Selected results from the ANTARES neutrino telescope

- The ANTARES neutrino telescope
- Some selected results from ANTARES:
  - Point source search
  - Diffuse flux search
  - Gravitational waves and high energy neutrino search

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For the ANTARES collaboration

24th Rencontres de Blois

High Energy Neutrino Astronomy

- Interaction of high energy particles with photons or matter
  - Protons/nuclei: pion production and decay

$p + p(\gamma) \rightarrow \pi^{\pm} + X$

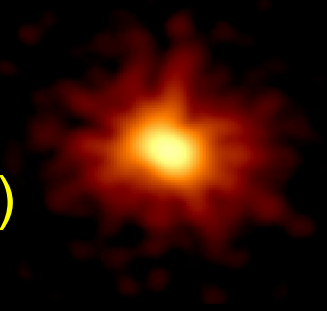
$\hookrightarrow \mu + \nu_{\mu}$

$\hookrightarrow e + \nu_{\mu} + \nu_{e}$

$p + p(\gamma) \rightarrow \pi^{0} + X$

$\hookrightarrow \gamma + \gamma$ (TeV)

- Potential HEN sources
  - Galactic (Supernova Remnants, Microquasars, ...)
  - Extragalactic (Active Galactic Nuclei, Gamma-ray Bursts, …)
  - Exotic (dark matter, magnetic monopoles, nuclearites)



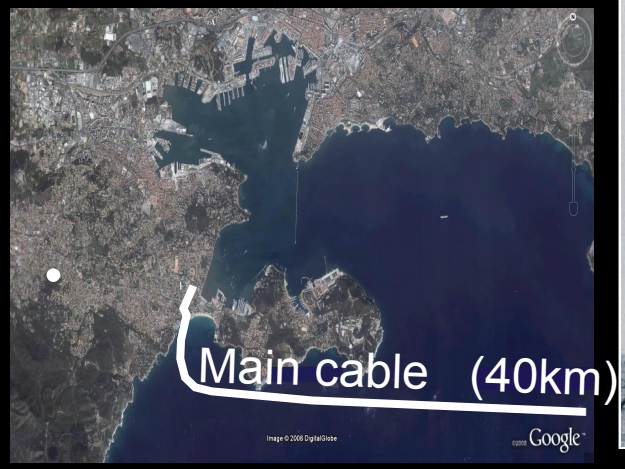
Neutrinos as Astrophysical Probes

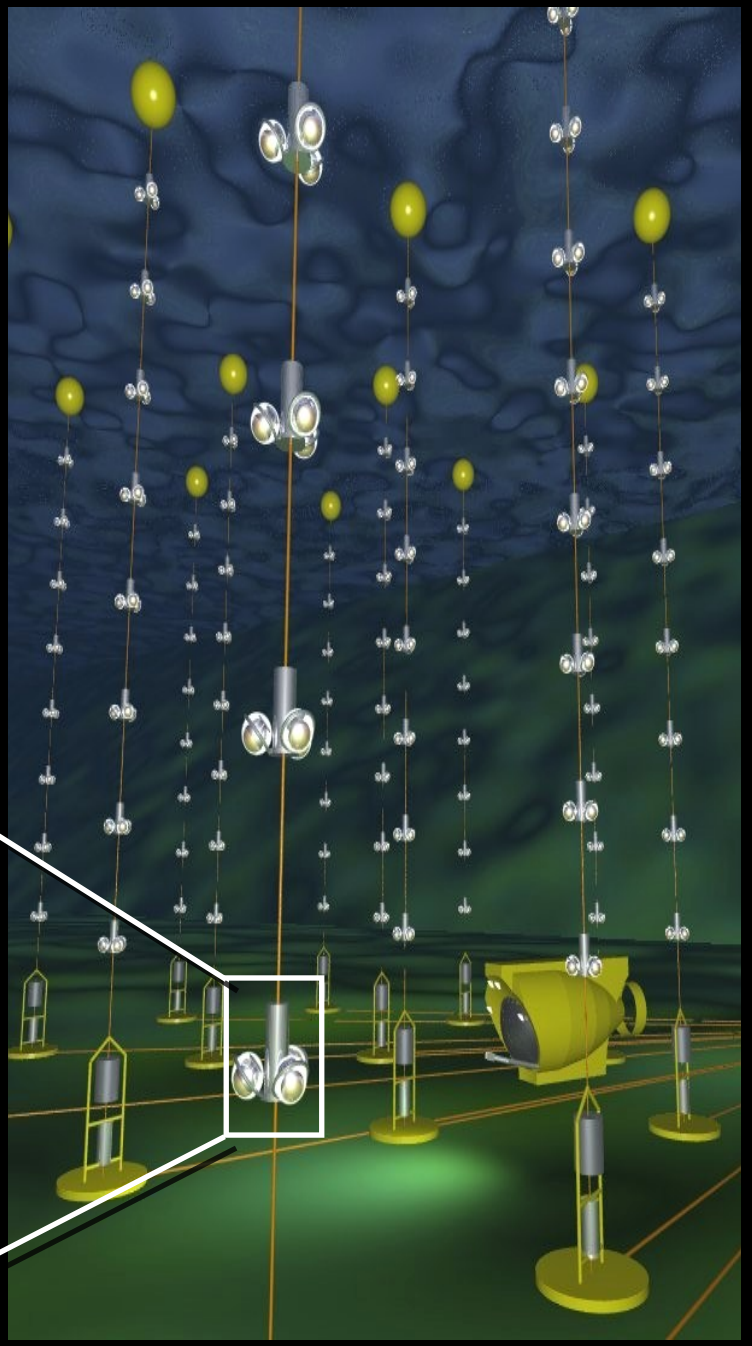
- Point back to the source
- Travel cosmological distances
- Escape from optically thick sources
- Are a clear sign for hadron acceleration

ANTARES

- 12 Lines (885 PMTs)
- Completion May 2008
- Instrumented volume: ~0.01 km^3

Shore station



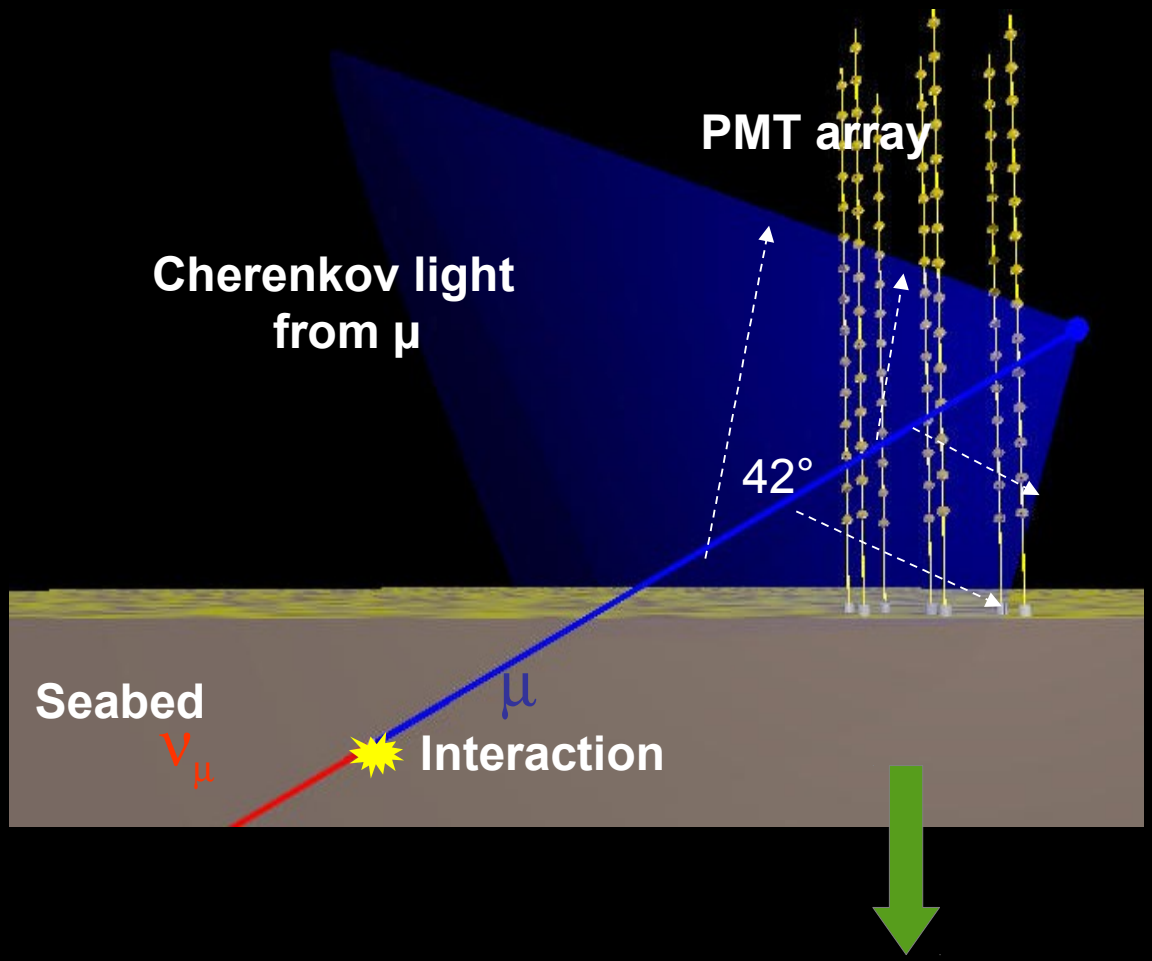


2100 m

2475 m

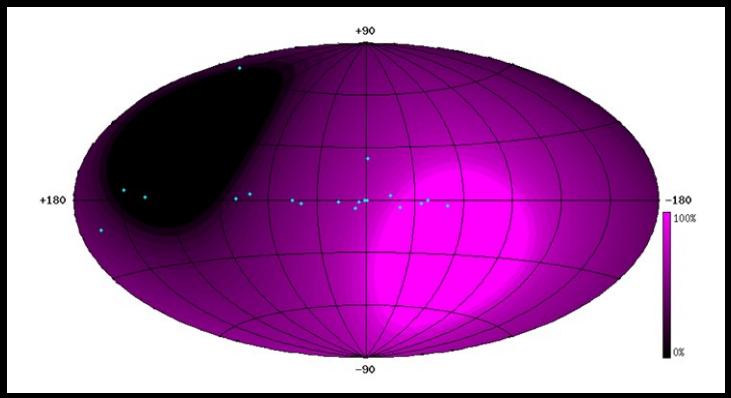
Antares Neutrino Telescope

Detection Principle

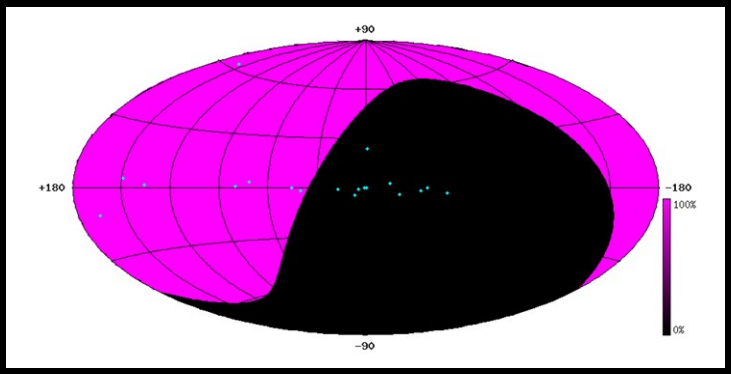


Back to muon (neutrino) direction

Visiblity for upgoing events
TeV-PeV



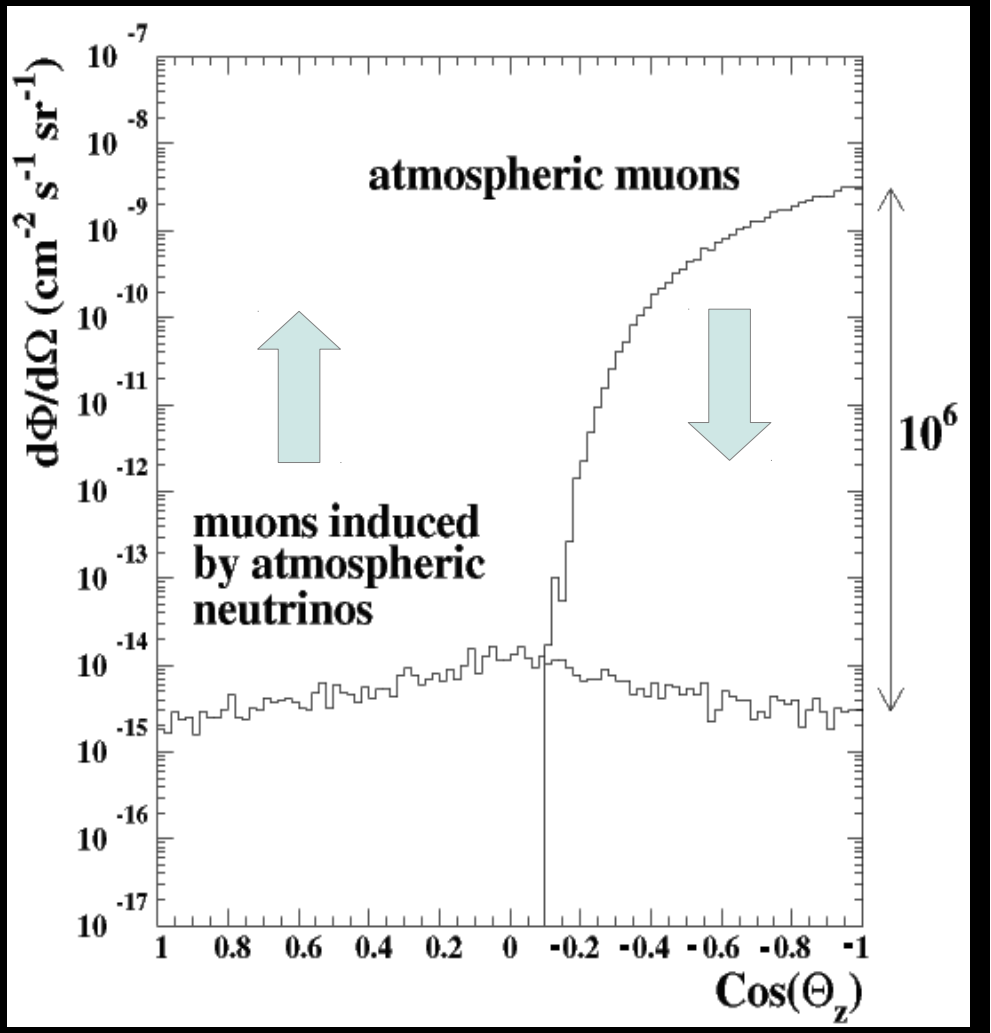
Mediterranean Sea, 43° North
Galactic Centre 2/3 of the time



South Pole

Physical Background : atmospheric muons and neutrinos

- **Cosmic vs atmospheric neutrinos: cosmic neutrinos are selected through dedicated cuts:**
  - **Select very energetic events**
    - ***Diffuse flux***
  - **Search for anisotropies, e.g.**
    - ***point sources***
    - **Fermi Bubbles**
  - **Time-space coincidence with other messengers, e.g.**
    - ***Gravitational waves***
    - **Flares, AGN (arXiv:1111.3473v1 [astro-ph.HE]), Microquasar**
    - **Alert system (Astrop. Physics V. 35, March 2012, 530–536)**

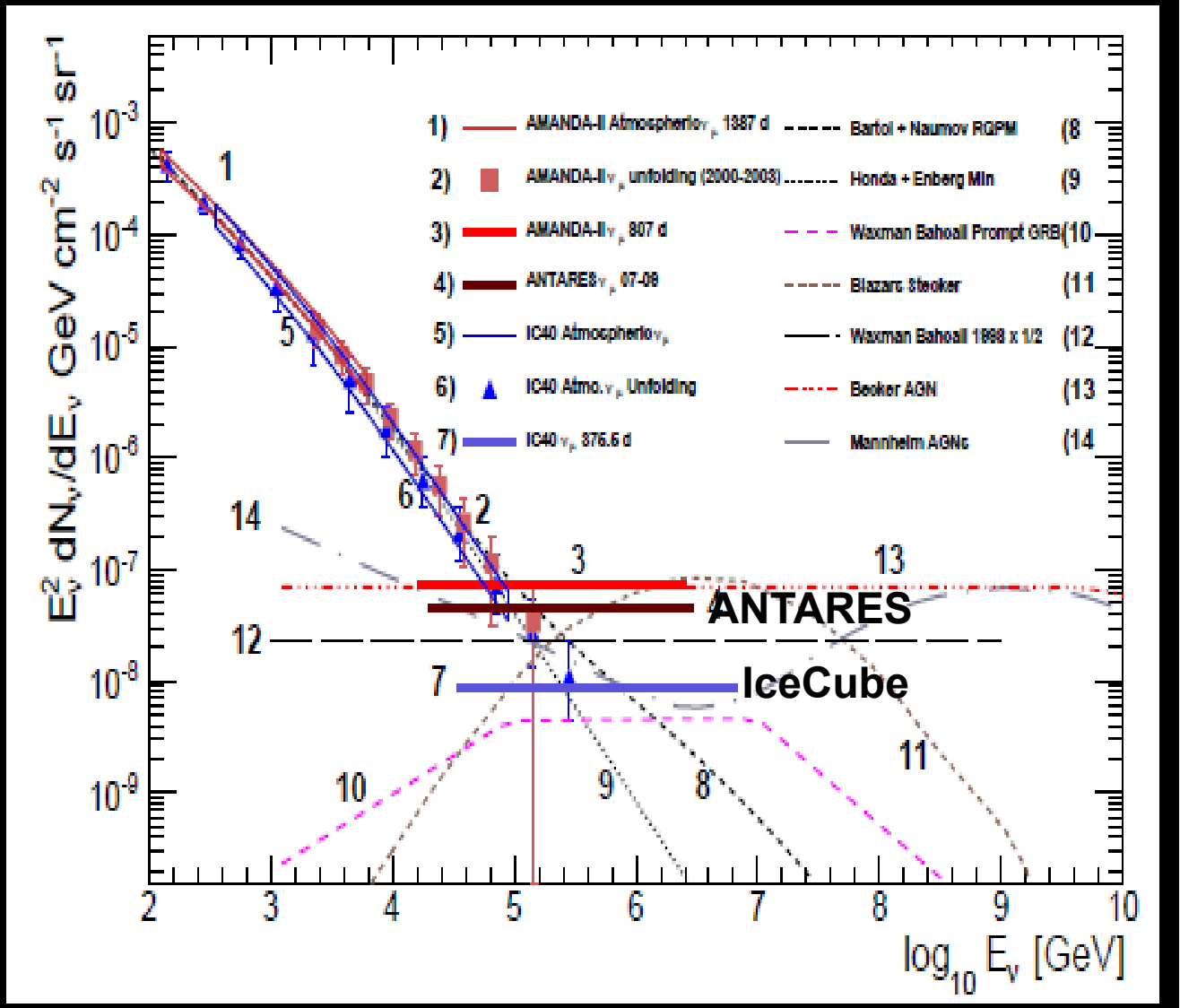


Search for a diffuse neutrino flux
All sky survey

Phys. Letter B696 (2011) 16-22 [arXiv:1011.3772]

- Data: 2007-2009
- Lifetime: 334 days
- 10 selected events
- No detection

The analysis will be updated using more data and sophisticated energy estimator

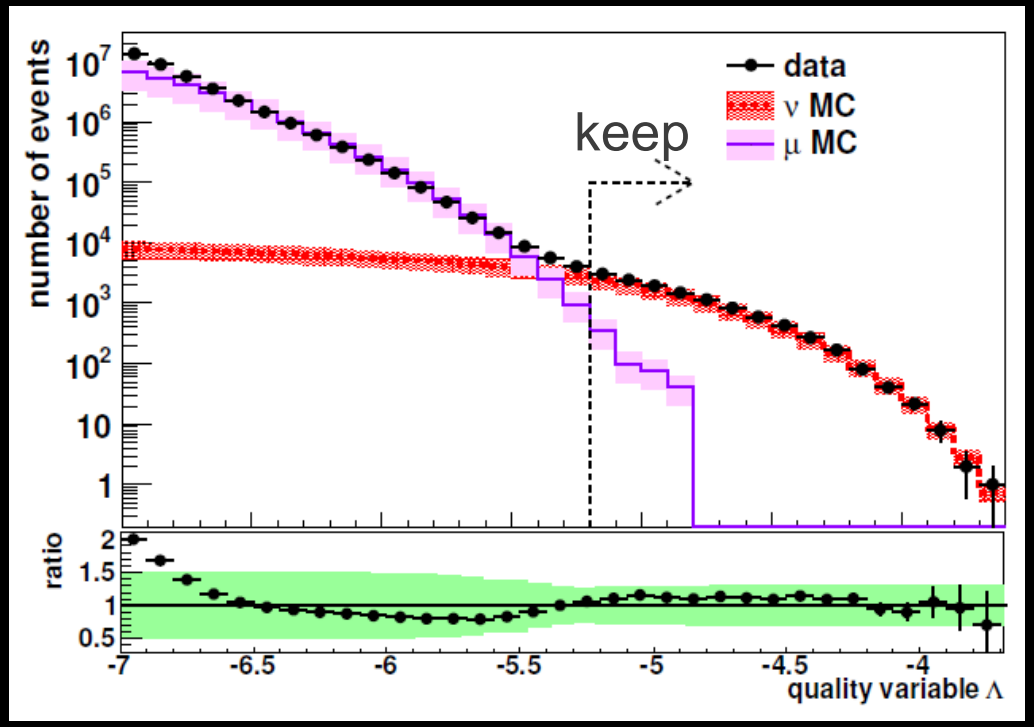


Taken from R. Abbasi et al. , Phys. Rev. D 84, 082001 (2011).

Search for point-sources

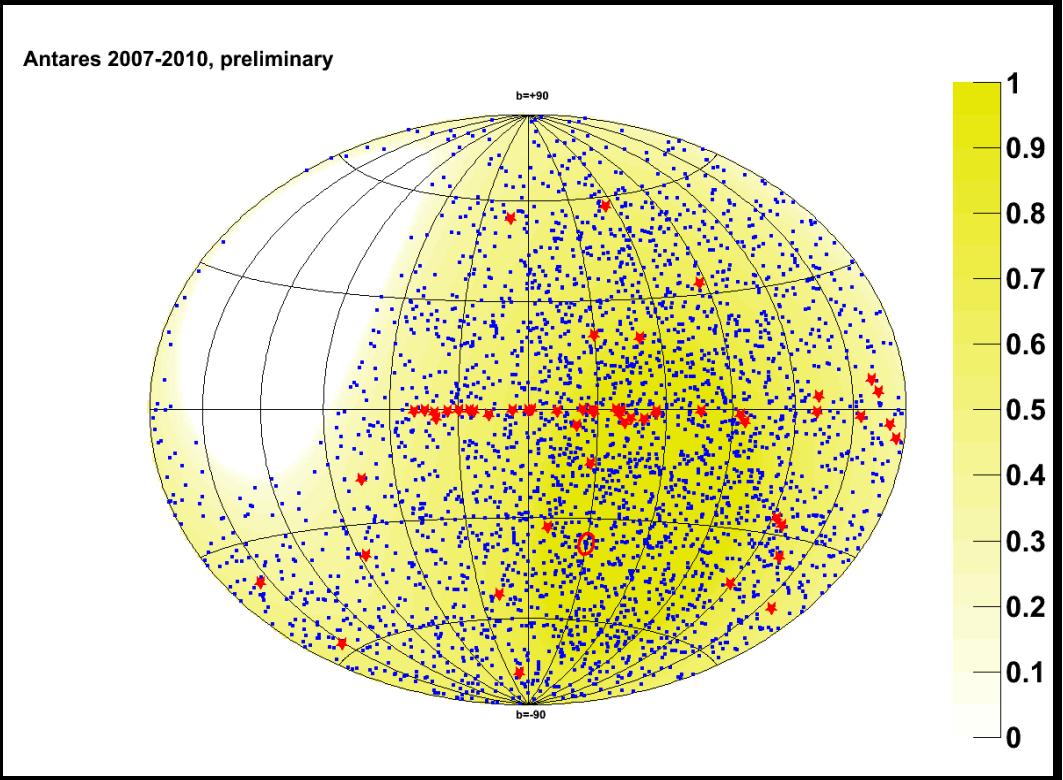
Astrophysical Journal Letters, 743:L14,2011 December 10
Th. Eberl et al arXiv:1205.2173 [astro-ph.HE]

- Data: 2007-2010
- 12 lines (813 days, 3058 events)
- Angular resolution for an E^{-2} spectrum: ~0.46° ± 0.1°



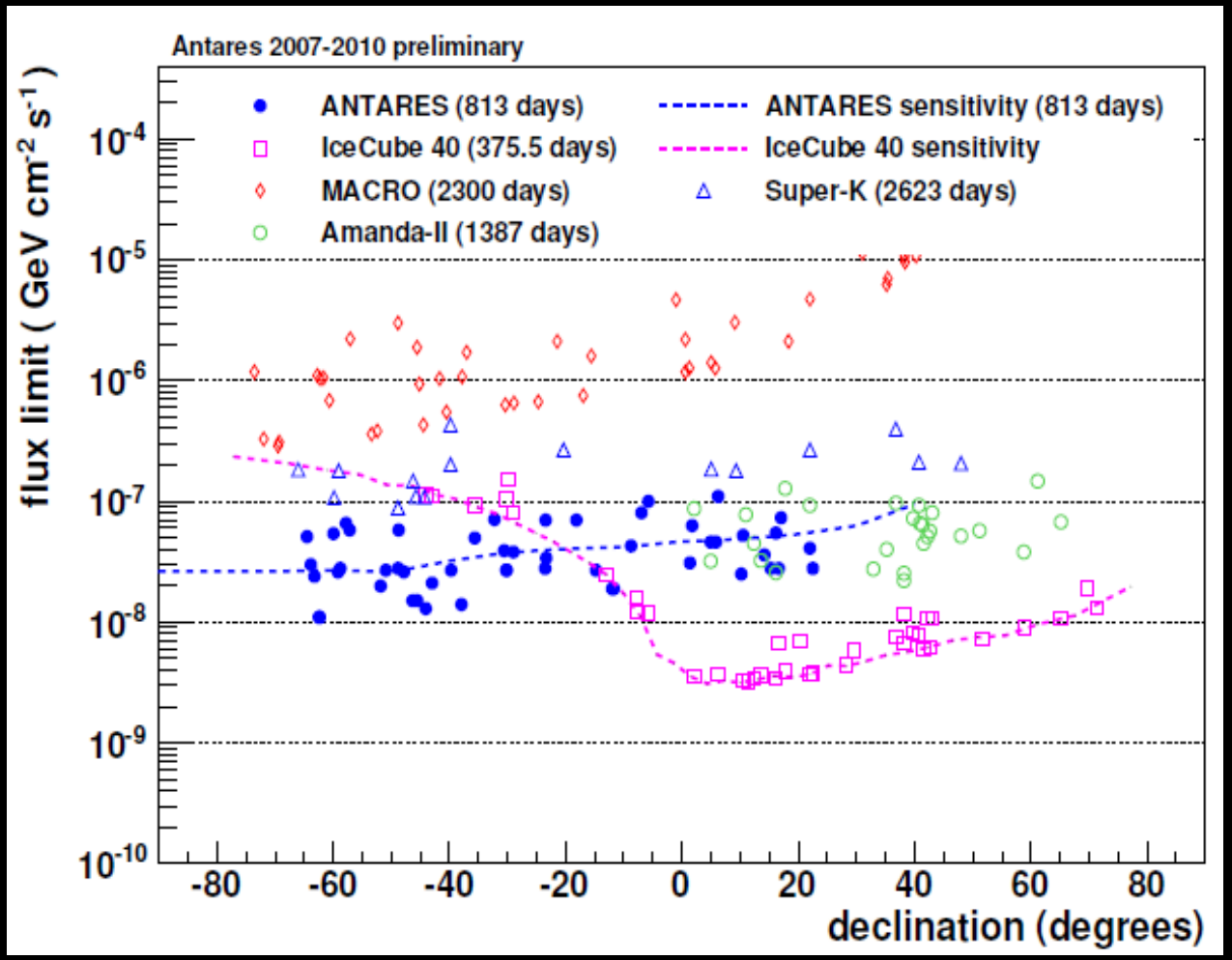
- blind all sky & 51 galactic and extragalactic sources
  - No significant excess

Galactic skymap of candidate events



Search for point-sources

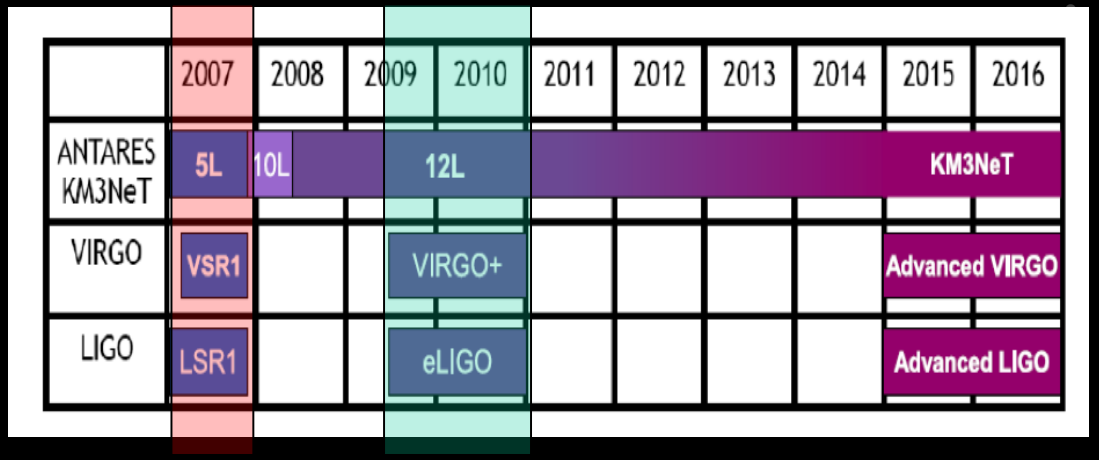
Upper limit on E^{-2} flux



Joint search of gravitational waves and high energy neutrino
ANTARES+LIGO+VIRGO

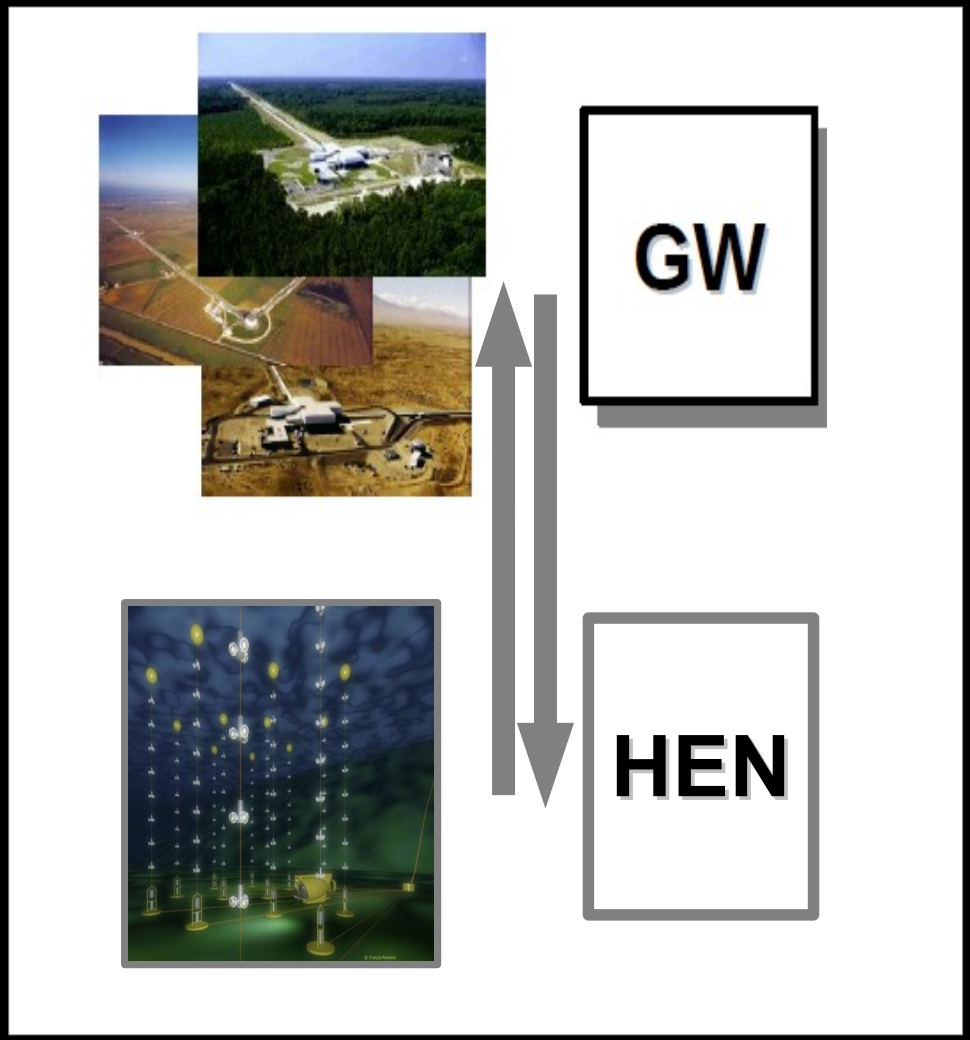
V. V. Elewyck *et al.* Int.J.Mod.Phys. D18 (2009) 1655-1659
B. Baret *et al.* Astropart.Phys. 35 (2011) 1-7
B. Baret *et al*. ArXiv:1112.1140
B.Bouhou et al arXiv:1201.2840v1 [astro-ph.HE]

Common data taking



Analysis Done On going

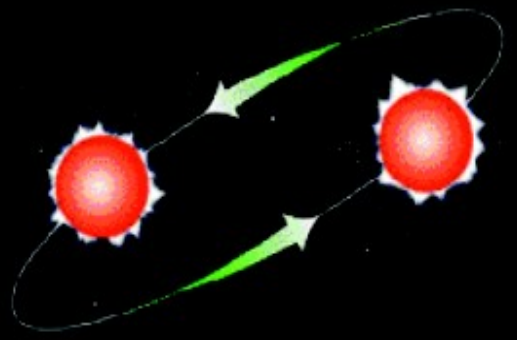
- Search for transient sources (e.g Long-GRBs, short GRBs)
- Possible detection of chocked GRBs
- Time window [-15, +15]min
- Triggered search: use HEN time and sky location as input for GW search



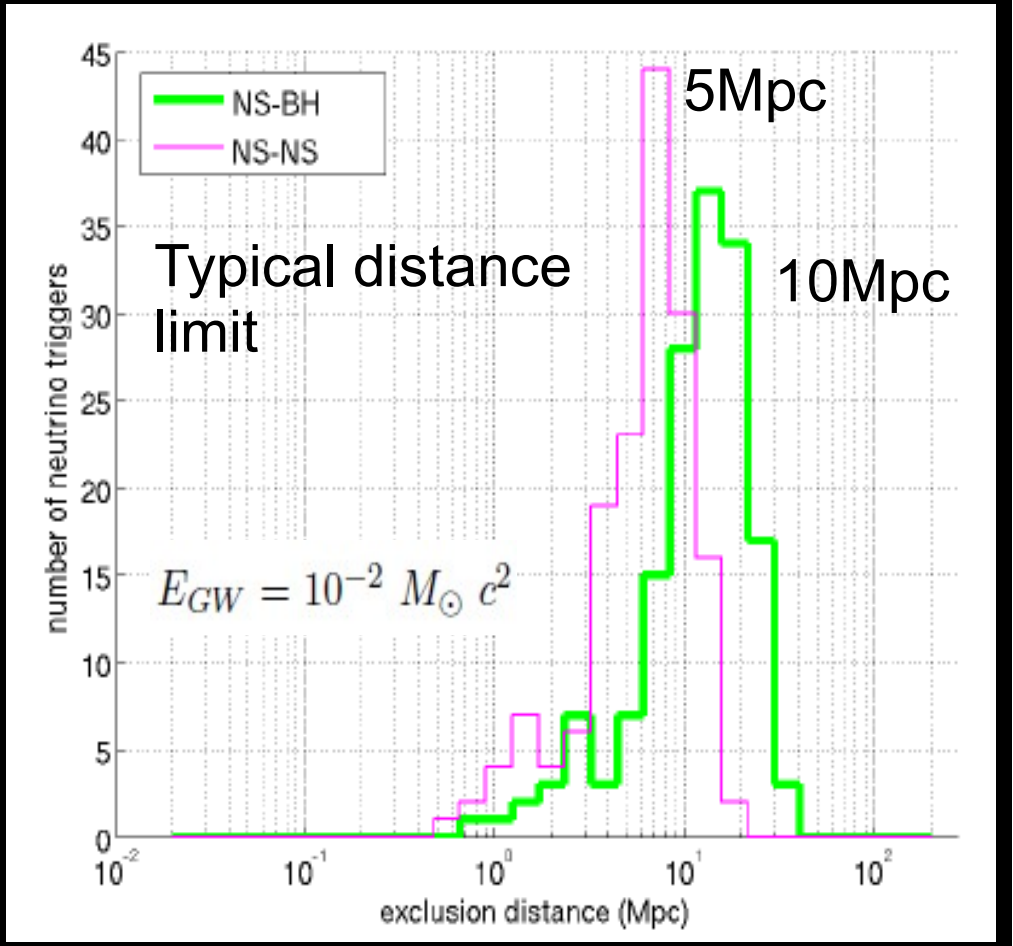
GW+HEN results: upper limit

arXiv:1205.3018v2 [astro-ph.HE]

- 2007 run (104 days, 158 neutrino events used as trigger)
- No coincident detection



Exclusion distance [60, 500] Hz



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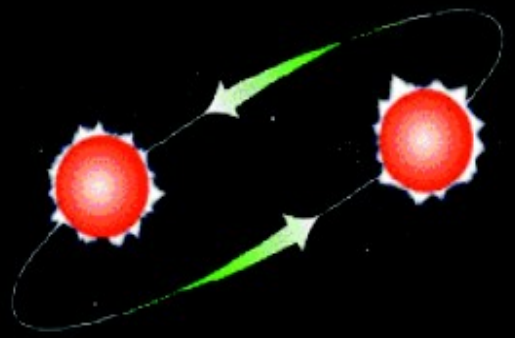

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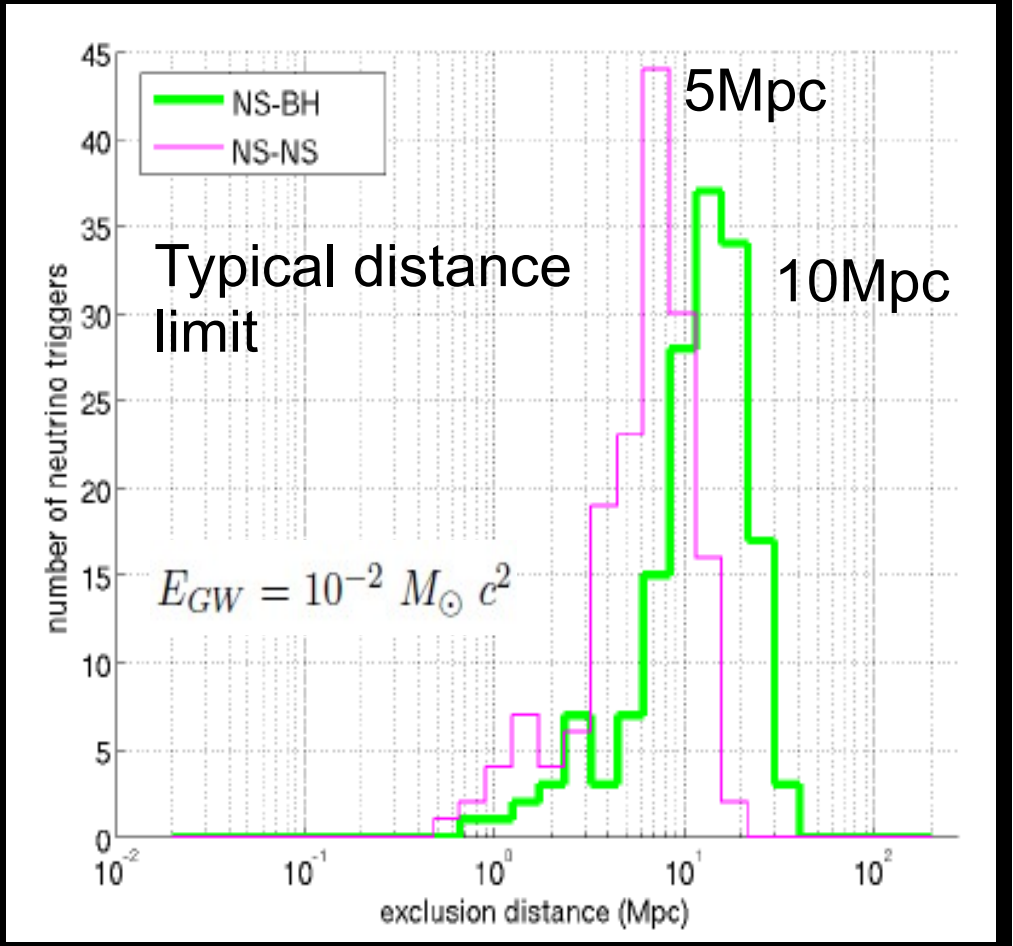

- Limits on the population density of
  - Long-GRB $\rho^{\mathrm{LGRB}}_{\text{GW-HEN}} \lesssim 10^{-3}\mathrm{Mpc}^{-3}\ \mathrm{yr}^{-1}$
  - Short-GRB $\rho^{\mathrm{SGRB}}_{\text{GW-HEN}} \lesssim 10^{-2}\mathrm{Mpc}^{-3}\ \mathrm{yr}^{-1}$

➡ Improvement of factor 2 (10) on the detection distance needed to constrain the fraction of star collapses (mergers) producing GW+HEN

Overview

- ANTARES complete and taking data since 2008 (12L)
  - Best limit in the northern hemisphere
  - Will be taking data until 2016
    - More results to come
- 1st step towards km3net