



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA



# The ANTARES Neutrino Telescope

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on behalf of the ANTARES Collaboration

TeV 2007, Venezia, 27-31 August 2007

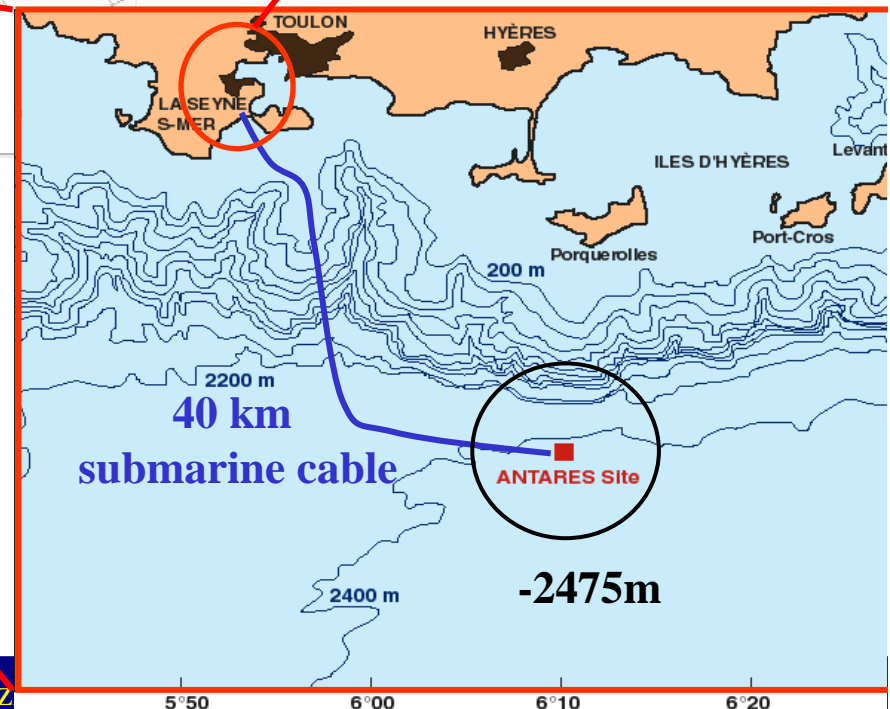


# ANTARES Collaboration & detector site

## ANTARES shore station



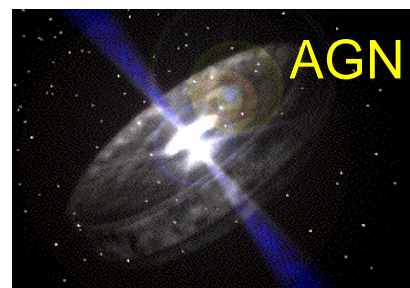
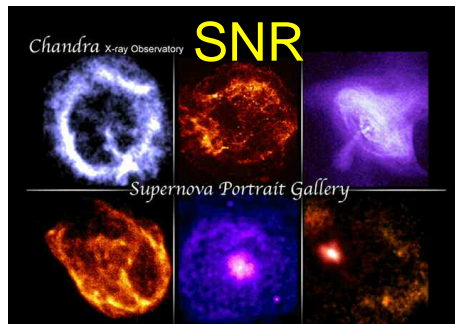
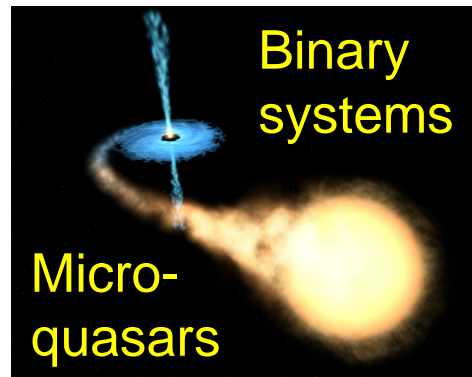
23 Institutes from  
7 European countries



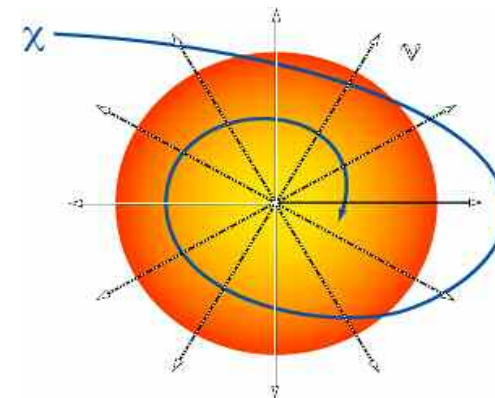


# Scientific goals

Search for galactic/extragalactic  $\nu$  sources:  
SN remnants, Galactic microquasars  
AGN, GRB, ...



New Physics:  
WIMPs annihilations, Monopoles...



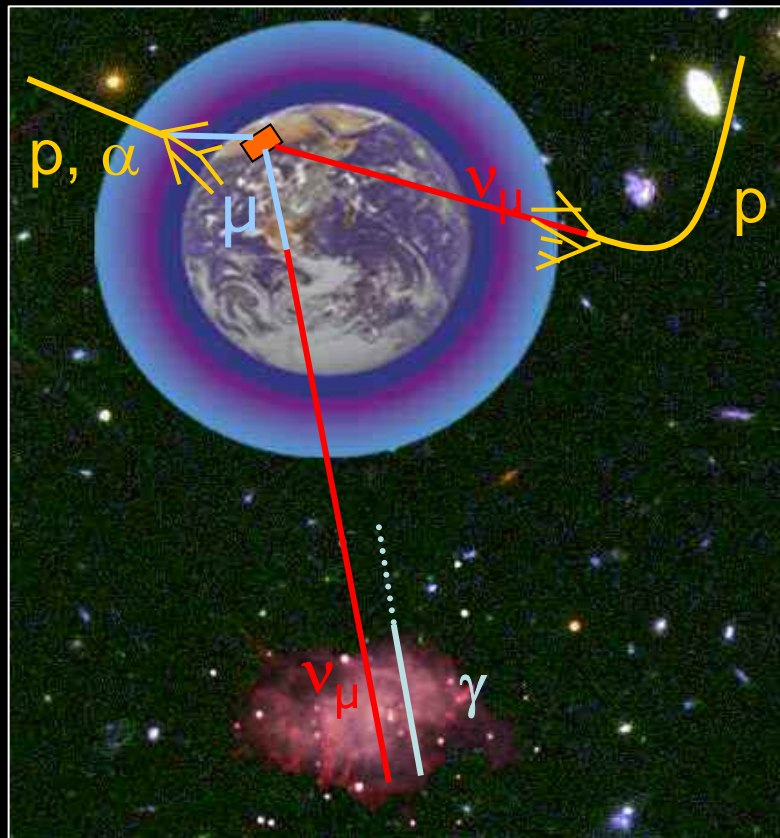
Neutralino Annihilation



Bioluminescent Organisms

Deep Sea Studies:  
oceanography, biology, seismology

# Neutrino telescope: Detection principle



Cherenkov light from  $\mu$

3D PMT array

Sea floor

$\gamma_c$

$43^\circ$

interaction

$\mu$

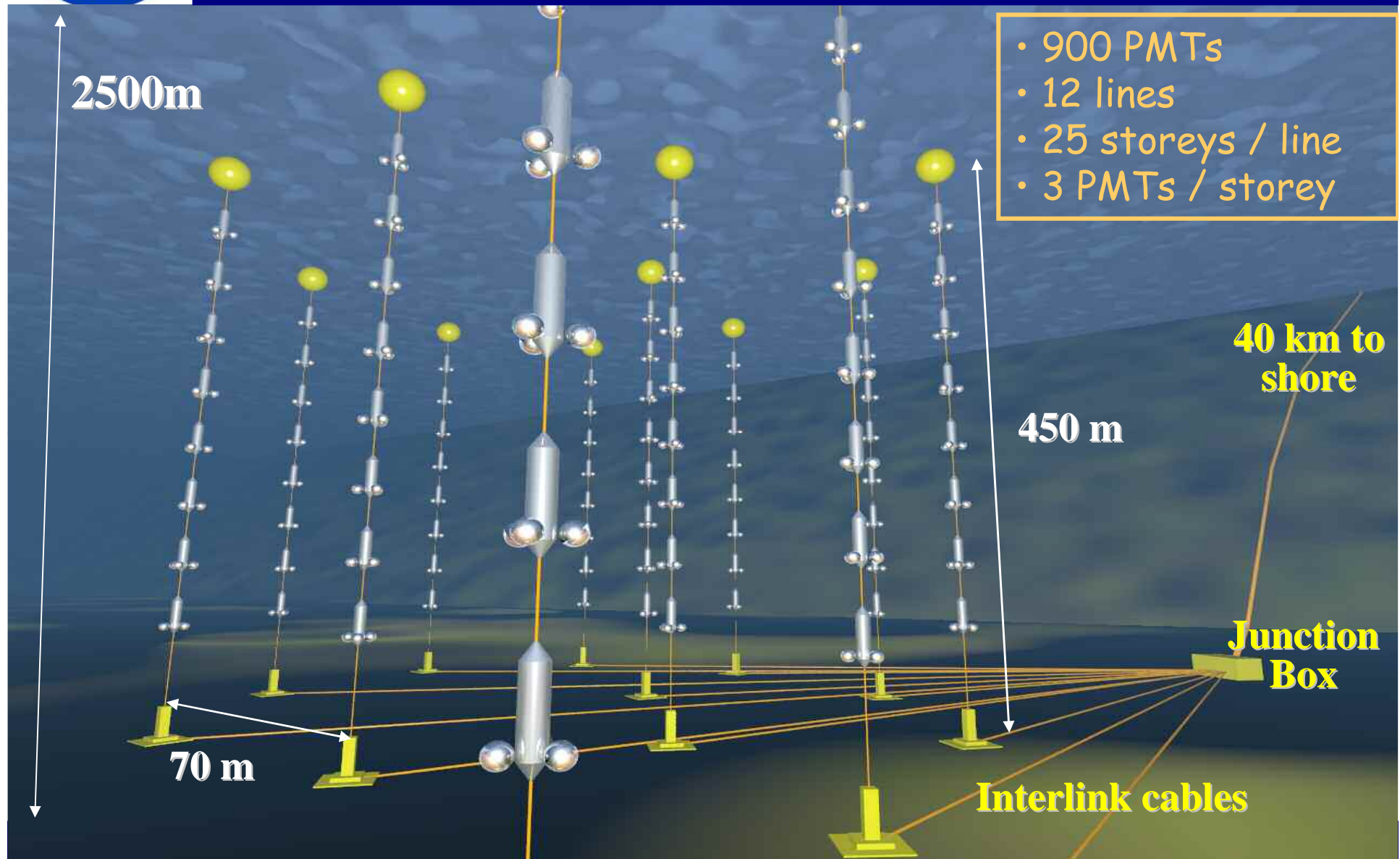
$\nu$

Reconstruction of  $\mu$  trajectory ( $\sim \nu$ )  
from **timing and position** of PMT hits





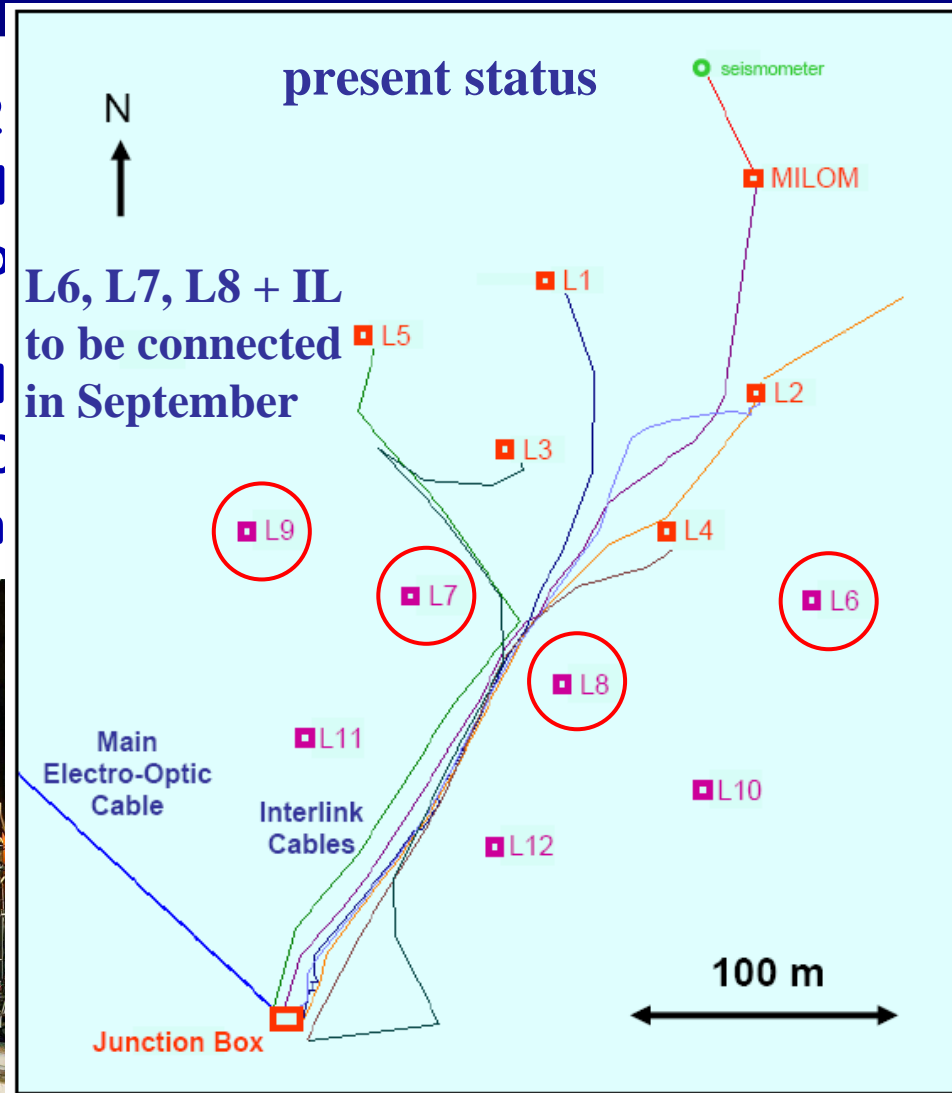
# The ANTARES detector



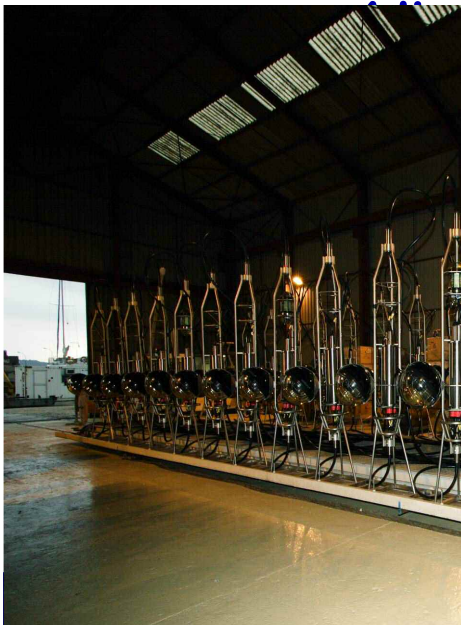


# ANTARES Construction Milestones

- 1996 – 2002
- 2001 : instal
- 2002 : depla
- April 2005 : Optical Mod
- January 200
- Today : 5 lin



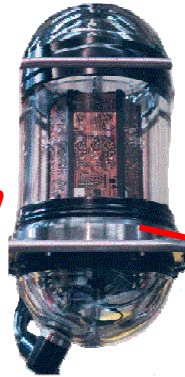
al cable.



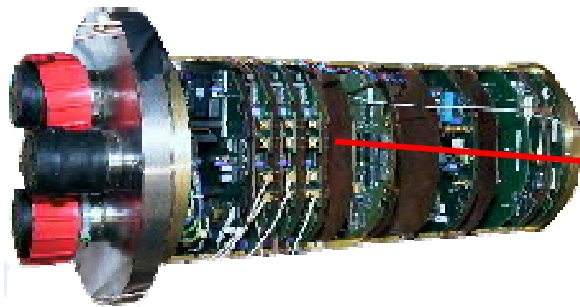


## Basic detector element: storey

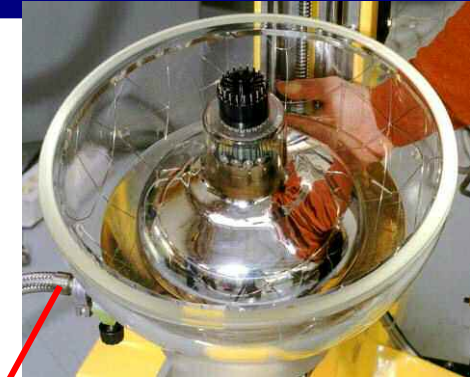
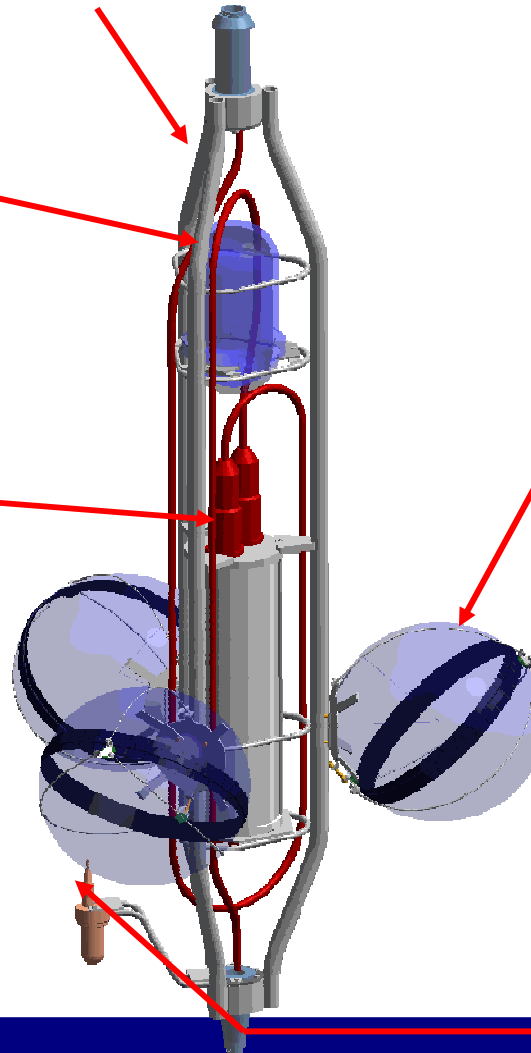
Optical Beacon  
with blue LEDs:  
*timing calibration*



titanium frame: *support structure*



Local Control Module  
(in Ti cylinder):  
*Front-end ASIC,  
DAQ/SC, DWDM,  
Clock, tilt/compass,  
power distribution...*



Optical Module:  
10" Hamamatsu PMT  
in 17" glass sphere  
( $\sigma_{\text{TTS}} \approx 1.3 \text{ ns}$ )  
*photon detection*

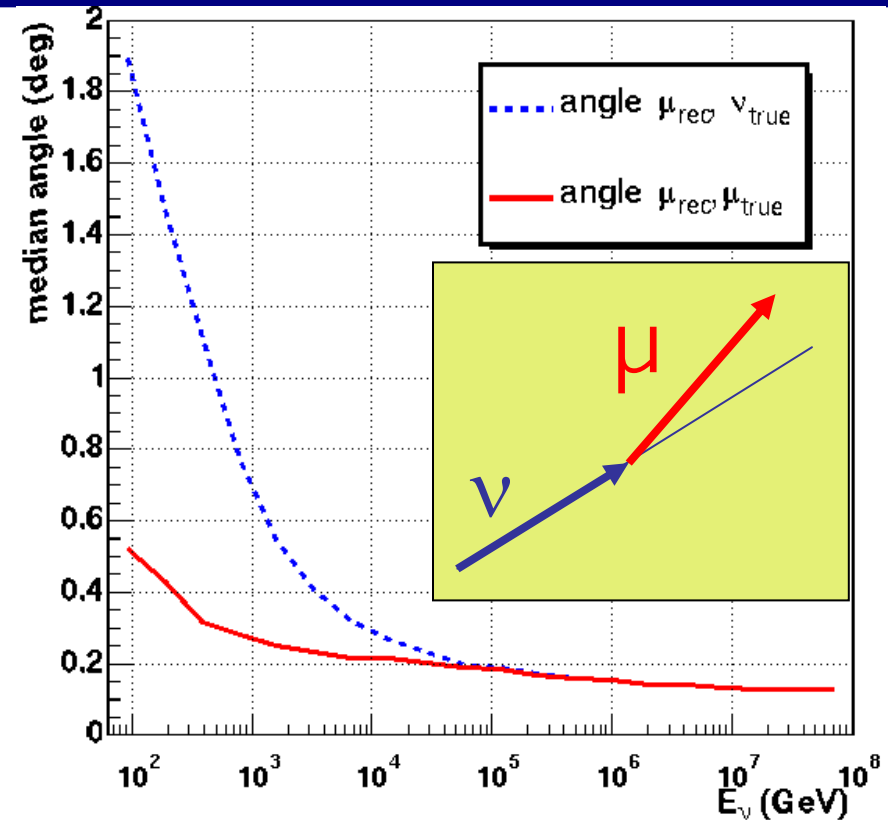
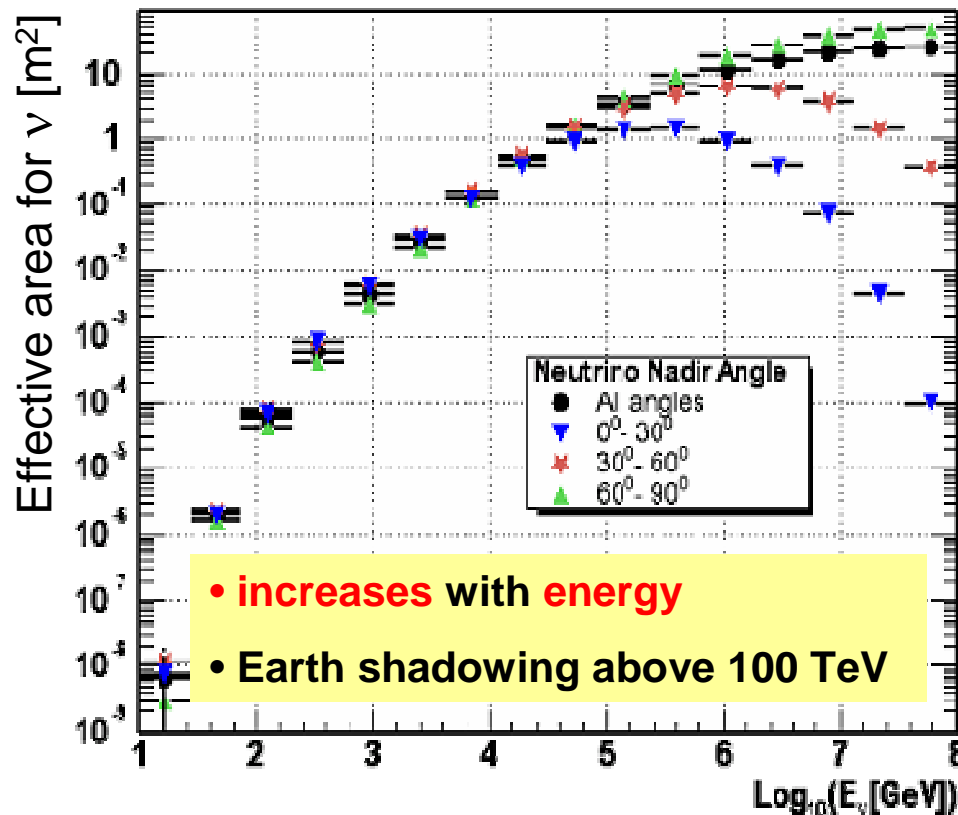


Hydrophone:  
*acoustic positioning*





# Expected performance (MC Studies)



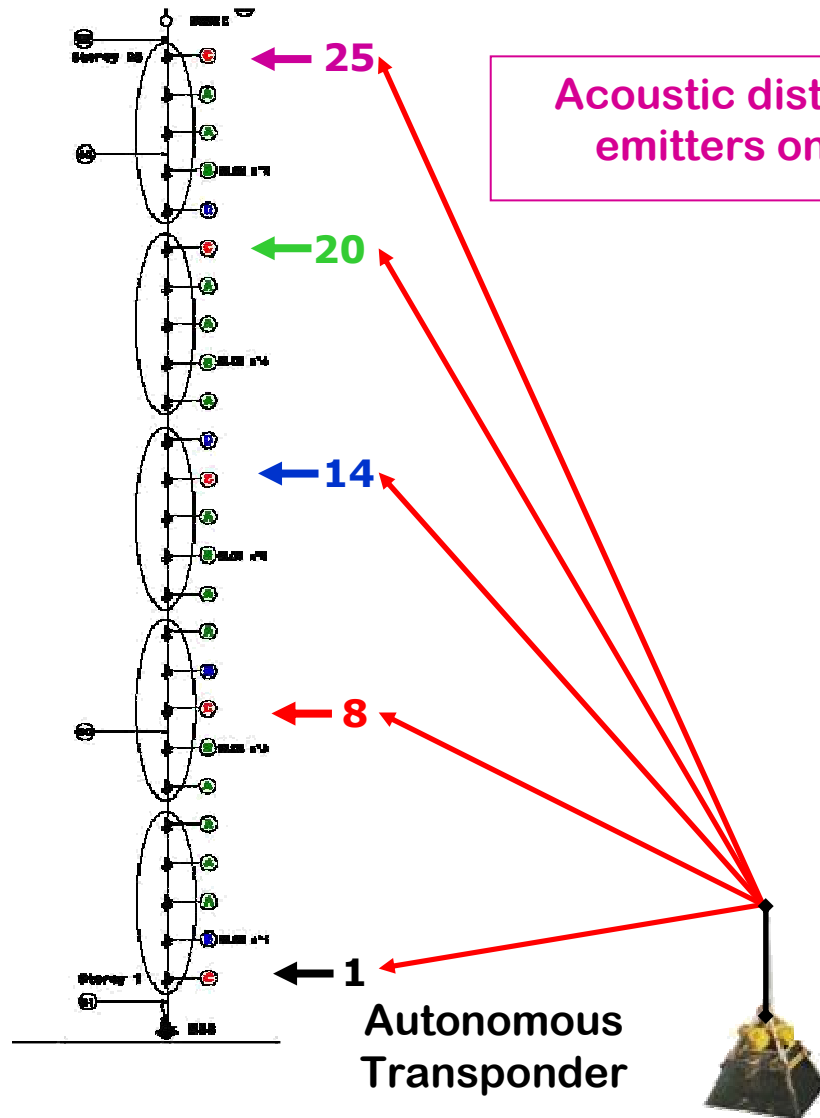
Angular resolution better than  $0.3^\circ$  above a few TeV, limited by:

- Light scattering + chromatic dispersion in sea water:  $\sigma \sim 1.0$  ns
- TTS in photomultipliers:  $\sigma \sim 1.3$  ns
- Electronics + time calibration:  $\sigma < 0.5$  ns
- OM position reconstruction:  $\sigma < 10$  cm ( $\leftrightarrow \sigma < 0.5$  ns)



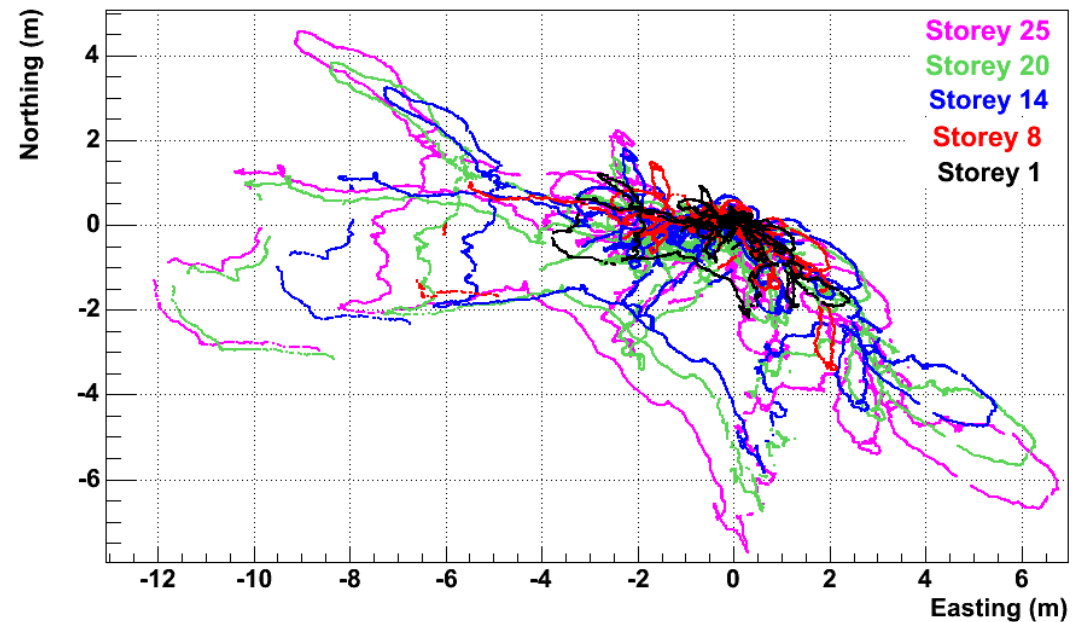


# Data from acoustic positioning system



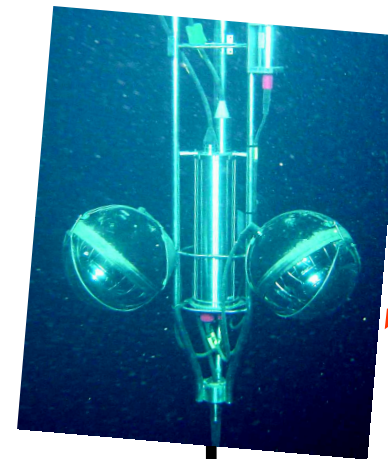
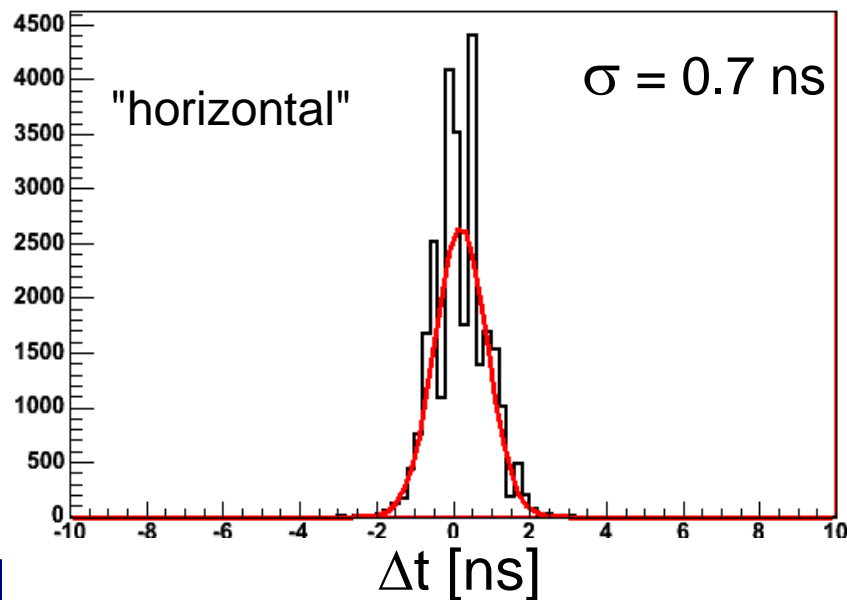
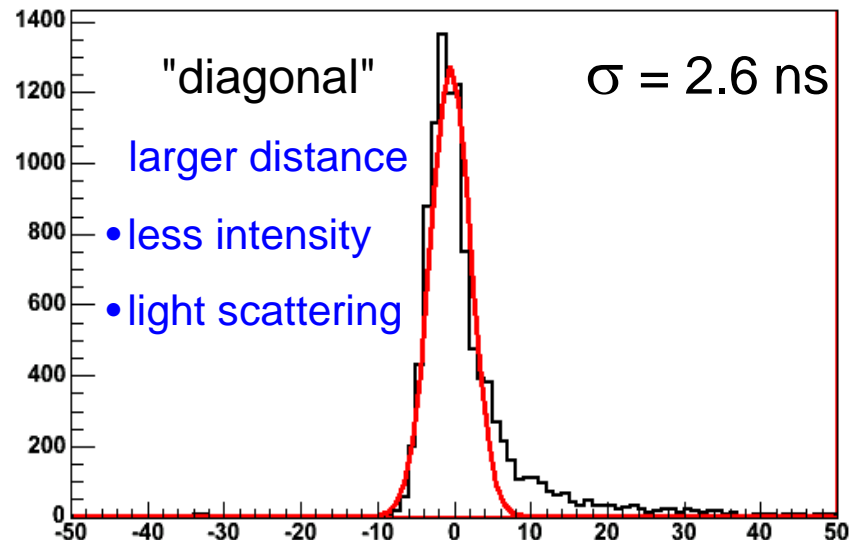
Acoustic distance measurement of hydrophones from fixed emitters on MILOM anchor + autonomous transponders

## Position of hydrophone relative to line base location





# Time calibration with LED beacons

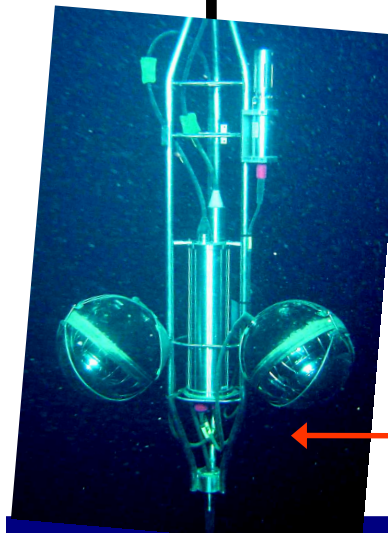


Line 1

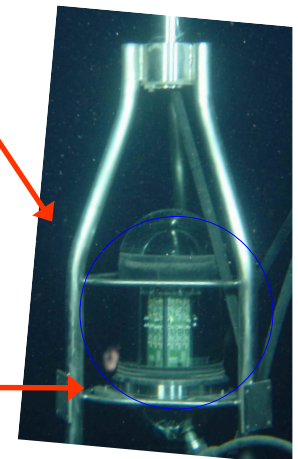
all timing measurements in good agreement with expectations

~150 m

Line 2



~70 m

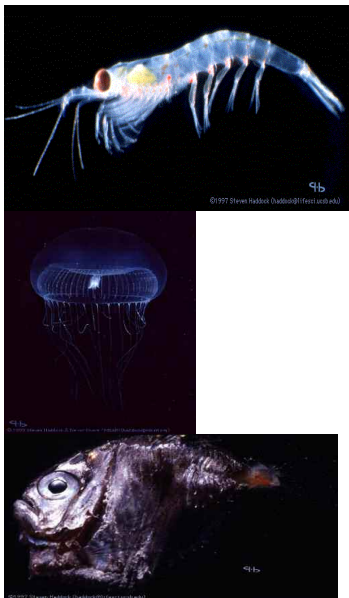




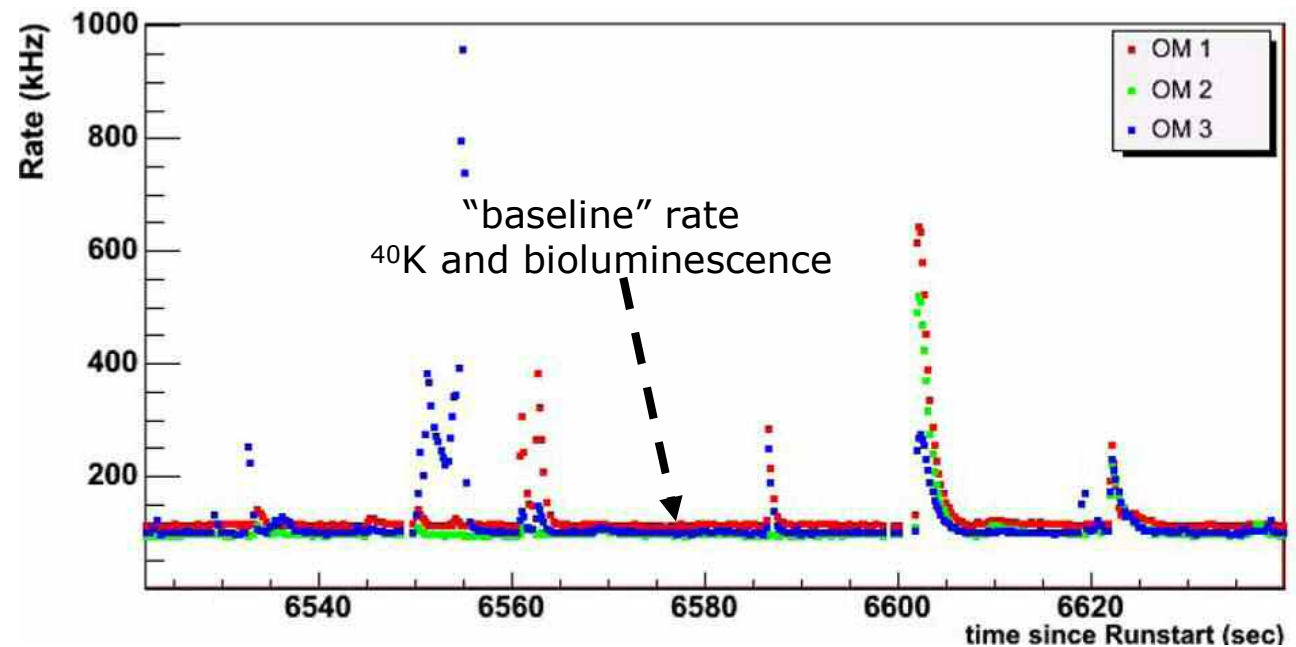
# Background sources

## Baseline + bursts:

- Baseline: a)  $^{40}\text{K}$  decays  
b) bioluminescence from microorganisms and bacteria
- Bursts from other marine organisms (strongly affected by current velocity)



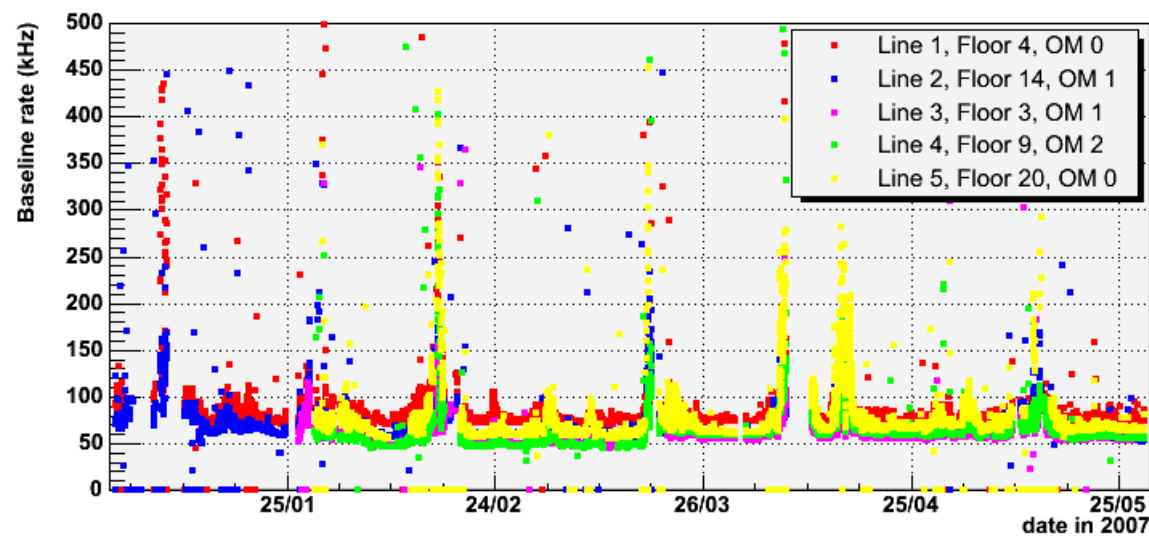
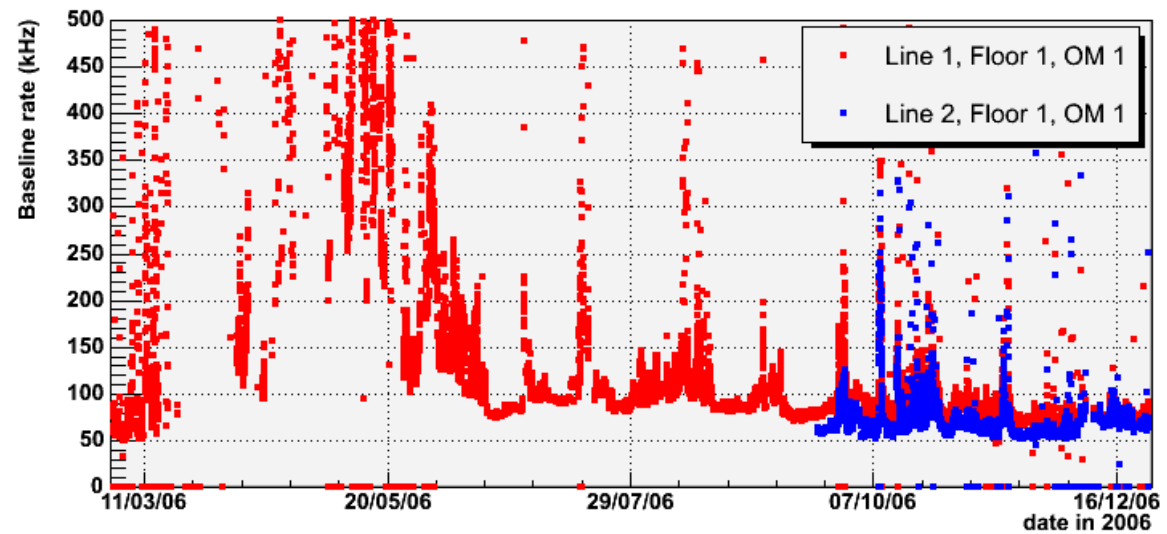
bursts





# Bioluminescence rates

2006

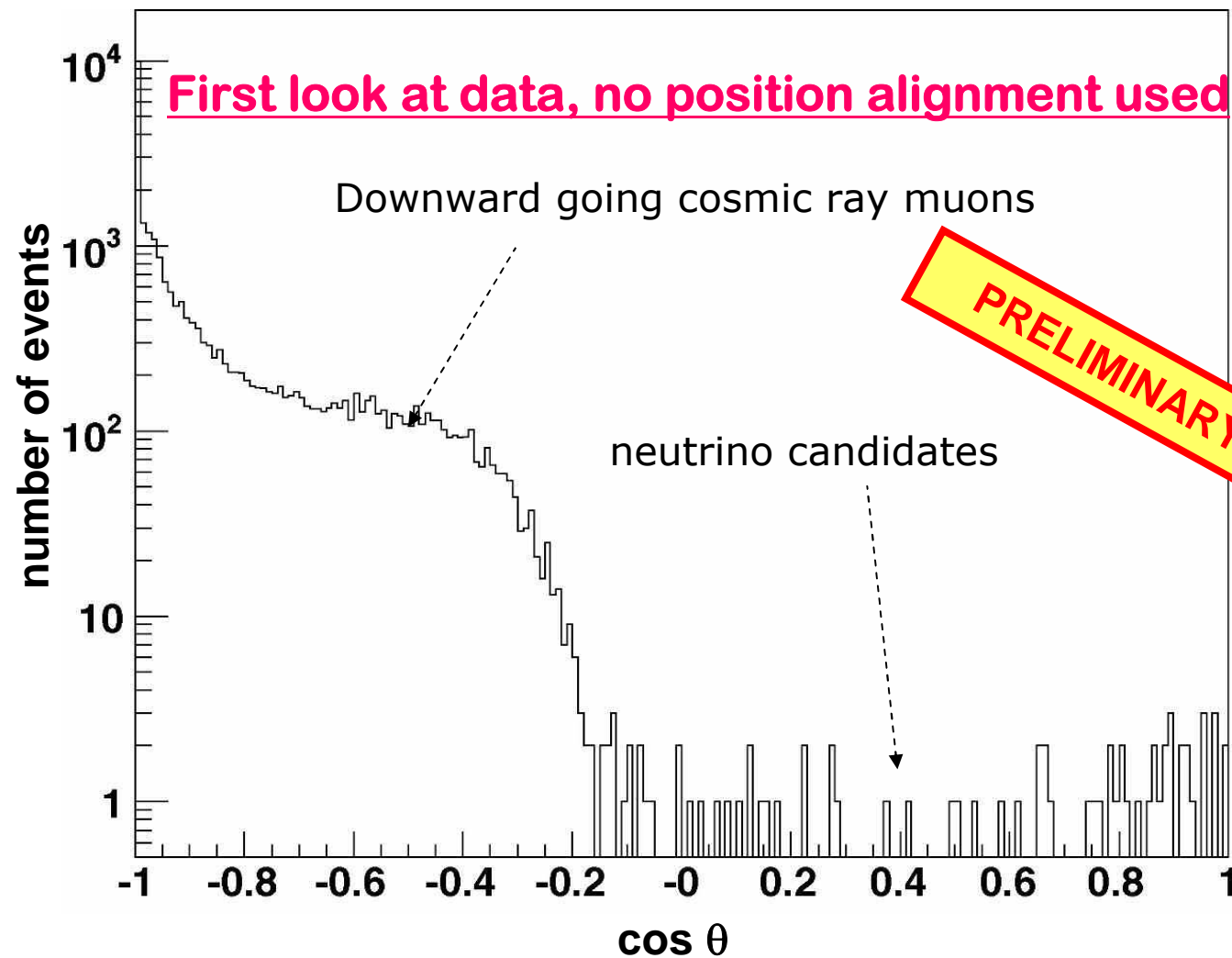


2007



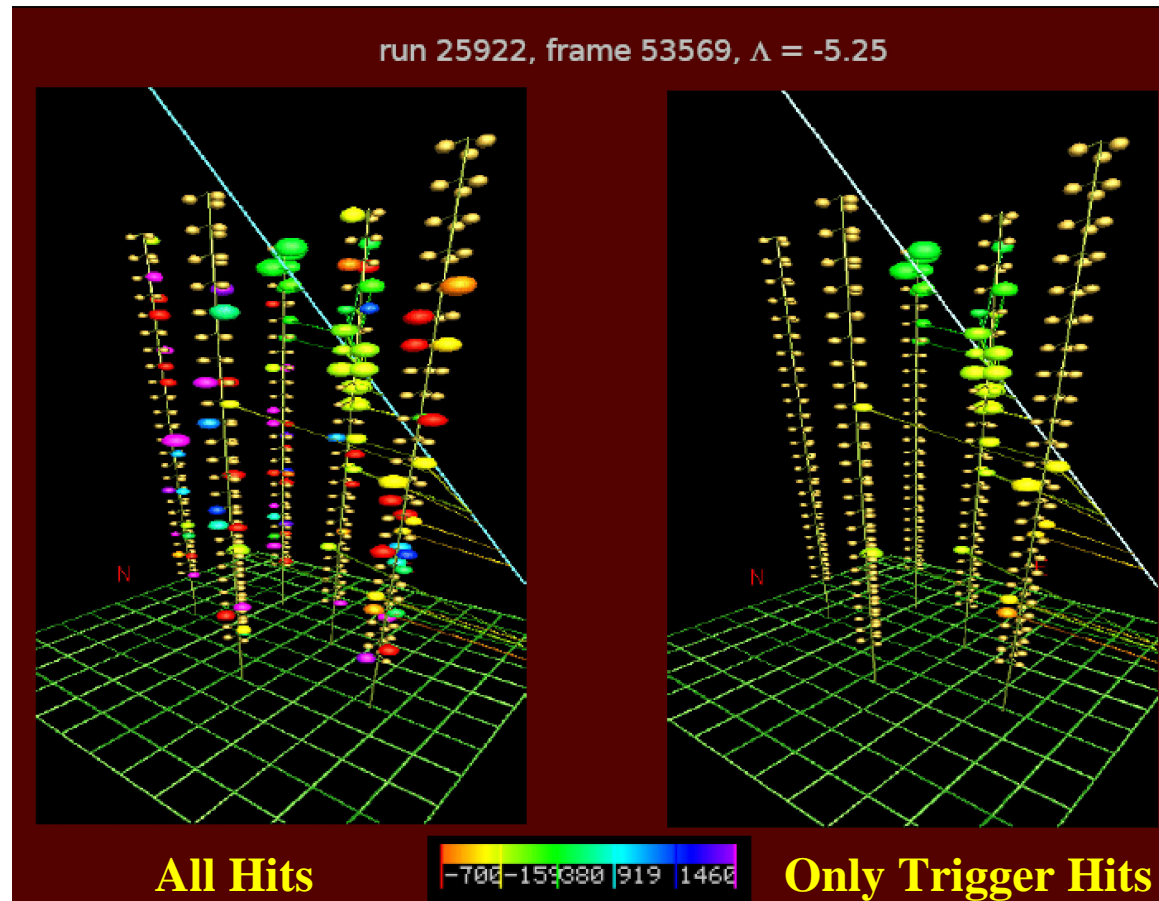


# Zenith angle distribution





# Candidates Neutrinos (I)

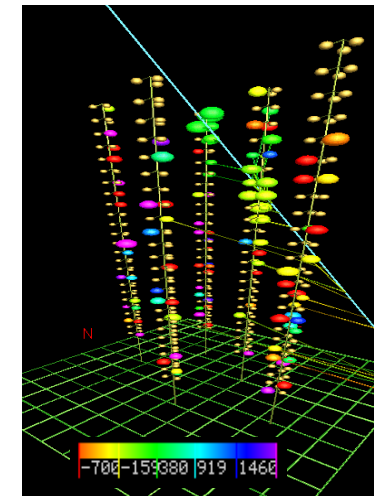
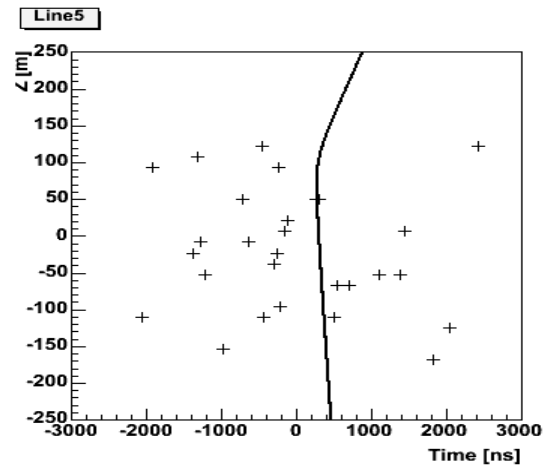
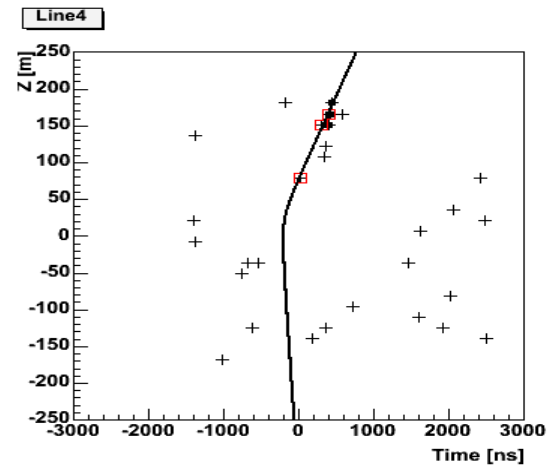
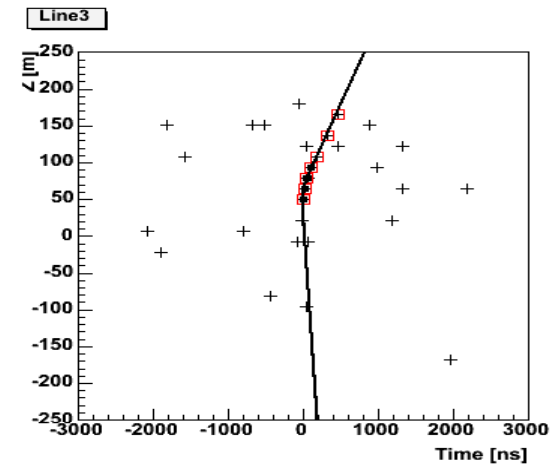
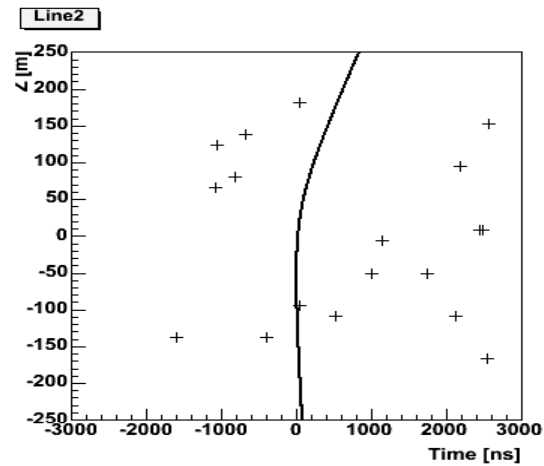
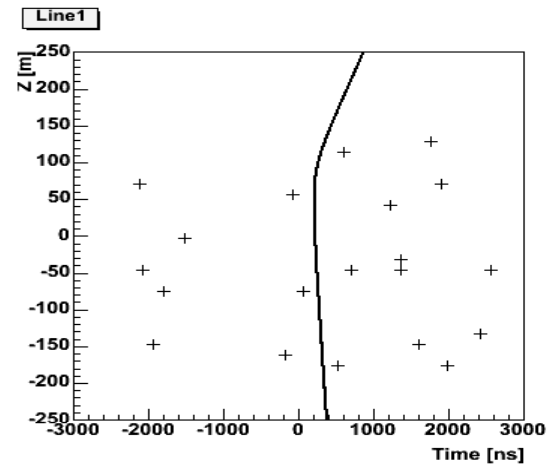




# Candidates Neutrinos (I) reconstruction

Run : 25922 Event : 3474 FrameTarget : 0 FrameIndex : 53569  
a: -53.897 b: 20.9544 t0: 57589859.58  $\theta$ : 0.96013  $\phi$ : 2.1613 # fits : 13

$\Theta = 55^\circ$





## Summary and conclusions

- Half the ANTARES detector complete
- Already the largest neutrino detector in Northern Hemisphere
- First data very encouraging
- Much work in progress to get physics results
- 5 lines connected and operative since January 2007  
4 lines deployed (+ Instrumentation Line) : to be connected in September

**Completion expected early 2008**



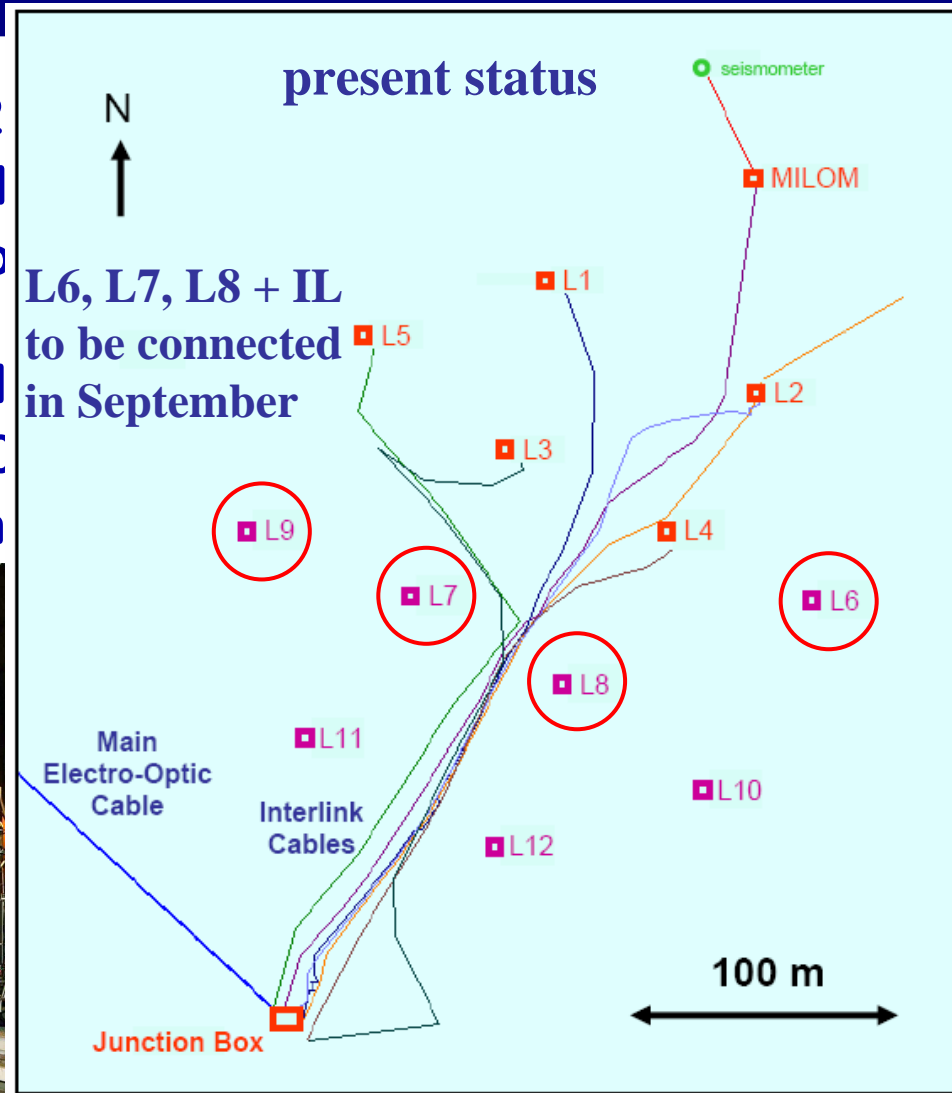






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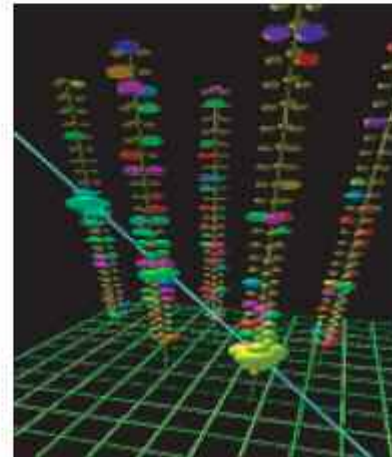
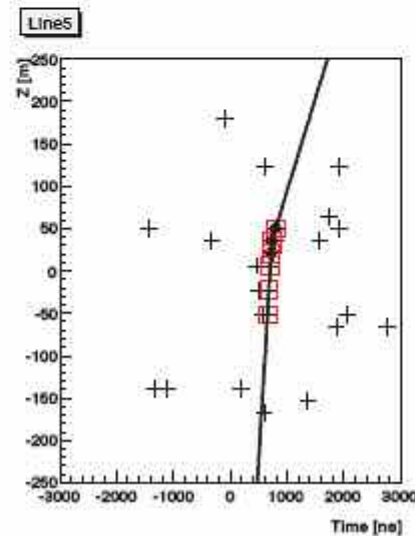
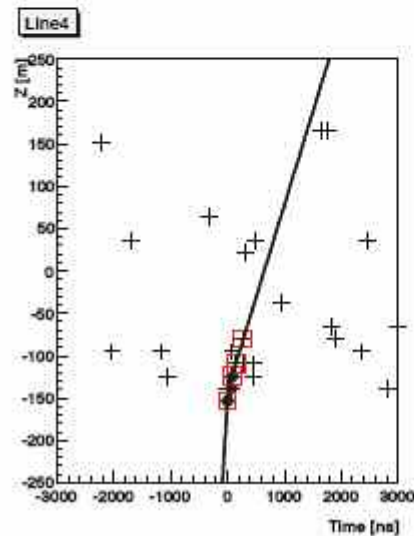
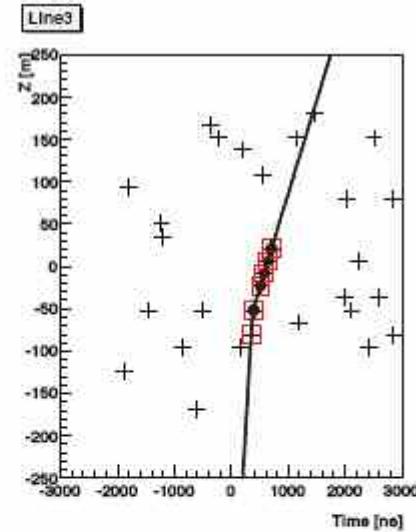
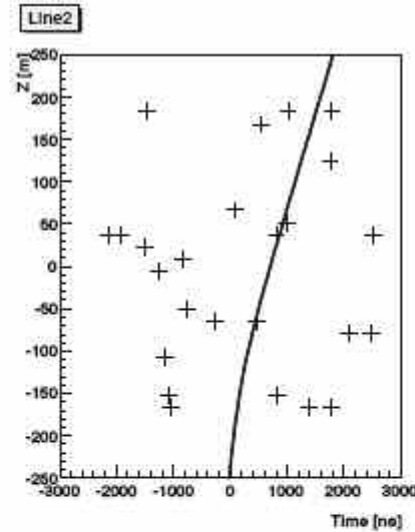
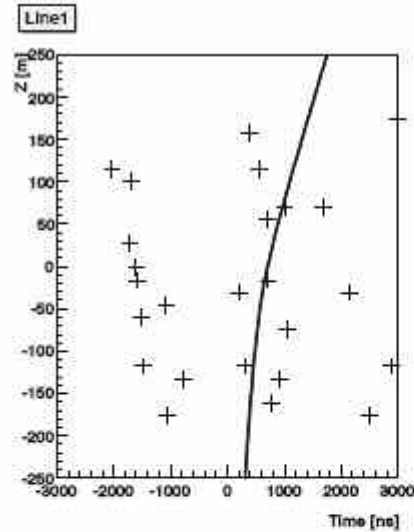




# Candidates Neutrinos (II)

Run : 25929 Event : 6742

$\Theta = 35^\circ$







# Region of sky observable by neutrino telescopes

AMANDA (South Pole)

ANTARES (43° North)

under ice → less light background

under water → better angular resolution

