

# Neutrino fluxes from the Galactic plane and the ANTARES limits

Luigi Antonio Fusco  
University of Bologna and INFN – Sezione di Bologna

On behalf of the ANTARES Collaboration



# Overview

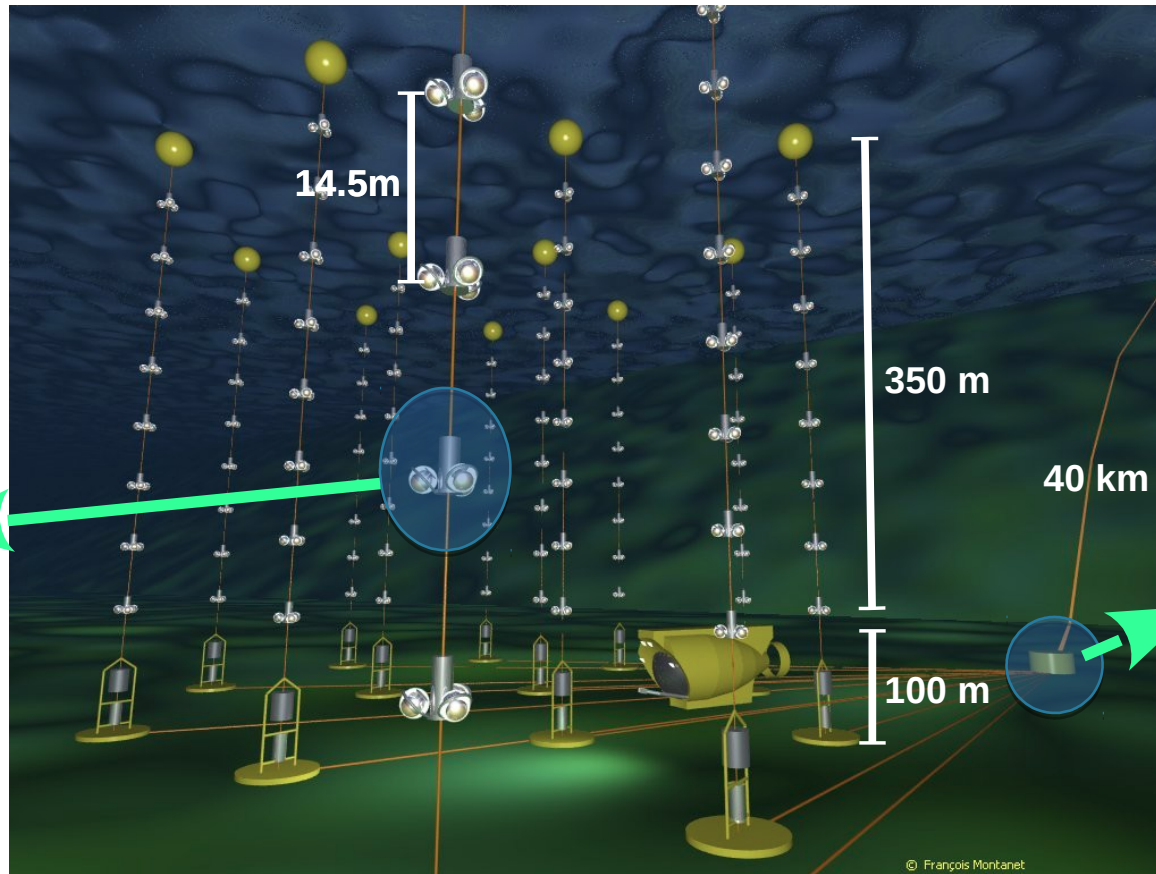
- The ANTARES neutrino telescope
- Searching for diffuse neutrinos from the Galactic Plane
- Sensitivity estimation and unblinding results

# The ANTARES detector

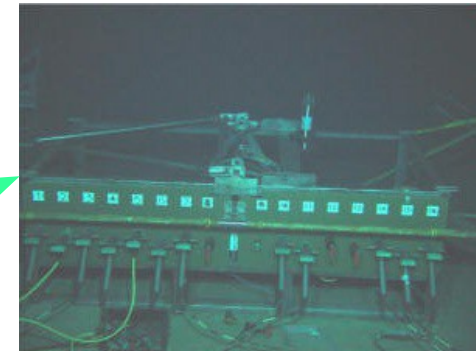
885 10" PMTs  
on 12 lines  
25 storeys/line  
3 PMTs / storey



storey



shore station

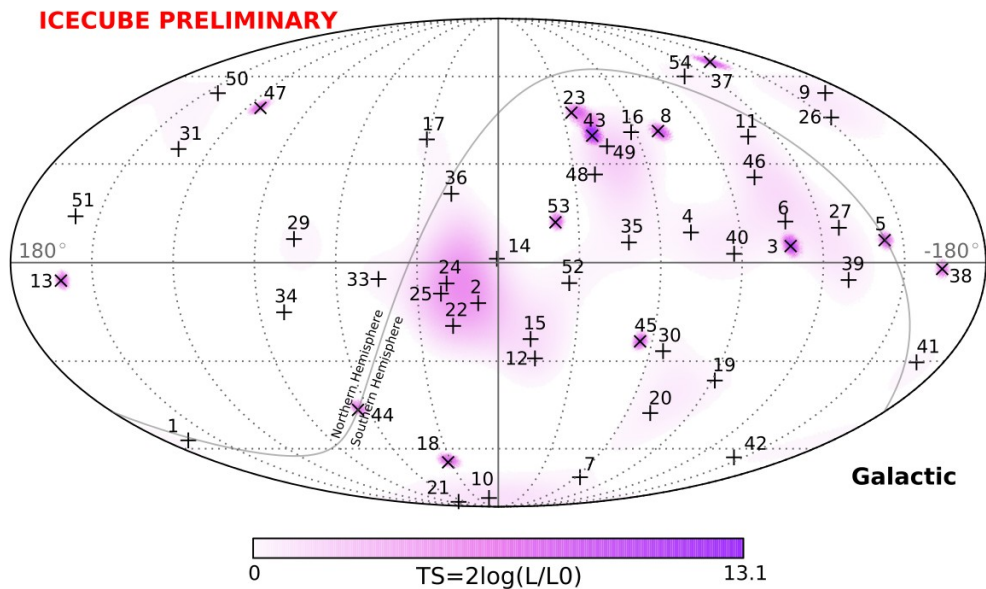


junction box

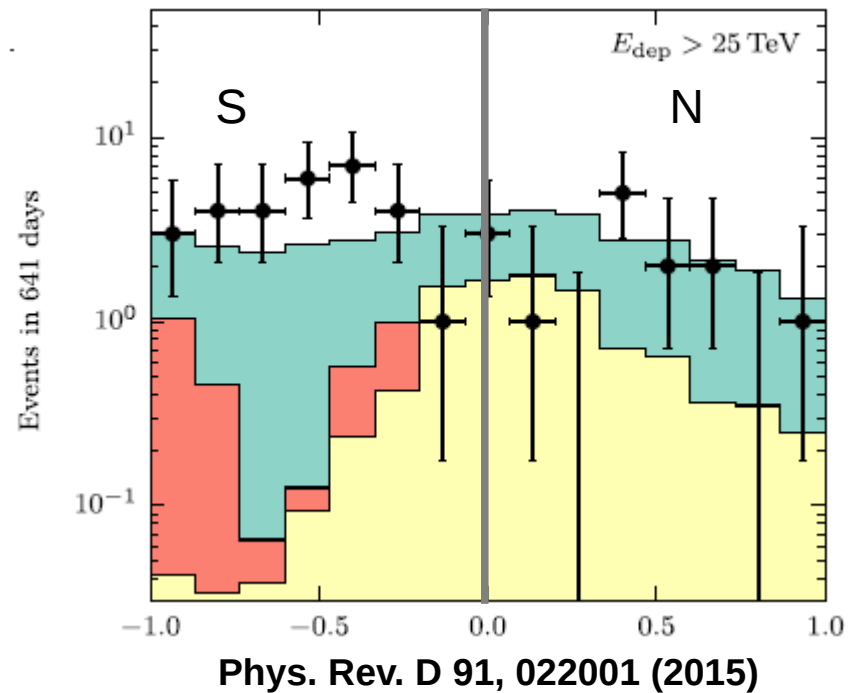
**In the Mediterranean Sea (Toulon): Southern sky visibility**  
**Depth of ~2500 m: atmospheric muon background reduced**

# The IceCube Signal

- First evidence of a diffuse cosmic flux of neutrinos → HESE
- $E^{-2.4 \pm 2.5}$  spectrum fits data



C. Kopper talk @ICRC 2015



- Some (possible) excess in the Southern Sky → Galactic Plane?

# An extended emission region

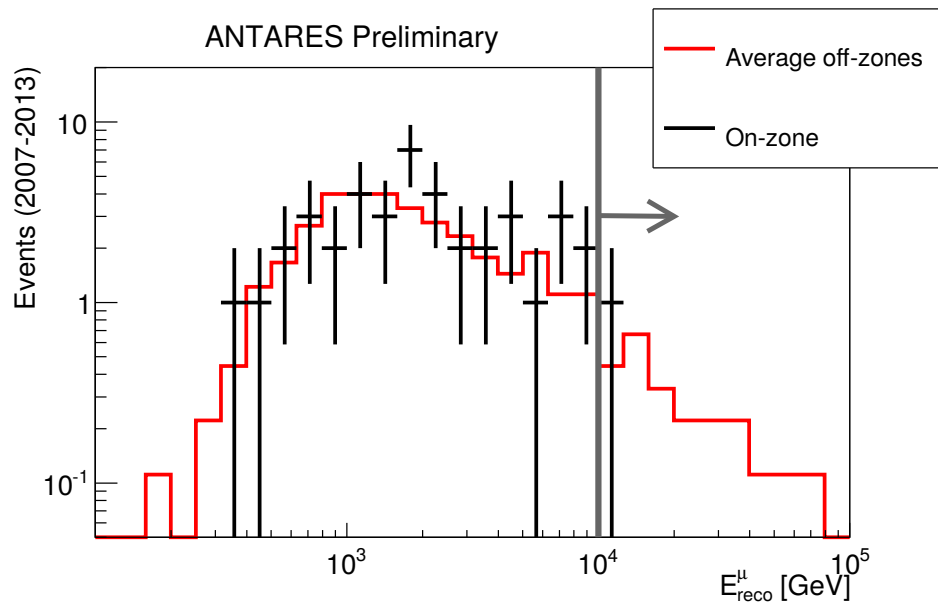
- IceCube signal mainly in the shower channel
  - Angular resolution 10 – 20°
  - Signal is compatible with isotropy
  - Smaller scale regions (such as the Galactic Plane) can produce part of the signal
- ANTARES looks at the Southern Sky
  - Upgoing muon tracks: much better angular resolution\*
    - 2007-2013 data, ~1600 days livetime
  - Effective areas in the Southern Sky are compatible in low energy regime
  - Part of an isotropic all sky signal from IceCube can appear as coming from an extended region.

\*sub degree resolution for tracks.  
But also a few degrees for showers

# Search method

- Assuming a signal spectrum proportional to  $E^{-2.4 \div 2.5}$ 
  - Optimised event selection with the Model Rejection Factor procedure:
    - Track quality parameters to reject wrongly reconstructed atmospheric muons
    - Energy estimation to suppress atmospheric background
- Signal region:
  - Galactic plane area:  $|l| < 40^\circ$  and  $|b| < 3^\circ$
- Background estimated from data:
  - Off-zones for which the telescope has the same exposure
  - Compare to the event rates from the signal region to the average from off-zones

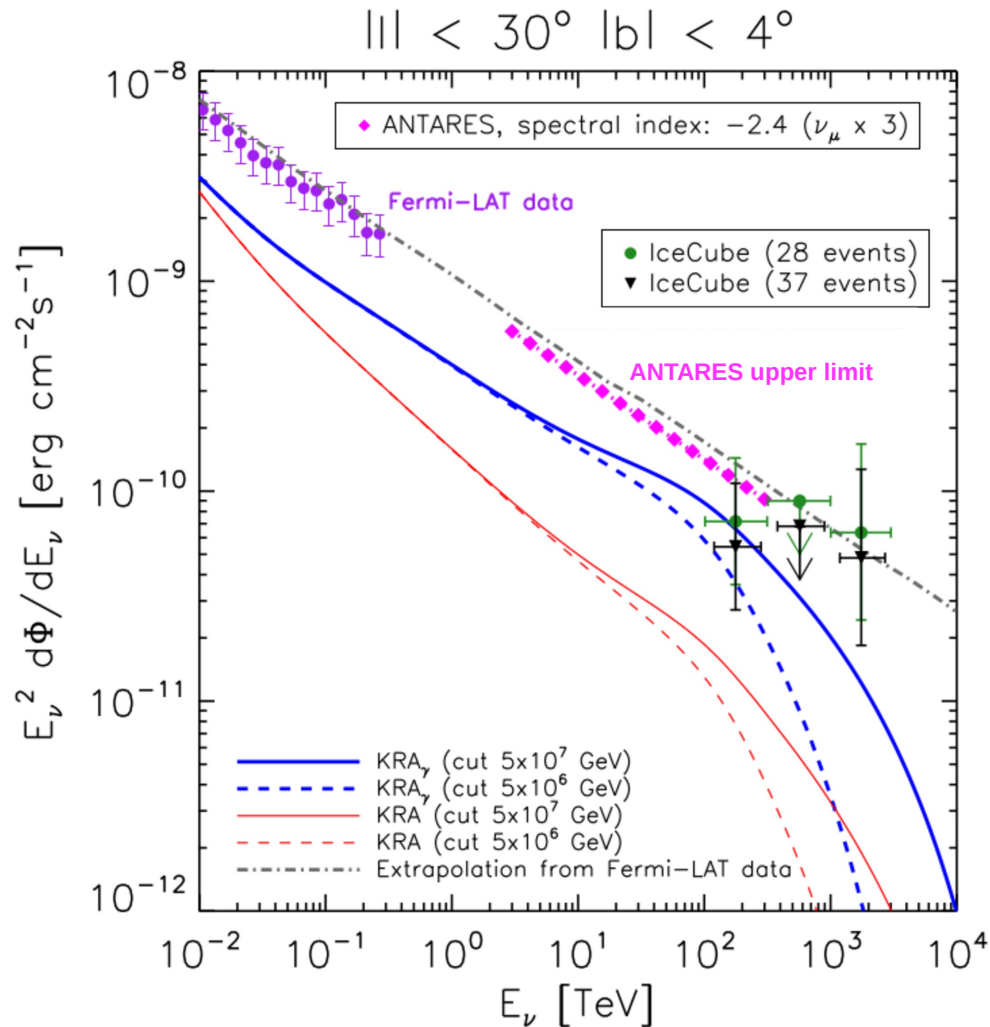
# Unblinded results



Reconstructed energy distribution  
for ON/OFF zones

- **2.5** events expected from background data regions
- **1** event is observed in the signal region
- Fully compatible with background expectations
- Upper limits corresponding to the sensitivity

# Upper limits compared to Galactic Plane models



$$\Phi^{90\% \text{C.L.}} = 2.0 E^{-2.4} \text{ GeV}^{-1} \text{ s}^{-1} \text{ sr}^{-1} \text{ cm}^{-2}$$

$$\Phi^{90\% \text{C.L.}} = 6.0 E^{-2.5} \text{ GeV}^{-1} \text{ s}^{-1} \text{ sr}^{-1} \text{ cm}^{-2}$$

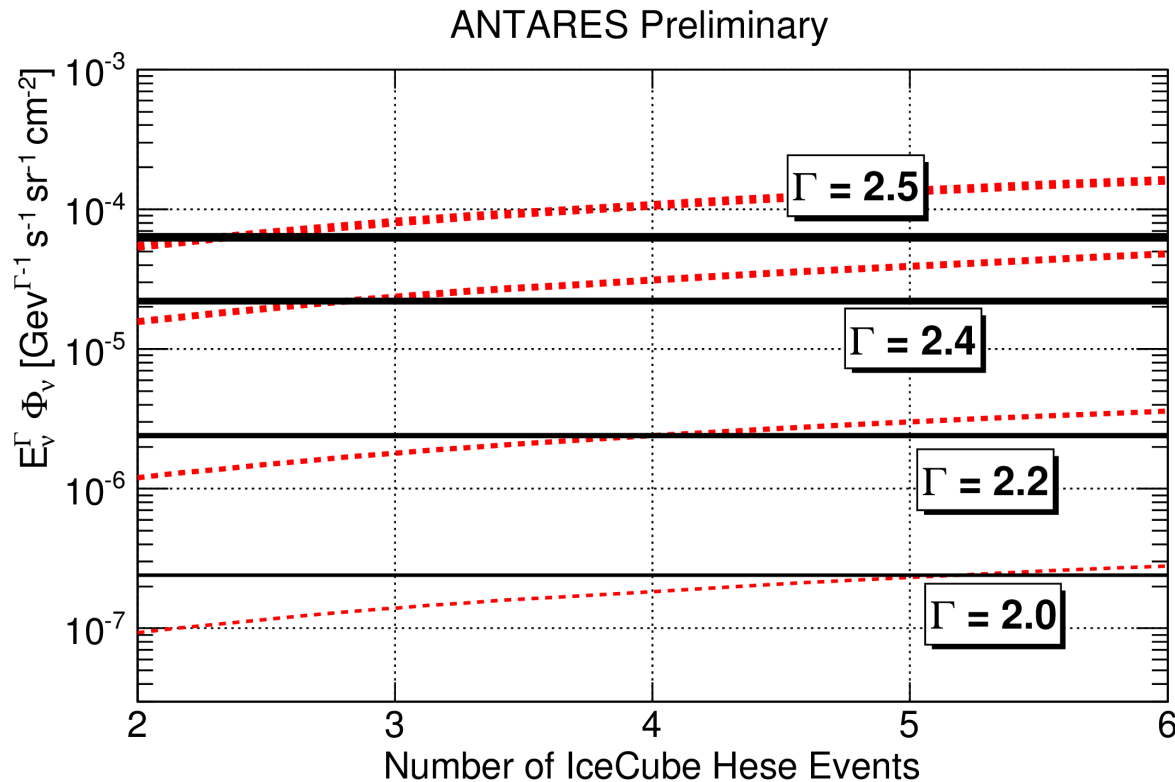
ANTARES 90% C.L. upper limit is below the expectation from *Neronov et al.* extrapolating Fermi-LAT data to IceCube energies  $\rightarrow$  limit on the hadronic component of Fermi diffuse flux.

KRA model (see A. Marinelli's talk) close to the sensitivity  
 $\rightarrow$  larger detector needed  $\rightarrow$  **KM3NeT!**



# Sensitivity to the IceCube signal

## 0.1 sr region



The upper limit can also constrain any model producing a certain number of events in the IceCube HESE coming from a small region of the sky

Soft spectra giving more than 2 events can be excluded

# Conclusions and outlook

- ANTARES is the largest underwater neutrino telescope, in its 8<sup>th</sup> year of operation.
- Good performance in Southern Sky searches thanks to its resolution and effective area.
- First stringent limits on the diffuse neutrino flux coming from the Galactic Plane.
  - Adding cascade events can improve this results.
- More to come → towards KM3NeT