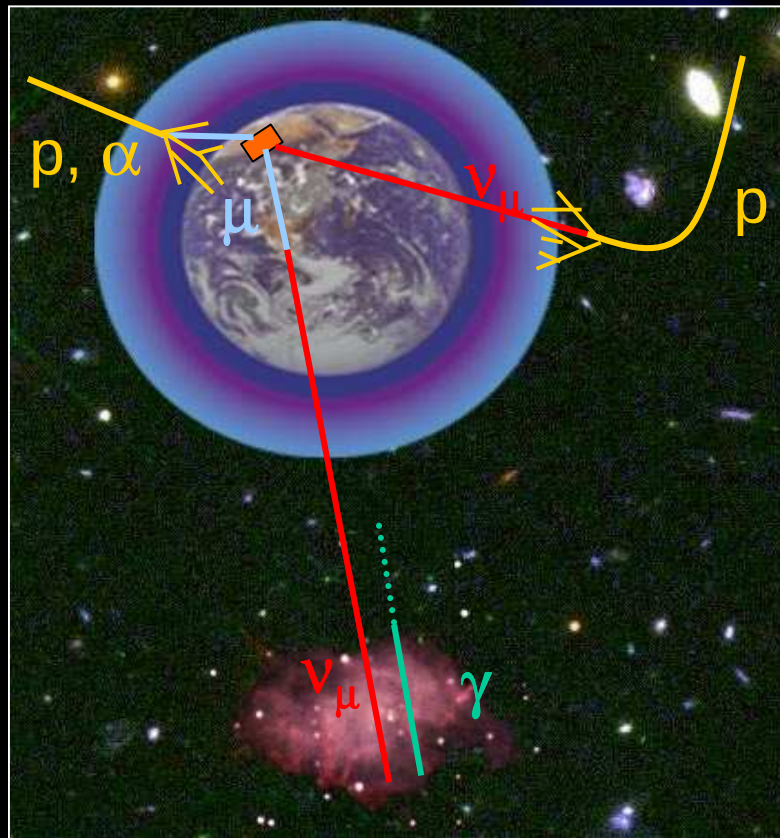


The ANTARES Neutrino Telescope

Jürgen Brunner - CPPM-Marseille
on behalf of the ANTARES Collaboration

Neutrino telescope: Detection principle



Cherenkov light from μ

3D PMT array

Sea floor

43°

γ_c

interaction

μ

ν

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

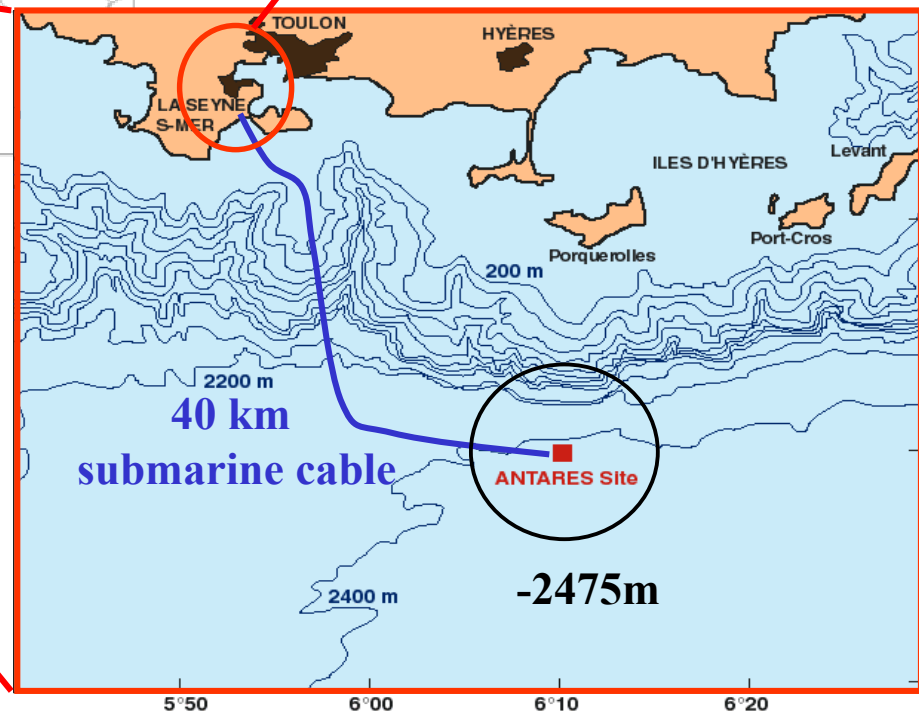
ANTARES Collaboration & detector site



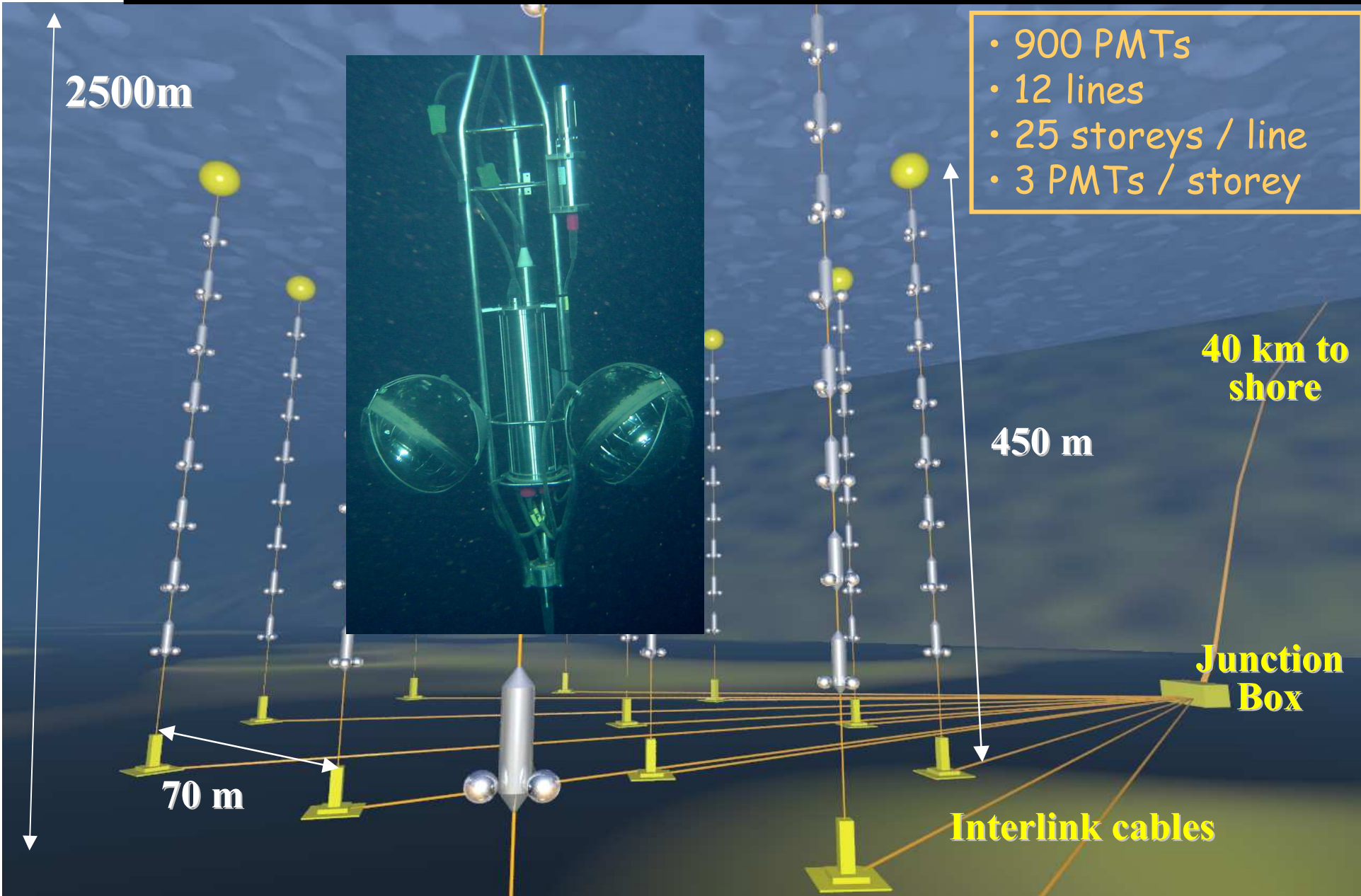
ANTARES shore station



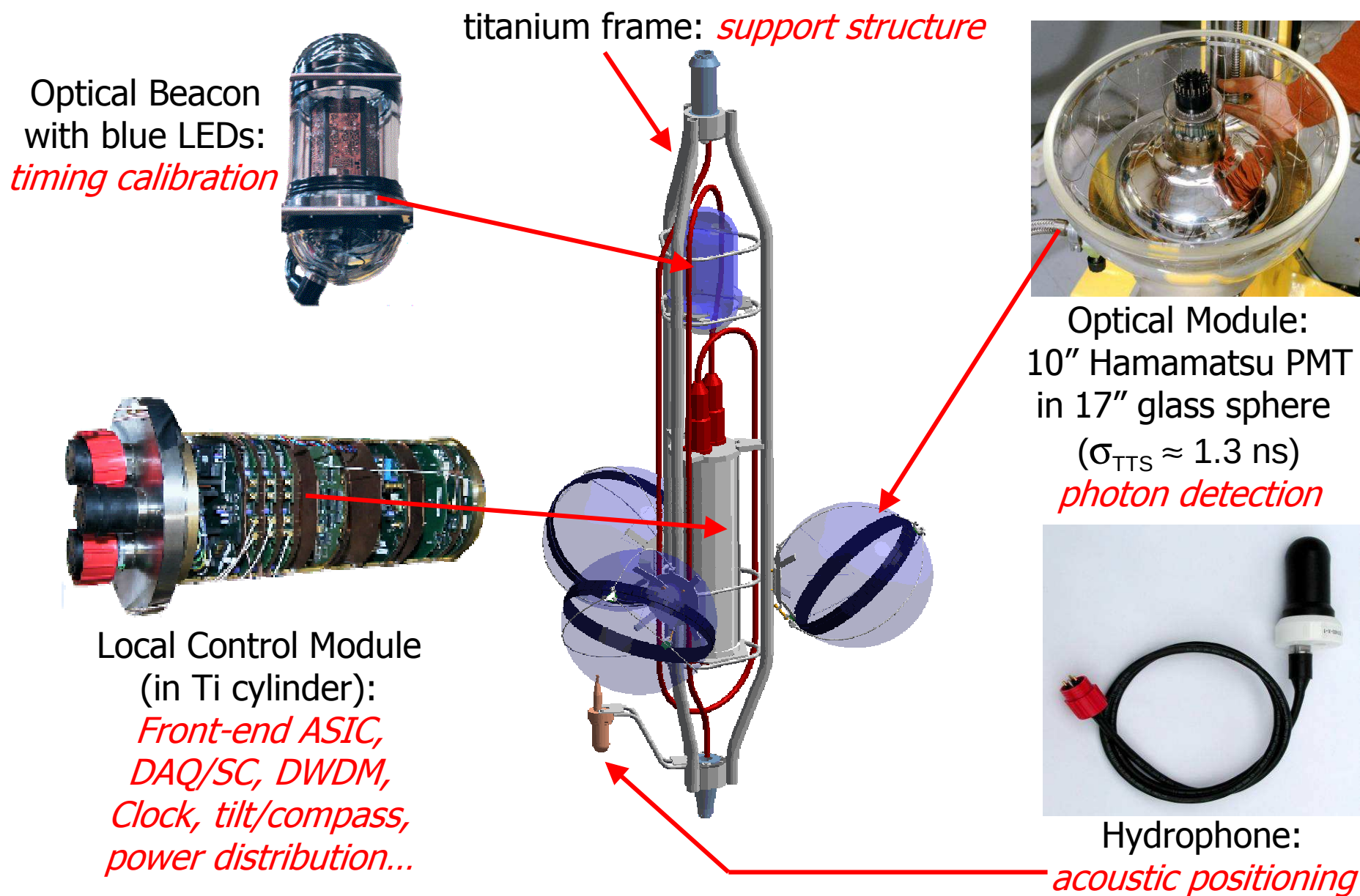
23 Institutes from
7 European countries



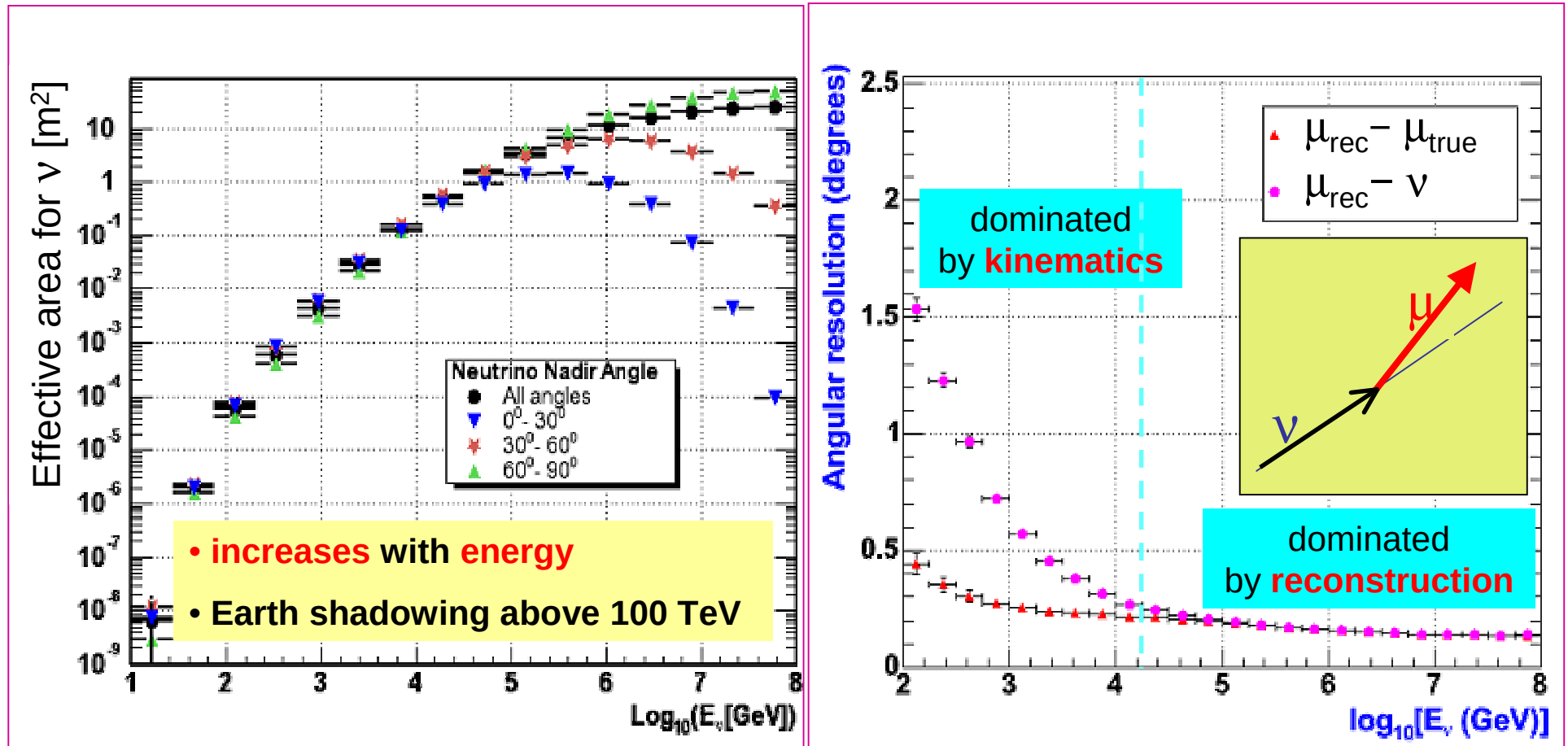
The ANTARES detector



Basic detector element: storey



Expected performance (MC Studies)



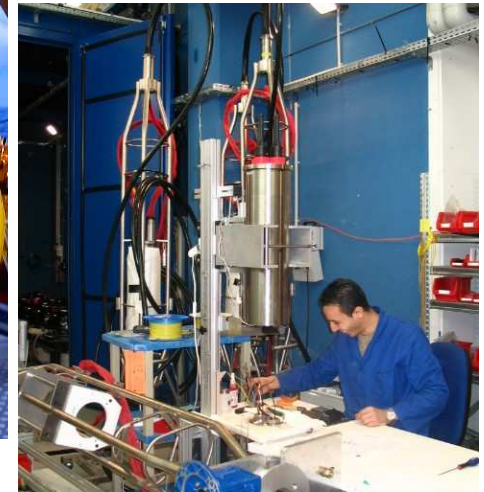
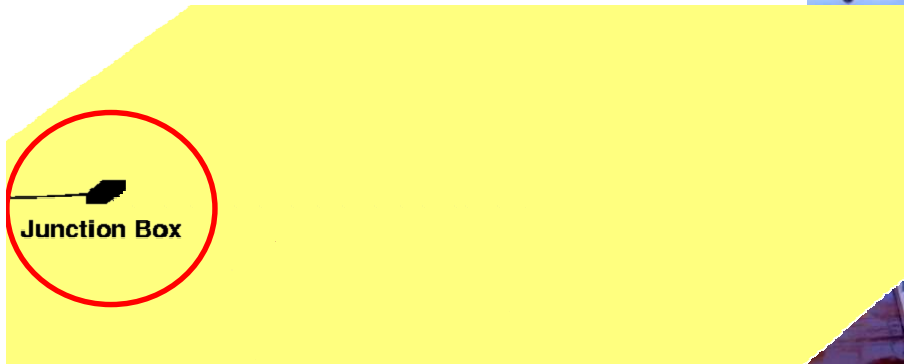
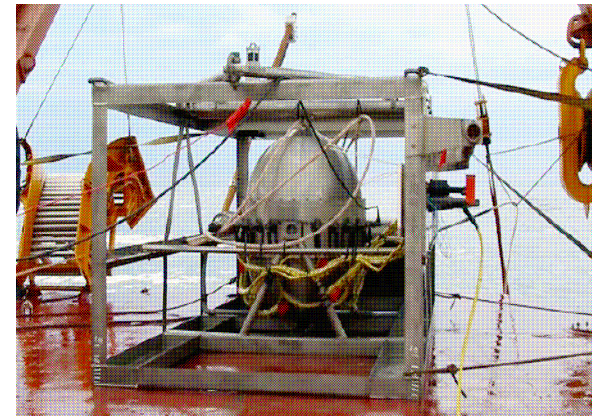
Angular resolution better than 0.3° above a few TeV, limited by:

- 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)

ANTARES Construction Milestones

2001 – 2003:

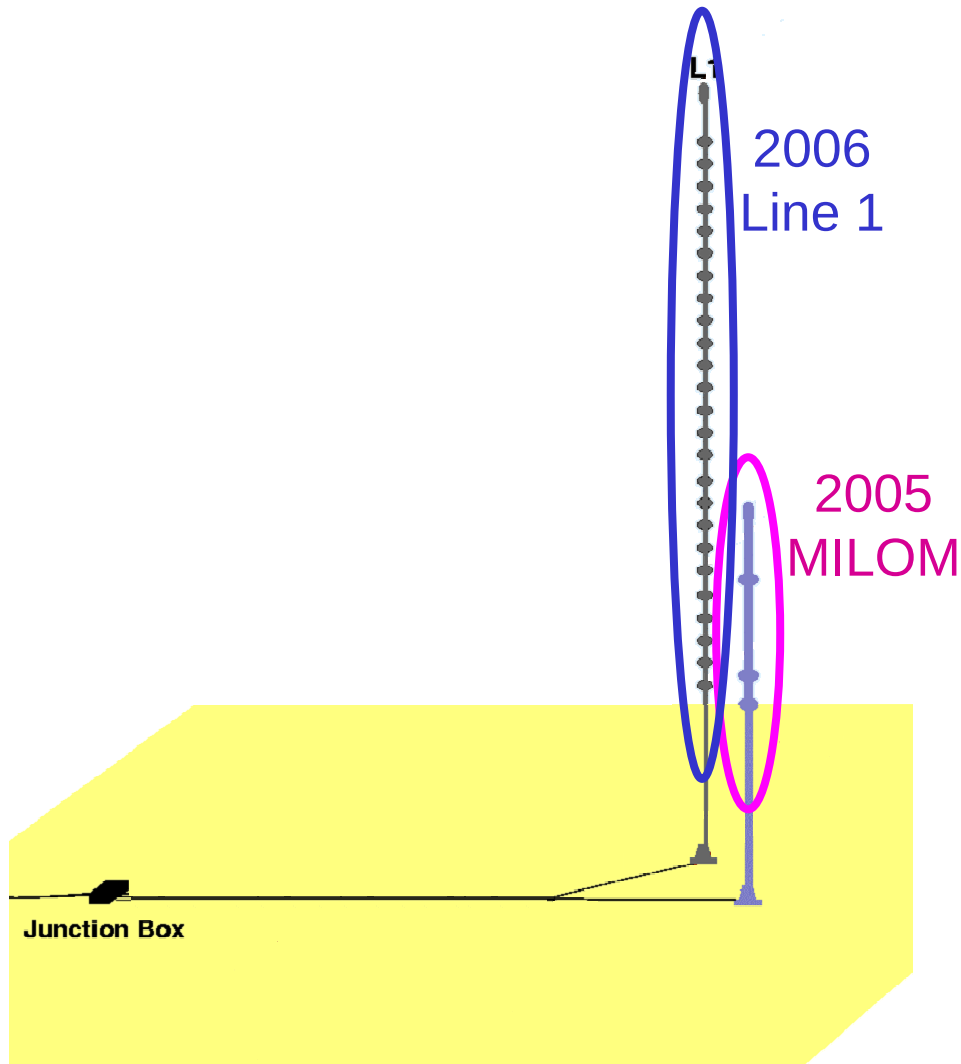
- *Main Electro-optical cable* in 2001
- *Junction Box* in 2002
- *Prototype Sector Line (PSL) & Mini Instrumentation Line (MIL)* in 2003



ANTARES Construction Milestones

2005 – 2006:

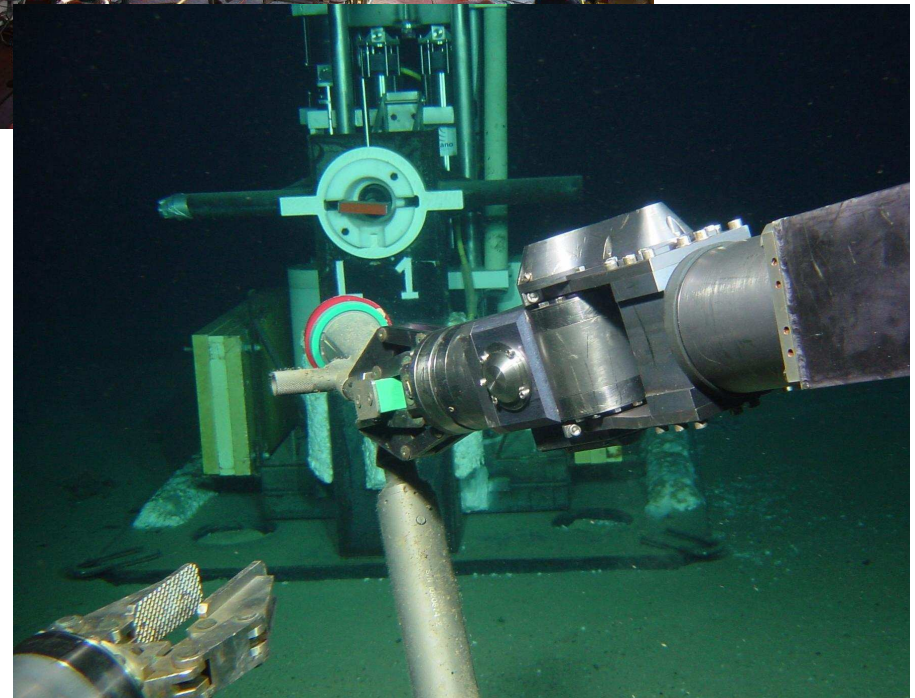
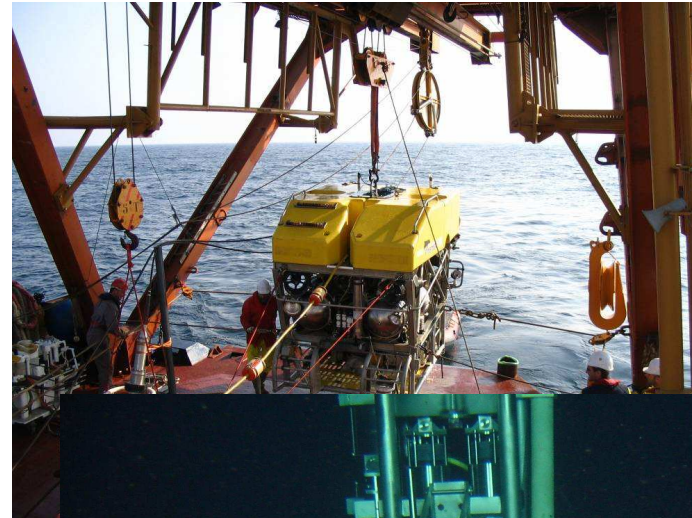
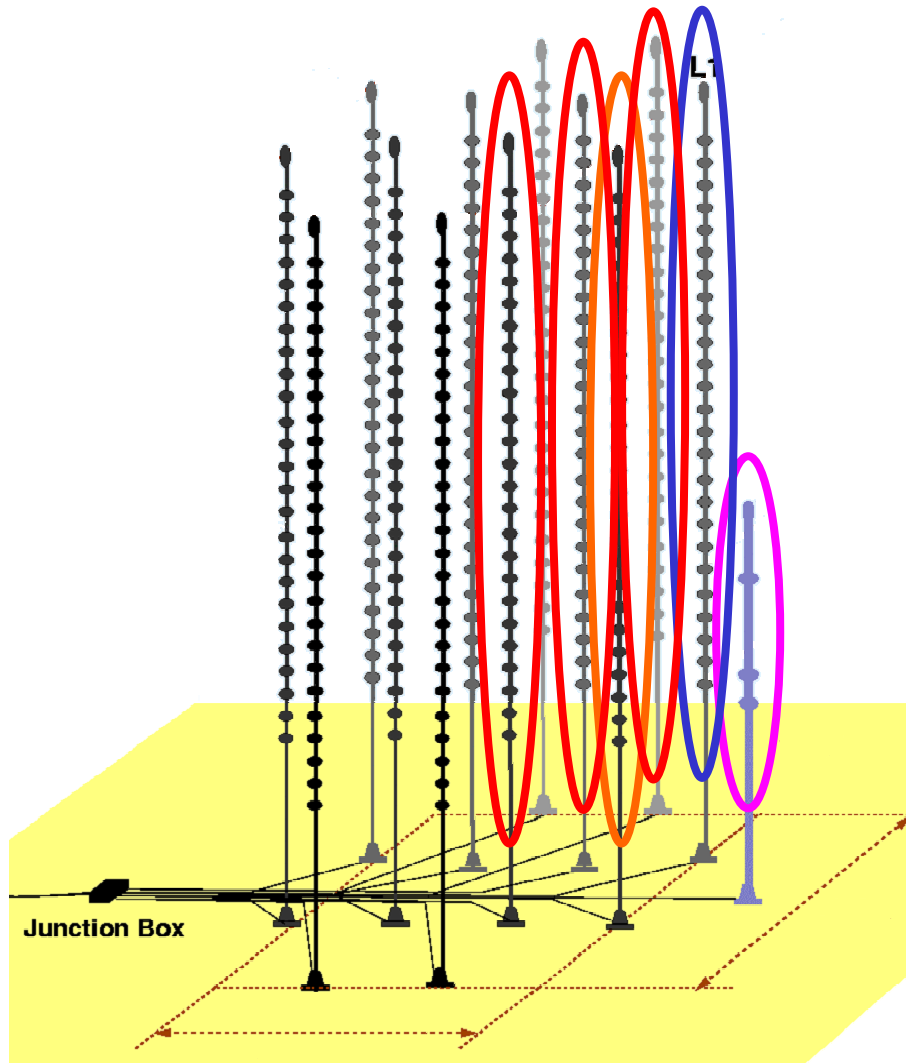
- *Mini Instrumentation Line with OMs (MILOM)* running since 12 April 2005
- *Line 1* connected March 2006,



ANTARES Construction Milestones

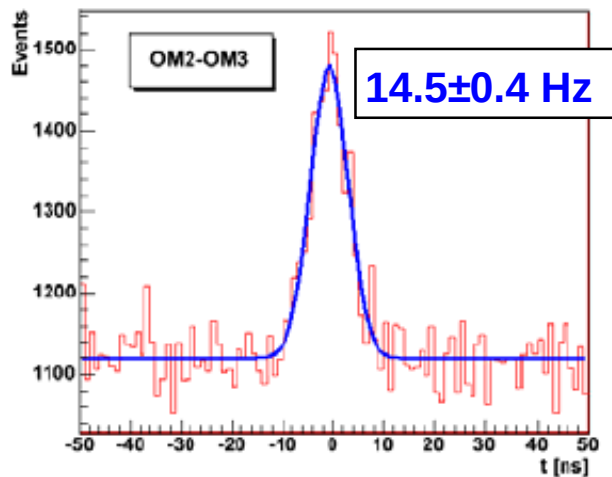
Last few months:

- *Line 2* connected September 2006
- *Lines 3,4,5* connected January 2007



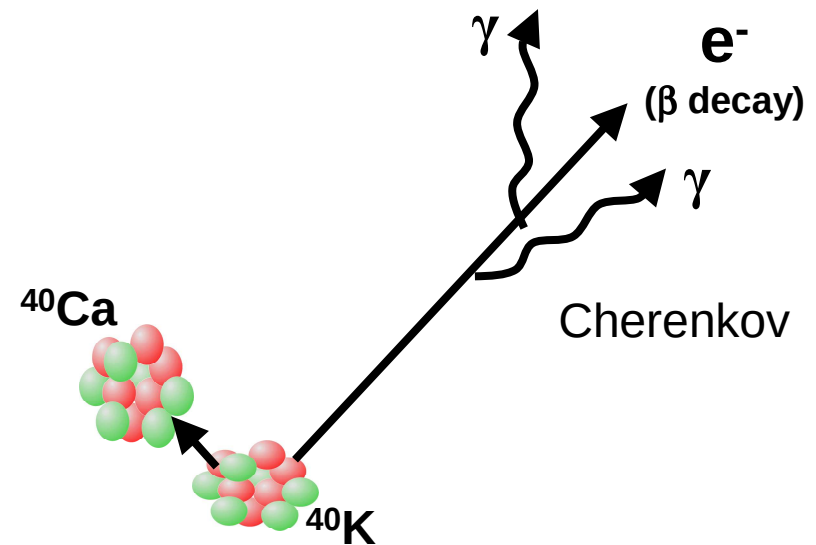
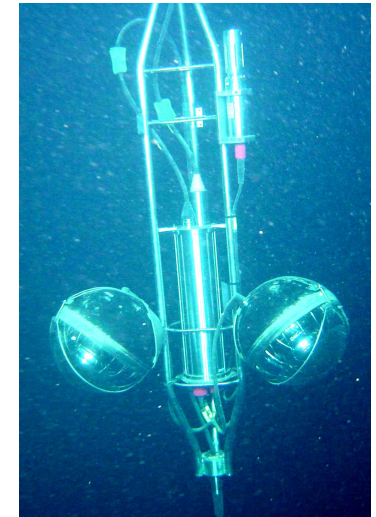
Coincidence rates from ^{40}K decays

^{40}K coincidence rate from Gauss fit:

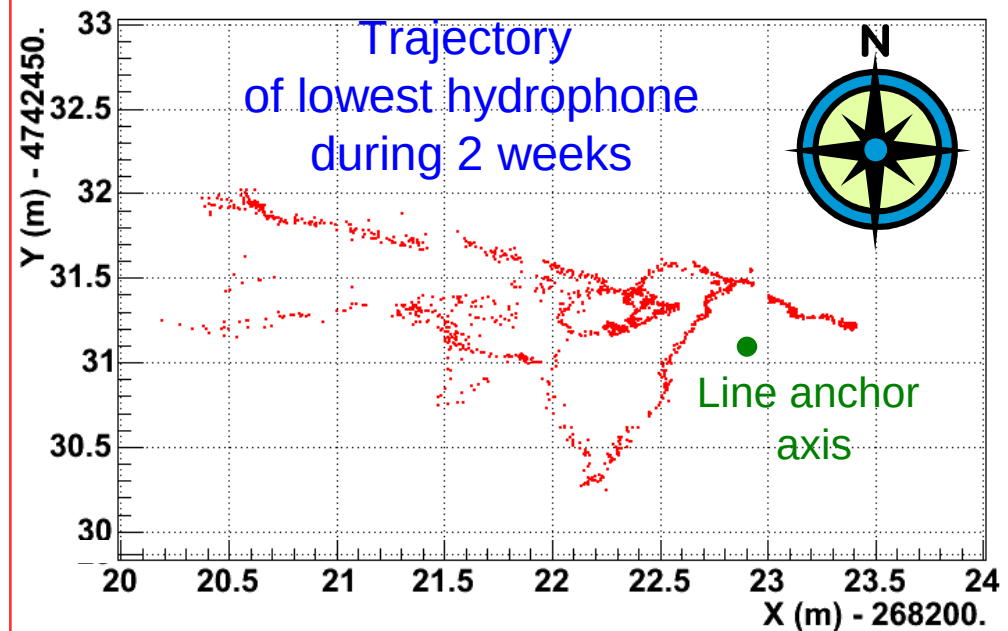
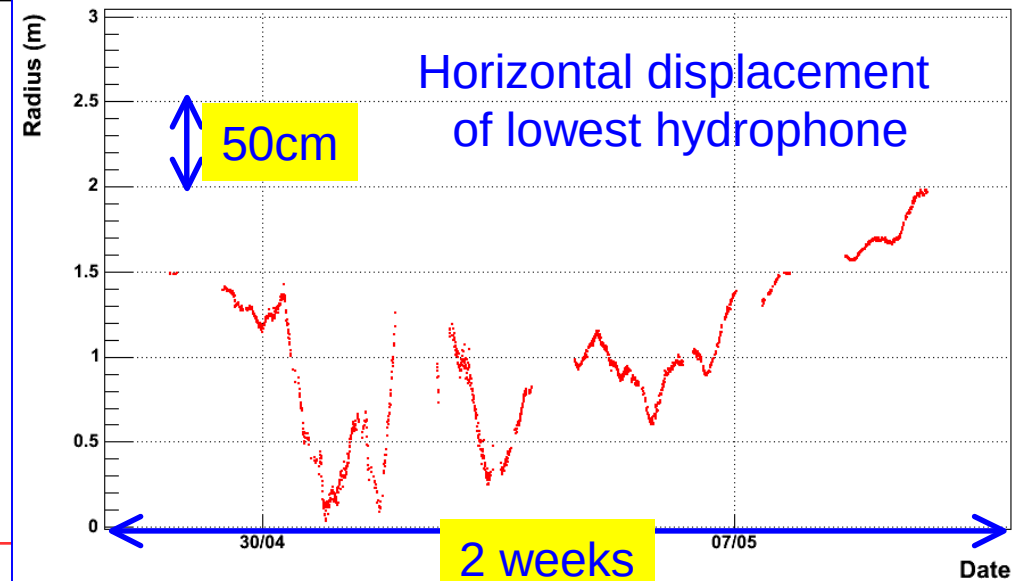
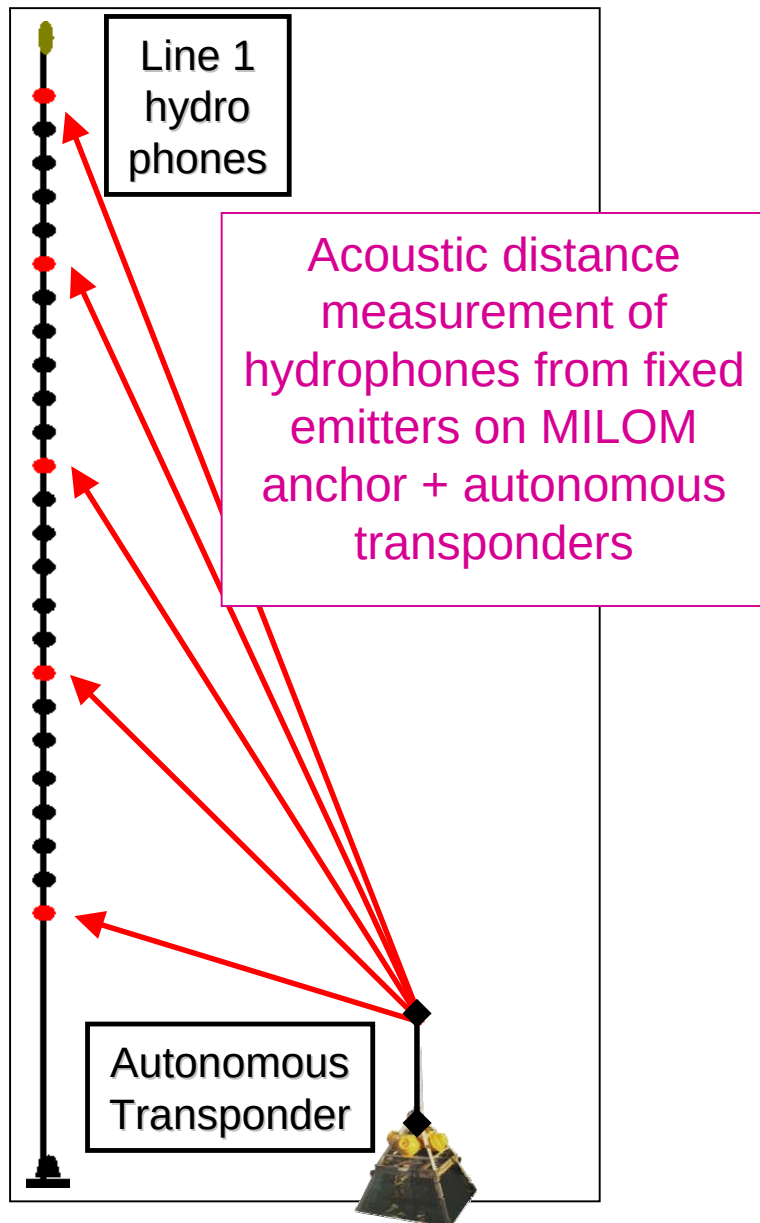


Simulation: $13 \text{ Hz} \pm 4 \text{ Hz (sys)}$

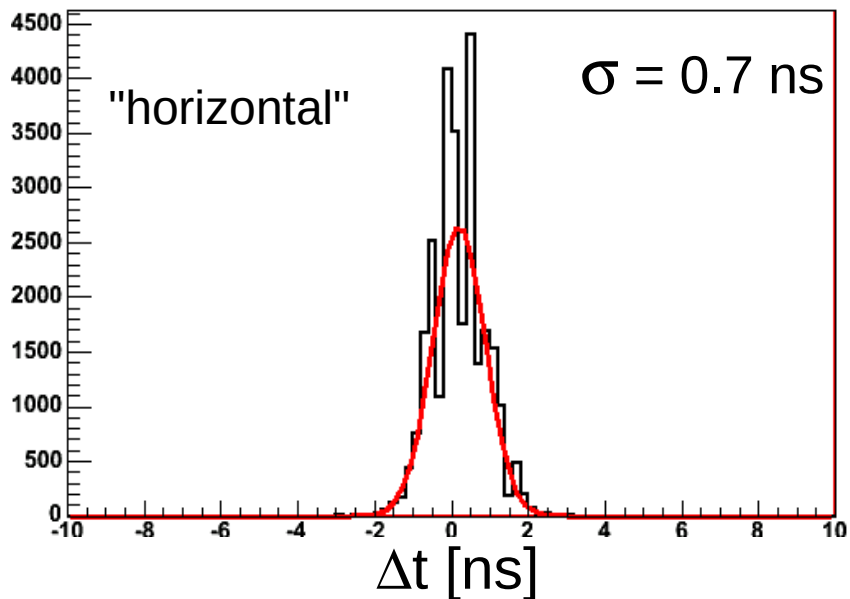
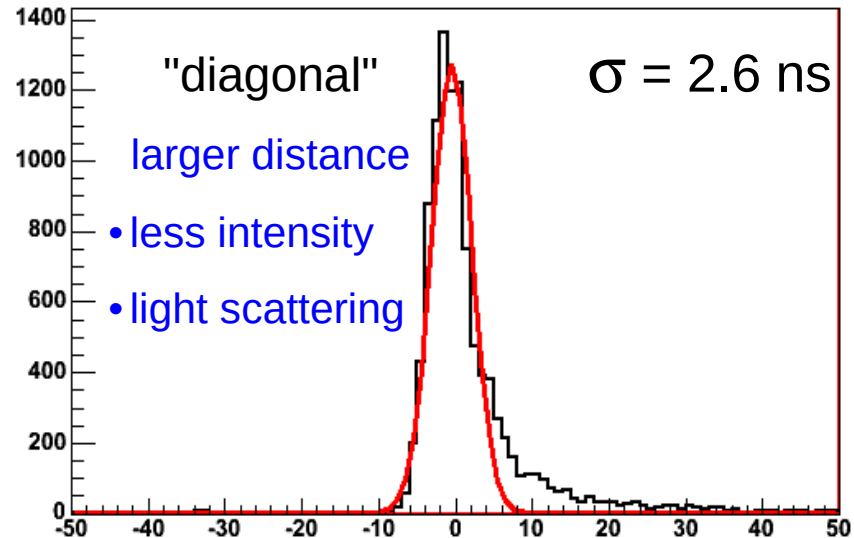
Useful for calibrations
Timing within a storey
Absolute PMT efficiencies
Agreement within 5%



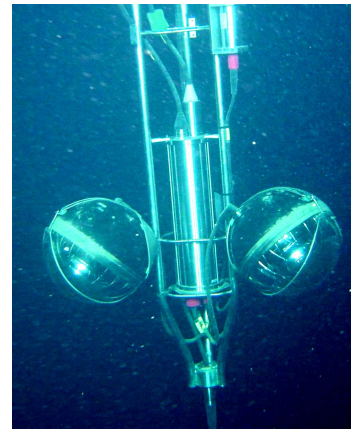
Acoustic triangulation of Line 1 hydrophone



Time calibration with LED beacons

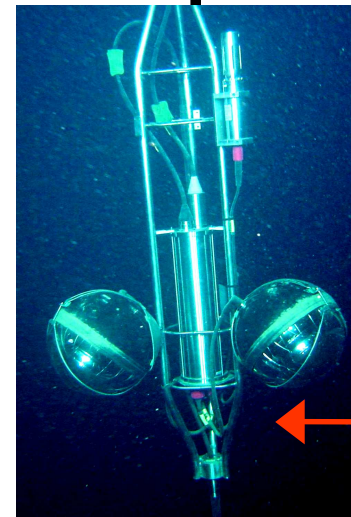


Line 1



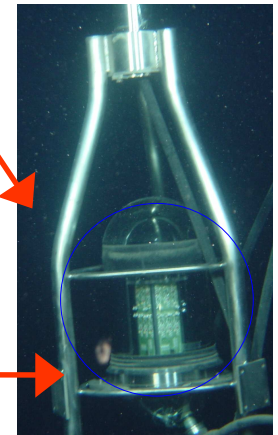
all timing
measurements in
good agreement
with expectations

Line 2

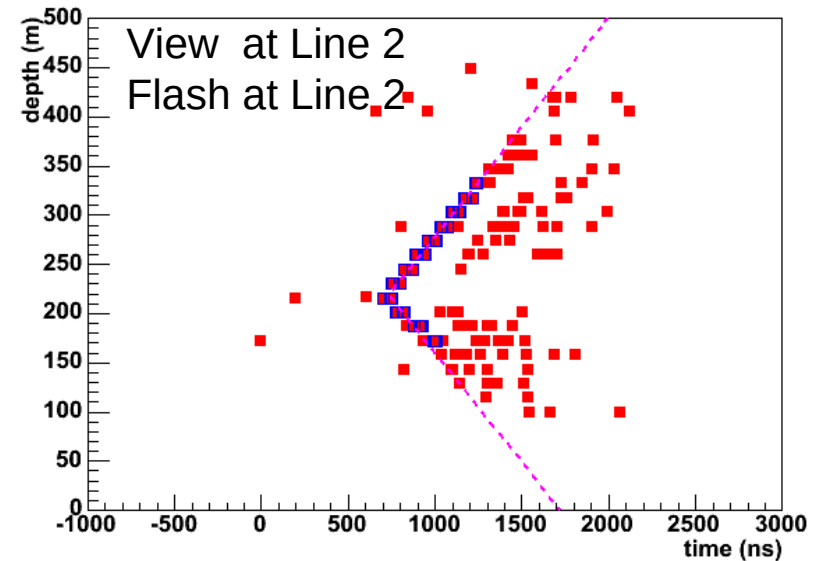
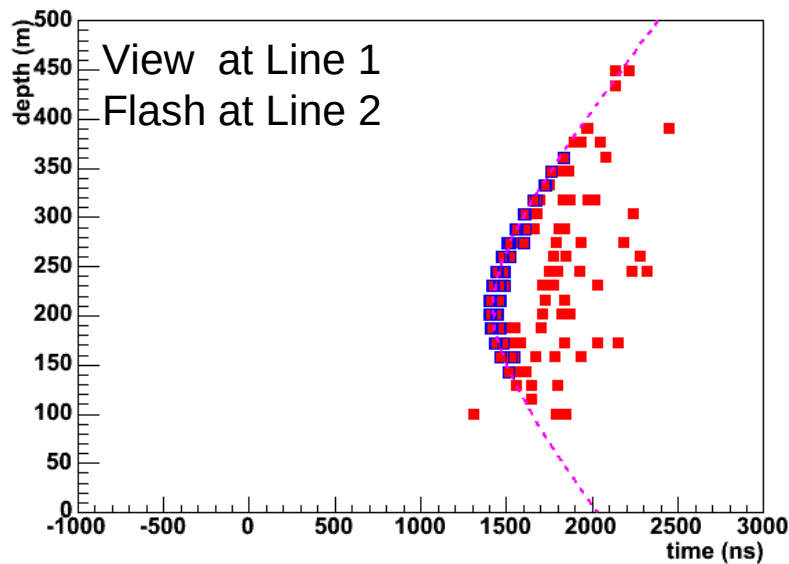
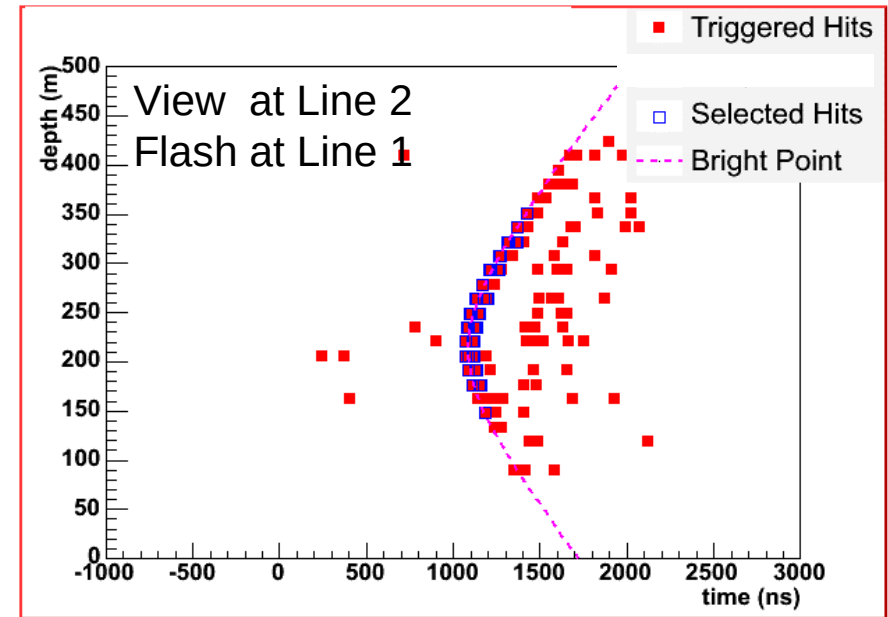
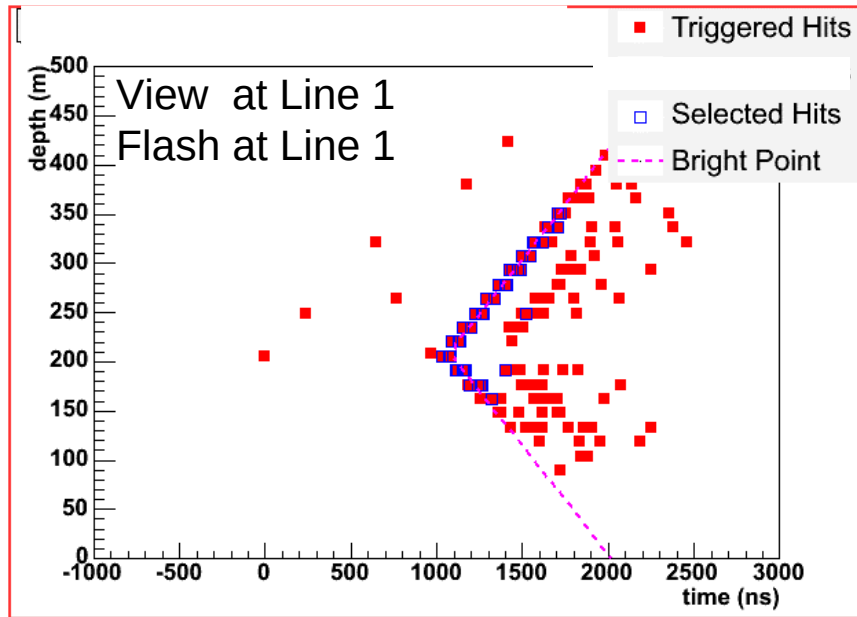


~150 m

~70 m



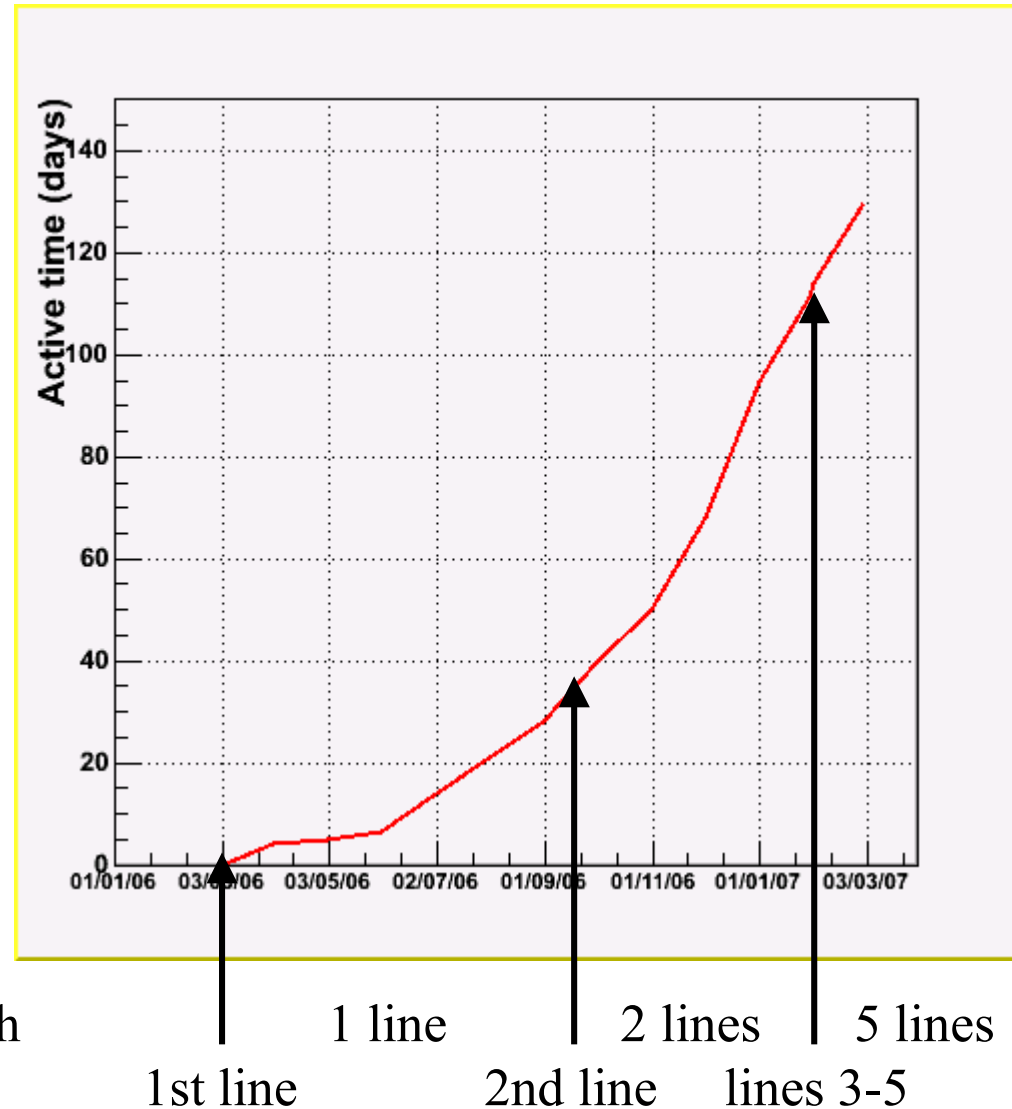
LED beacon events between Lines 1 and 2



Antares data taking

More than 1 year of
continuous data taking
with growing detector and
increasing efficiency

Overall accumulated data
equivalent to 130 days
Highest efficiency 85%
(Dec2006)

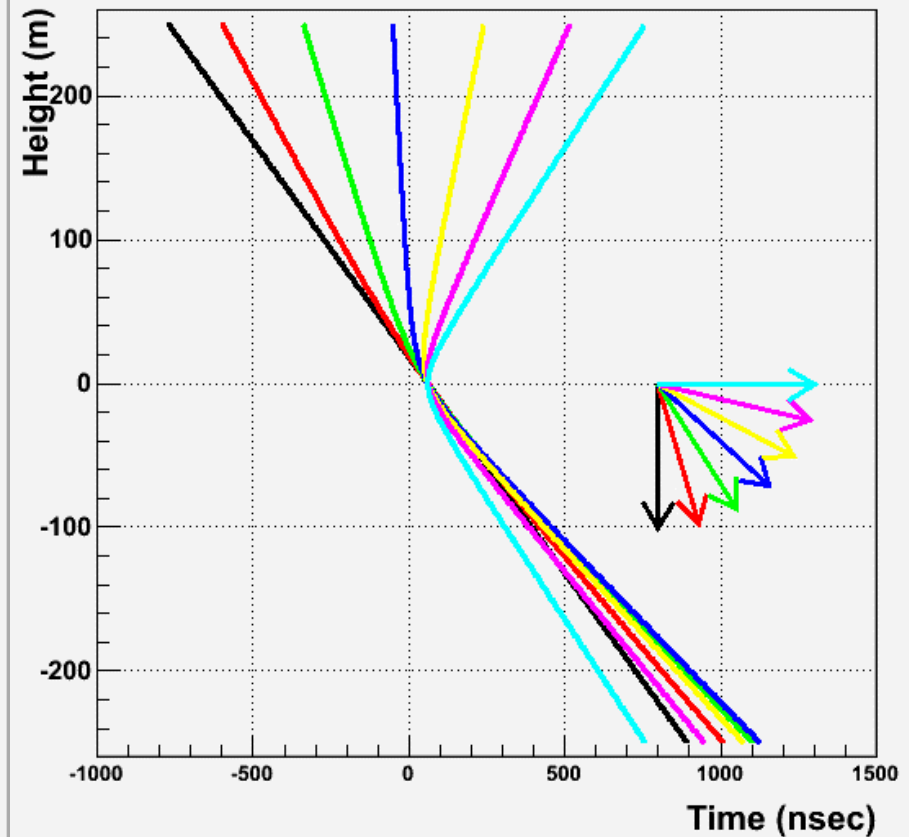
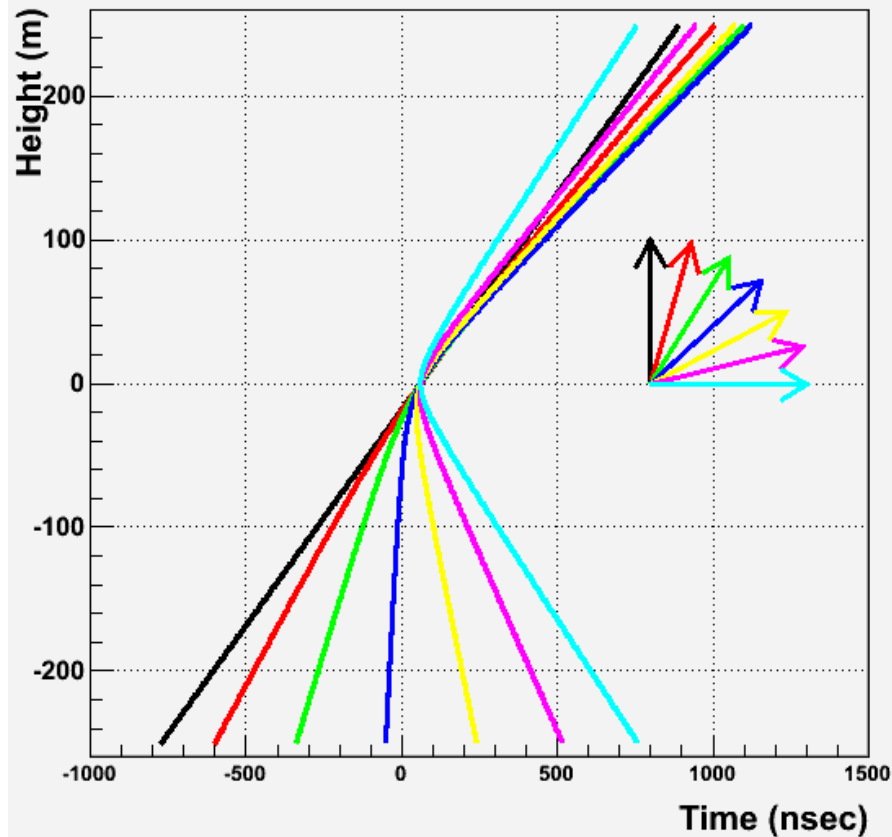


Event displays

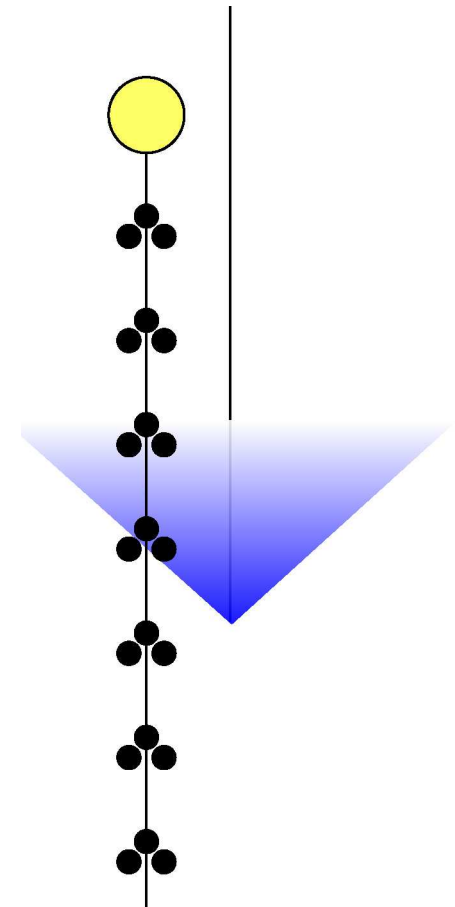
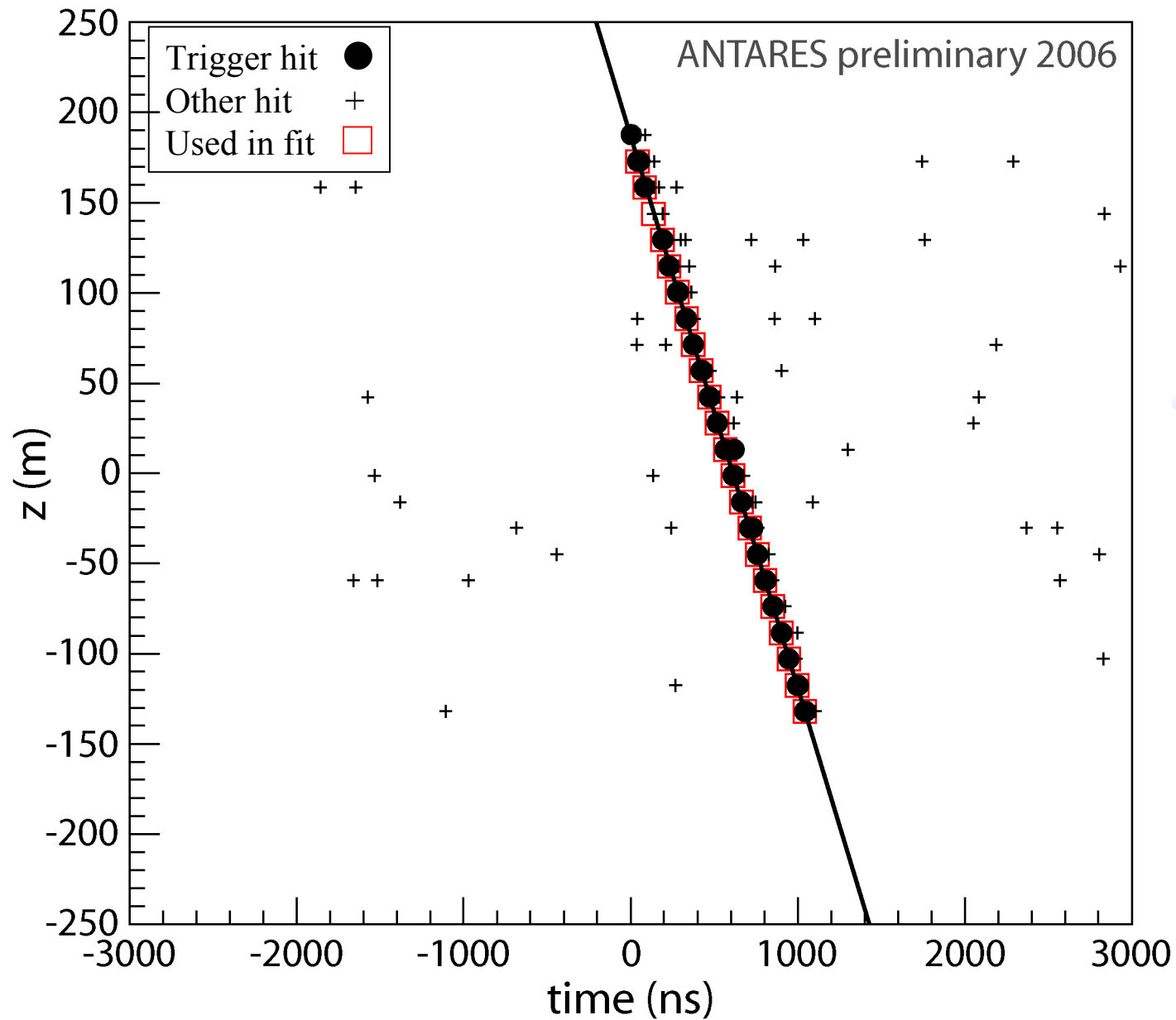
Hits are plotted for each line: z coordinate (height) as function time
Characteristic pattern in function of zenith angle and point of
closest approach between line and track

upward

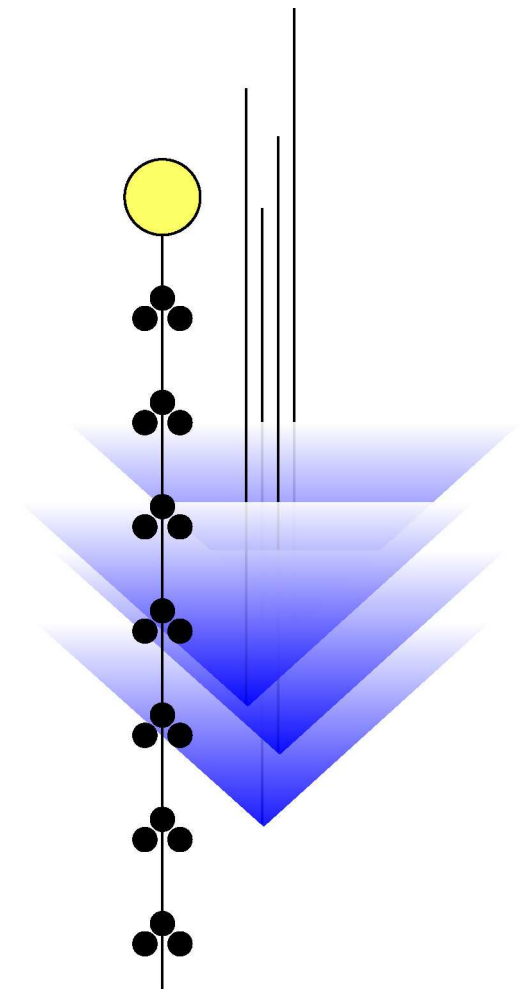
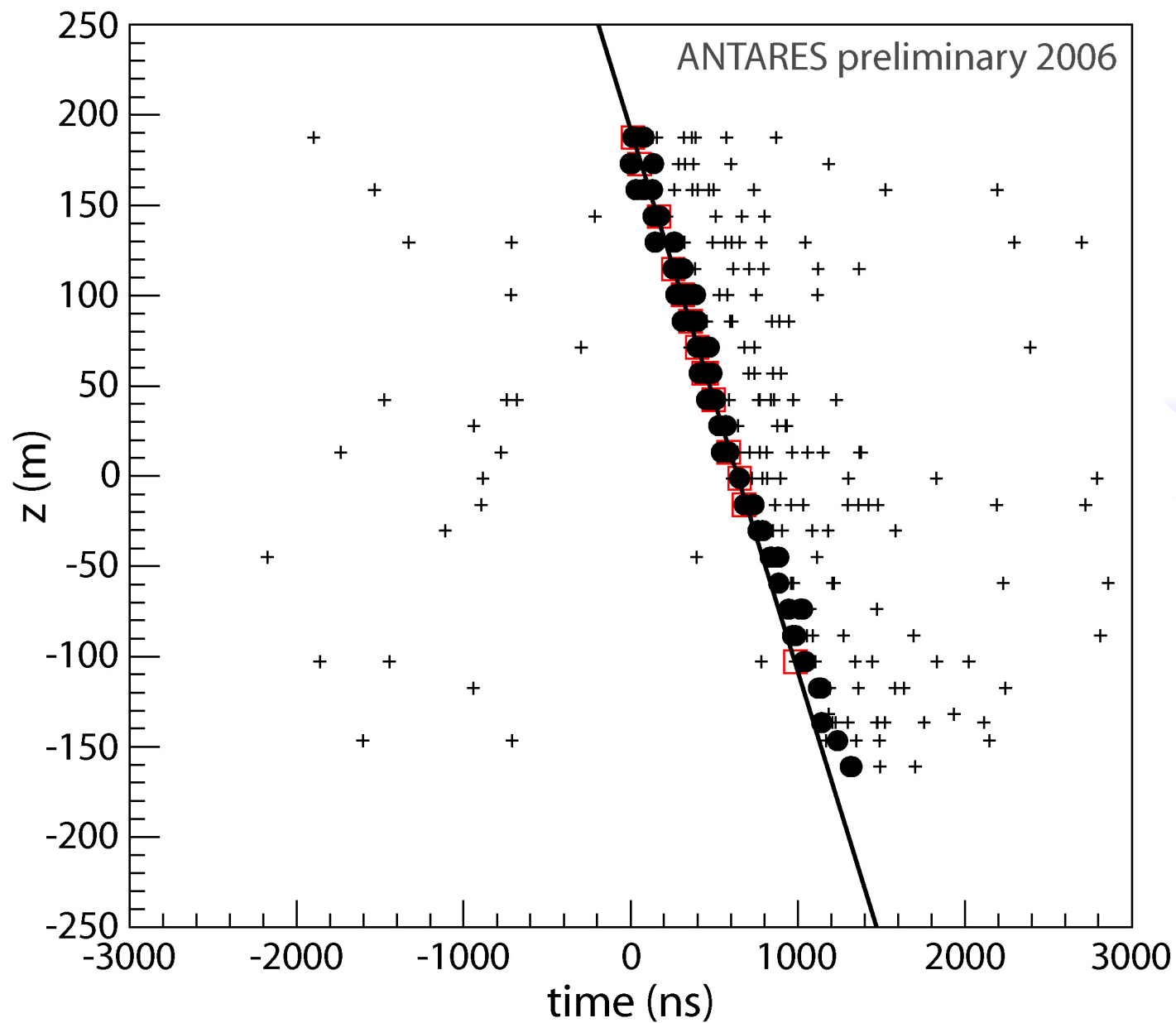
downward



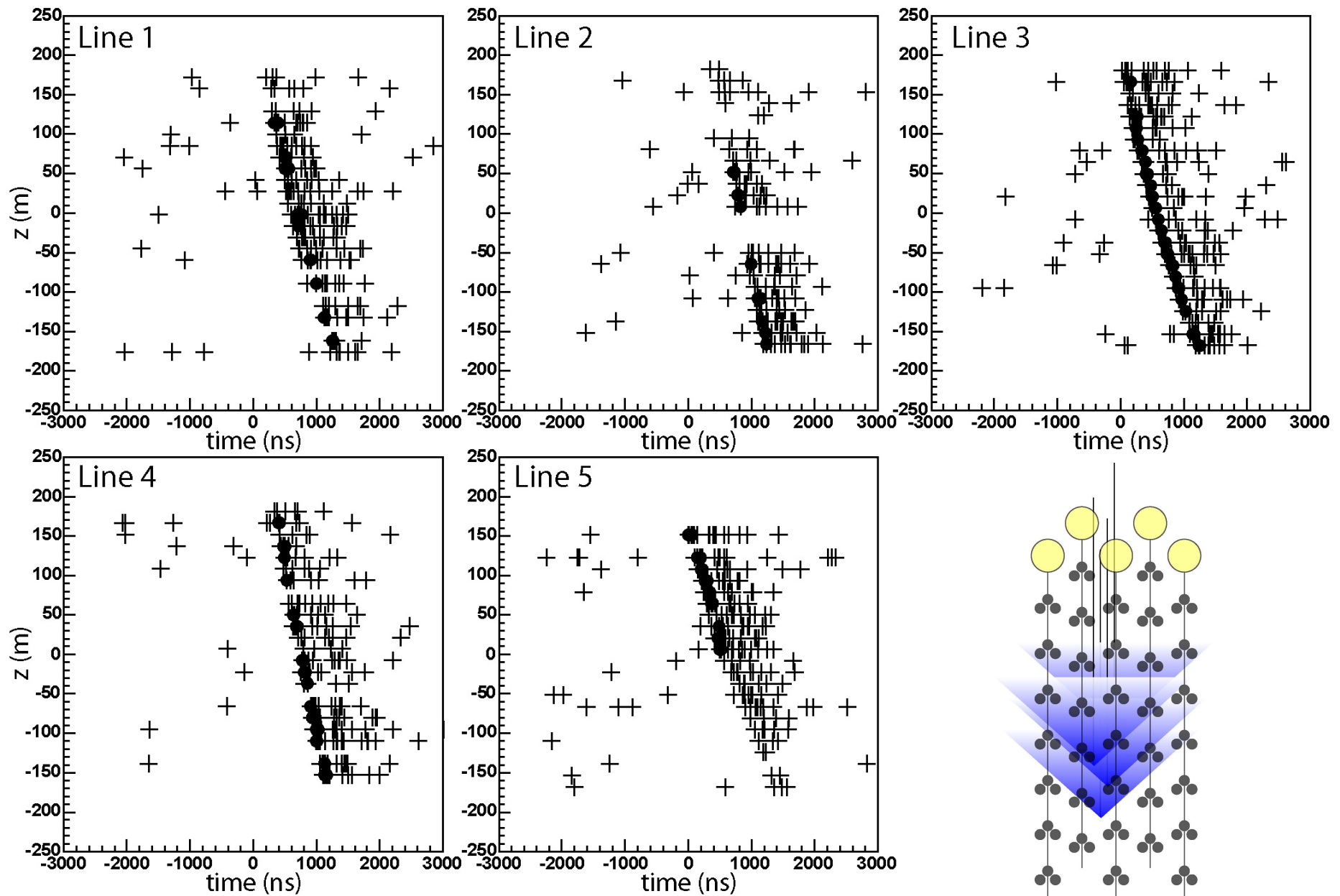
Downgoing muon



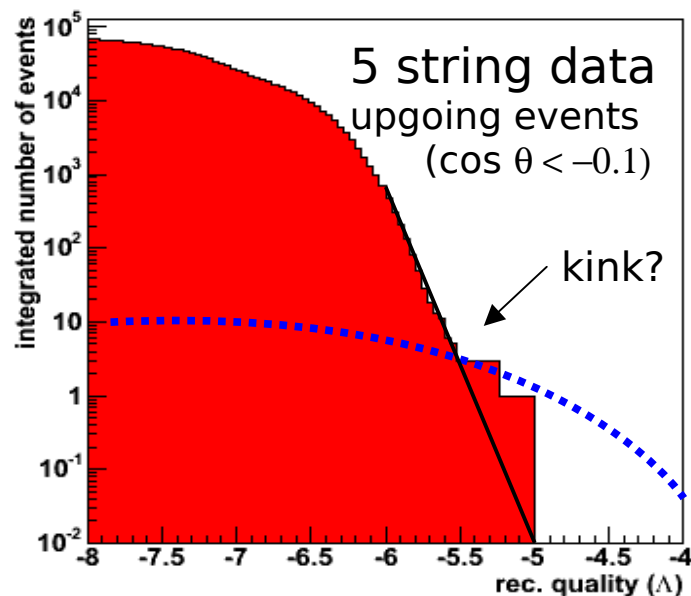
Atmospheric muon bundle ?



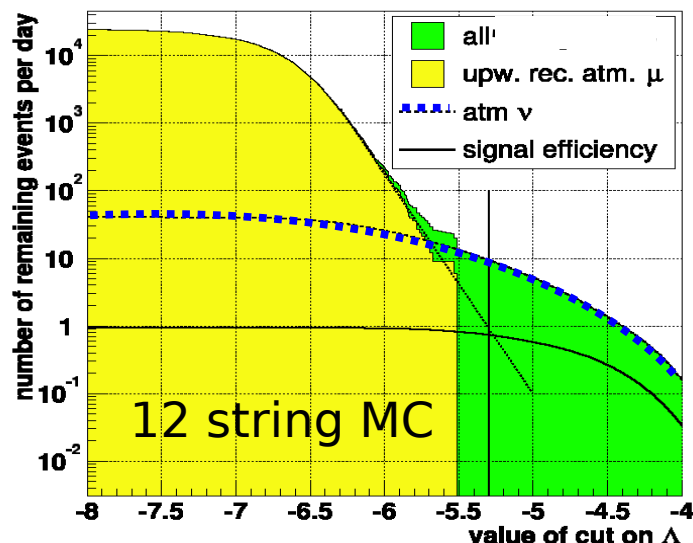
Atmospheric muon bundle on 5 line detector



Do we see already neutrinos ? (A. Heijboer)



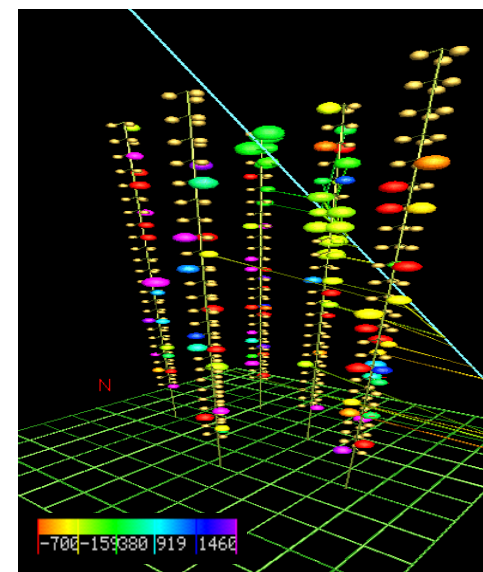
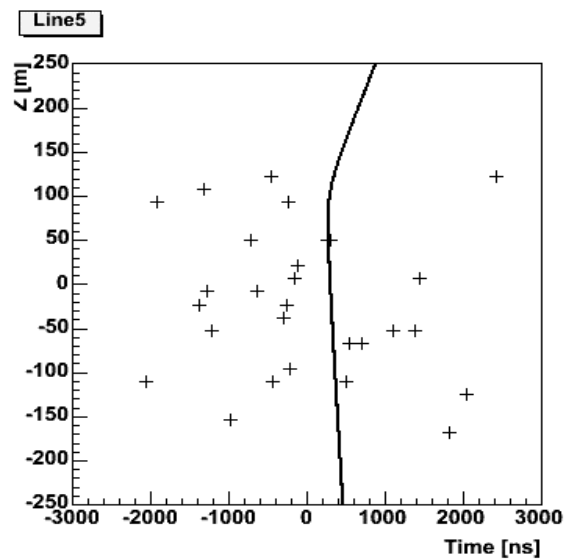
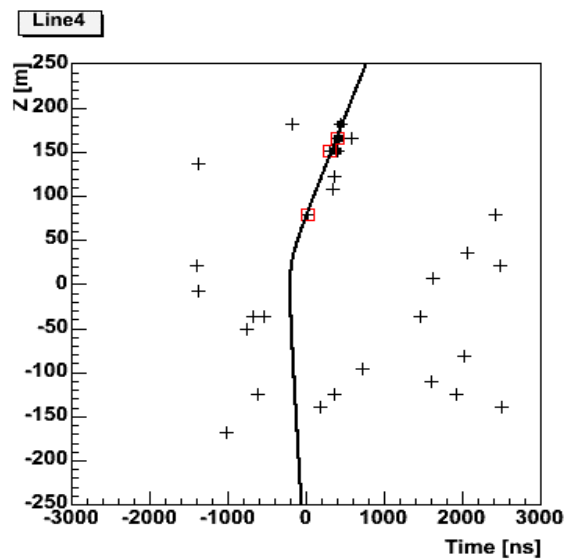
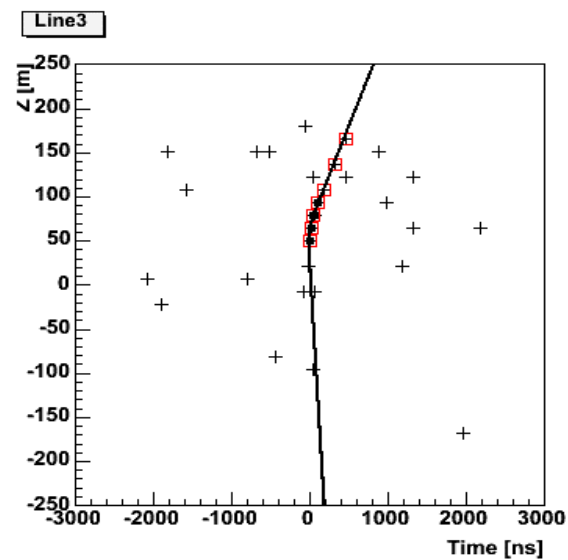
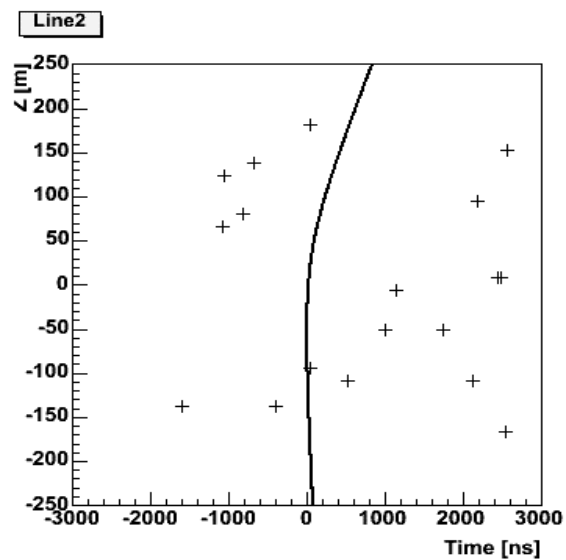
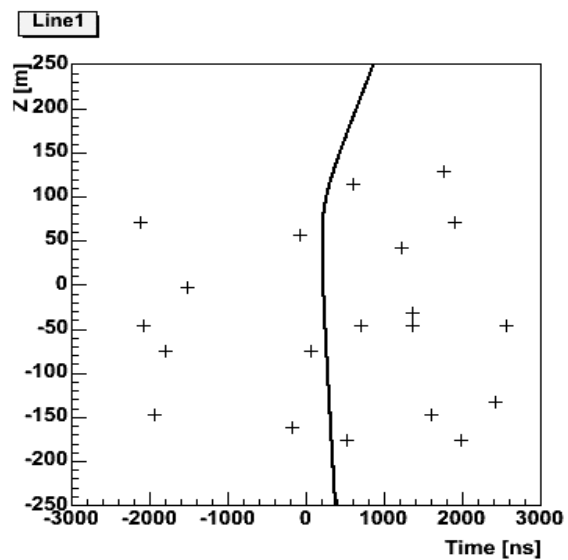
Real data February 2007
(first 2 weeks of data taking)
Detector not calibrated, 5 lines only
No tuning of fitting & likelihood
Blind test !
Same structure found as in MC
Kink at same value !



MC study 3 years ago (PhD thesis A. Heijboer)
Complete fully calibrated detector
Track fit based on likelihood
Atmospheric muons reconstructed as upward going
Atmospheric neutrinos
Cut on likelihood allows to select genuine upward
going tracks

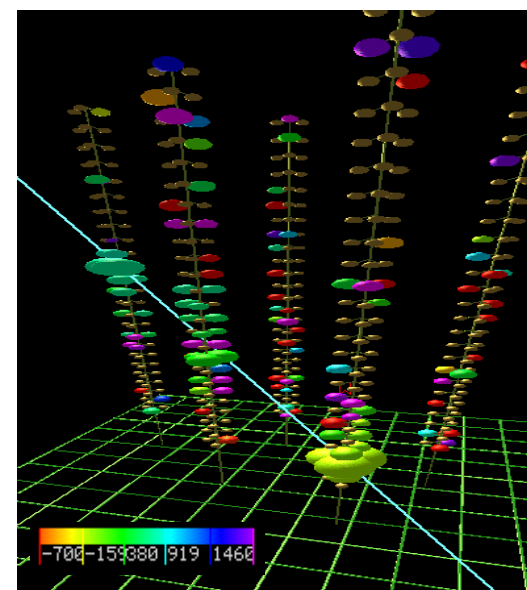
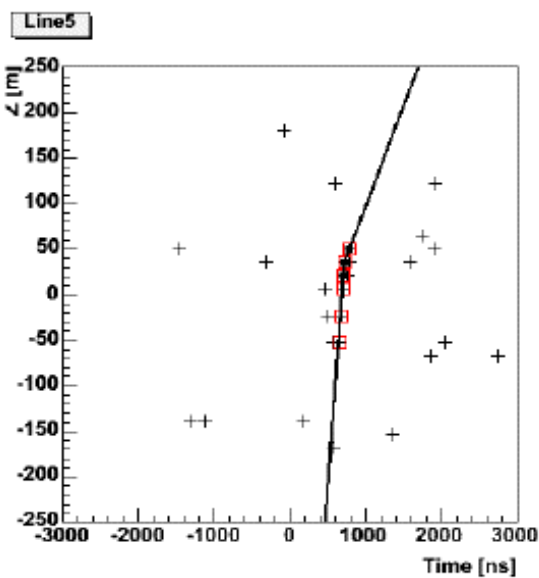
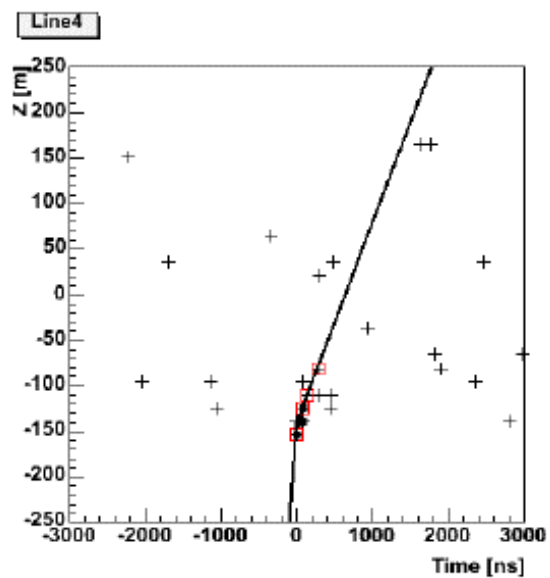
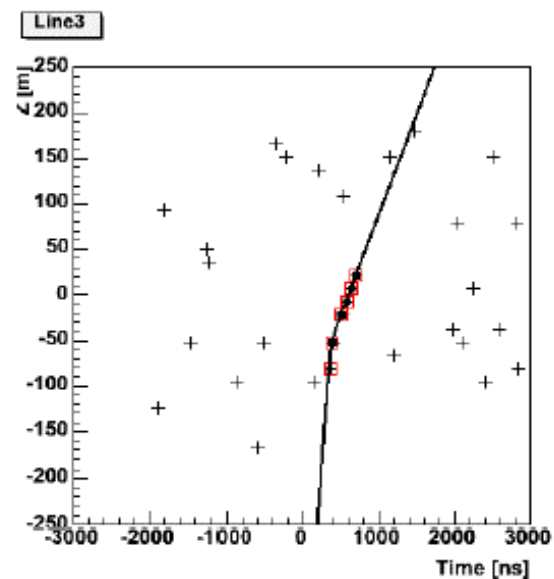
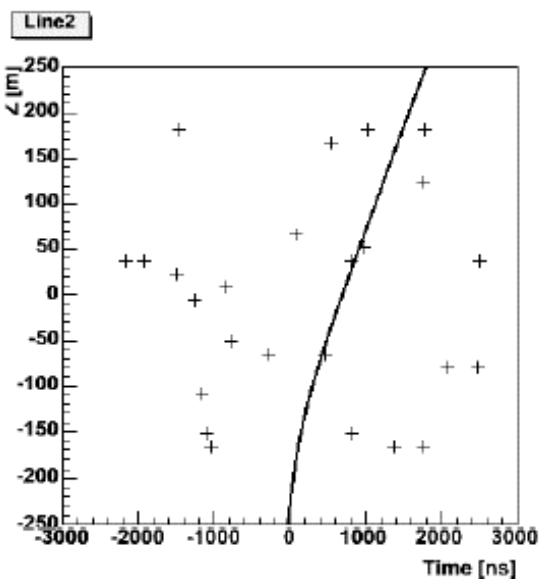
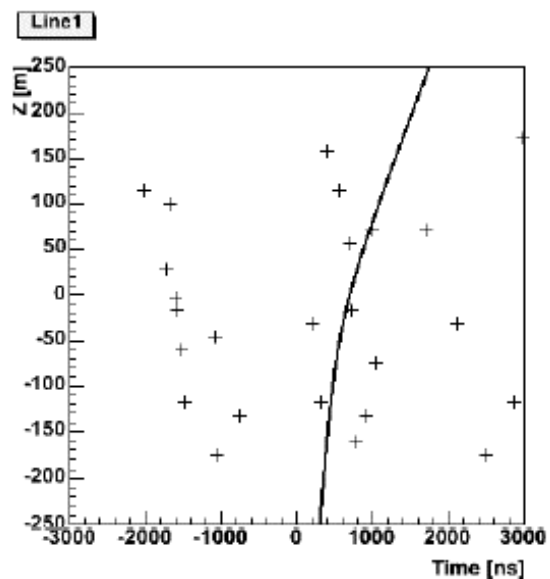
$\Theta=55^\circ$

Run : 25922 Event : 3474 FrameTarget : 0 FrameIndex : 53569
a: -53.897 b: 20.9544 t0: 57589859.58 θ : 0.96013 ϕ : 2.1613 # fits : 13



$\Theta = 35^\circ$

Run : 25929 Event : 6742 FrameTarget : 18 FrameIndex : 61770
a: 37.1598 b: 22.0721 t0: 164892932.2 θ : 0.61779 ϕ : -3.7146 fit : 1/4



Conclusion

Detector Construction well advanced
5 lines with 375 optical modules operational
In January 2008 12 lines detector will be complete
All detector components work within specifications
Neutrino physics starts now