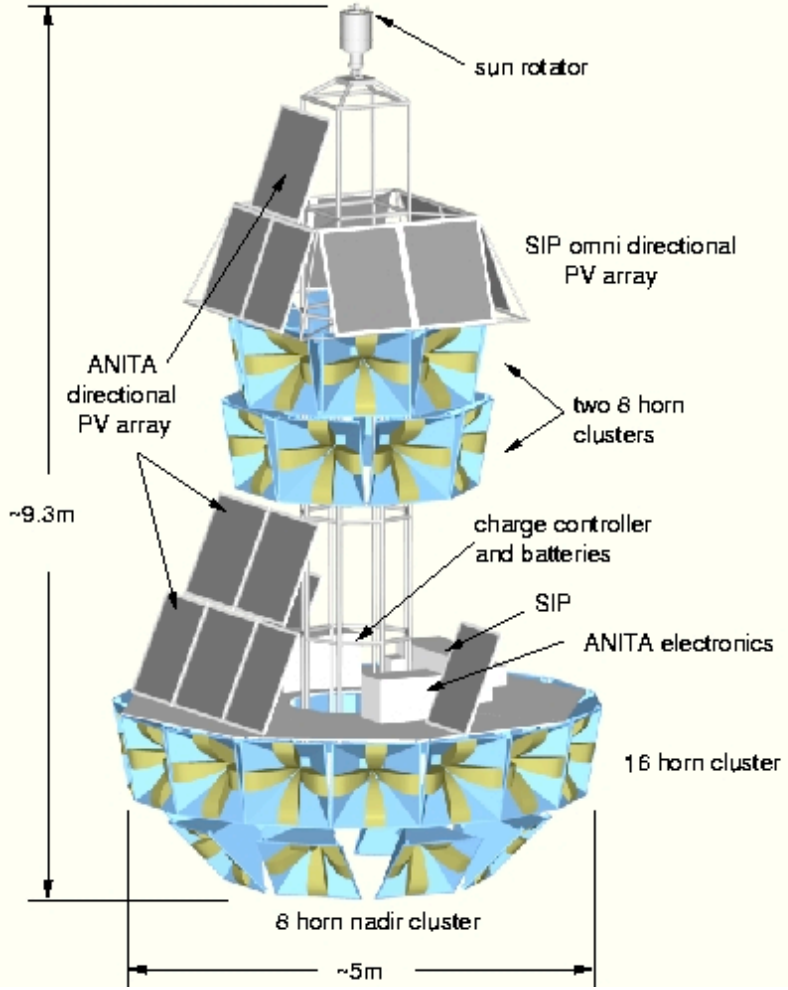
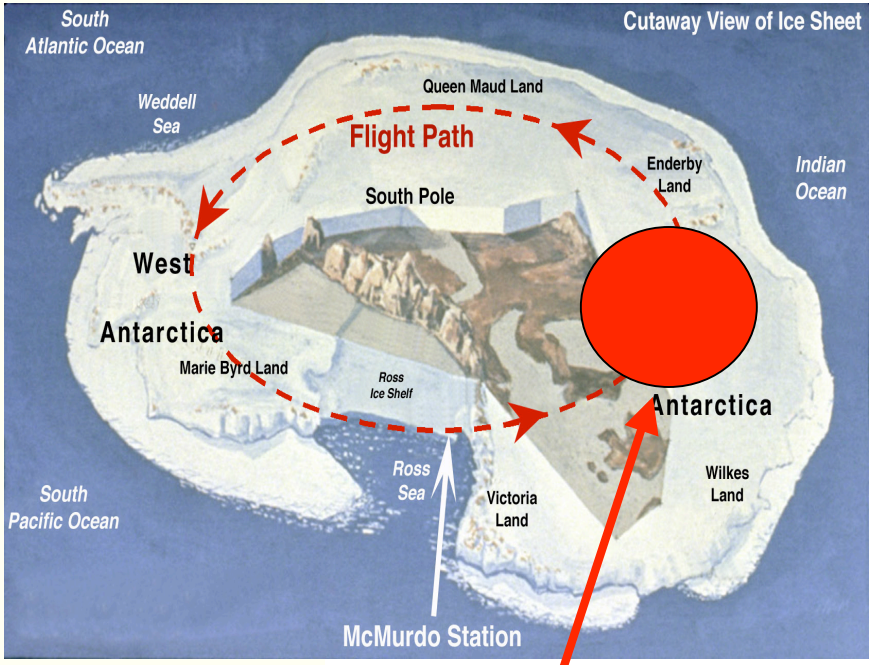
ANtarctic Impulsive Transient Antenna

www.ps.uci.edu/~anita

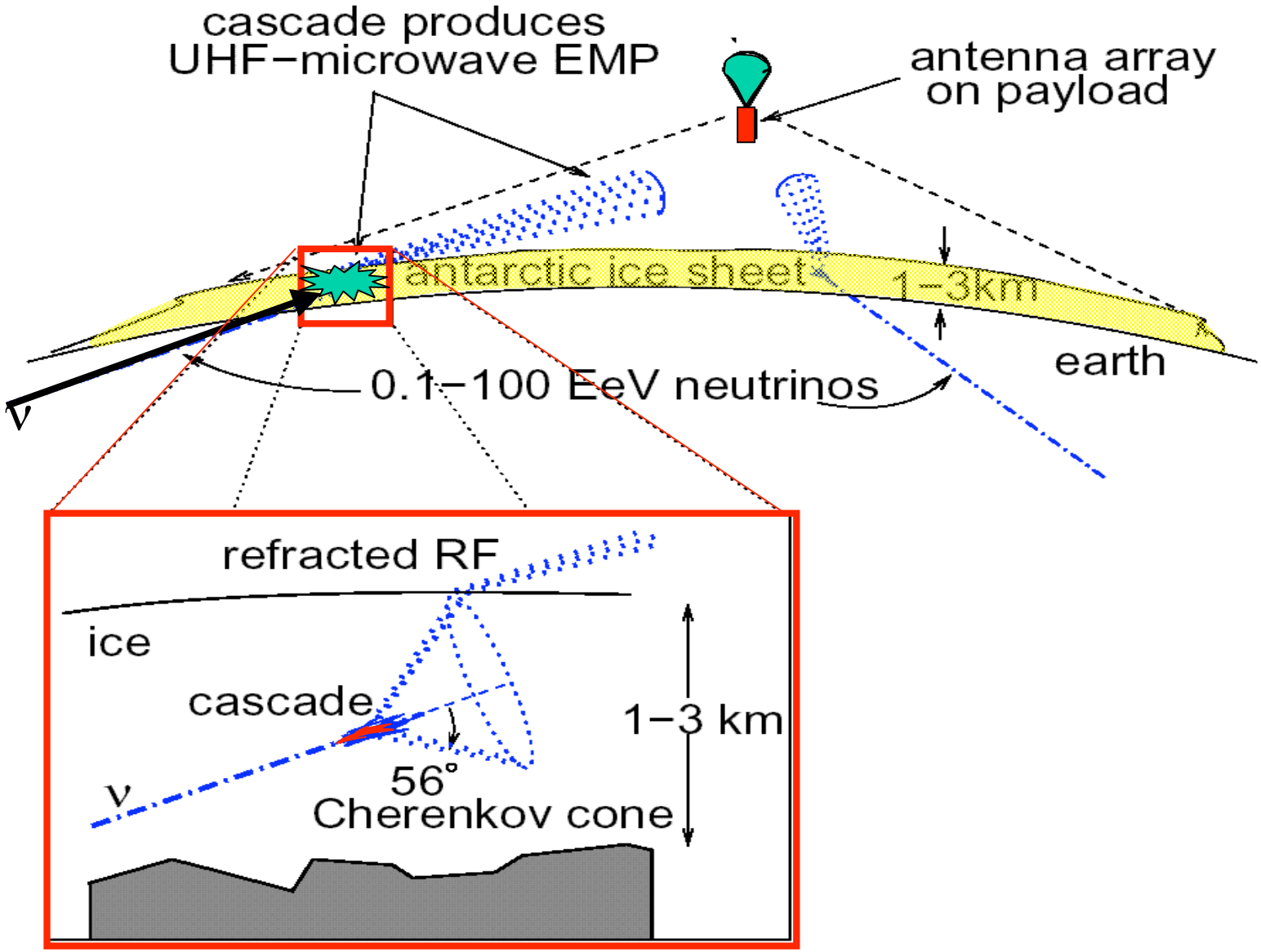




600 km radius,
1.1 million km^2

- NASA funding started 2003 for first launch in 2006
- Phase A approval for SMEX ToO mission

ANITA concept



ANITA-lite

2 Receiver Horns

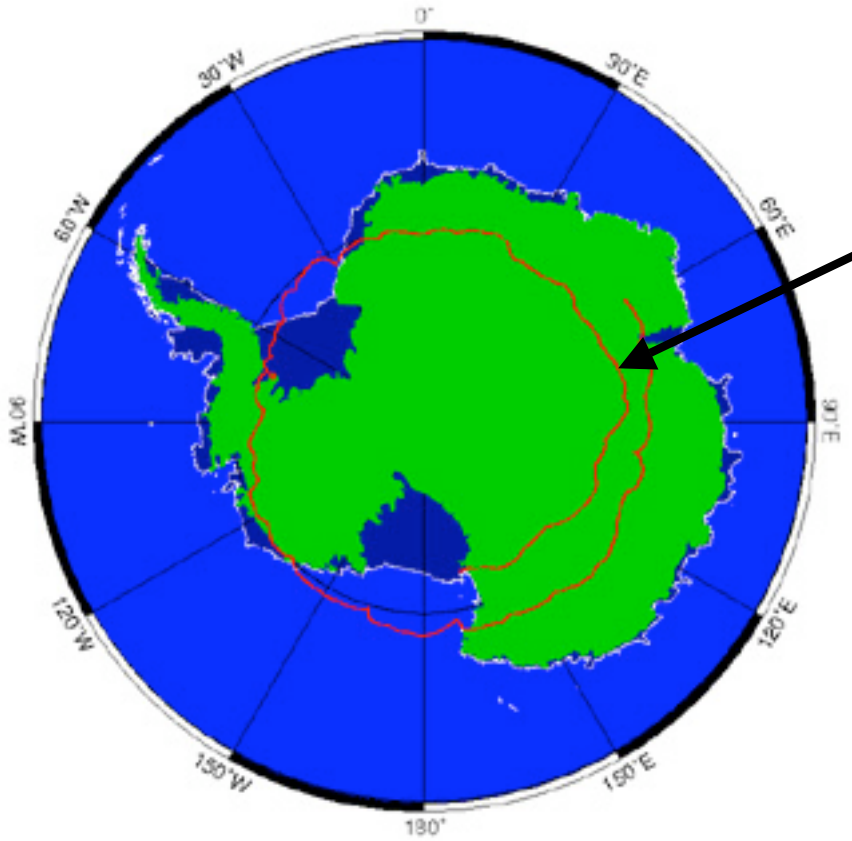
Electronics

Piggyback on TIGER Launch Dec '03

RF Survey of Antarctica

ANITA-lite prior to launch @ WF

ANITA-lite flight path 03/04

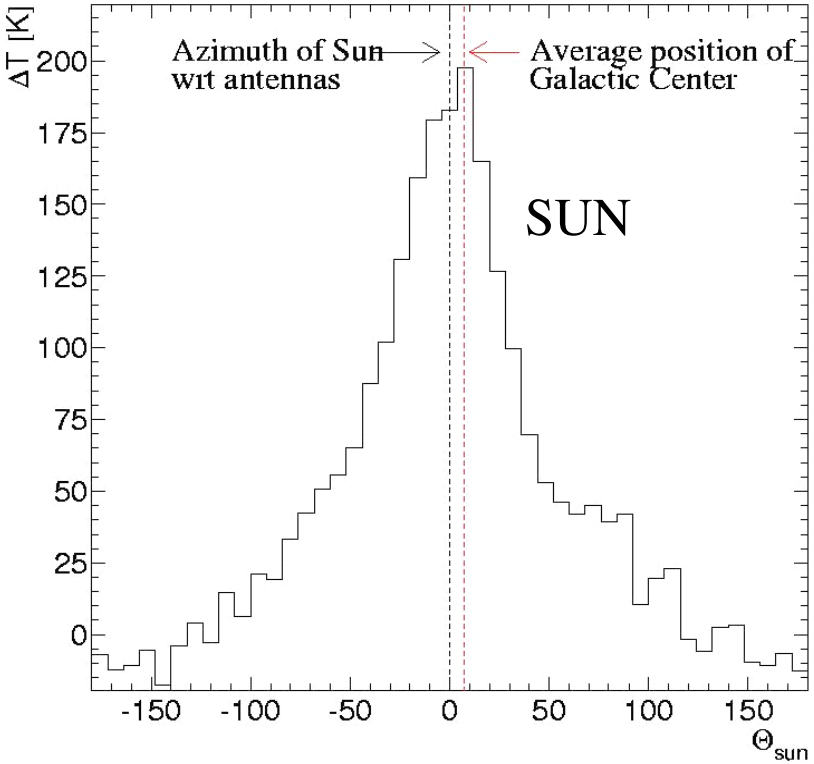


18 days at float altitude

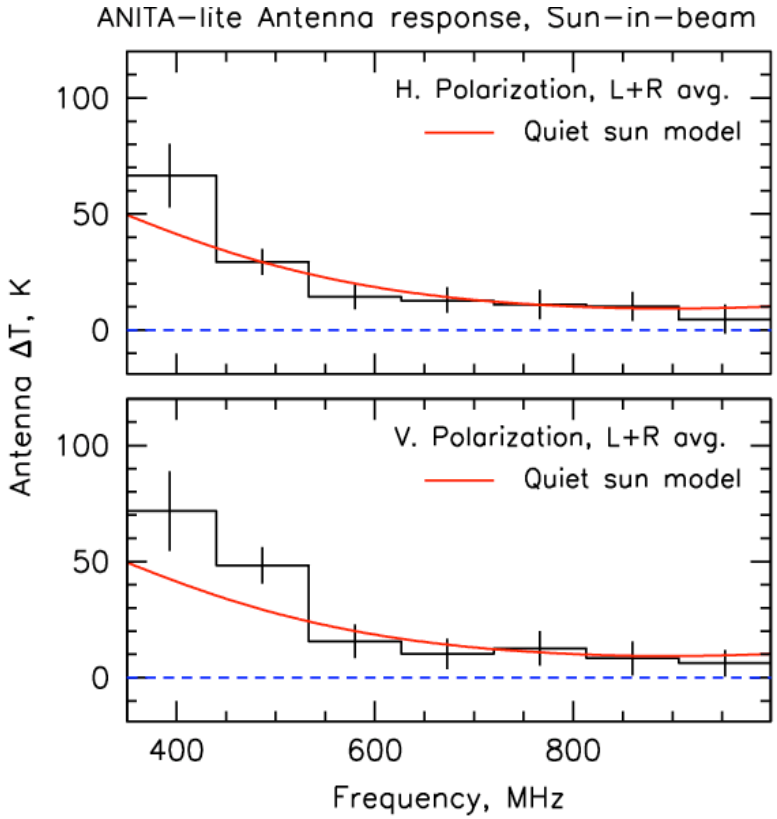
1.25 revolutions, landing near Mawson Station

Data recovered in Feb 04

Initial results from ANITA-lite



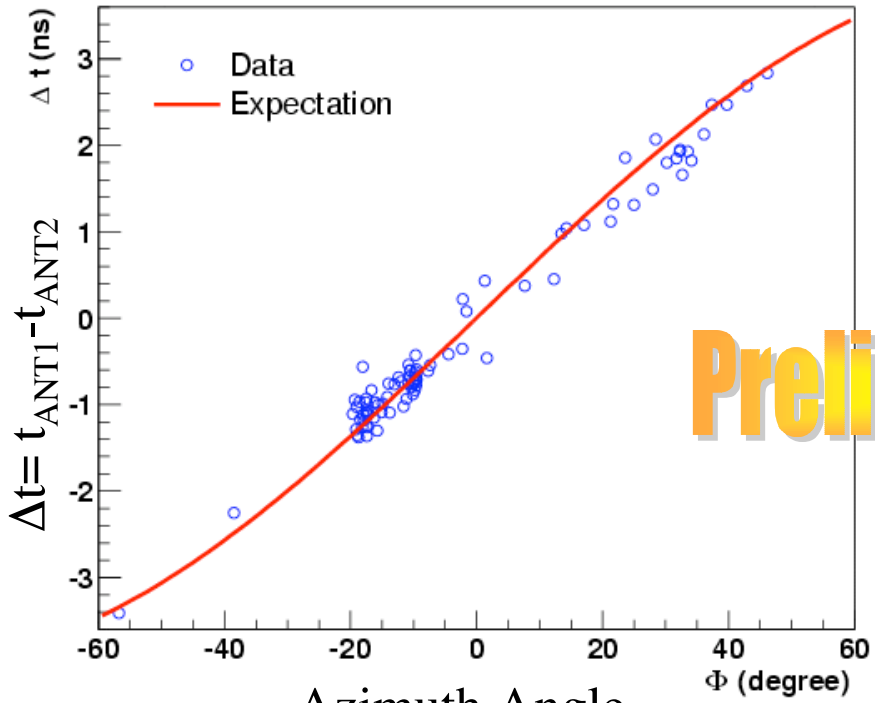
The ANITA-LITE antennas were able to discern the excess radio power in the direction of the Sun and the Galactic Center.



Antarctic Thermal noise measurements -consistent with galactic+solar+kT_{ice}

ANITA-lite timing resolution

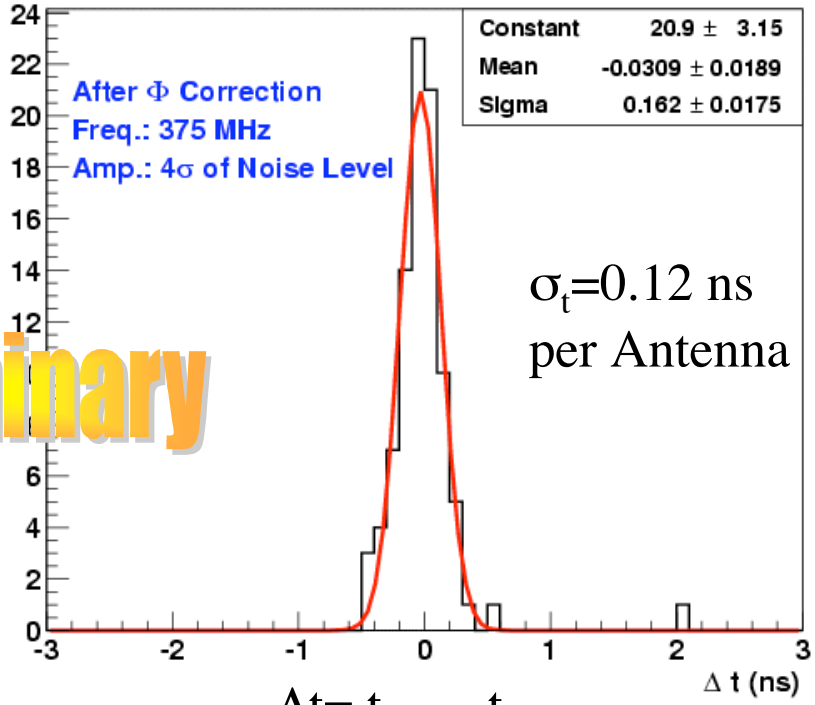
Ground antenna transmits calib. pulse to Anita-lite @40km



$\Delta t = t_{ANT1} - t_{ANT2}$

Azimuth Angle

Preliminary



σ_t=0.12 ns per Antenna

$\Delta t = t_{ANT1} - t_{ANT2}$

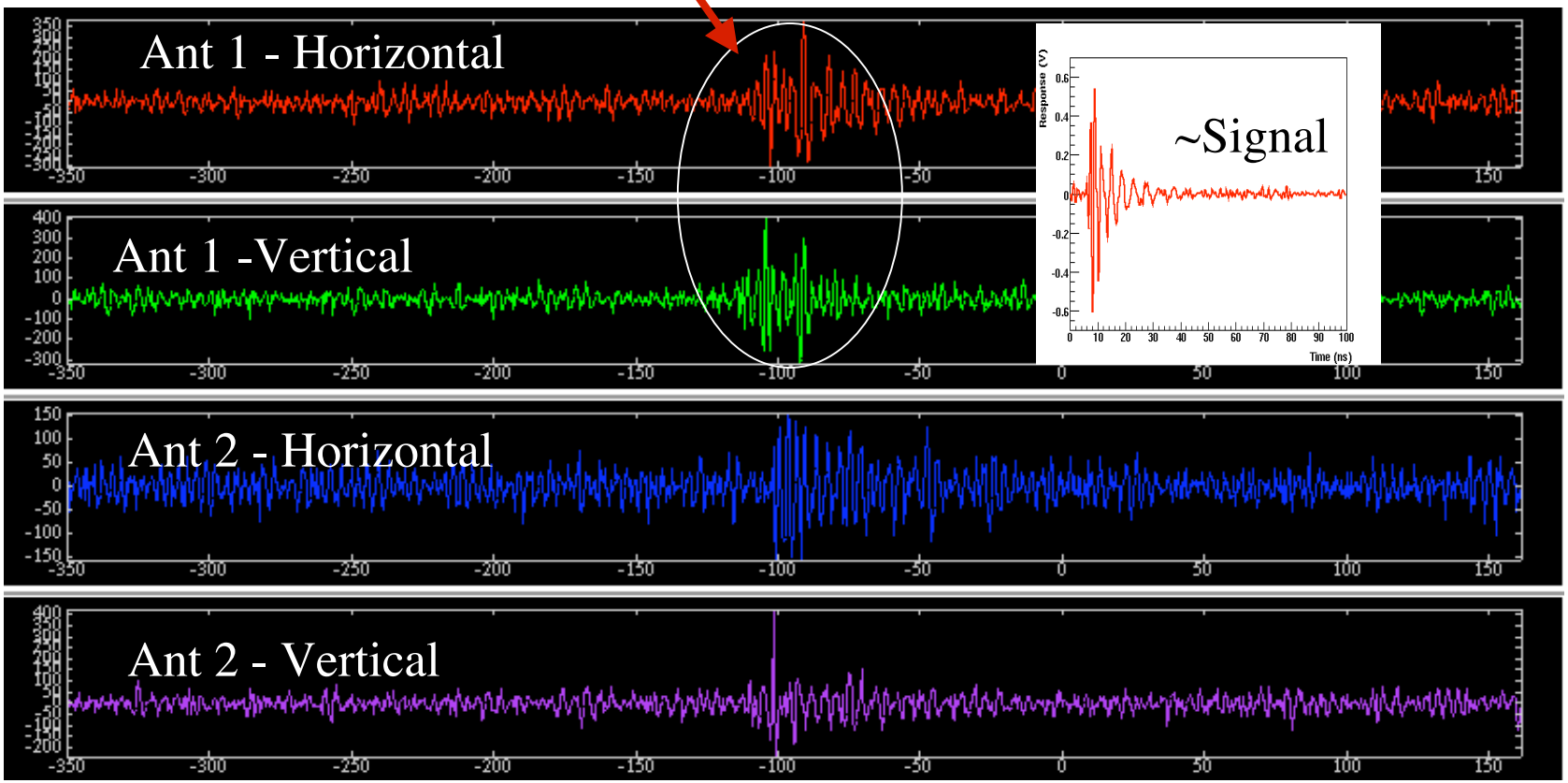
Expected Angular Resolution for ANITA

$\delta\theta \sim 0.5$ deg $\delta\phi \sim 2$ deg

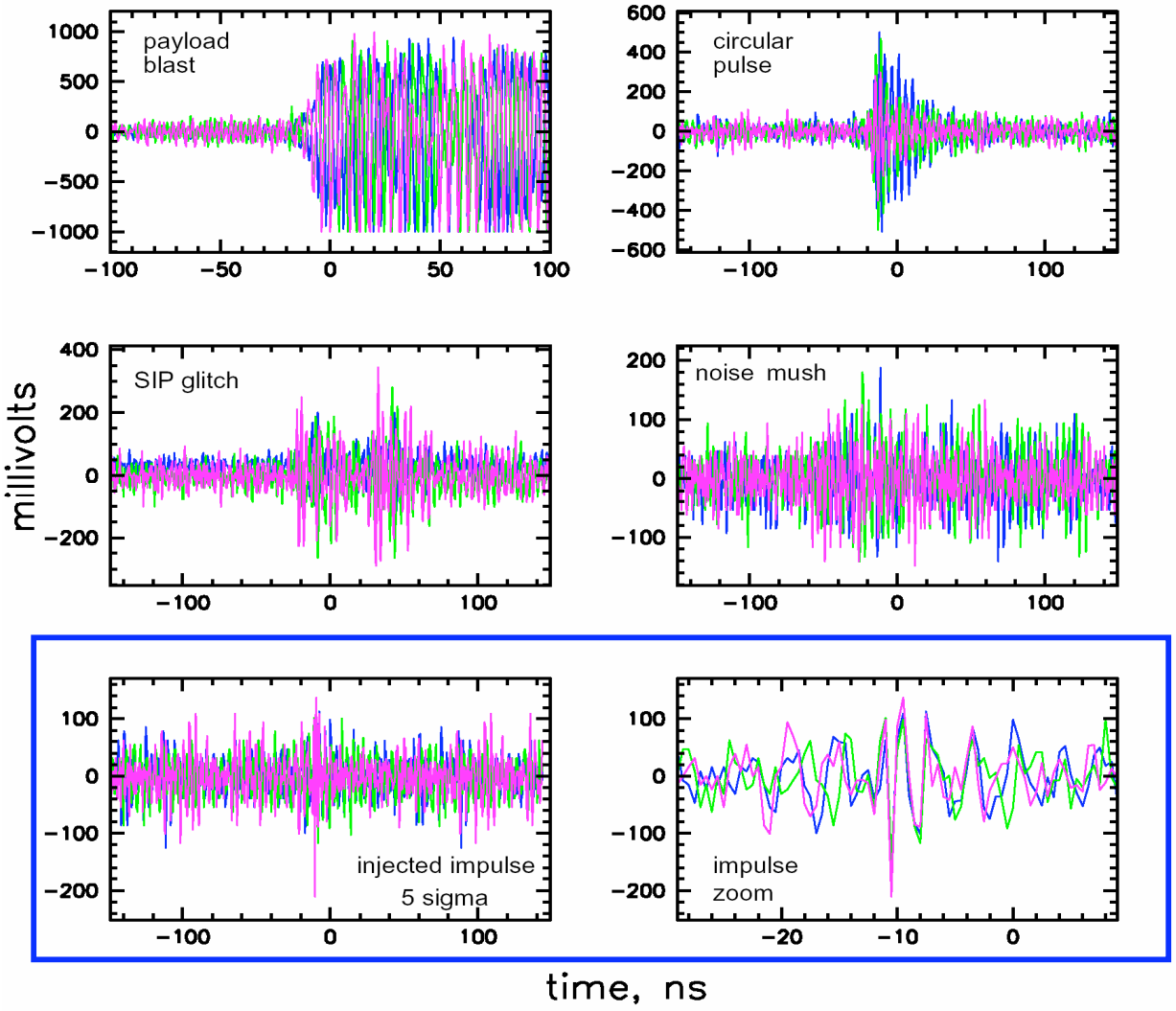
ANITA-lite BG event

Initial scan of data reveals no obvious ν signal

Duration is too large for ν - associated with local TRX



ANITA-lite impulse analysis

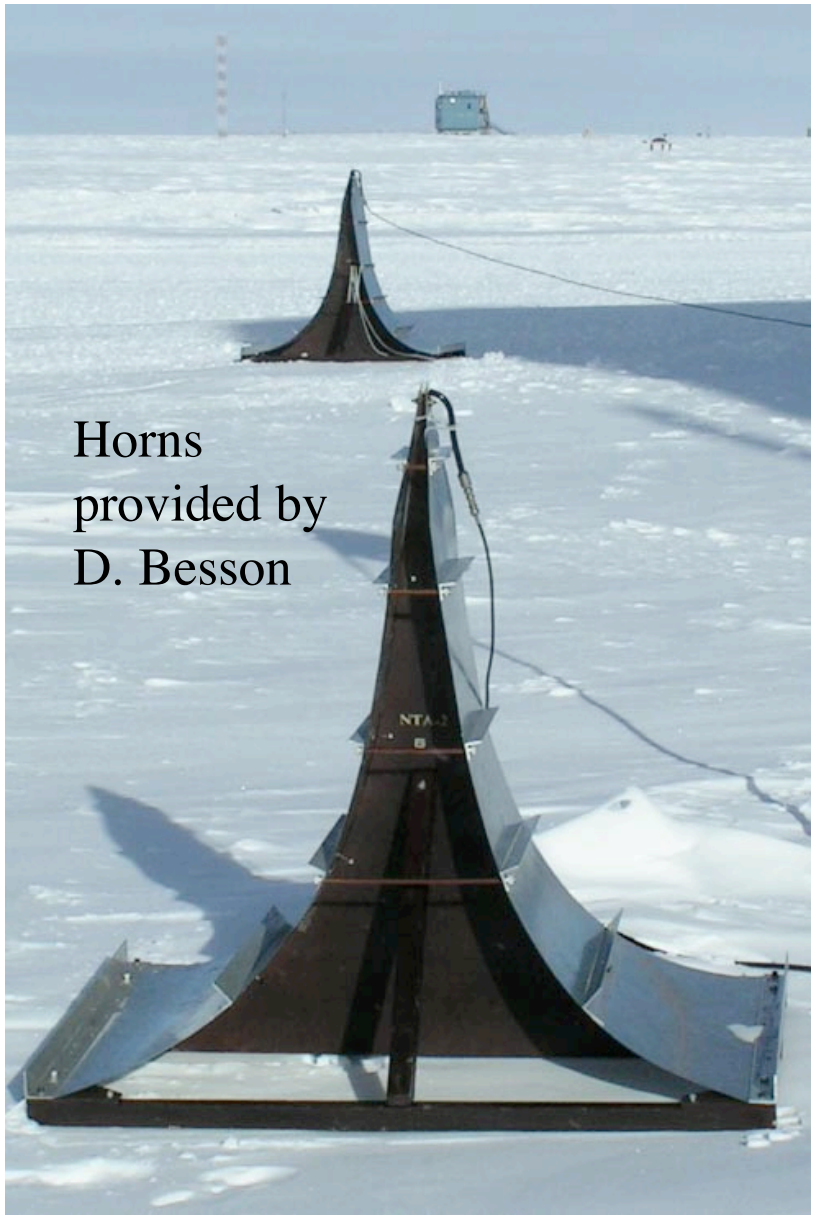


- Dominated by payload local noise
- Circularly polarized impulses (TDRSS relay turn-on?)
- Glitches from balloon support package (charge controller MOSFETS)

- **Injected 3 and 5 sigma signals** (superimposed on actual thermal noise)

Ice Attenuation at South Pole

- from 200MHz to 700MHz



Steve Barwick -Jan. 2004

D. Besson, S. Churchwell, J.Nam, P. Gorham

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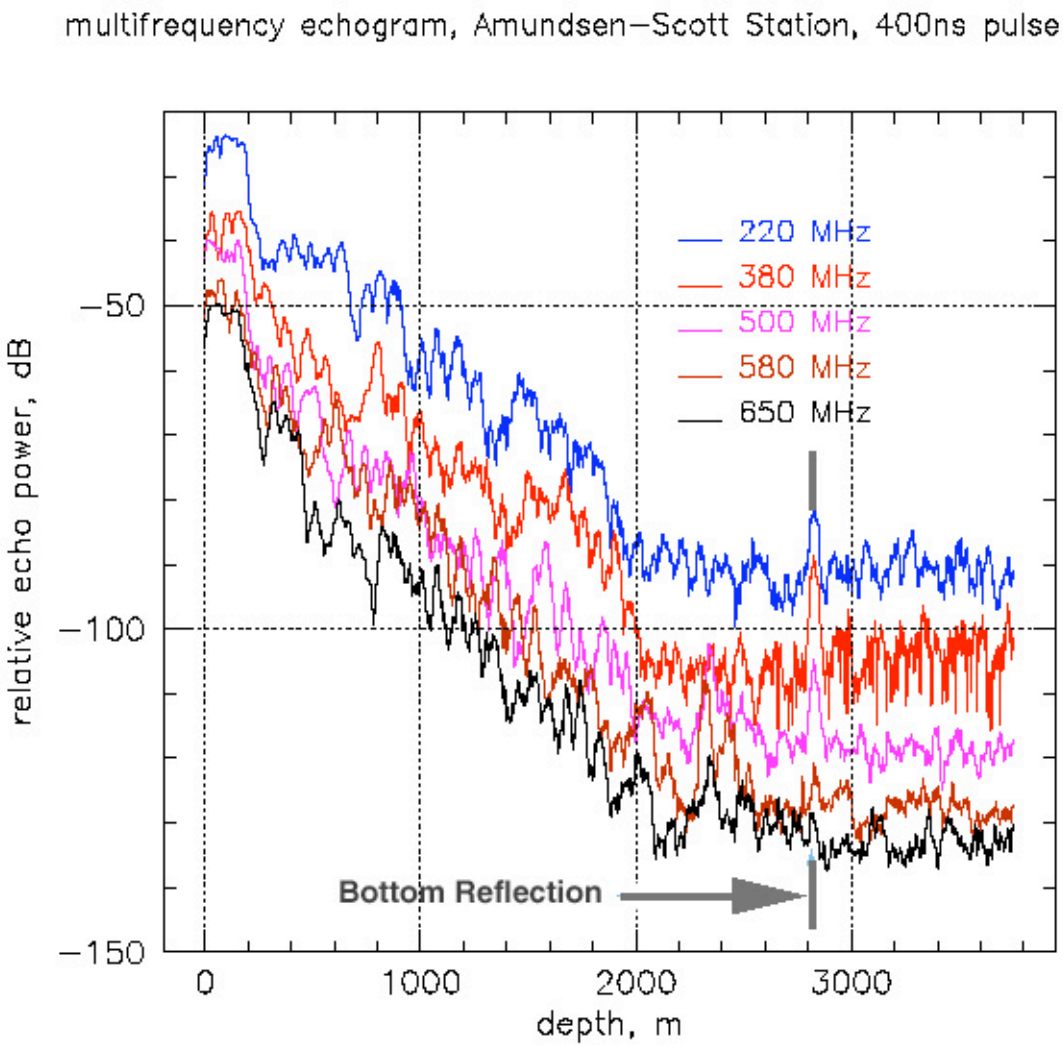
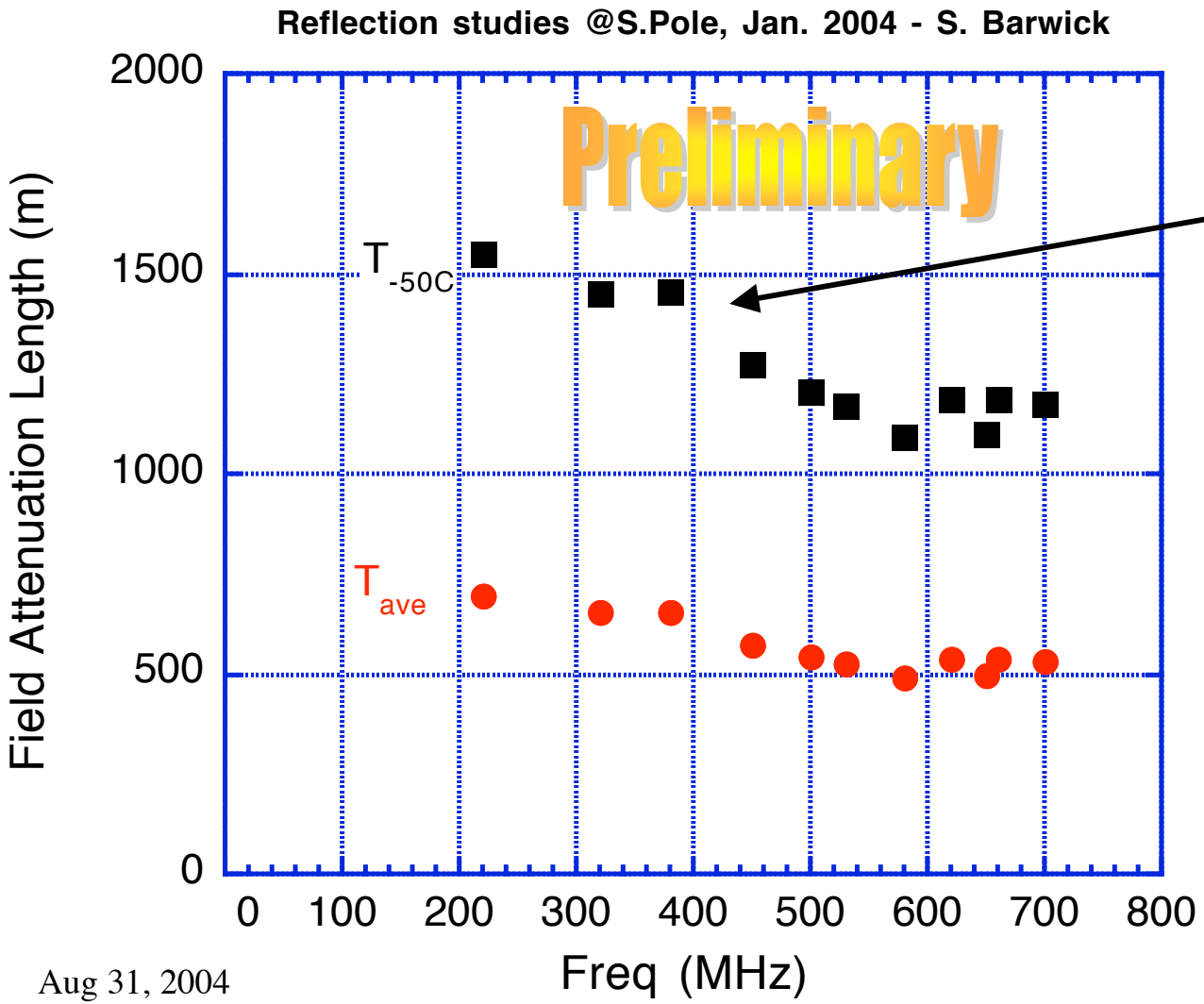


Typically 40k triggers
Stable T0
400ns wide
Lecroy WavePro 950
2 Gsa/s
50 us window

A clean reflection from the bottom implies that the attenuation lengths are very long!

Ice Attenuation at South Pole

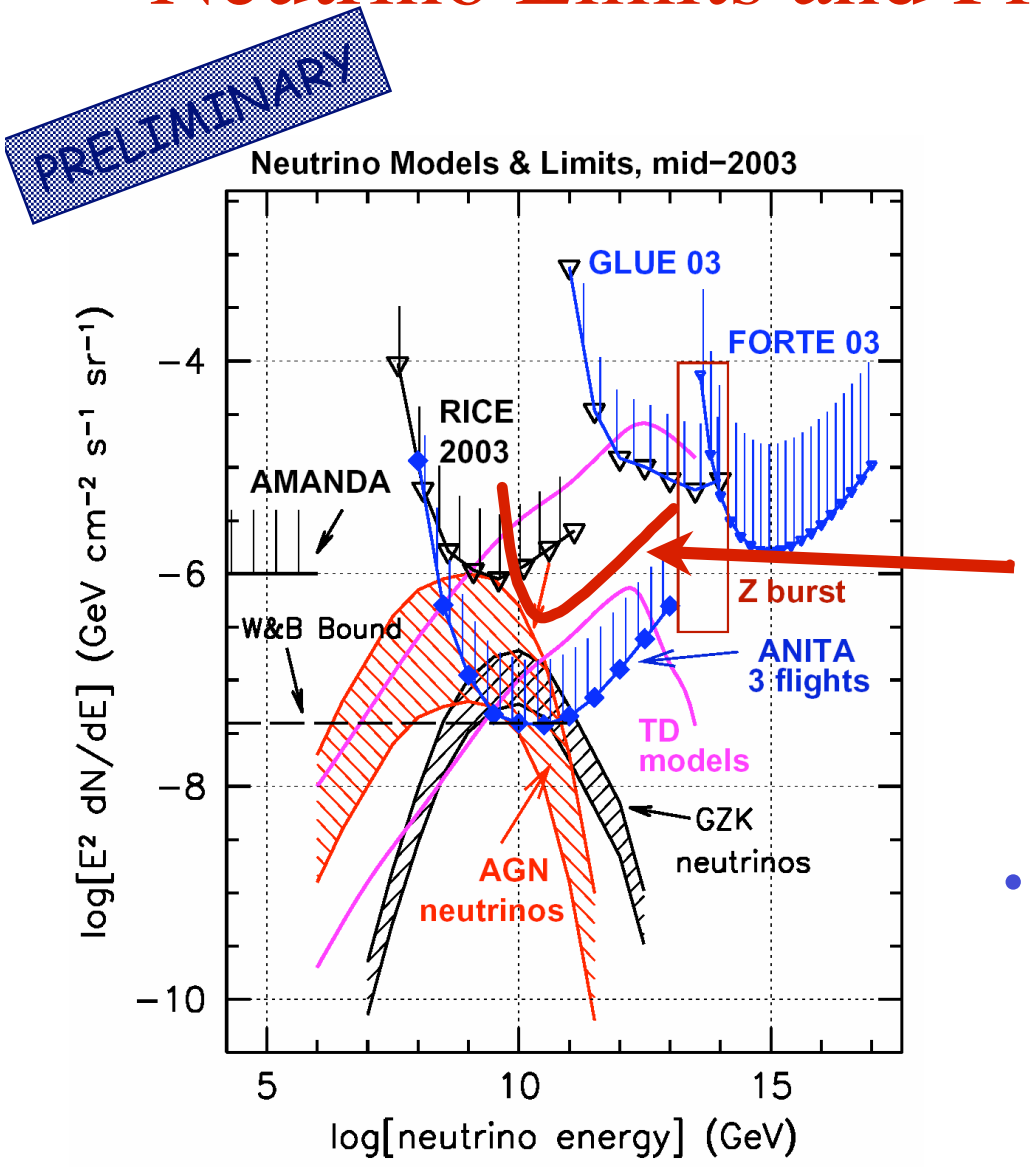
- from 200MHz to 700MHz



Most of Antarctic ice is -50C!

Excellent transparency, compare to ~100 meter for light, it is 10x larger

Neutrino Limits and Projected Sensitivity



Anita-lite '03 sensitivity

- ***7 days integrated livetime***
- ***Not yet a limit!***

- **Expected ANITA sensitivity**:
  1.5-2 orders of magnitude gain

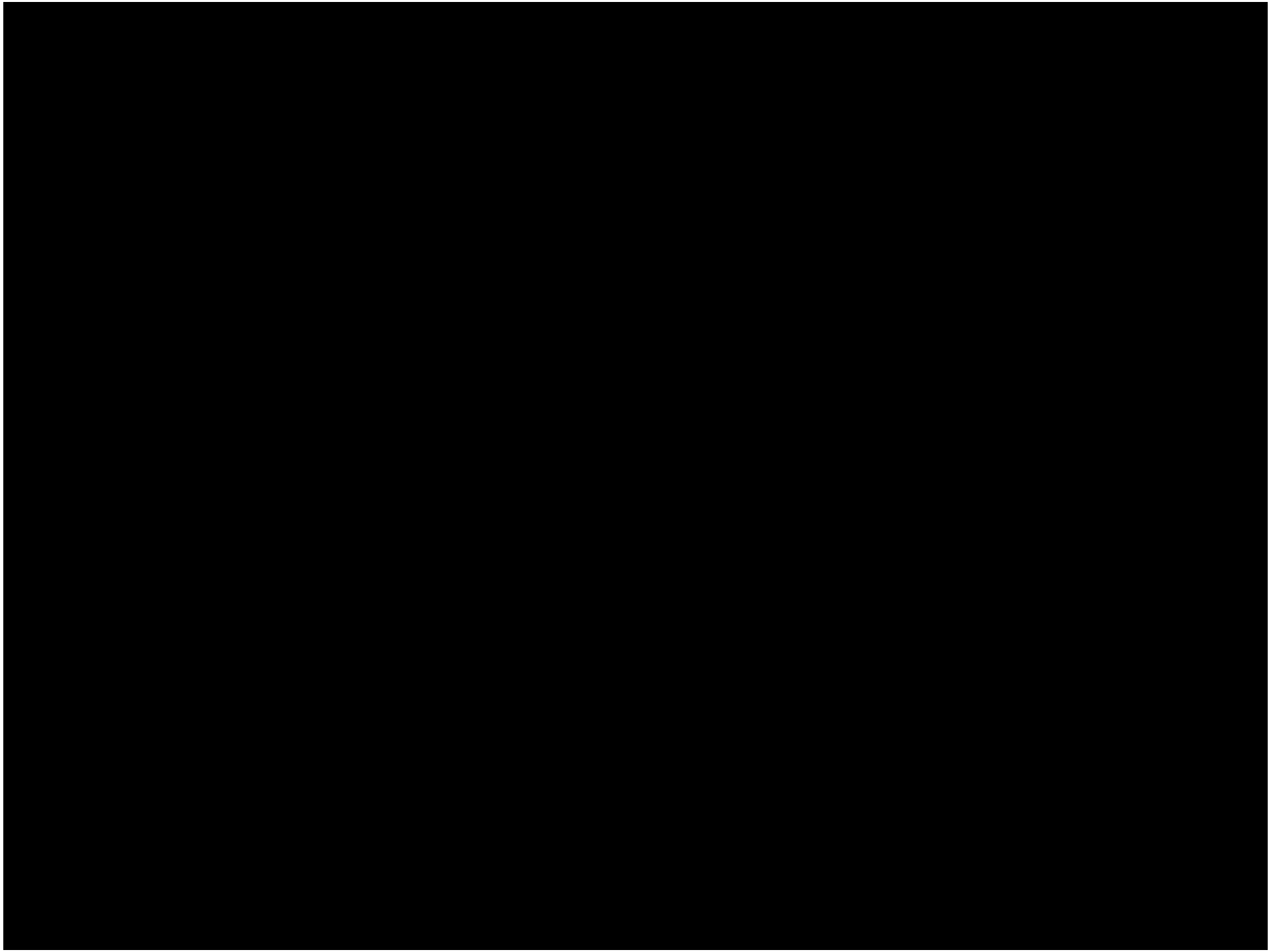
Summary

- ANITA-lite successfully demonstrated the performance of many ANITA subsystems
  - e.g., timing resolution 0.12ns per antenna

- Initial inspection of ANITA-lite data reveals:
  - -No unexpected sources of narrowband RF background events
  - -No obvious neutrino signals
  - -Preliminary sensitivity curves

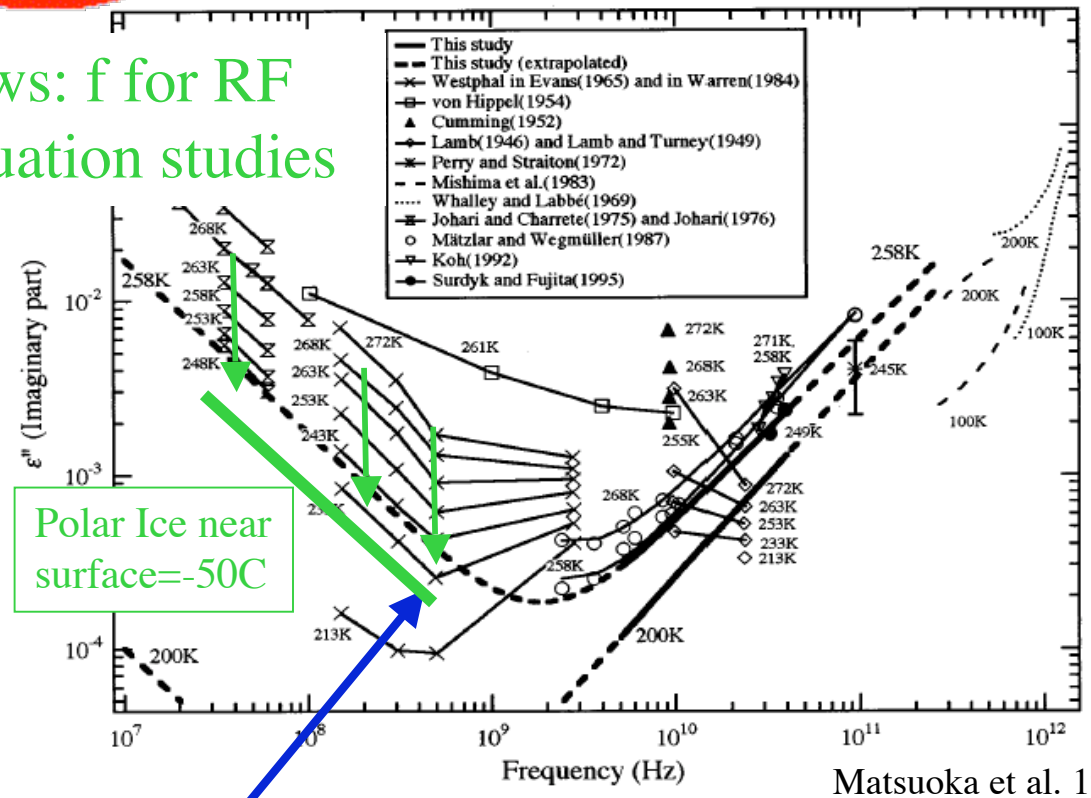
- Attenuation length ~1.5 km at -50C, more than 10x optical

- Anticipated launch of ANITA: Dec 06, viewing 10^6 km^3



Ice transparency - ideal

Arrows: f for RF attenuation studies



Matsuoka et al. 1996

FIG. 7. The ε'' plotted logarithmically against frequency with temperature as a parameter. The bold lines represent fitted lines in this study with the parameters $B=1.747\times10^{-5}$, $C=1.168$ and $B=4.696\times10^{-5}$, $C=1.056$ at 200 and 258 K, respectively. The previous reported values are from Warren (Ref. 2).

Loss tangent a strong function of temperature

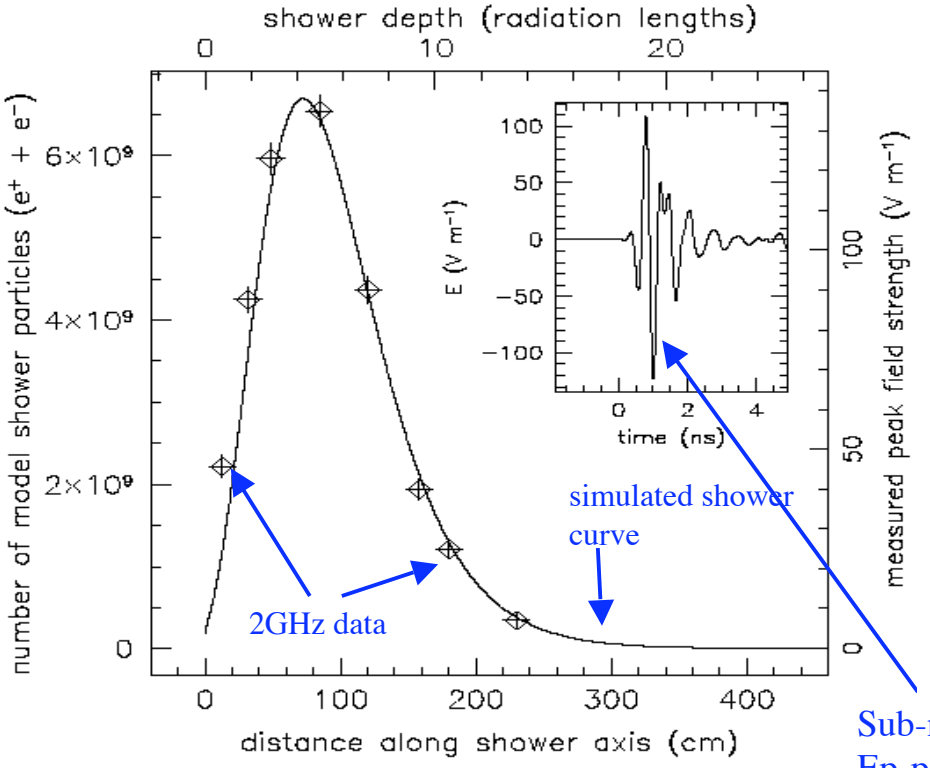
For cold ice, UHF (0.1-1GHz) best

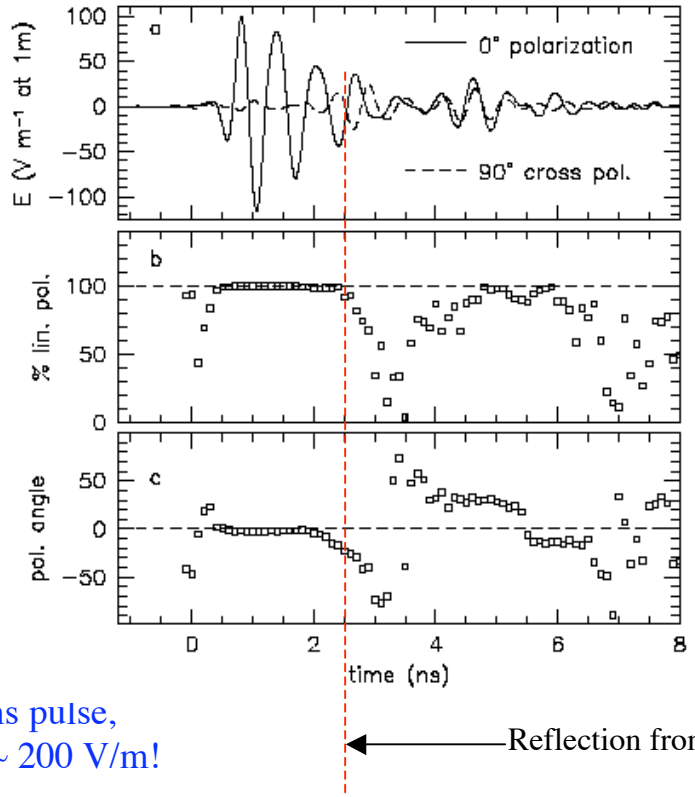
Antarctic data approaches pure ice values

$L_\alpha = \lambda\,[\pi n\,(\varepsilon''/\varepsilon')]^{-1} \sim 6$ km at 300 MHz & -60C (pure ice)

$\lambda \sim 1/f$ $\quad [\varepsilon'']^{-1} \sim [1/f]^{-1} \sim f$ $\quad L_\alpha \sim$ constant for f < 500 MHz

Shower profile observed by radio (~2GHz)

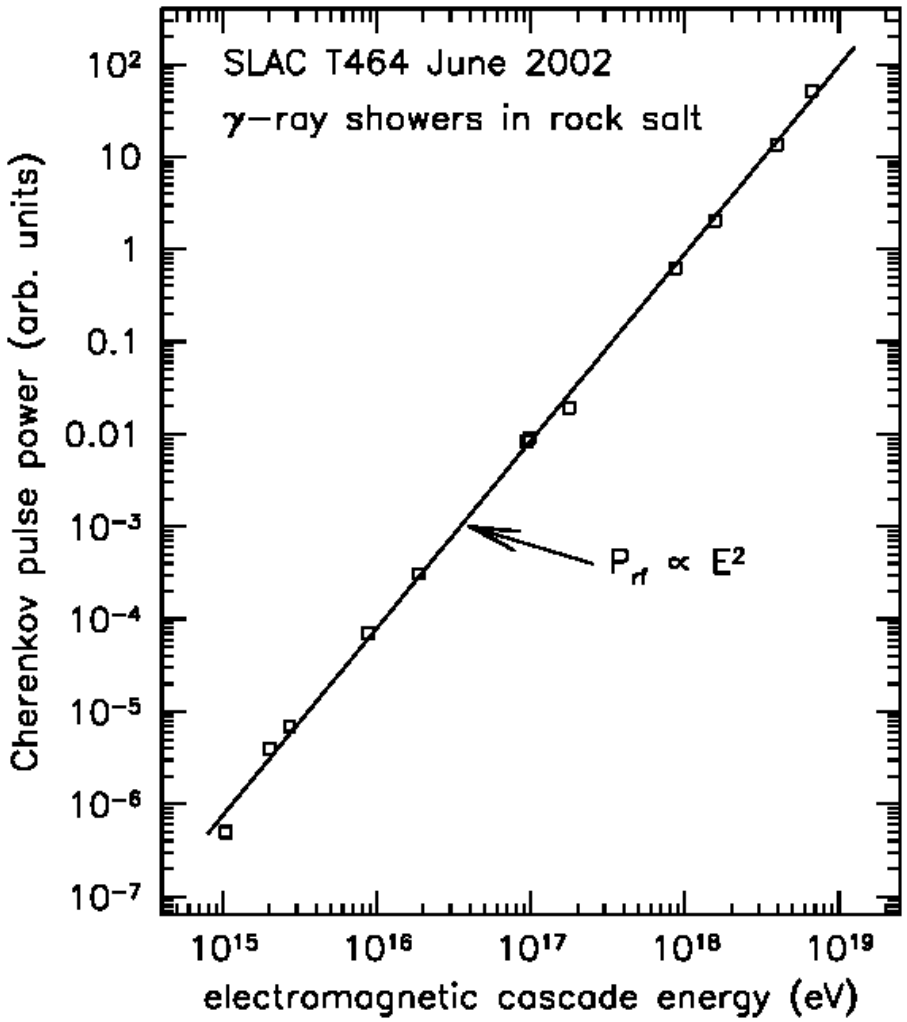




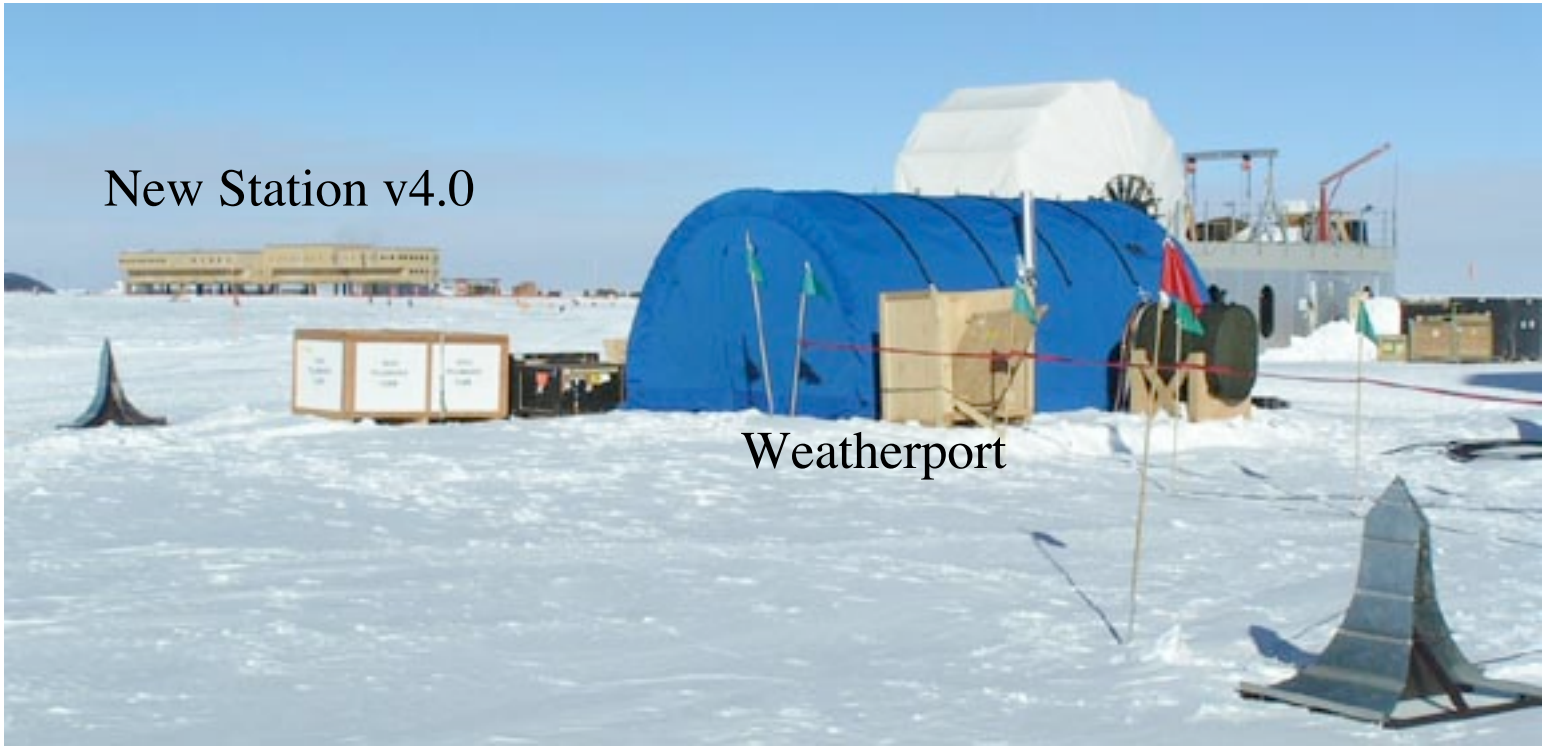
- Measured pulse field strengths follow shower profile very closely
- Charge excess also closely correlated to shower profile (EGS simulation)
- Polarization completely consistent with Cherenkov

New results—SLAC T460 June 2002

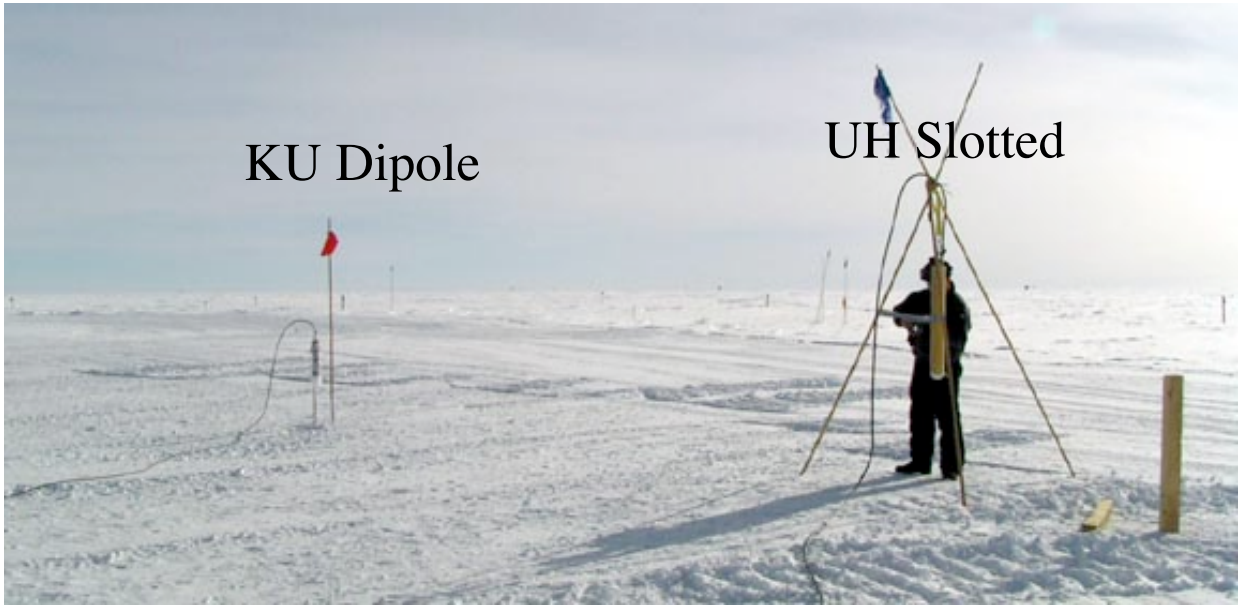
Follow up experiment to SLAC T444, with rock-salt target



- Much wider energy range covered:
  - <1PeV up to 10 EeV
- Radio Cherenkov observed over 8 orders of magnitude in radio pulse power



ANITA



Aug 31, 2004

Ice Attenuation at South Pole

Steve Barwick -Jan. 2004

Schedule for ANITA

03/04	Fly ANITA-lite, measure attenuation length in ice
04	Recover ANITA-lite, analyze data, begin construction
05	Jan :Begin assembly and integration June: test partial instrument in New Mexico, mechanical Aug: Begin final integration and testing
06	June: NSBF integration in Palestine, TX Sept: Ship to Antarctica Dec : Launch ANITA payload from McMurdo, Antarctica
07	Jan : Recover payload, ship back to ConUS