Search for an enhanced emission of neutrinos from the Southern Sky with the ANTARES telescope

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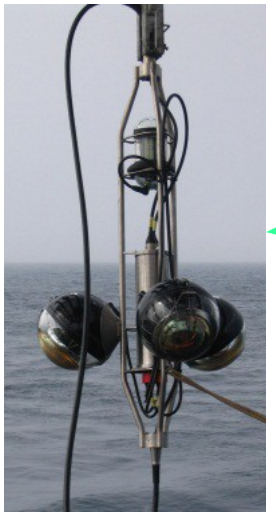
On behalf of the ANTARES Collaboration

Overview

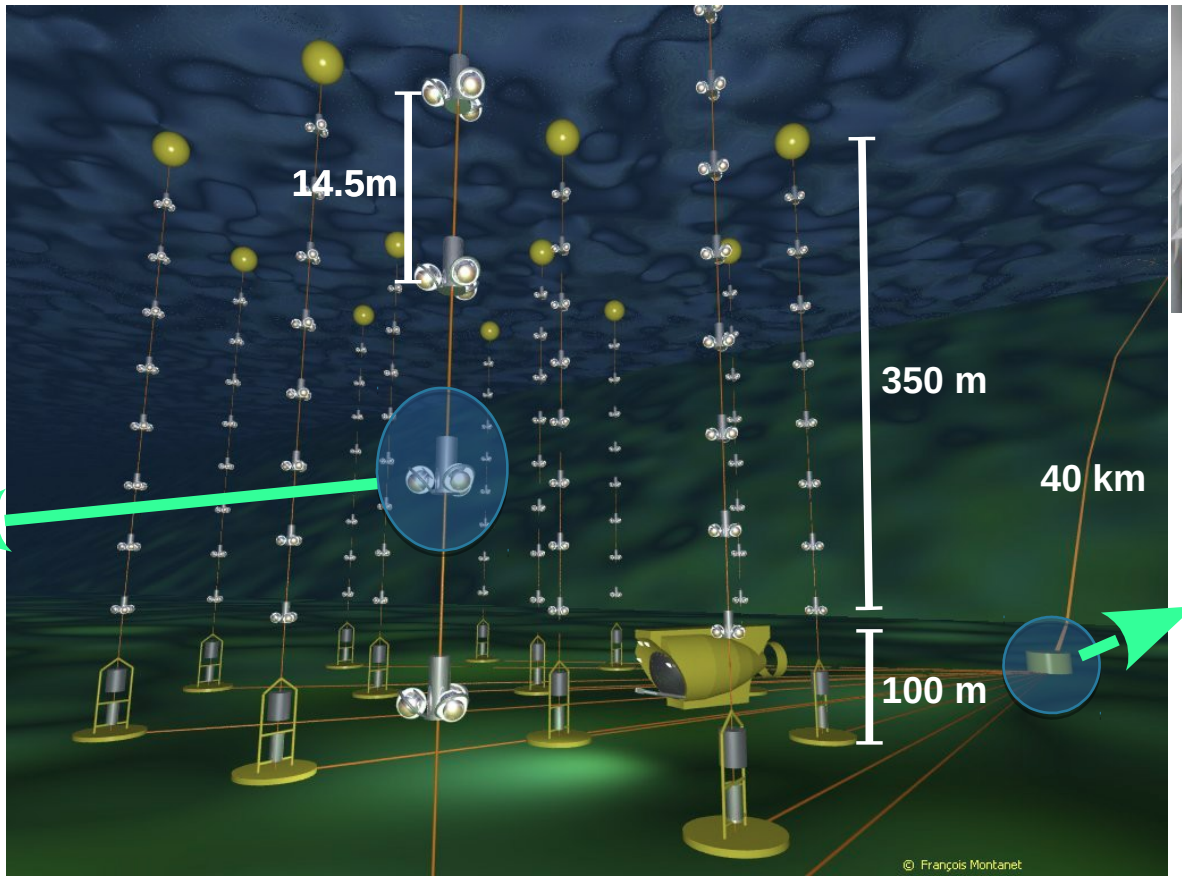
- The ANTARES neutrino telescope
- Search for diffuse fluxes of neutrinos from an enhanced emission scenario
  - Trying to explain the IceCube signal
  - Southern Sky emission region hypothesis
- Sensitivity estimation and unblinding results

The ANTARES detector

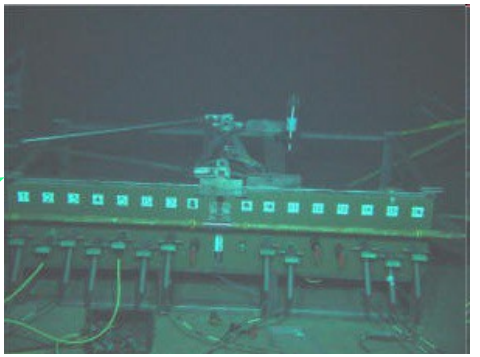
885 10” PMTs
on 12 lines
25 storeys/line
3 PMTs / storey



storey



shore station

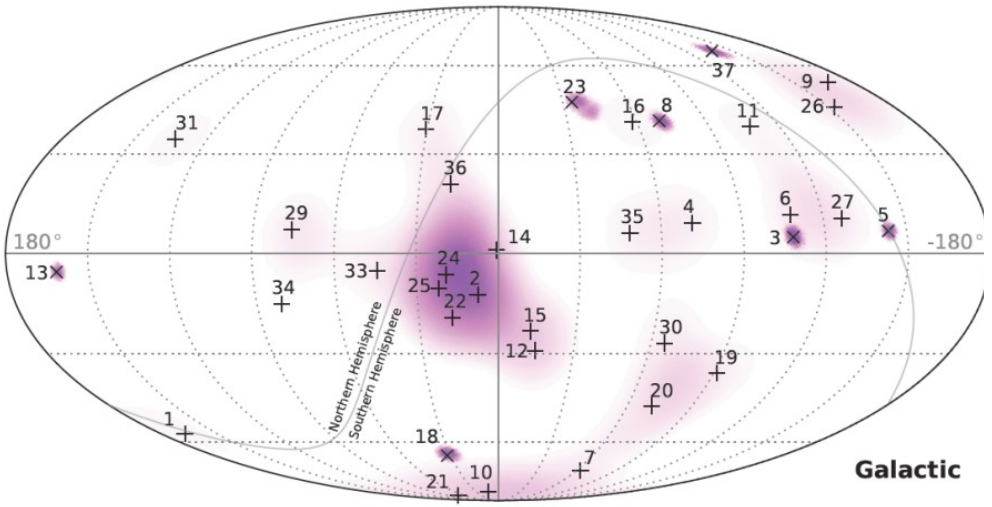


junction box

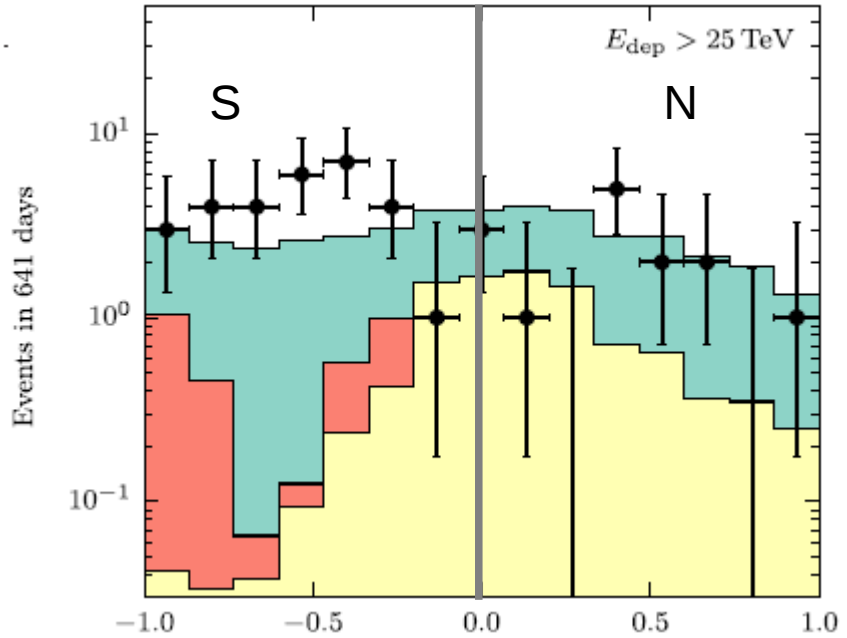
In the Mediterranean Sea (Toulon): Southern sky visibility
Depth of ~2500 m: atmospheric muon background reduced

The IceCube Signal

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



Phys. Rev. Lett. 113, 101101 (2014)



Phys. Rev. D 91, 022001 (2015)

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

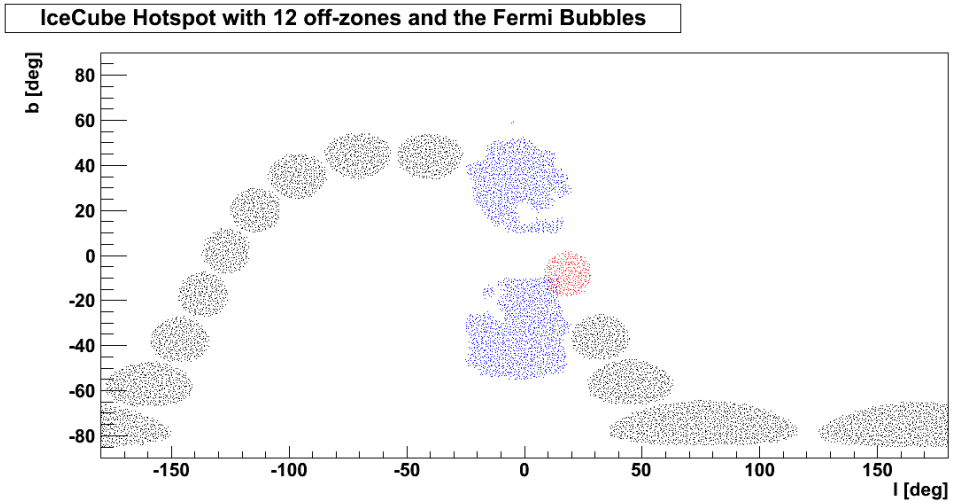
An extended emission region

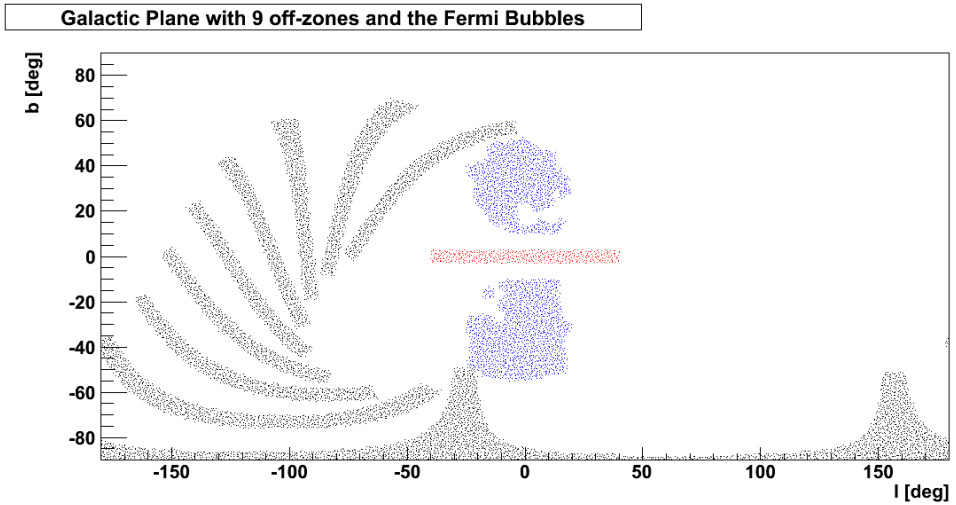
- IceCube signal mainly in the shower channel
  - Angular resolution ~20°
    → Signal is compatible with isotropy
  - Smaller scale regions can produce part of the signal
- ANTARES looks at the Southern Sky
  - Upgoing muon tracks: much better angular resolution
    - 2007-2013 data, ~1500 days livetime
  - Effective areas in the Southern Sky are compatible in low energy regime
  - An isotropic all sky signal from IceCube can appear as coming from an extended region.

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 to be defined:
  - 10° circle around the IceCube “hotspot”
  - Galactic plane area
- 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

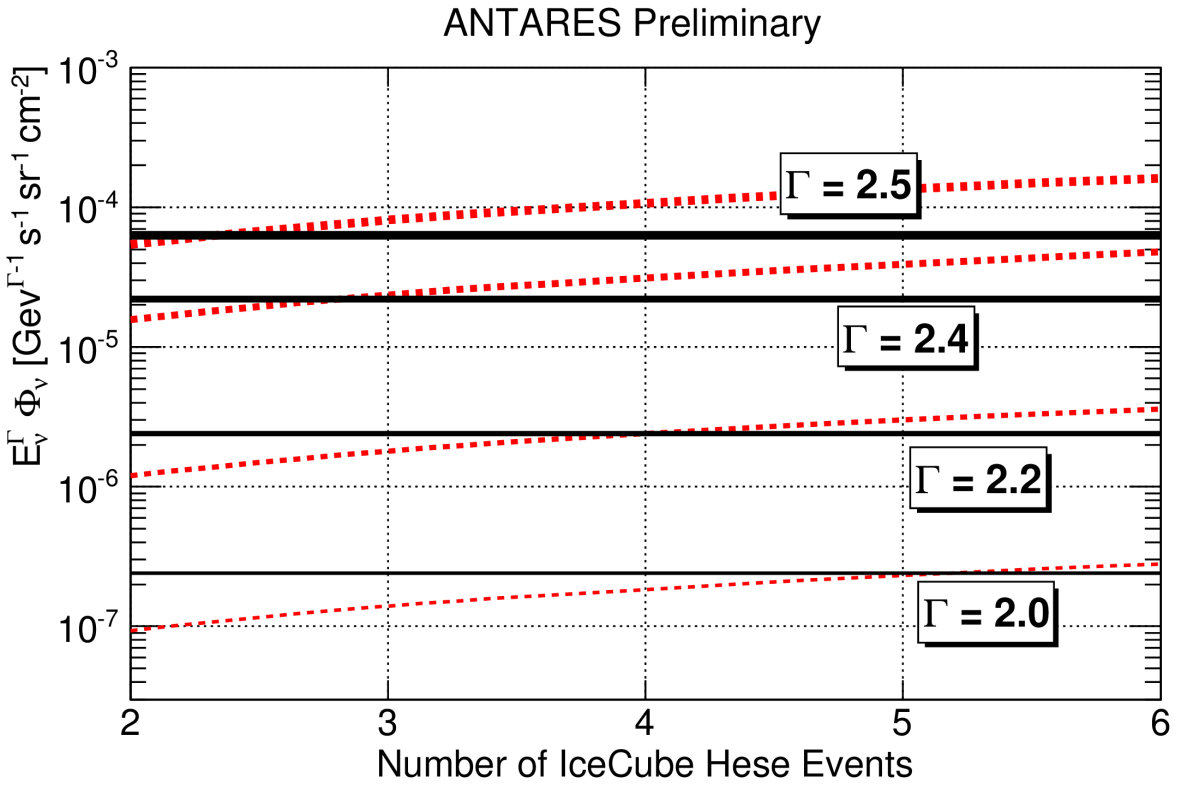
Search method





- Sensitivity depends on the N_{bkg}/Ω
  - Similar exposure for different regions gives same background expectations
- One optimised selection for both regions and spectral indices
  - Differences ~5% with respect to full optimisation
  - The result still holds for analogous regions of the sky

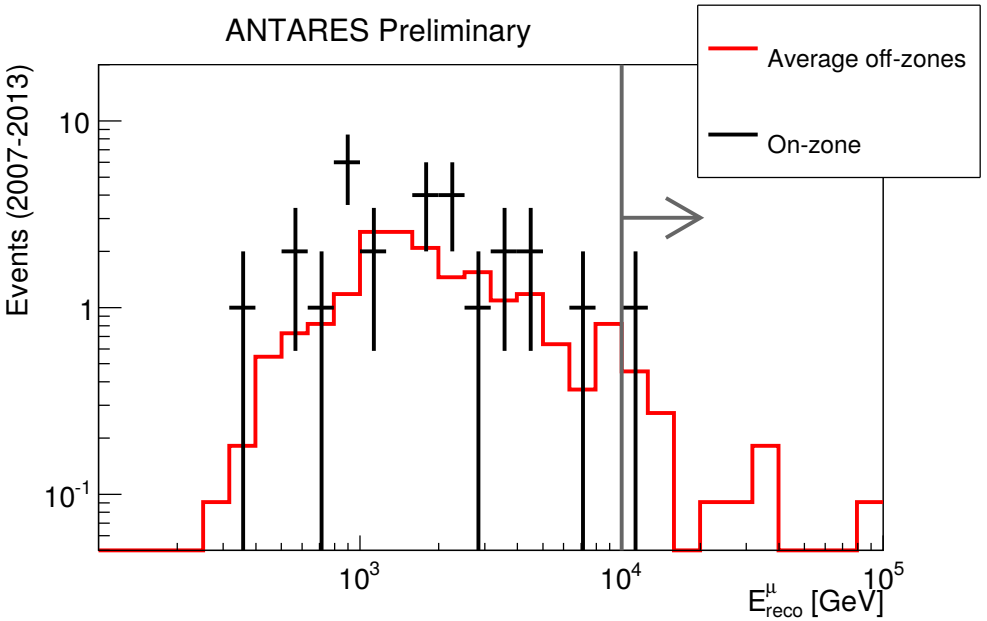
Sensitivity to the IceCube signal

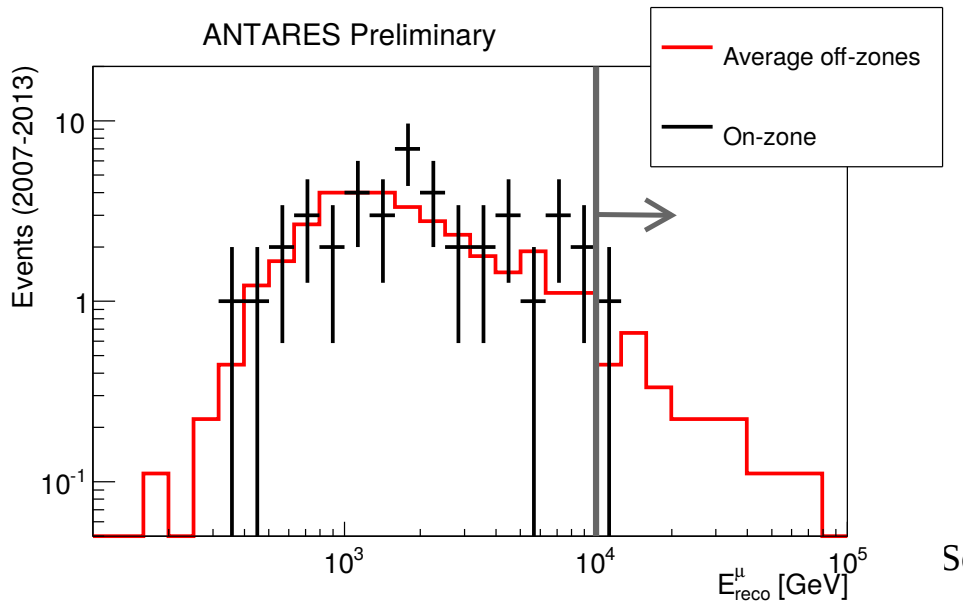


Sensitivity compared to the expected flux producing a certain number of events in the IceCube HESE coming from a 0.1 sr region

ANTARES can exclude many hypothesis for the origin of IceCube signal

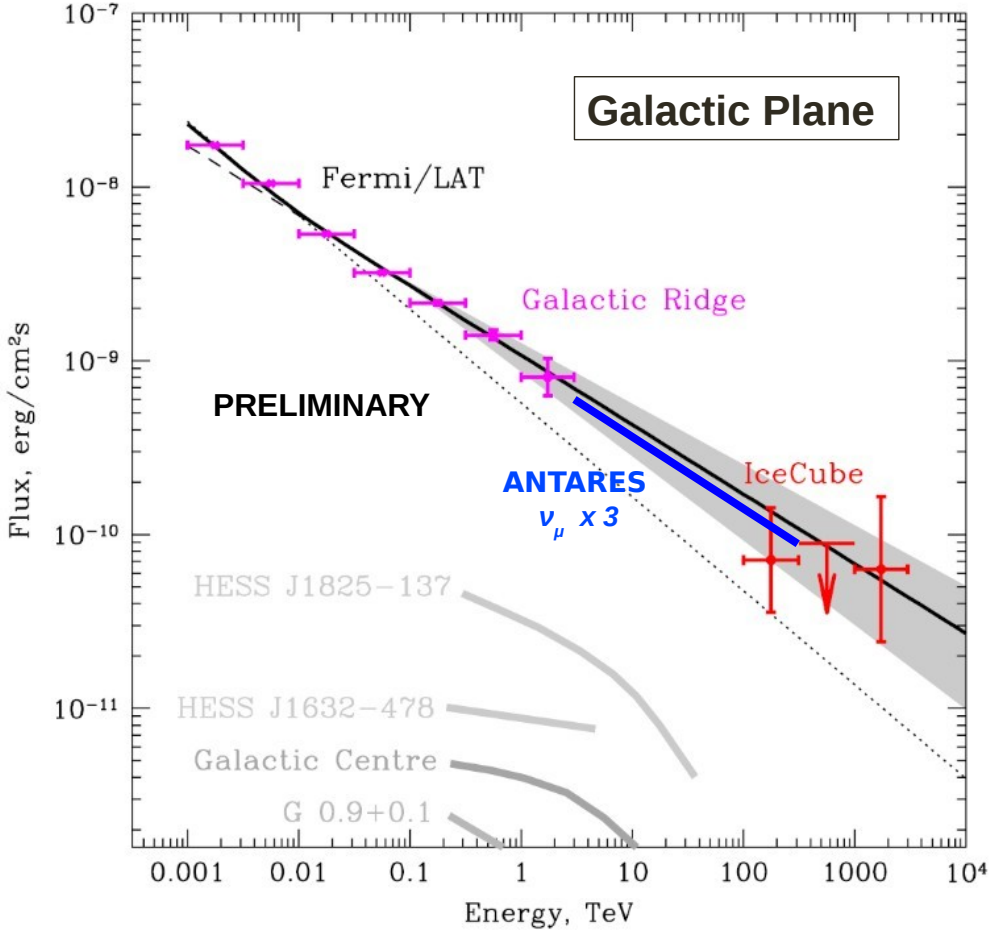
Unblinded results



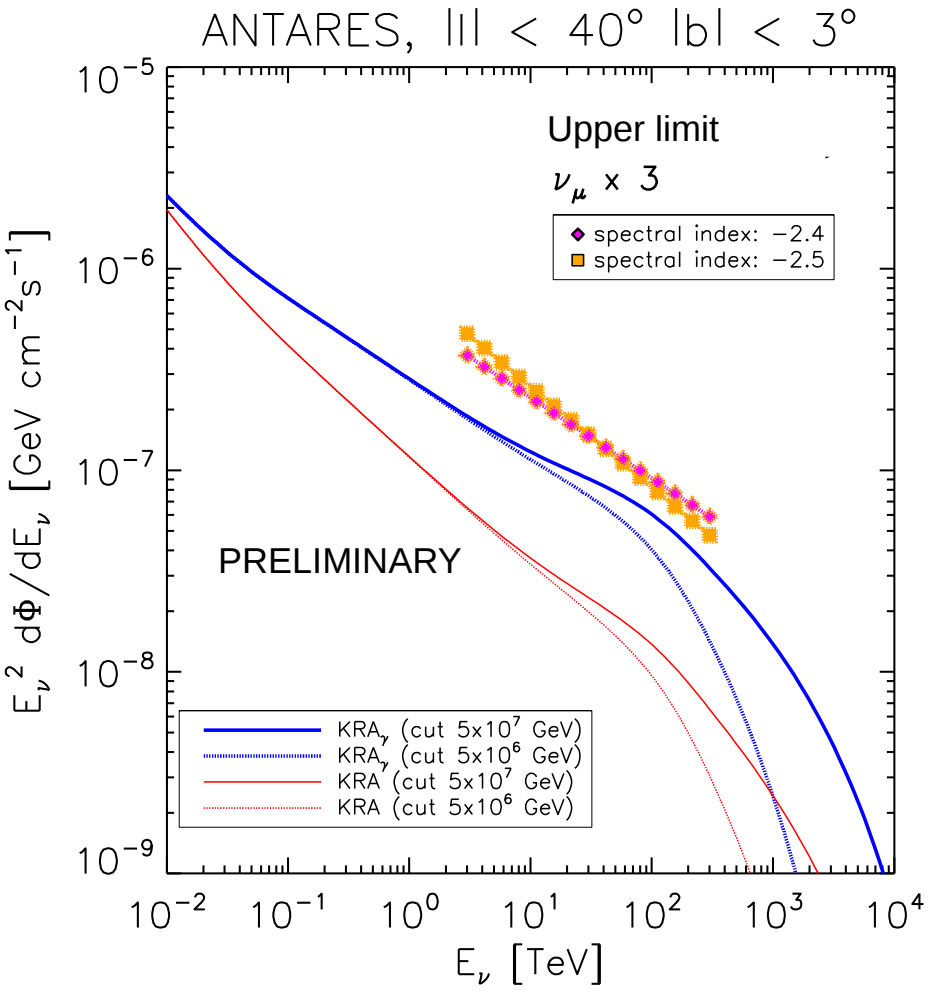


- 1.0 and 2.5 events expected from background only for the HS and the GP respectively
- 1 event is observed in both the two signal regions
- Fully compatible with background expectations
- Upper limits corresponding to the sensitivity

Upper limits compared to Galactic Plane models



Lines from Phys. Rev. D 89, 103002 (2014)



Lines from arXiv:1504.00227 (2015)

Conclusions and outlook

- Antares is the largest underwater neutrino telescope, in its 8th year of operation.
- Good performance in Southern Sky searches thanks to its resolution and effective area.
- Stringent upper limits on the possible origin of the IceCube signal from an extended region in the Southern Sky.