



# ANTARES neutrino telescope Status and first results

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on behalf of the ANTARES collaboration



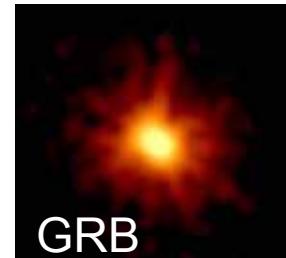
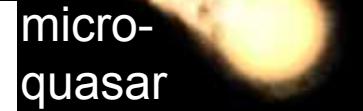
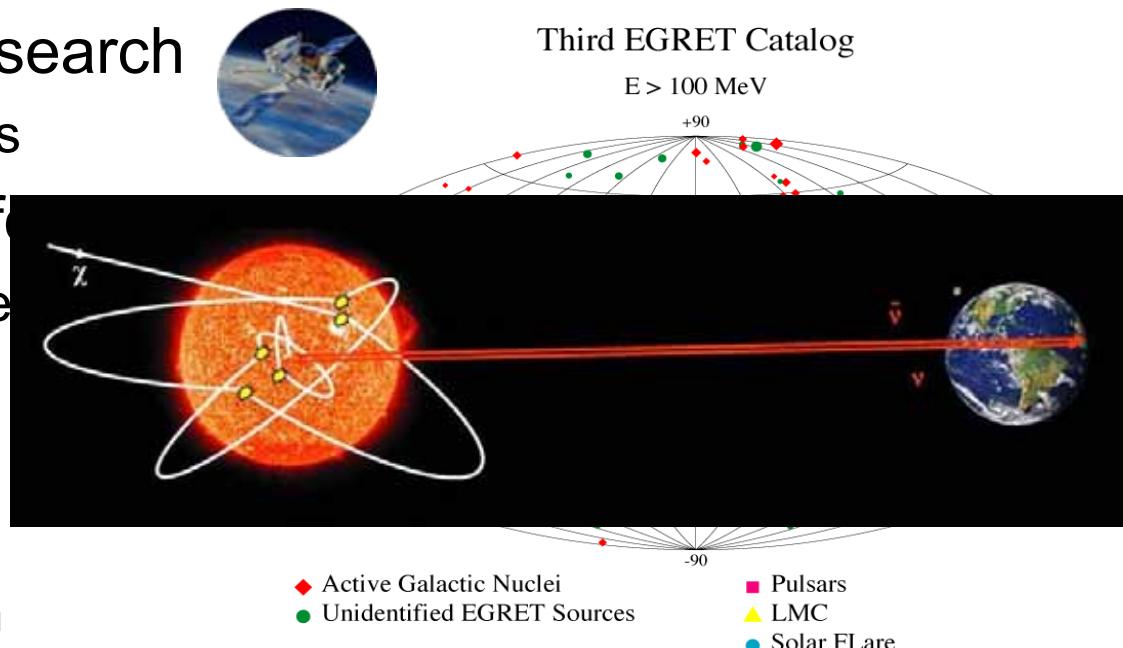
# Contents



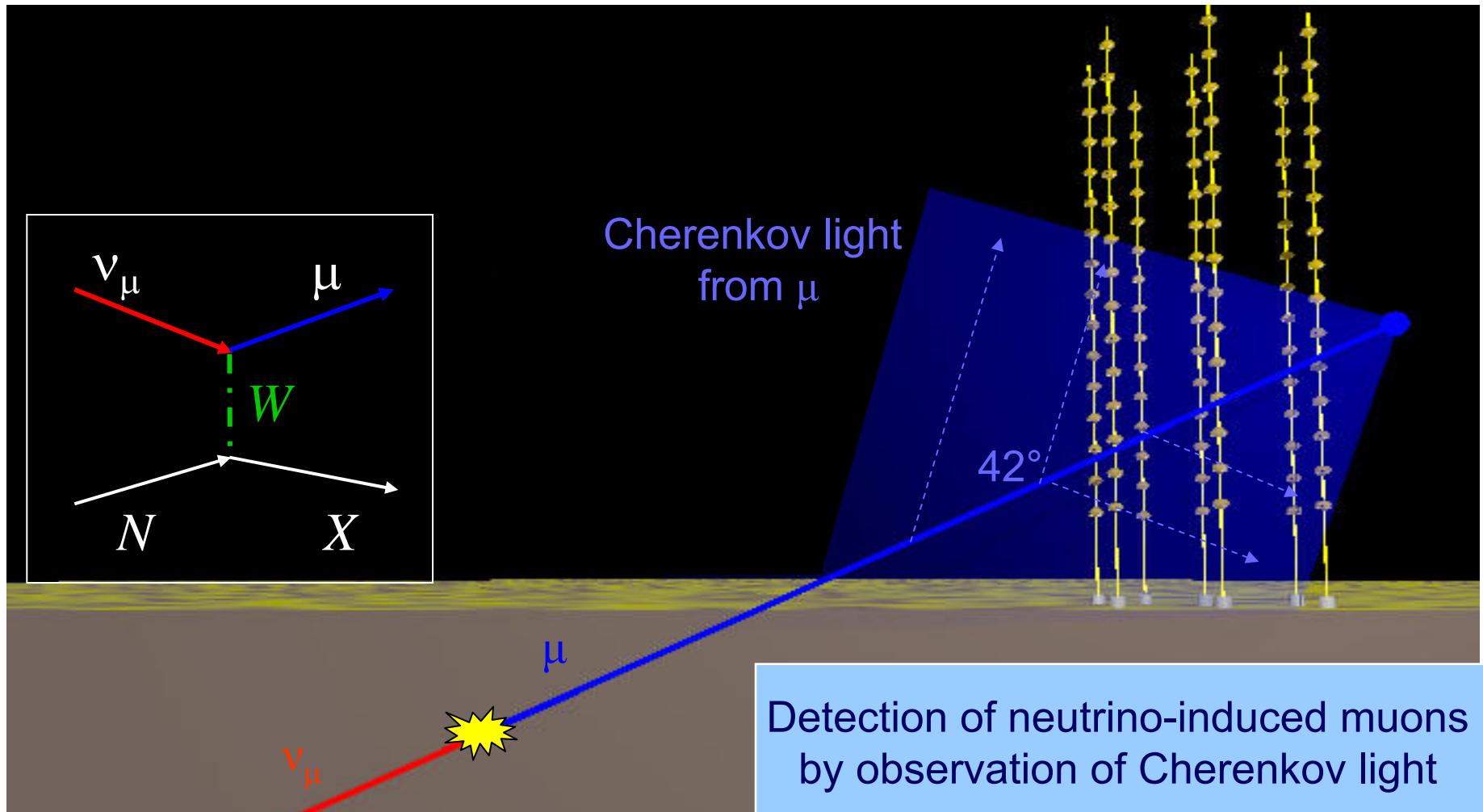
- Astrophysics motivation
- The ANTARES detector
- Detector operation
- The first physics analyses
  - Atmospheric muons
  - Atmospheric neutrinos
  - Search for cosmic neutrino sources
  - Dark matter search by indirect detection

# Physics with High Energy cosmic neutrinos

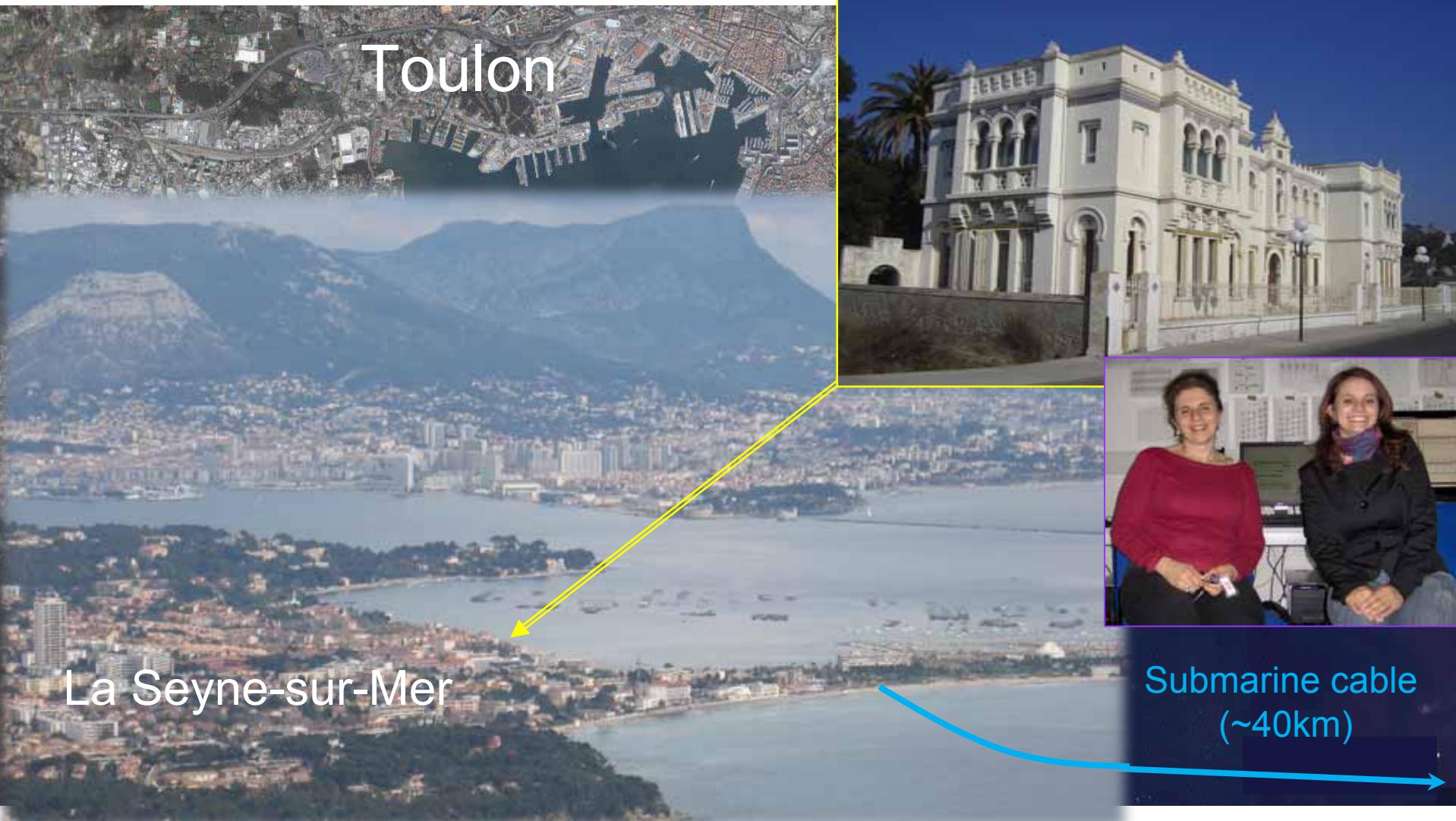
- Understanding production mechanism ('cosmic accelerators') of HE cosmic rays
- Study very energetic objects
  - Galactic: SNRs, pulsars, microquasars
  - Extragalactic: GRBs, AGNs
- Indirect search
  - WIMPs
- Search for
  - magnetic field



# Detection principle



# The ANTARES site



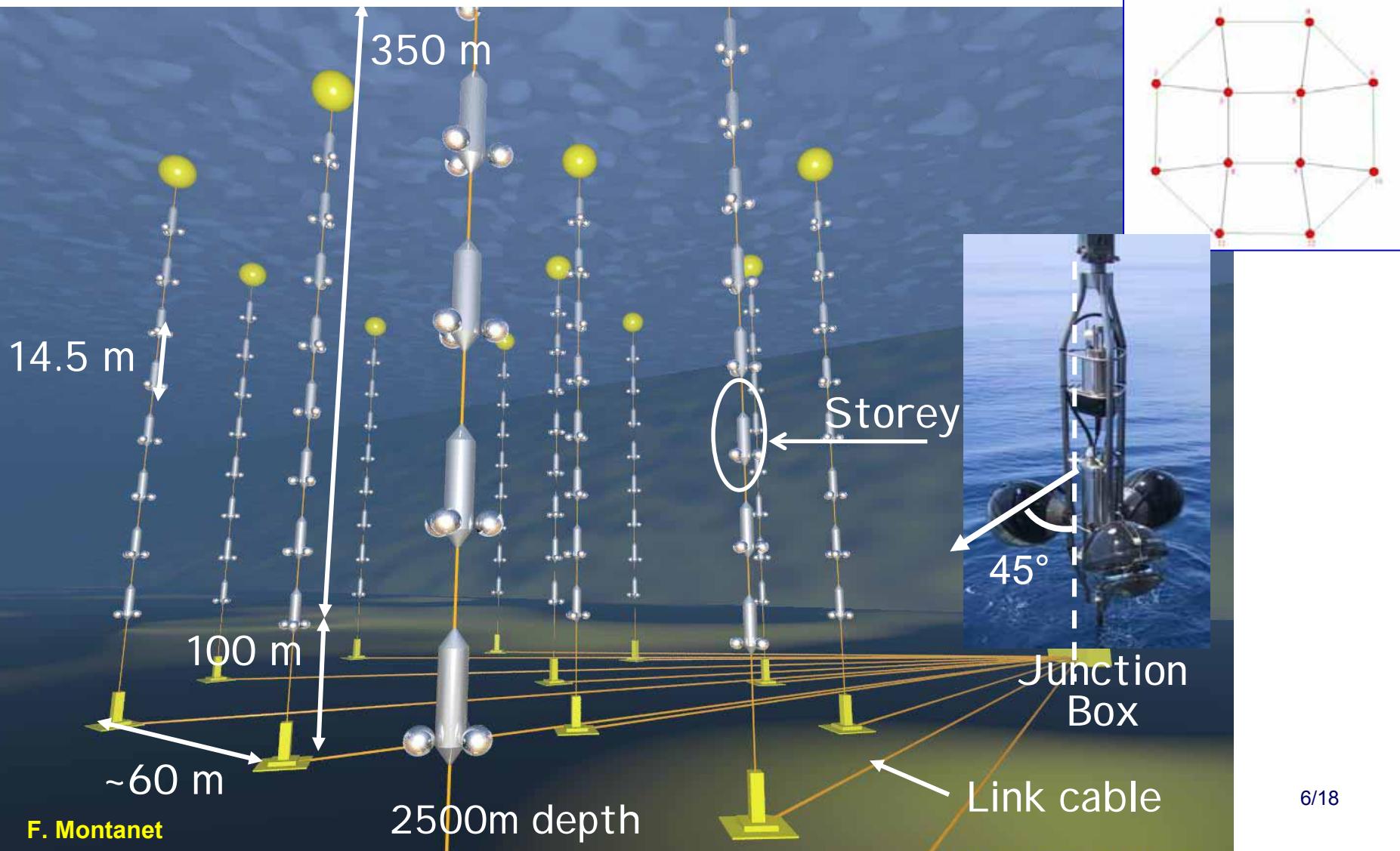
Toulon

La Seyne-sur-Mer

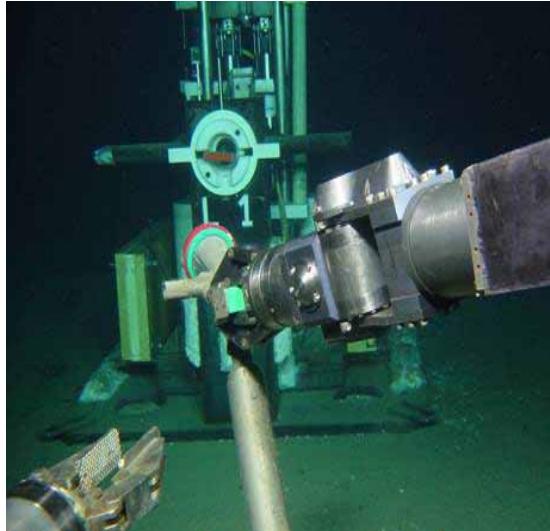
Submarine cable  
(~40km)

- 12 lines
- 25 storeys / line
- 3 PMTs / storey
- 885 PMTs

# The ANTARES detector



# 2005 – 2008: detector deployment



The detector is fully operational since the 30<sup>th</sup> May 2008

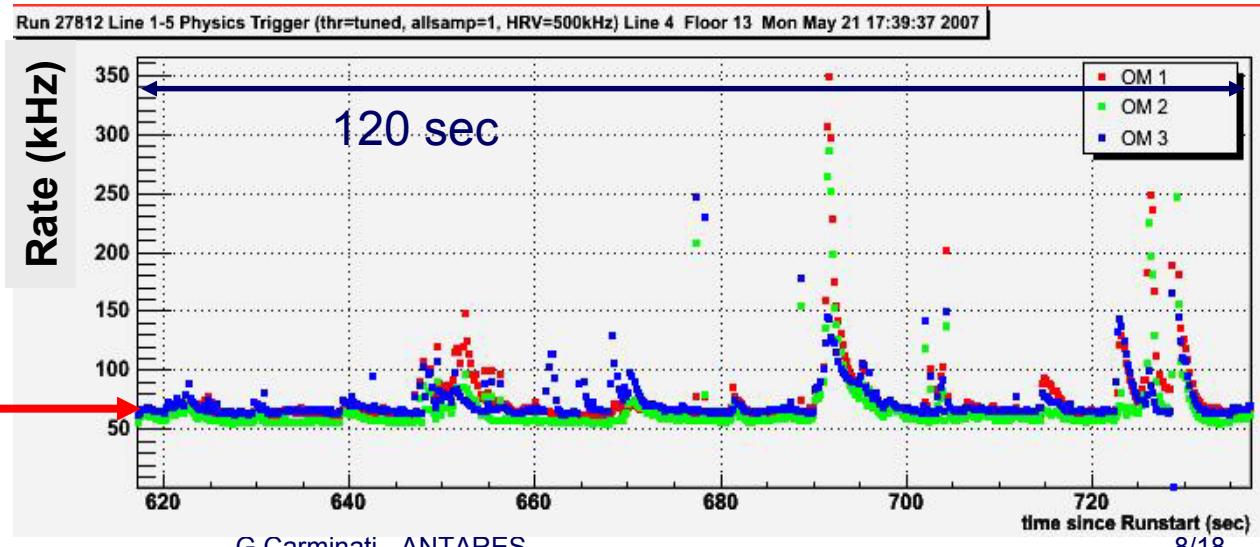
# Signal and light background

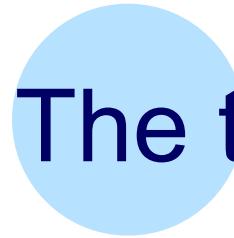
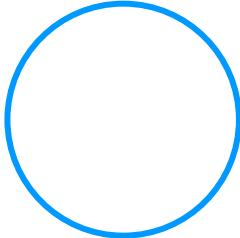
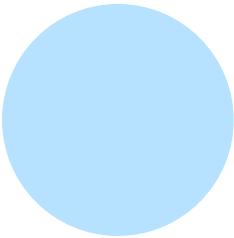


- Muon (Cherenkov)
  - 2  $\mu$ sec crossing time
- $^{40}\text{K}$  decay
  - Continuous background  $\sim 30$  kHz \*
- Bioluminescence
  - Continuous background  $\sim 30$  kHz \*
  - Occasional bursts  $\sim$  MHz

\* 10'' PMT, 0.3 p.e. threshold

60 kHz/PMT

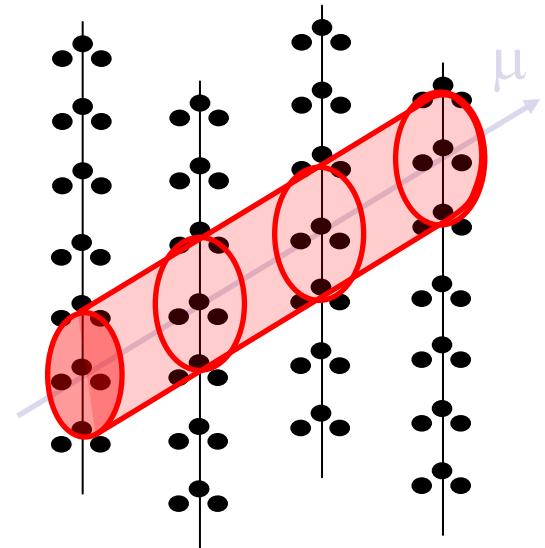




# The trigger

- Front end chip digitizes charge and time of all light signals above 0.3 p.e.
- **ALL DATA TO SHORE:**

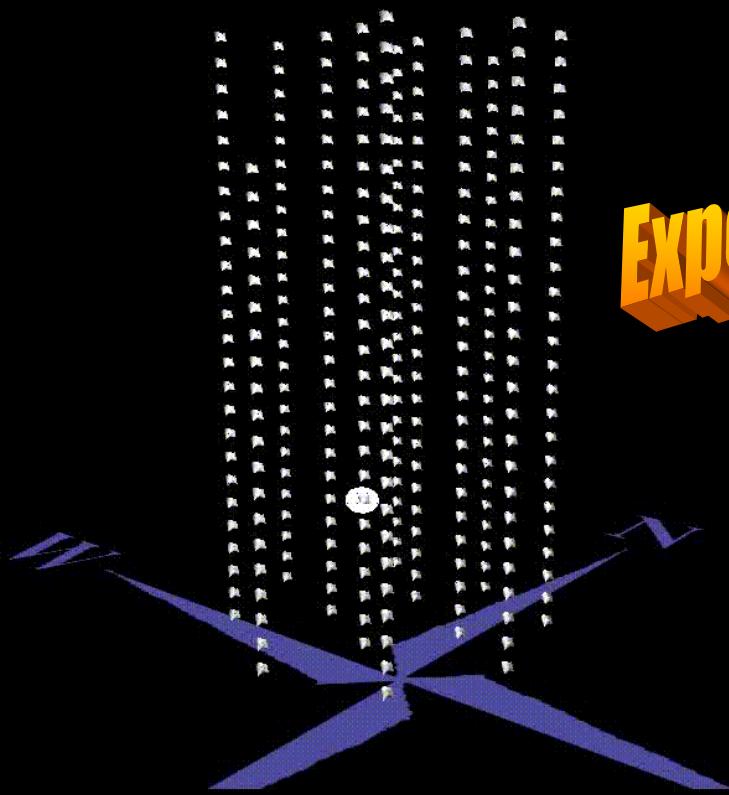
- All data transmitted through multiplexed Gigabit links
- Computer farm running software triggers:
  - look in all directions for light signals compatible with a muon track
  - when found, write a Physics Event
- Other triggers: cluster of storeys, GRBs, Galactic Center, ...





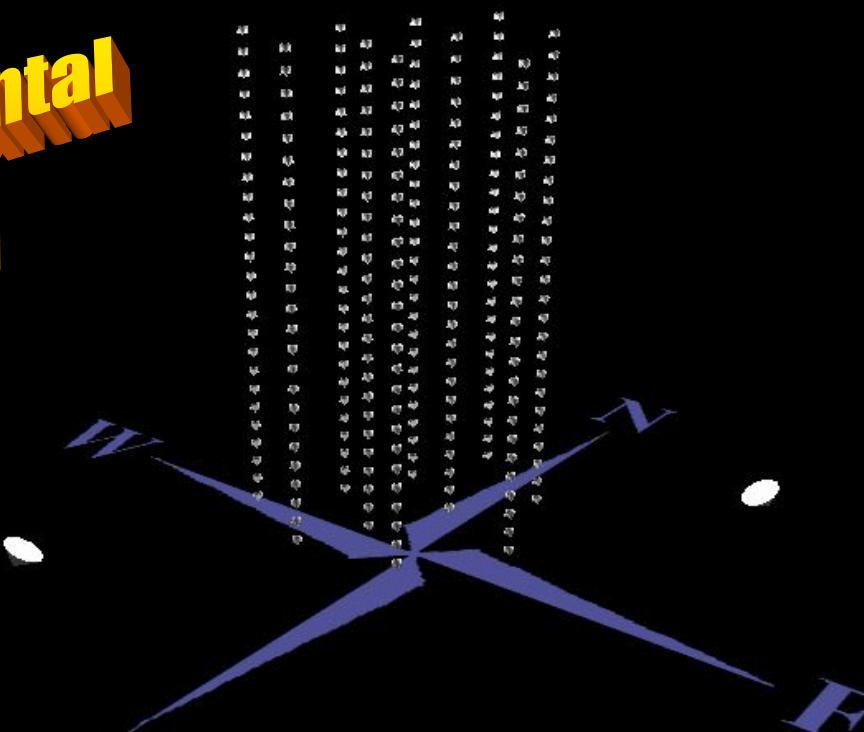
# Atmospheric muons and neutrino-induced muons

Example of a **reconstructed down-going muon**, detected in all 12 detector lines

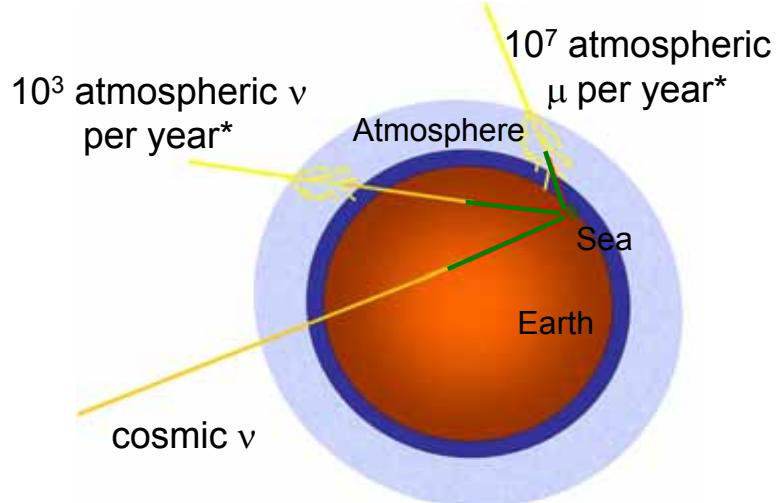
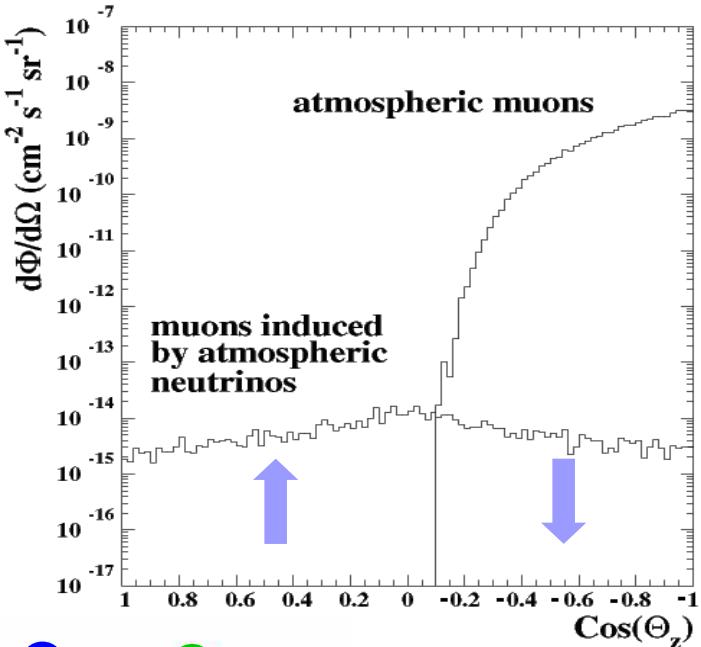


**Experimental  
data**

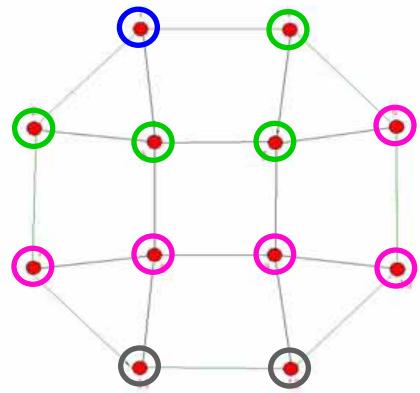
Example of a **reconstructed up-going muon** (i.e. a neutrino candidate) detected in 5/10 detector lines



# Muon flux at the detector



\* Reconstructed tracks in 12 line detector



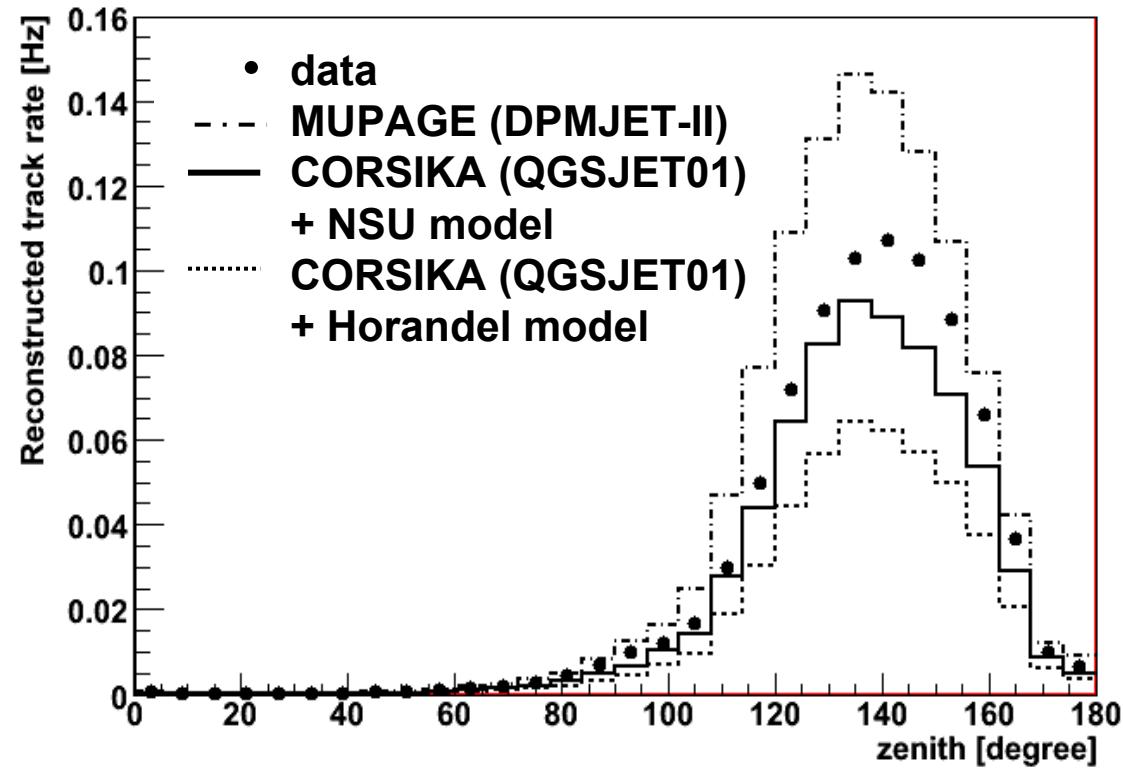
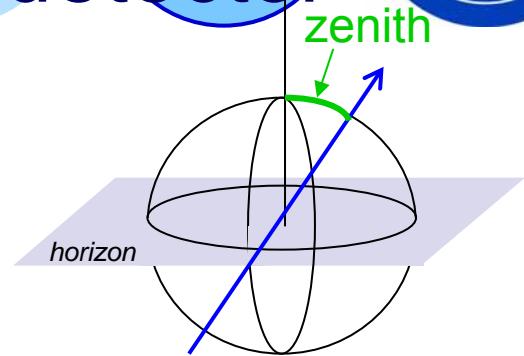
- Line 1: → arXiv:0812.2095, accepted by APP
- Line 2, 3, 4, 5: → First physic analyses completed
- Line 6, 7, 8, 9, 10: → Ongoing analyses
- Line 11, 12: → Data taking

**5 Line Detector**

Jun - Dec 2007

76 active days

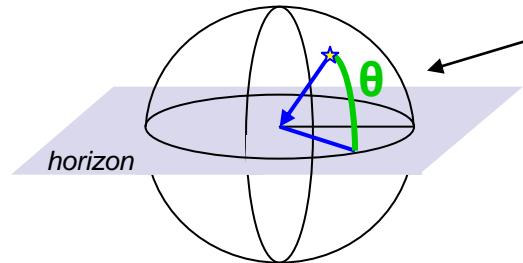
# Atmospheric muons with 5 line detector



- Systematic MC uncertainty  $\pm 35\%$
- Main contributions
  - optical module response
  - absorption length of light in water

**5 Line Detector**  
Feb - Dec 2007  
140 active days

# Atmospheric neutrinos with 5 lines detector

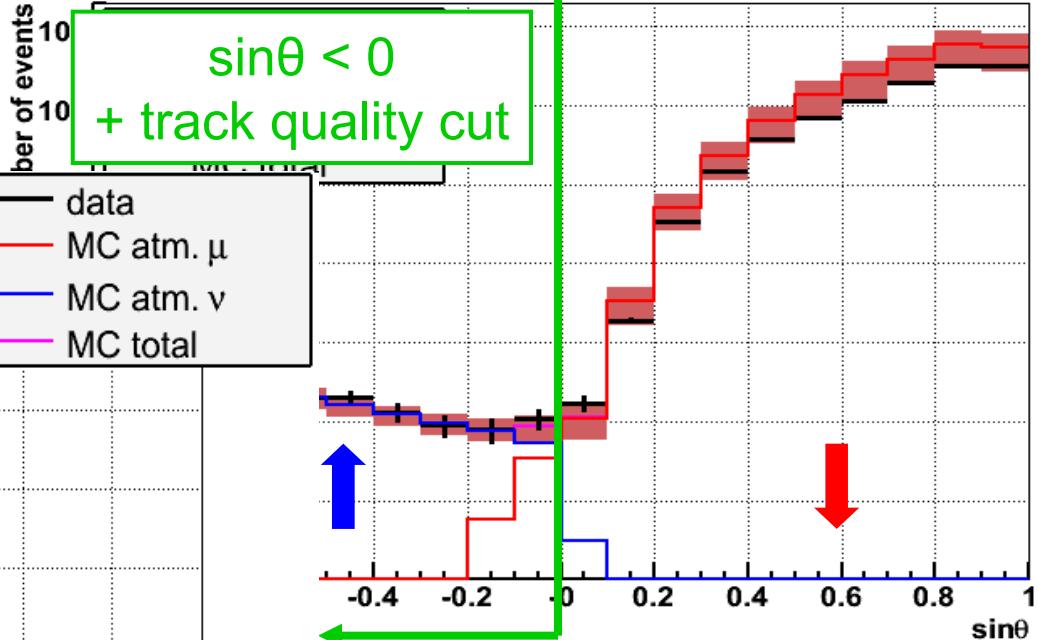


Elevation

Number of events

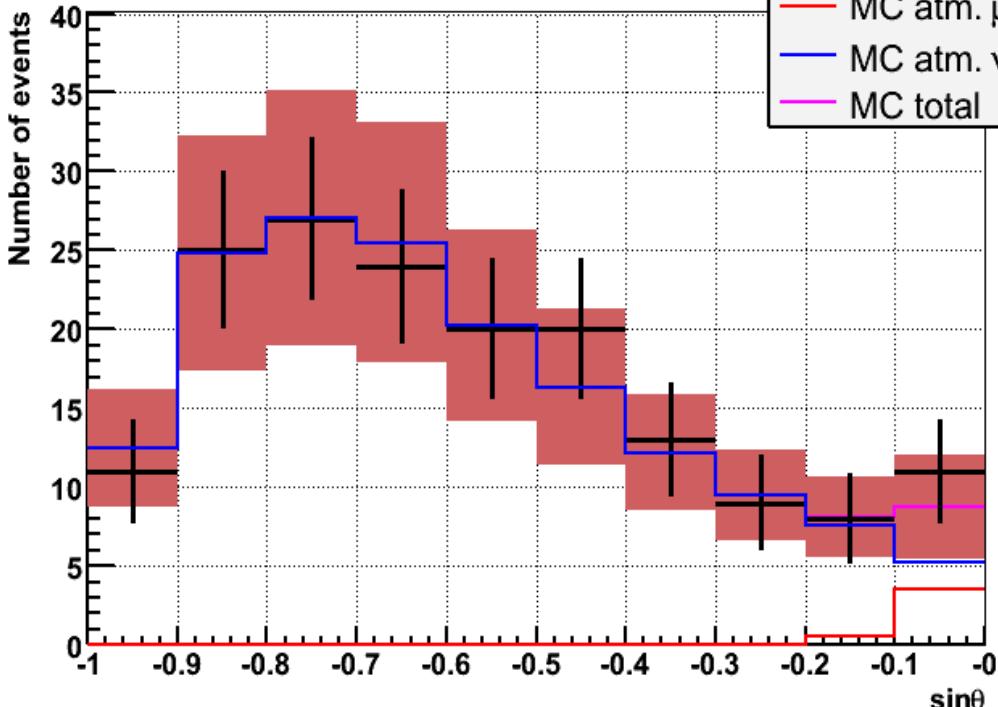
$\sin\theta < 0$   
+ track quality cut

— data  
— MC atm.  $\mu$   
— MC atm.  $\nu$   
— MC total



Data: 168  
MC:  $161 \pm 32(\text{theor}) \pm 20(\text{syst})$

Elevation

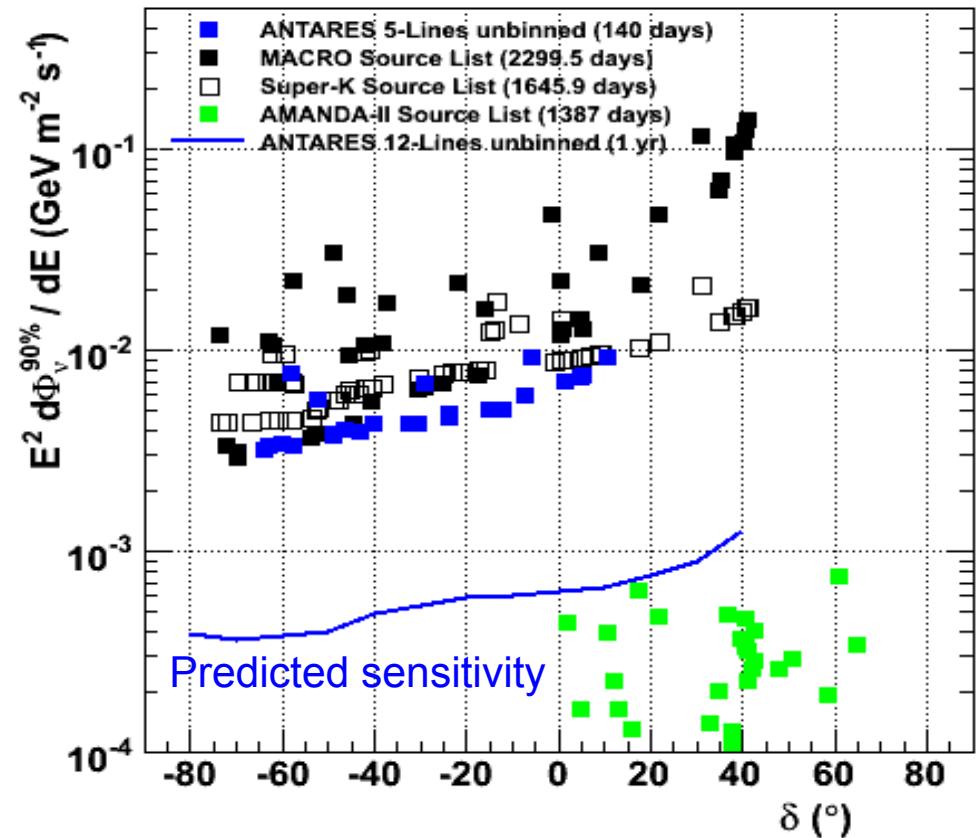
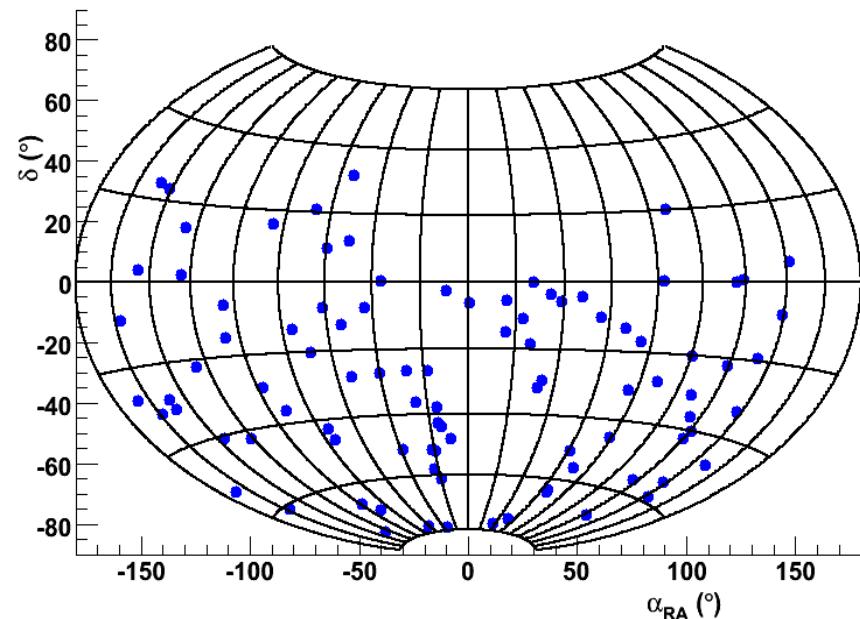


**5 Line Detector**  
Feb - Dec 2007  
140 active days

# Searching for point like neutrino sources



- Upper flux limit (differential) for the sources of the candidate list
- Analysis optimization by MC, for  $E^{-2}$  flux



No discovery  $\rightarrow$  90% CL flux limit

# Indirect detection of dark matter



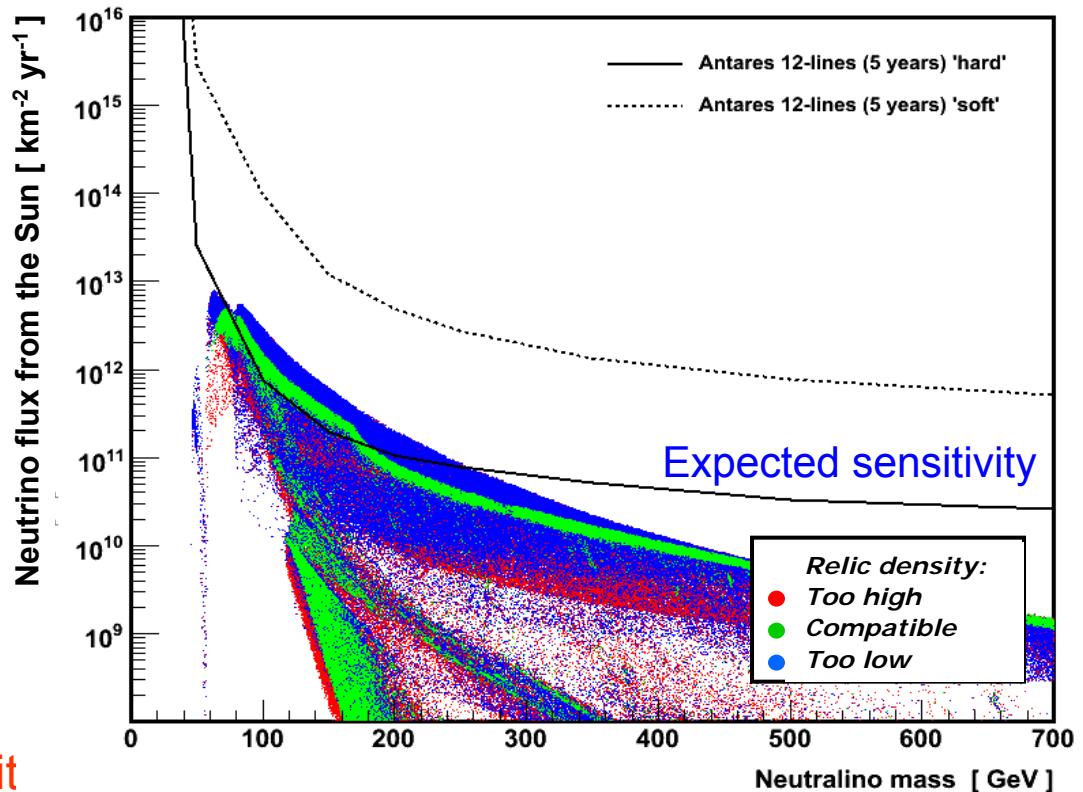
## 5 Line Detector

Feb - Dec 2007

140 active days

- Upper limit on the total  $\Phi(\nu_\mu + \bar{\nu}_\mu)$  from neutralino annihilation in the Sun

No discovery  $\implies$  90% CL flux limit



Various detector  
configurations

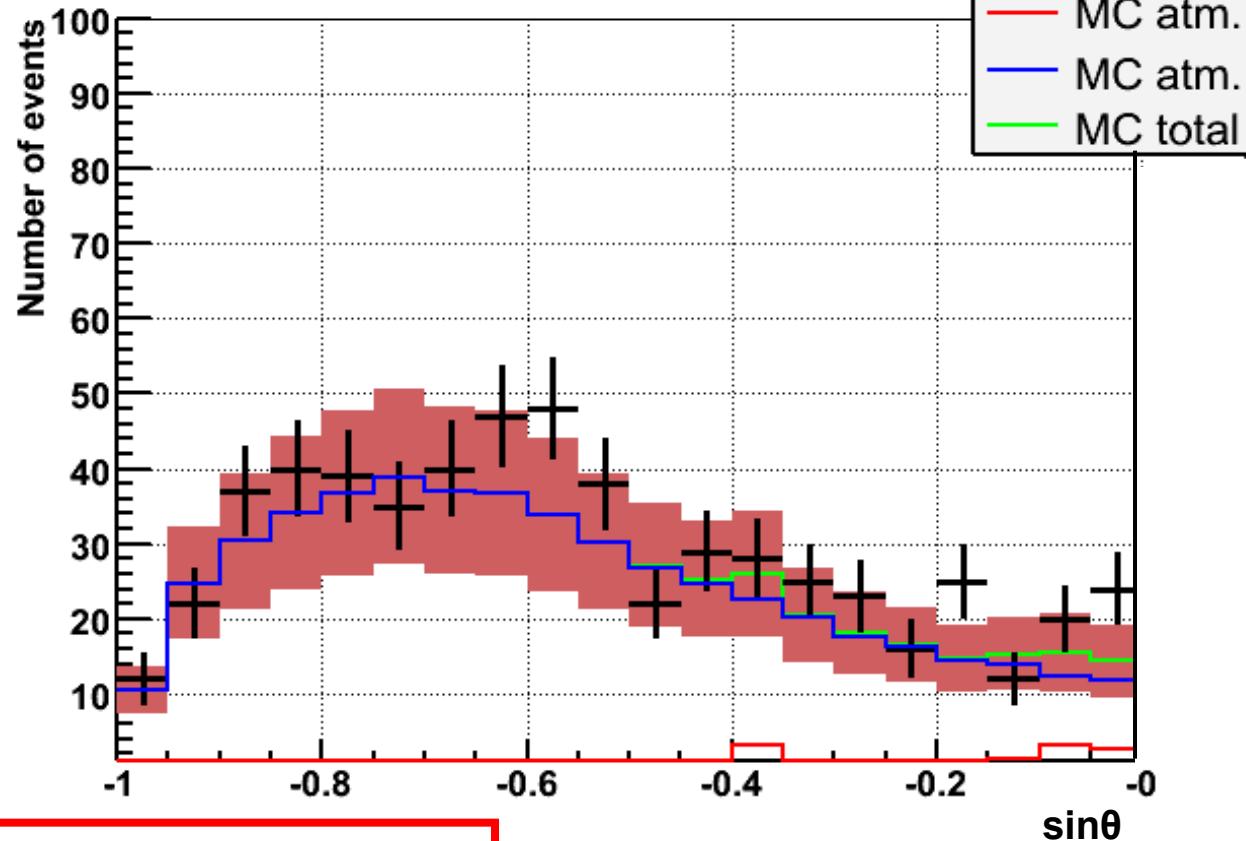
Dec 2007 – Dec 2008

173 active days

# Preliminary analysis of 2008 data



Elevation



Data: 582

MC:  $494 \pm 148$  (theor+syst)

# Conclusion

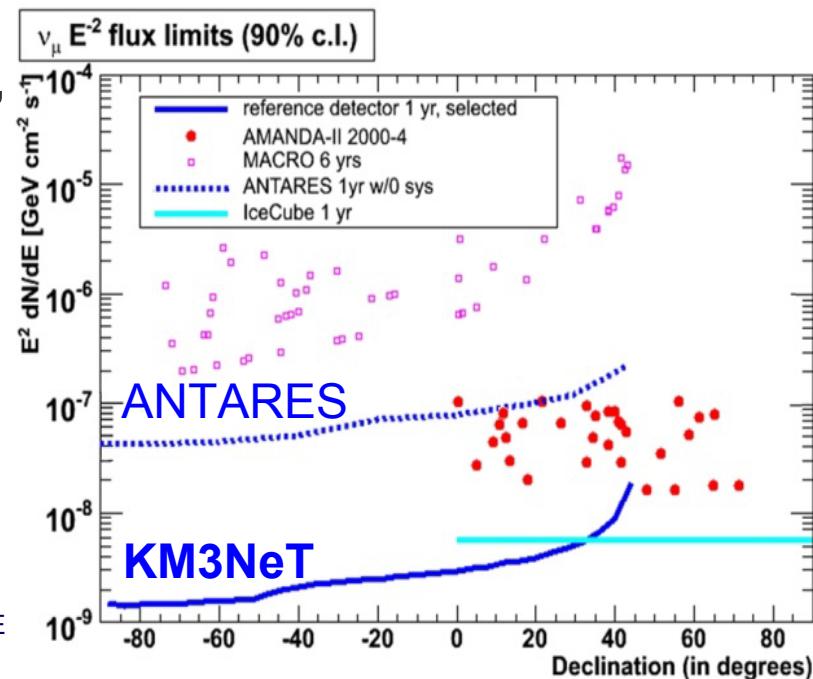


## ● ANTARES today

- Successful end of construction phase
  - Technology proven
  - Data taking ongoing
- First physics outputs
  - Atmospheric  $\mu$  and  $\nu$ , cosmic neutrino source and dark matter limits
  - To come: magnetic monopoles, UHE neutrino interactions, ...

## ● On the road for the cubic kilometer detector in the Mediterranean Sea

- KM3NeT



# A view from the ANTARES control room

