

ANITA Analysis



TeVPA 2017
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Outline

Anita-4 Flight

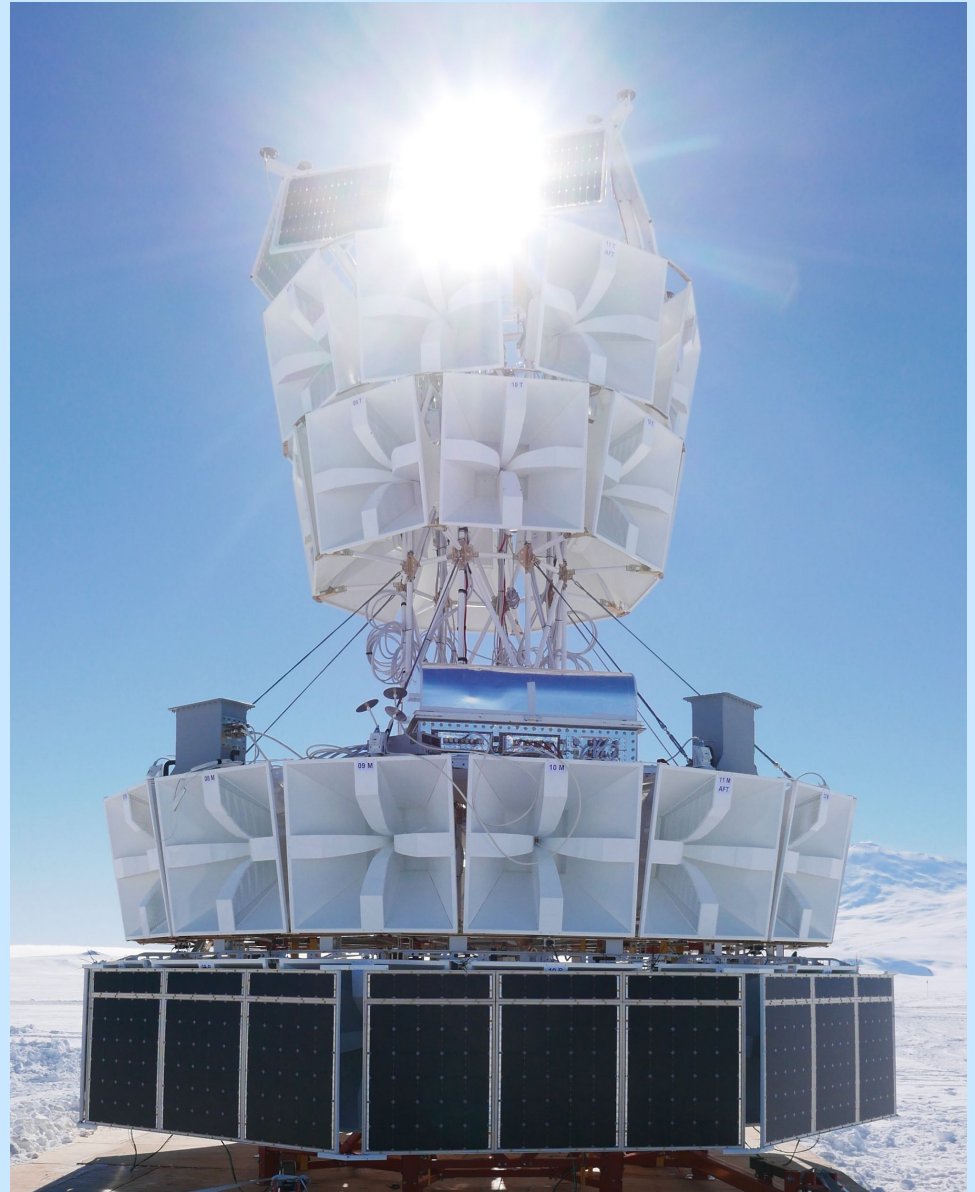
Calibration

Analysis Procedure

- Filtering
- Pointing
- Cutting
- Clustering

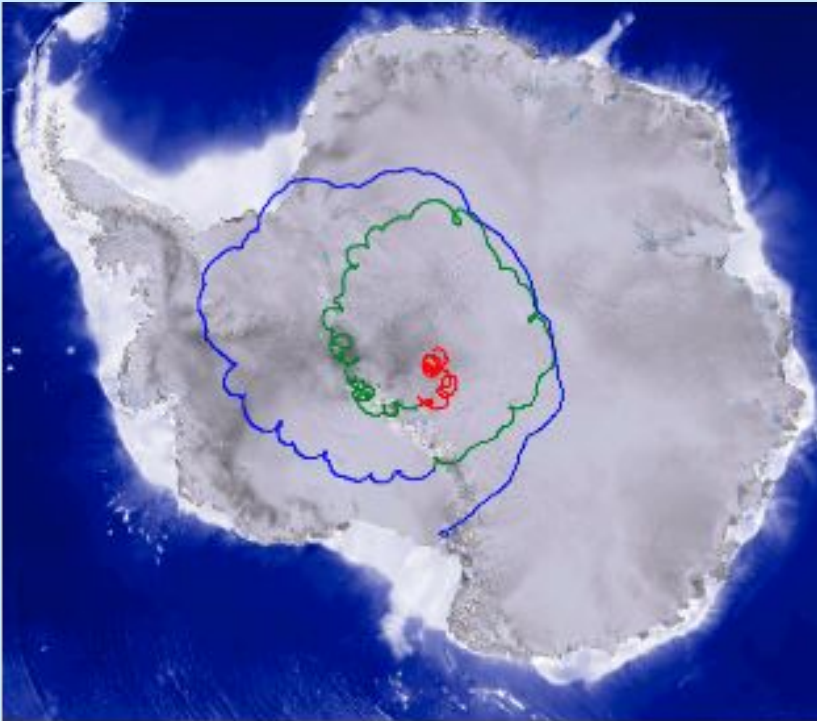
Searches

Future



Anita at its prettiest (E. Oberla)

ANITA-4 flight



ANITA-4 Flight Path

Flew for 28 days

Data (97M events!) recovered in January

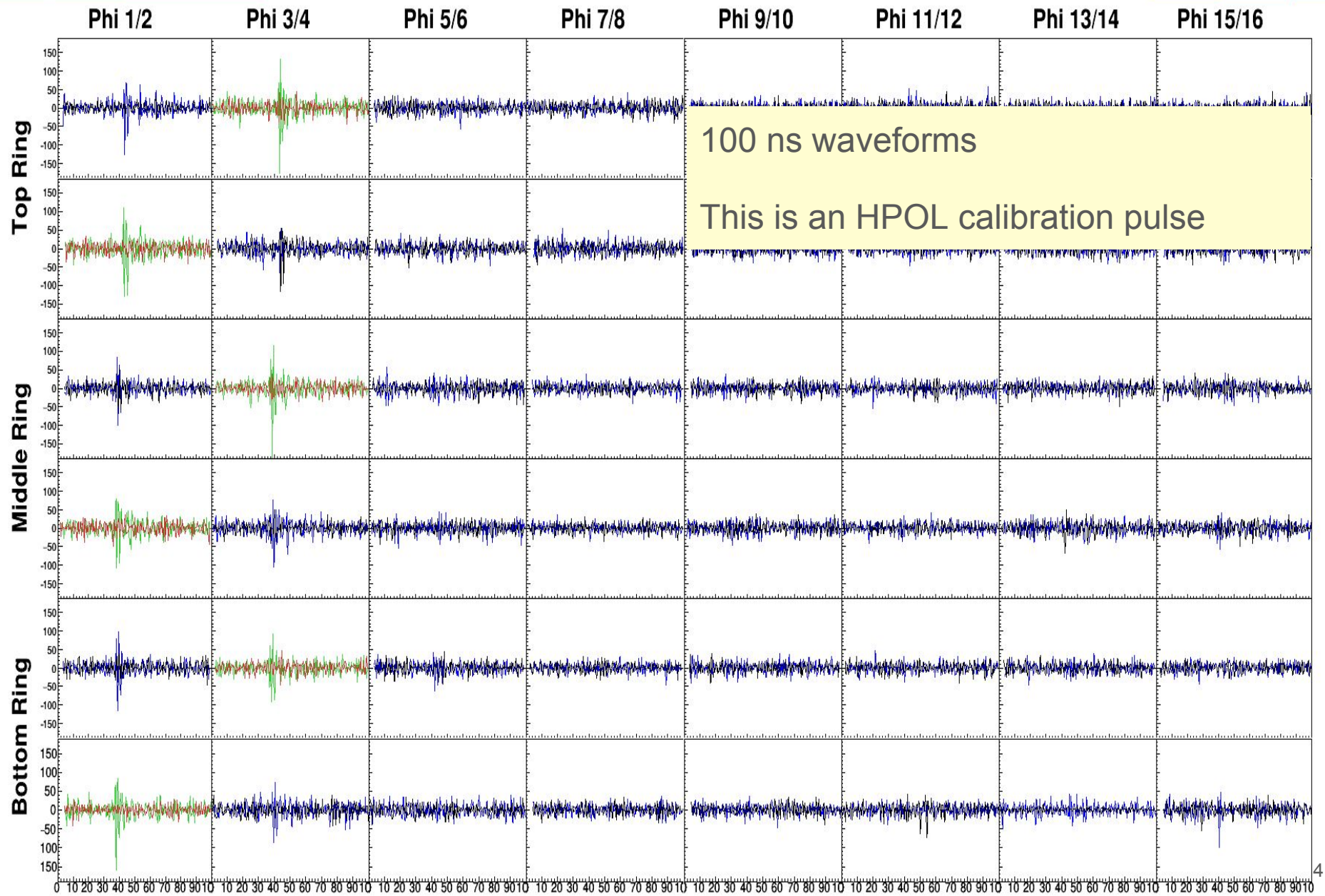


ANITA crash site (C. Miki)

Crash site was 120 nautical miles from South Pole Station

Rest of recovery this winter

Our Data



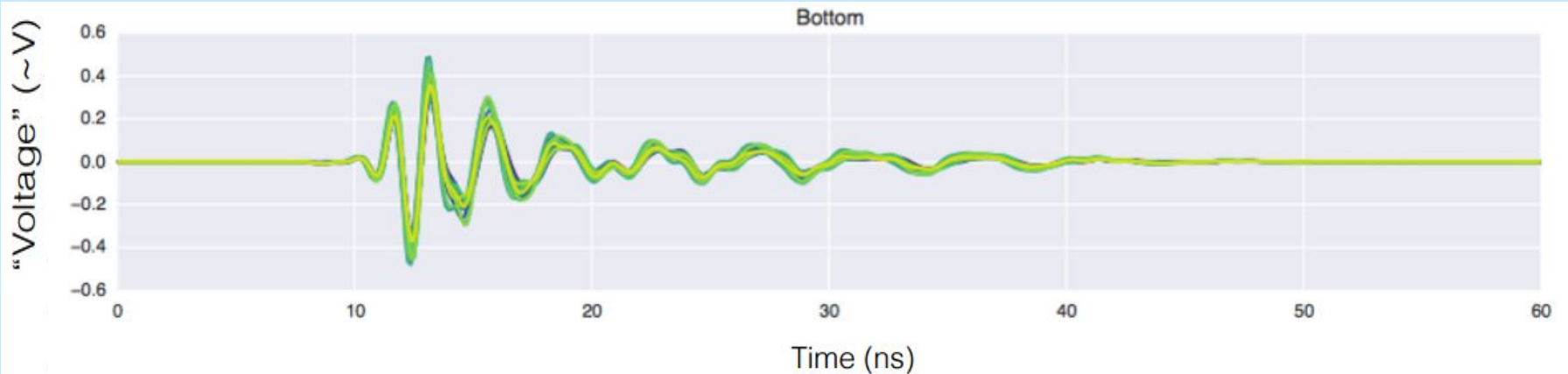
Calibration

Some calibration done with data taken in or before Antarctica

- inter-channel timing
- ADC counts to voltage
- impulse responses



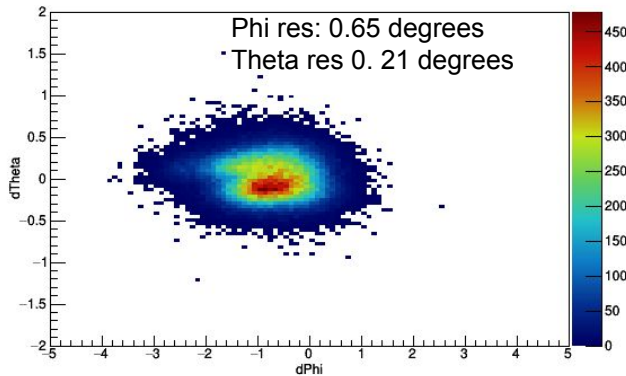
Cabling (E. Oberla)



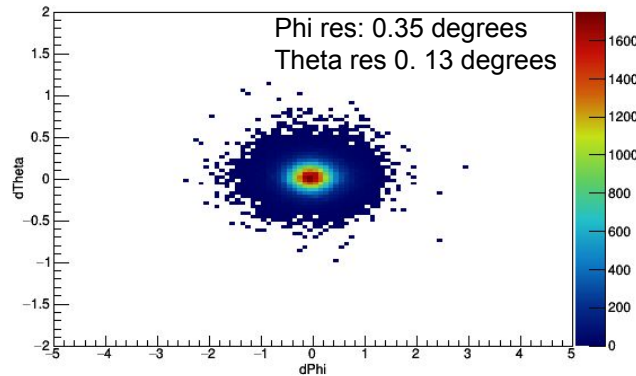
Impulse responses for 16 channels stacked on top of one another (B. Rotter)

Calibration — Pointing Resolution

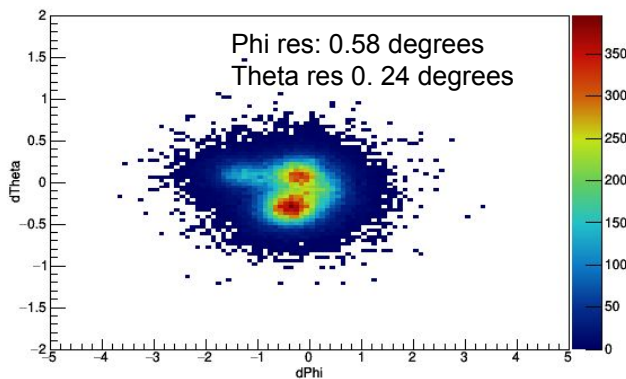
No Calibration HPOL



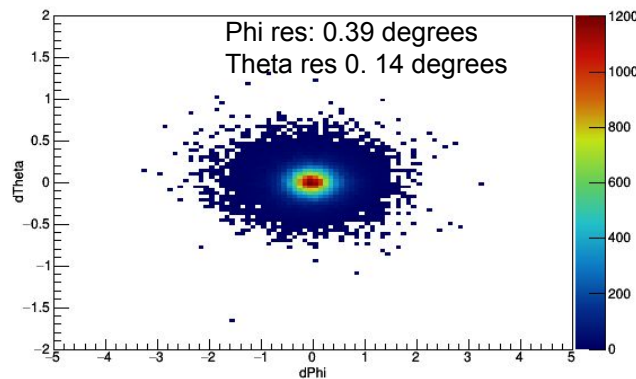
Best Calibration HPOL



No Calibration VPOL



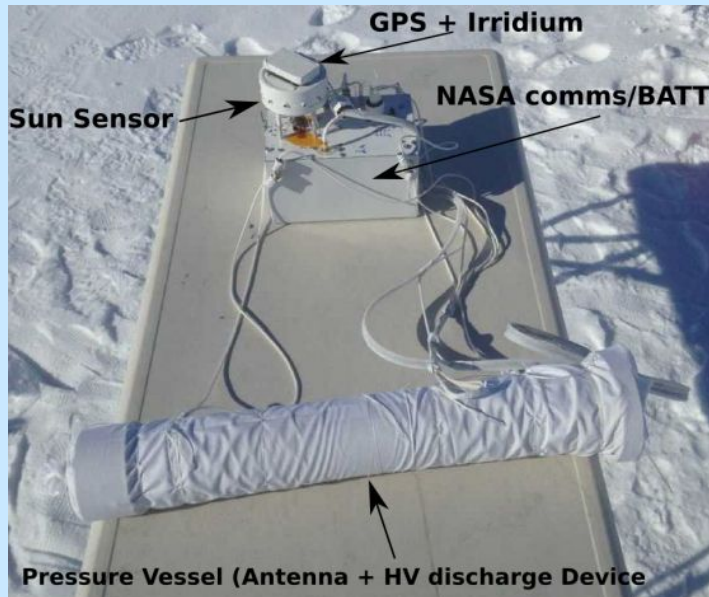
Best Calibration VPOL



Pointing calibration is done by calibrating exact antenna positions (phase center positions)

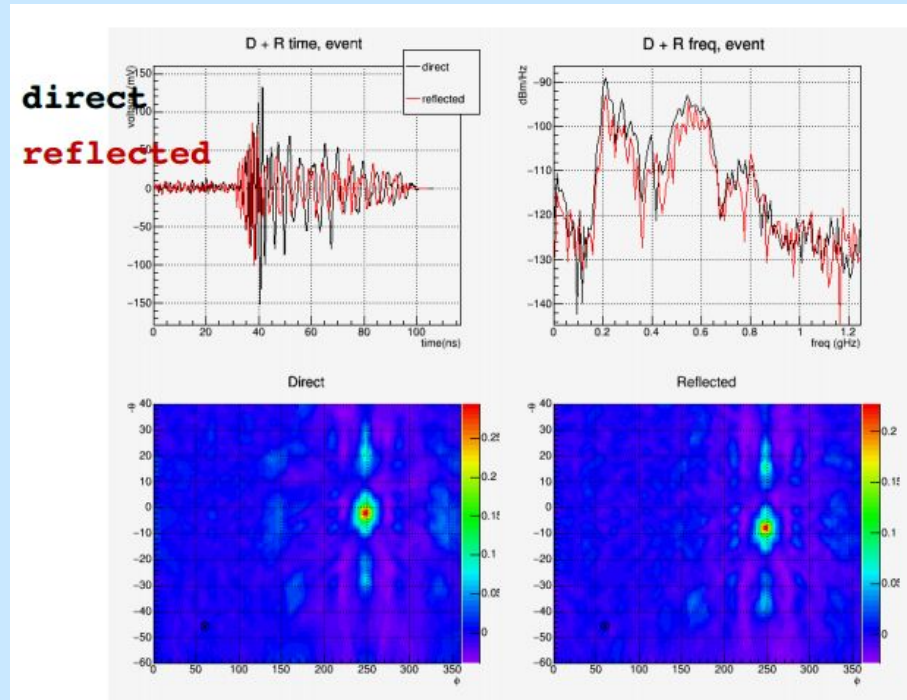


Calibration pulser setup (E. Oberla)



The HiCal instrument

Calibration — HiCal



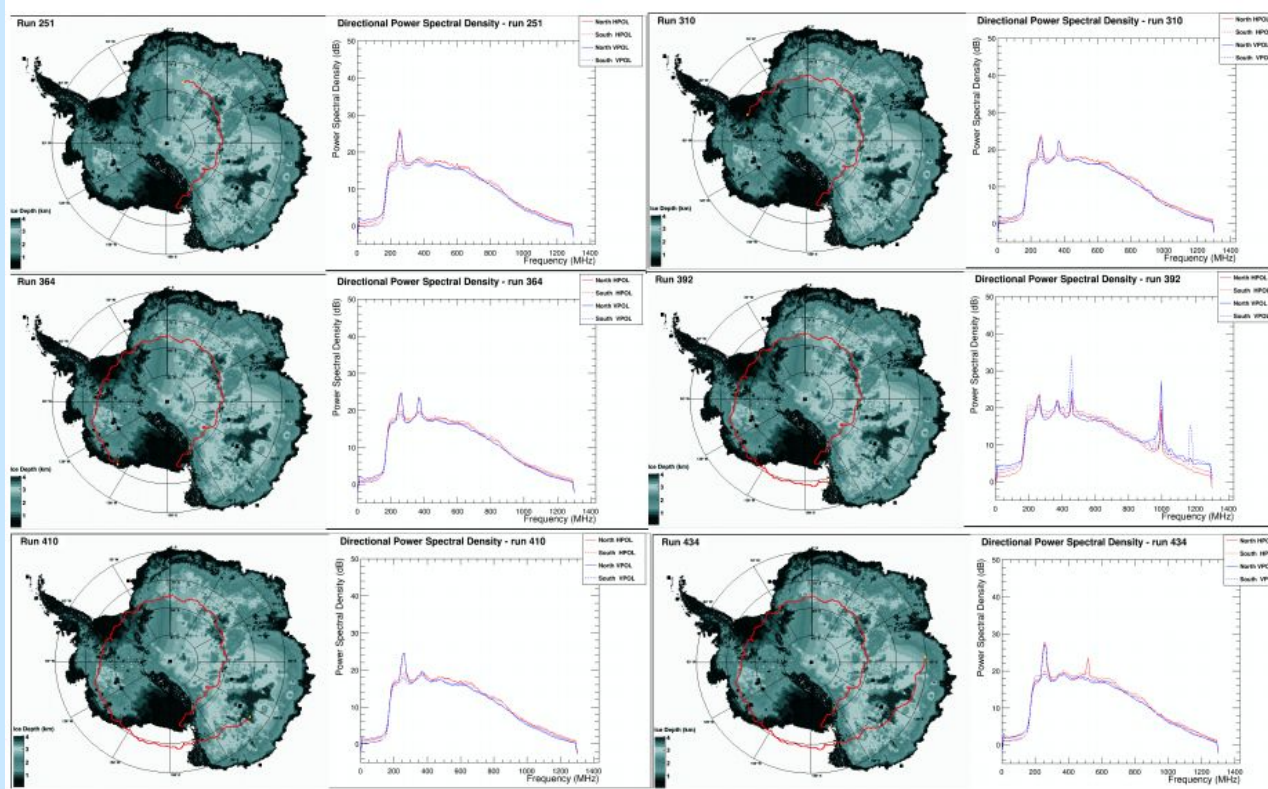
HiCal launch

Smaller balloon payload for calibration

2 purposes:

- calibration pulses
- surface roughness/reflectivity

Filtering



ANITA-3's sources of CW interference changed greatly throughout the run (B. Strutt)

We want to cut out satellites, comms from bases, etc.

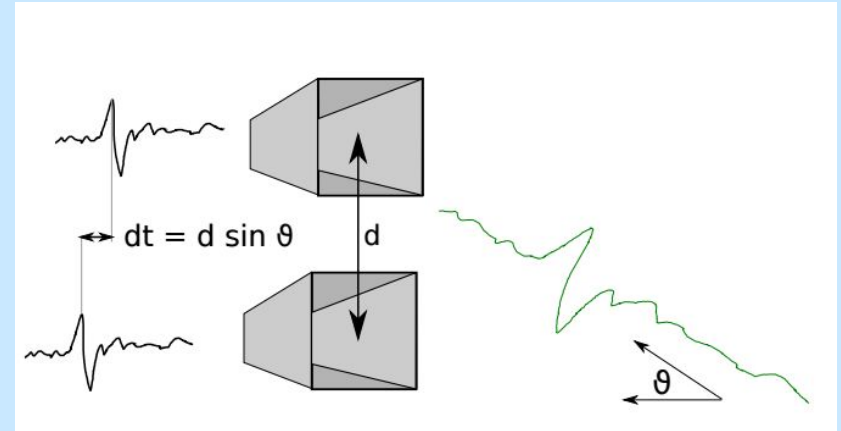
Satellites were a problem for A3

Previously used brick wall filters

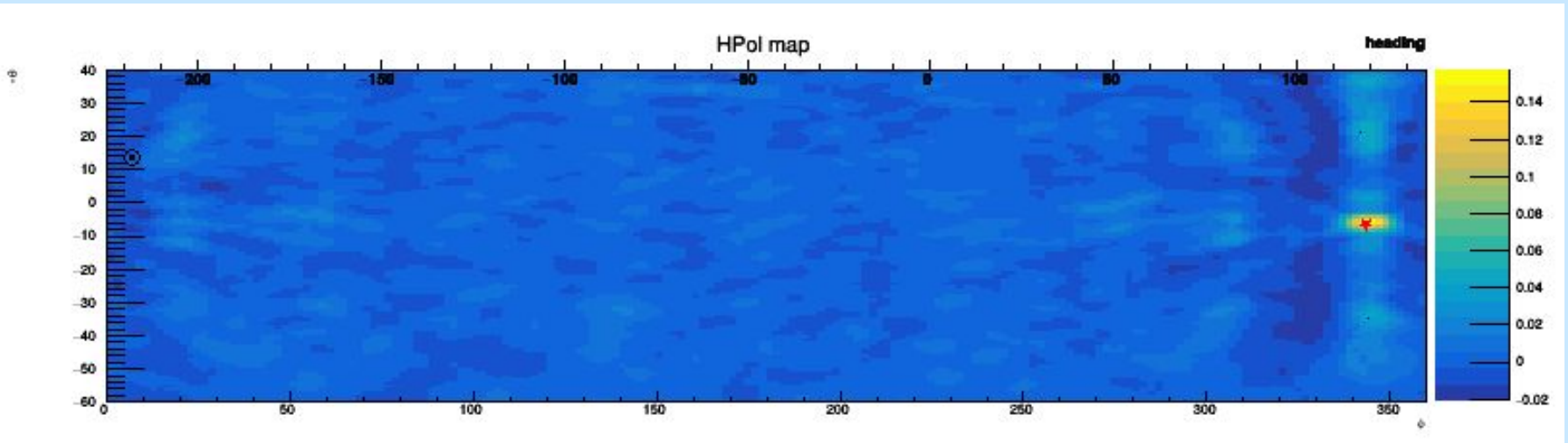
Have moved towards time domain phasor removal type filtering

Pointing

- For each incoming angle, work out time delays between antennas.
- Fill interferometric map with cross-correlation values at appropriate time delay.
- Peak gives likely incoming direction relative to ANITA



Interferometry schematic (C. Deaconu)



Calibration pulse as seen in ANITA-4

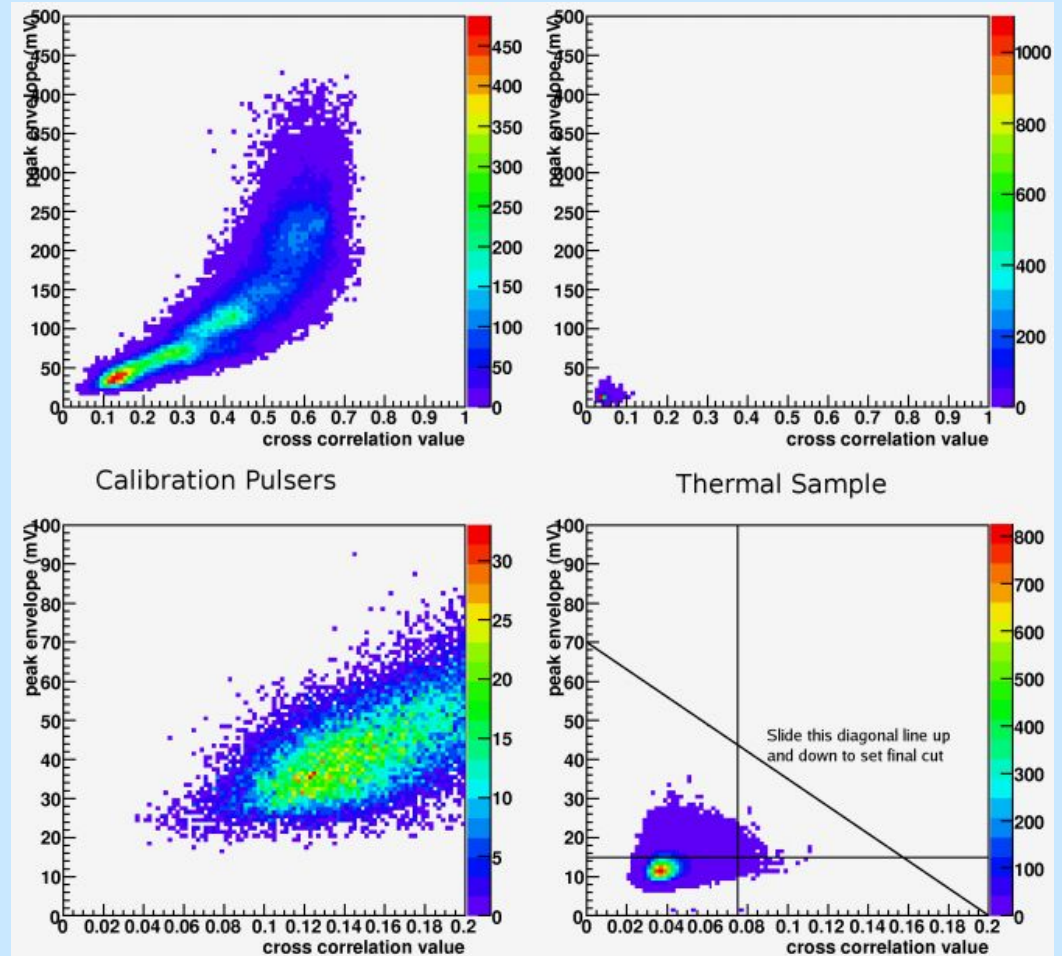
Cuts

Cut out:

- noise, both continuous waveform and thermal
- glitchy things

Previous analyses used just a few features and a Fisher discriminant

Ongoing analyses have many more features and use more sophisticated ML techniques



Example of distributions used for cuts for ANITA-2 (A. Viereg)

Clustering

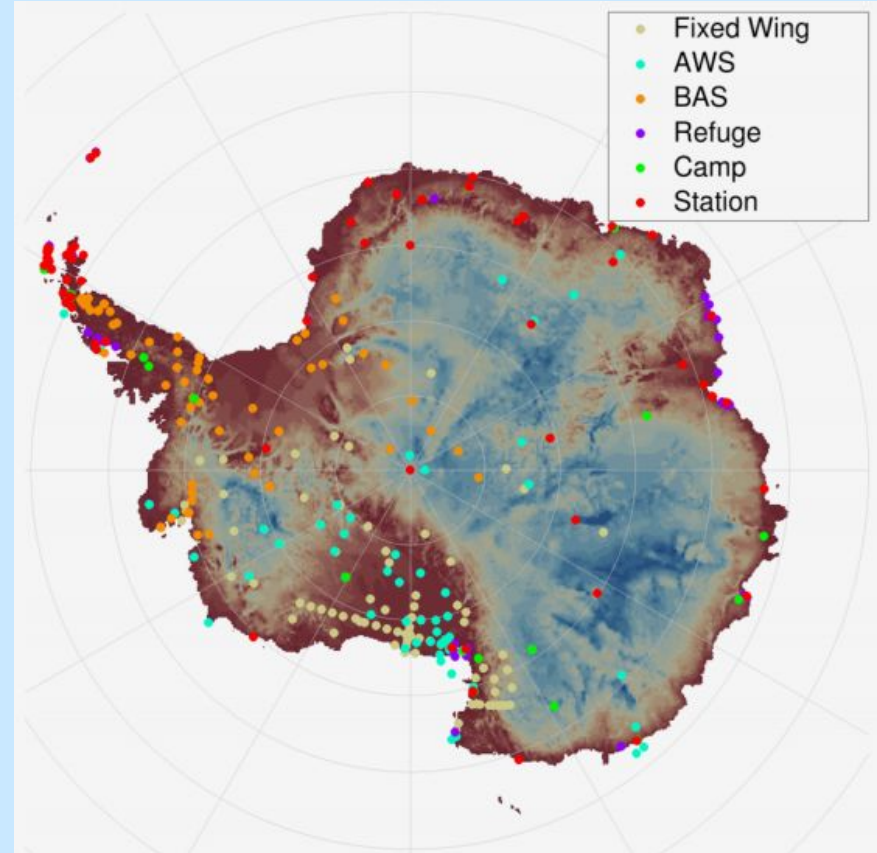
Look for isolated events

Things that cluster are probably from an anthropogenic source

At the same time, make sure event doesn't come from a known base

After clustering, whatever is left goes in your signal region

HPOL events are cosmic ray candidates and VPOL events are neutrino candidates



Known bases for ANITA-3 (J. Russell)

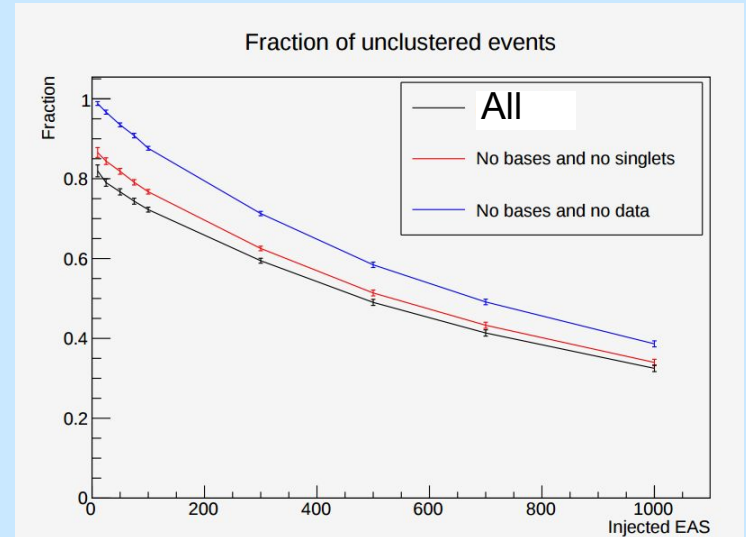
Cosmic Ray Search

Traditionally, HPOL events that pass all cuts and clustering are considered signal

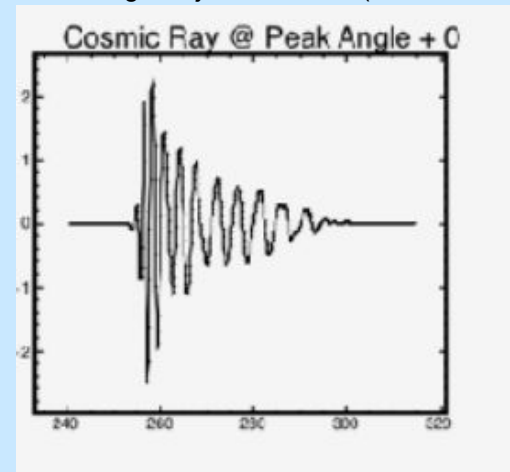
Simulation suggests that we may have too many cosmic rays (CRs) in Anita 4 to do this (likely to cluster with each other)

Currently developing a template search

CR search is blind to polarity of cosmic rays to stay blind to Tau candidates

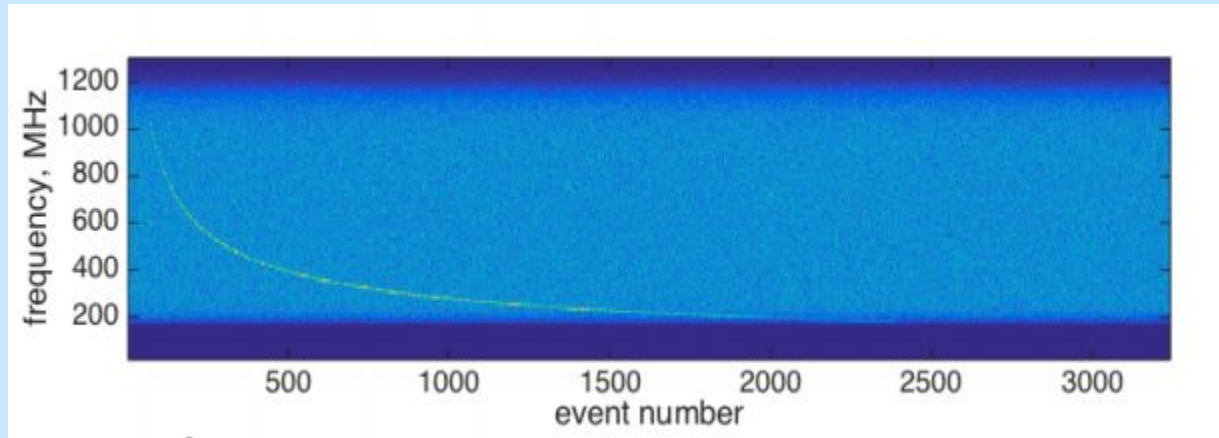


Clustering of injected events (L. Cremonesi)



On boresight cosmic ray template (B. Rotter)

FRB Search



Unrealistically large, simulated FRB, just to show behavior (P. Gorham)

Recent FRB hype has infected ANITA

Work on this is still young, but simulations suggest we could see FRBs with steep spectral indices

Outlook



ANITA-3 neutrino/CR analysis will be done very soon, keep an eye out

ANITA-4 neutrino/CR analysis should be done within a year

Follow up analyses include

- FRB search
- Neutrino search from GRBs
- Anything else we think up

ANITA-5 might be around the corner, with much improved everything