

An underwater scene featuring a submersible on the left and a large hydrographic survey net on the right. The net consists of numerous vertical lines, each with a green cylindrical float and a pair of black spherical weights. The submersible is white with a blue stripe and has the word 'mautile' written on its side. It is emitting a bright white light from its front. The background is a deep blue ocean with some rocky structures on the right side.

STATUS AND RECENT RESULTS OF THE
ANTARES
EXPERIMENT

23rd Rencontres de Blois

Dimitris Palioselitis
on behalf of
the ANTARES Collaboration

Overview

- Motivation for neutrino astronomy
- The ANTARES neutrino telescope
- Selected results
- Summary and outlook



WHY NEUTRINO ASTRONOMY?

- Point to source, no deflection
- Travel cosmological distances, no absorption
- Escape optically thick sources
- Complementary information to photons and protons

PHYSICS WITH NEUTRINO TELESCOPES

- Galactic sources
- Extra galactic sources
- Dark Matter
- Cosmogenic neutrinos
- Supernovae
- Neutrino oscillations
- Cosmic ray anisotropy
- Exotic physics (Lorentz violation, monopoles)



The ANTARES detector

- 12 Lines
- 25 storeys / line
- 3 PMTs / storey
- 885 PMTs
- 2475m deep
- $\sim 0.01 \text{ km}^3$

14.5m

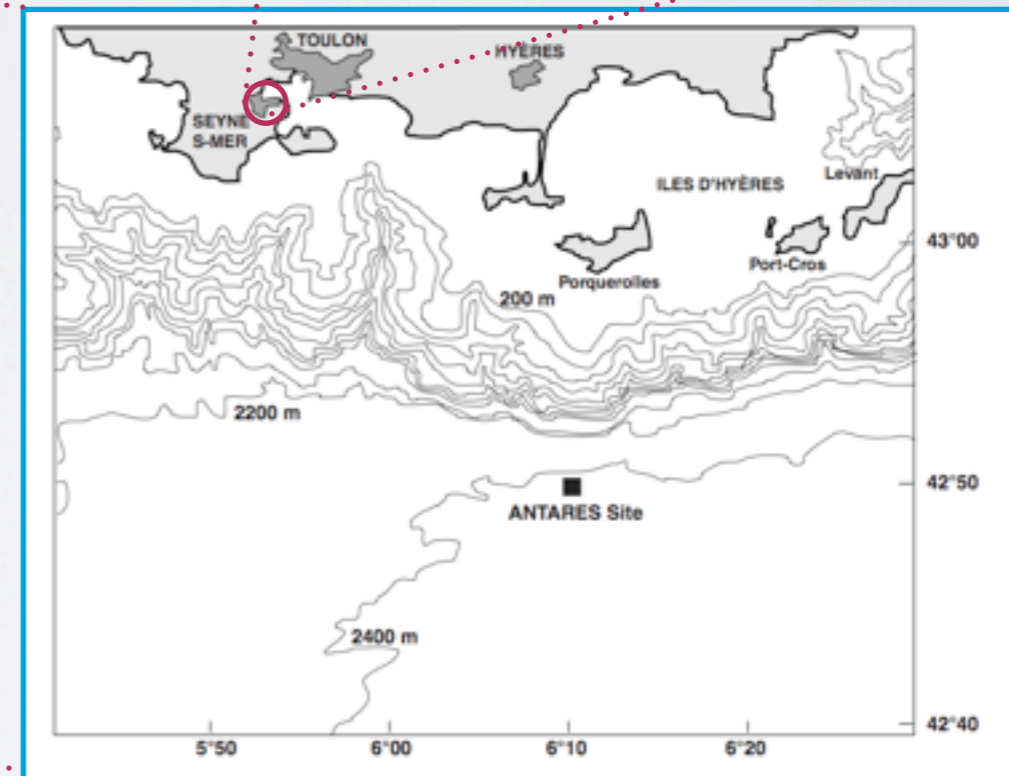
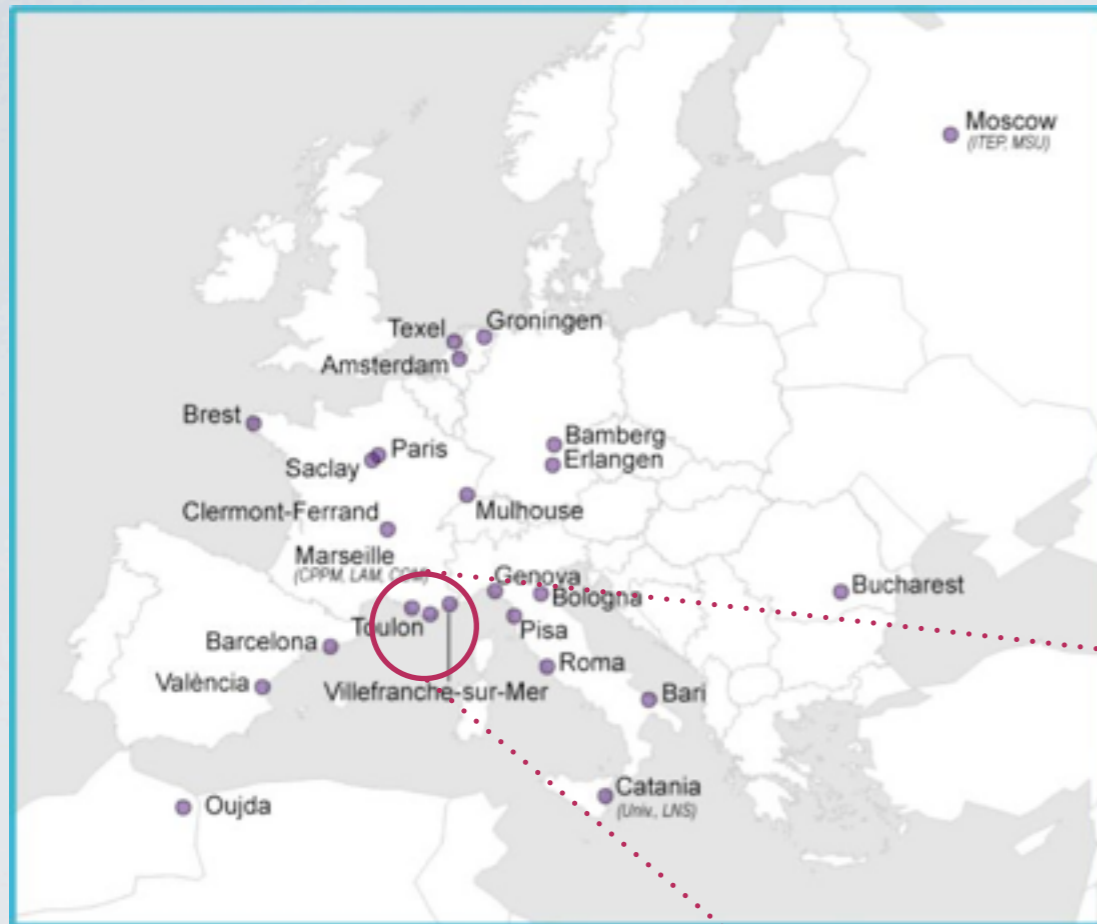
100m

$\sim 70\text{m}$

40km cable
to shore

Junction Box

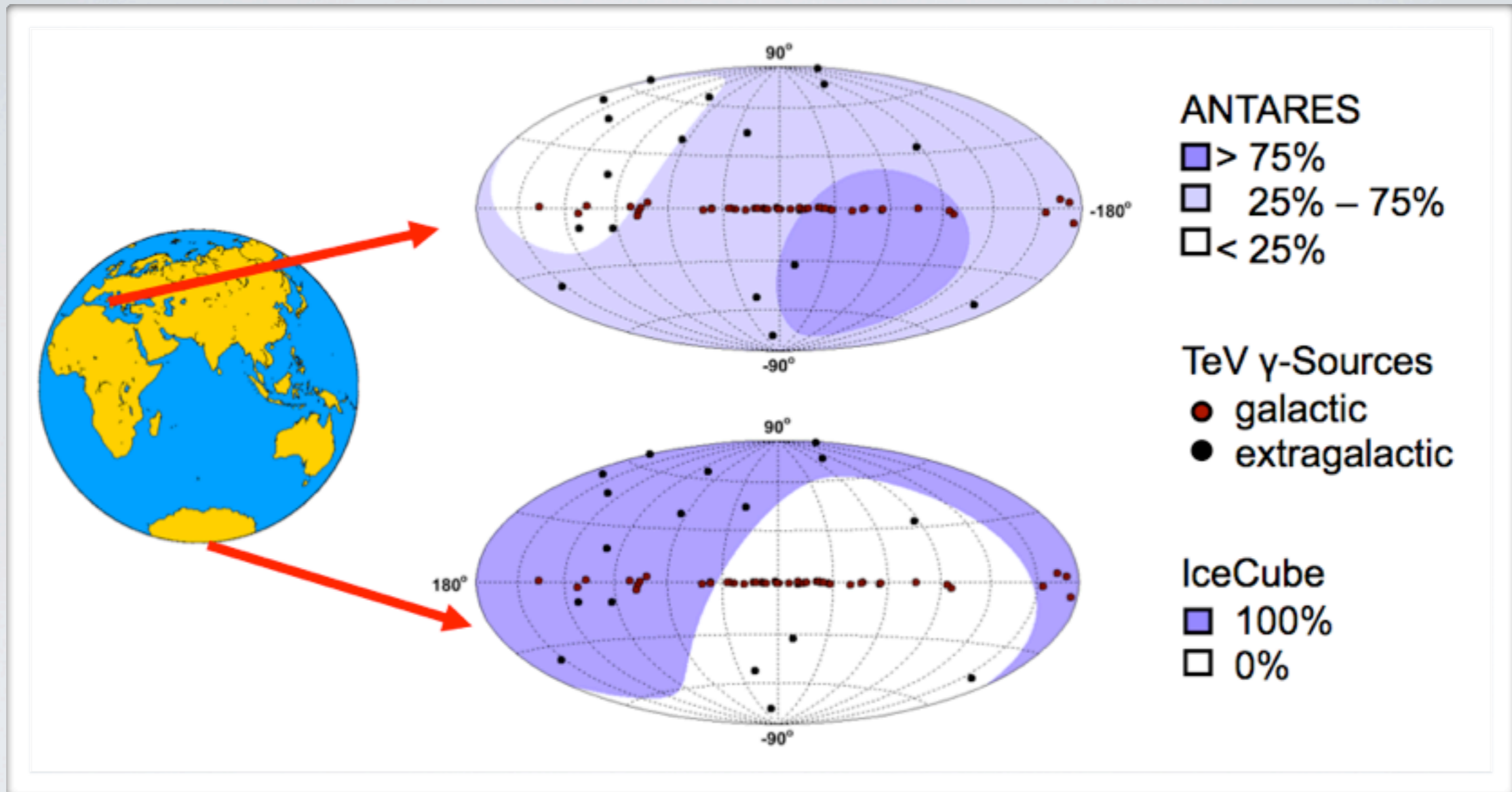
THE ANTARES COLLABORATION



- 29 institutes
- 8 countries



SKY COVERAGE

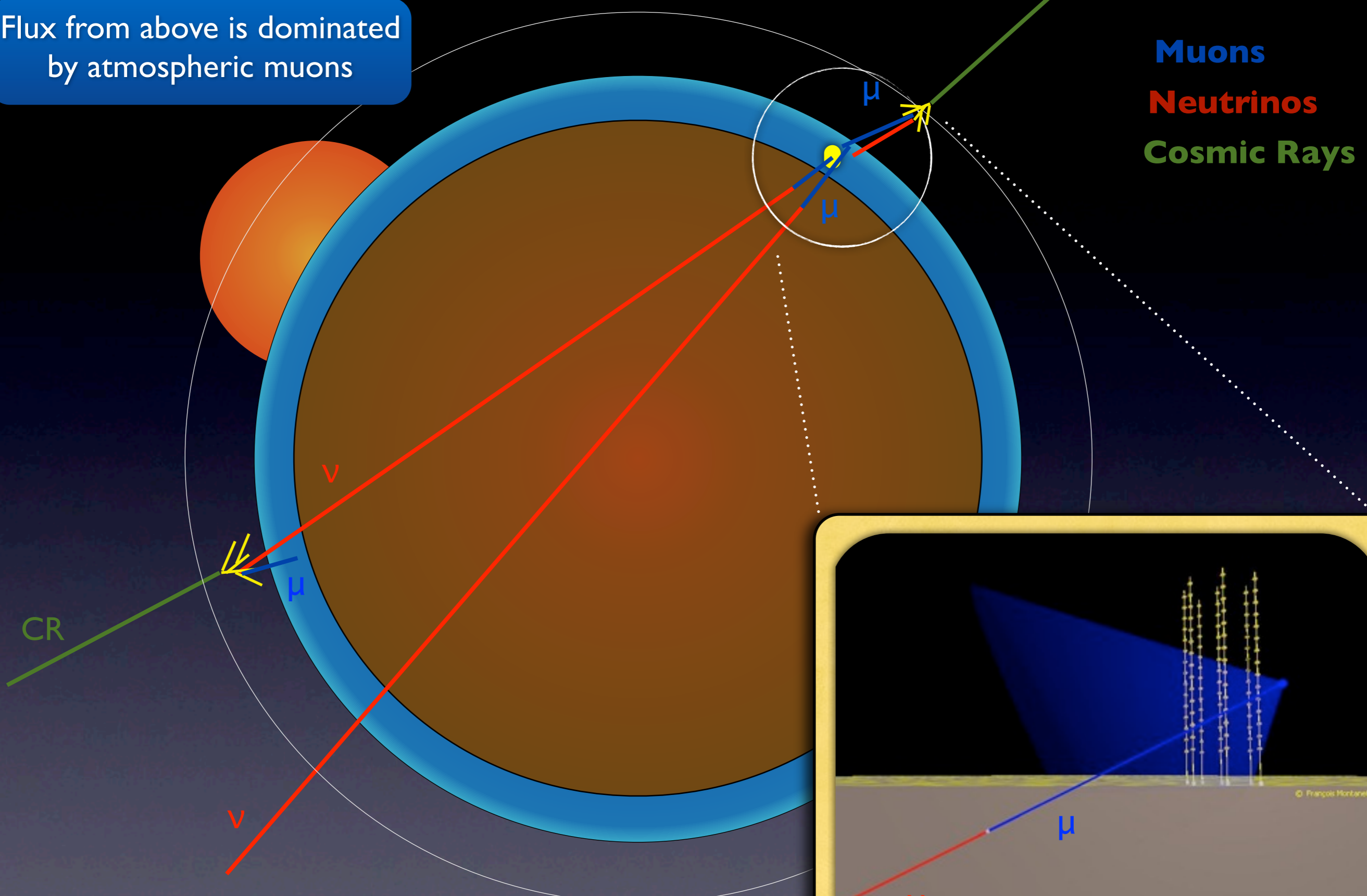


0.5 π sr instantaneous common view
1.5 π sr common view per day



Flux from above is dominated by atmospheric muons

Muons
Neutrinos
Cosmic Rays

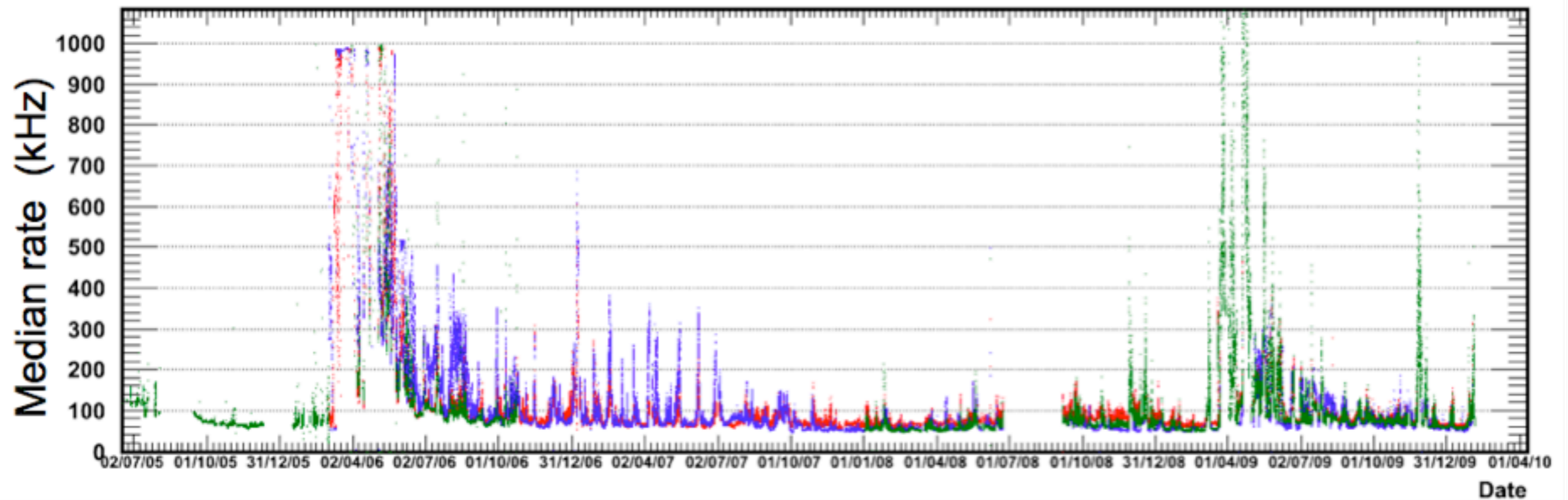


Optimized to be sensitive to neutrinos from below

ν_τ and ν_e give E/M and hadronic shower signatures
 ν_μ gives track signature

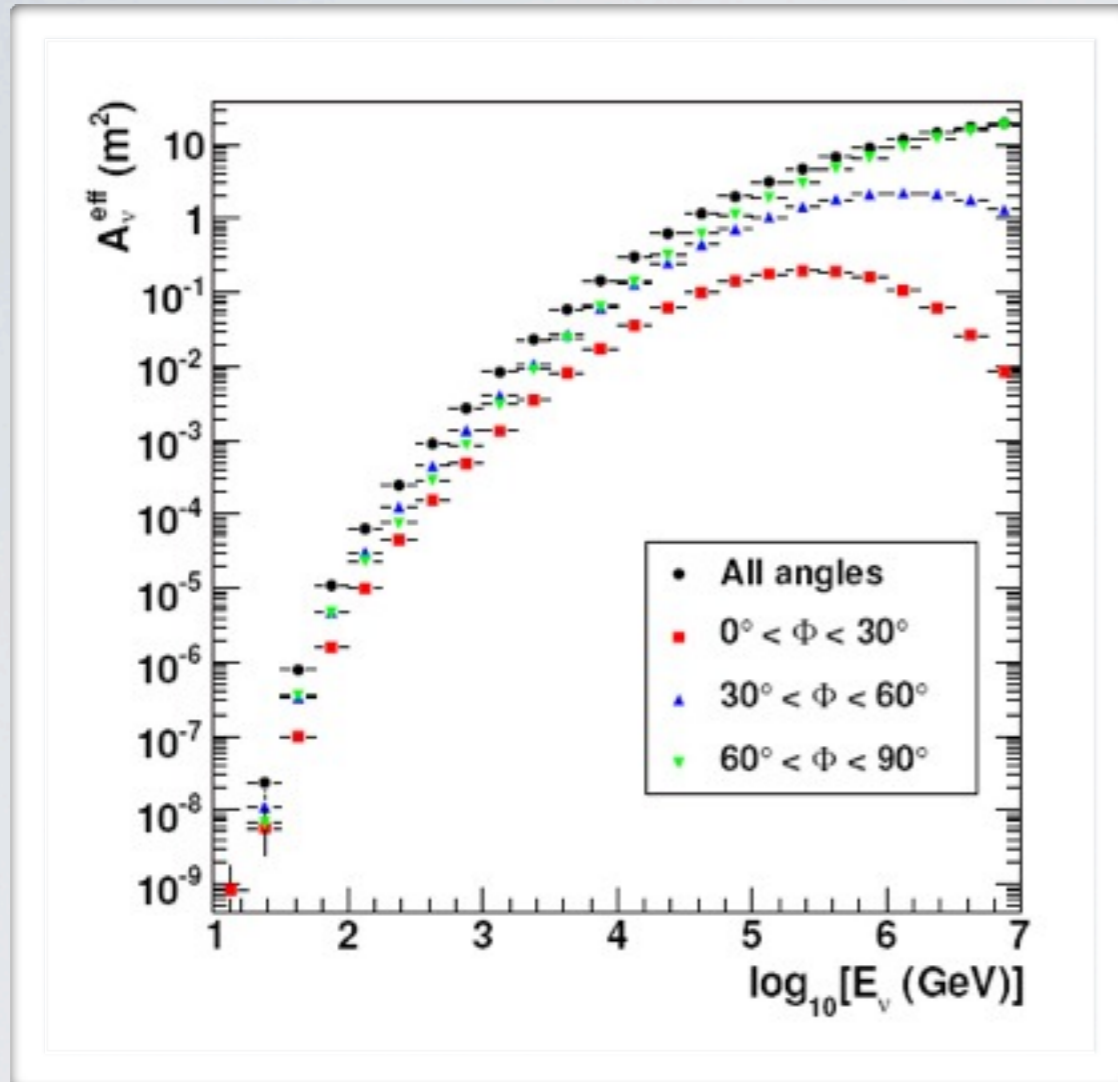
© François Monbet

OPTICAL BACKGROUND



- Another type of background - Potassium (K^{40}) decay and bioluminescence
- Typical rate per PMT 60-120kHz
- Short bursts due to bioluminescence and periods with higher rates

PERFORMANCE

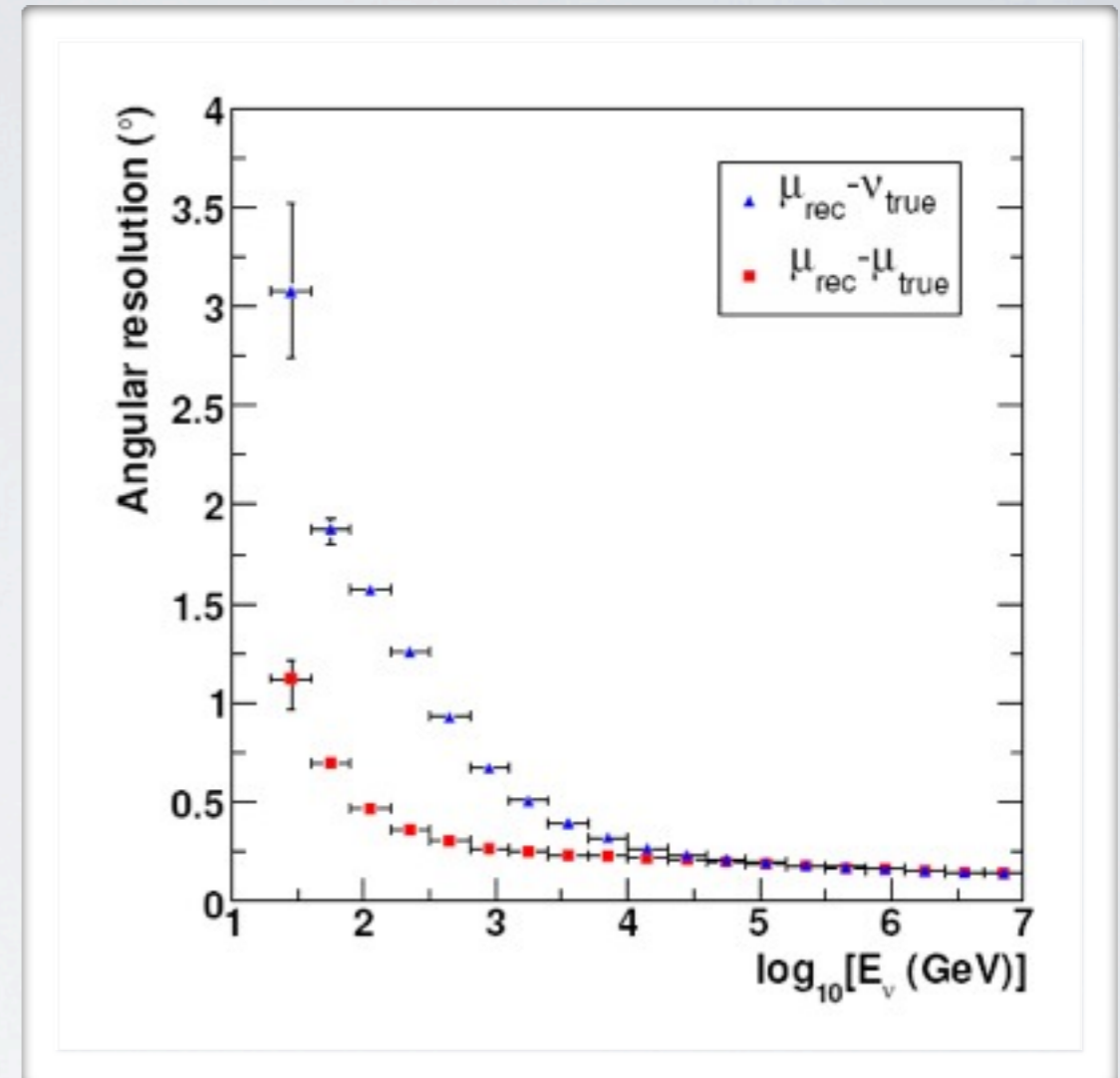


$E_\nu < 10 \text{ PeV}$

A_{eff} grows with energy due to increase in interaction cross section and muon range

$E_\nu > 10 \text{ PeV}$

the earth becomes opaque to neutrinos



Angular resolution $< 0.3^\circ$ for $E_\nu > 10 \text{ TeV}$

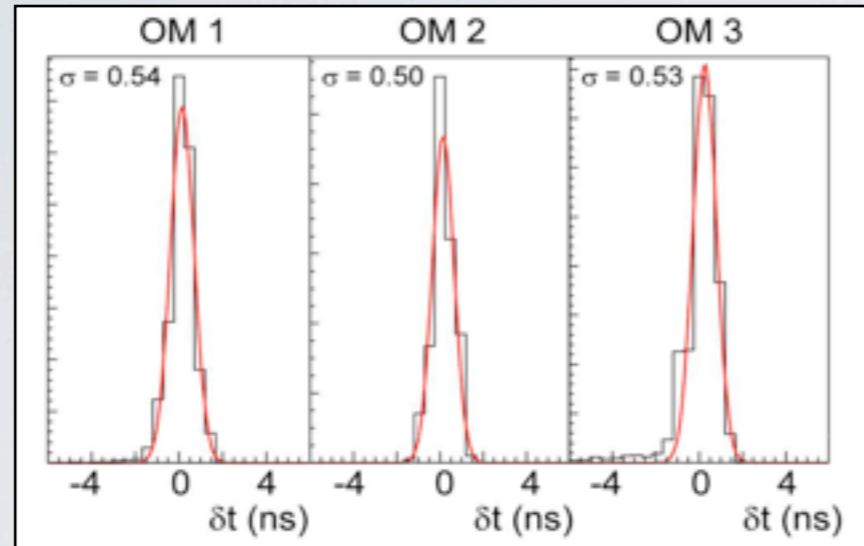
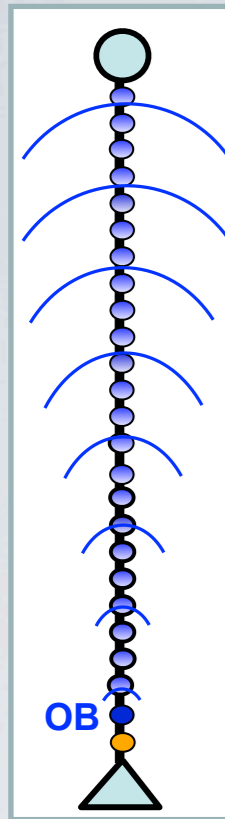
$E_\nu < 10 \text{ TeV}$

angular resolution dominated by ν - μ angle

$E_\nu > 10 \text{ TeV}$

resolution limited by track reconstruction uncertainties

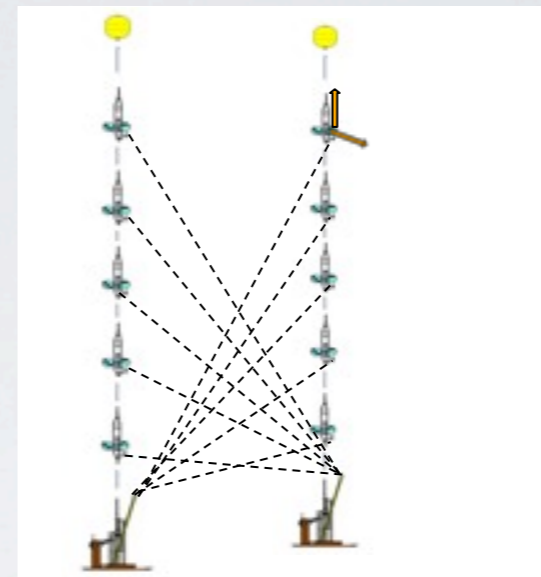
MEASUREMENTS AND CALIBRATION



Optical and LED beacons.

- Electronics + Calibration : $\sigma < 0.5\text{ns}$
- TTS in PMT's : $\sigma \sim 1.3\text{ns}$
- Light scattering + dispersion : $\sigma \sim 2\text{ns}$

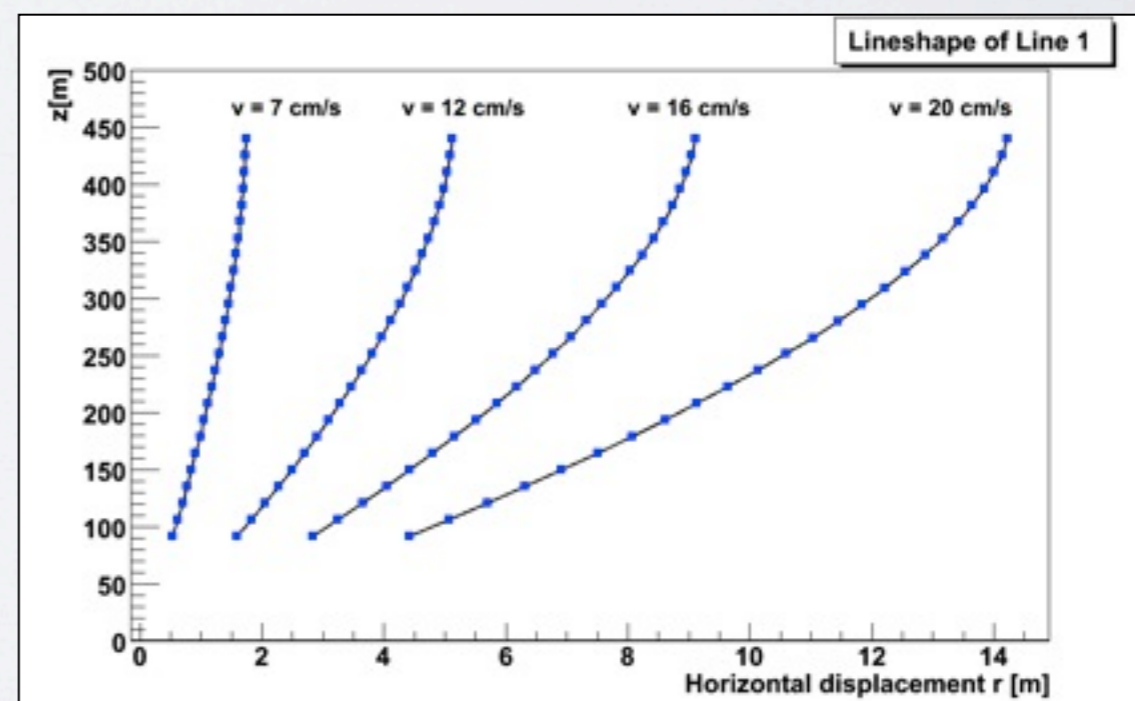
- charge resolution 30%



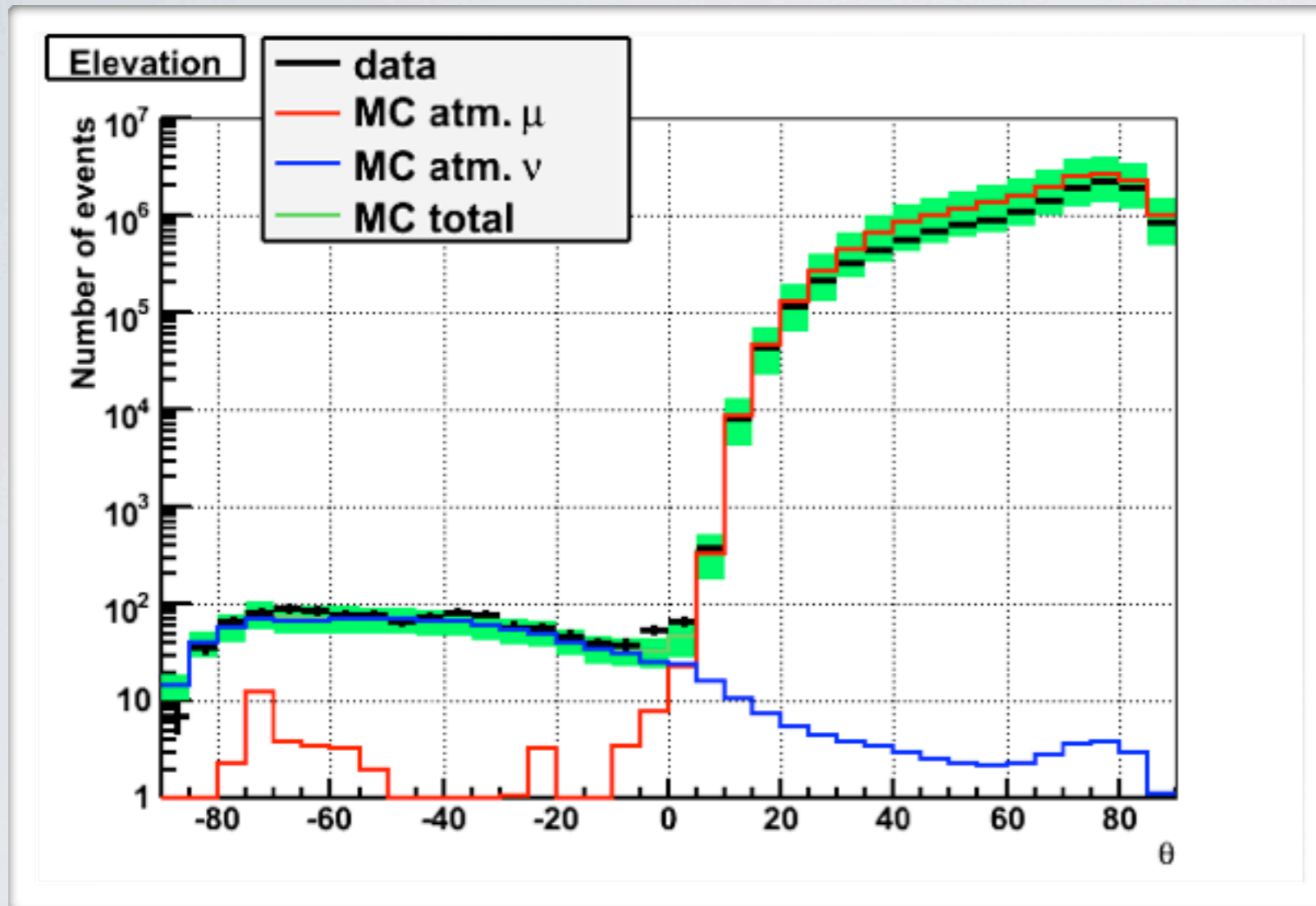
Line shape :
by acoustic devices
Orientation of each storey :
by compasses/tiltmeters

Precision of $\sim 10\text{cm}$

- 1 emitter/receiver in each line bottom
- 5 receivers in each line
- 1 compass and accelerometer on each storey
- Measurement every 2 minutes



ANGULAR DISTRIBUTION



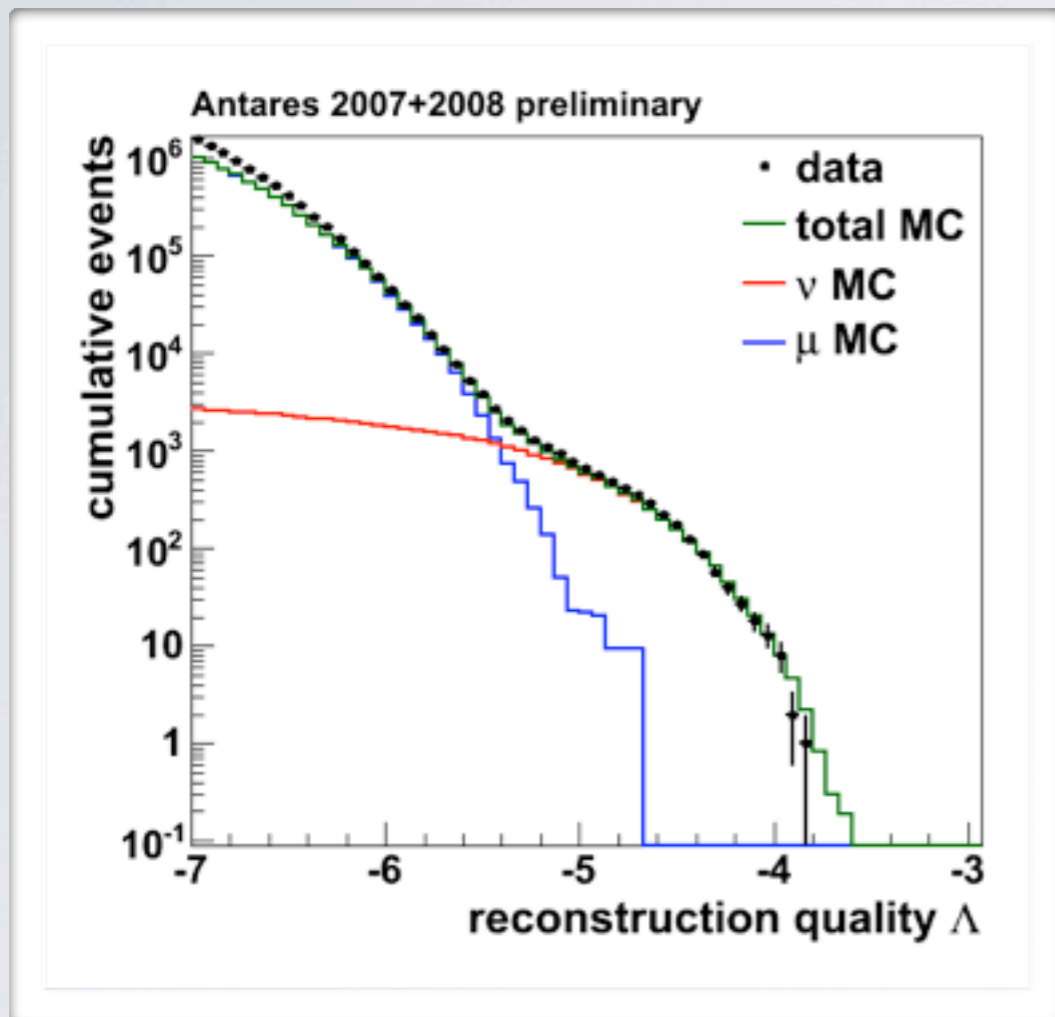
5 line 2007 data
9-12 line 2008 data
341 days livetime
1062 neutrino candidates

good agreement with MC
916 upgoing atm. ν 30% syst. error
40 upgoing atm. μ 50% syst. error



SEARCH FOR POINT SOURCES

Full sky search + candidate list search

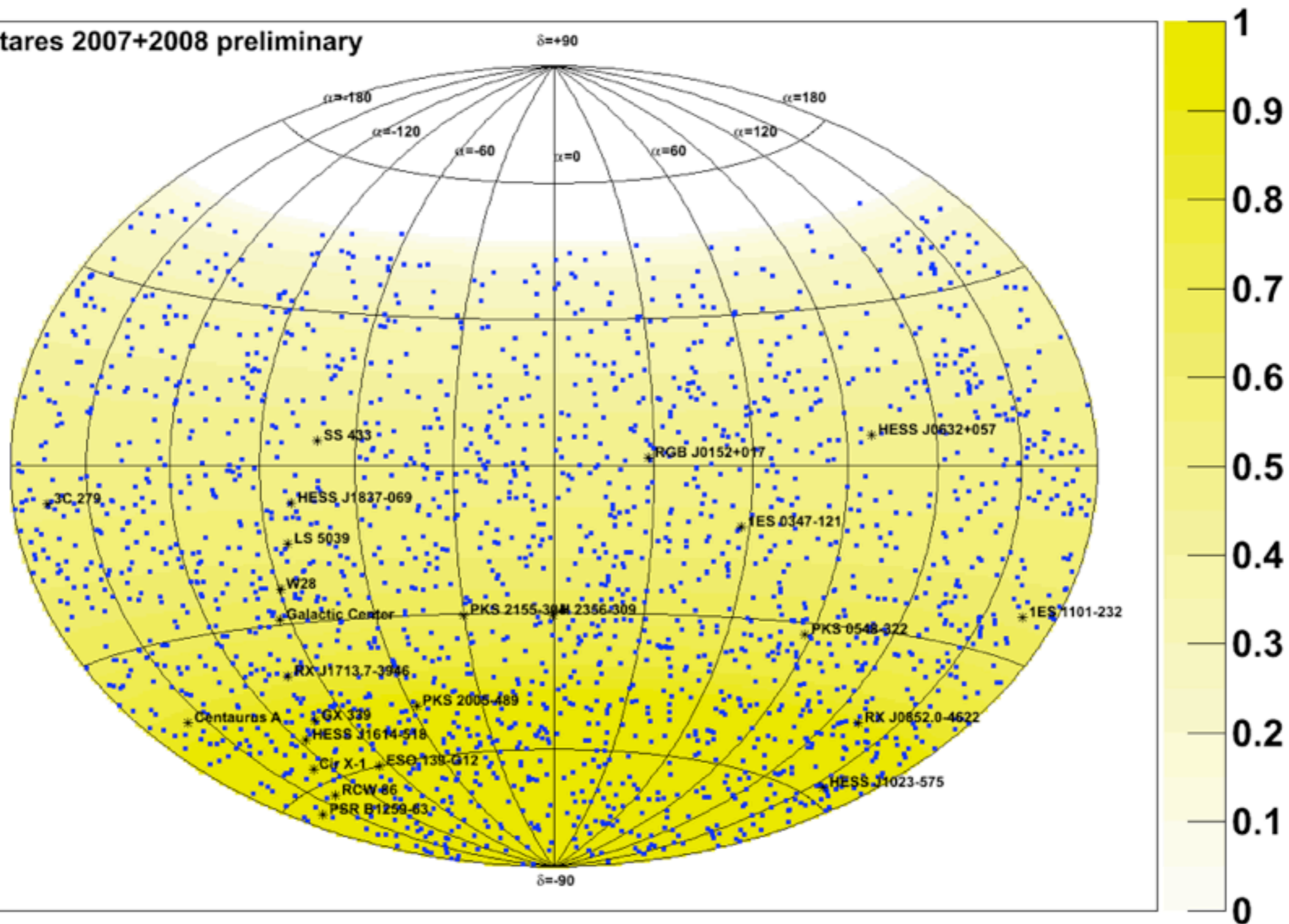


- Jan 2007 - Dec 2008, 295 days livetime
 - 5, 9, 10, 12 line detector configuration
- Selection: upgoing, good reconstruction quality, uncertainty from fit < 1 degree
- 2040 neutrino candidates (estimated 40% muon contamination)
- 0.5 ± 0.1 degrees median angular resolution



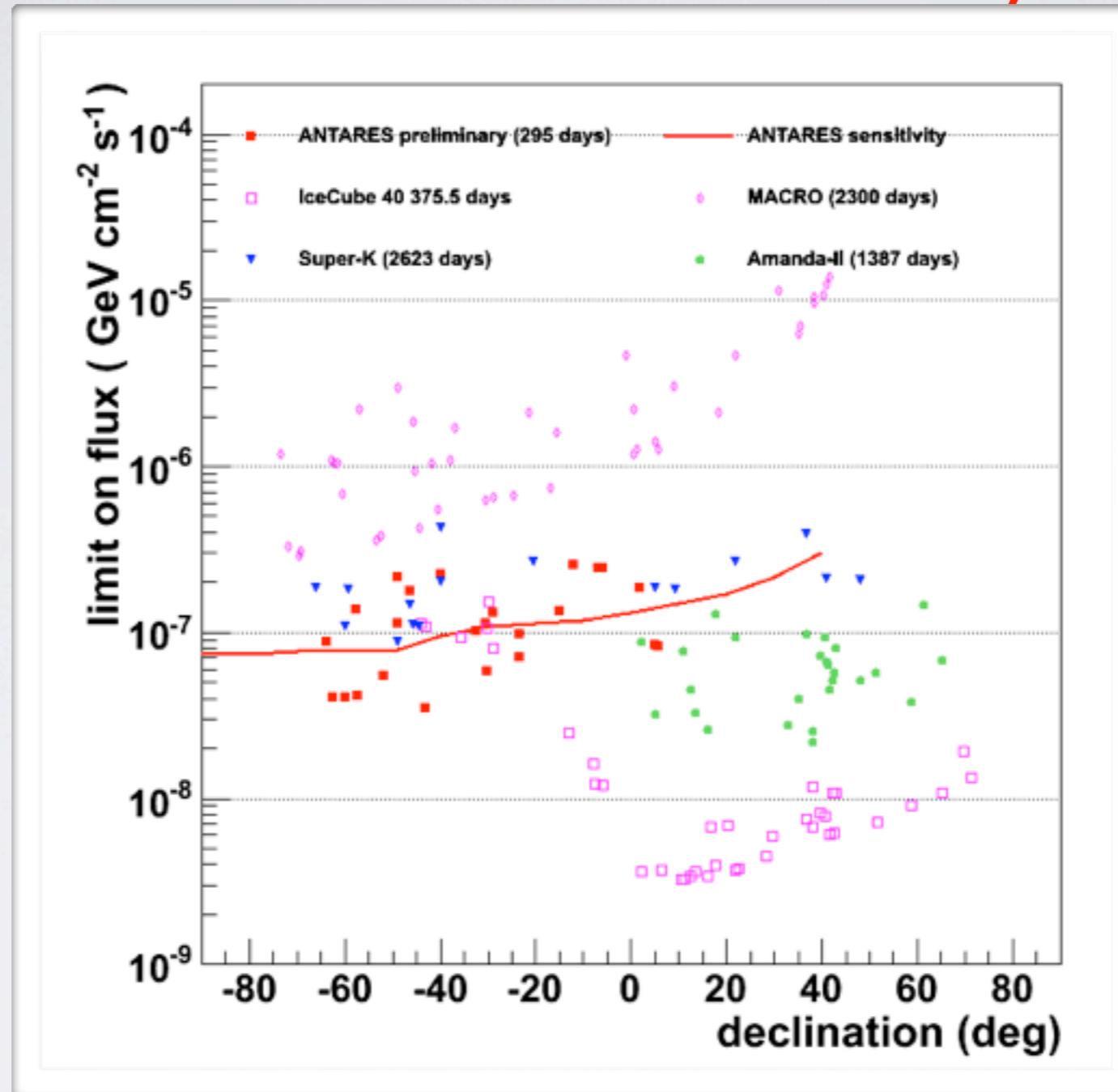
SEARCH FOR POINT SOURCES

Antares 2007+2008 preliminary

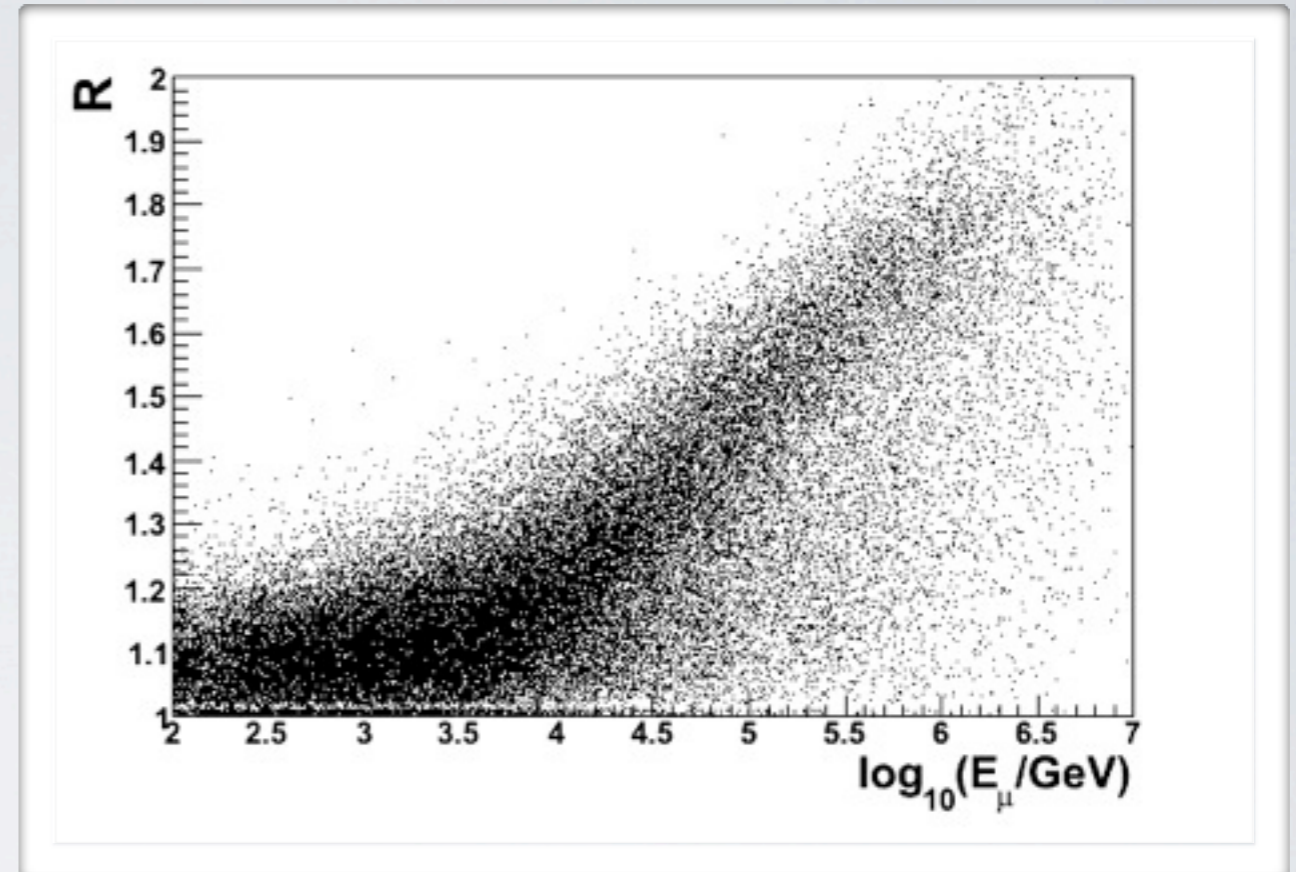
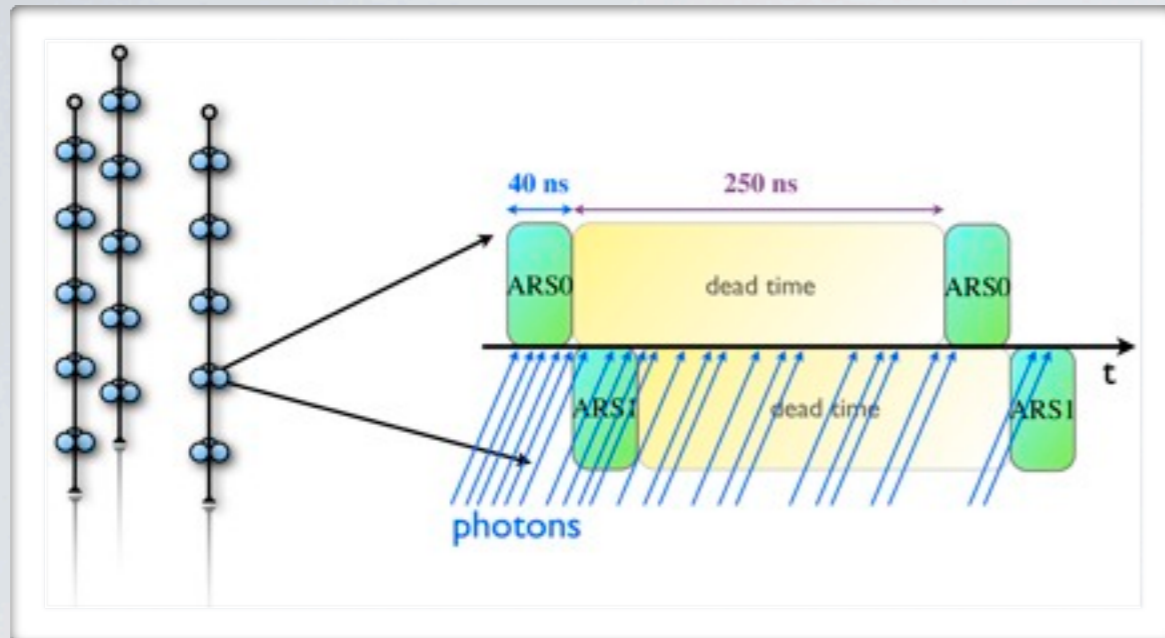


SEARCH FOR POINT SOURCES

Best limits for Southern Sky



HIGH ENERGY DIFFUSE NEUTRINO FLUX



Energy estimator

$$R = \frac{\# \text{ of hit repetitions on the OM}}{\# \text{ of total OMs}} = \frac{\sum R_i}{N_{OM}}$$

Repetition (R) of integration gate on the same OM

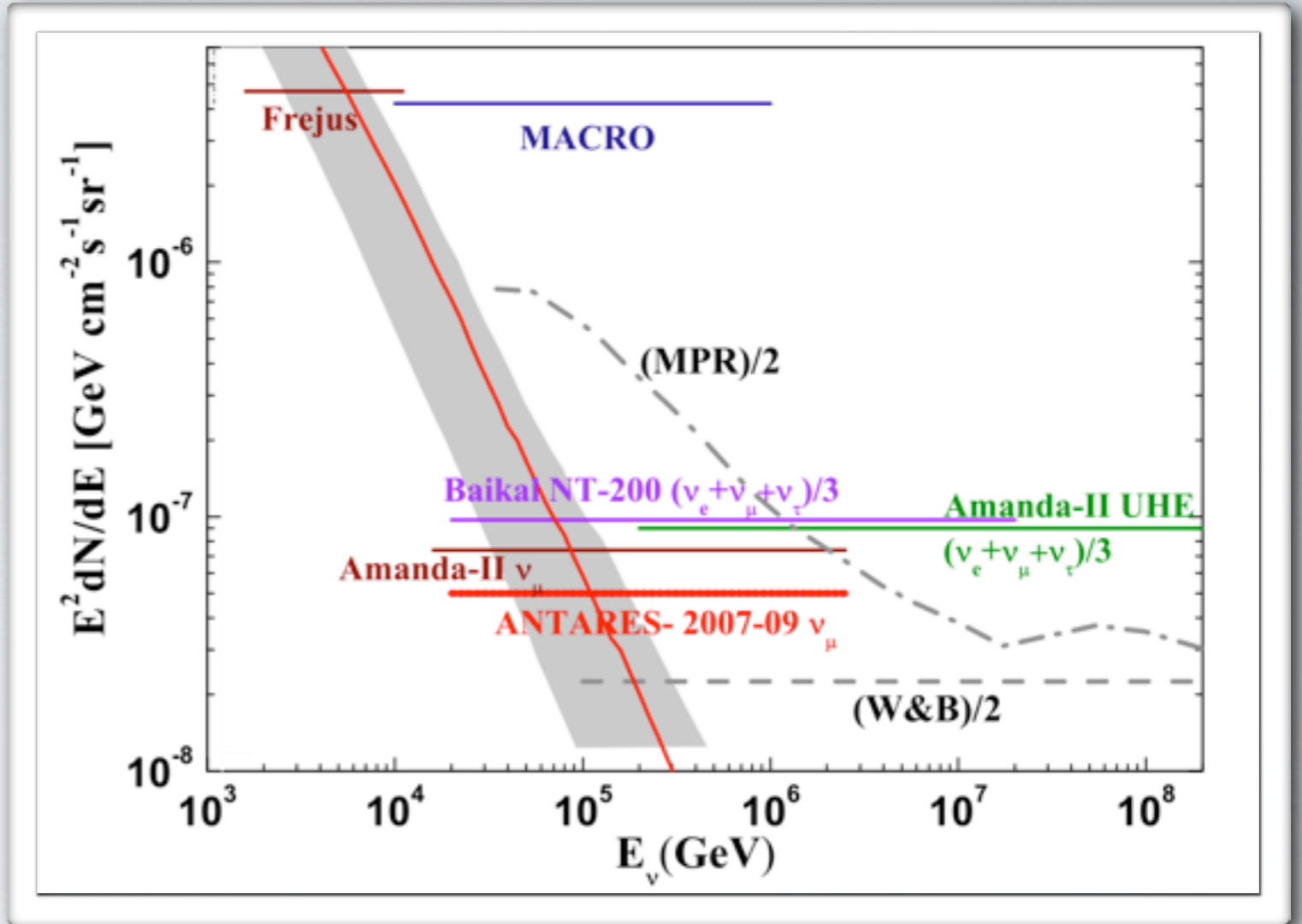
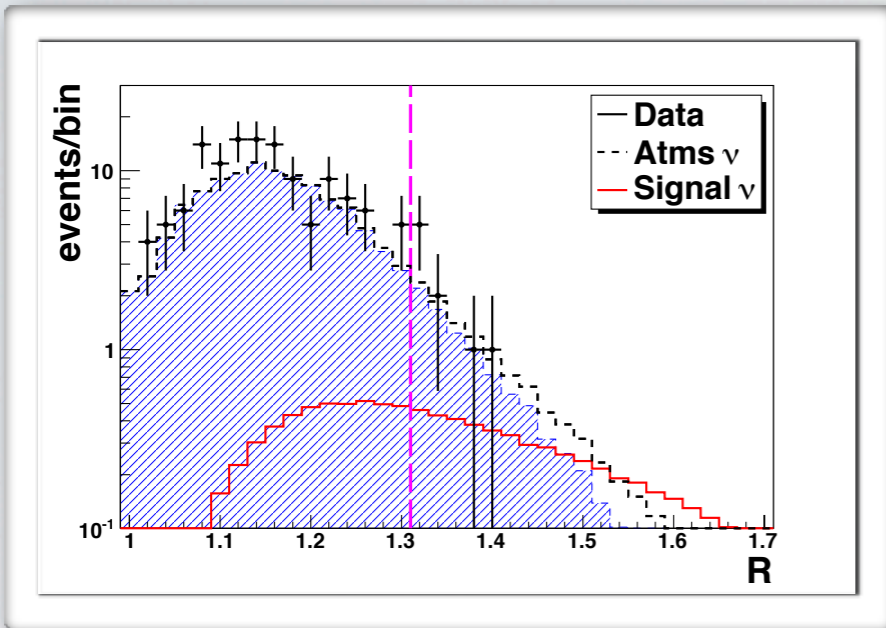
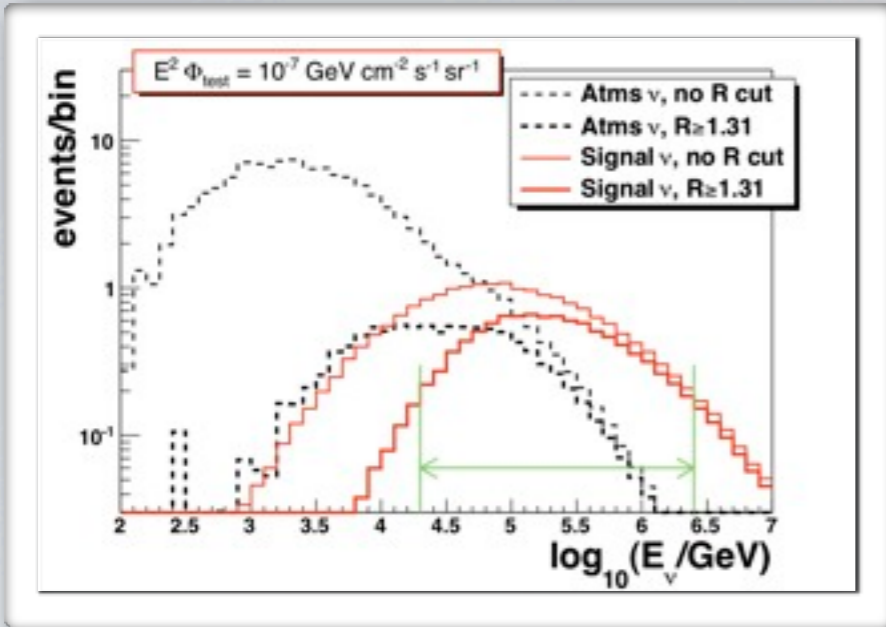
selection criteria

Level 1: good quality upgoing tracks

Level 2: combined cut on number of hits and track reconstruction quality

A cut on R variable used to discriminate signal vs background





0.83*2π sr monitored for 334 days
 134 high energy neutrino candidates (almost no muons)

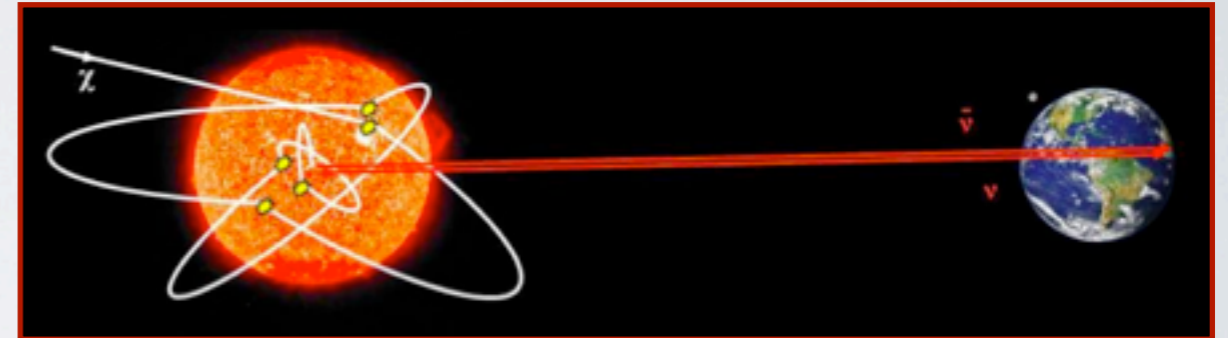
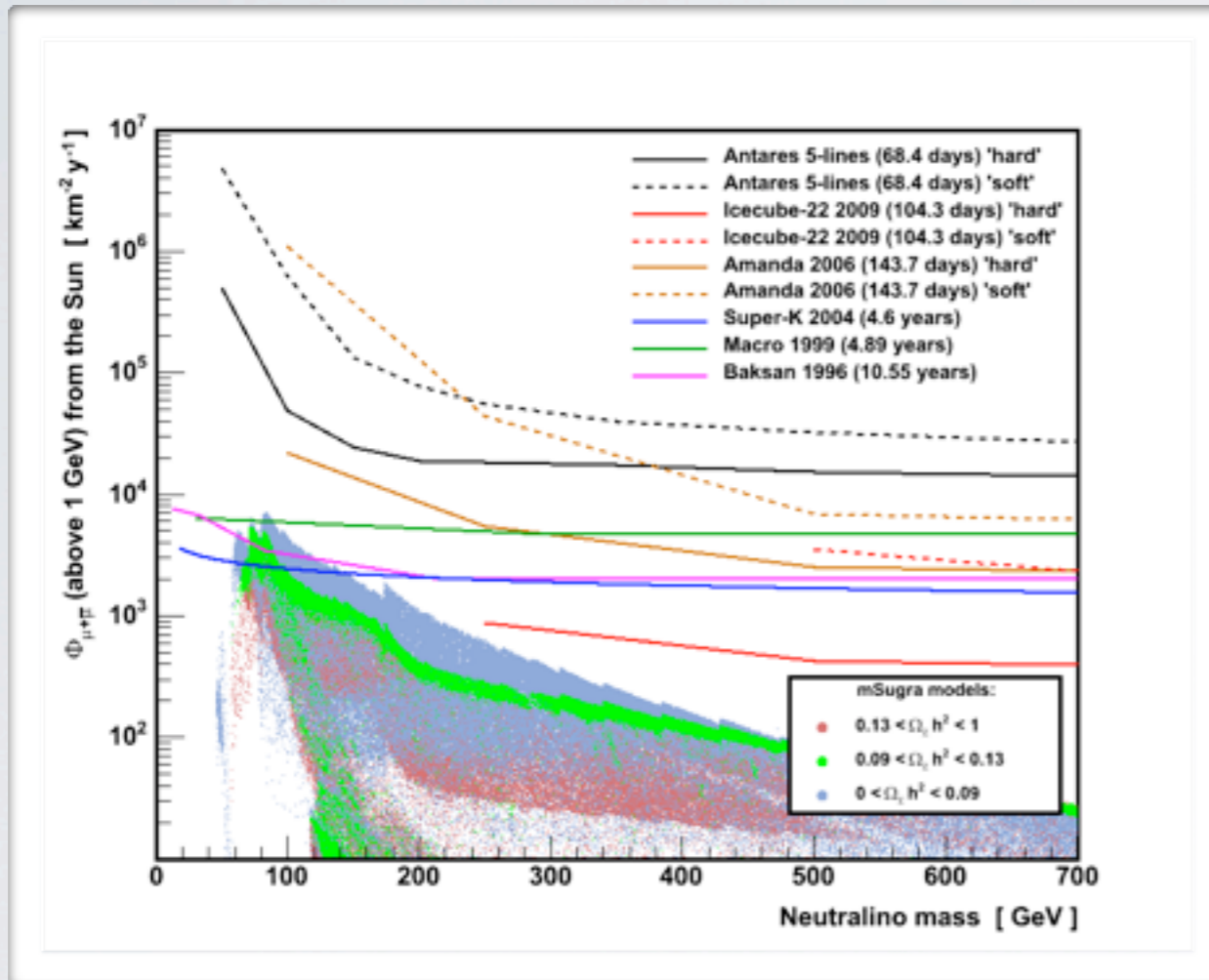
No excess of events found
 above the predicted atmospheric neutrino flux

$$E^2 \Phi(E)_{90\%CL} = 5.3_{-1}^{+2} \cdot 10^{-8} \text{ GeV cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1} \quad \text{for } 20 \text{ TeV} < E < 2.5 \text{ PeV}$$

DARK MATTER

Upper limit (90% CL) on the total $\nu_\mu + \bar{\nu}_\mu$ flux from neutralino annihilations in the Sun as a function of m_χ

5 line data (2007) - 68 days livetime

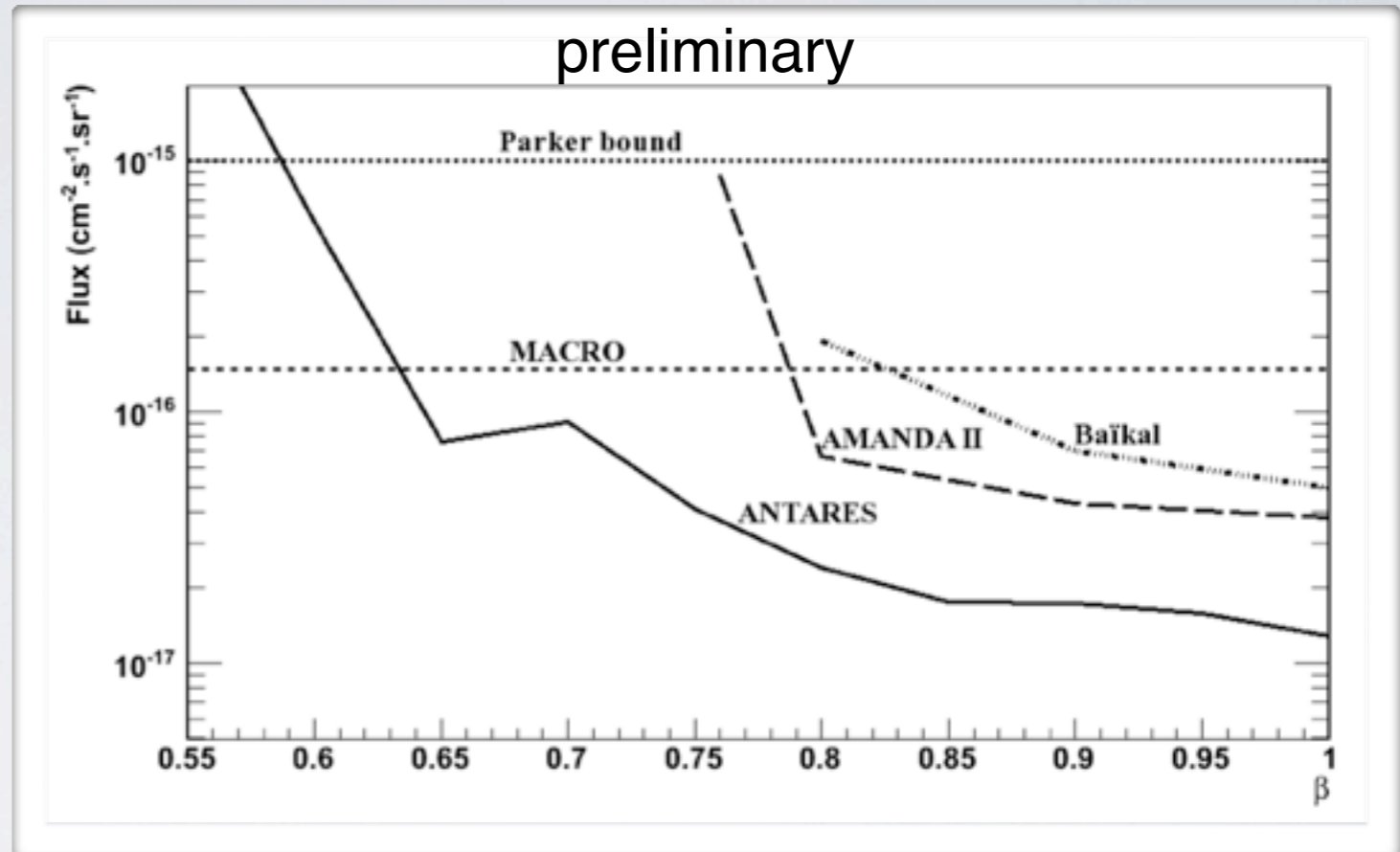
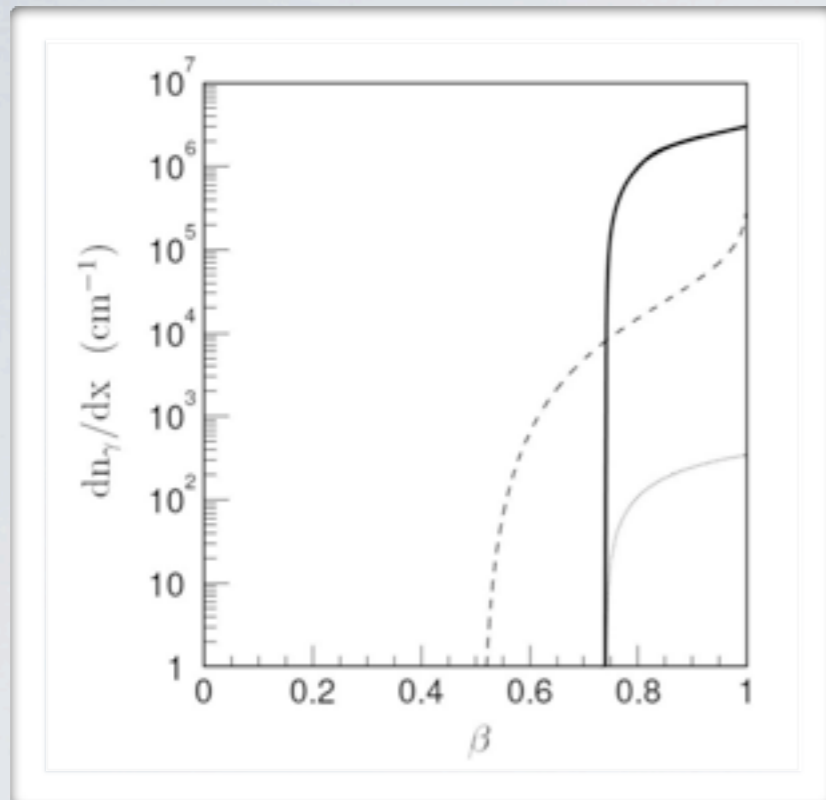


- WIMPs gravitationally trapped via elastic collisions in the sun
- Neutrino flux calculated with mSUGRA
- 2 extreme annihilation cases:
 - into vector-bosons ('hard')
 - into $b\bar{b}$ ('soft')

mSugra model predictions

- green : WMAP favored relic density
- red : > WMAP favored relic density
- blue : < WMAP favored relic density

MAGNETIC MONOPOLES



- fast monopoles ~ 8000 more photons than muons of the same velocity
- selection optimized for the discovery potential

December 2007 - December 2008
(livedtime 116 days)

No signal found.

Currently the best upper limit



SUMMARY

- ANTARES complete since 2008
- First operational and largest neutrino telescope in northern hemisphere
- ANTARES has seen thousands of (atmospheric) neutrinos
- Results available. Exciting physics analyses ahead
- Complements sky coverage of IceCube
- Step towards KM3NeT



Thank you for your attention!