Highlights from RNO-G and RET

Ruben Camphyn on behalf of RNO-G/RET

RNO-G

Radio Neutrino Observatory - Greenland

RADAR ECHO TELESCOPE

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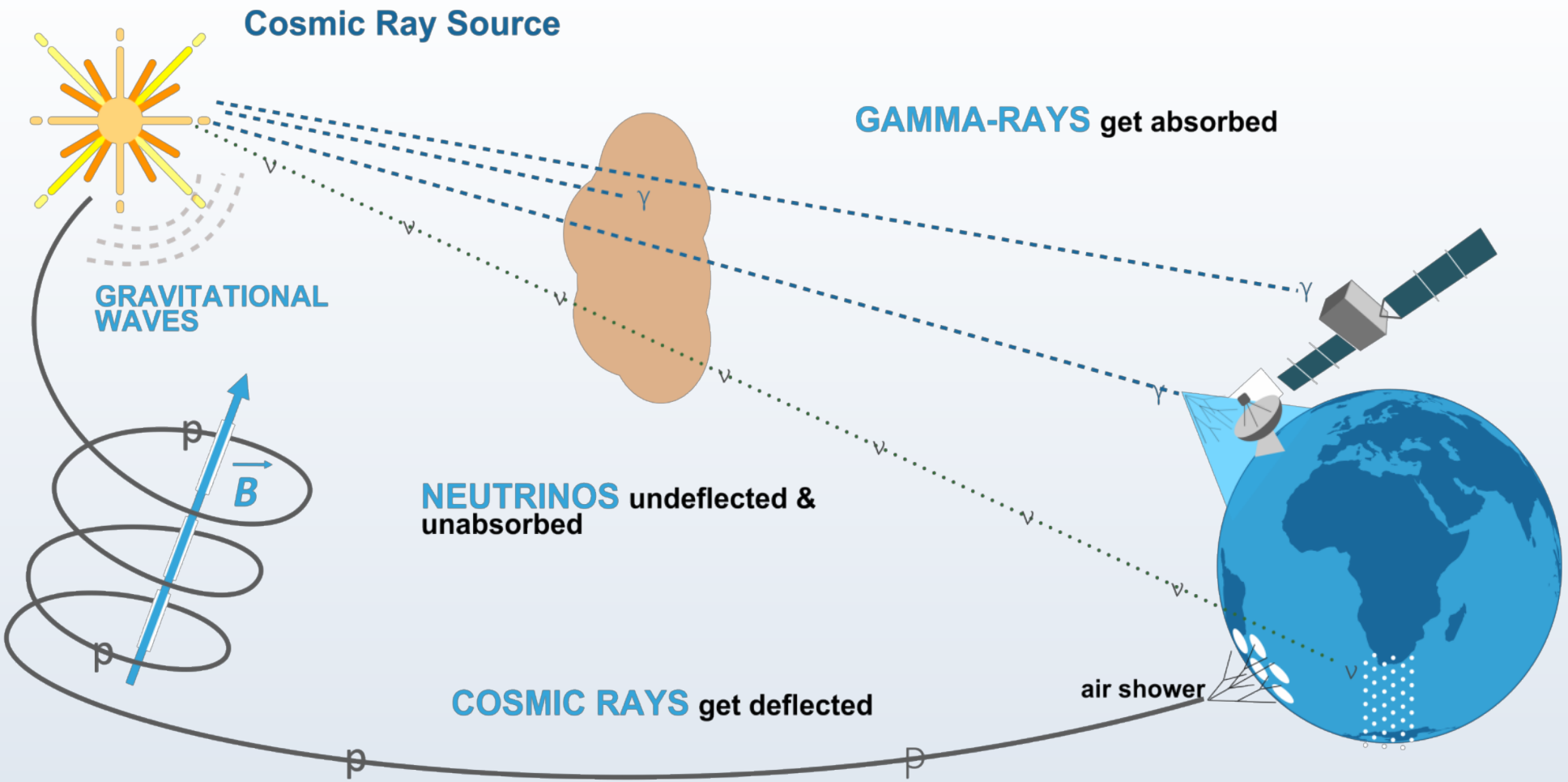
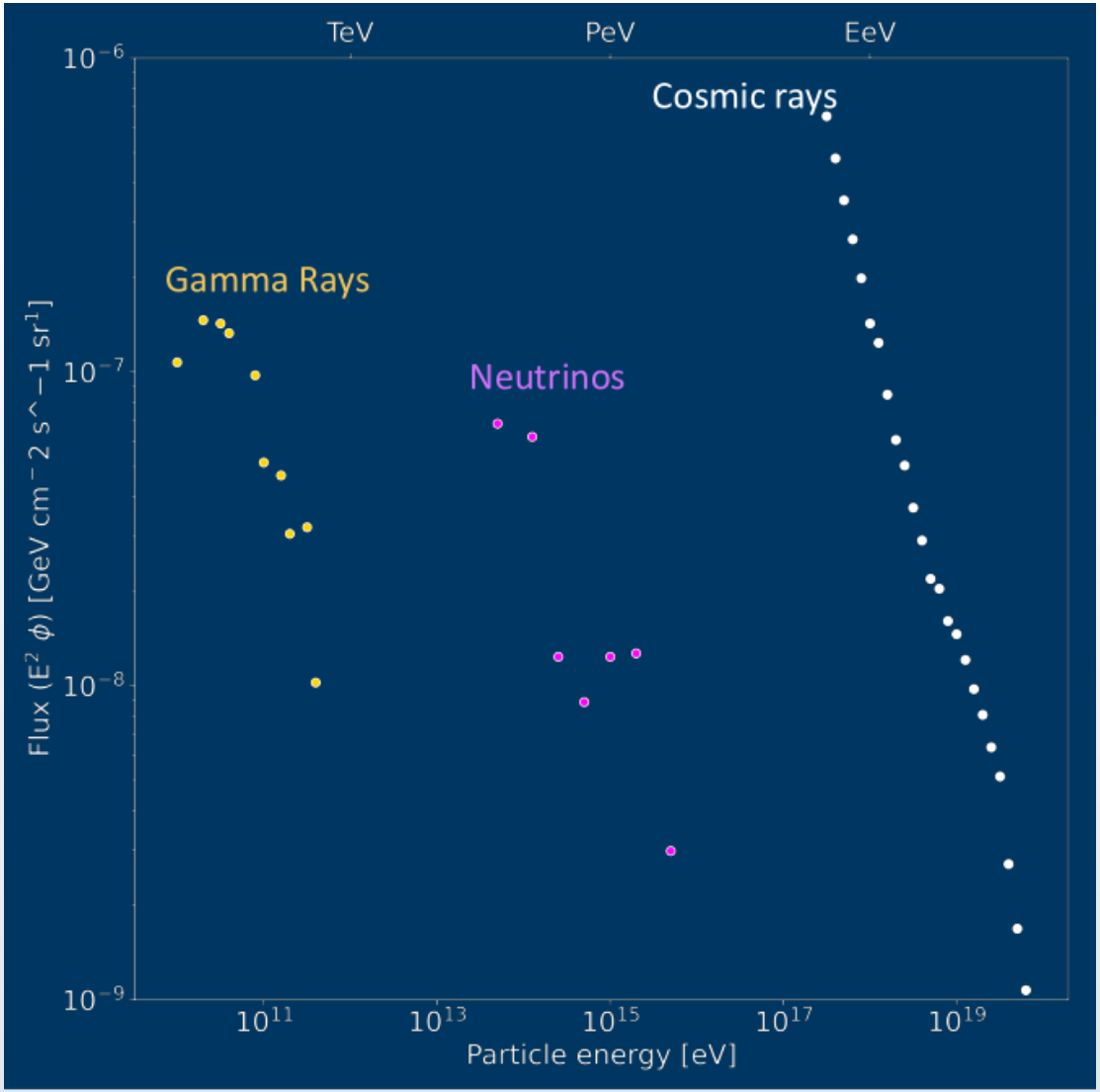
Neutrino astronomy



Neutrino astronomy



Detection principles

RADAR ECHO TELESCOPE

Radio signal can travel ~ 1 km unattenuated
Key point of radio detectors

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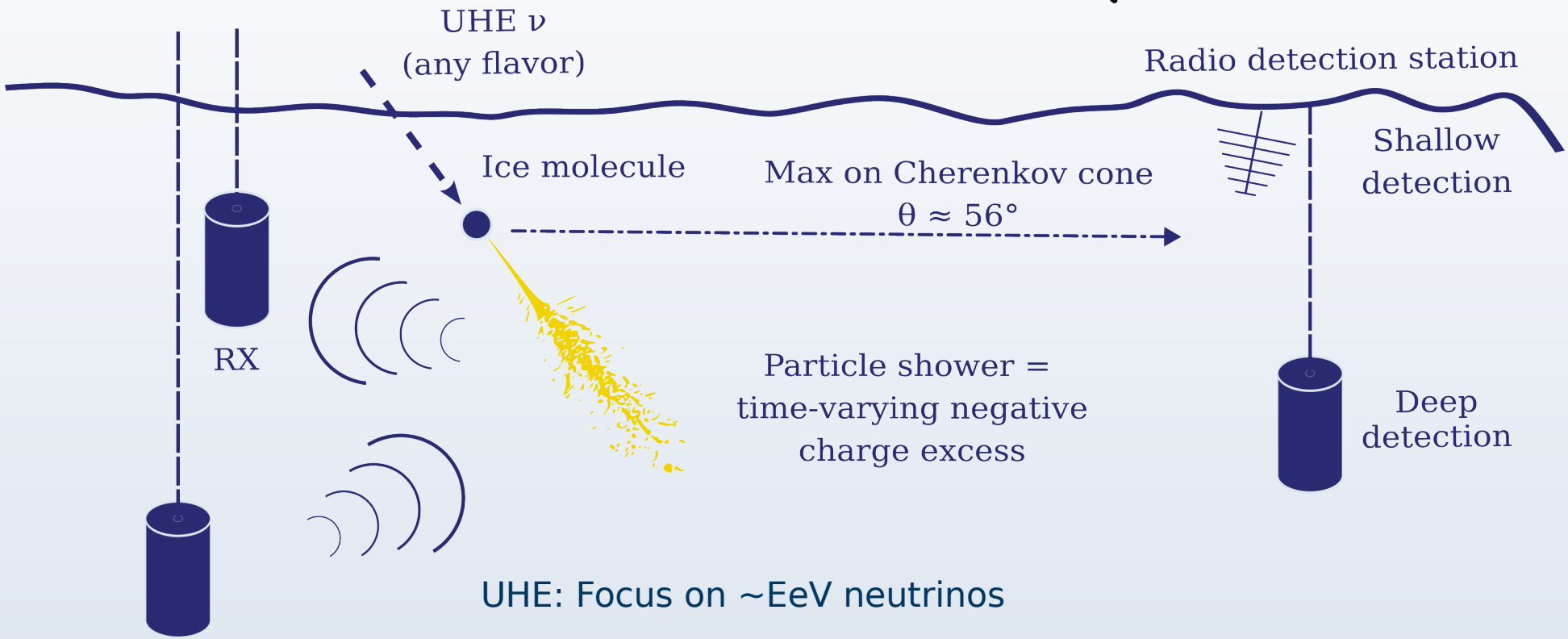
Radio Neutrino Observatory - Greenland



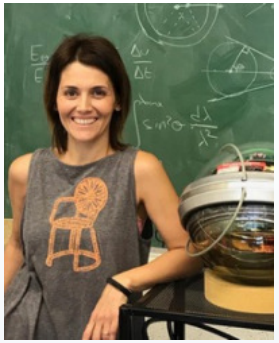
UHE: Focus on ~EeV neutrinos

Infrastructure

- Summit Station Greenland*
- Ice sheet ~3 km
- Summer deployment
- 9 months sunlight
- ()

* location not yet set for next stage RET





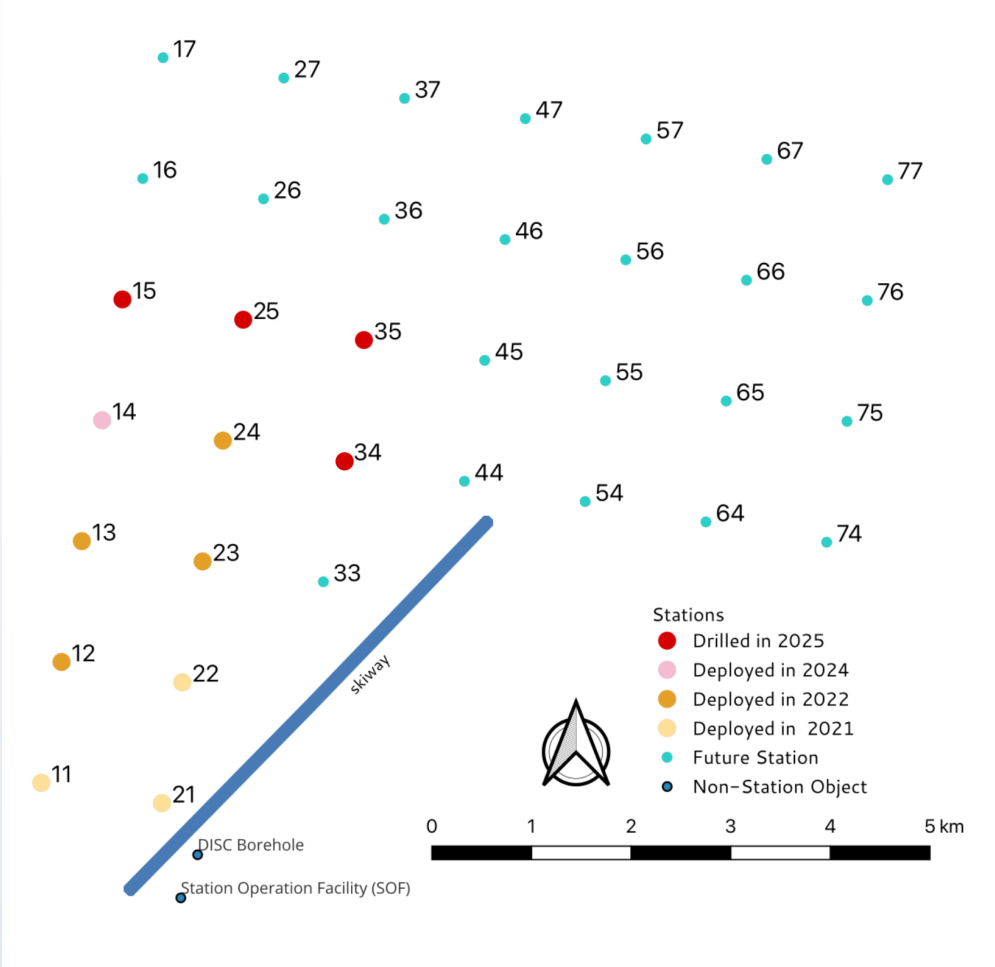


RNO-G

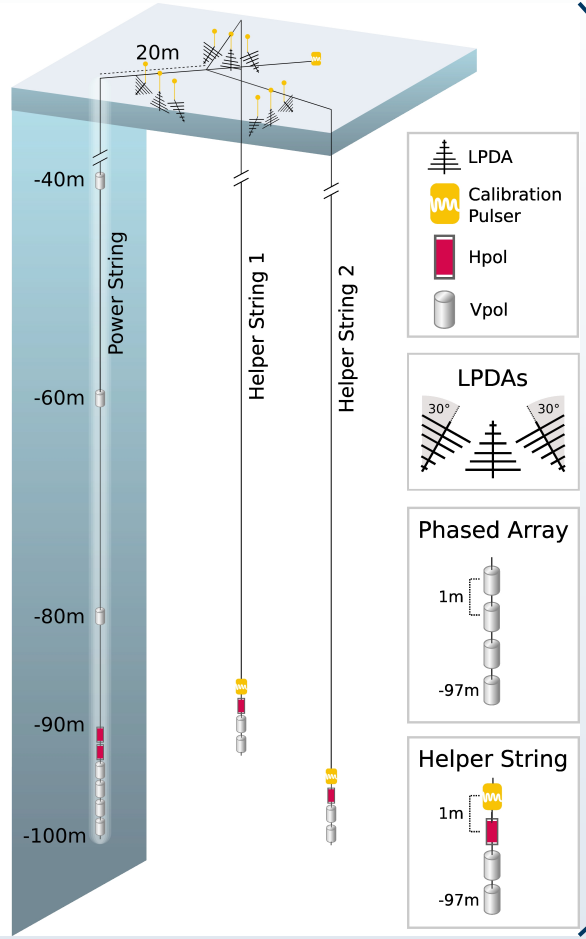
Radio Neutrino Observatory - Greenland

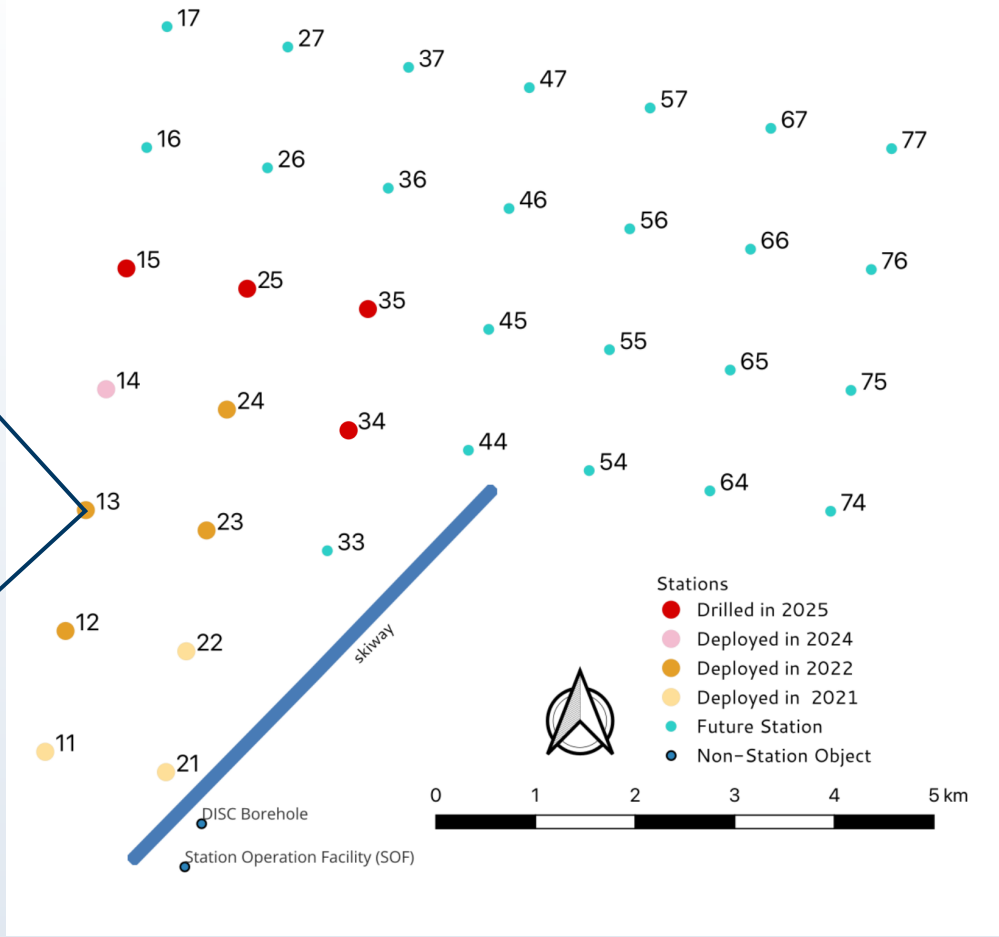
Detector deployment

- 35 independent stations
- Solar / wind powered
- 8 stations operational
- ~50 km²

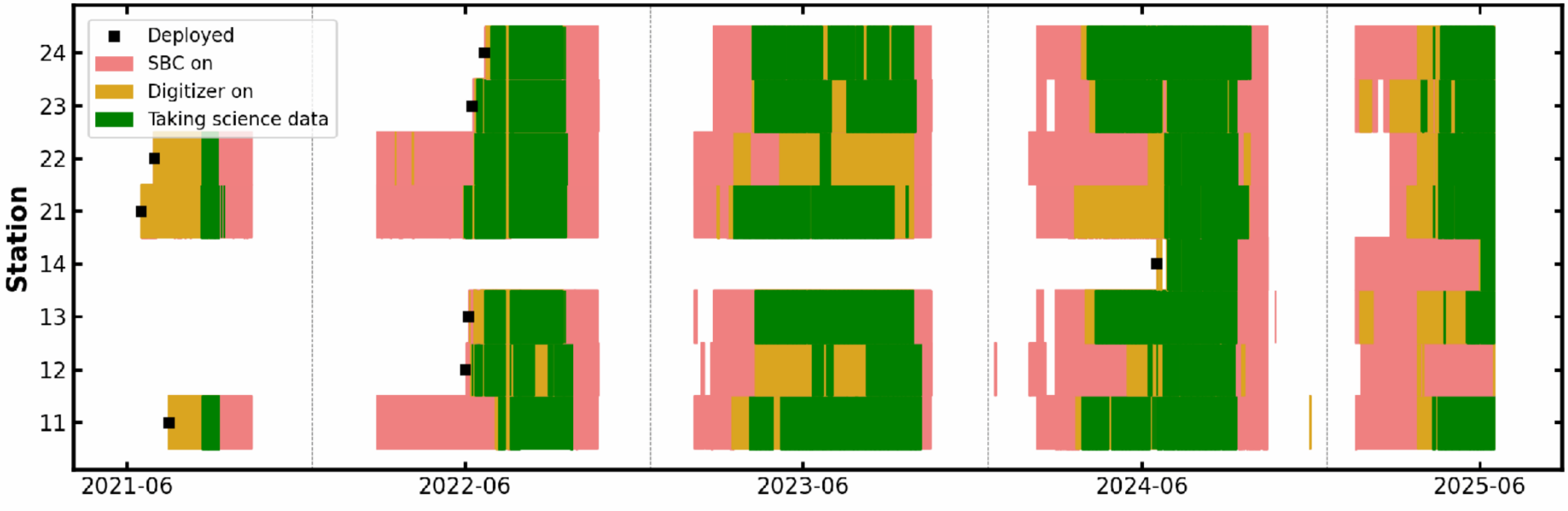


Station layout



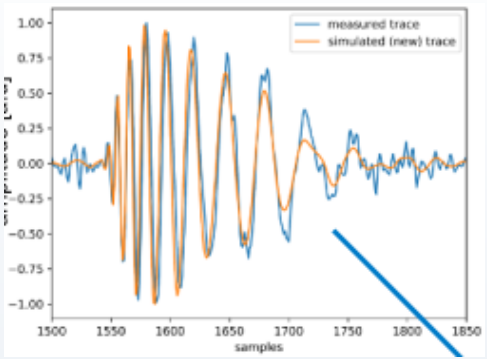


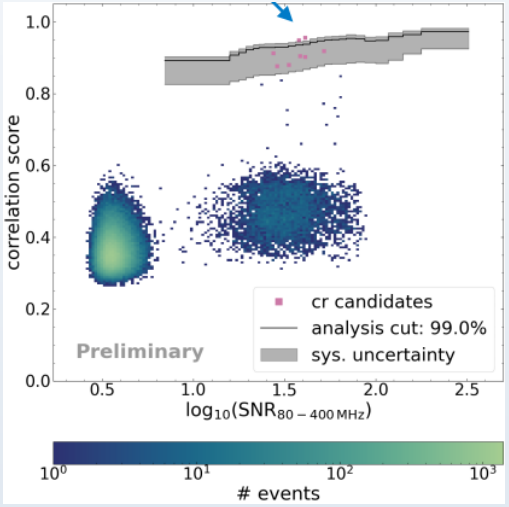
Science data



Progress and analyses

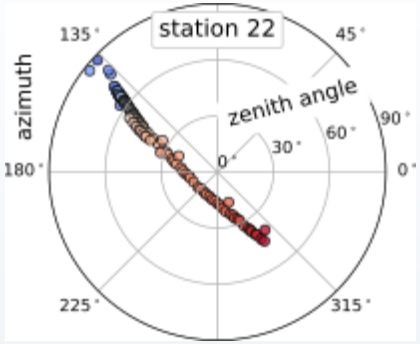
Cosmic rays in air





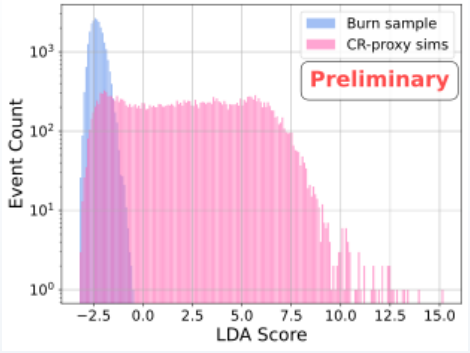
PoS(ICRC2025)288

Airplanes



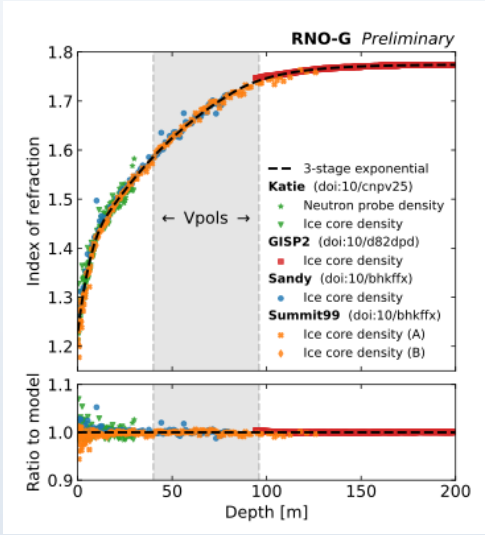
Arxiv 2506.17522

Cosmic rays in ice



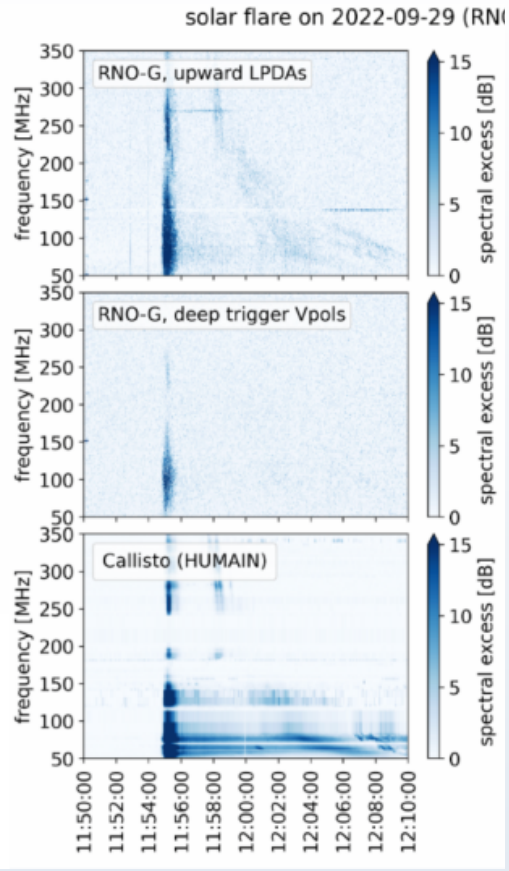
PoS(ICRC2025)1057

Ice properties →



PoS(ICRC2025)1121

Solar flares



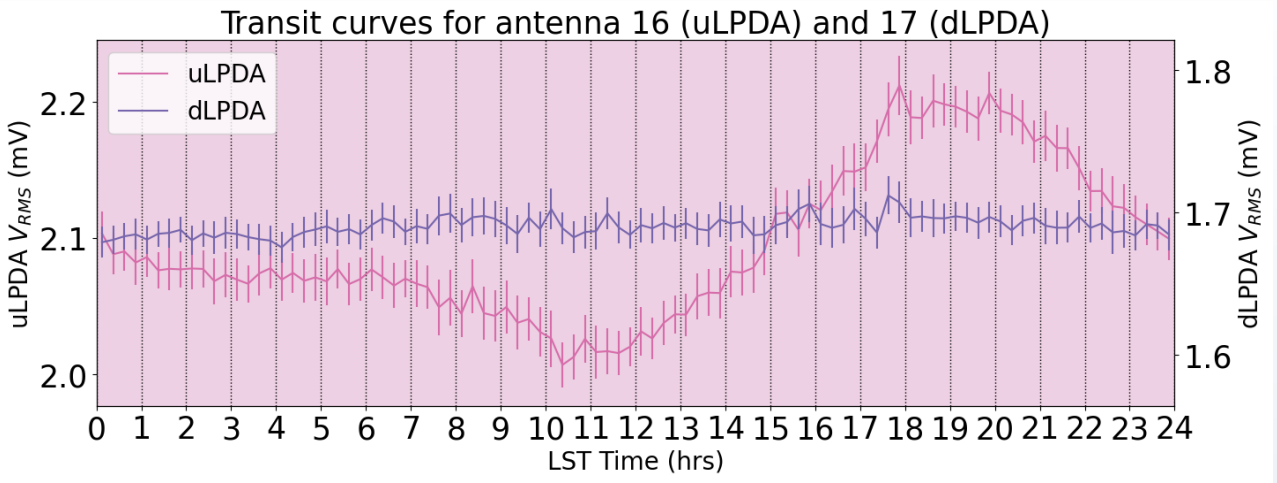
Arxiv 2404.14995

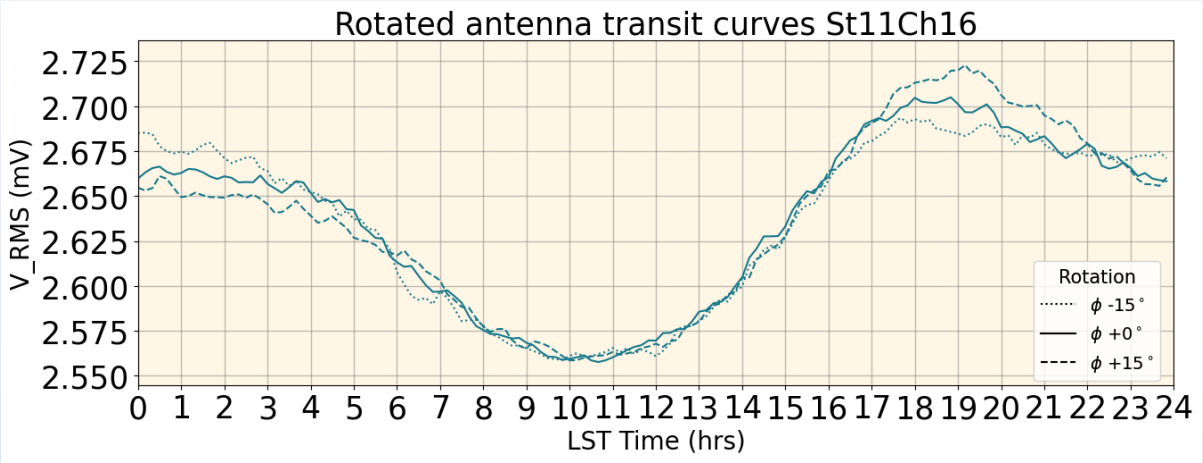
... and more

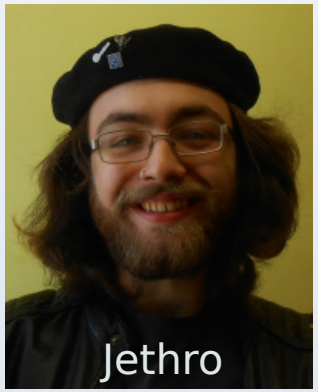
IIHE contributions

Galactic signal

- Transit curves $V_{rms}(LST)$
- Antenna orientation calibration
- Necessary for reconstruction



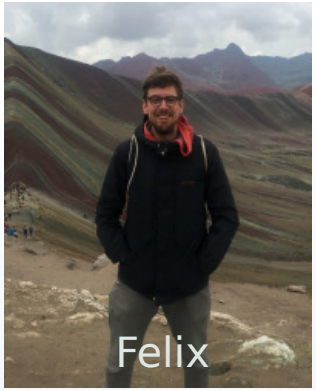


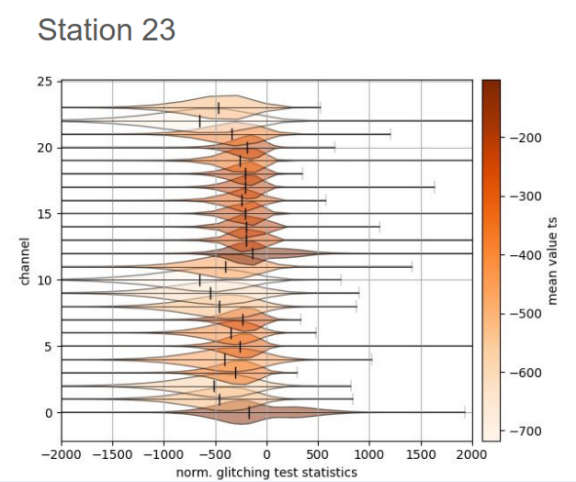


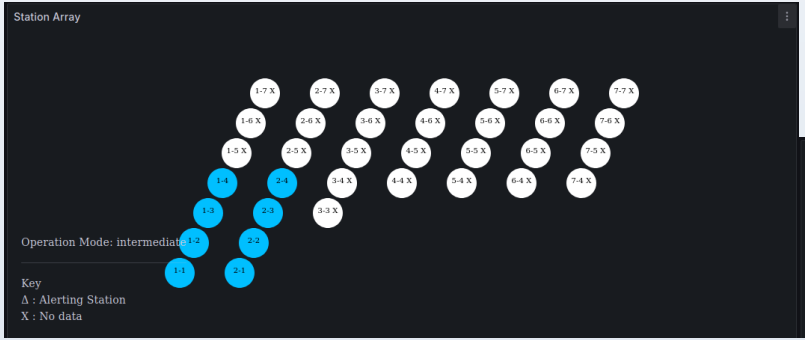
IIHE contributions

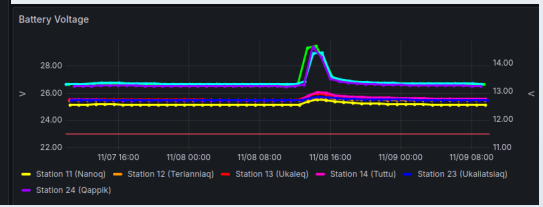
Deployment, software, calibration, …

- Deployed this summer
- Operations coordinator
- NuRadio development
- Calibration
- Triggers
- ∞





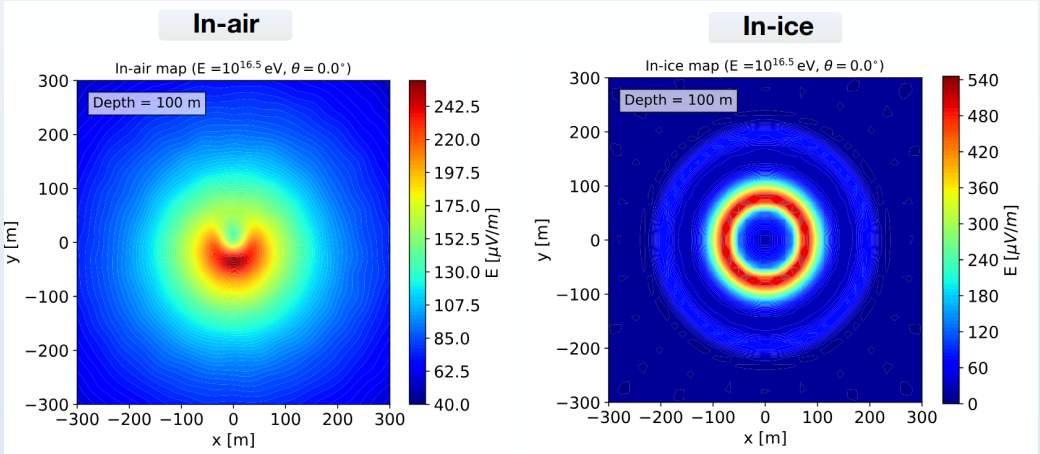


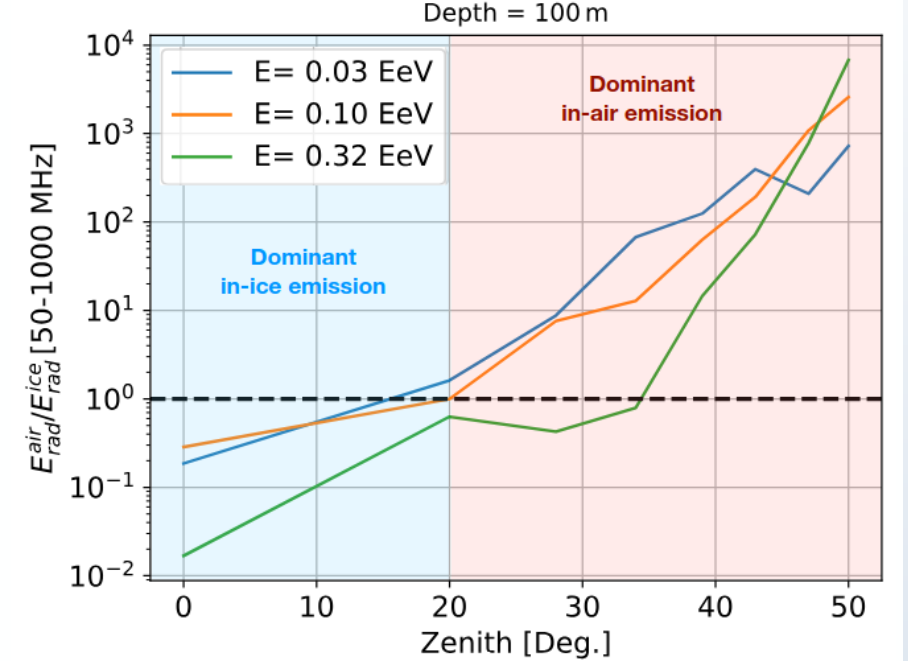


IIHE contributions

Cosmic rays with deep in-ice antennas

- Simulate CRs air and ice radio signal
- Investigate dominating contribution

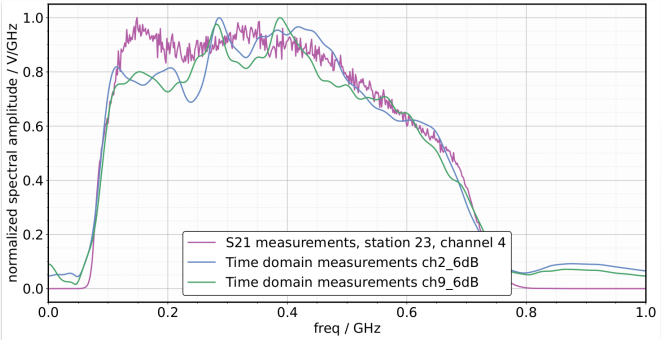


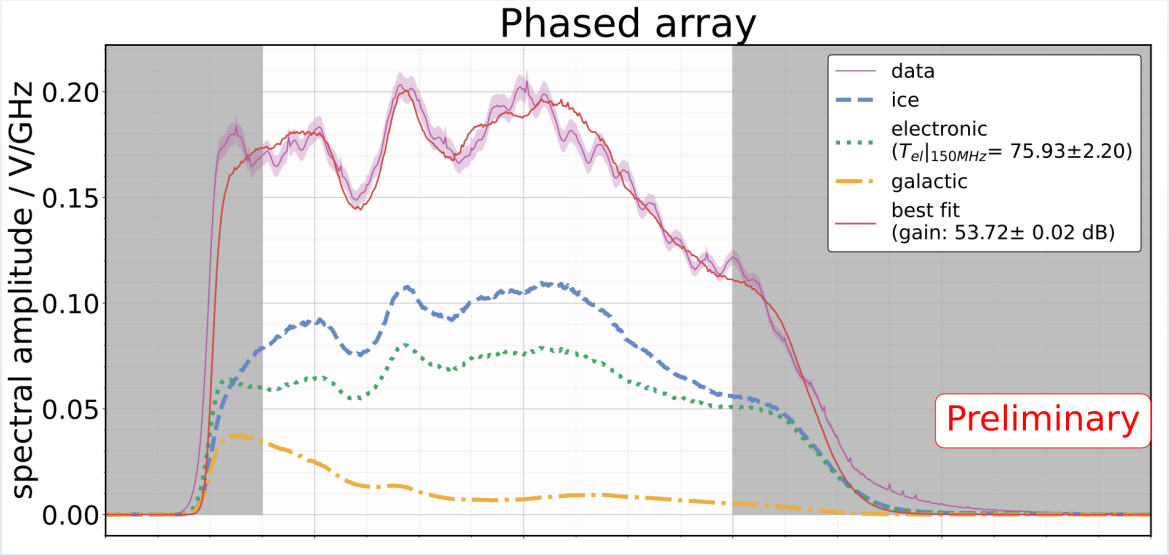


IIHE contributions

System chain gain calibration

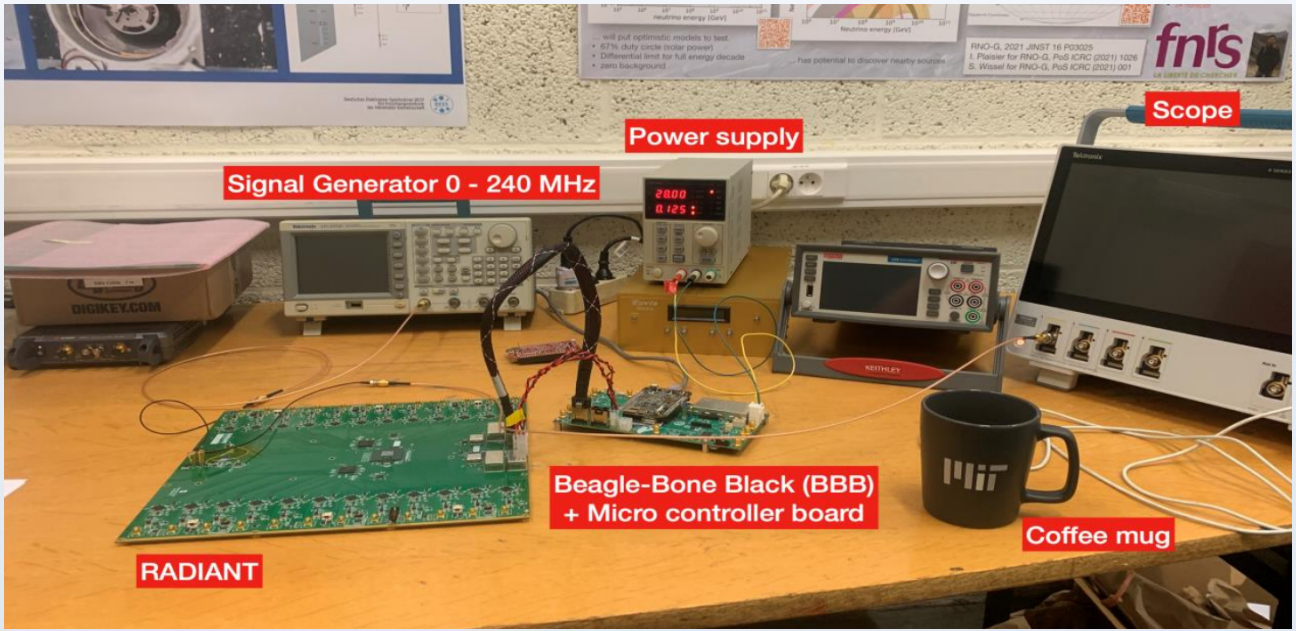
- System noise as calibration source
- Calibrate system amplitude to match data

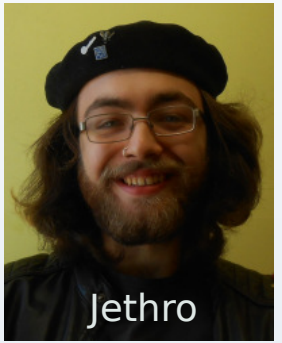


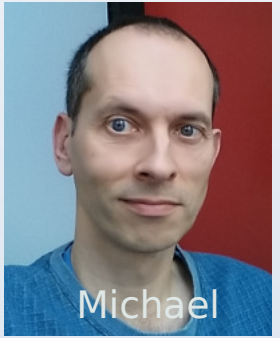


IIHE contributions

- Development & testing of hardware
- Radio Lab
- RADIANT digitizer board

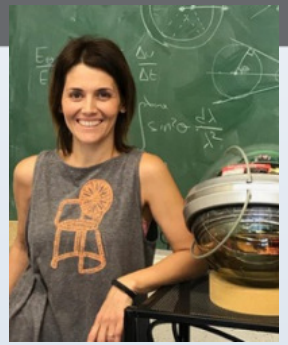






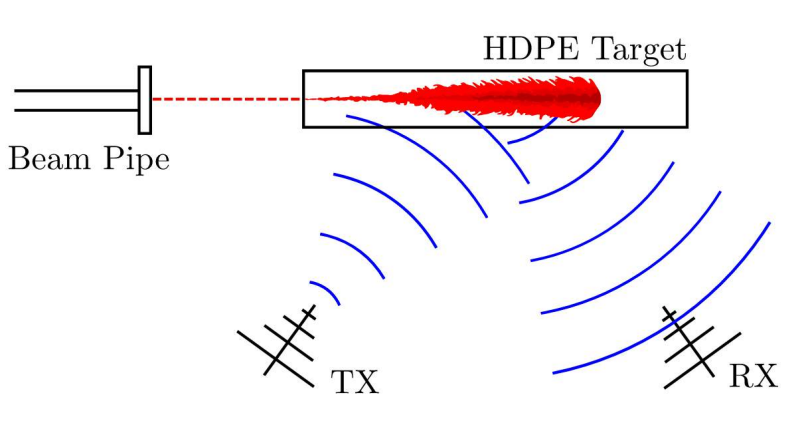


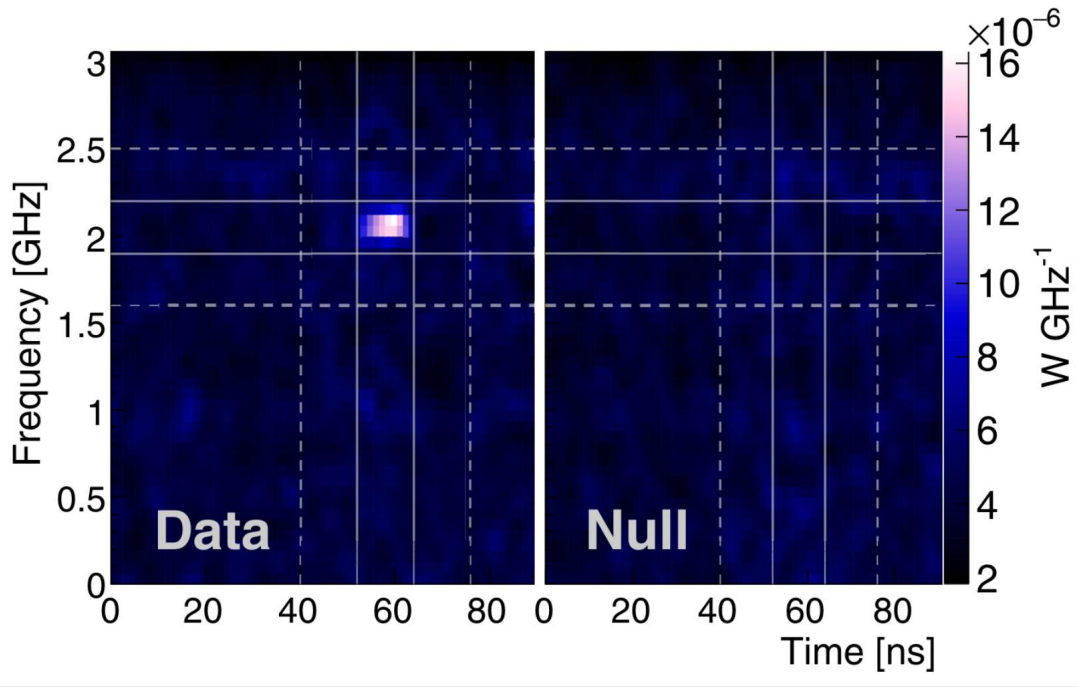
RADAR ECHO TELESCOPE



Proof of concept

- Radar method demonstrated in SLAC laboratory experiments





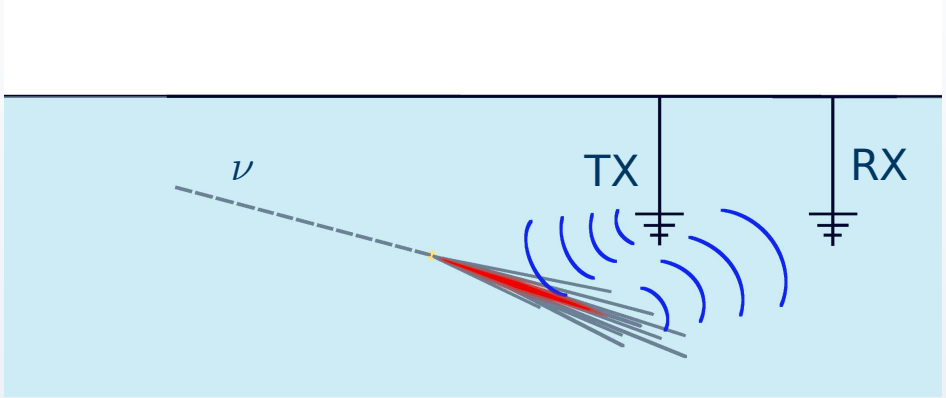
Arxiv 1910.12830

- RET-CR → RET-N

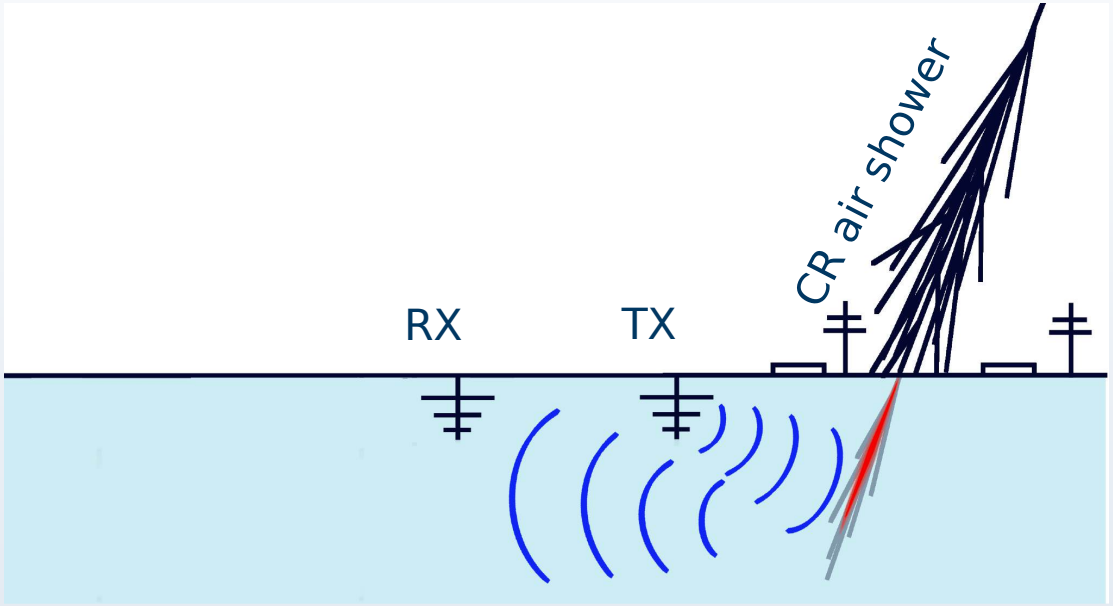
RET-CR arxiv 2104.00459

In-ice CR Cascade

- Method demonstration in nature



- Target in-ice continuation of > PeV CRs

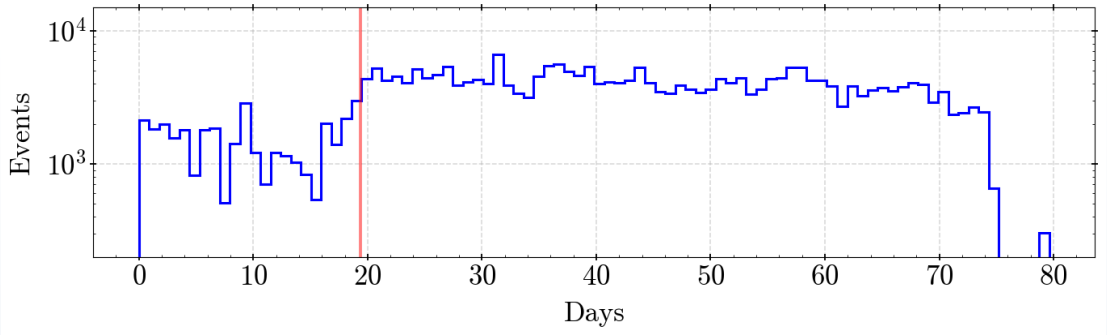


- Closely resemble cascaded produced by neutrinos

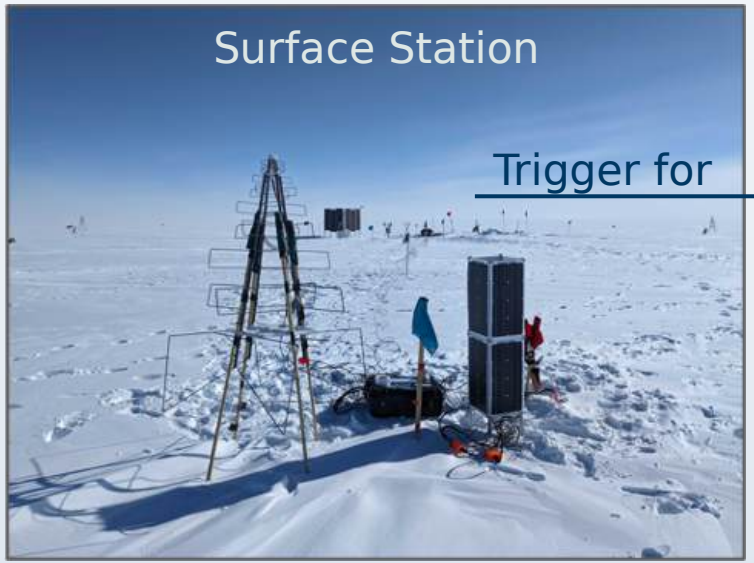
→ Successful detection of in-ice CR cascades will support targeting UHE neutrinos

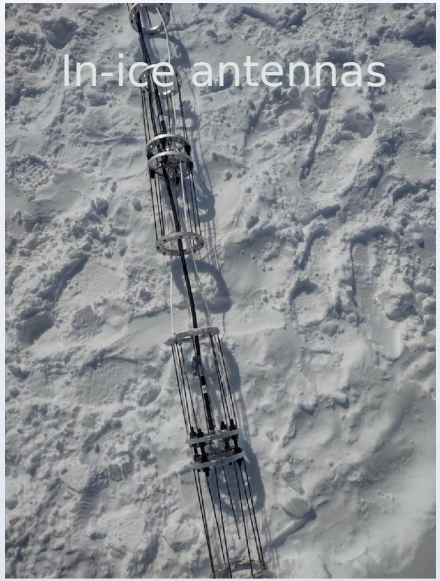
RET-CR

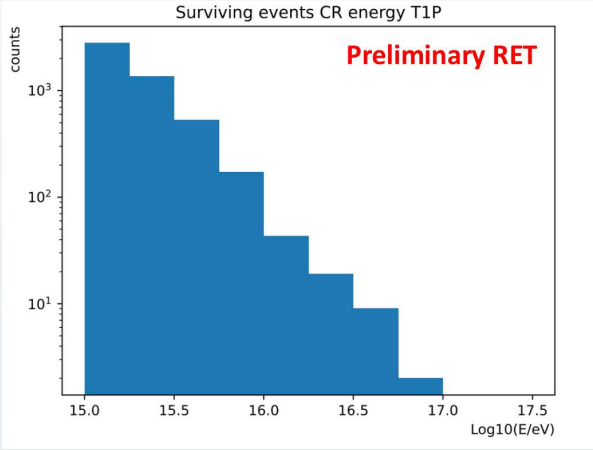
- Deployed at Summit Station 2023-2024
- Surface stations validate findings
- Hardware development and testing



O(10^5) CR triggers over 2024 summer season







Scintillator panel → 1.8 events with $E > 10^{17}\,eV$ in 10% burn sample

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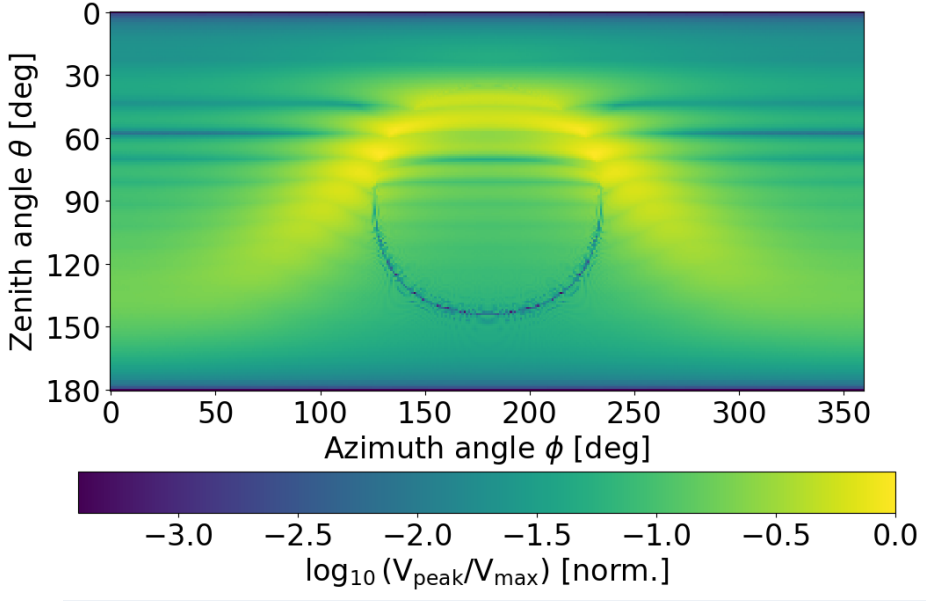
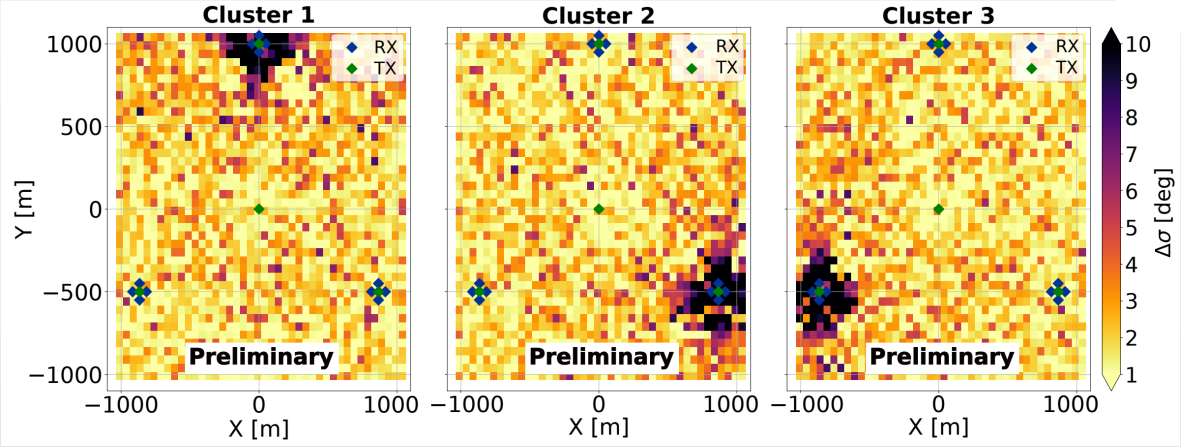
IIHE contributions

Radar signal & neutrino vertices

- Investigate radar signal properties (arrival direction)



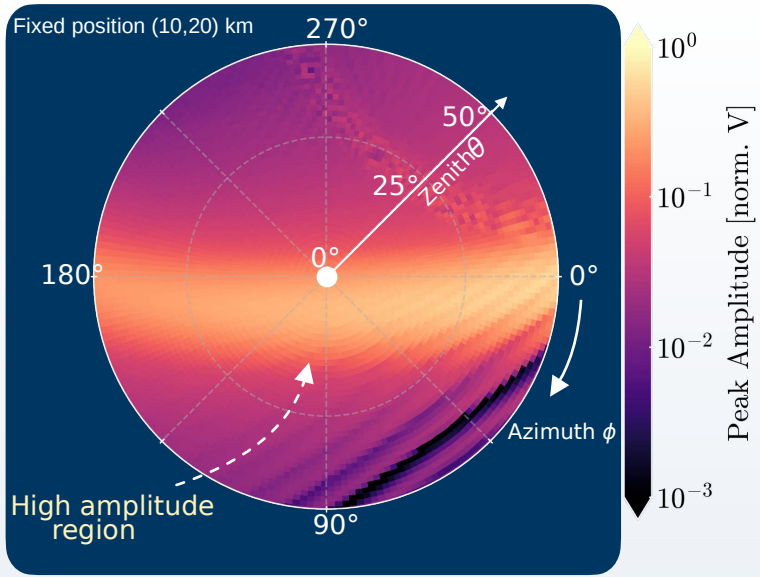
- Neutrino interaction vertex reconstruction

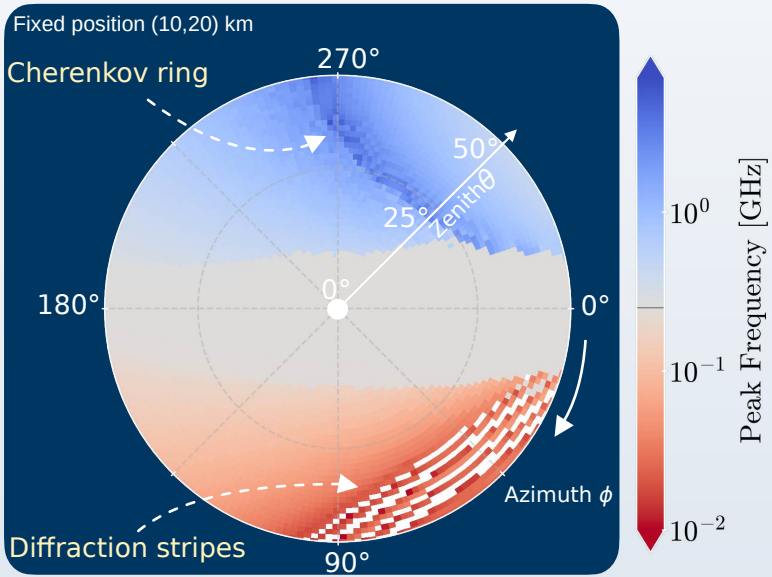


IIHE contributions

Radar echo properties

- Model signal peak amplitude
- Model signal peak frequency

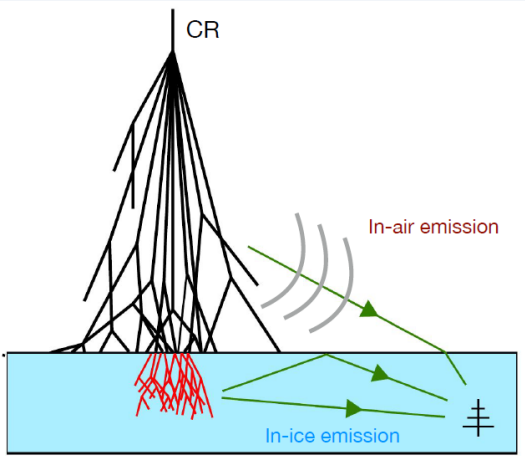


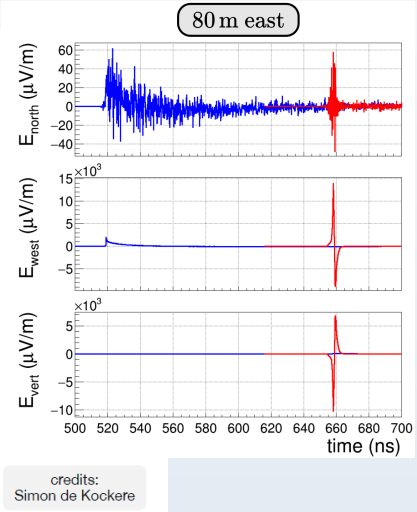


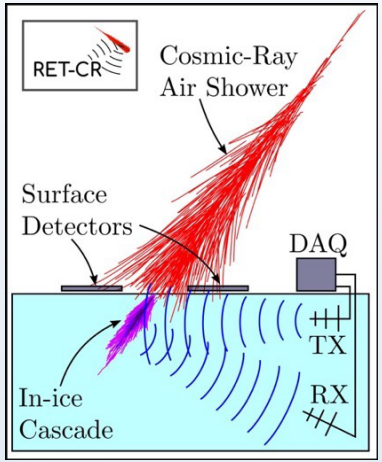
RNO-G & RET software develop by IIHE

Cosmic-Ray analysis and simulations: Focus on Cosmic-ray in-ice signals
FAERIE simulation framework developed at VUB-IIHE
Neutrino and cosmic-ray in-ice core radar reflection model MARES developed at VUB

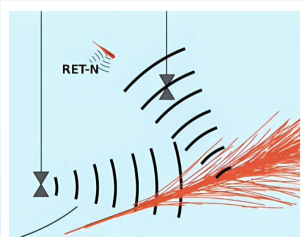
FAERIE

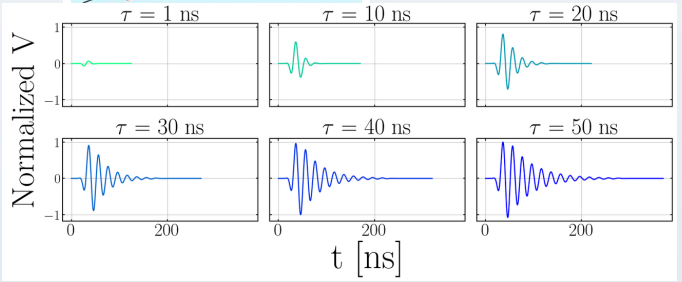






MARES





Codes publically available and in use by RET, RNO-G, ARA, IceCube-Gen2-radio

Conclusion

- Both RNO-G and RET set to contribute to high energy neutrino physics
- Strong IIHE involvement in both
- RNO-G
  - 8 stations operational, set to expand to 35
  - IIHE contributions to simulation, deployment, data analysis, calibration, ...
- RET
  - RET-CR pathfinder deployed in 2023-2024, data under analysis
  - IIHE contributions to simulation, signal properties, reconstruction, ...
- IIHE has the lead in both