http://amanda.uci.edu

AMANDA

ANTARCTIC MUON AND NEUTRINO DETECTOR ARRAY

RECENT RESULTS

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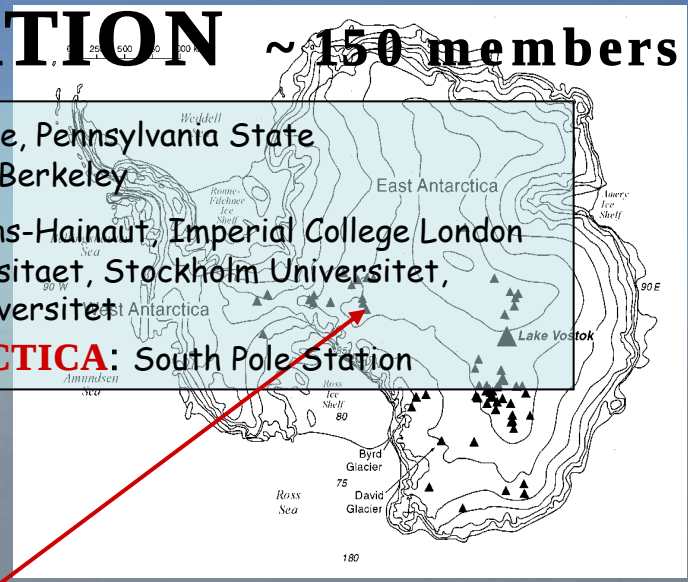
THE AMANDA COLLABORATION ~150 members

UNITED STATES: Bartol Research Institute, UC Berkeley, UC Irvine, Pennsylvania State
UW Madison, UW River Falls, LBNL Berkeley

EUROPE: VUB-IIHE Brussel, ULB-IIHE Bruxelles, Universite' de Mons-Hainaut, Imperial College London
DESY Zeuthen, Mainz Universitaet, Wuppertal Universitaet, Stockholm Universitet,
Uppsala Universitet, Kalmar Universitet

SOUTH AMERICA: Universidad Simon Bolivar Caracas **ANTARCTICA**: South Pole Station



Airport

AMANDA

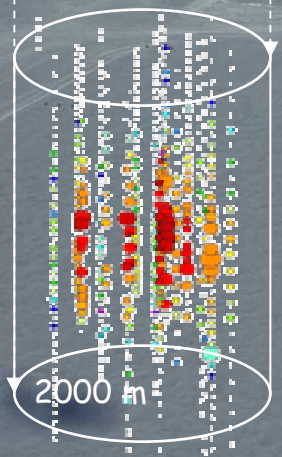
MAPO

South Pole

Dome

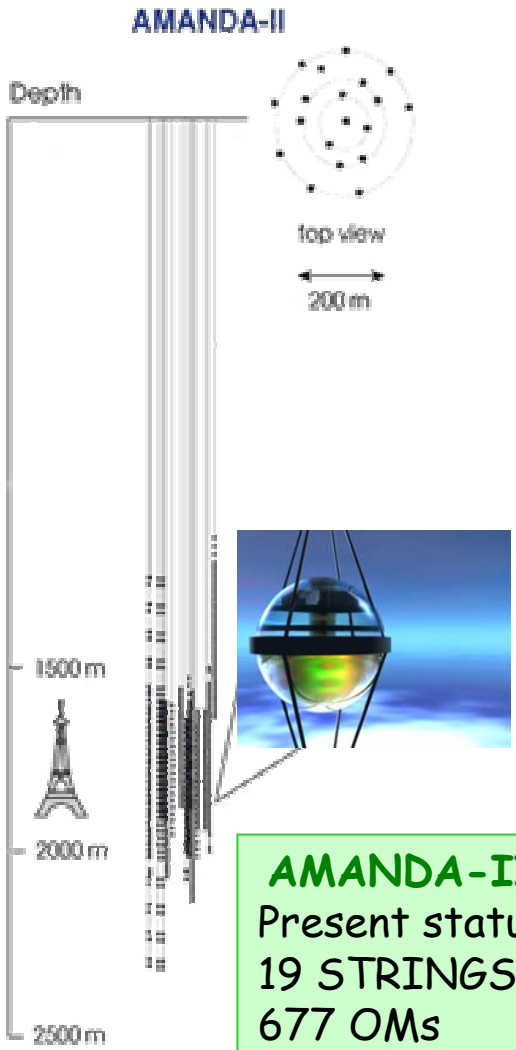
ICECUBE

Summer camp

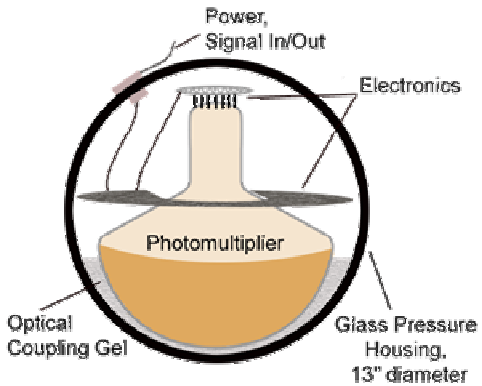


Amundsen-Scott South Pole Station

THE AMANDA DETECTOR



AMANDA B-10
Inner core of AMANDA-II
10 STRINGS
302 OMs
Data years: 1997-1999



OPTICAL MODULE
8-inch Hamamatsu R591202
10^9 gain, 14 dynode stages
PMT noise (300-1000)Hz

Time resolution ~ 5ns

AMANDA-II: astro-ph/0211269

AMANDA-II
Present status of the detector
19 STRINGS
677 OMs
Data years: 2000-2004
Trigger rate ~ 80Hz

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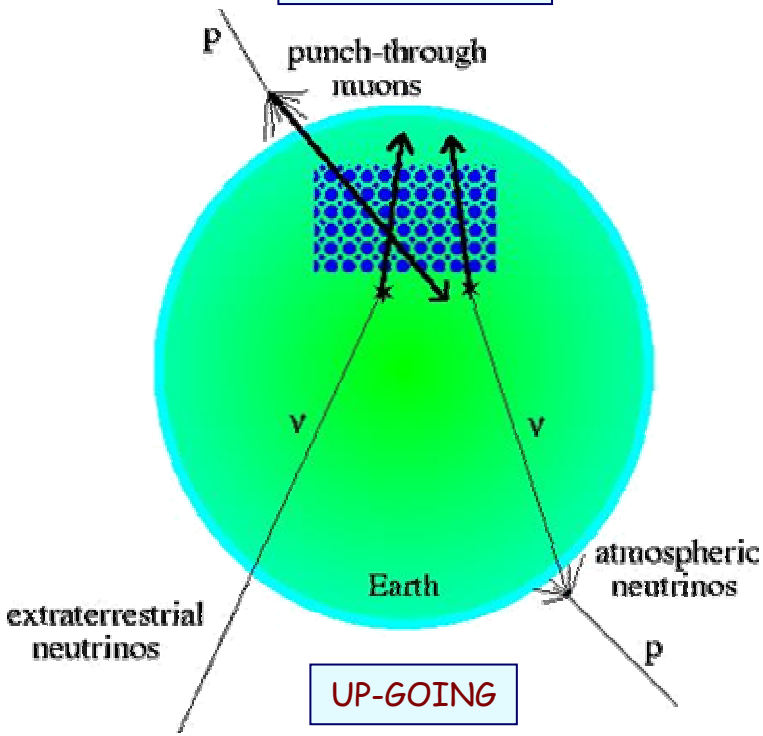
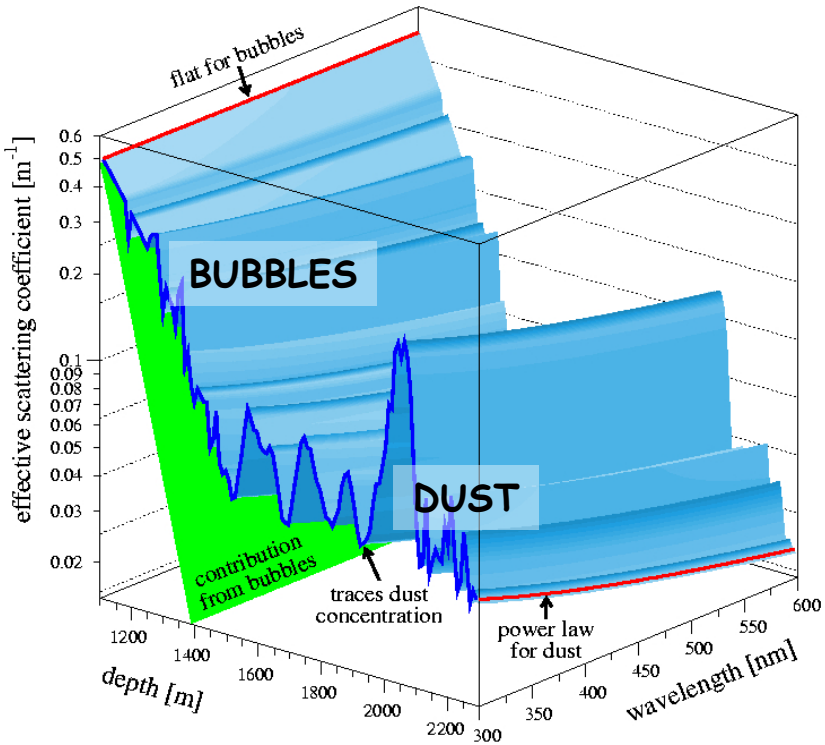
PRINCIPLE OF NEUTRINO DETECTION

DOWN-GOING



UP-GOING

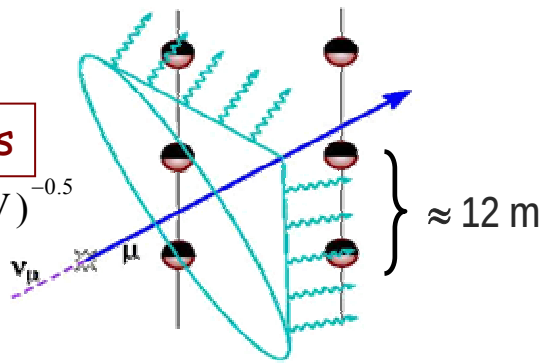
SCATTERING



O(km) long muon tracks

TeV Muons

$$\Theta_{\mu\nu} \approx 1.5^\circ \cdot (E_\nu / \mathrm{TeV})^{-0.5}$$



ν_μ Event

AVERAGE OPTICAL ICE PARAMETERS

λ_{abs} ~ 110 m @ 400 nm

λ_{sca} ~ 20 m @ 400 nm

ATMOSPHERIC ν & DIFFUSE FLUX LIMITS [ν_μ]

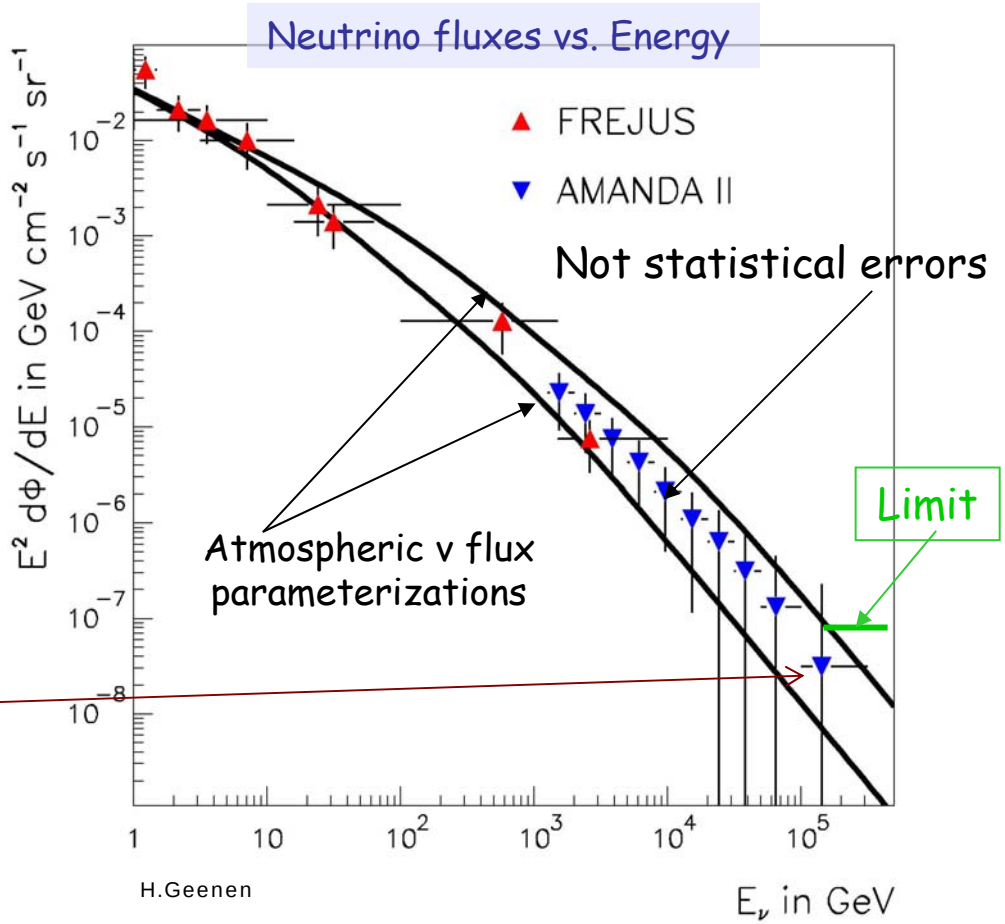
AMANDA test beams: atmospheric ν and μ

Diffuse Flux analysis strategies:

- Atmospheric ν excess
- Cascades
- UHE downgoing

First spectrum > 1 TeV (up to 100TeV)

Last bin info to calculate the limit to Extraterrestrial E^2 neutrino flux



Observation compatible with atm. ν flux:

includes 33% systematic uncertainty

$$E^2\Phi_{\nu_\mu}(E) < 2.58\cdot10^{-7}\ \text{GeV cm}^{-2}\ \text{s}^{-1}\ \text{sr}^{-1}$$

PRELIMINARY

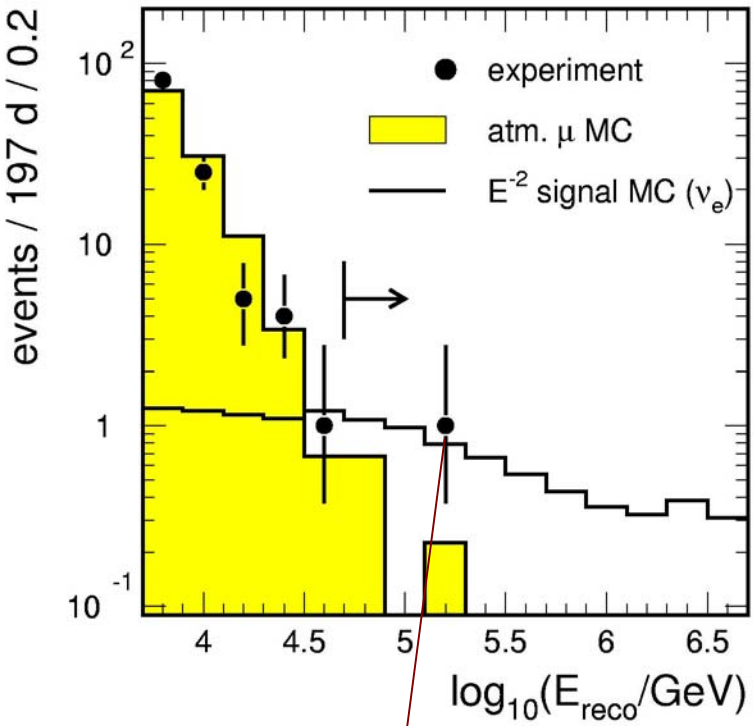
Phys. Rev. Lett. 90 251101 (2003)

DIFFUSE FLUX SEARCH & LIMITS [CASCADES]

4π coverage for cascades

Sensitive to all three flavors

2000 data sample (AMANDA-II)
197 days livetime
$1.2 \cdot 10^9$ events @ trigger level



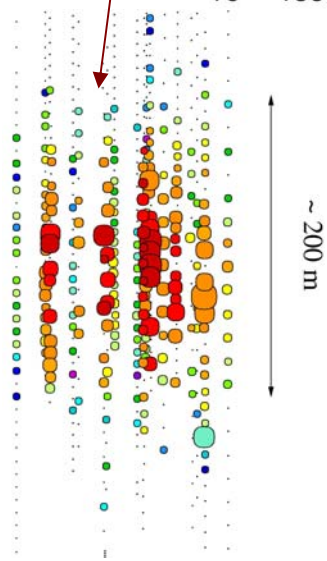
After optimized cuts:

$N_{obs} = 1$ **event**

$N_{atm\ \mu} = 0.90\ ^{+0.69}_{-0.43}$

$N_{atm\ \nu} = 0.06\ ^{+0.09}_{-0.04} \pm 25\%_{norm}$

Assuming E^{-2} signal spectrum



$E^2\Phi_{all\ \nu}(E) < 8.6 \cdot 10^{-7}$ GeV cm^{-2} s^{-1} sr^{-1}
(flavor mixing $\nu_e:\nu_\mu:\nu_\tau$ =1:1:1)
50 TeV < E_ν < 5 PeV

'00 paper submitted to Astropart.Phys.

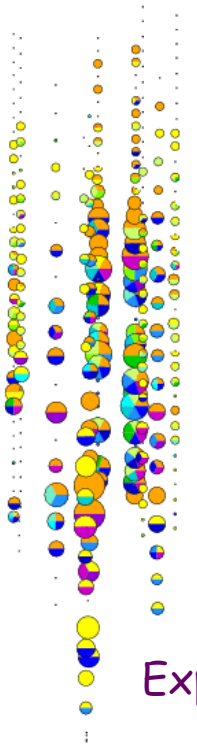
UHE NEUTRINO LIMITS $\Phi_{all\ \nu}$

1997 data (AMANDA-B10)131 days livetime

$E_\nu > 10^{16}$ eV

Earth opaque

→ search in the upper hemisphere
mostly close to horizon

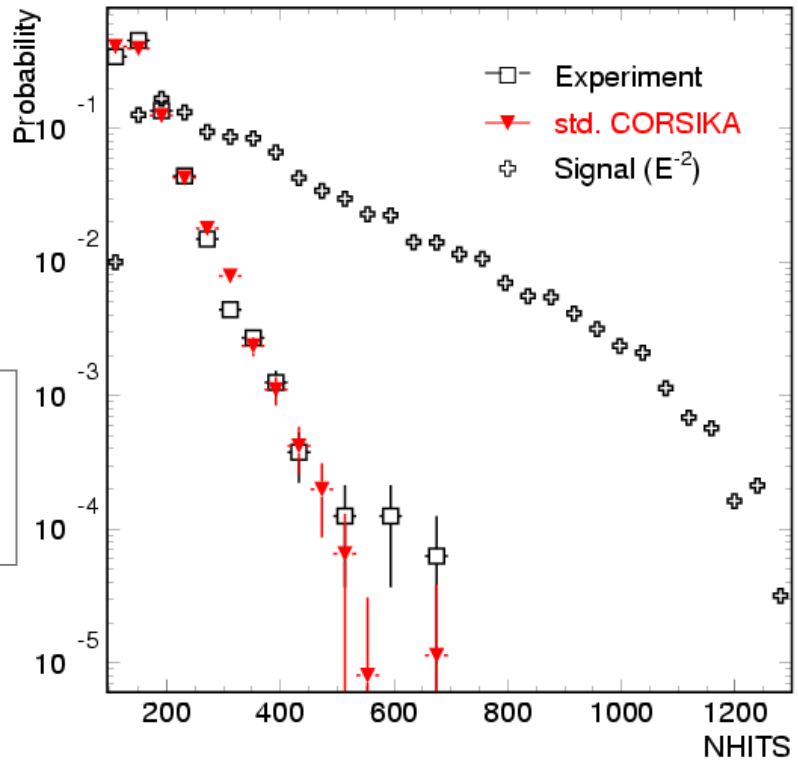


Experimental UHE event

N_{obs} = 5 events

N_{bgr} = 4.6 ± 36% events

NO EXCESS OBSERVED



assuming E^{-2} flux (1 PeV < E_n < 3 EeV) :

$E^2\ \Phi_{all\ \nu}(E) < 1.5 \cdot 10^{-6}$ GeV cm^{-2} s^{-1} sr^{-1}

($\nu_e:\nu_\mu:\nu_\tau$ = 1:1:1)

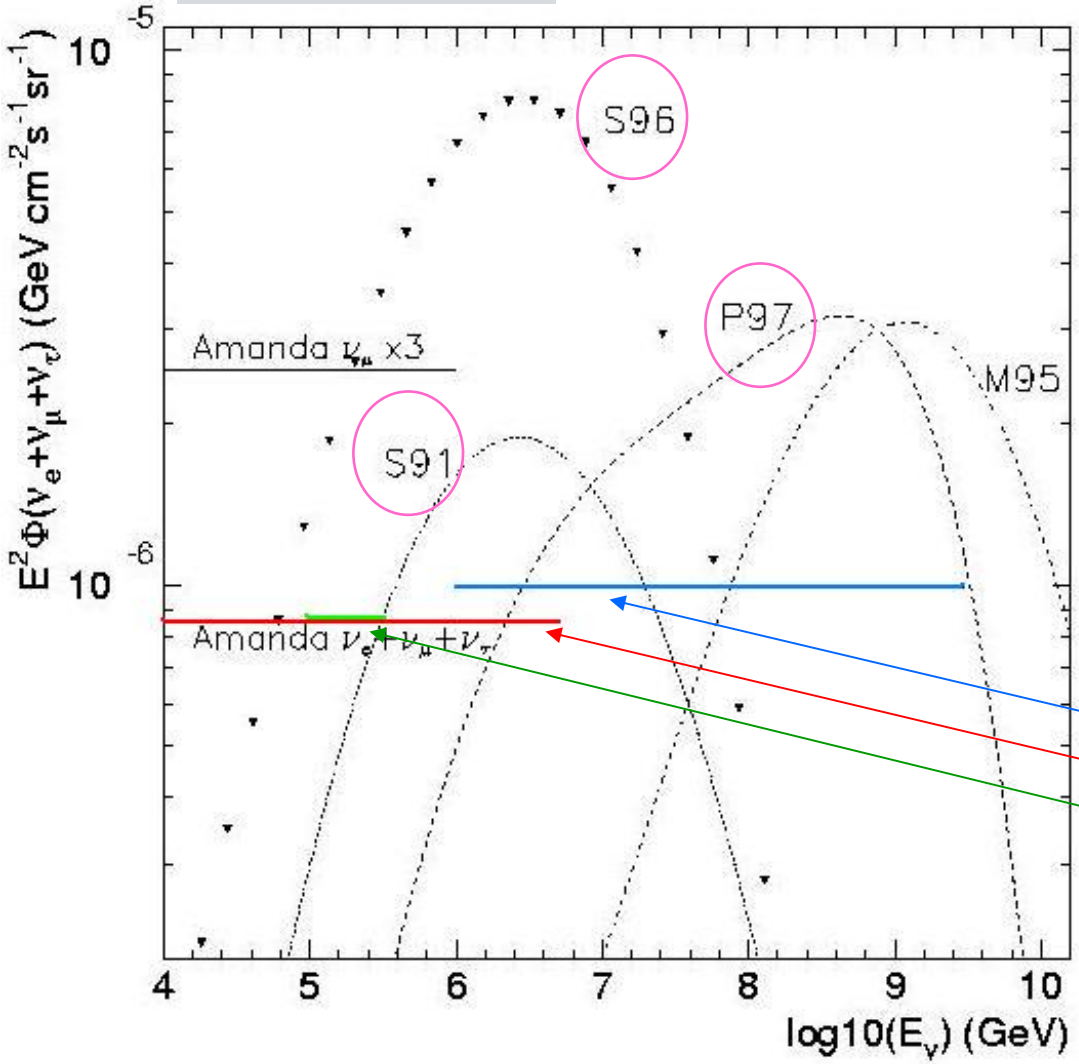
PRELIMINARY

Paper submitted to Astropart.Phys.

AMANDA-II (TWR 2003): expected further improvement using waveforms

SUMMARY: DIFFUSE NEUTRINO FLUXES $\Phi_{all\ \nu}$

PRELIMINARY



Specific predicted model spectra excluded by AMANDA:

- ✓ Szabo,Protheroe (1992)
- ✓ Protheroe (1997)
- ✓ Stecker,Salamon (1996)
- ✓ Nellen et al.(1993)
- ✓ Stecker(1991)

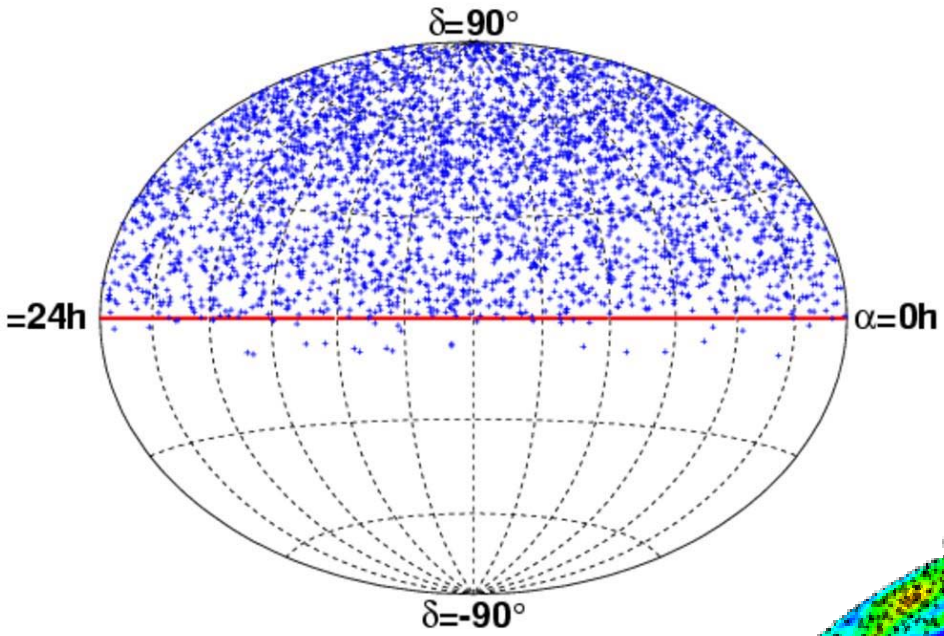
AMANDA 90% CL upper limits to a diffuse E^{-2} $\Phi_{all\nu}$ obtained from :

- ❖ search for UHE events
- ❖ search for cascade events
- ❖ High energy tail of atm. neutrino spectrum

POINT SOURCE

4 YEAR AMANDA-II (00-03) SEARCH

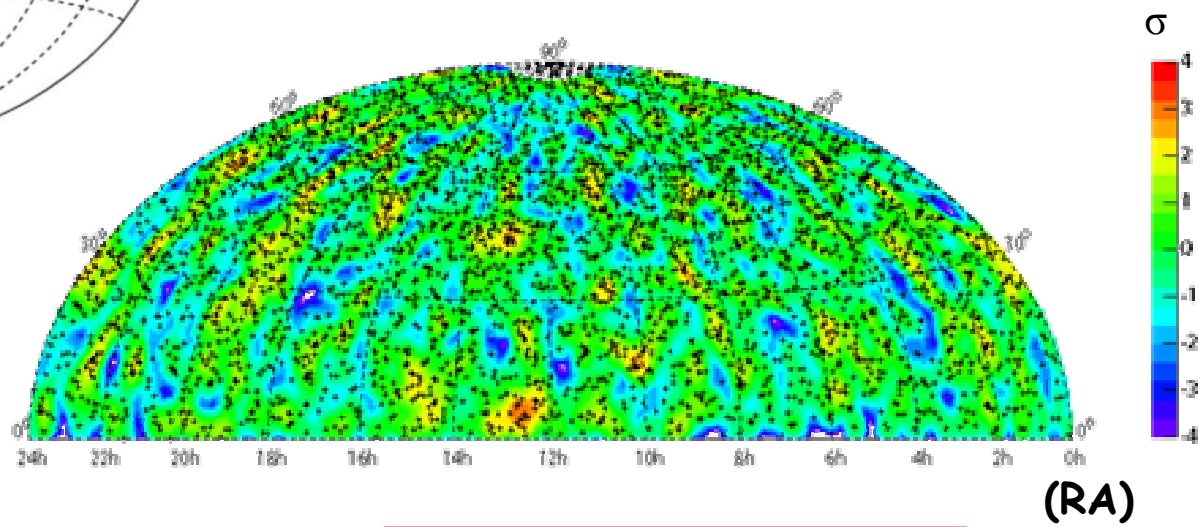
Cuts optimized in declination bands for $E^{-2..-3}$ signal spectra (grid of 300 bins)



3369 observed below the horizon
[+ declination]

3438 expected from atm-V simulation

Livetime = 807 Days



Phys. Rev. Lett. 92 071102 (2004)

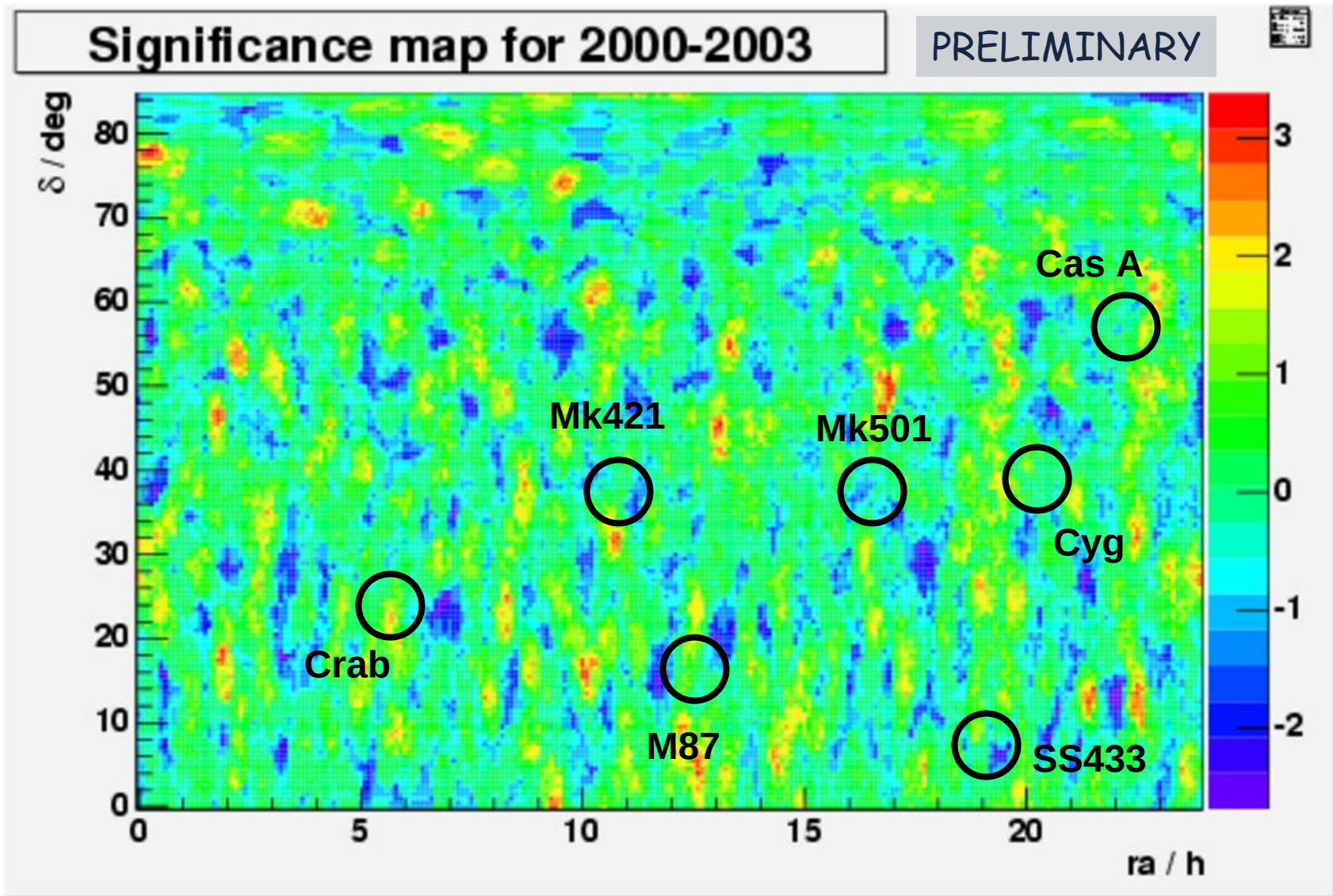
PRELIMINARY

NO EXCESS
beyond randomly expected

compatible

Atmospheric Neutrinos!

Neutrinos from known Sources

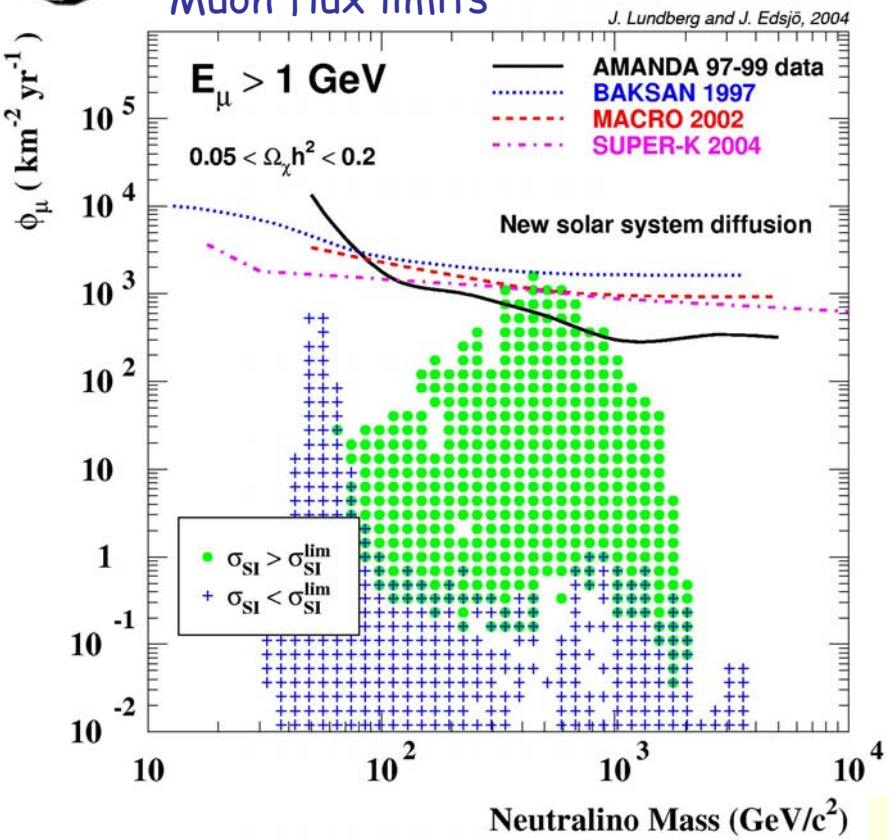


DARK MATTER INDIRECT SEARCH

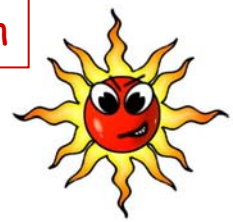
Look for vertically upgoing tracks

Combine 3 years: 1997-99
Total livetime (80%): 422 days

Muon flux limits

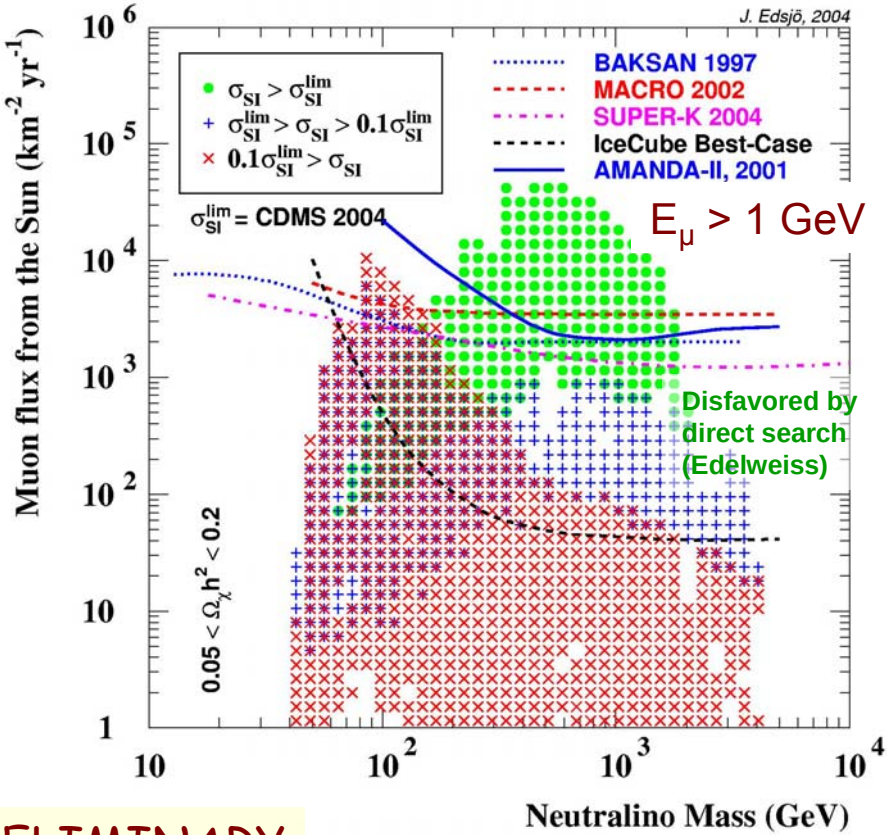


Sun is maximally 23° below horizon



2001 data 0.39 years livetime

Muon flux limits



PRELIMINARY

Limit for "hardest" channel:

$\chi\chi \rightarrow \tau^+\tau^- \rightarrow \nu_\mu$ $M_x = 50$ GeV $\chi\chi \rightarrow W^+W^- \rightarrow \nu_\mu$ $M_x = 100\text{-}5000$ GeV

SUMMARY & OUTLOOK

AMANDA hasn't seen ν sources yet,
But "she" has produced a lot of Physics!!

- Ice description mature
- Limits on diffuse neutrino fluxes (TeV-EeV)
- Papers on 1997-2003 data in progress
- Search for GRB neutrinos: Kyler Kuehn tomorrow VHE astrophysics session
- Results from AMANDA-II:
  - Four year Point source search (data set 00+01+02+03)
  - Improved Diffuse limits: over wide energy interval
  - Several predictions excluded
- For update: **http://amanda.uci.edu**