

NAS Boards on Physics & Astronomy and Space Studies
Joint Committee on Astronomy & Astrophysics
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NSF Antarctic Astronomy and Astrophysics

Current Projects and Recent Results

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<http://www.usap.gov>



Palmer x

South Pole
x

NSF
x

LAX / PTH
x

x
ASC

McMurdo
x

Why we take Astronomy & Astrophysics to Antarctica?

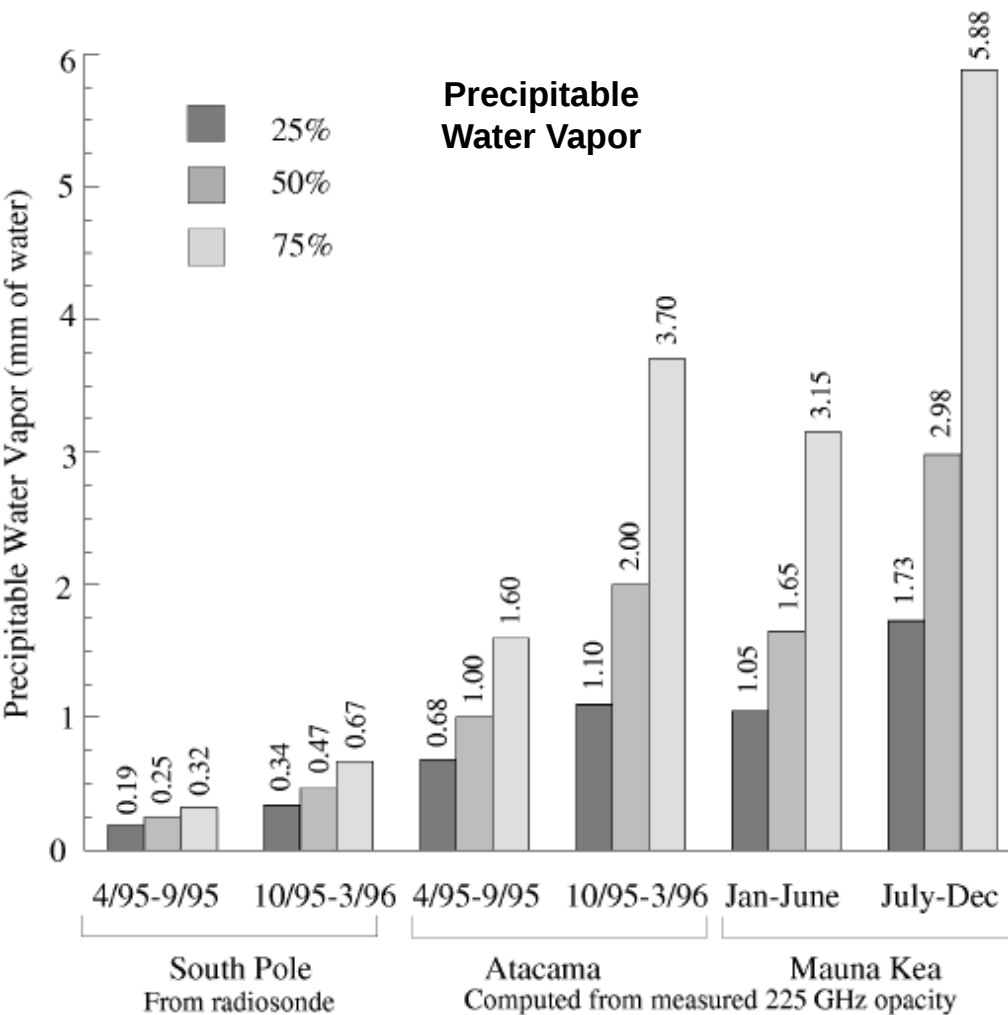
**Can
Antarctic
Astronomy &
Astrophysics
contribute to
advancing
science for the
entire field?**

Yes, yes, and yes!

Recent results from Antarctic Astronomy & Astrophysics research are excellent and very promising

Excellent partnership within NSF and with other U.S. agencies; and international collaboration via science and the Antarctic Treaty

Why we take Astronomy & Astrophysics to Antarctica?



South Pole & East Antarctic Plateau:

- High elevation, very dry and cold atmosphere with almost no winds over 6-mo long austral winter
- ~2.5-km thick and transparent ice sheet suitable for a cubic-km neutrino detector

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• U.S. Antarctic Program infrastructure & logistics are readily available

nd yes!

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Historical Perspective



1916 – 2008

- Paul Siple - Astronomy Hut, 1956-1957
- **Martin Pomerantz** – deployed cosmic ray neutron monitor, 1964
- ... tried 5" optical telescope with Arny Wyller in 1968-1969
- ... 1st astronomy project funded: 6" optical telescope, 1978
- ... deployed Polar Solar Observatory with Eric Fossat, 1980
- ... studied helioseismology at "Pomerantz Land", 1981-1984
- ... with Mark Dragovan, Tony Stark, and Bob Pernic in 1987:
Debut of Polar Cosmology: 1-m parabolic telescope, looking vertically upward, with two bolometers at 0.3 K
- **Center for Astrophysical Research in Antarctica** (1990-2001)
More than a dozen astronomy & astrophysics projects were deployed and tried at South Pole with variable success
- **Post-CARA:** Mostly CMB-focused research, neutrino astrophysics

Martin was a scientist who opened South Pole to astronomers... here is what he wrote in his memoir "Astronomy on Ice" (2004):

"My efforts over many years, from 1970 to 1987 to get the ball rolling throughout the astronomical community had finally succeeded."

Ridge A – Terahertz HEAT telescope
4.1 km elevation above sea level

NA

Dark Sector

Snow runway

ARA →

IceCube area

IceCube Lab

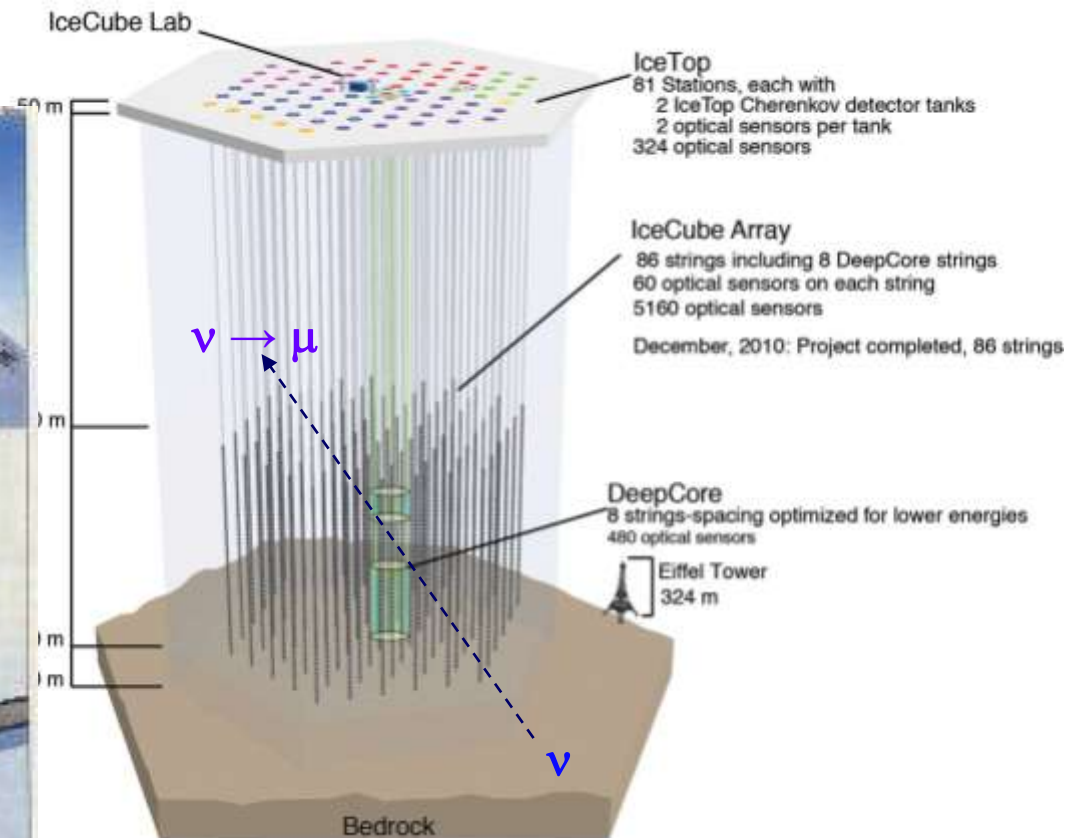
MAPO with
SPUD/Keck array

DSL with
BICEP2 & SPT



U.S. Amundsen-Scott South Pole Station
2.9 km elevation above sea level

• Polar neutrino astrophysics



**New window on the
Universe is now open!**

- 86 deep-ice strings (each with 60 optical modules) detecting Cherenkov's emission from muons produced by neutrino interactions
- IceTop array (4 optical modules over 80 strings) vetoes IceCube muons produced in cosmic ray air showers

<http://icecube.wisc.edu>

nature

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NATURE | LETTER

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An absence of neutrinos associated with cosmic-ray acceleration in γ -ray bursts

IceCube Collaboration

[Affiliations](#) | [Contributions](#) | [Corresponding authors](#)

Nature 484, 351–354 (19 April 2012) | doi:10.1038/nature11068

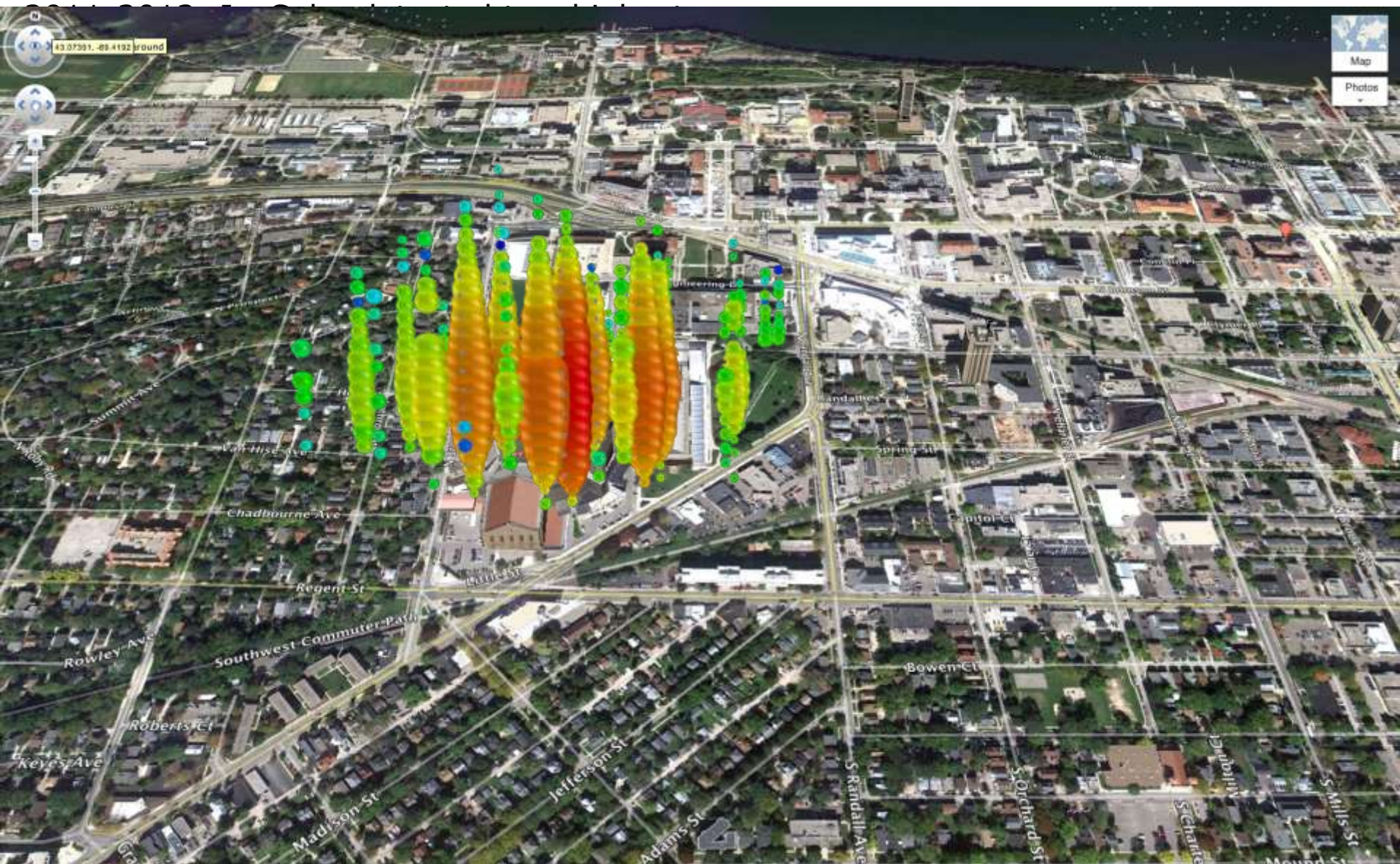
Received 06 January 2012 | Accepted 08 March 2012 | Published online 18 April 2012

Very energetic astrophysical events are required to accelerate cosmic rays to above 10^{18} electronvolts. GRBs (γ -ray bursts) have been proposed as possible candidate sources^{1,2,3}. In the GRB 'fireball' model, cosmic-ray acceleration should be accompanied by neutrinos produced in the decay of charged pions created in interactions between the high-energy cosmic-ray protons and γ -rays⁴. Previous searches for such neutrinos found none, but the constraints were weak because the sensitivity was at best approximately equal to the predicted flux^{5,6,7}. Here we report an upper limit on the flux of energetic neutrinos associated with GRBs that is at least a factor of 3.7 below the predictions^{4,8,9,10}. This implies either that GRBs are not the only sources of cosmic rays with energies exceeding 10^{18} electronvolts or that the efficiency of



NSF Press Release (May 2012)

It was found that an upper limit on the flux of energetic neutrinos associated with Gamma-Ray Bursts is at least a factor of 3.7 below the model predictions



(jointly supported by NSF's POLAR, PHYSICS, and ASTRONOMY)

2001 Astrophysics Decadal
Survey:

SPT as a moderate initiative
<\$50M

NSF Funded: August 2002

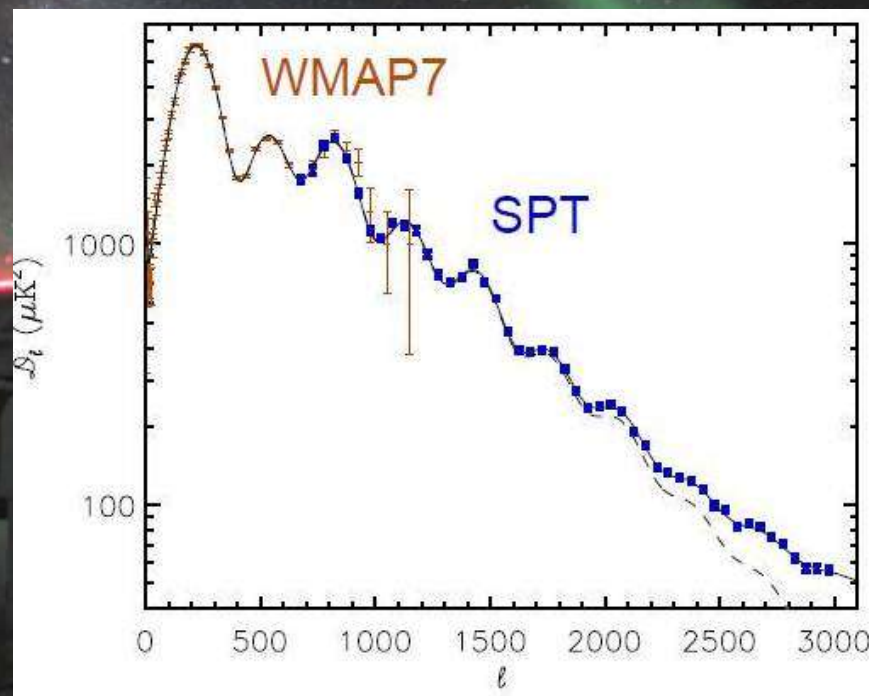
First light: Feb 17, 2007

**Right on the budget
(~\$25M) and schedule!**

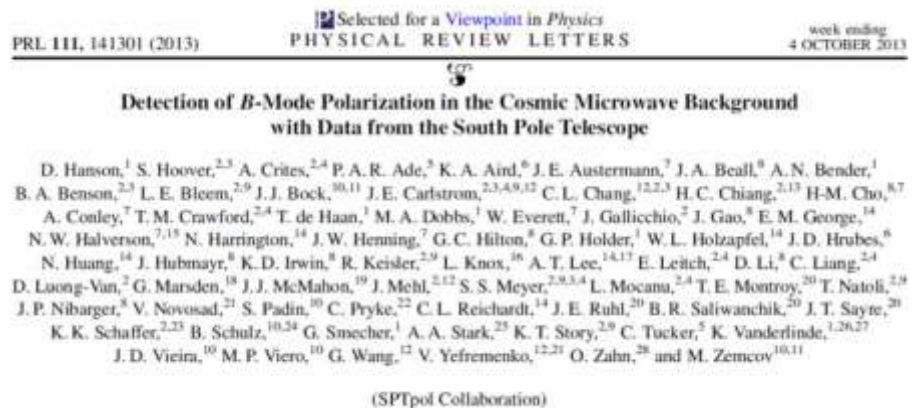
**SPT discovered over 500 distant
galaxy clusters via Sunayev-
Zeldovich Effect and reached
multipoles up to 3,000**

NSF Press Release (May 2012):

South Pole Telescope Provides New Insights
Into Dark Energy and Neutrinos



**SPTpol survey detected
B-mode signal from
gravitational lensing!**



Since 2008, SPT team has published: 39 peer-reviewed scientific papers (including two in *Nature* & one public data release), 6 "project overviews" and 22 technical papers

Long-Duration Ballooning from McMurdo, Antarctica

1988 – NASA/NSF MoA: one LDB launch every other year beginning in 1990

- 22 payloads flown in 1990 – 2002; ~ 1.7 /year

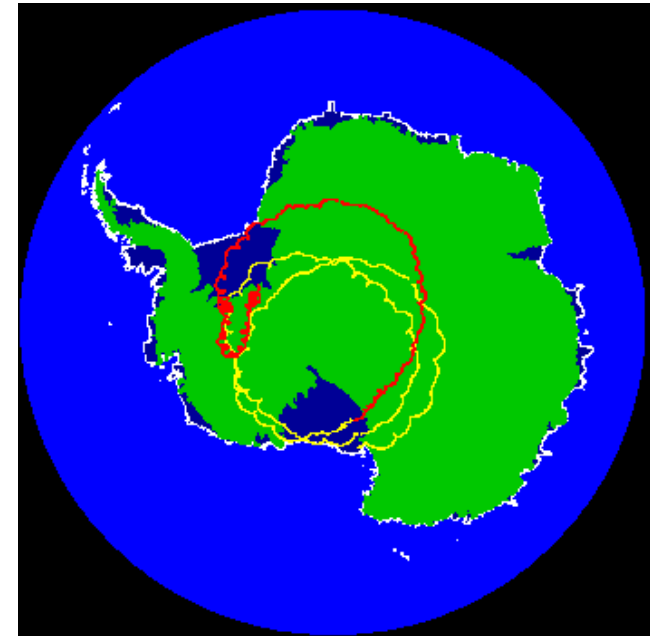
2003 – New NASA/NSF MoA: two LDB launches per year in 2003 – 2009

- 12 payloads flown in 2003 – 2008; ~ 2.0 /year

2009 – Third NASA/NSF MoA: up to three LDB launches per year in 2009 – 2013

- 15 payloads flown so far; ~ 3.0 /year

Because of the Government's shutdown no science payloads will be flown from McMurdo during austral summer 2013-2014



Super Pressure Balloon (SPB)
flight tracks in 2009/10

**Total 49 LDB/SPB
payloads over 23 years**



Why we take Astronomy & Astrophysics to Antarctica?

**Can
Antarctic
Astronomy &
Astrophysics
contribute to
advancing
science for the
entire field?**

Yes, yes, and yes!

**Upon learning
on our projects,
welcome to join
us in Antarctica!**

**We have excellent
partnerships &
international
collaboration!**

**Recent results from Antarctic
Astronomy & Astrophysics
research are excellent and
very promising**

**Excellent partnership within NSF
and with other U.S. agencies; and
international collaboration via
science and the Antarctic Treaty**

Any questions?

