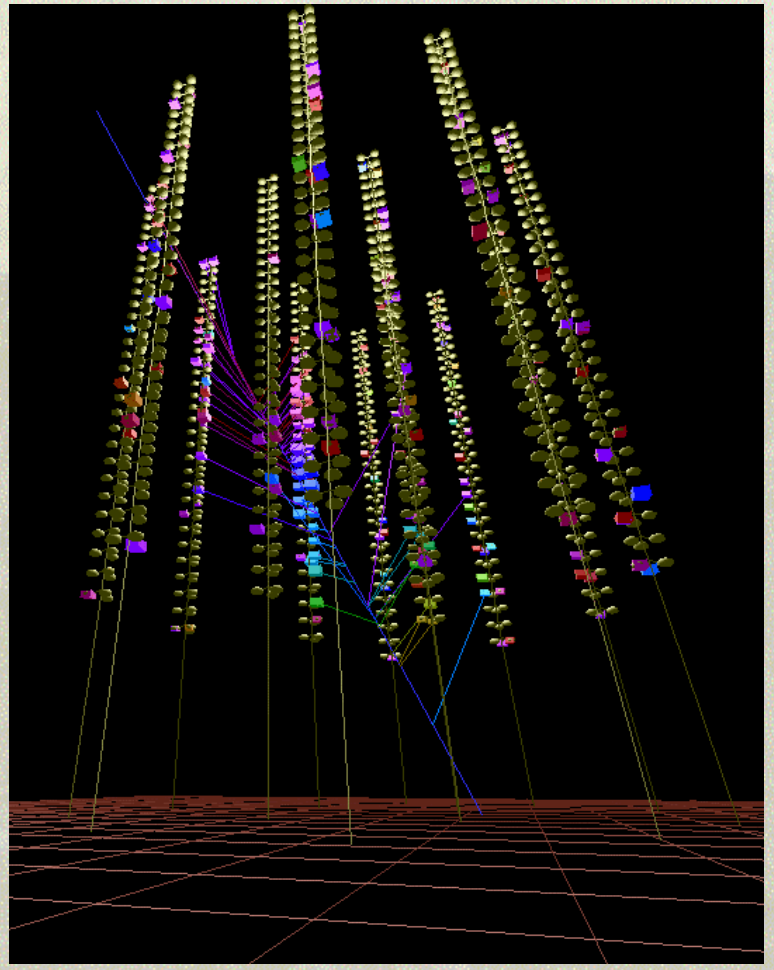
ANTARES



Juan José Hernández

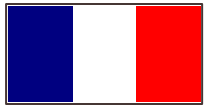
IFIC, Valencia, Spain

On behalf of the

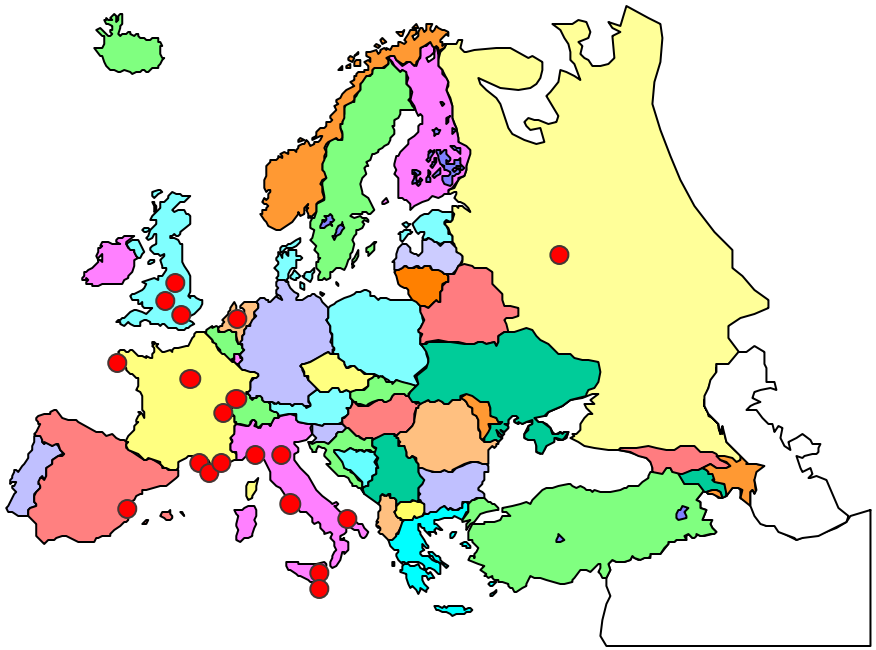
ANTARES Collaboration

ICHEP 2000, July-August 2000, Osaka, Japan

ANTARES Collaboration



- CPPM, Marseille (IN2P3)
- DSM/DAPNIA, Saclay (CEA)
- IReS, Strasbourg
- Univ. of H.-A., Mulhouse
- C.O.M. Marseille
- IFREMER, Marseille/Brest
- IGRAP (INSU), Provence



- University of Birmingham
- University of Oxford
- University of Sheffield

- ITEP, Moscow

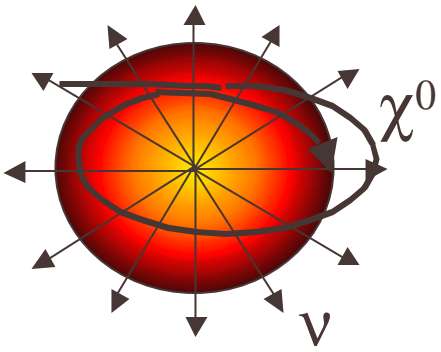
- University of Bari
- University of Bologna
- University of Catania
- LNS – Catania
- University of Rome
- University of Genova

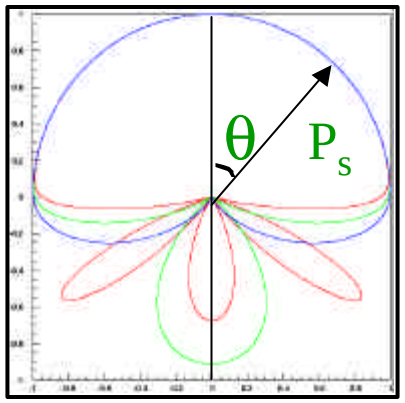
- NIKHEF, Amsterdam

- IFIC, Valencia

Motivations

- High Energy Neutrino Astrophysics:
  - Galactic (SN bursts, young SN, SNR, microquasars)
  - Extragalactic (AGN, GRB)
- Cosmology:
  - WIMPS (neutralinos)
  - Topological defects
  - Monopoles, Q-balls, strangelets...
- Neutrino properties:
  - *n* oscillations
- Other studies:
  - Oceanology
  - Earth Tomography
- Unexpected phenomena

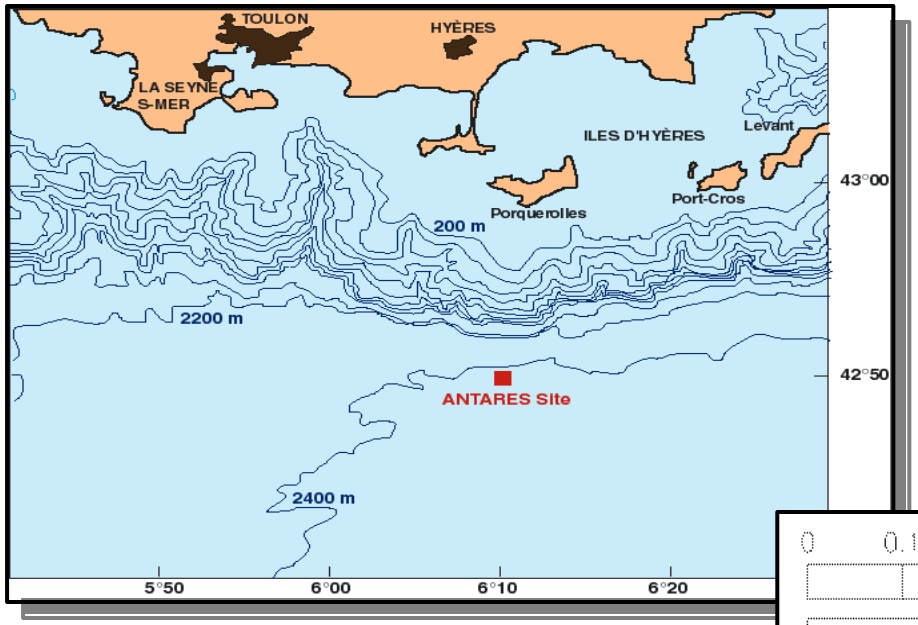




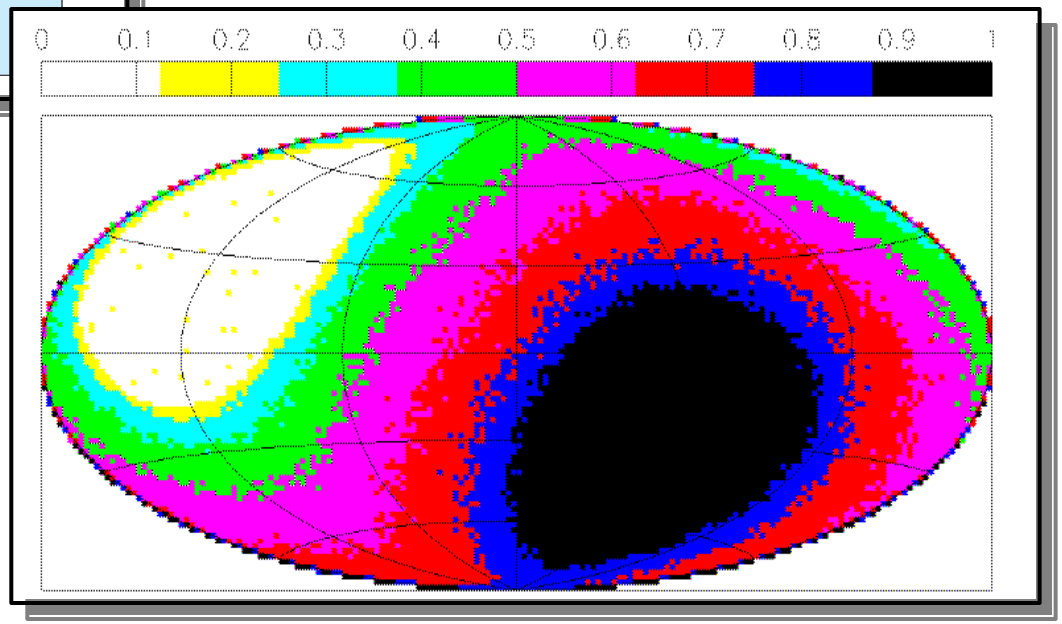
Antares evolution

- **1996** Creation of the ANTARES Collaboration.
- **Oct 1996–1999:** Site exploration (more than 30 deployments):
  - Optical water properties
  - Biofouling and sedimentation
  - Optical backgrounds (bioluminescence and ^{40}K)
- **1996–1999** 0.1 km^2 design, R&D.
- **1998–1999** Special tests :
  - Test of mechanics and deployment techniques.
  - Tests of submarine connection.
- **May 1999:** Proposal of a 0.1 km^2 detector.
- **Nov. 1999:** A demonstrator string. Test of:
  - Full-size string deployment
  - Mechanical issues
  - Positioning systems
  - EO cable, data transmission, reconstruction, etc.
- **2000:** Start of final design and construction phase.
- **2001:** Deployment of a first string.
- **2002:** First six strings deployed.
- **2003:** 0.1 km^2 string detector in place.

Antares site



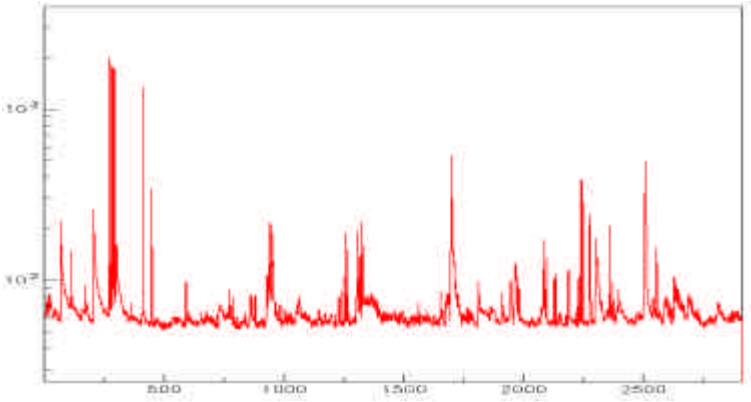
- 40 km SE of Toulon, Southern France (42º 50' N, 6º 10' E)
- Shore base at La Seyne-sur-Mer (excellent infrastructure)
- 2400 m below sea level



- 3.5π sr of the sky is covered
- 0.5π sr overlap with Amanda
- Galactic Centre surveyed

Environmental measurements

Optical background

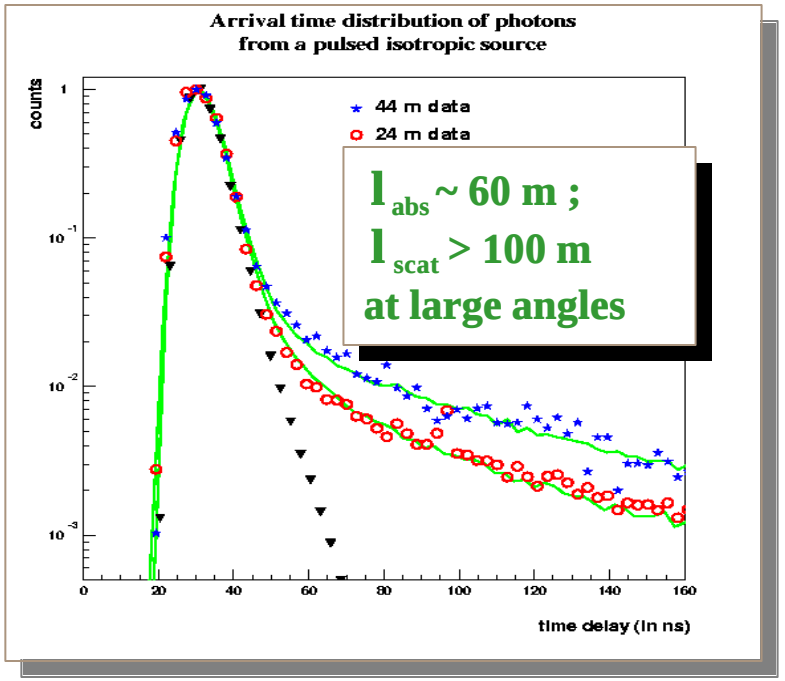


Short bursts (bioluminescence) over a continuous background (^{40}K).
~ 40 kHz (8" PM) + < 5% deadtime

Efficiency loss

On lower hemisphere, efficiency loss is smaller than <1.5% after 8 months.

Water transparency



- **No major drawbacks**
- **Good optical properties**

Antares 0.1 km² design

Shore station

Optical module

hydrophone

Compass, tilt meter

13 strings

12 m between storeys

2400m

float

~60m

300m active

~100m

Electro-optical submarine cable ~40km

Electronics containers

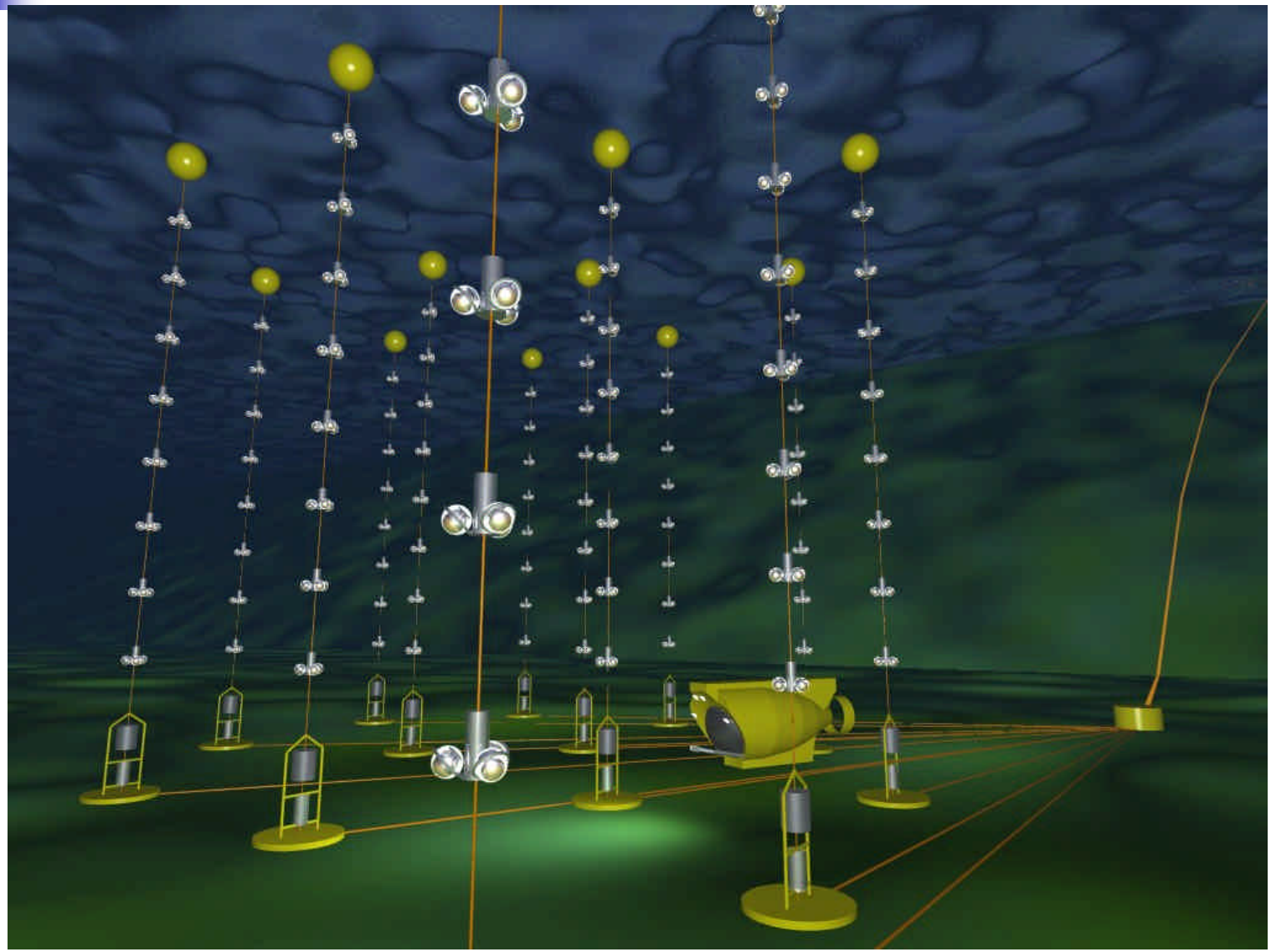
Readout cables

Junction box

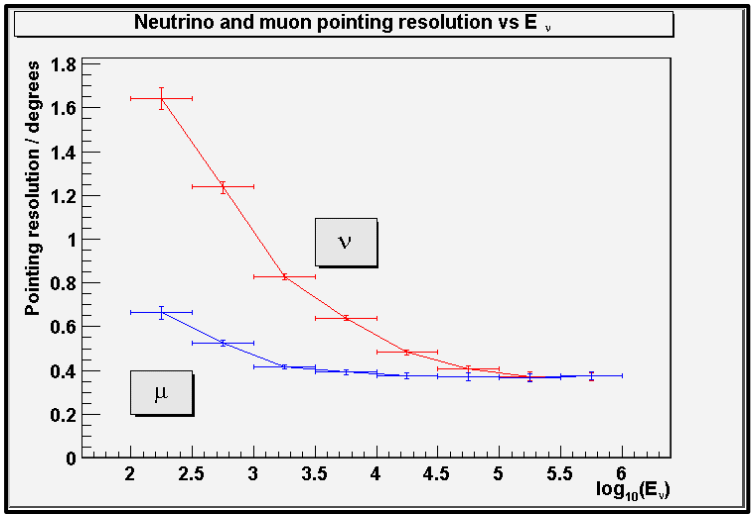
anchor

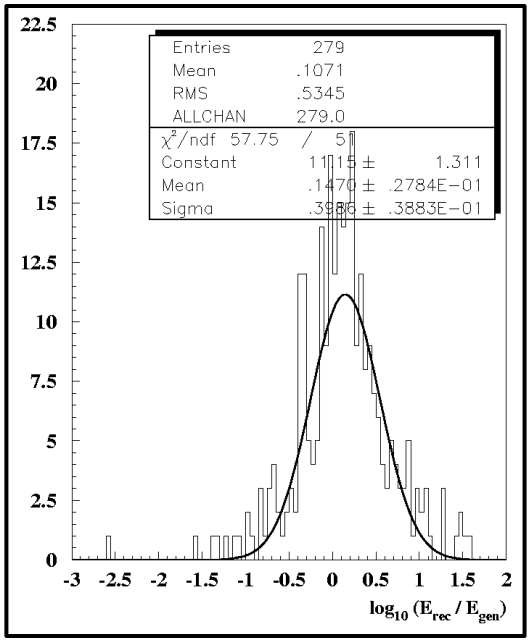
Acoustic beacon

The 0.1 km^2 detector (a view)



Expected performances





❖ Including effects of reconstruction and selection, PMT TTS, positioning, timing calibration accuracy and scattering.

❖ Below ~10 TeV angular error is dominated by **n-m** physical angle.

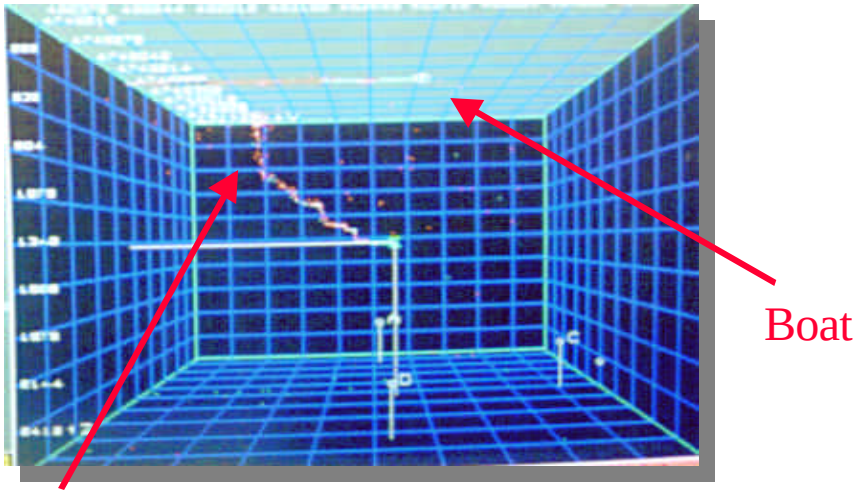
❖ Above ~10 TeV angular accuracy is better than 0.4° (reconstruction error).

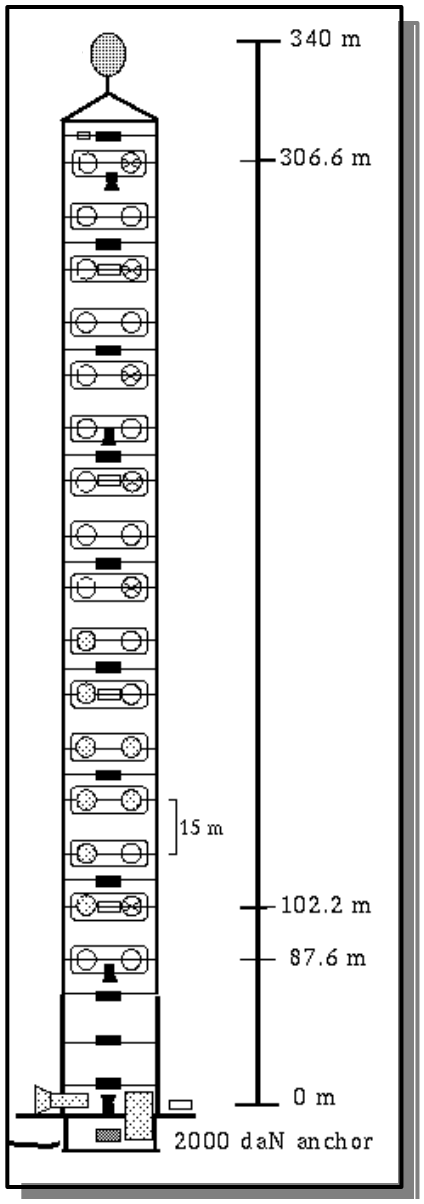
❖ $\sigma_E / E \approx 3$ (E > 1 TeV)

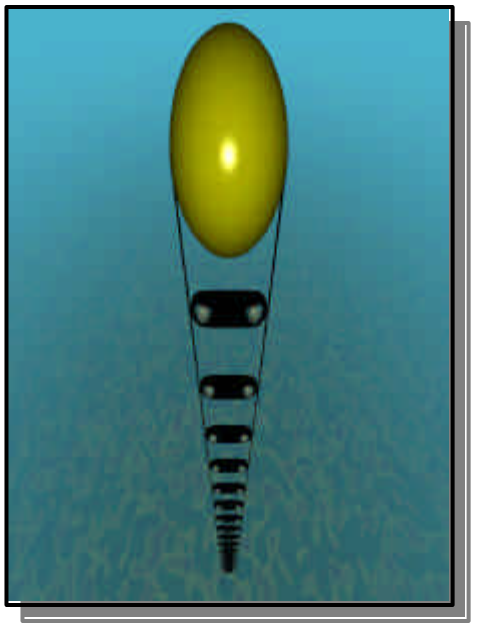
❖ Below E ~ 100 GeV, energy estimation via muon range.

A demonstrator string

- A full-scale line (340 m): test of mechanics and deployment .
- Partially instrumented: 7 PMTs, CTDs, tiltmeters, positioning system, Slow Controls, etc.
- Read-out via electro-optical cable.
- Operational since December 1999 (retrieved last month) .



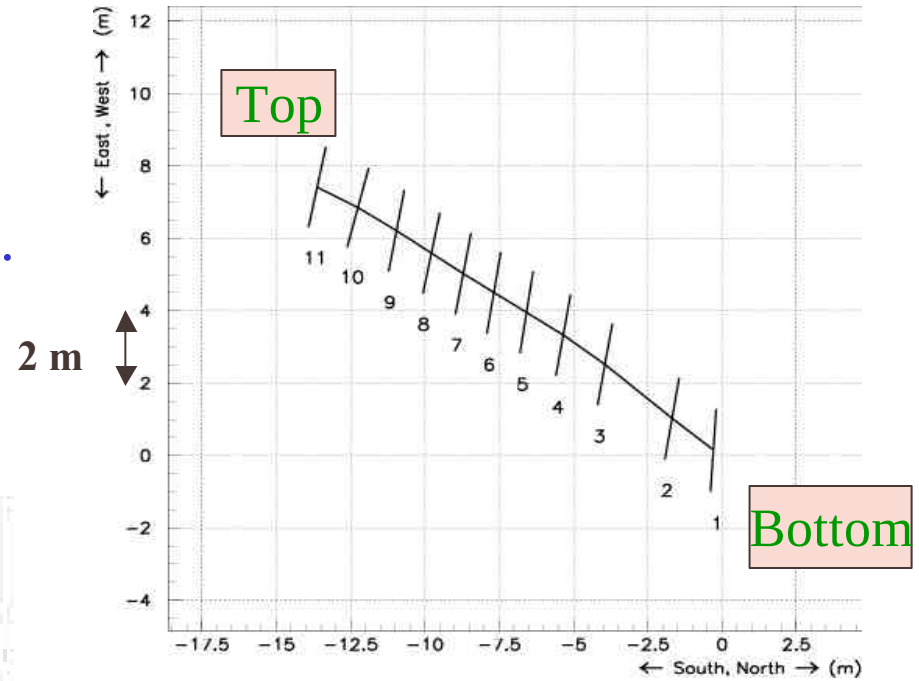


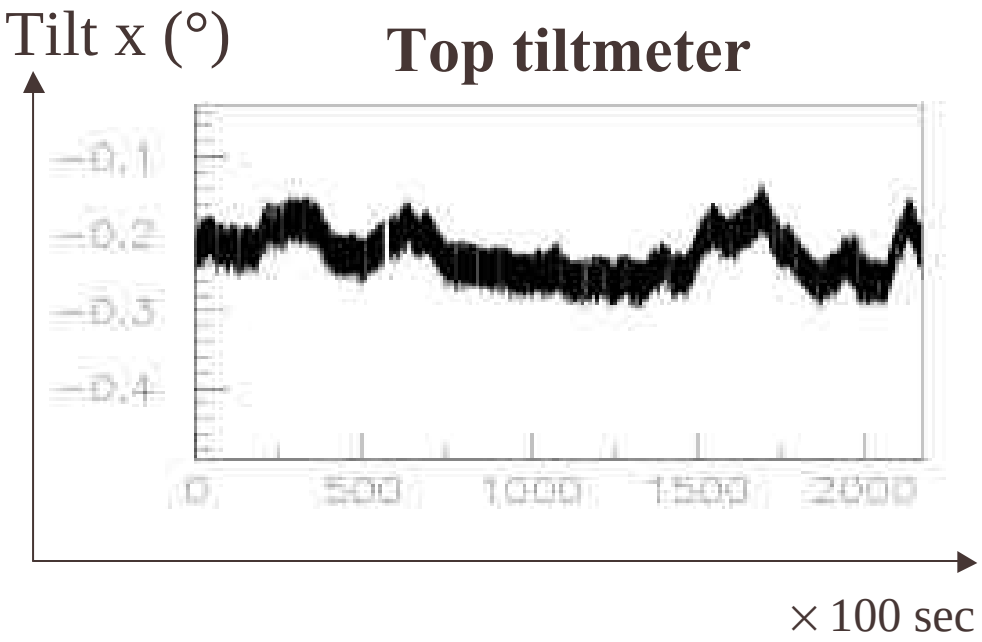


Compass and tiltmeters

- Taut string at ~2.3° from vertical.
- Tilt stability: ~0.2° over one week (x and y).
- Heading stability: 2° over one week.

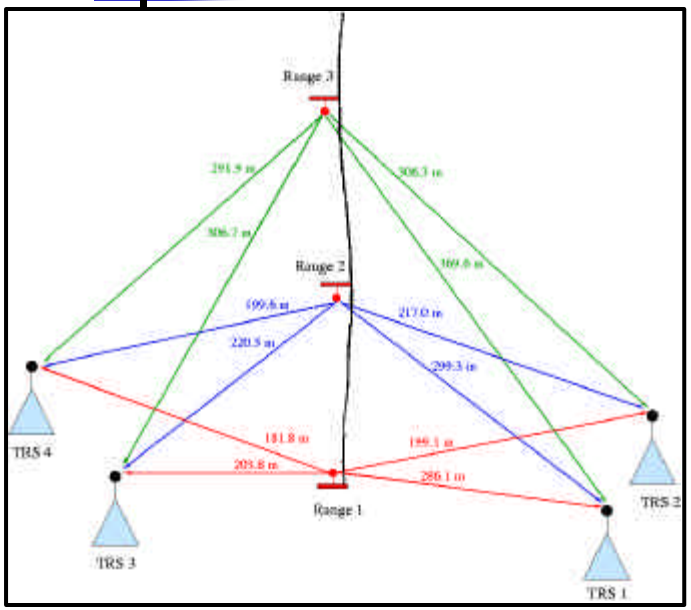
Top view

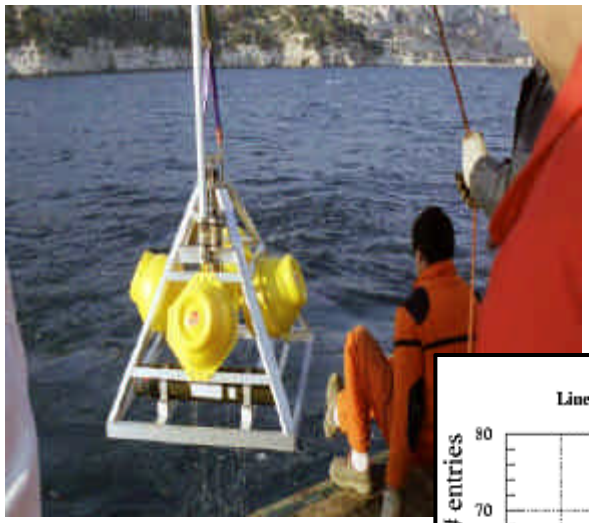




- **Very stable**
- **Negligible twist**

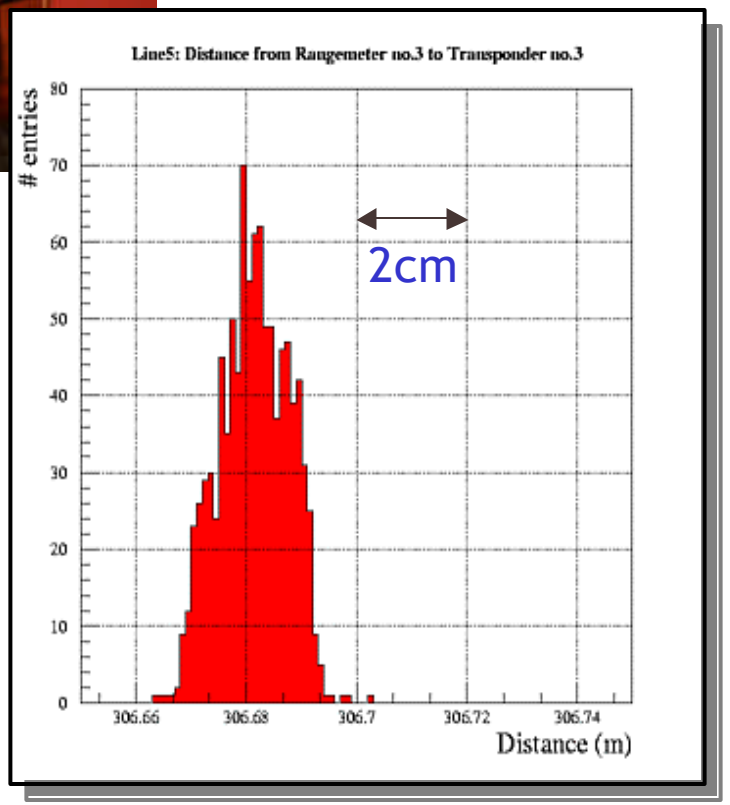
Acoustic positioning





4 transponders
3 rangemeters
+Sound velocimeter

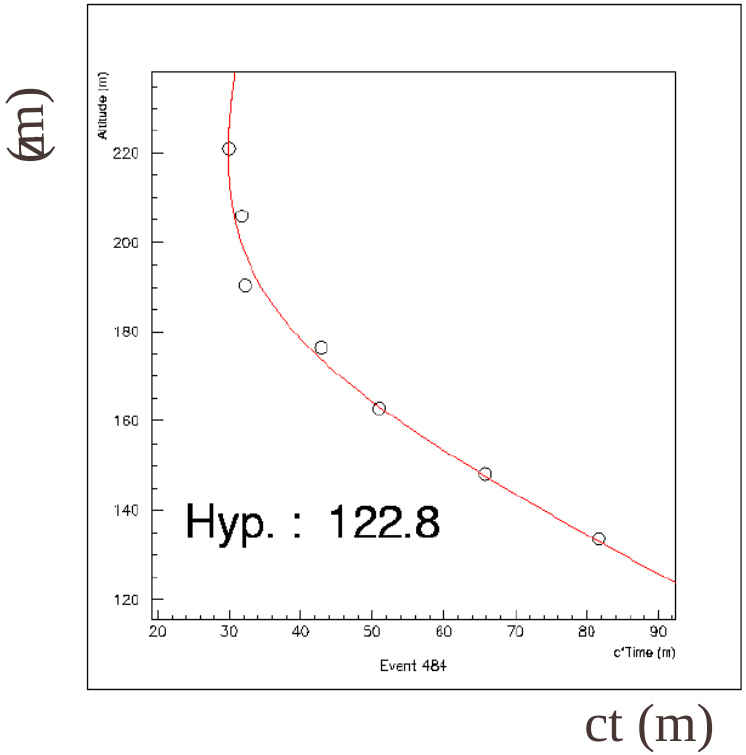
Devices	Accuracy (σ)
Inter-rangemeter	~ 1 cm
Inter-transponder	~ 1 cm
Rang.-Transpond.	≤ 6 cm



Triangulation allows ~5 cm accuracy

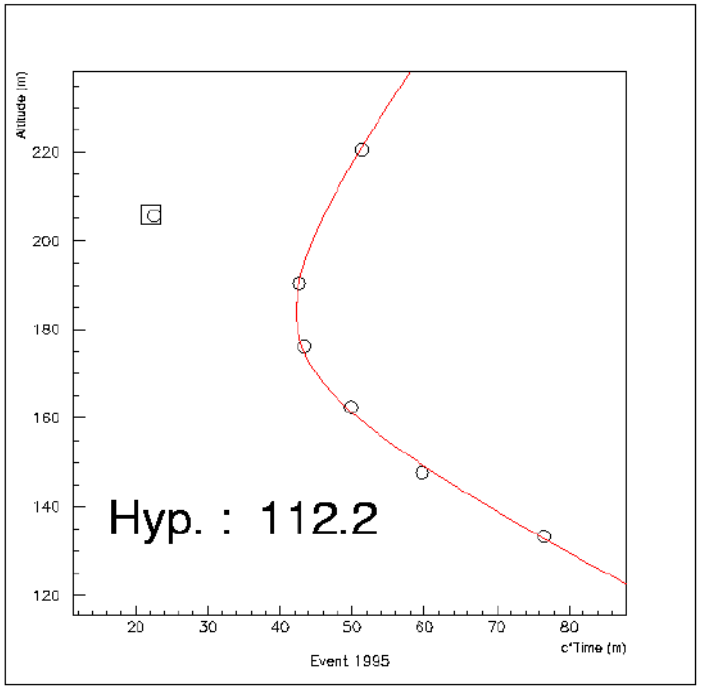
Atmospheric muons

- More than 5×10^4 coincidences in all 7 PMTs have been recorded.
- Polar angle of down-going muons deduced from depth vs. time pattern.
- Hyperbolic fit (including multimuons).
- ^{40}K filtered out by the reconstruction software (see boxed hit in example).



(m)

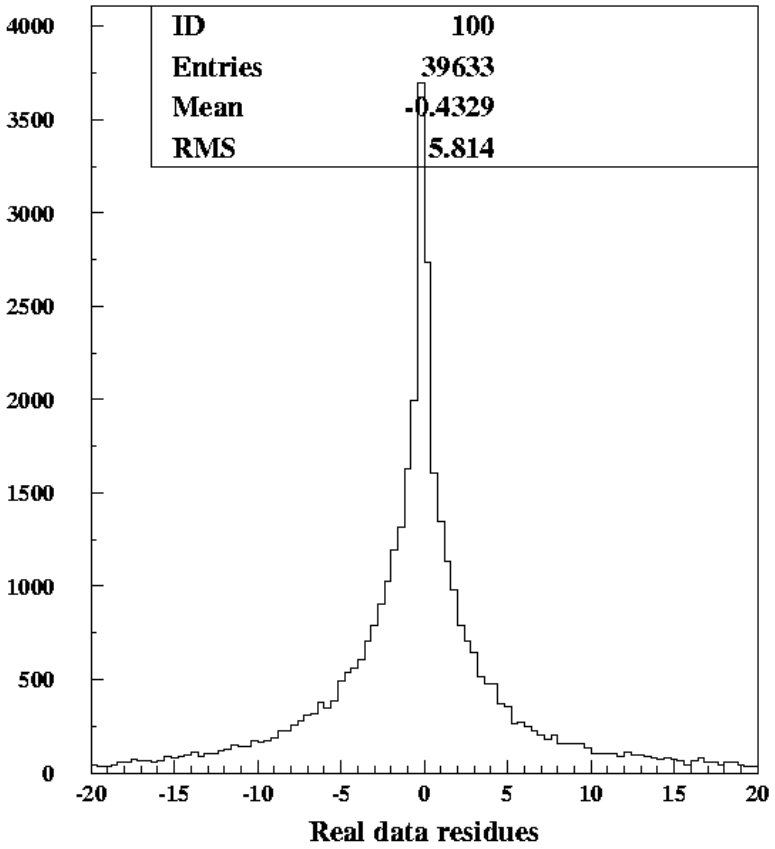
ct (m)

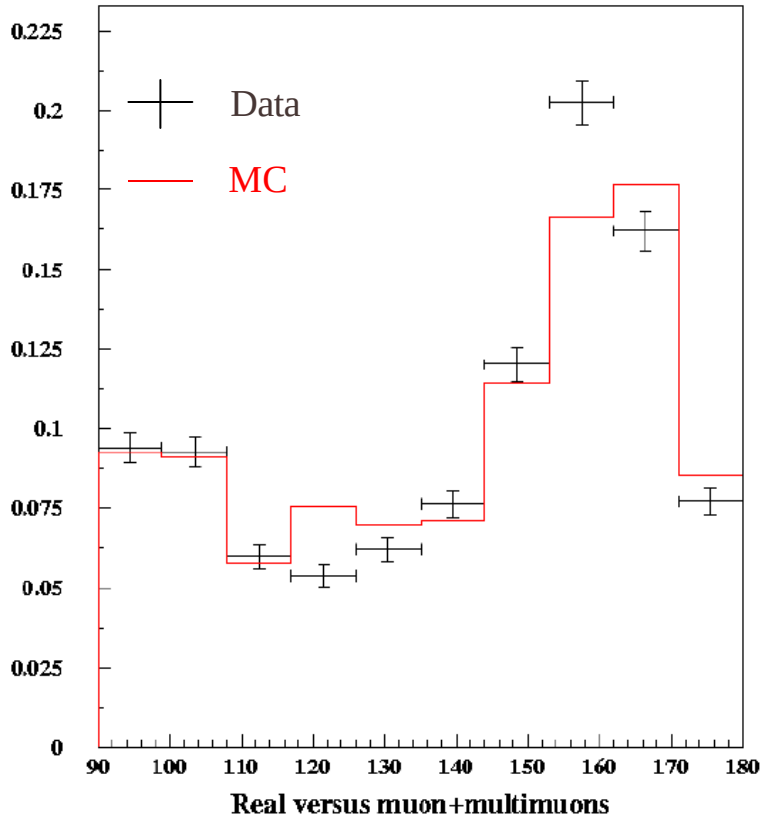


(m)

ct (m)

Demonstrator results





- Fit residuals are well centered ($\sigma \sim 6$ ns).
- Angular distribution agrees with expectations from single + multi-muons.

Around 1100/day down-going μ's reconstructed (in agreement with MC).

Conclusions

- ANTARES has succesfully performed its planned R&D programme:
  - Site exploration (environmental parameters)
  - Design of a 0.1 km^2 detector
  - Detailed tests of its components
  - Verification of undersea connection procedure
  - Deployment of a demonstrator string
- First string will be deployed in summer 2001.
- A 0.1 km^2 detector (13 strings) will be deployed by the end of 2003.
- Operation of such a detector will be a thorough test-bench for a 1 km^3 neutrino telescope in the Mediterranean Sea.