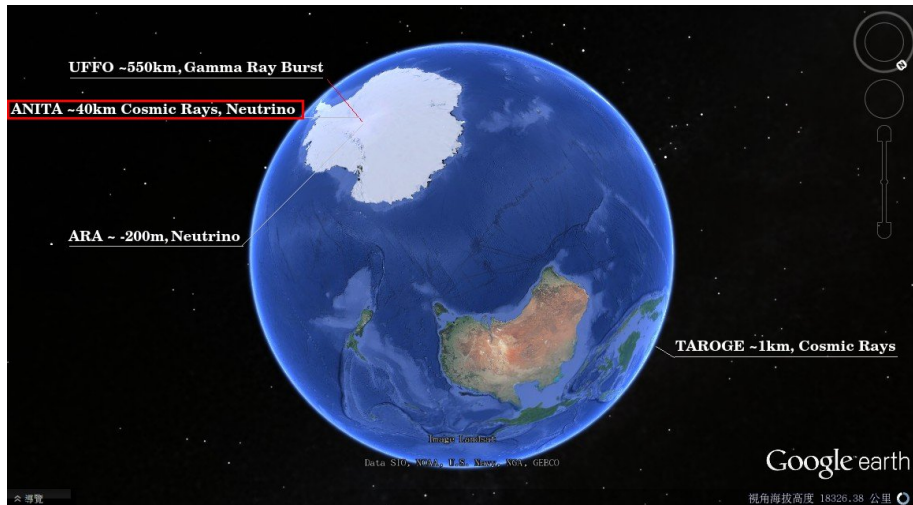


# Profile Of Third Flight Of The Antarctic Impulsive Transient Antenna (ANITA) In 2015

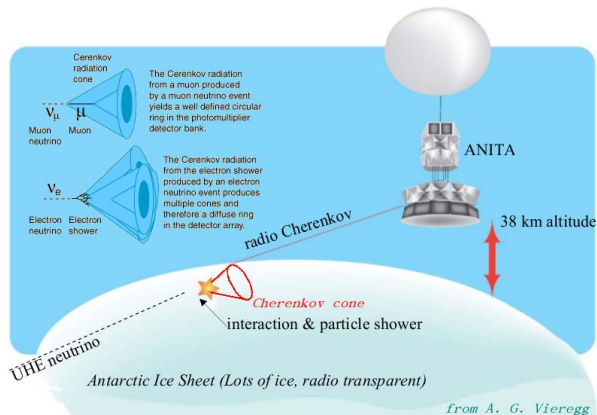
TC Liu, NTU  
Jan 25, 2016



# The ANtarctic Impulsive Transient Antenna (ANITA)



# The ANITA Concept



**Figure:** Cherenkov radiation is electromagnetic radiation emitted when a charged particle passes through a dielectric medium at a speed greater than the velocity of light in that medium.

# Flight Path of ANITA & ANITA-II

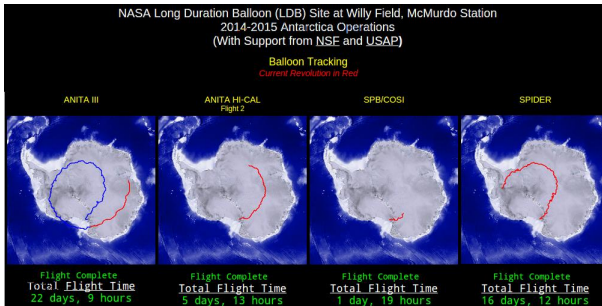


Figure: flight path of ANITA & ANITA- II.

# FoV of ANITA

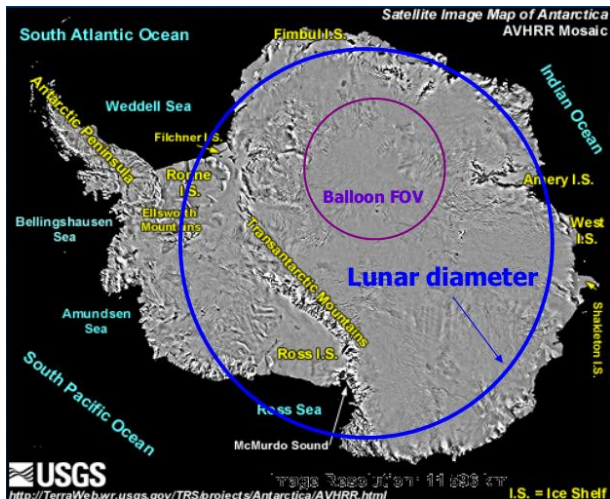
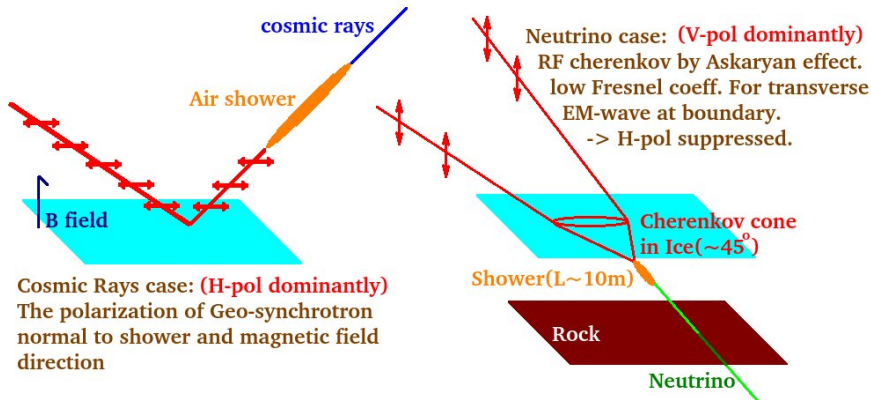


Figure: The radius of FoV is about 500km.

# Signal Type (Neutrino VS. Cosmic Rays)



# The ANtarctic Impulsive Transient Antenna (ANITA-III)

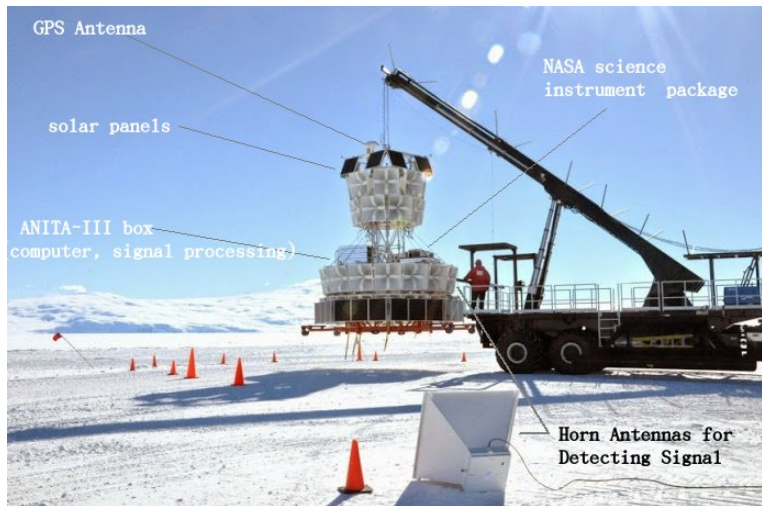
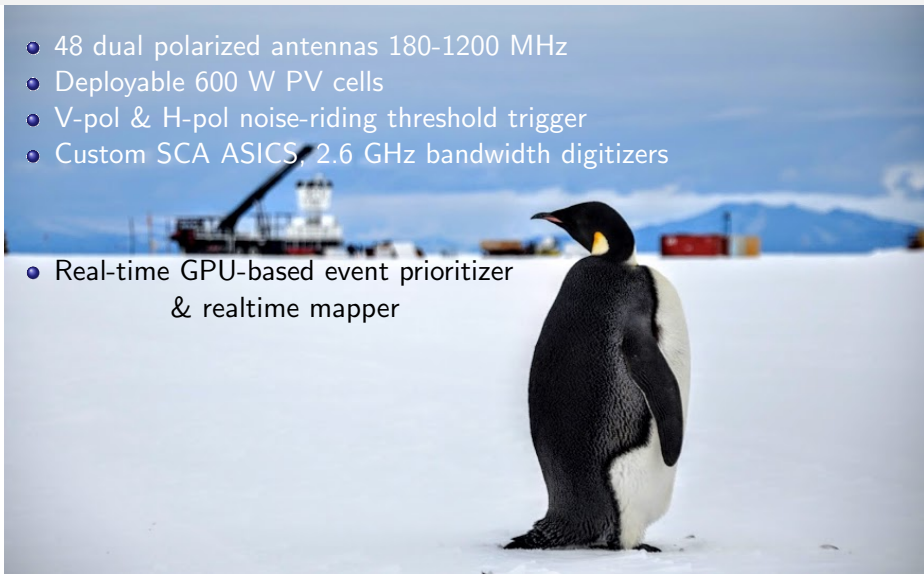


Figure: ANITA-III instrument, 2014-1015.

## ANITA-III Instrument:

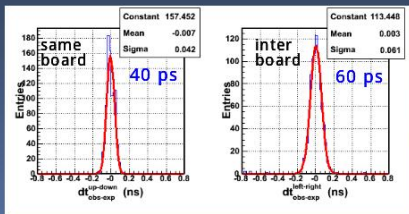
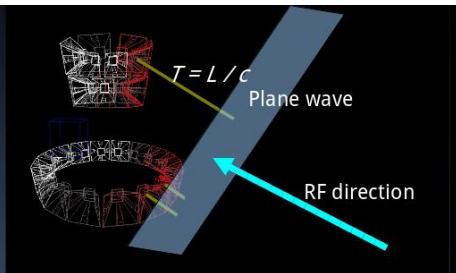
- 48 dual polarized antennas 180-1200 MHz
- Deployable 600 W PV cells
- V-pol & H-pol noise-riding threshold trigger
- Custom SCA ASICS, 2.6 GHz bandwidth digitizers
- Real-time GPU-based event prioritizer & realtime mapper





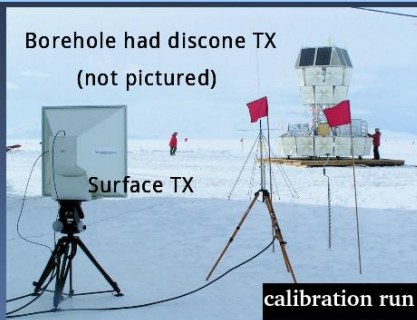
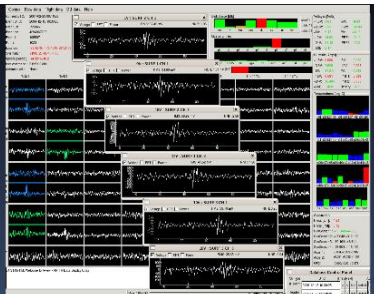
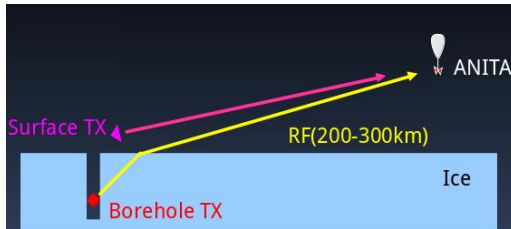
# Event Reconstruction

- Angular reconstruction is a crucial part in the ANITA data analysis.
- Powerful background rejection
  - incoherent thermal events (99% of data set)
  - anthropogenic RF events from existing bases
  - air shower RF events.
- Neutrino reconstruction
  - neutrino direction information
  - provides R and refraction angle for energy measurement.
- Angular reconstruction using timing.
- time resolution; 40-60 ps (time difference between channels)
- Achieved angular resolution;  $0.2^\circ$  (zenith) and  $0.8^\circ$  (azimuth.)



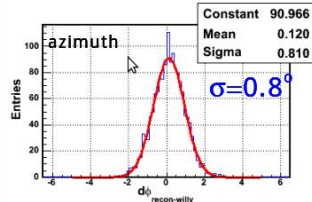
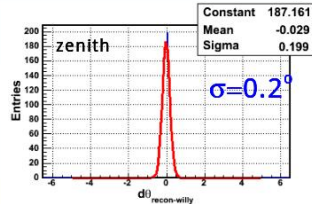
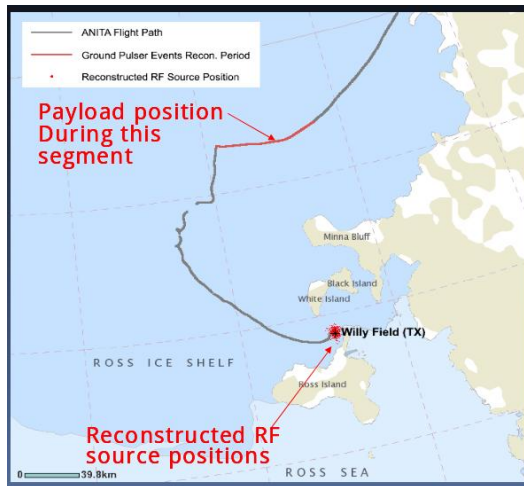
from jiwoo Nam

# Ground Pluser System



- Two Ground Pluser Systems @Williams Field and Taylor Dome
- System Verification
- Trigger Test
- Propagation and Surface
- Timing / Angular Resolution

# Angular Resolution



# The Candidates of UHECRs of ANITA-III

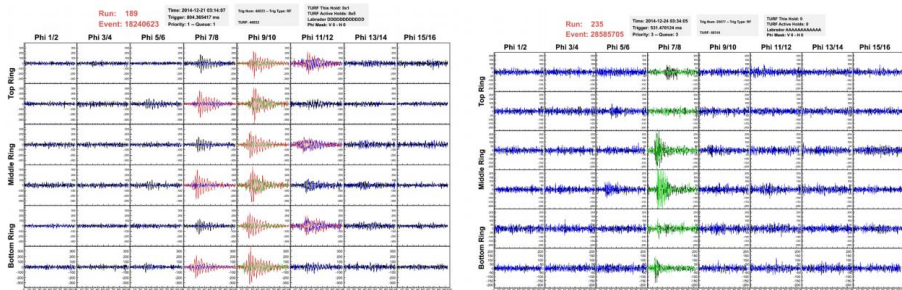


Figure: Predominately Hpol, no known bases, strong SNR.

# Flight Path of ANITA-III 2014-2015

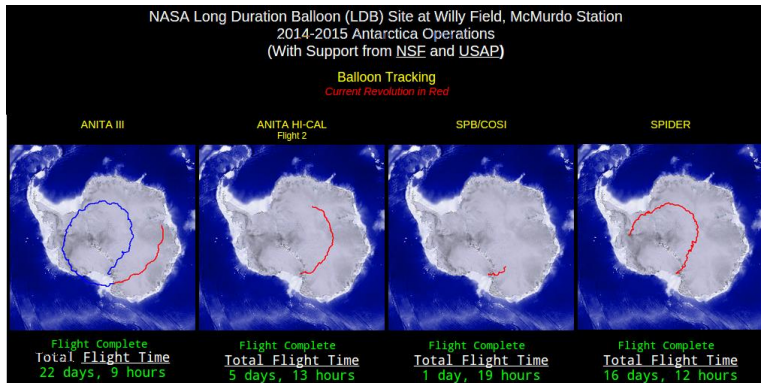
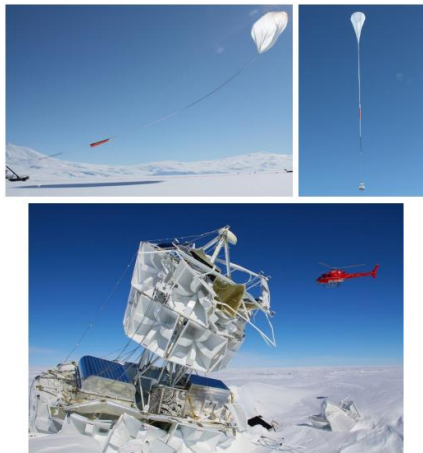


Figure: Flight path of ANITA III.

<http://www.csbf.nasa.gov/antarctica/payloads.htm>

## Launch and landing



**Figure:** Photographs of the launch and landing of the ANITA-III payload. Credit to C. Miki and the Australian Antarctic program.

## Summary of ANITA -III

- Flight in 14/15 austral summer lasted 22 days
- Several improvements → most sensitive trigger to date
- HiCal to measure surface roughness
- Several UHECR candidate events and more to come (dozens)
- At current limit, ANITA-III could see several neutrinos
- 84 M events recorded

# ANITA-IV

- Planned flight in **2016/2017** Antarctic season
- Expected 50-60% improvement in energy threshold:
- Low-noise amplifiers & receivers with 30-40K lower noise → 20%
- Real-time 3-bit signal correlator trigger → 15%
- Programmable notch filters → ~30% improvement in exposure
- Improved GPU-trigger processor, higher trigger rates → 10-15%

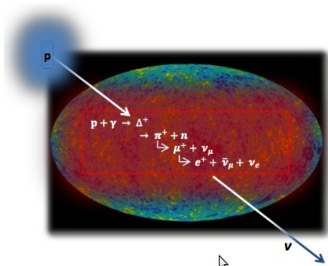




# Space

# Space

# UHE Neutrino & GZK Effect



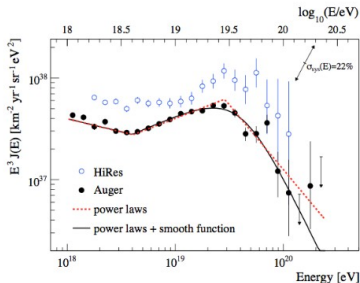
Auger and HiRes measurements of UHE cosmic rays consistent with GZK cut-off

**Guaranteed GZK neutrino flux, but how large?**

*copy from Jonathan's slides*

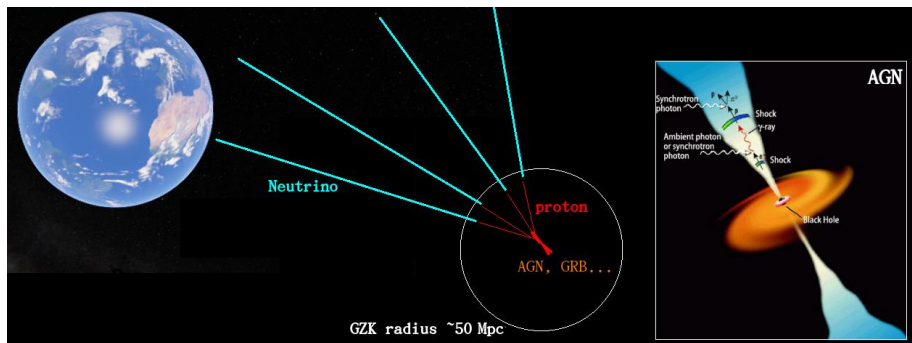
At energies above  $\sim 10^{19.5}$  eV cosmic rays will interact with CMB photons producing neutrinos

Process is known as the GZK effect



The Pierre Auger Collaboration (2010): Phys. Lett. B 685 (4-5): 239-246. HiRes Collaboration, Astropart. Phys. 32 (2009) 53.

# GZK Radius



**Figure:** The UHE neutrinos can point back to the original UHE source without bending of B field.

# The UHE Neutrinos

- Trace particle UHECR hyper-accelerators to very early epochs  
Even at  $z \sim 10$  or more, GZK neutrino energies peak at 10-100 PeV  
they all point back directly to the UHECR sources
- Their flux is constrained by UHECR sources, once determined  
Can become a quasi-isotropic “test beam” of UHE neutrinos
- Neutrino Flavor physics  
Can encode source information by flavor ratio, even new physics  
(neutrino decay? )

# Man-Made EVENTS of ANITA

- 300k events pass thermal cuts
- Cluster with:
  - Other events
  - Known bases of activity
  - "Hot-Spots"
- **Neutrinos are single, isolated events!**

