

ANITA: Antarctic Impulsive Transient Antenna



Science Objectives: *Detection of ultra-high energy cosmic neutrinos*

ANITA addresses NASA Structure and Evolution of the Universe (SEU) themes:

- Examines the *ultimate limits of energy in the universe* by measurements of completely new kinds of energetic particles: **neutrinos**, which are the only known ultra-high-energy particles that are able to reach earth unabsorbed from cosmological distances
- Probes the *nature and origin of the highest energy cosmic rays*, via the most sensitive observation to date of their characteristic neutrino by-products.

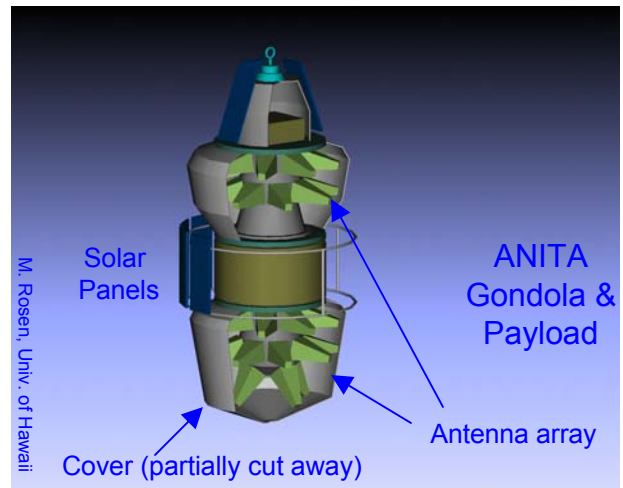
Mission Overview: *A long-duration balloon mission over Antarctica*

- First flight in 2004-2005, two additional flights in 05-06, 06-07
- Each Flight: 9-12 days; Baseline Mission plan: 30 days total flight time
- Radio-frequency monitoring of Antarctic ice sheet from ~40 km altitude
- Flights are circumpolar due to continuous wind circulation around south pole
- Neutrino cascades within ice sheet produce strong Electro-magnetic pulse (EMP) which propagates through ice
- Antarctic ice is transparent to radio waves up to ~1-1.5 GHz
- Ice sheet becomes a neutrino “converter:” neutrinos enter and radio waves come out.
- Effective telescope area: ~1M km² !



A cutaway view of Antarctic ice sheet: ANITA observations penetrate deep into the ice itself. Balloon flight path is shown.

Science Payload: *36 Dual-Polarized Antennas covering 0.3-1.5 GHz*



- Array of low-gain log-periodic antennas views ice sheet out to ~680 km
- Utilize Askaryan effect in neutrino cascades: radio pulse mechanism tested at accelerators
- ~10° azimuth resolution via antenna beam gradiometry within antenna clusters
- ~3° elevation resolution by interferometry between top & bottom antenna clusters
- Pulse polarimetry to get additional information on neutrino direction

ANITA

Balloon Gondola / Launch vehicle

- Balloon gondola plus science payload mass = 1730 kg (3800 lbs)
- Power requirements = 950 W, solar photovoltaic panels
- Gondola is anti-rotation stabilized, sun-pointing
- Long-duration balloon launch from McMurdo Station, Antarctica
- No deployments or articulations necessary during flight



Typical Antarctic long-duration balloon launch

Science Team: *Combining Neutrino astronomy, High Energy Cosmic rays, & Ballooning expertise*

P. Gorham^{1,10} (PI), S. Barwick², J. Beatty³, J. Clem⁴, S. Coutu³, M. DuVernois⁵, P. Evenson⁶, F. Halzen⁷, A. Jacobson⁸, D. Kieda⁹, J. Learned¹⁰, K. Liewer¹, S. Lowe¹, C. Naudet¹, D. Saltzberg¹¹, D. Seckel⁶

1. Jet Propulsion Lab; 2. UC Irvine; 3. Penn State Univ.; 4. Bartol Research Inst.; 5. Univ. of Minnesota; 6. Univ. of Delaware; 7. Univ. of Wisconsin; 8. Los Alamos Nat'l Lab; 9. Univ. of Utah; 10. Univ. of Hawaii; 11. UCLA.

Collaborators:

D. Besson, J. Ralston (*Univ. of Kansas*), G. Frichter (*Florida State Univ.*), A. Odian (*Stanford Linear Accelerator Center*)

Mission Management

Principal Investigator: P. Gorham, joint position as senior staff member at JPL, and Prof. of Particle Astrophysics, University of Hawaii at Manoa

Project Management & Instrument Development: Jet Propulsion Laboratory

Gondola development: UC Irvine

Antarctic Balloon Operations: National Scientific Balloon Facility (NSBF)

Polar Programs: National Science Foundation

Schedule & Cost

Initial Flight	Dec. 2004 / Jan. 2005
2 nd Flight	Dec. 2005 / Jan. 2006
3 rd Flight	Dec. 2006 / Jan. 2007
Initial Data release	April 2005
Phase A/B	\$1.8 M
Phase C/D	\$13.2M
Phase E	\$7.7M
Total (FY2002 \$)	\$22.7M