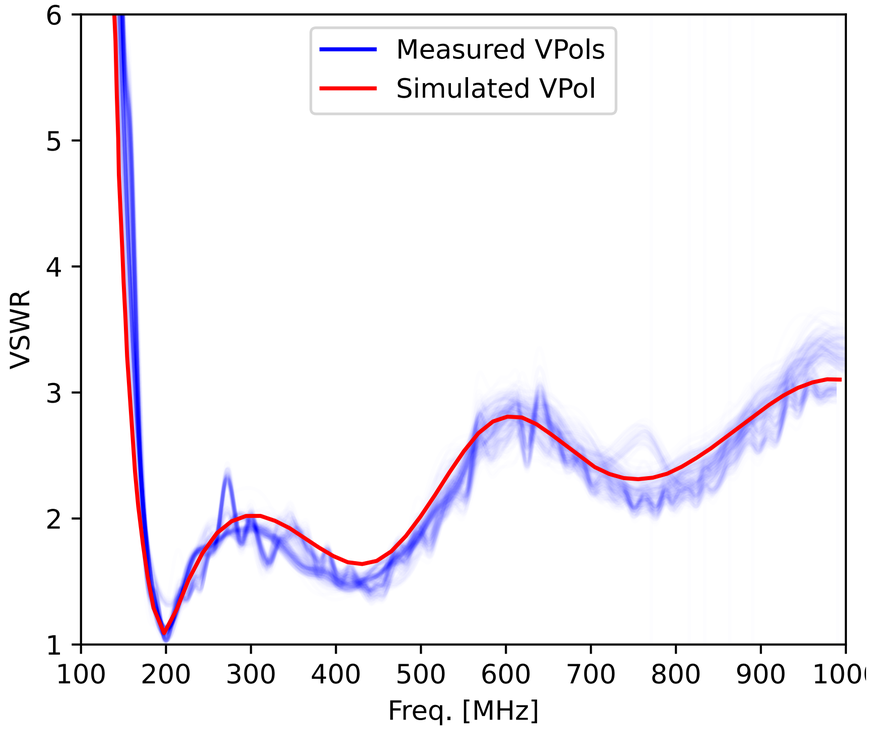
Modeling our antennas

Good agreement between simulation and measurement (in air) will improve our detector simulation accuracy. Currently, we extrapolate this to an in-ice response.

Horizontally Polarized Antennas



Vertically Polarized Antennas

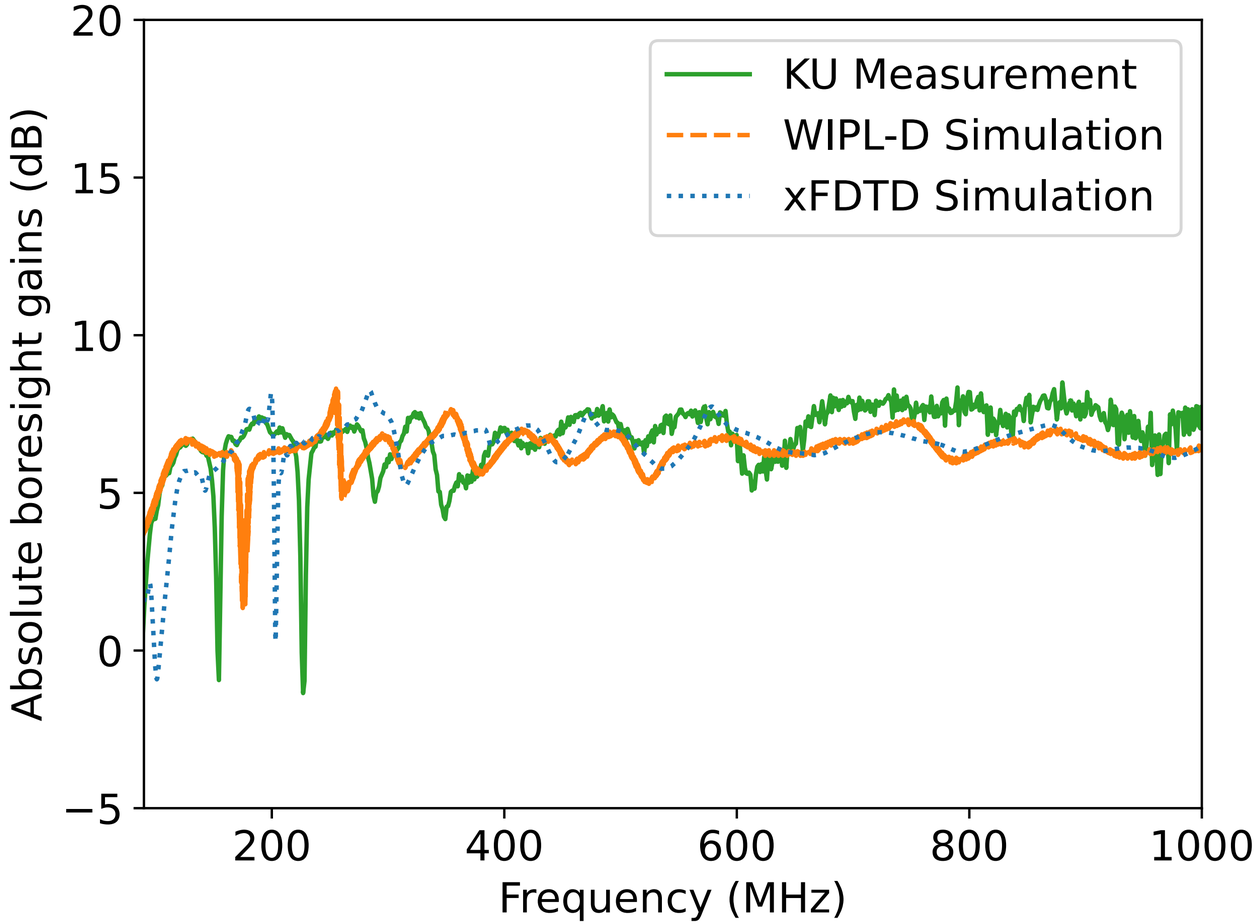


Credit: Bryan Hendricks (Penn State)

Modeling our antennas

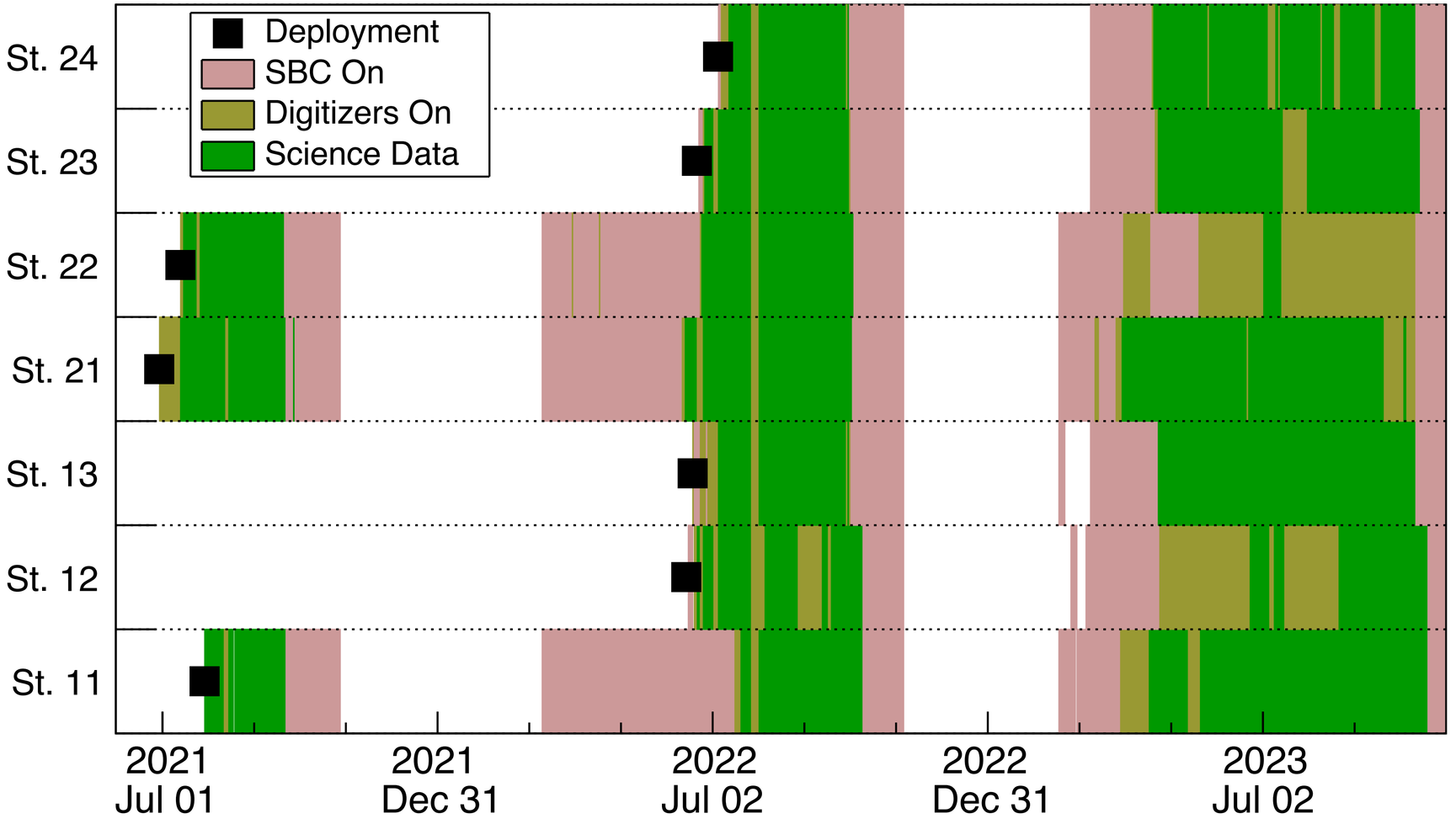
LPDAs

Credit: Mohammad F. H. Seikh



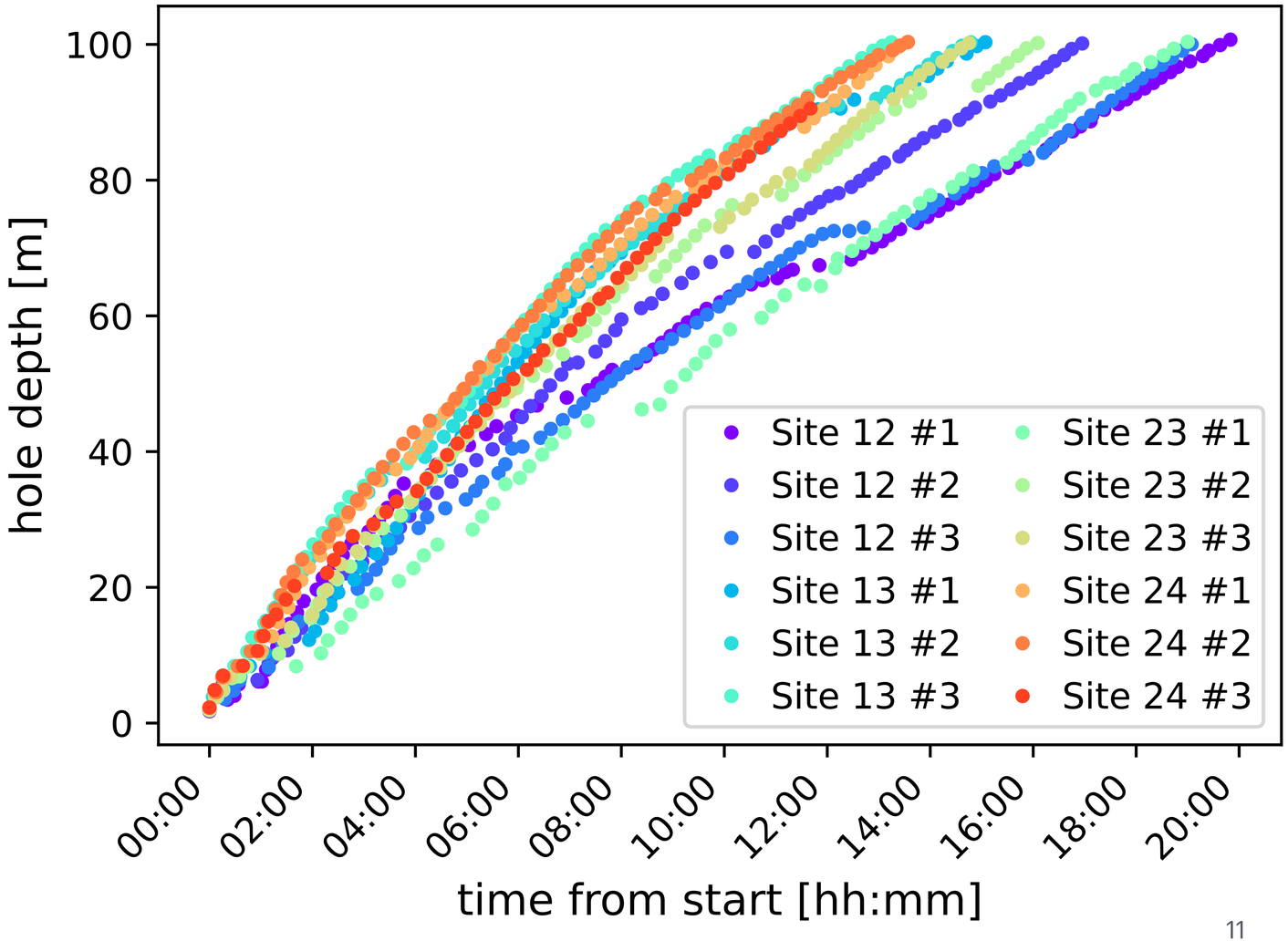
Deployment Progress

- RNO-G is solar powered; limited to taking data during summer months when sun and batteries can support power needs (~25 W per station)
- Investigating wind power as an alternative to extend livetime into winter months (see Ryan Krebs' talk)

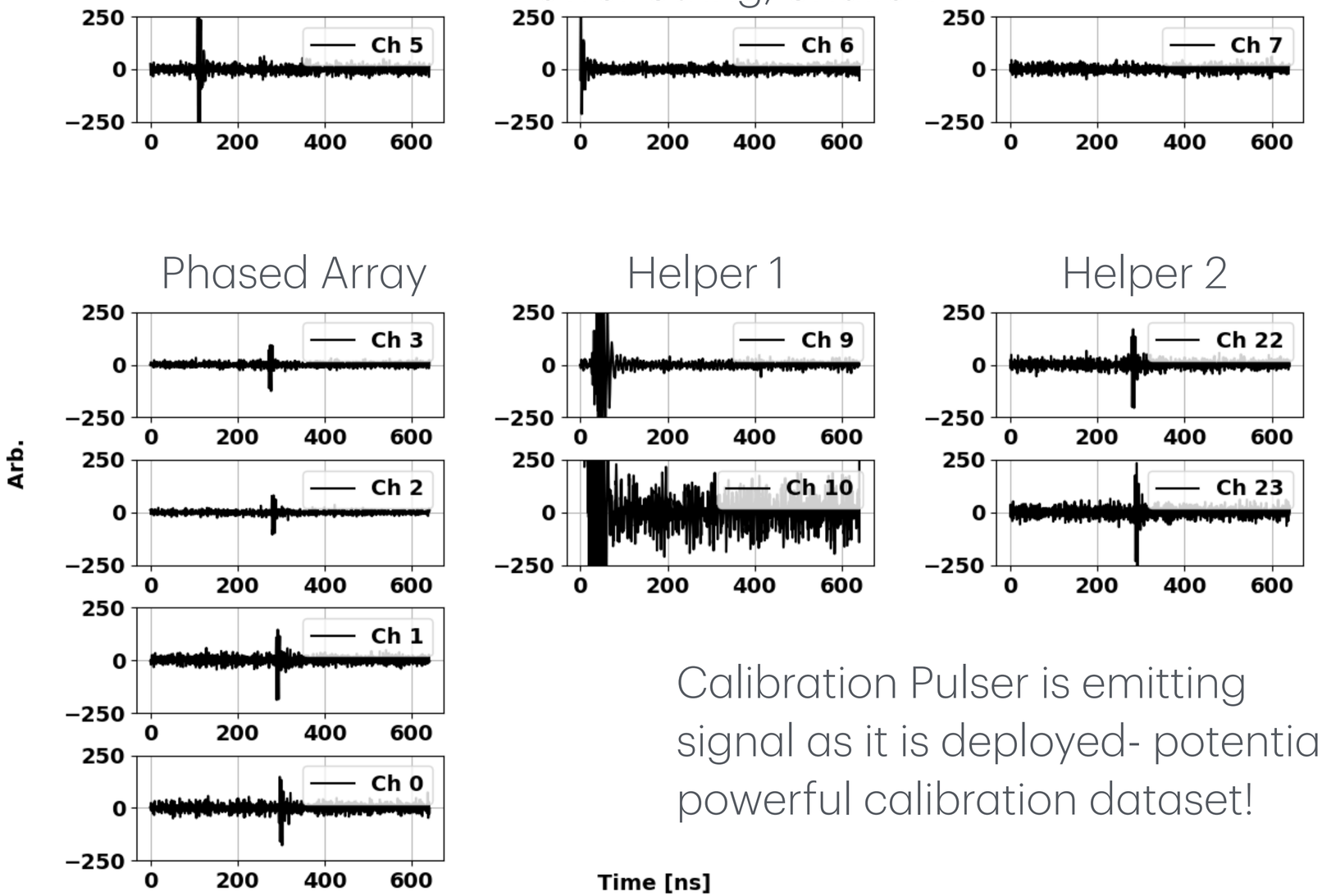


Deployment Plan: Summer 2024

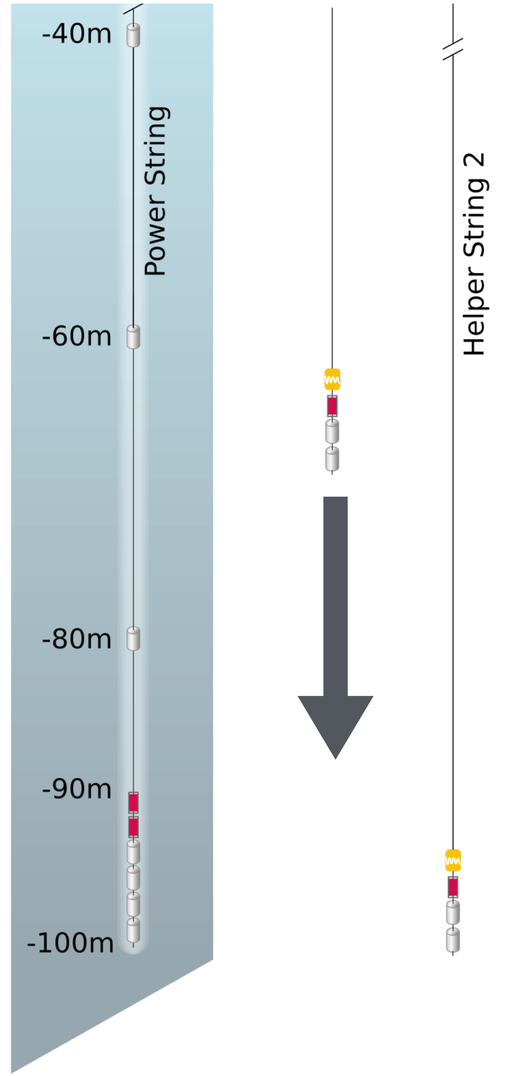
- **Drilling**: enough for 7 new stations
  - This would double our rate of hole production compared to previous years; seems feasible with drill upgrades and longer drill season
- **Retrofitting** existing stations with updated RADIANT trigger and digitizer board:
  - Improved surface trigger efficiency + fix for non-working filter banks
- **Calibration**: pulsing using nearby Saltzman hole to light up RNO-G Station 21 and test holes



Example Calibration Event: Vpol channels

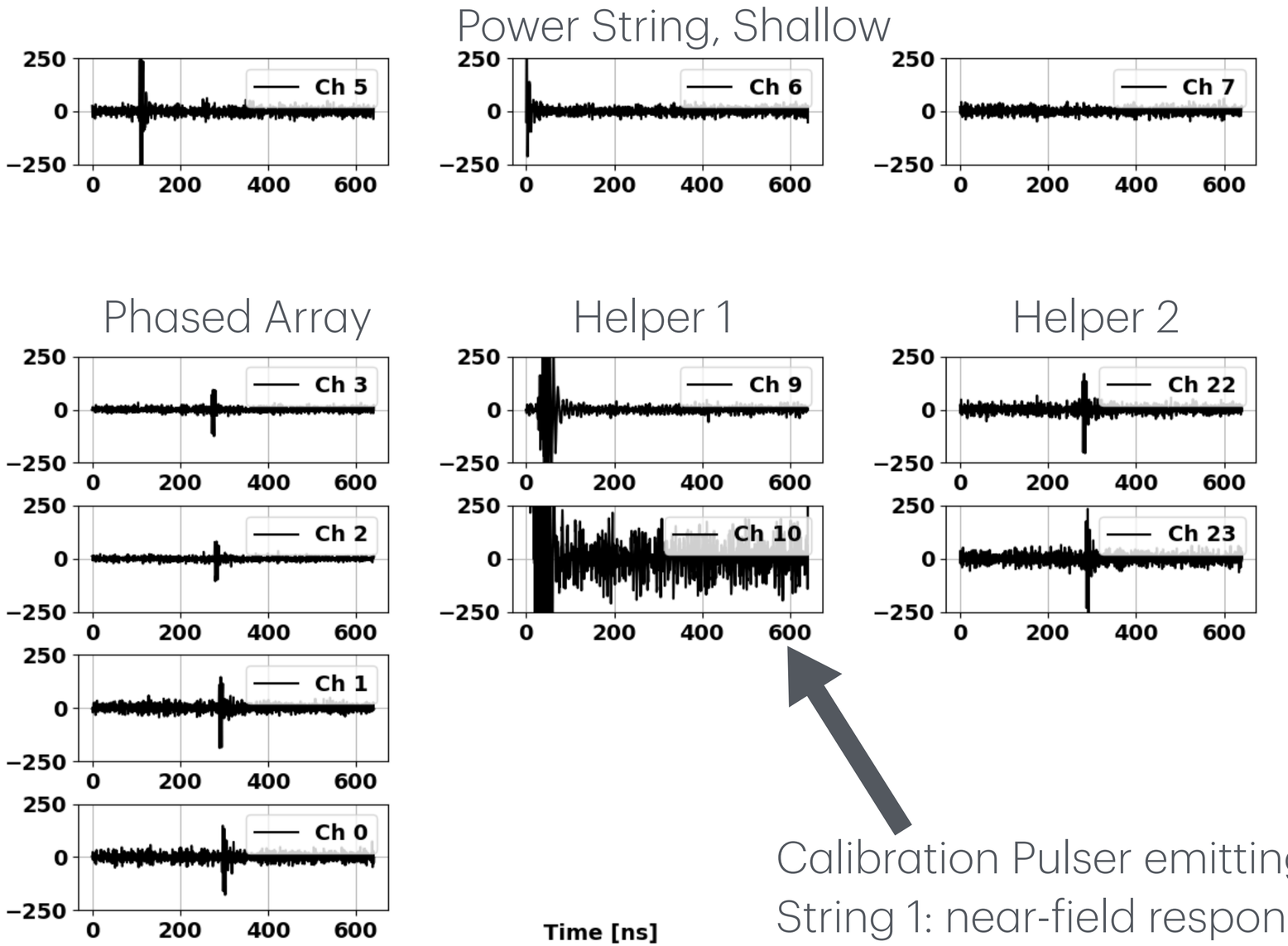


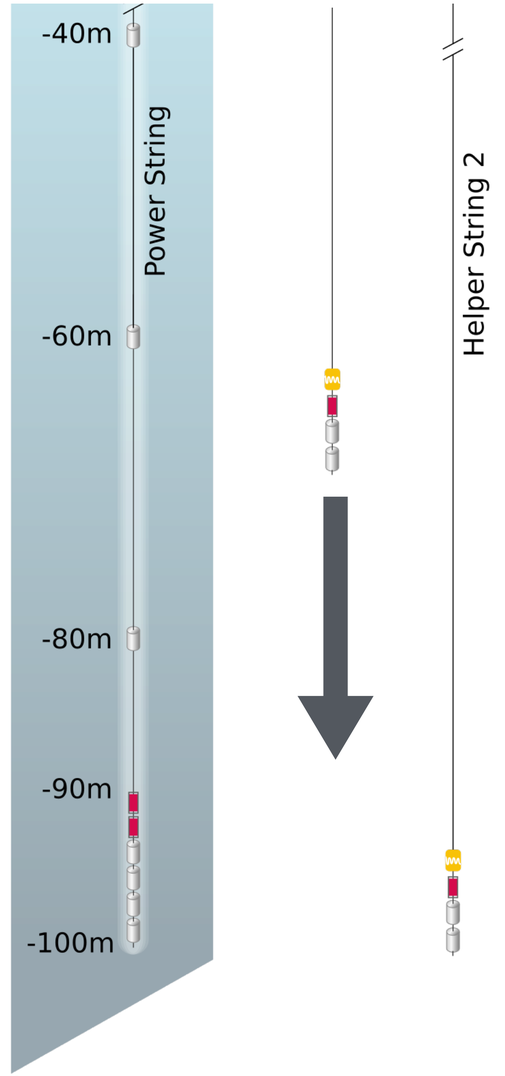
Calibration Pulser is emitting signal as it is deployed- potentially powerful calibration dataset!



For more background signals, see Jethro Stoffels' talk!

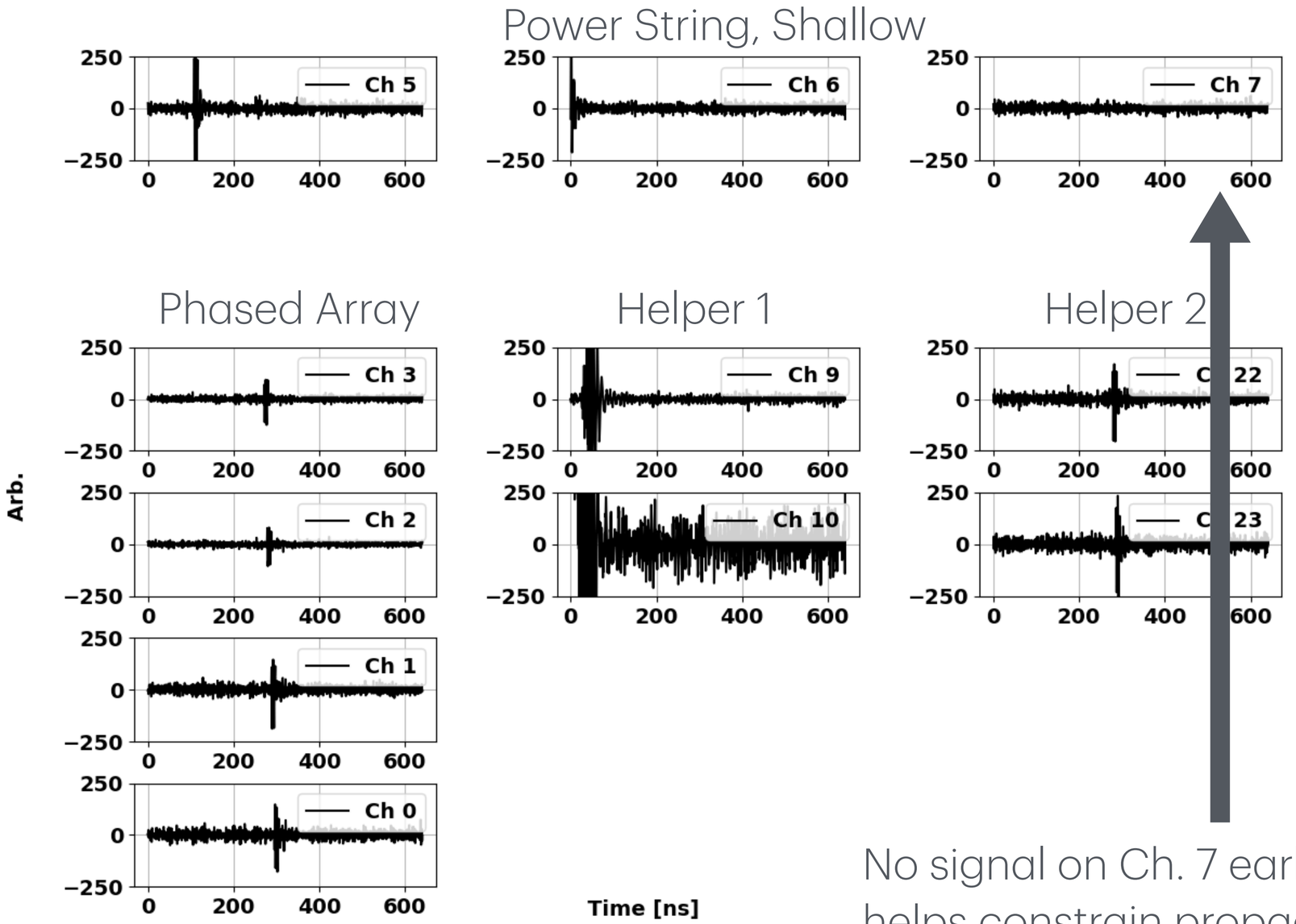
Example Calibration Event: Vpol channels

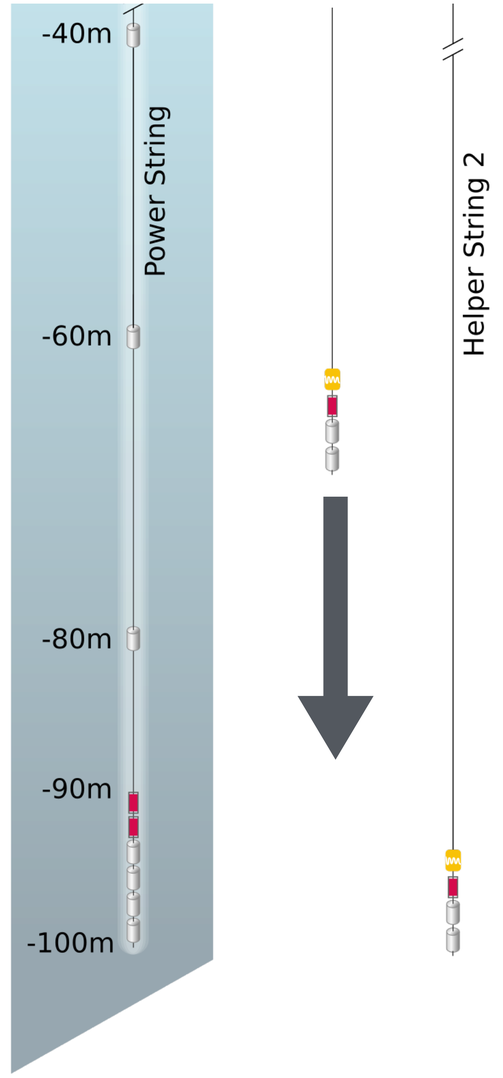




Calibration Pulser emitting from Helper String 1: near-field response on Ch. 9 and Ch. 10

Example Calibration Event: Vpol channels

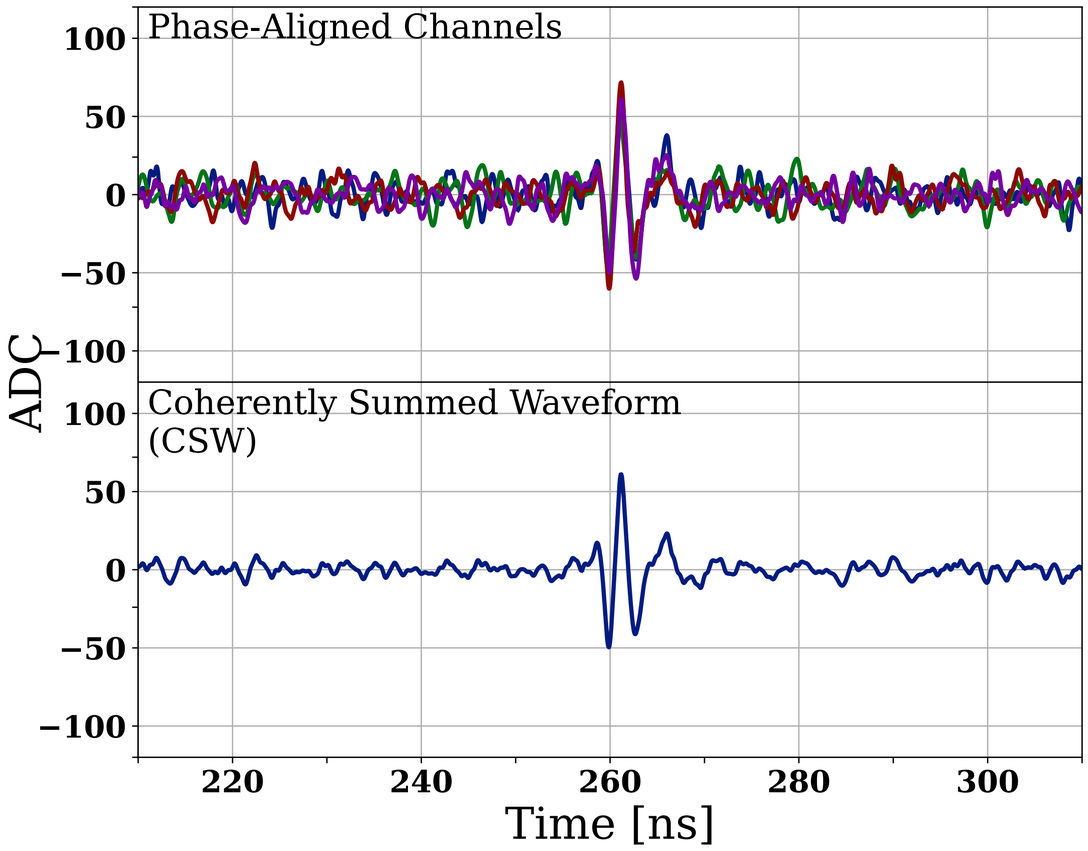


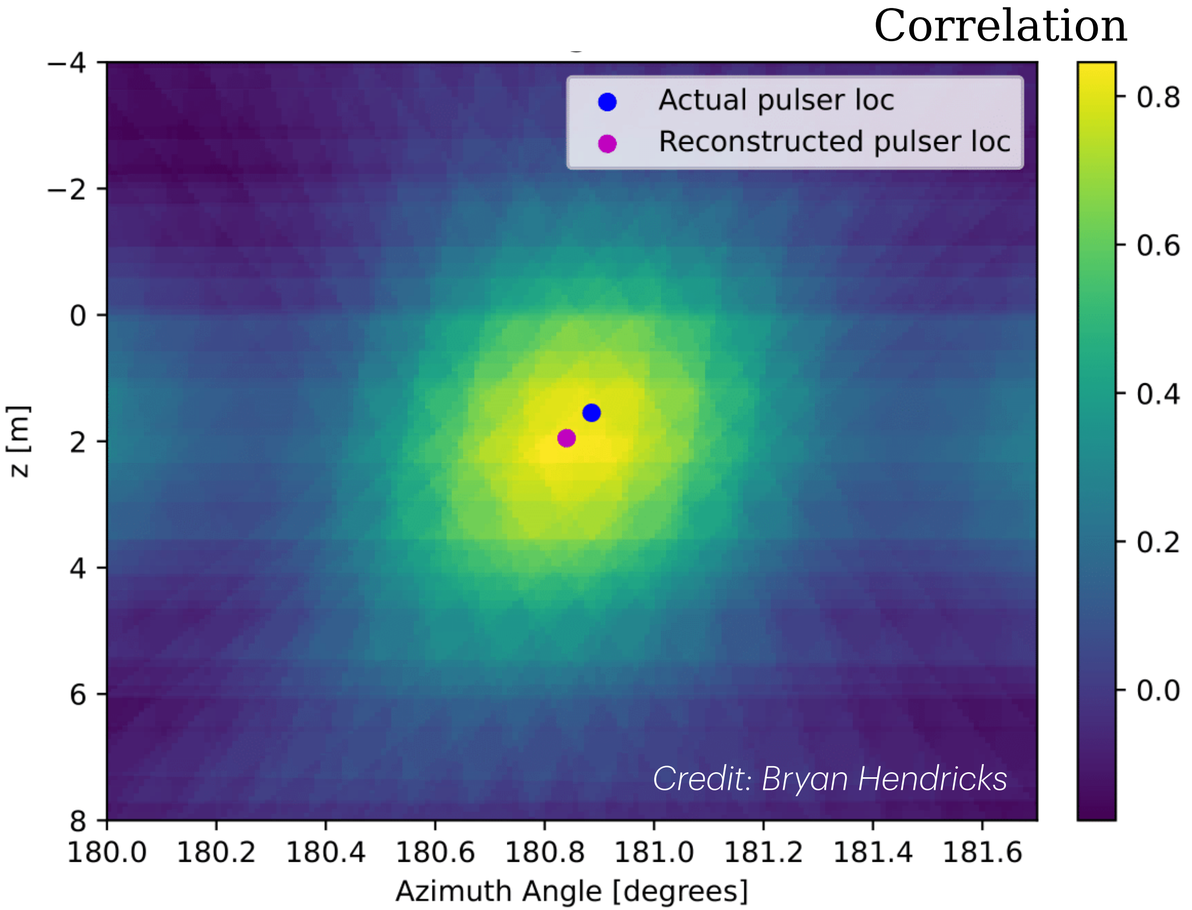


No signal on Ch. 7 early in pulser drop helps constrain propagation time

Calibration Pulser Reconstruction

Local calibration pulser plays a crucial role in station position calibration (see Philipp Windischhofer's talk)



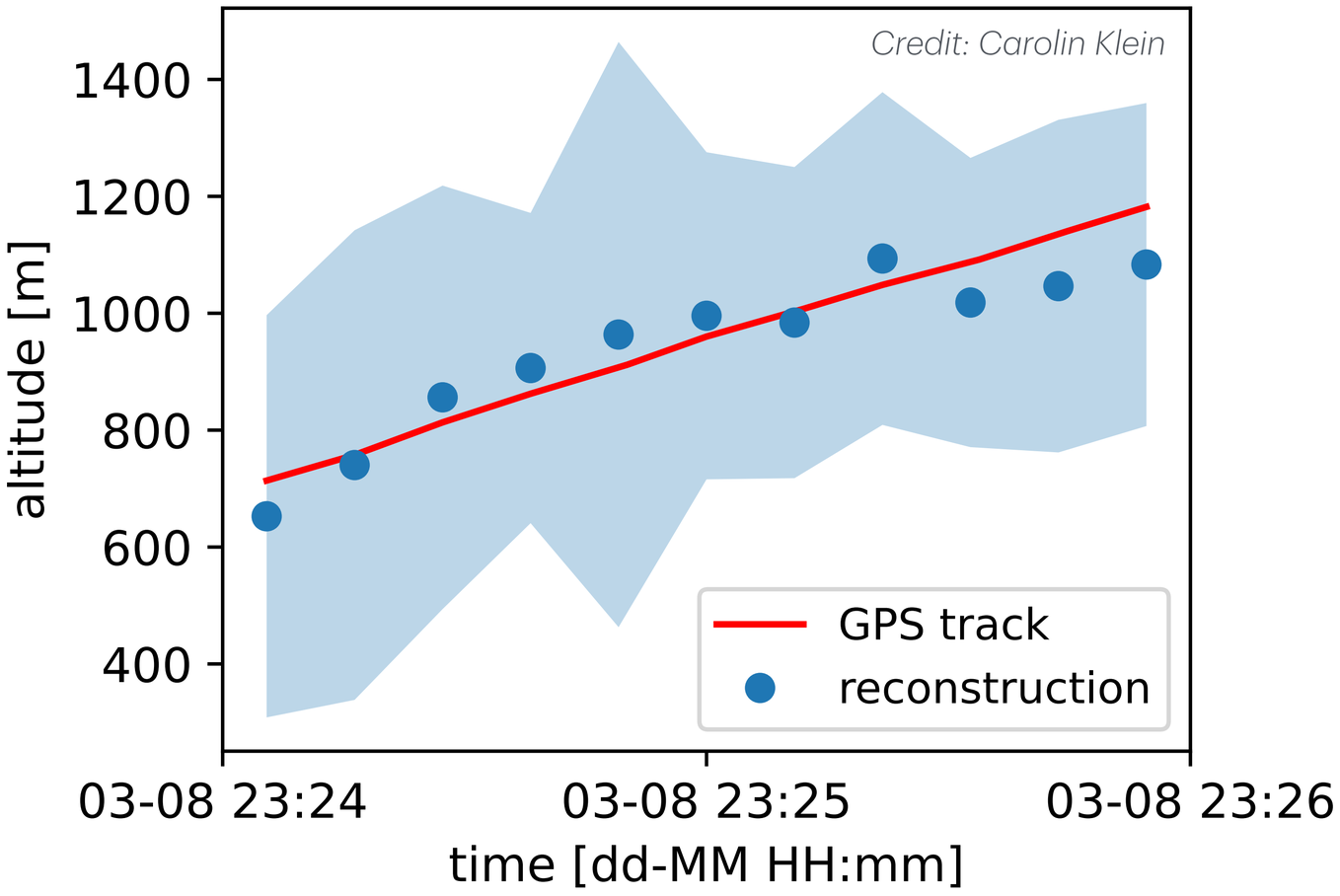


Also solar flares! See Dave Besson's talk

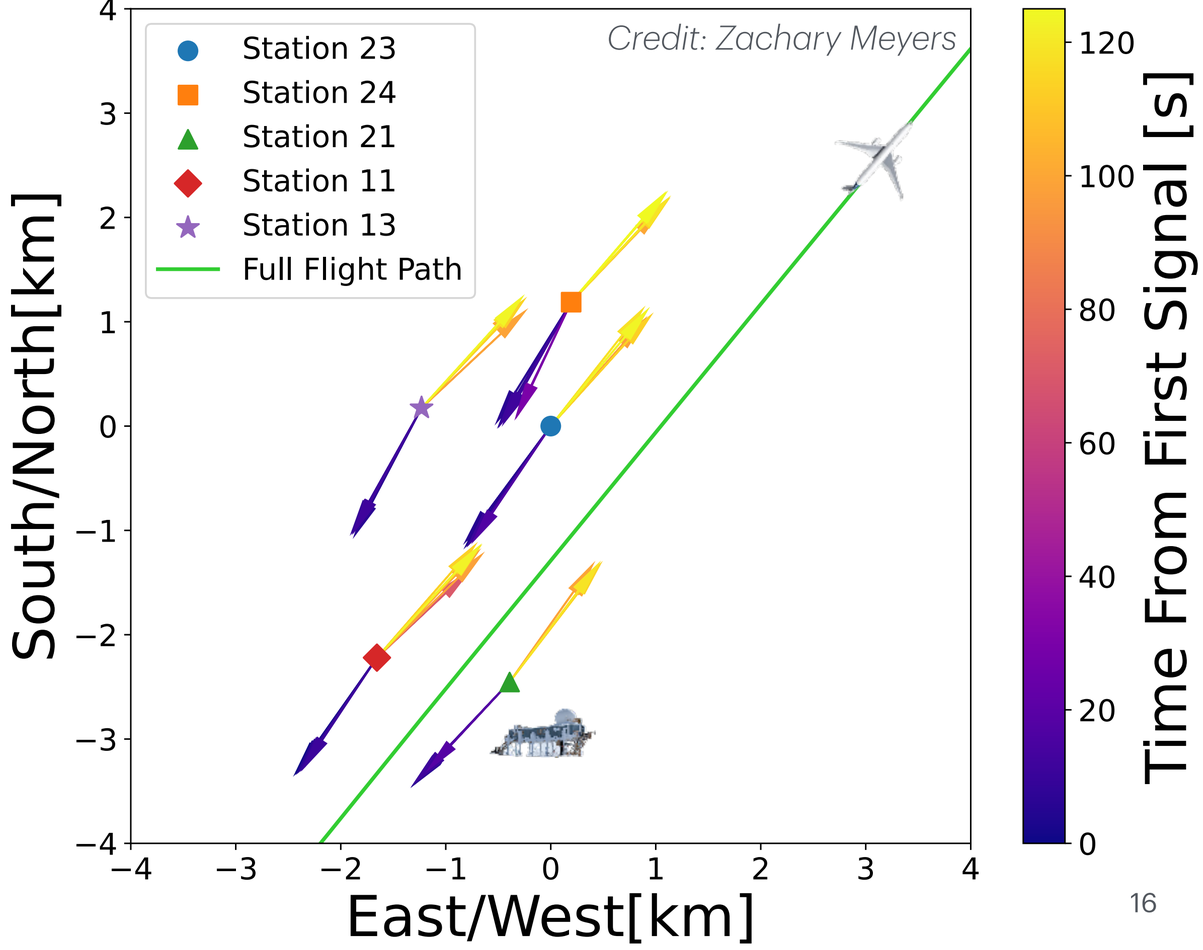
External Radio Sources

Anthropogenic signals like radiosonde weather balloons and airplanes are detected as well; this is a potential future calibration source

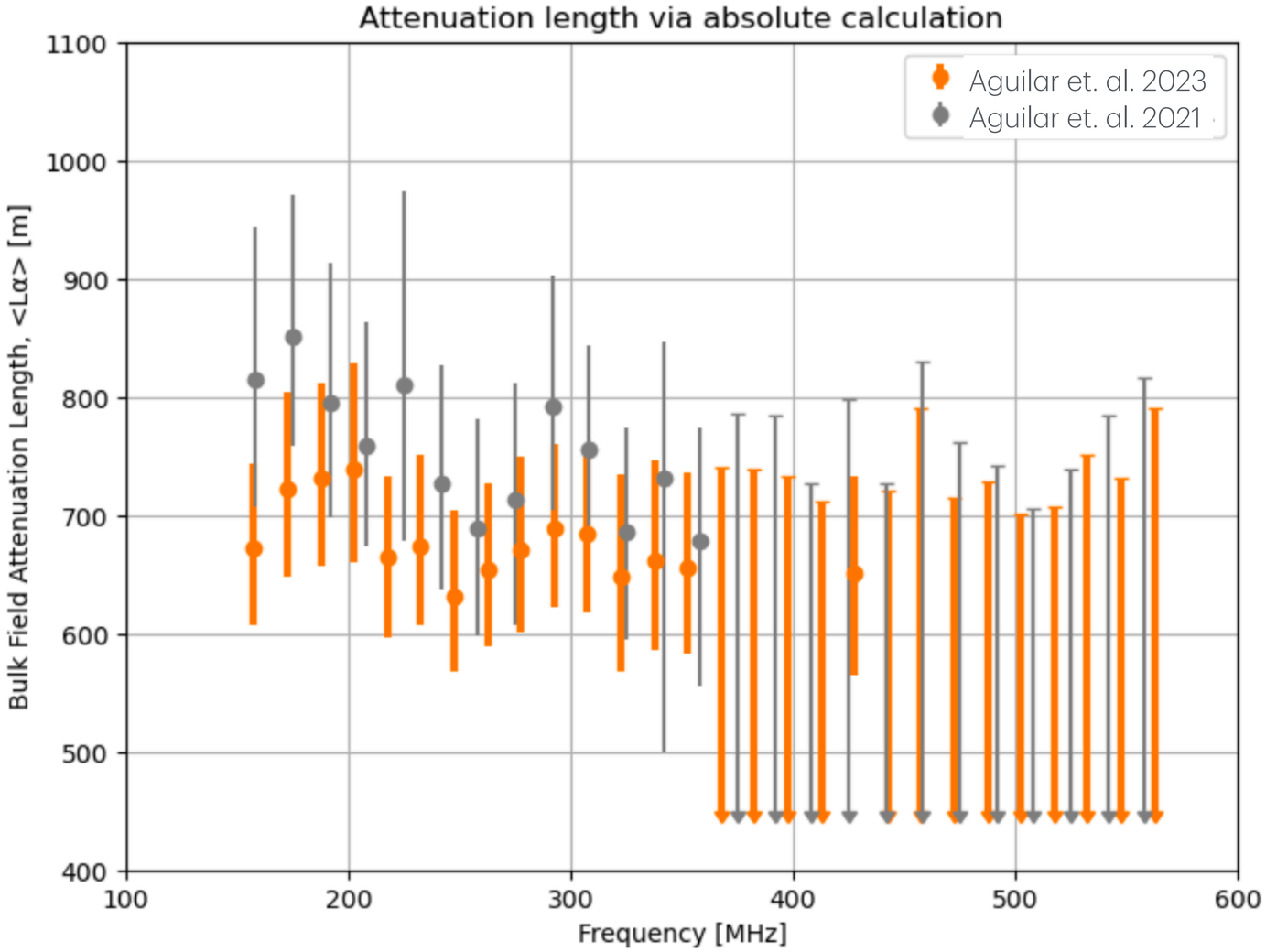
Radiosonde Balloon Reconstruction



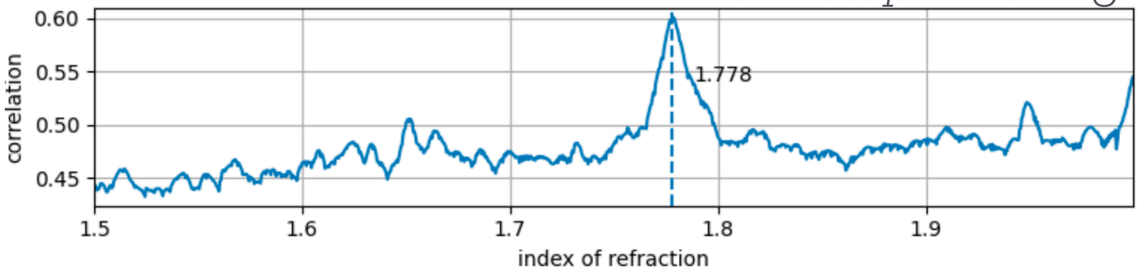
Airplane Reconstruction



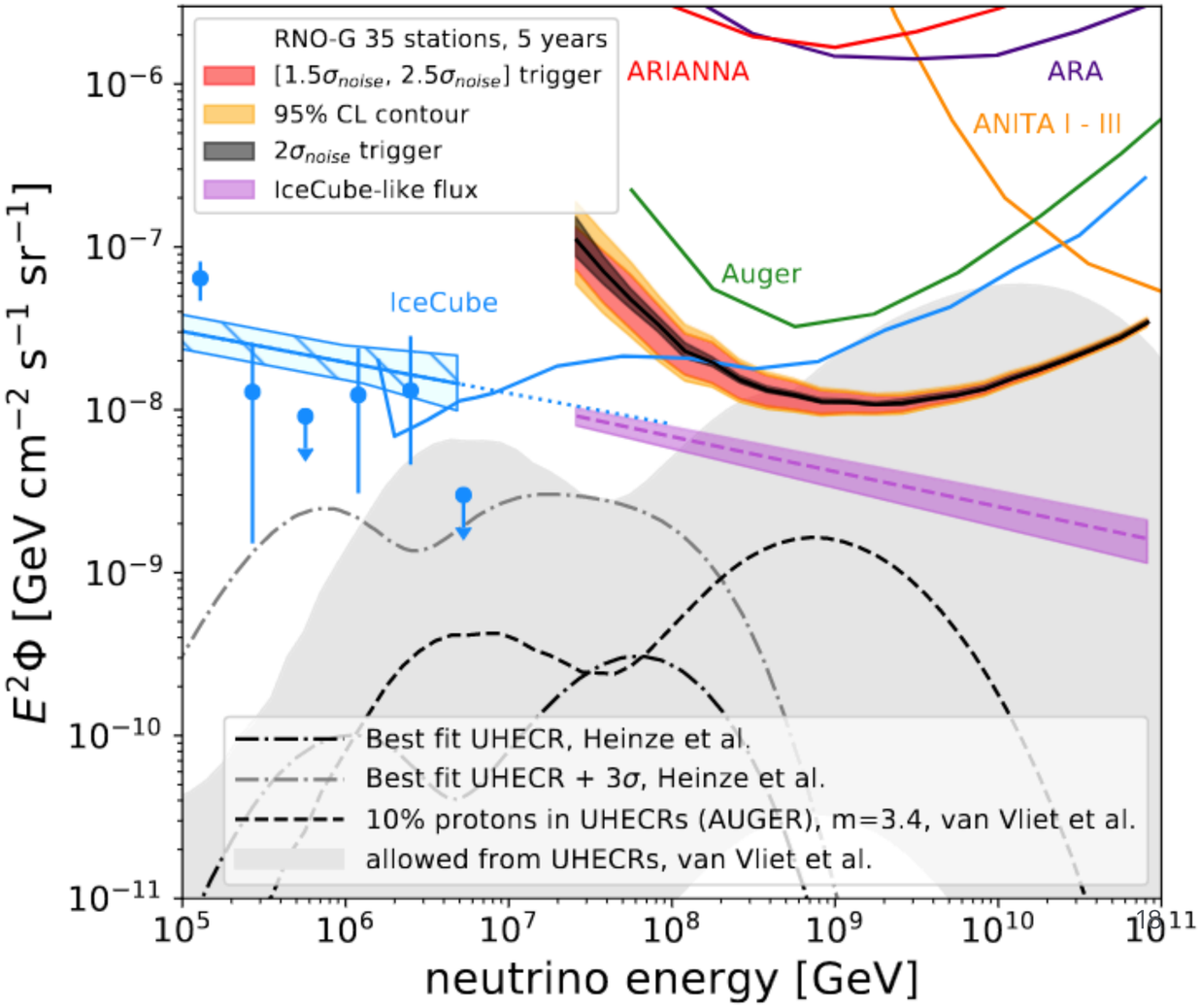
Ice Measurements



Christoph Welling



- Lots of effort has gone into studying the ice around RNO-G; critical for successful calibration and reconstruction
- The attenuation length and bulk index of refraction for radio frequencies have been measured; index of refraction in firn still a work in progress (see Philipp's talk)
- No significant birefringence effects observed on vertically propagating signals

Building towards the future

- RNO-G is currently being constructed and is carefully building tools needed to conduct a neutrino search
- Currently using cosmic rays to determine instrument performance (see Anna Nelles' talk)
- Lots of advancements have been needed to make this happen, on every front: drilling, antenna design, hardware/firmware, and calibration
- 35 stations + 5 years of data will make RNO-G sensitive to most optimistic cosmogenic flux models