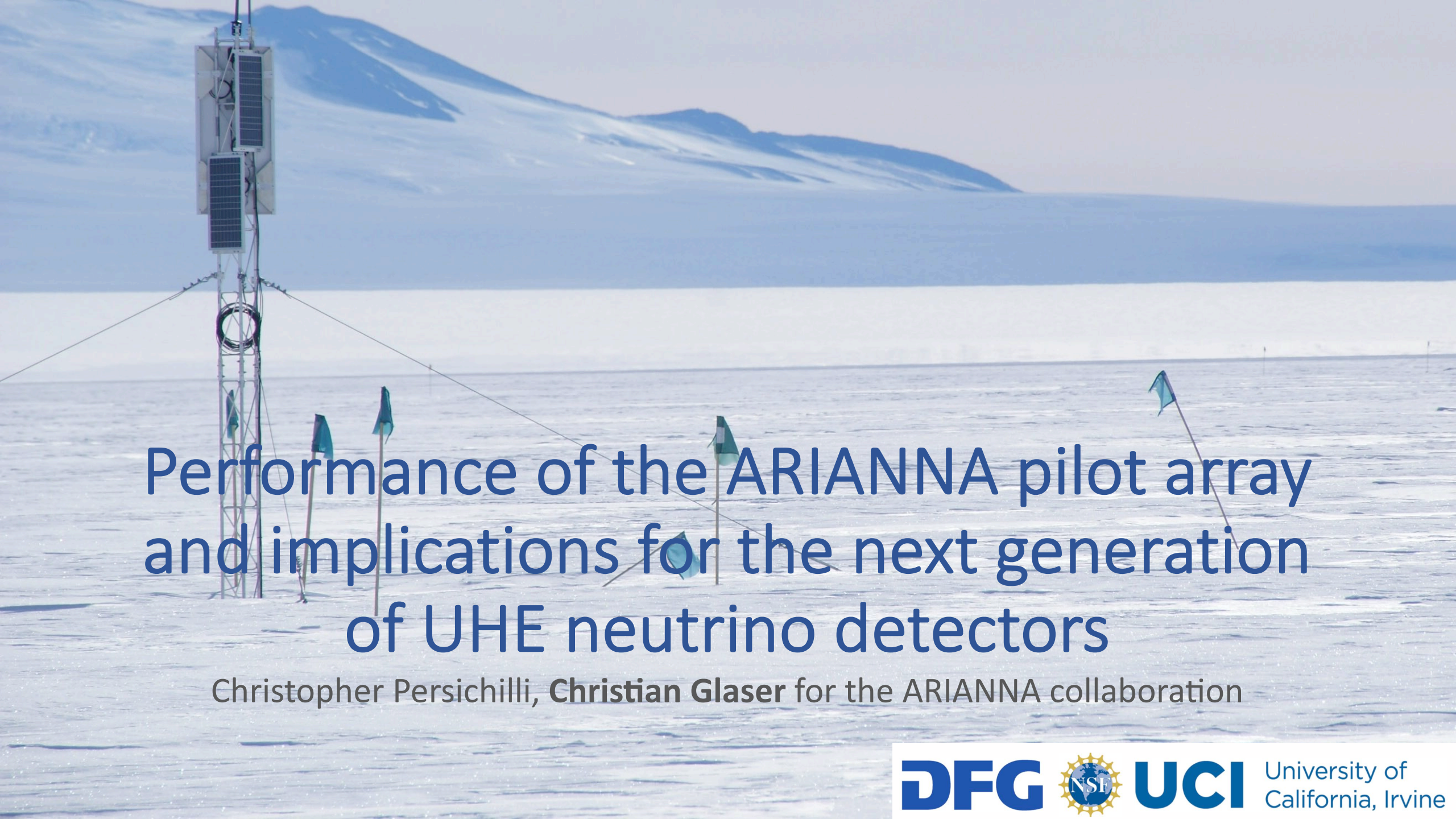
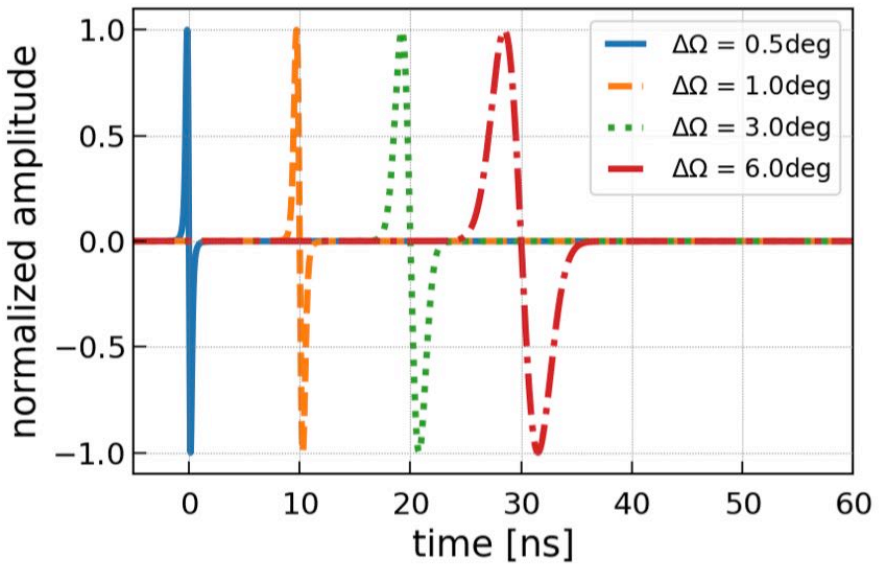


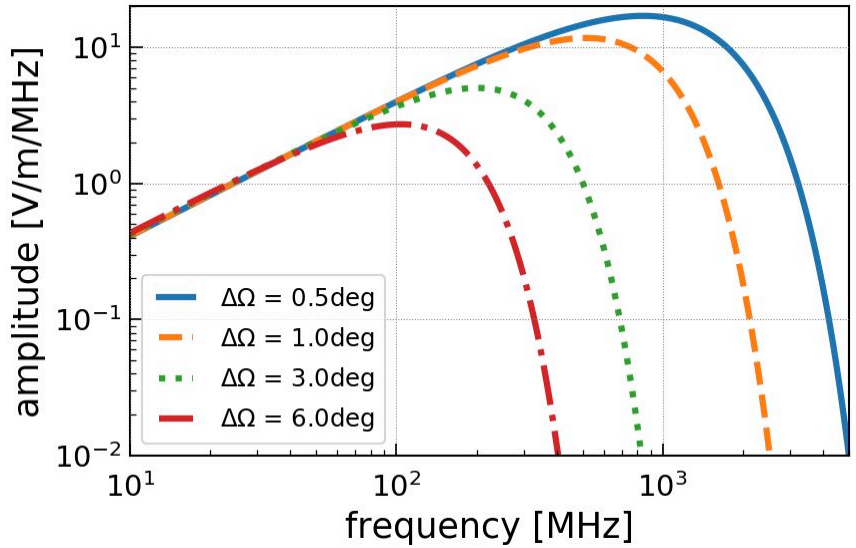
Performance of the ARIANNA pilot array and implications for the next generation of UHE neutrino detectors

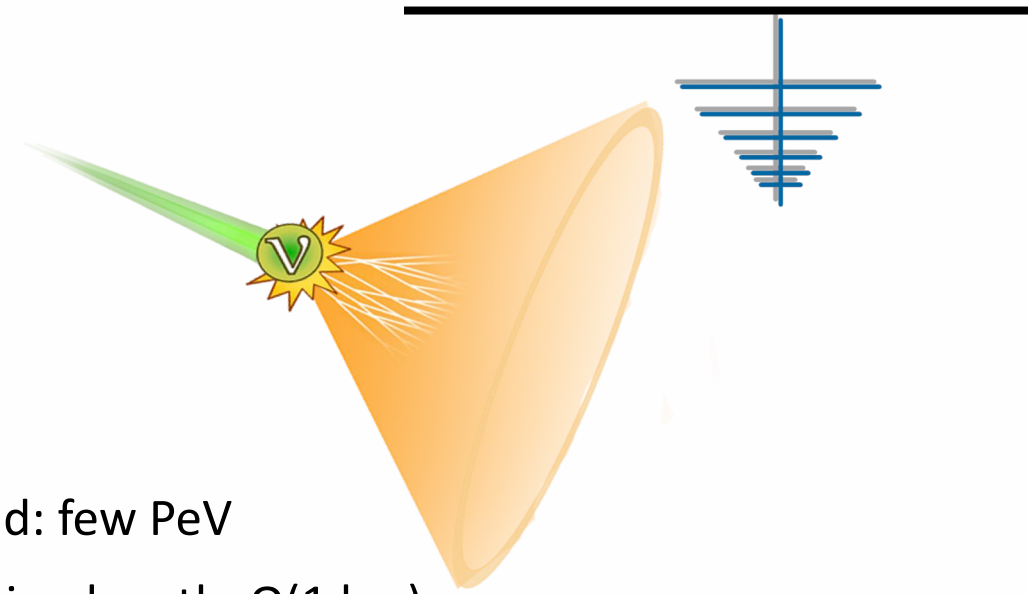
Christopher Persichilli, **Christian Glaser** for the ARIANNA collaboration

DFG NSF UCI University of California, Irvine

Detection principle of Askaryan radio detectors





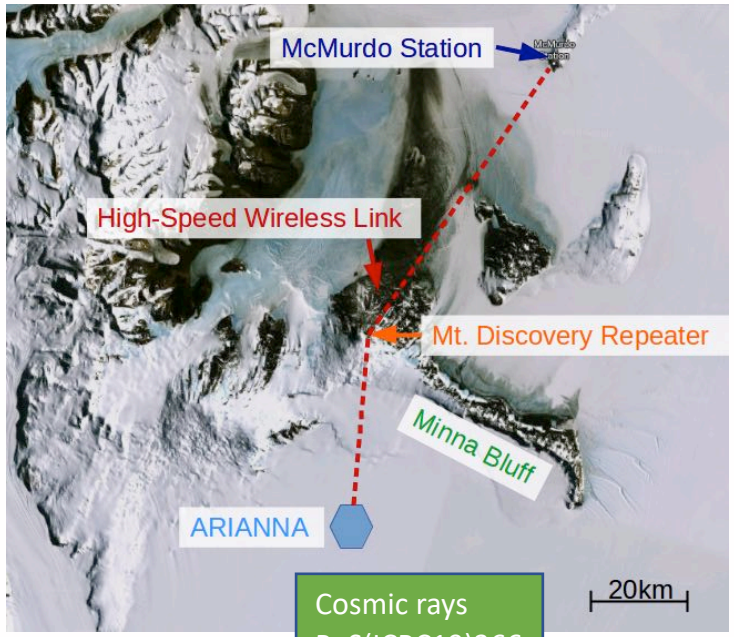


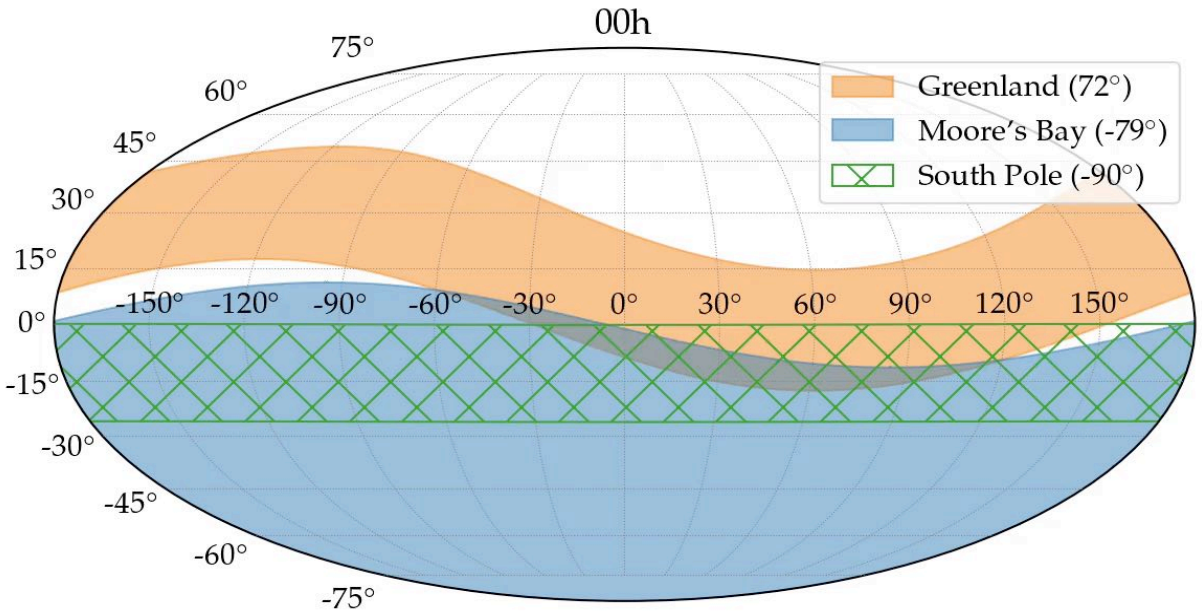
- Threshold: few PeV
- Attenuation length: O(1 km)

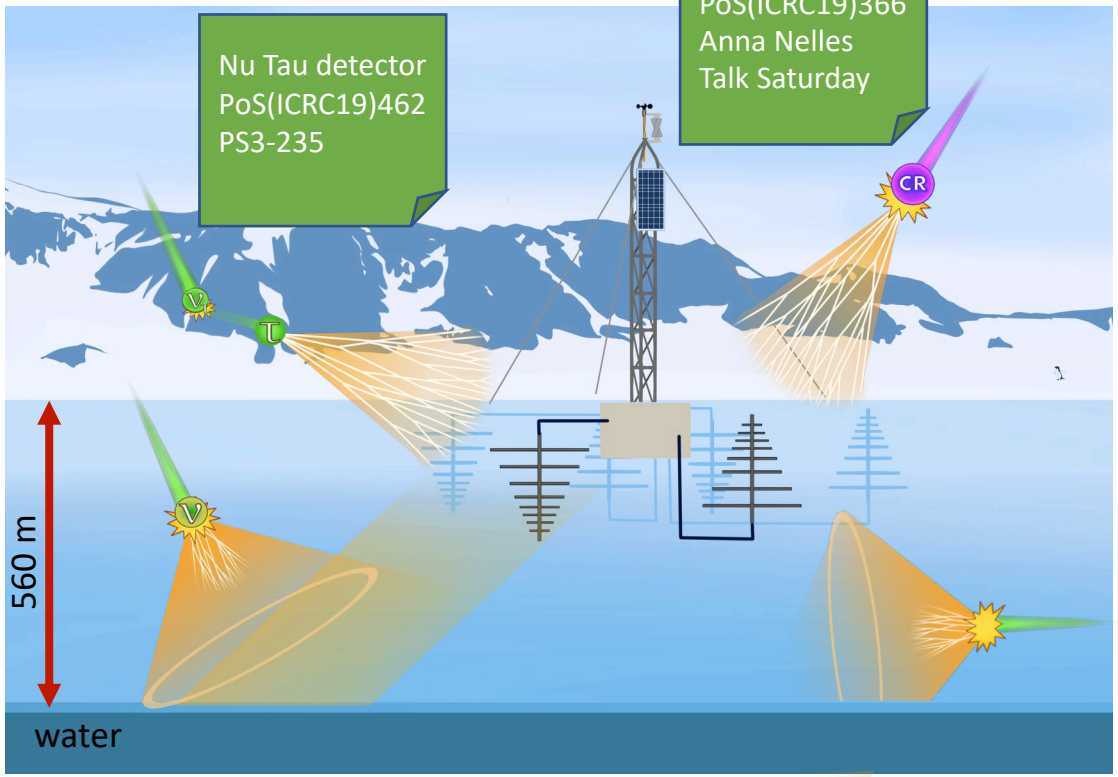
→ **Cost-effective instrumentation for ultra-high energy (UHE) neutrinos (10^{16}-10^{20} eV)**

ARIANNA site selection

- Main site: **Moore's Bay on Ross ice shelf**
  - RF quiet, shielded by Mountains
  - close to McMurdo → simplified logistics, land traverse possible
- Reflections at bottom of ice shelf: Substantially increases
  - ice volume
  - sky coverage → **multi messenger astronomy**



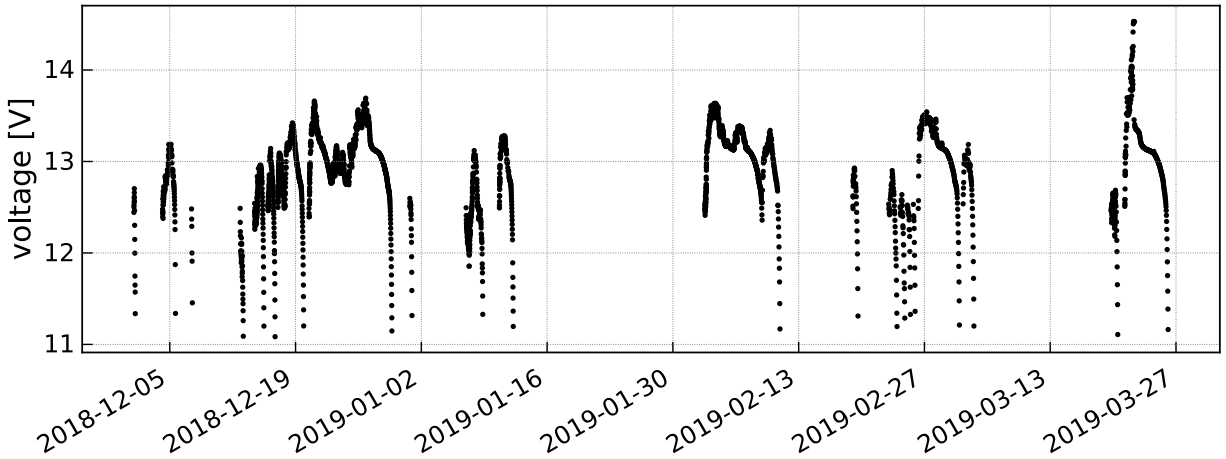




Versatile + autonomous hardware design

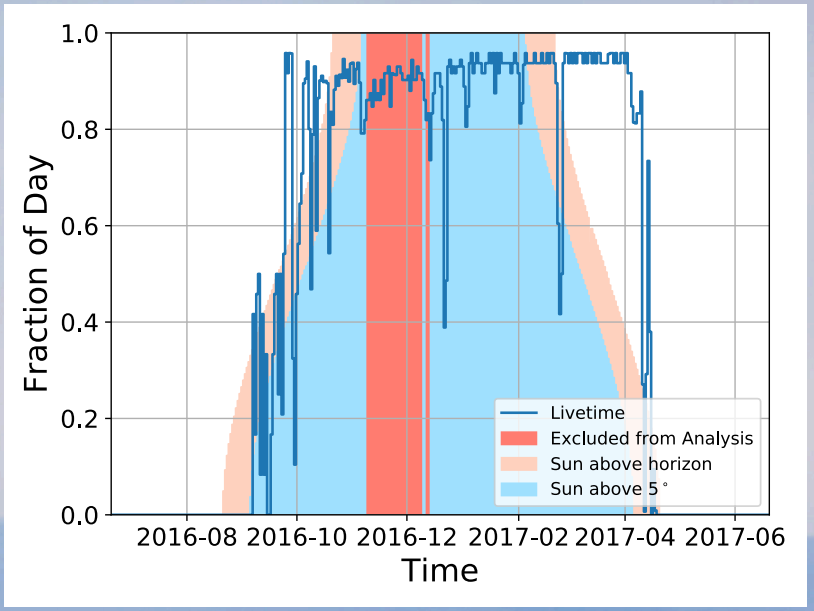
- Works reliable, low power ~5W
- Autonomously powered: solar power + wind
  - current prototype survives harsh Antarctic conditions and powers station for ~40% of the time
  - realistic option for any considered site: South Pole, Greenland
- Iridium satellite + WiFi communication
- Can be used at any location (Moore's Bay, South Pole, Antarctic mounts.)
  - easy deployment

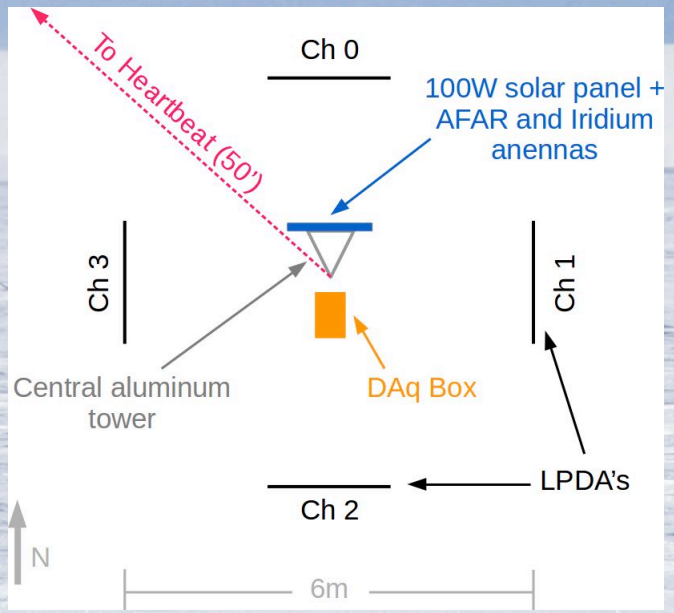
TAROGE
PoS(ICRC19)967
Jiwoo Nam
Talk on Wed.

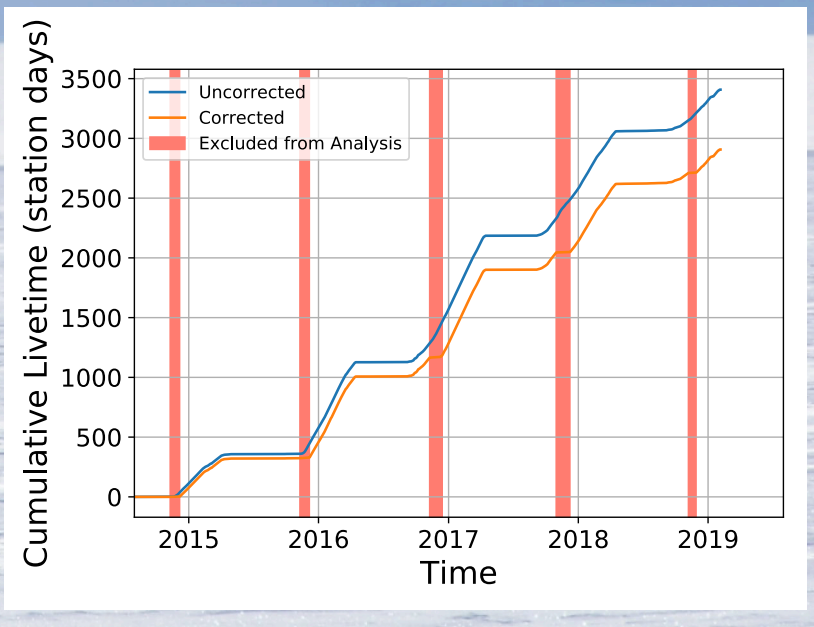


Hexagonal Radio Array (Test bed for larger scale array)

- 7 station array @ Moore's Bay
- Completed in 2015 and successfully operating since then
- Uptime > 90% achievable
- Neutrino search on full data set: 8 station years



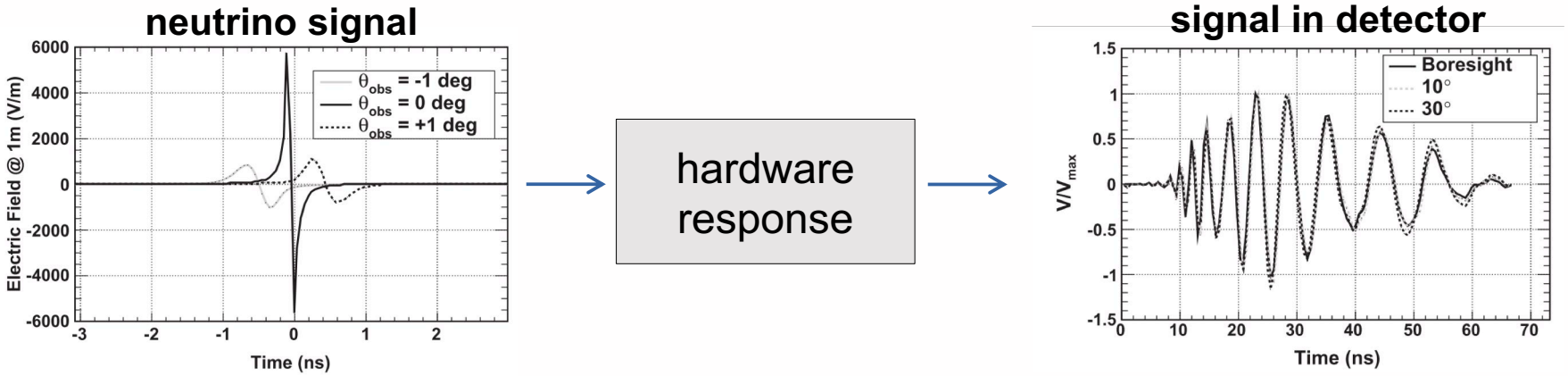


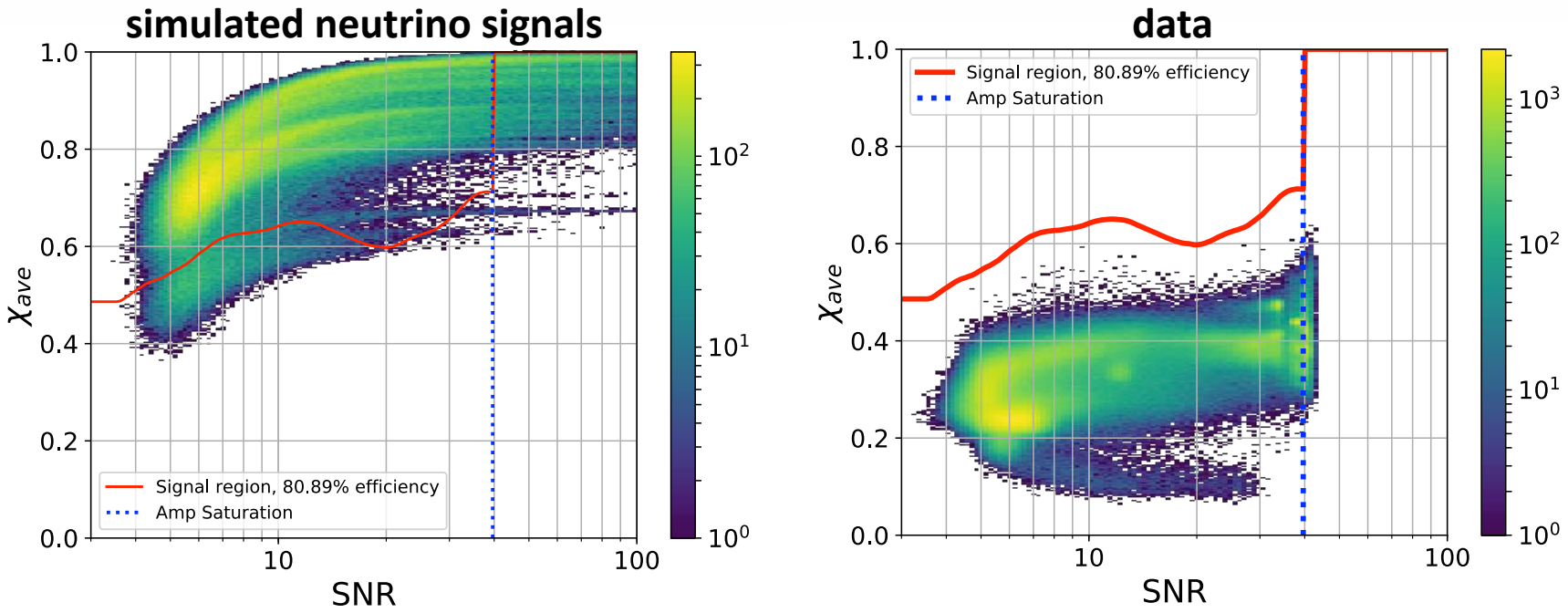


Neutrino Search

Tested with cosmic rays
PoS(ICRC19)366
A. Nelles
Talk Saturday

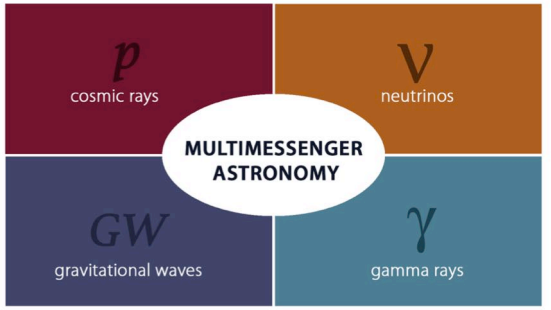
- ARIANNA employs template matching to find neutrinos

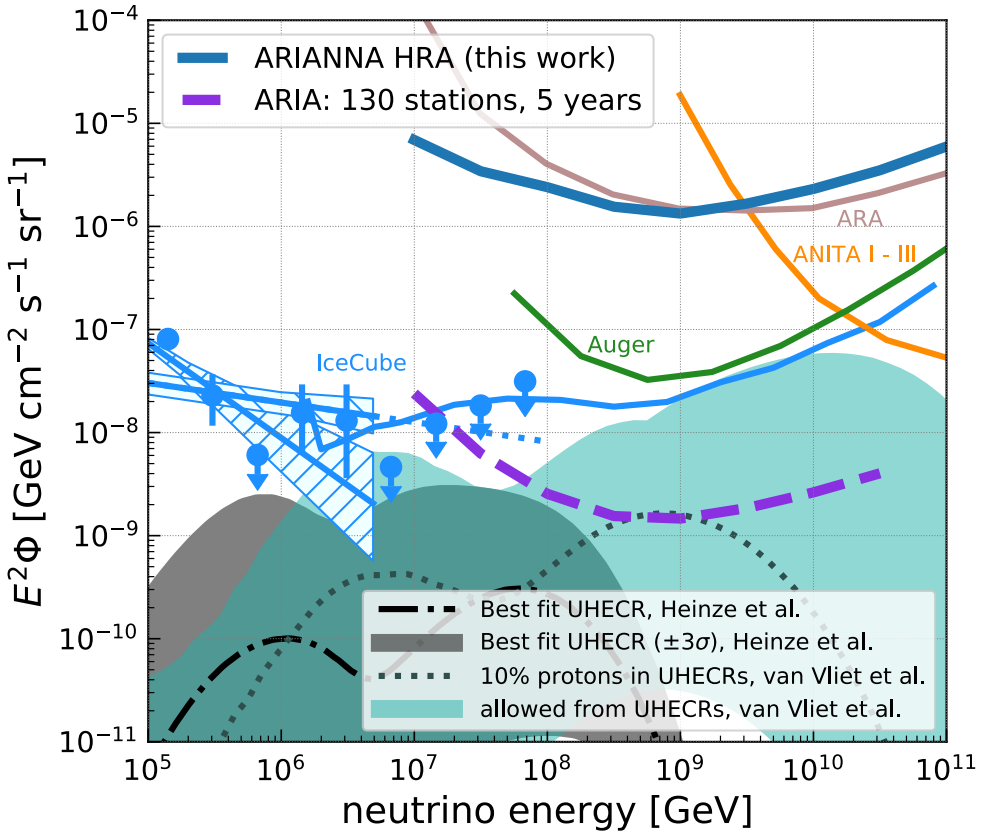


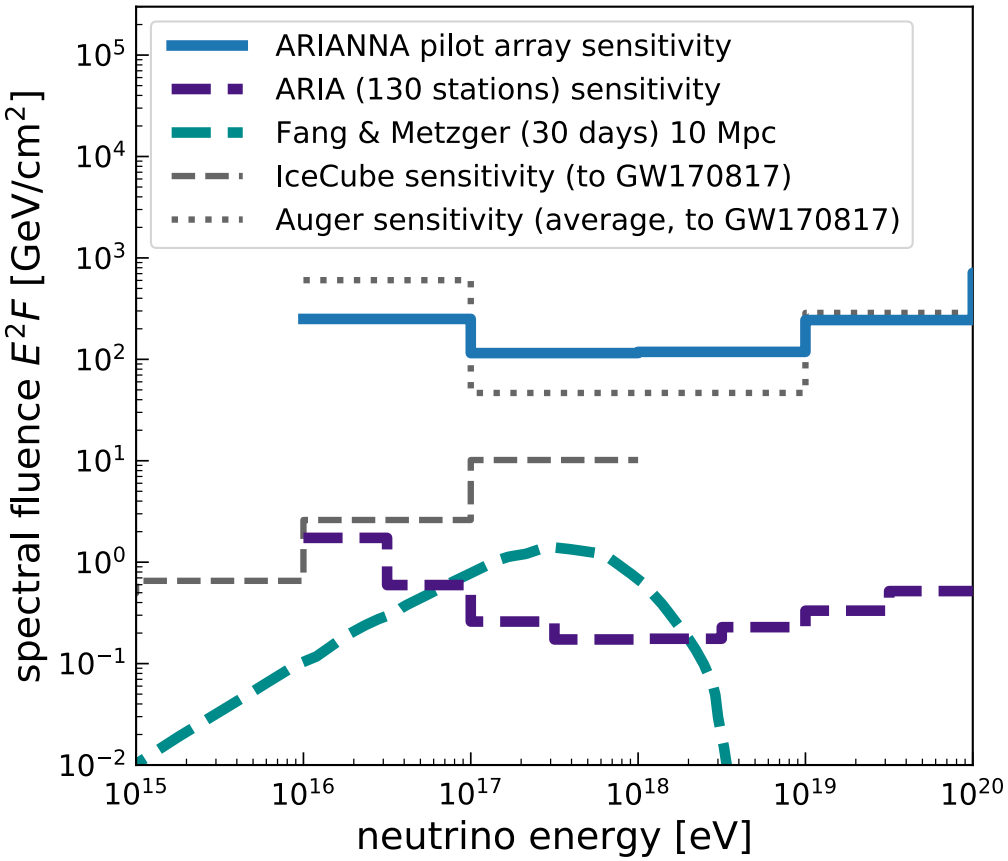


No neutrino candidate found

Diffuse and Transient Sensitivity





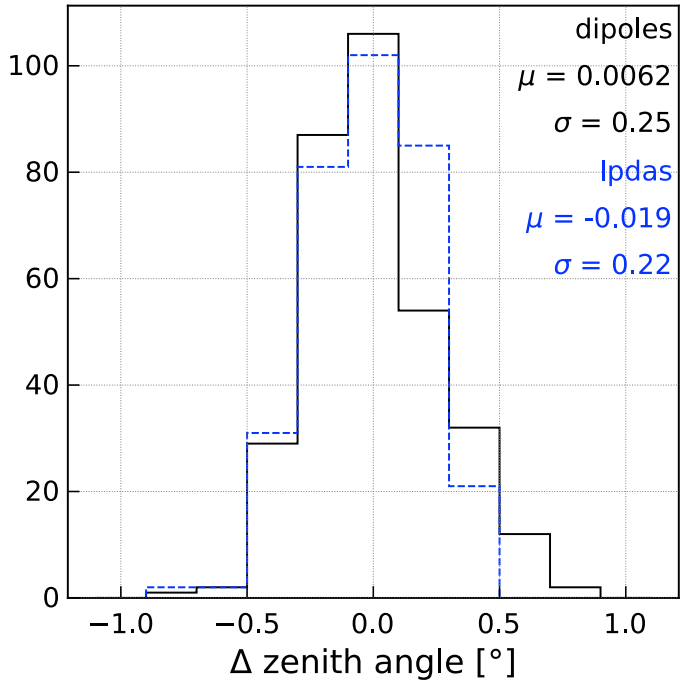


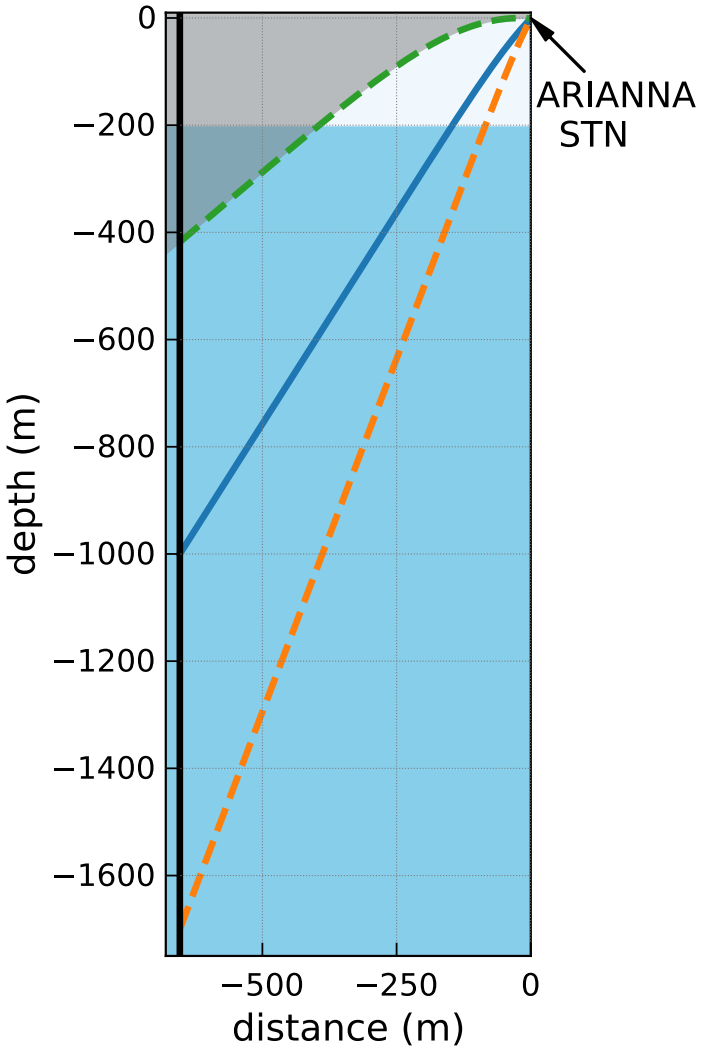
Test of firn and ice effects in the refraction zone

In-situ ice tests
PoS(ICRC19)897
PS3-108

- Calibration measurement at South Pole
  - Transmitter lowered into SPICE hole (1700m deep)
- Ice properties well understood
  - Direction measured independently by dipoles (Vpol) and LPDAs (Hpol)
  - Bending of signal trajectories in firn corrected with < 0.3° precision
- No evidence for for signal distortion in firn (shape and polarization)

Shadow zone propagation
PoS(ICRC19)939
R. Lahmann
Talk on Wednesday





Reconstruction of Neutrino Direction and Energy

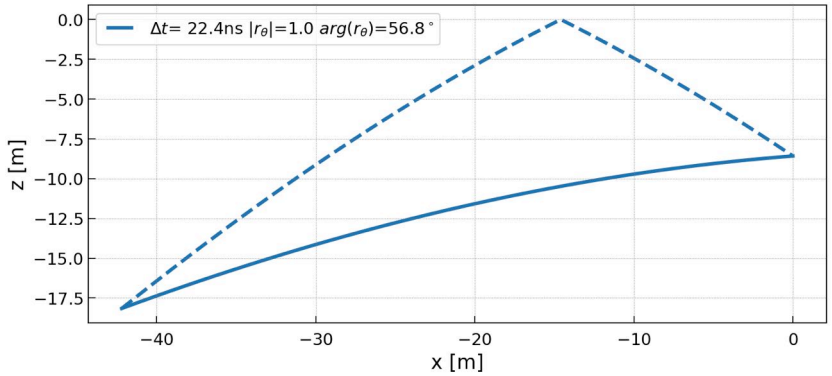
- A shallow detector has good sensitivity to the neutrino
  - **direction** (2° dominated by signal polarization, 7° already demonstrated via CRs)
  - **energy** (factor of two, limited by inelasticity fluctuations)
- Precise vertex distance reconstruction *(15%)* via **direct** and **reflected** signal detection

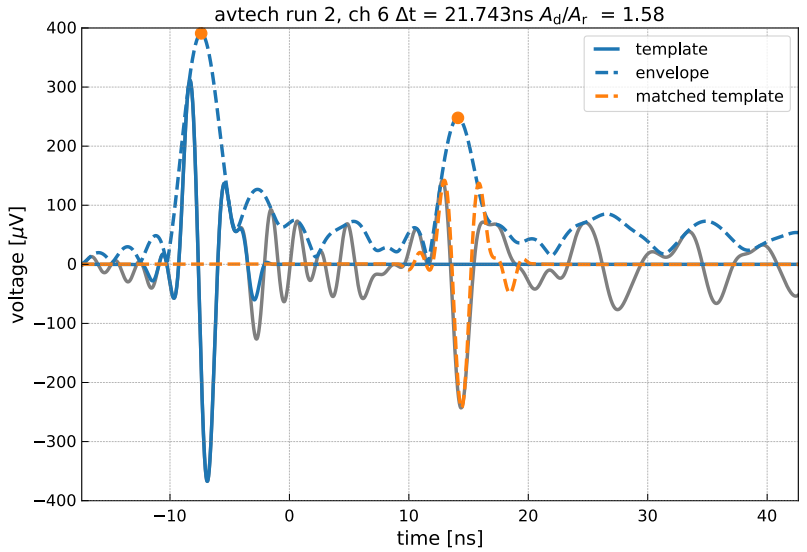
Neutrino reconstruction
PoS(ICRC19)899
PS1-108

Cosmic rays
PoS(ICRC19)366
A. Nelles
Talk Saturday

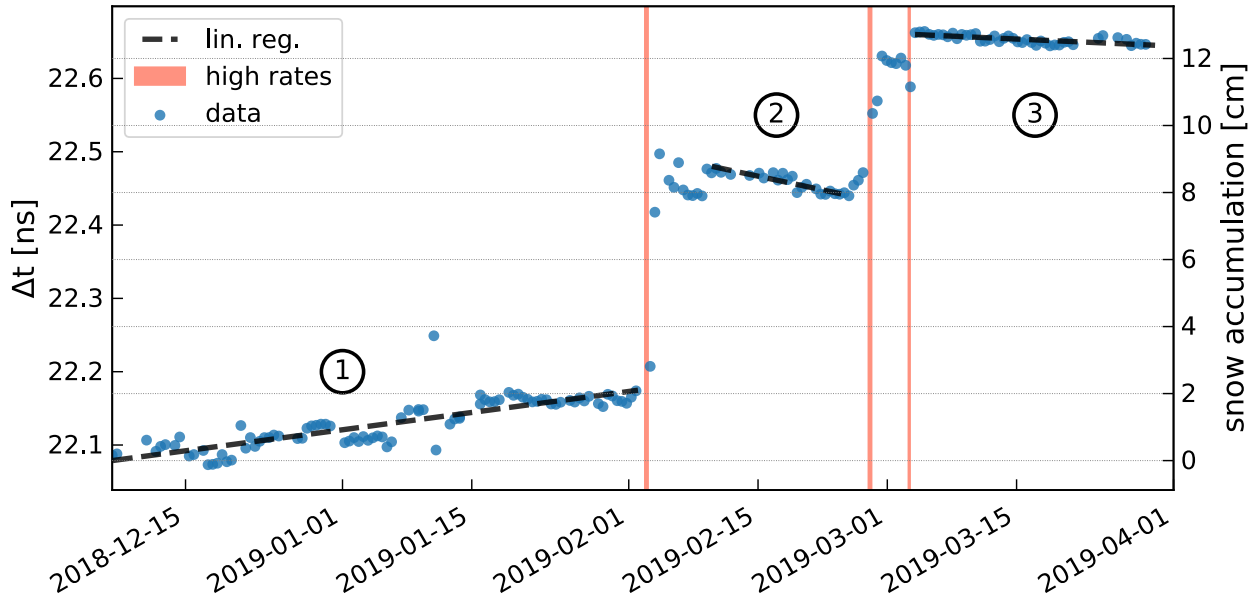
NuRadioReco software
PoS(ICRC19)900
PS3-110

NuRadioMC software
PoS(ICRC19)896
PS3-107





Proof of concept: Snow accumulation measurement



Summary

- ARIANNA design: autonomous, independent, shallow detector stations
- Reliable operation (tested at Moore's Bay and South Pole)
- Advantages of Moore's Bay:
  - Full coverage of southern sky
  - Radio quiet
- Neutrino flux limit from 7 station test bed: $E^2\Phi = 1.3 \times 10^{-6} GeV cm^{-2} s^{-1} sr^{-1}$
- Firn and ice properties understood, no evidence for signal distortion
- Good resolution of neutrino direction and energy: important for multi-messenger astrophysics
- Ready to built a large-scale UHE neutrino detector