Search for point-like neutrino sources above the horizon with the ANTARES Neutrino Telescope

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ANTARES is located on the bottom of the Mediterranean Sea, at **~ 2475 m** depth, ~ 40 km south-east off the coast from Toulon (France).

It is the 1st undersea ν telescope, completed in May 2008, and the largest ν telescope in the Northern Hemisphere with an instrumented volume of **~ 0.02 km³**.

The main purpose of ANTARES is the search for neutrino fluxes from astrophysical objects.

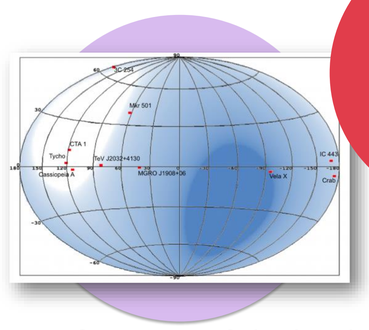
The observation is based on the detection, by means of 885 photomultiplier tubes, of the Cherenkov radiation induced by the passage in water of superluminal charged particles produced in the interactions of cosmic neutrinos near the detector.

1. Goal and data set

• The search for point-like sources with neutrino telescopes is normally performed using the "up-going" events, *i.e.* the events for which the direction of the neutrino candidate is reconstructed as coming from below the telescope's horizon. In this way it is possible to significantly reduce the atmospheric muons background.

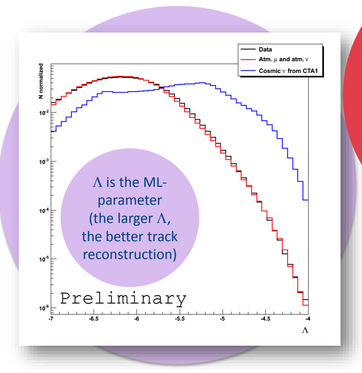
• **Here we present a strategy for the study of "down-going" neutrinos and the ANTARES sensitivity for two candidate sources placed in the region of the sky which ANTARES cannot see with the "up-going" analysis.**

Object	*b* (deg)	*l* (deg)	δ (deg)	α (deg)
Tycho	1.45	120.11	64.18	6.36
CTA 1	10.40	119.60	72.98	1.61

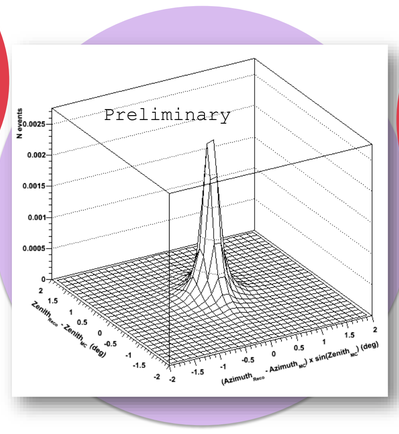


Sky visibility of ANTARES for "up-going" events (blue scale) and some candidate cosmic sources in galactic coordinates

• Data set: June 2009 – June 2011 (live-time = 366.6 days)
• Down-going track events have been analyzed (CC ν_μ)
• Tracks have been reconstructed using the time and position information of the hits by means of a maximum likelihood (ML) fitting algorithm.



Data/MC comparison. The flux of the atmospheric component is ∝ E^{-3}, the flux of the cosmic one is ∝ E^{-2}

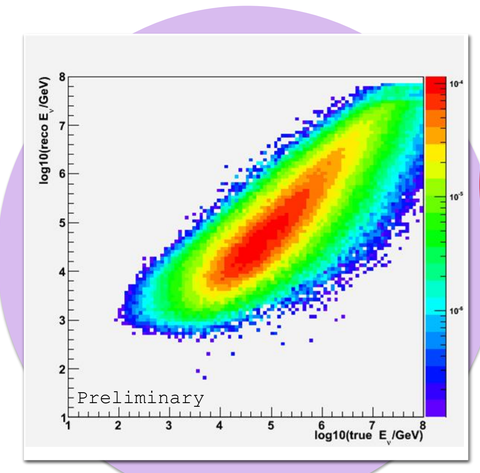


Point-spread function in local coordinates for the full Monte Carlo signal event sample of ν-induced muons from CTA 1 after the Λ > - 6.0 cut

2. Analysis method

• The big challenge of this analysis is due to atmospheric muons which can penetrate through several kilometres of water to ANTARES, providing the major component of the background.

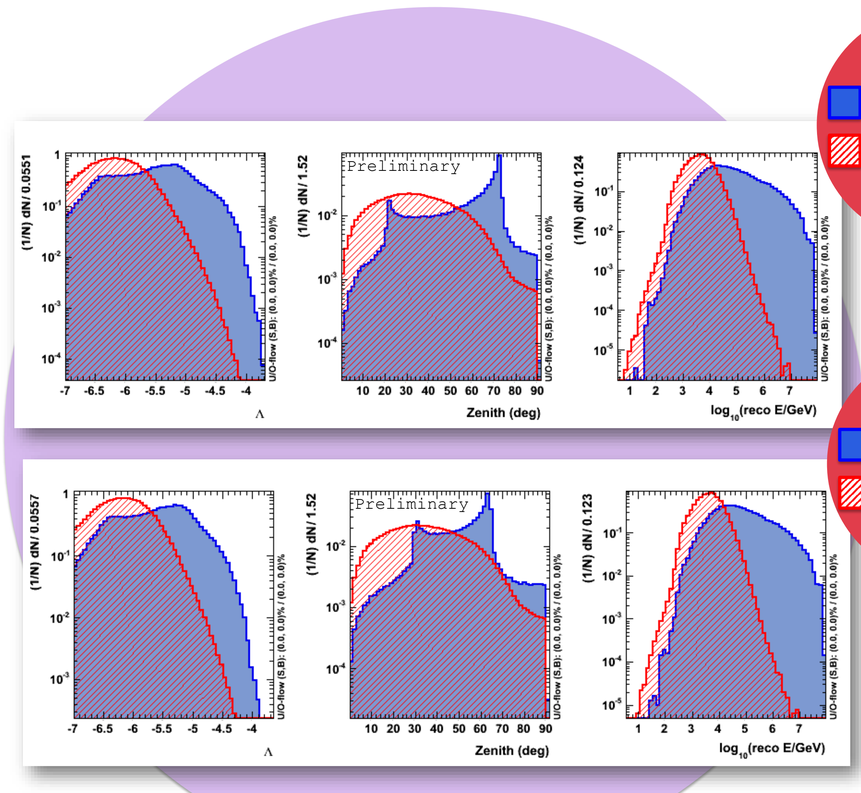
• **To retain the sensitivity to a neutrino signal flux, it is necessary to boost the rejection power. This can be achieved by using a good energy estimator and a good signal/background separation technique.**



Distribution of Monte Carlo - generated signal events for the neutrino energy estimator as a function of the true neutrino energy

2.2 BDT training

• A multivariate analysis based on the BDT (Boosted Decision Tree) method has been performed. The variables used for the BDT training are: the Λ parameter, the zenith angle and the reconstructed energy (reco *E*) of the event.



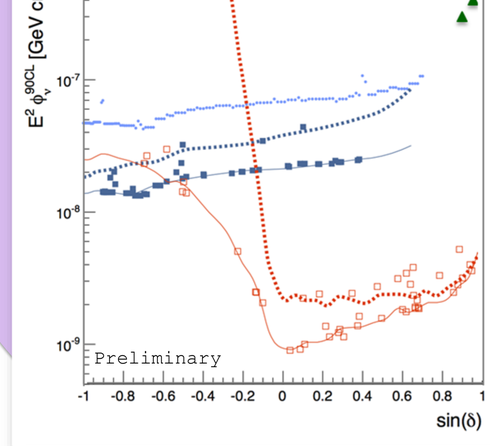
Signal from Tycho
Background

Signal from CTA 1
Background

3. Sensitivity

• A binned point source search has been performed. It consists in the search for a spatial cluster of events from a given point of the sky by counting the events occurred in small solid angles around the given point.

• **Sensitivity *à la* Feldman and Cousins has been computed.**



Sensitivity for a point-source with an E^{-2} spectrum as a function of the declination

4. References

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