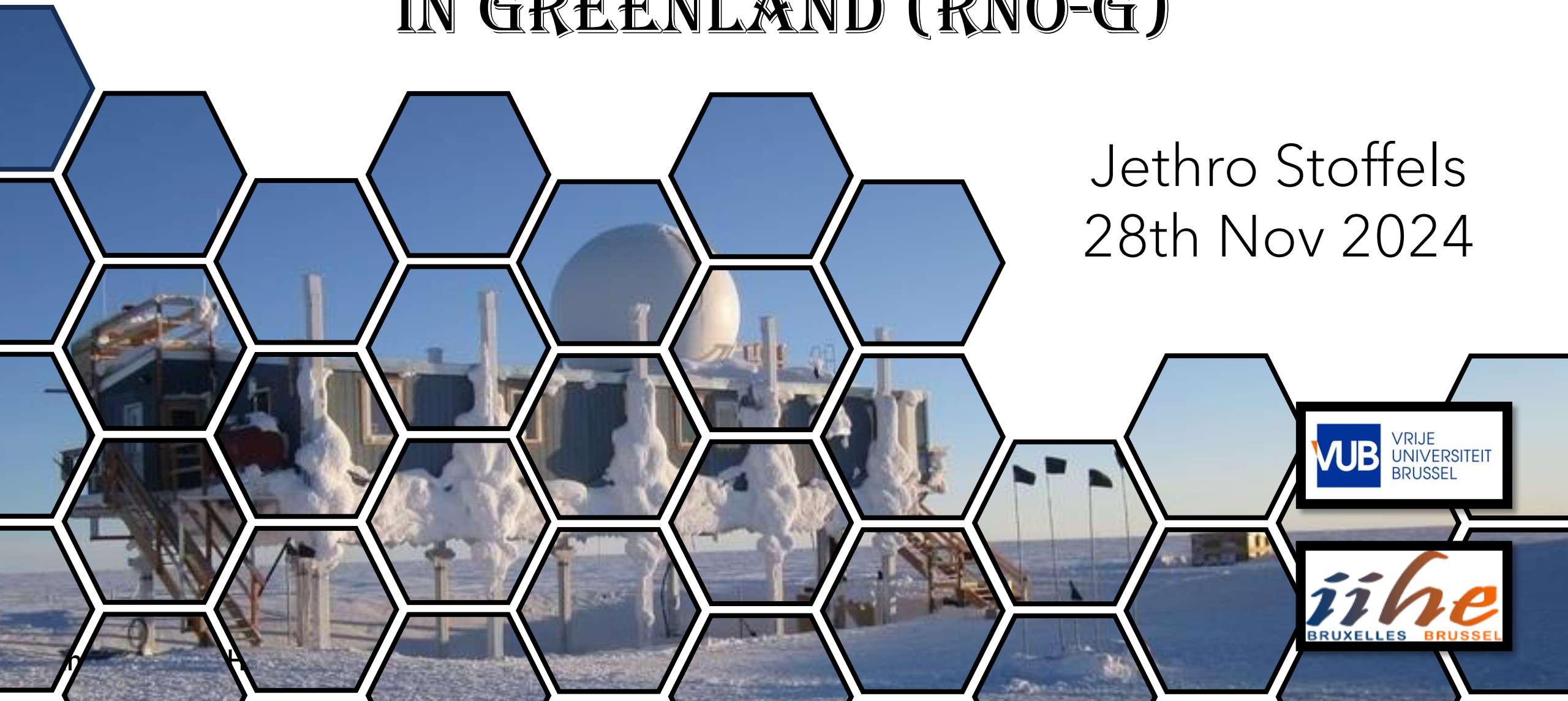
The Radio Neutrino Observatory in Greenland (RNO-G)



Jethro Stoffels

28th Nov 2024

VRIJE UNIVERSITEIT BRUSSEL

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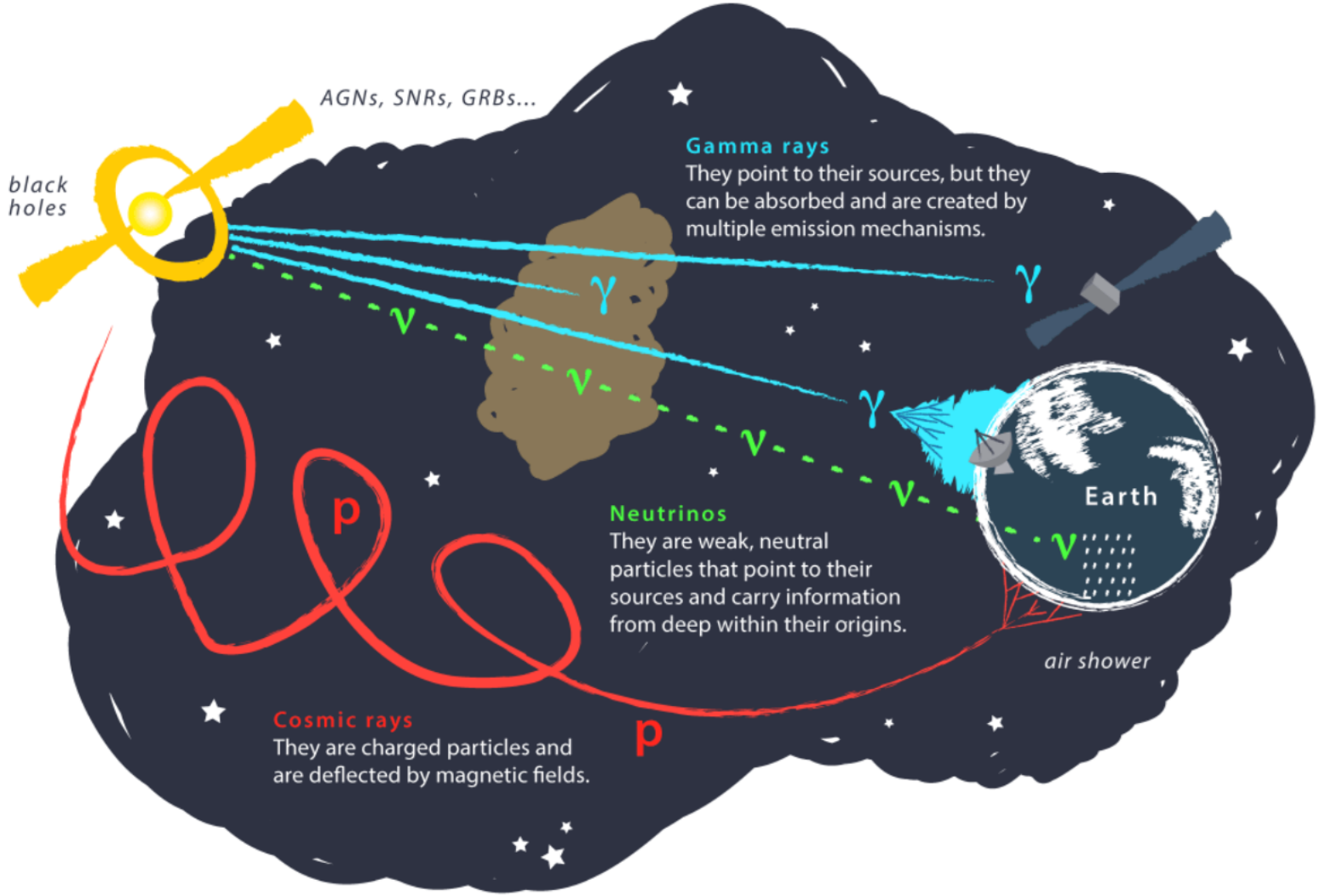
Neutrino astronomy



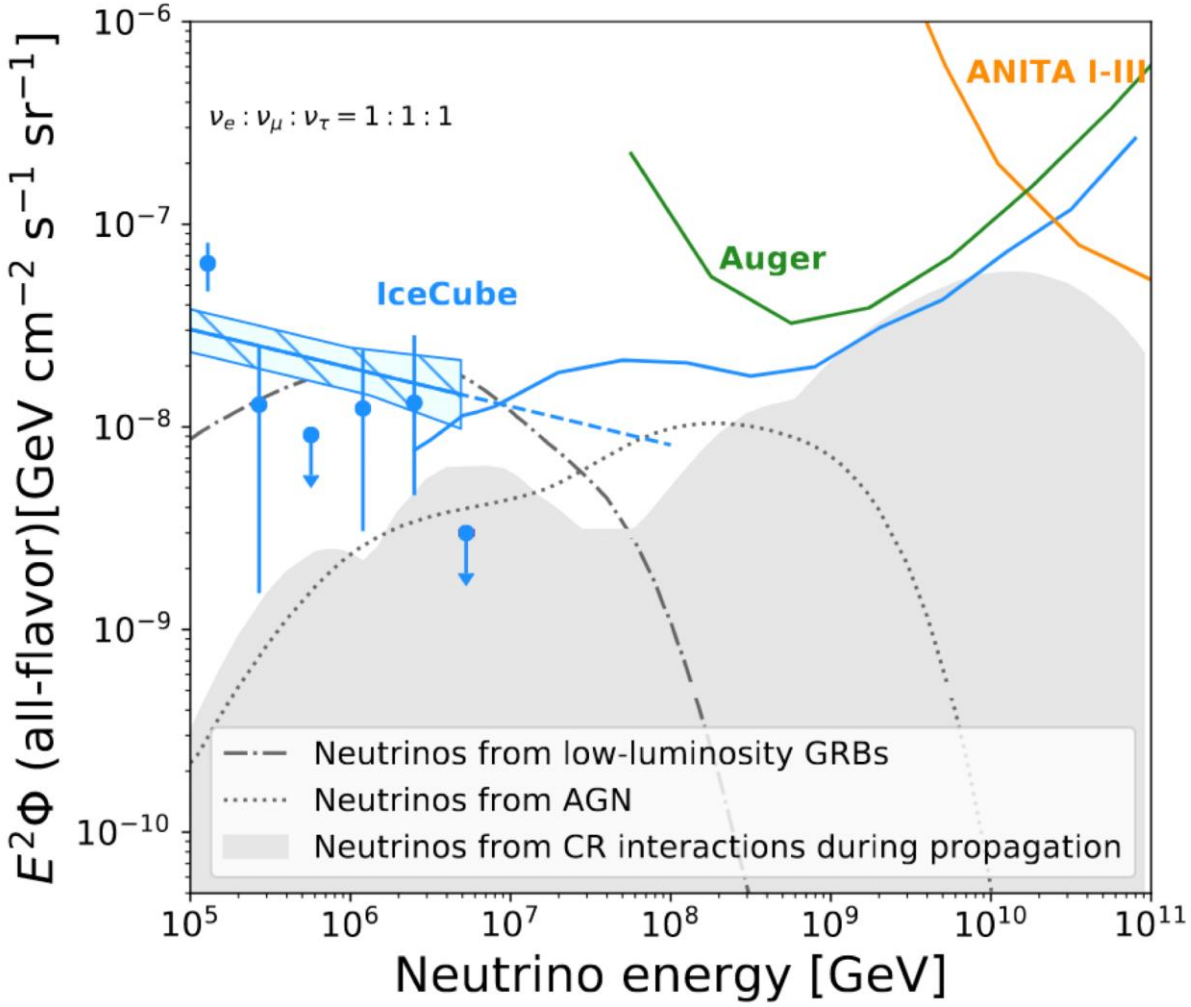
Source: Juan Antonio Aguilar and Jamie Yang. IceCube/WIPAC

Neutrino astronomy

- E < 10PeV: IceCube
  > 10PeV: Terra Incognita

- Models predict Ultra high energy (100PeV – 10EeV) neutrino flux
  ⇒ want to observe flux or place limit

- Higher energy ⇒ Lower flux
  ⇒ 100 IceCubes required!

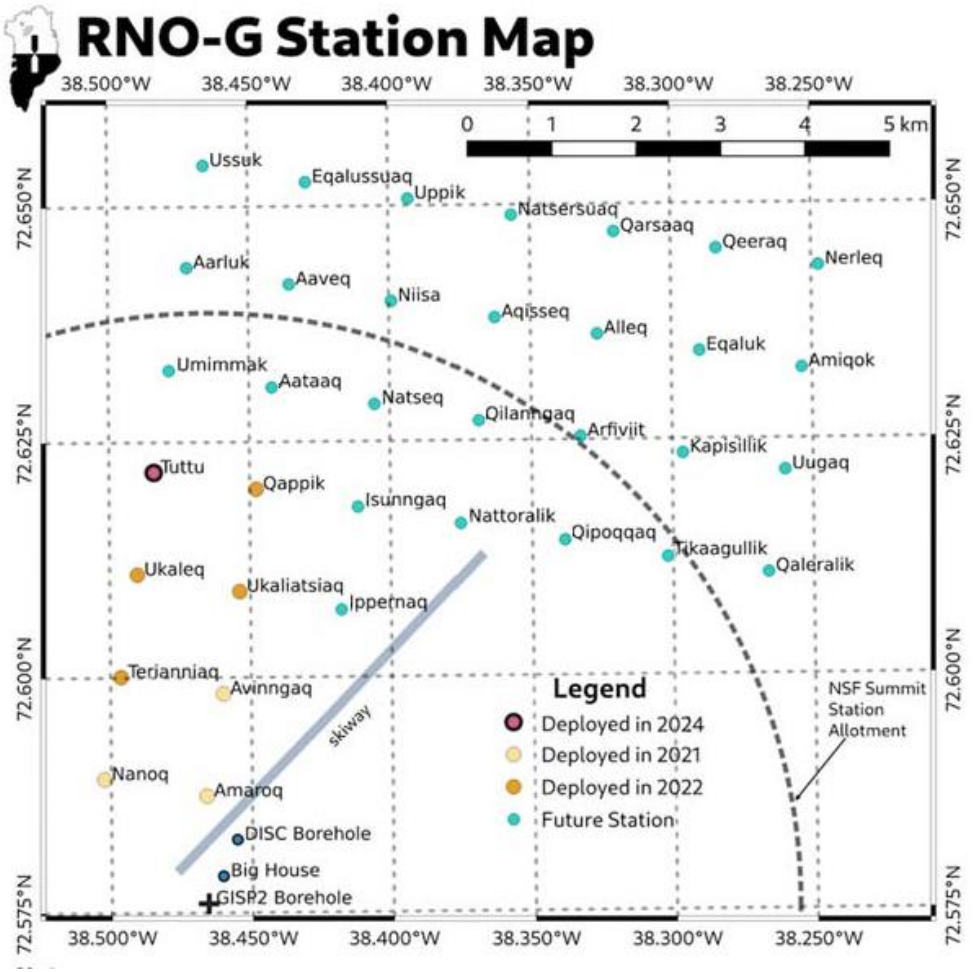


The RNO-G array

- Base sits atop 3km icesheet

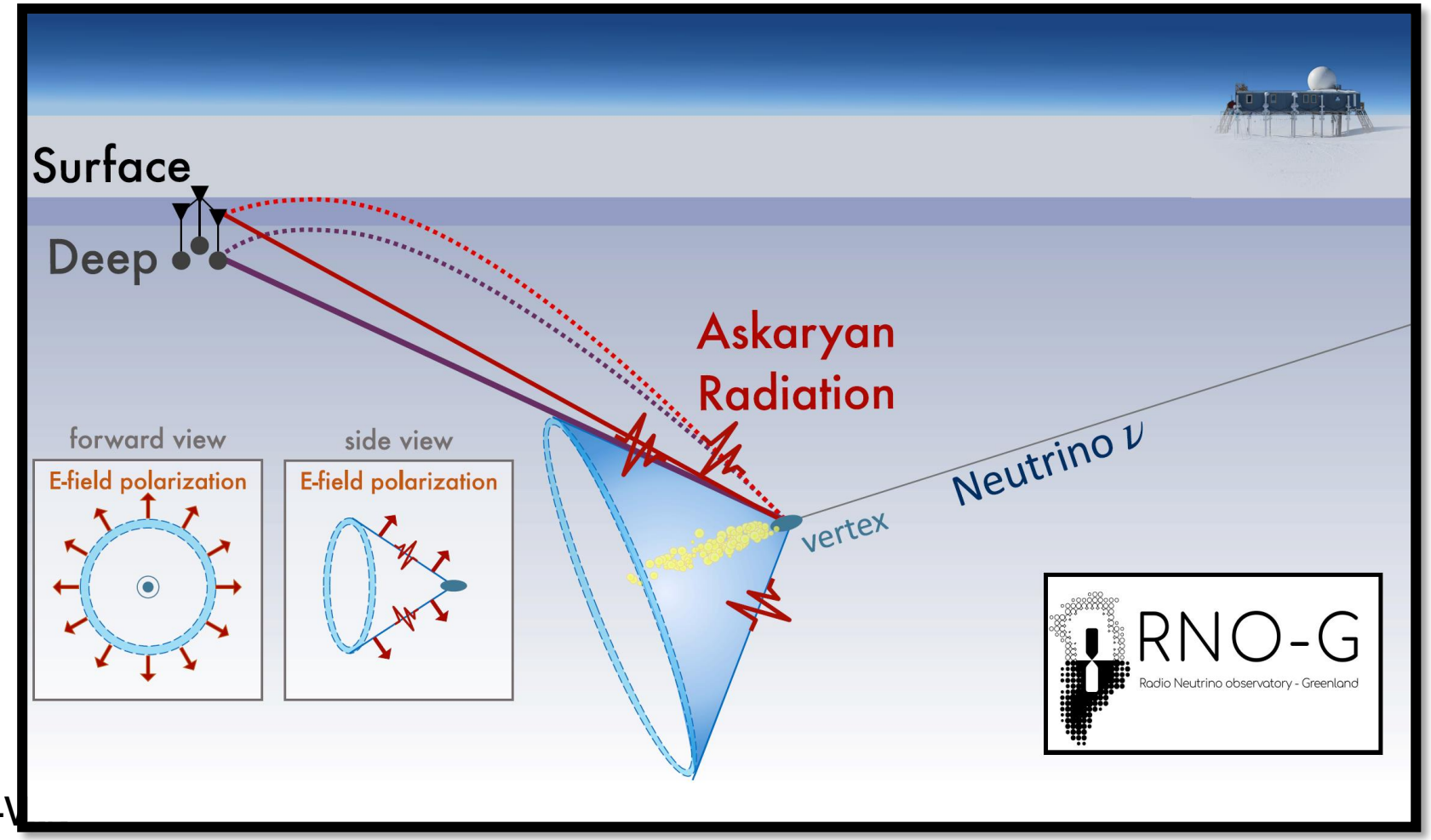
- Infrastructure: Summit Station (NSF)

- 8 of the planned 35 stations installed
  - 1,25km interstation distance



Detection principle

- Charge excess ⇒ Askaryan radiation
- Coherence ⇒ cone shape

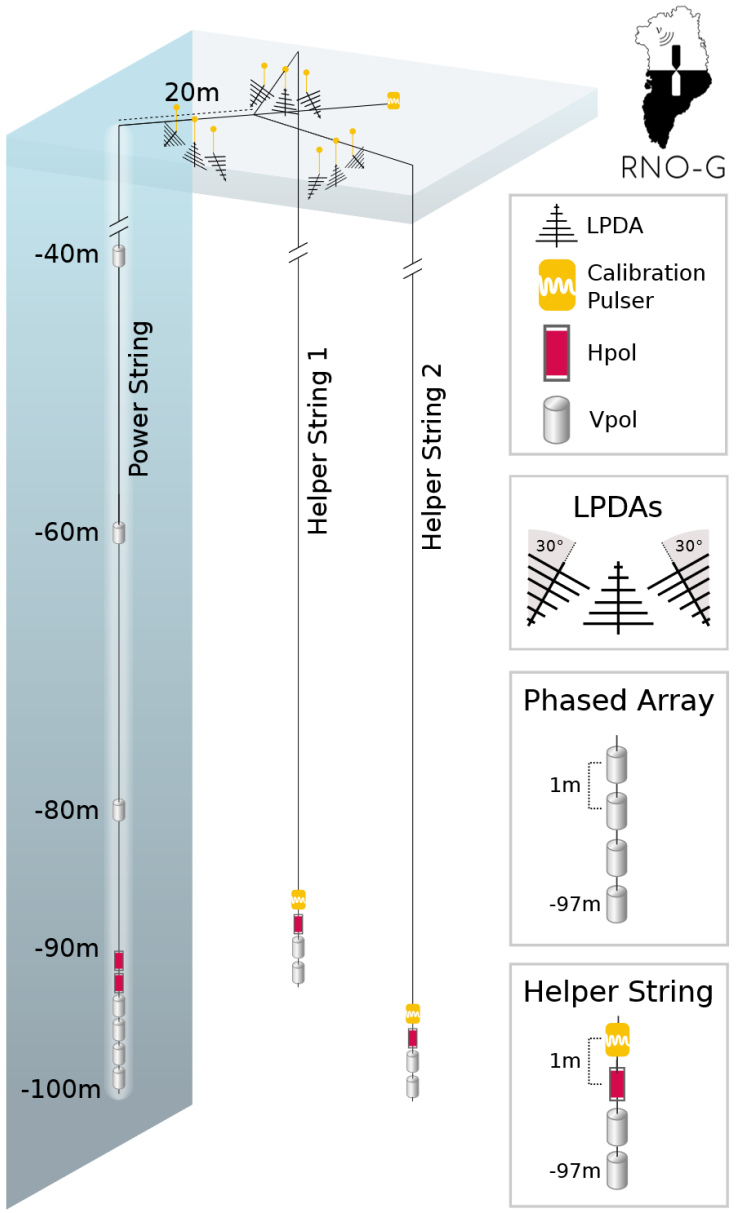


Station design

- 24 antennas/station
  ⇒ 9 surface antennas ↦ Bkg rejection veto
  ⇒ 15 in-ice antennas:
    - Low threshold trigger
    - Phased array interferometry
    - Calibration pulsars

- Solar powered
  ⇒ 7 months operational per year
  ⇒ Extendable via wind power (WIP)

- Highly scalable!



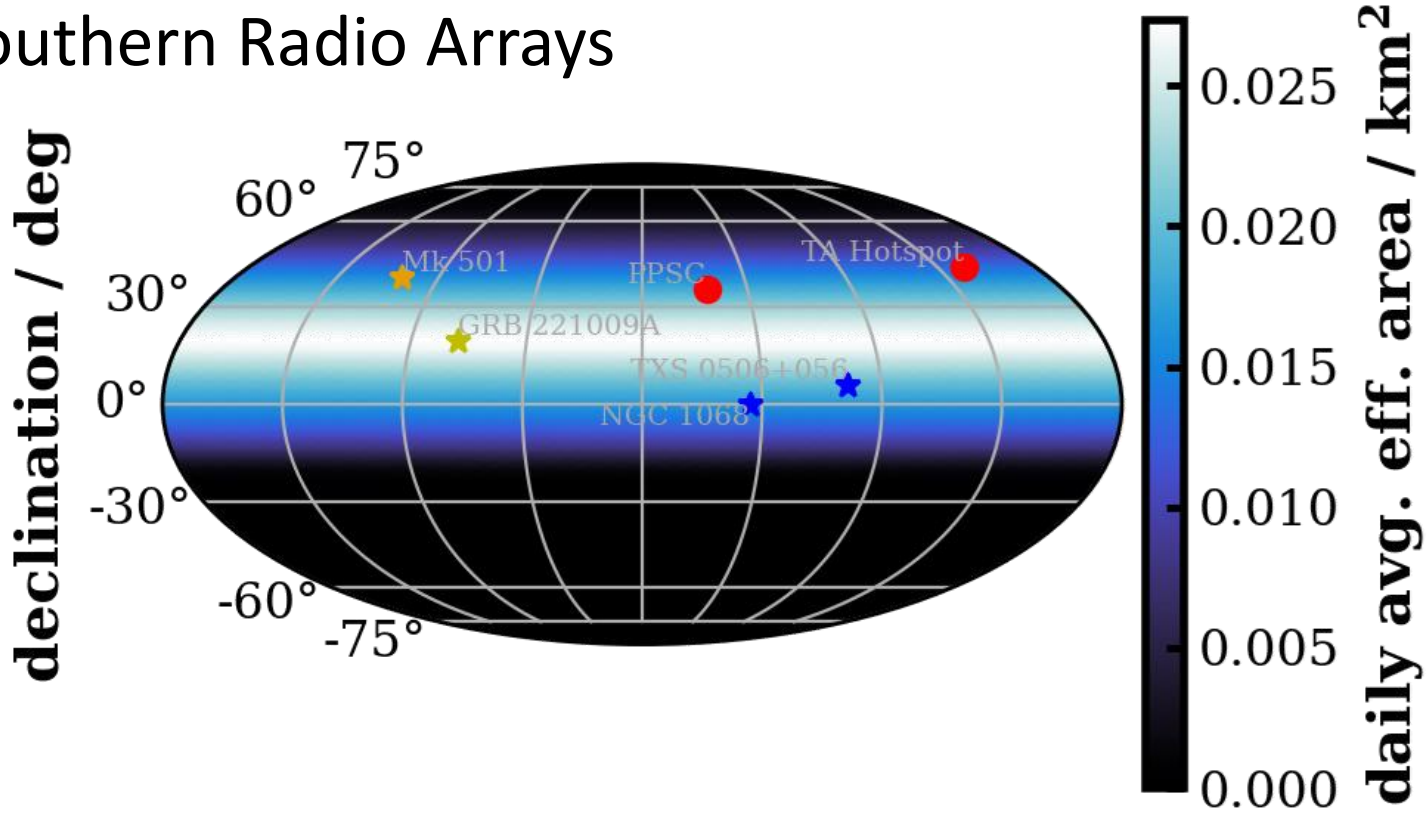
Source: S. Agarwal et al, (RNO-G Collaboration), arXiv:2411.12922

Field of view

- Overlapping with IceCube (but at different energies)

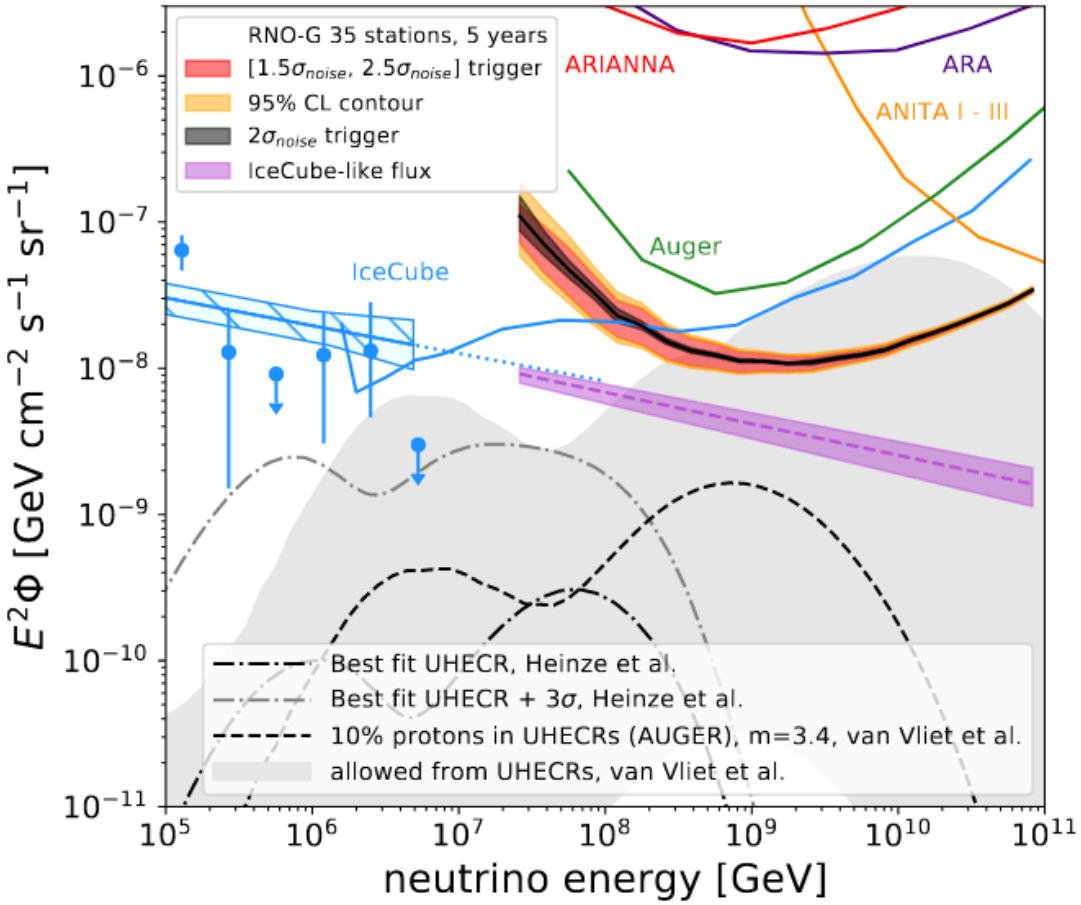
- Complementary to Southern Observatories
  ⇒ Complementary FoV to Southern Radio Arrays

- Covers popular sources
  ⇒ Multimessenger studies



Sensitivity

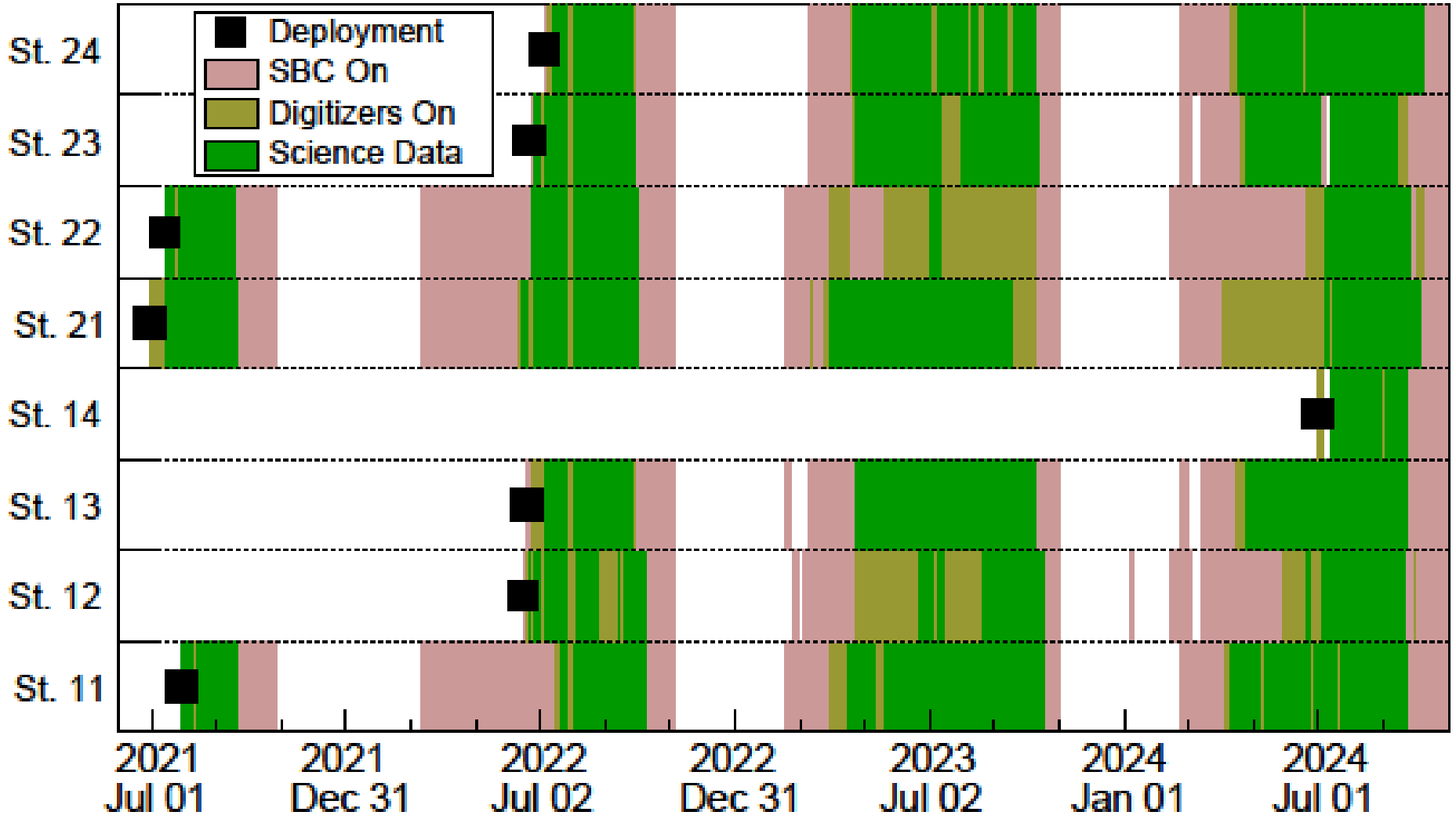
- World leading sensitivity @ 1EeV
- Testing optimistic cosmogenic neutrino models (grey)
- Testing extension of astrophysical source flux measured by IceCube



Source: J. Aguilar et al, (RNO-G Collaboration),JINST 16 P03025 2021

CURRENT RESULTS

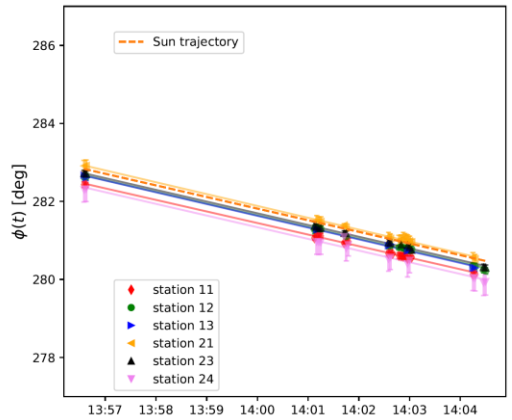
Performance

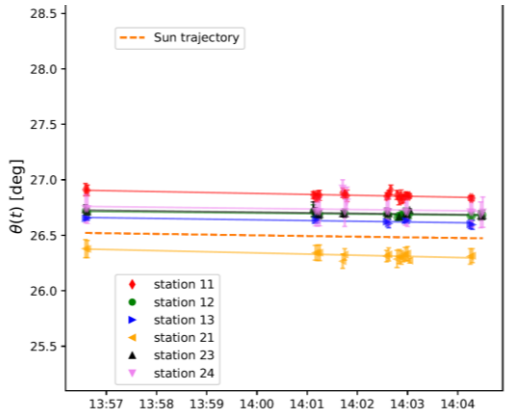


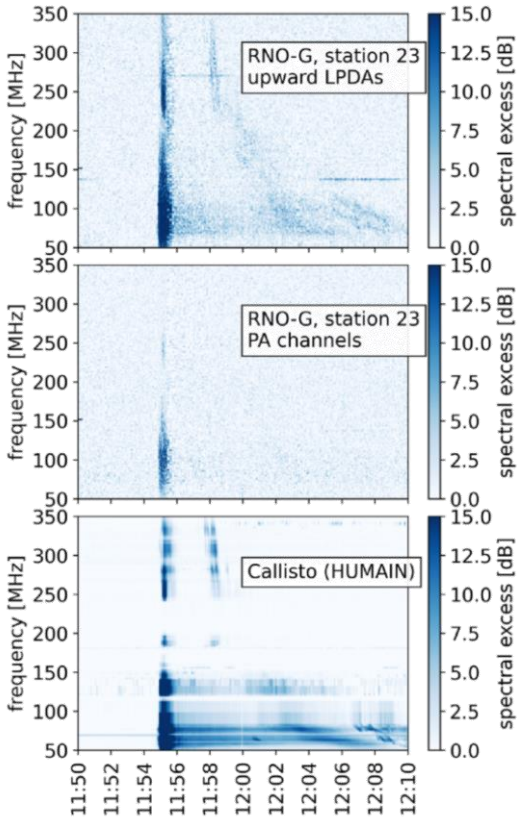
CURRENT RESULTS

Solar flares

- Solar flare pointing: degree accuracy

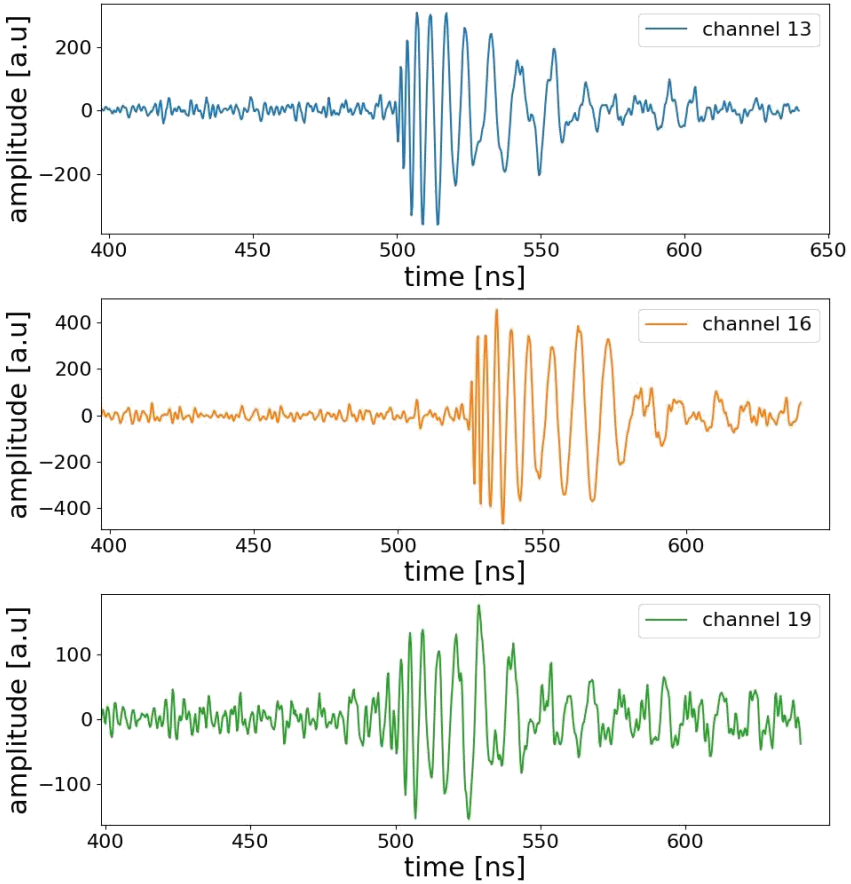






Source: S. Agarwal et al, (RNO-G Collaboration), arXiv:2404.14995

CR Candidate event

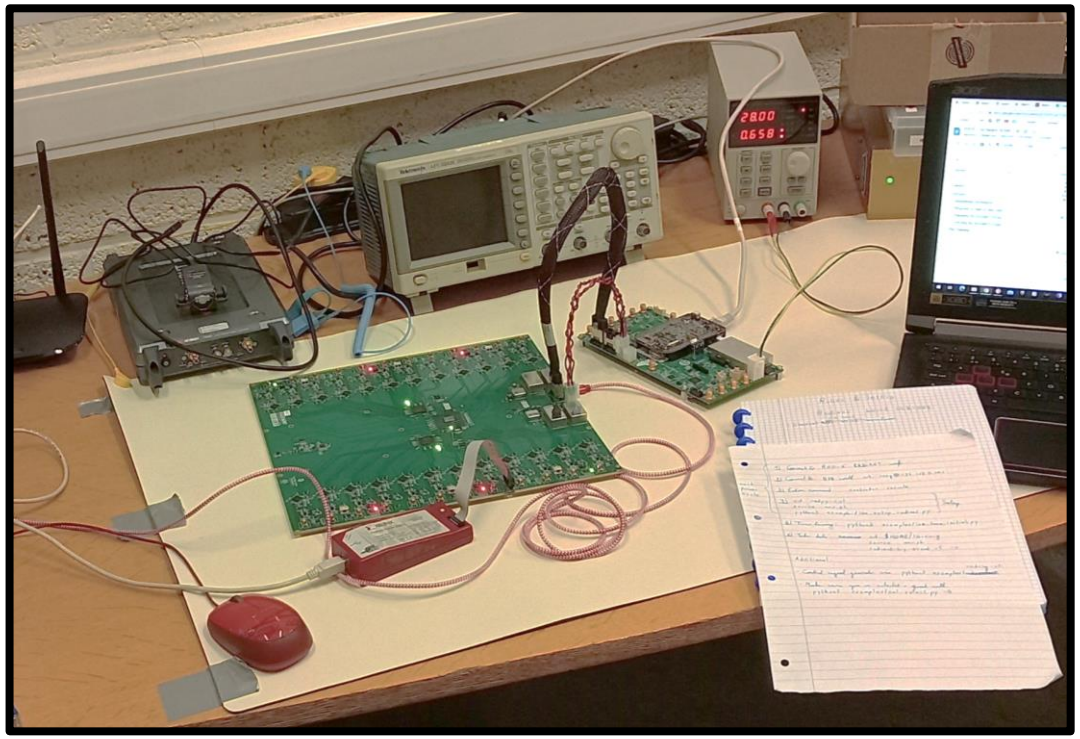


Source: PoS(ICRC2023)259, Full paper in preparation

RADIANT Production

- Total of 7 RADIANTS deployed in the ice

- Both production and testing done here



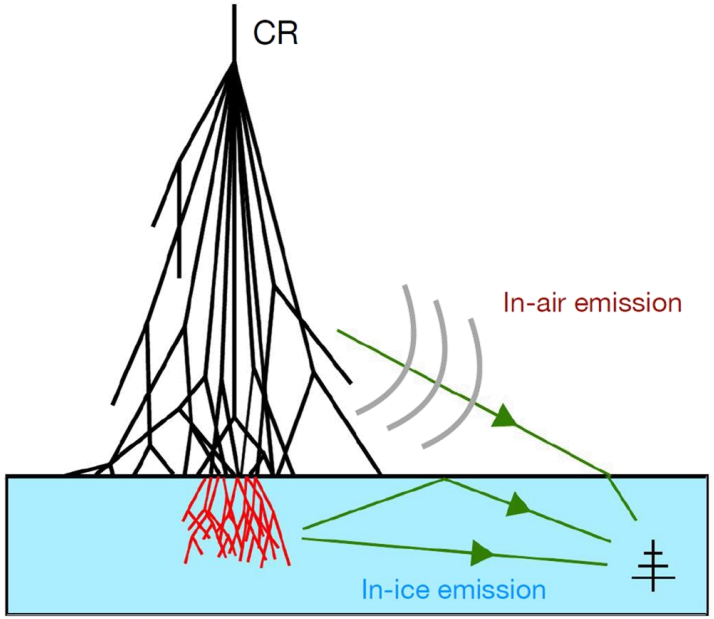
Returned to USA

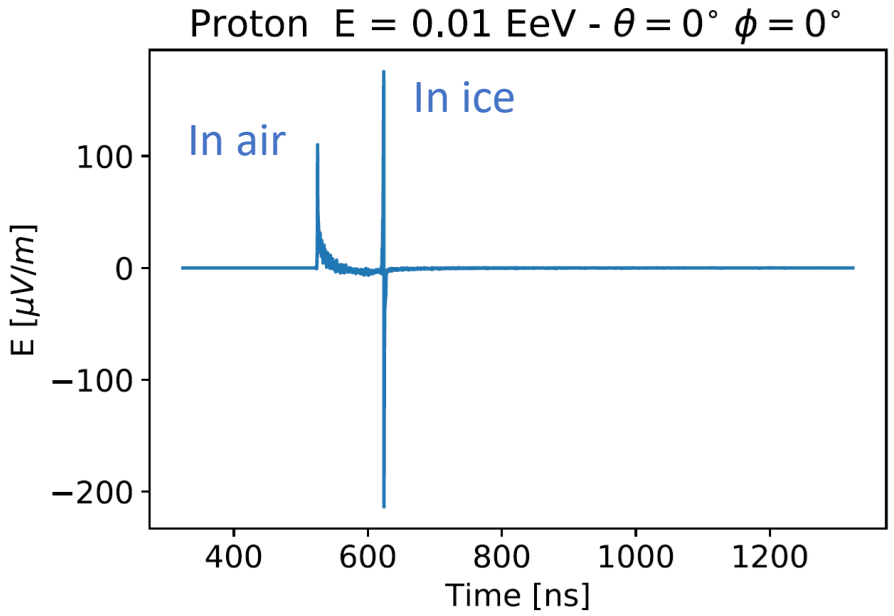
And more…

Cosmic ray airshower simulations

- Builds from FAERIE code

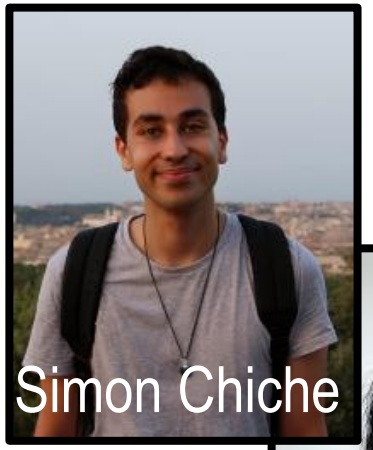
- Investigate CR VS neutrino signal characteristics

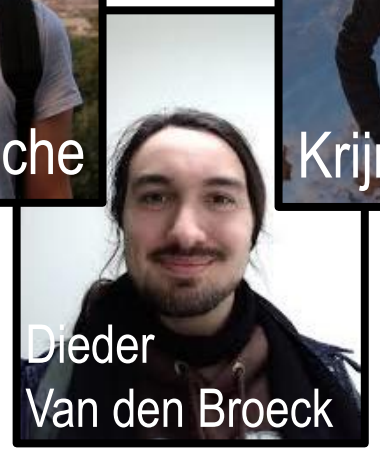




Now in industry

Graduated



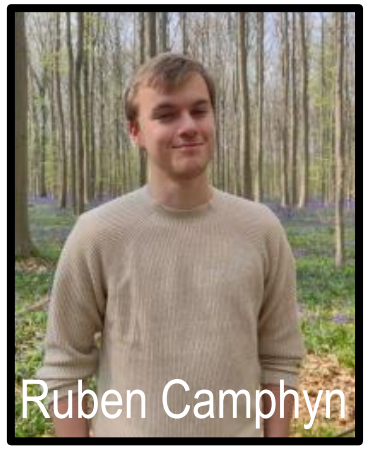


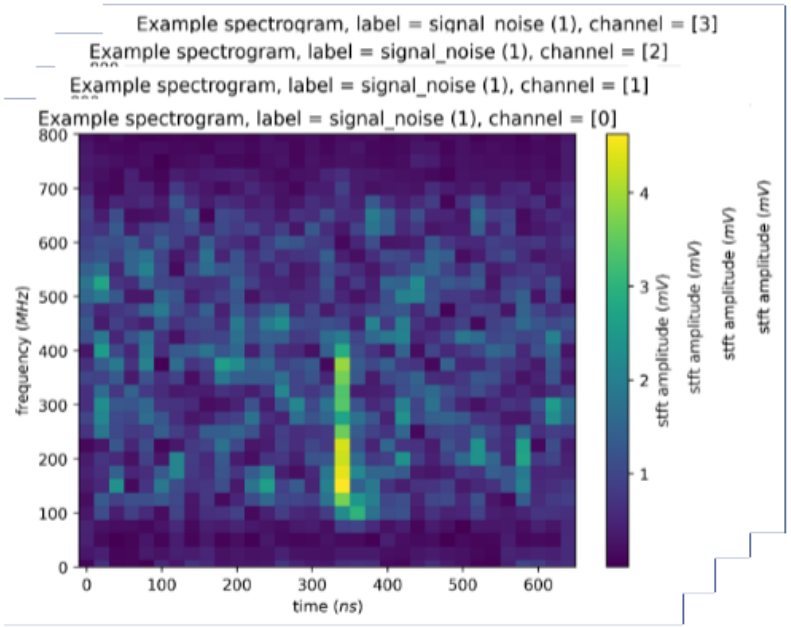
Source: S. Chiche et al, arXiv:2409.02185

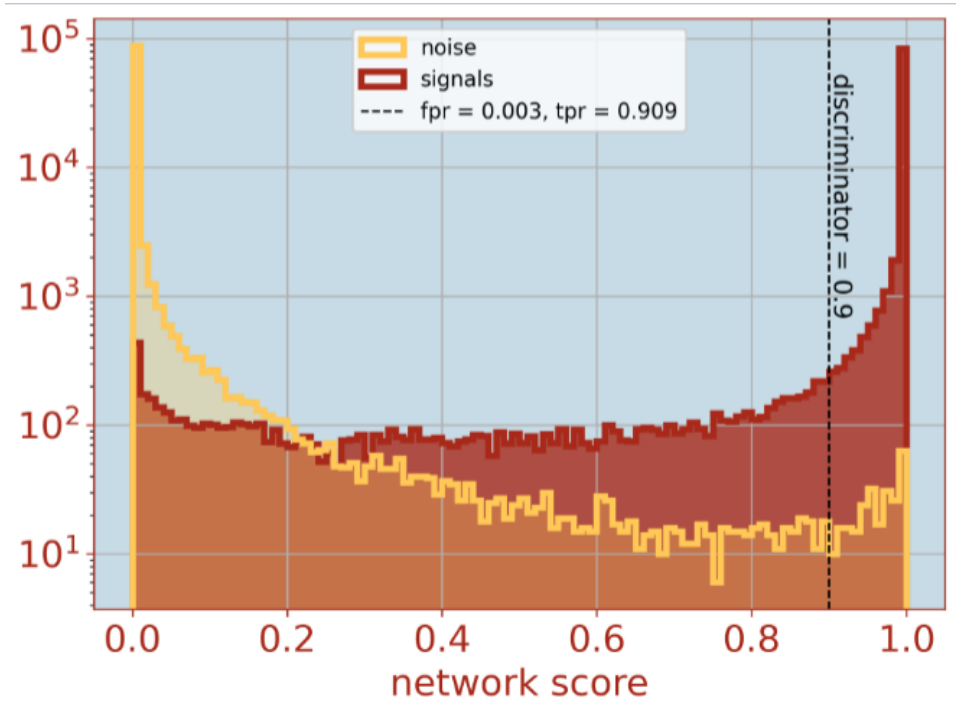
Developing neutrino search

- CNN based algorithm using spectrograms to filter noise events

- Encouraging result: FPR (~0.2 – 0.1 %)

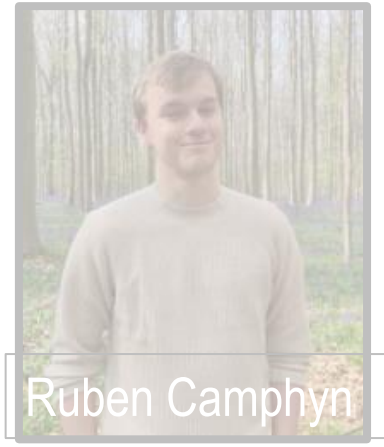






Developing neutrino search

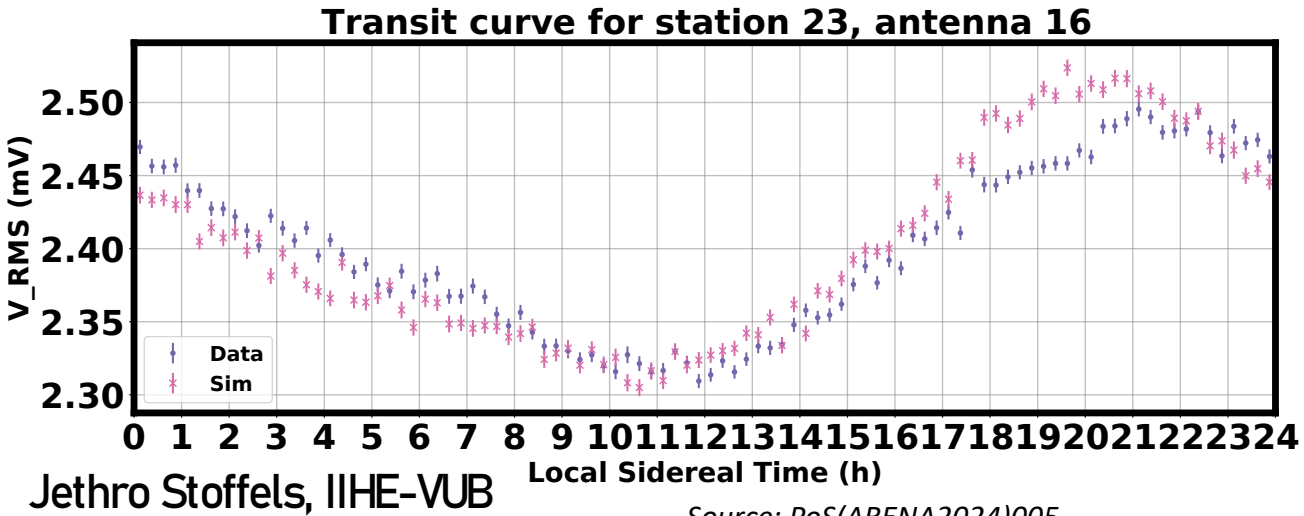
- Current efforts:
  - Simulations
  - Operations
  - …

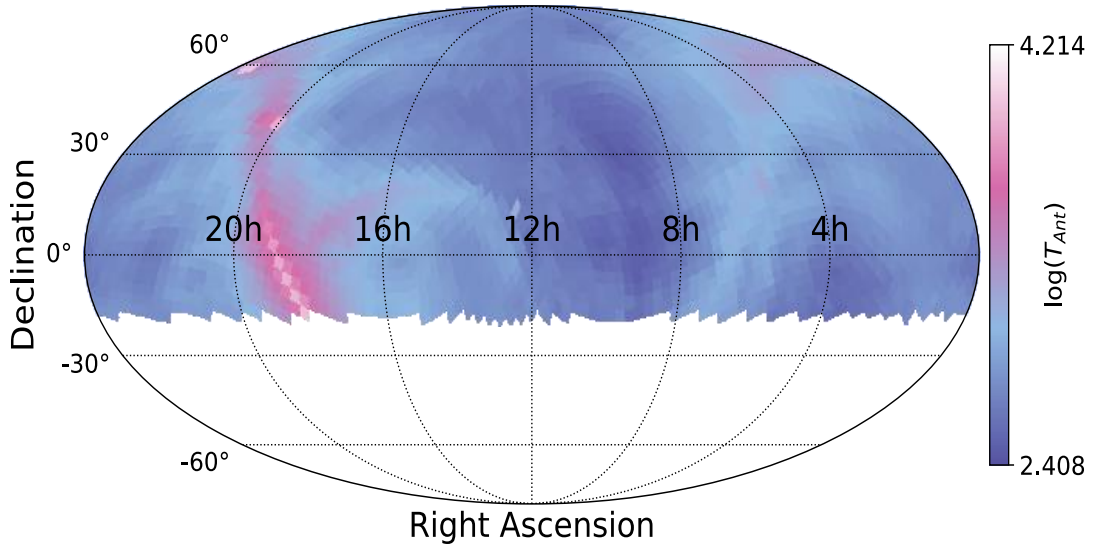


Galactic signal

- Transit curves (V_{RMS} vs LST) - Sim = Thermal + Galactic noise

- Good agreement for T=266,1K
  - Except for 18hr->21hr! (cf other experiments)
  - Still under investigation





Filter for galactic dominant region (<110MHz)

Source: PoS(ARENA2024)005

IIHE EFFORTS

Deployment

- People sent so far: Uzair, Paramita, Katie, Simon, Felix & Jethro

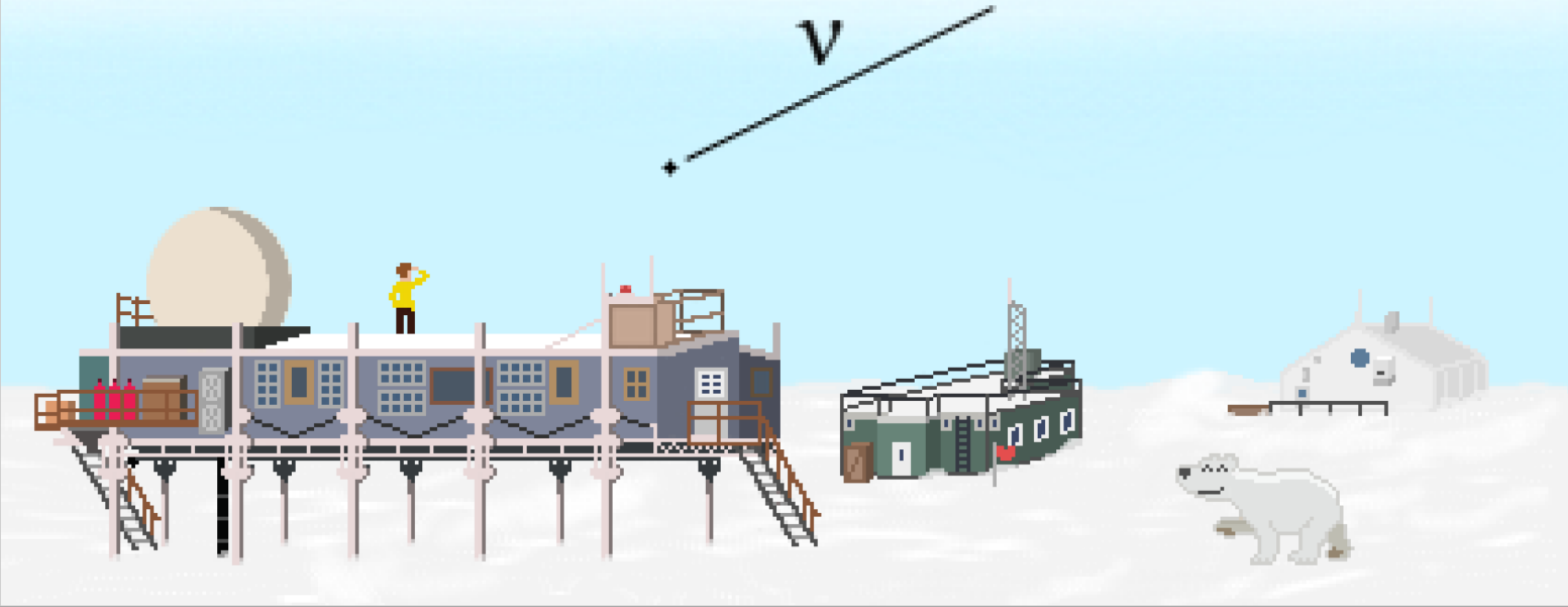
RNO-G COLLABORATION

VUB VRIJE UNIVERSITEIT BRUSSEL
PennState
University of Nebraska Lincoln
Radboud University
ULB UNIVERSITÉ LIBRE DE BRUXELLES
WISCONSIN UNIVERSITY OF WISCONSIN–MADISON
THE UNIVERSITY OF CHICAGO
UPPSALA UNIVERSITET
DESY.
KU THE UNIVERSITY OF KANSAS
GHENT UNIVERSITY
FAU Friedrich-Alexander-Universität Erlangen-Nürnberg
THE OHIO STATE UNIVERSITY
WHITTIER COLLEGE 1887
UNIVERSITY OF MARYLAND
UNIVERSITY OF DELAWARE
THE UNIVERSITY OF ALABAMA

SUMMARY

- RNO-G:
  - 35 Stations (eight installed)
  - Array finished in few years
  - World leading sensitivity @ 1EeV
  - Strong case for multi-messenger astronomy

- Extensive group at IIHE led by Nick & Simona

- Contribute to various efforts:
  - Simulation tools
  - Data analysis
  - Deployment
  - Hardware production

Questions