

# Predicted sensitivity of the KM3NeT/ARCA detector to a diffuse flux of cosmic neutrinos

**Luigi Antonio Fusco**<sup>1</sup>, Rosa Coniglione<sup>2</sup> and Dominik Stransky<sup>3</sup>  
On behalf of the KM3NeT Collaboration

<sup>1</sup> University of Bologna and INFN – Sezione di Bologna

<sup>2</sup> INFN – Laboratori Nazionali del Sud

<sup>3</sup> Erlangen Center for Astroparticle Physics

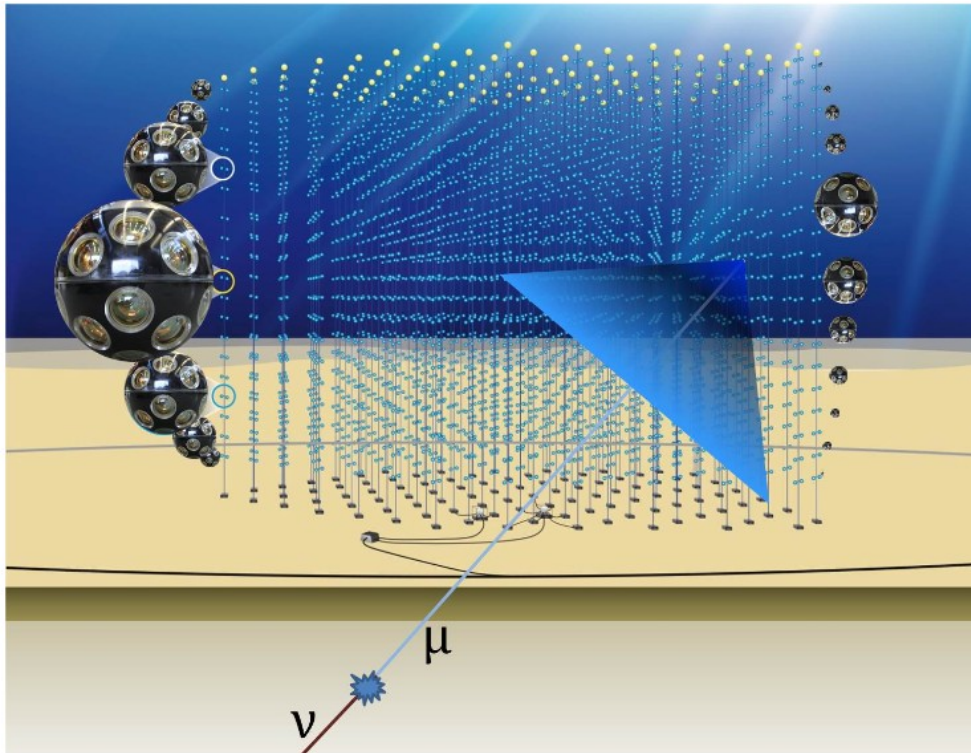
VLVnT 2015 Workshop  
Rome, 14th – 16th September 2015

# Outline

- The KM3NeT/ARCA detector
- Searching for the IceCube signal in all-sky analyses
- The Galactic Plane view
- Perspectives

# The KM3NeT/ARCA detector

- Part of the next generation Mediterranean neutrino observatory
  - Devoted to high energy neutrino astronomy
- 1 km<sup>3</sup> instrumented volume to be installed at the KM3NeT-It site



## Detector design:

- Detection Unit (DU): slender string anchored to the sea-bed;
- 18 multi-PMT DOM on each DU;
- 31 3" PMT per DOM;
- 36 m spacing between DOMs;
- 90 m spacing between DUs;

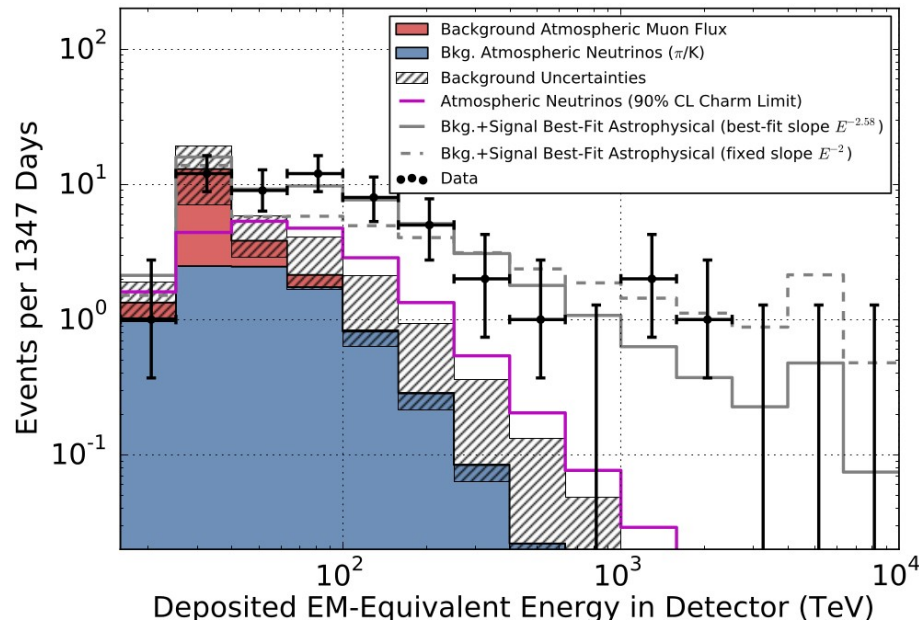
KM3NeT/ARCA will be made of 2 building blocks with 115 DUs each

# The IceCube signal

Plots from ICRC talks

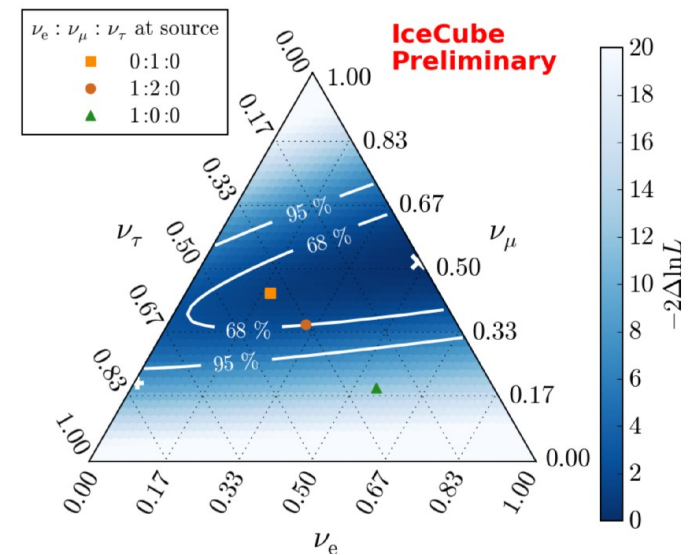
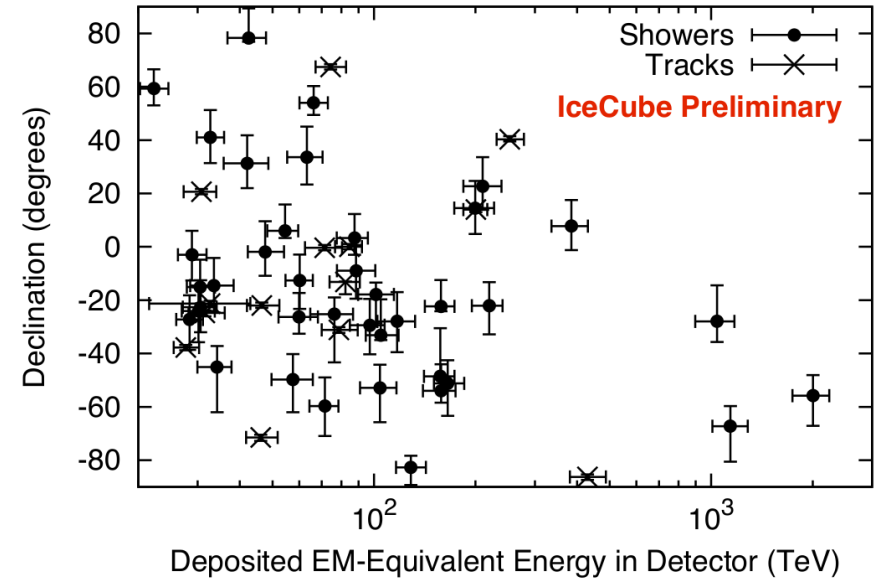
- First detection of astrophysical neutrinos:

- Isotropic diffuse flux;
- 1:1:1 flavour ratio;
- Power law spectrum (broken?).



VLVnT 2015

KM3NeT/ARCA diffuse searches



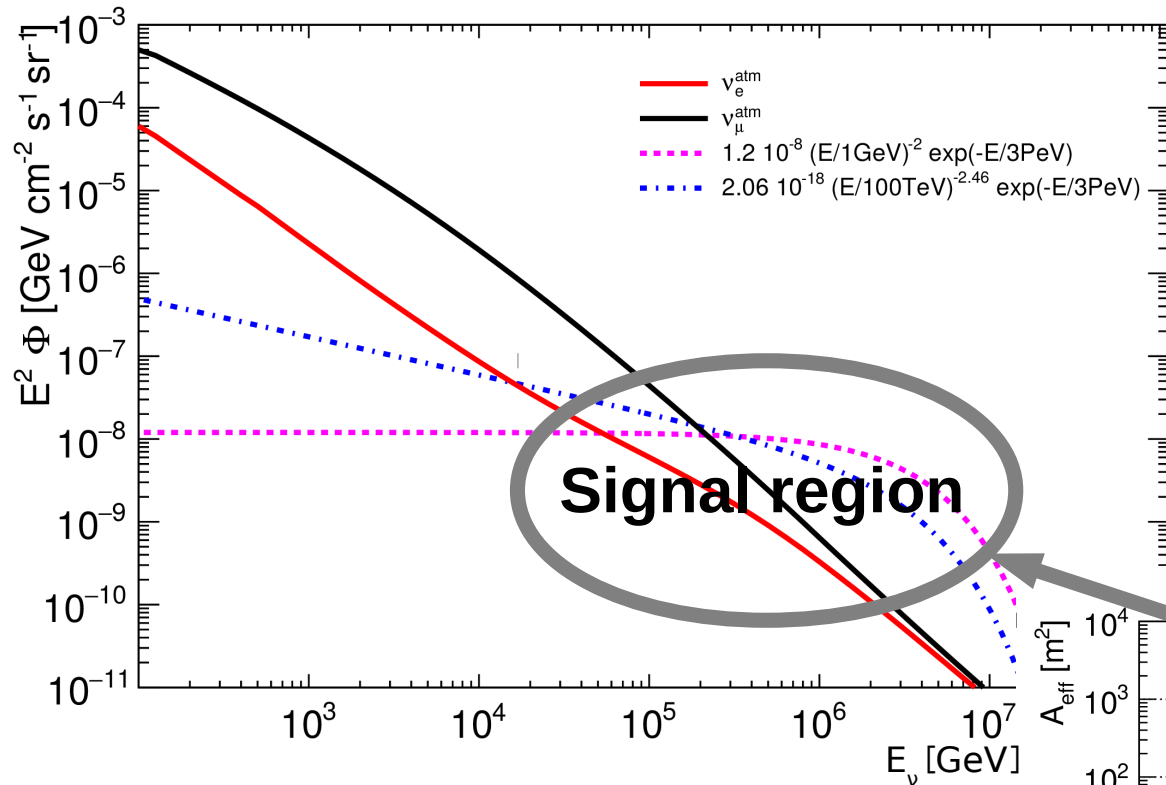
# The search strategy

- What can a cubic km neutrino telescope in the Mediterranean Sea say about the IceCube signal?
- Track and cascade diffuse analyses performed:
  - Preliminary selection of events for background rejection;
  - Likelihood methods applied for significance calculation.
    - Based on energy estimation and event selection
- Possible Galactic Plane origin of part of the signal?
  - Southern sky → good visibility for the detector

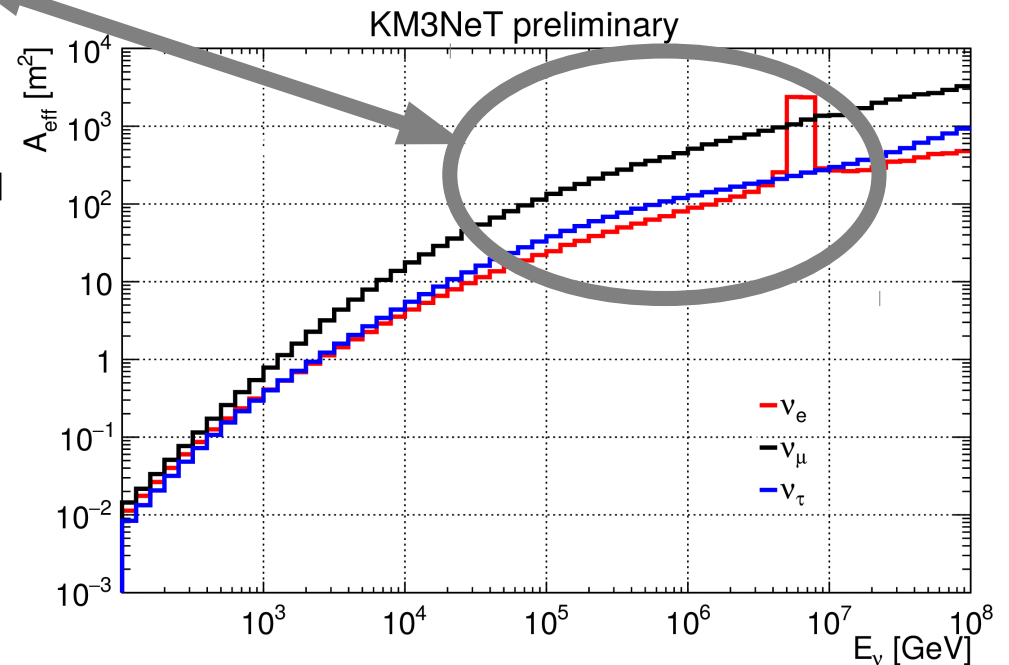
# Neutrino fluxes

- Signal:
  - Benchmark flux:  $E^{-2}$  spectrum with cutoff at 3 PeV
$$\Phi(E) = 1.2 \cdot 10^{-8} (E/1 \text{ GeV})^{-2} e^{-E/3 \text{ PeV}} \text{ GeV}^{-1} \text{ s}^{-1} \text{ sr}^{-1} \text{ cm}^{-2}$$
  - Also tested:  $E^{-2.46}$  spectrum (with and w/o cutoff)
- Background:
  - *Honda et al.* conventional + *Enberg et al.* prompt
  - Correction for the CR primary knee applied
  - Atmospheric muons from CR air showers (MUPAGE code)

# Neutrino fluxes and effective areas

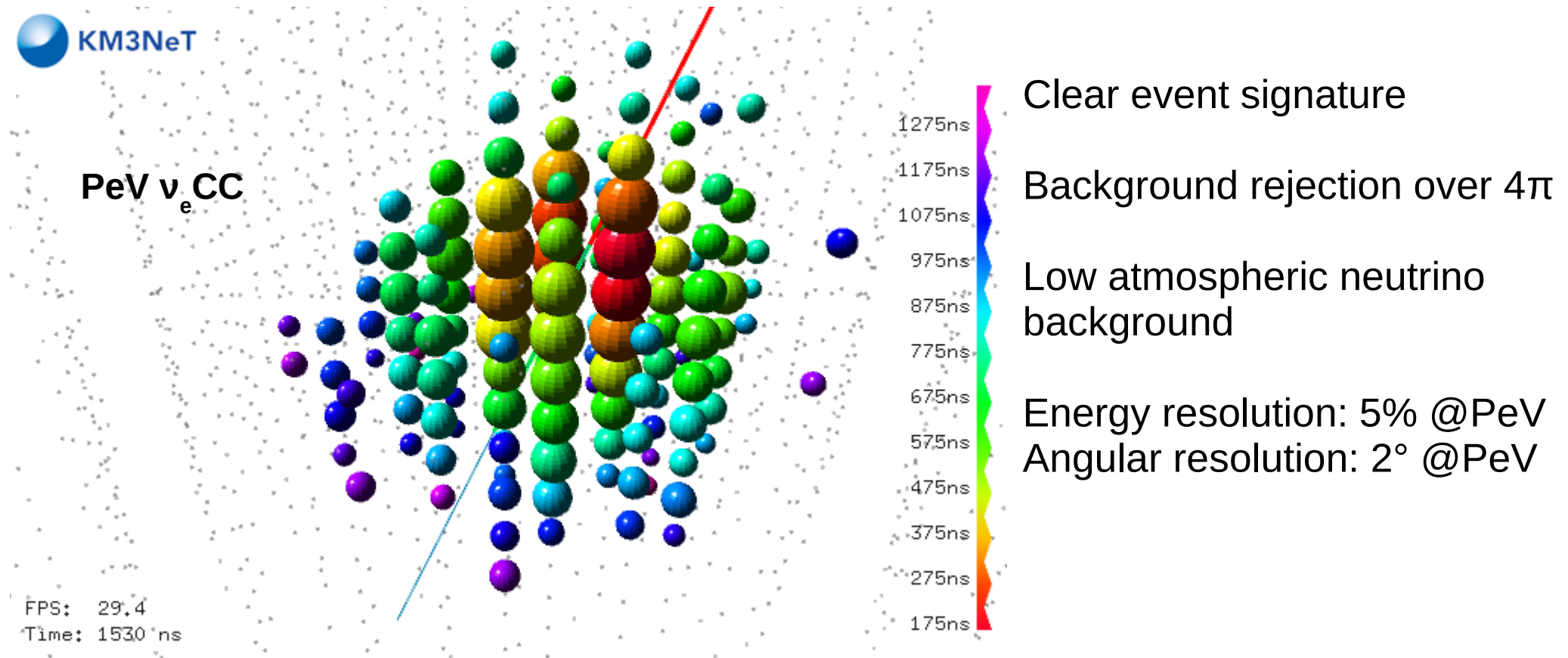


Effective area at trigger level:  
High efficiency required in the  
signal energy range



# The cascade channel

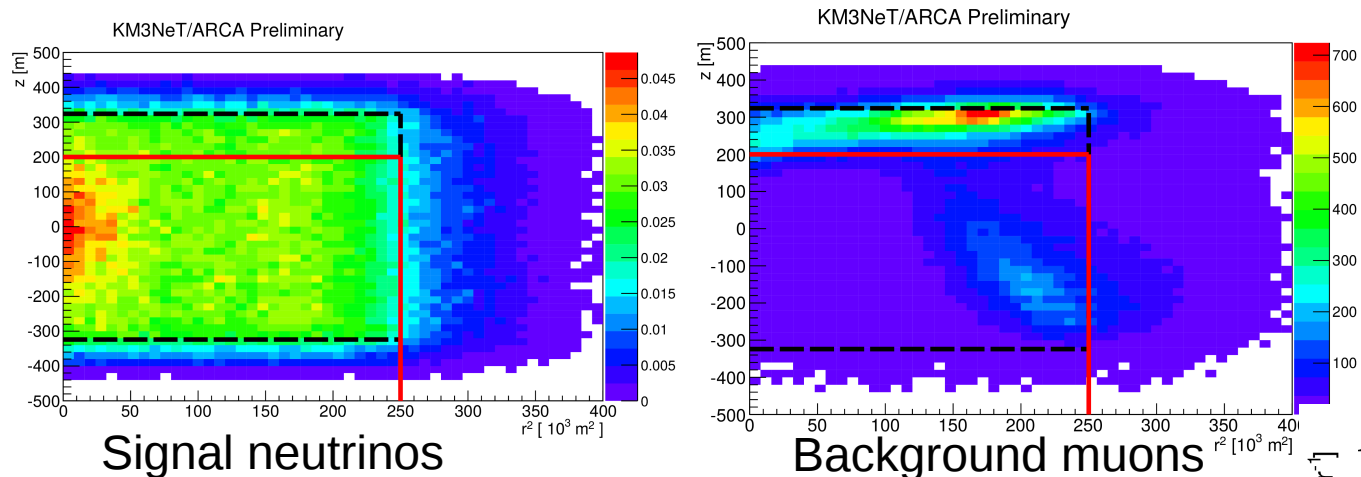
- Events given by CC  $\nu_e$  and  $\nu_\tau$  and all flavour NC interactions



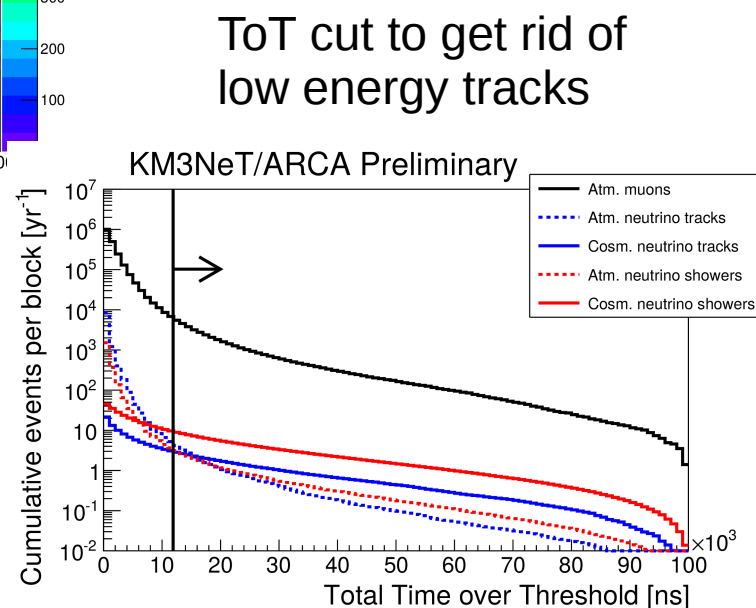


# The cascade channel

- Event selection:
  - Triggering + reconstruction containment + ToT selection
  - 2D likelihood ratio maximisation based on energy reconstruction and BDT event classifier score

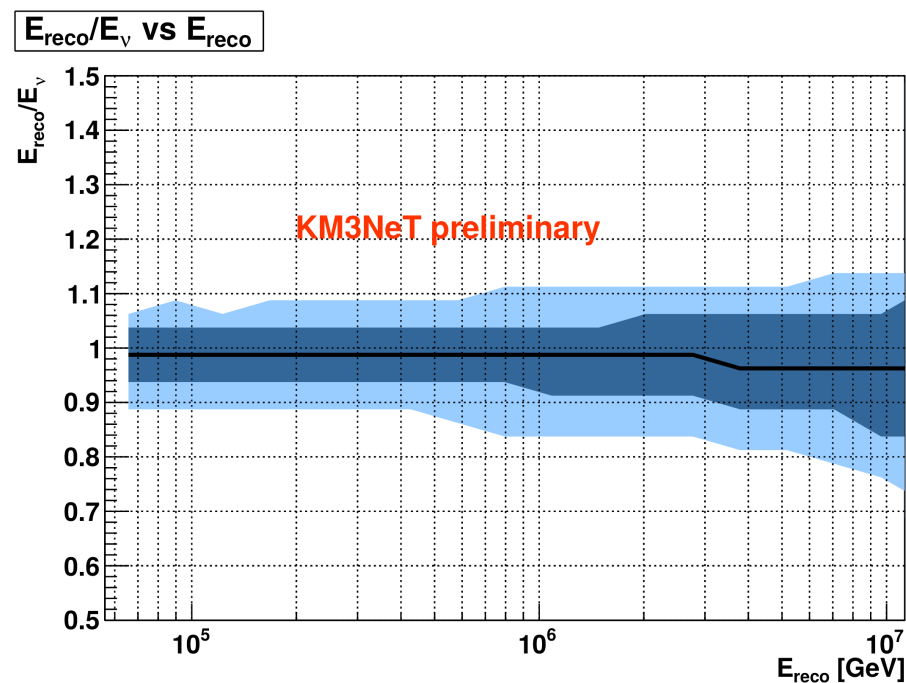
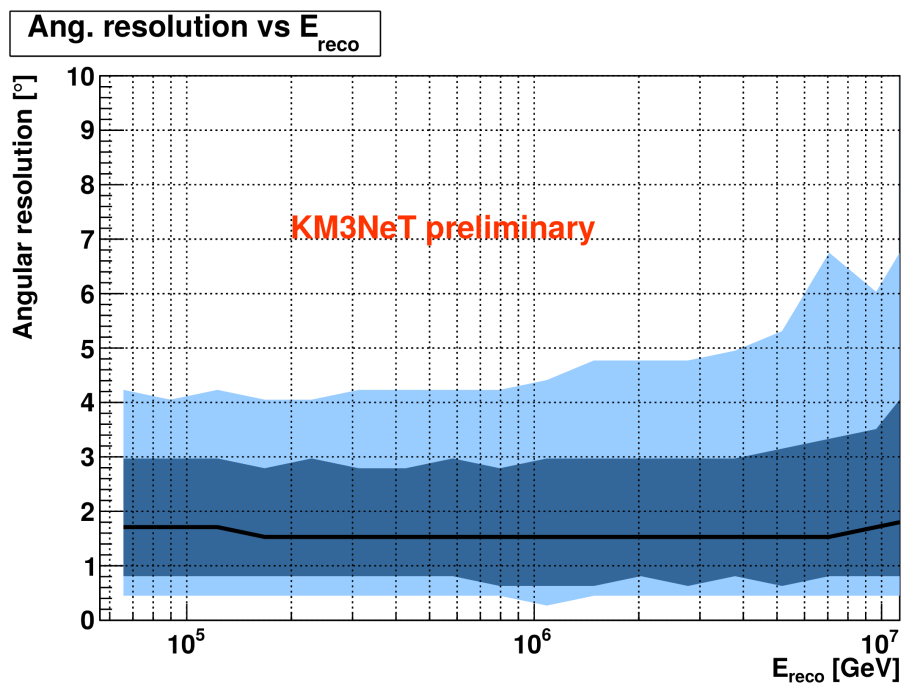
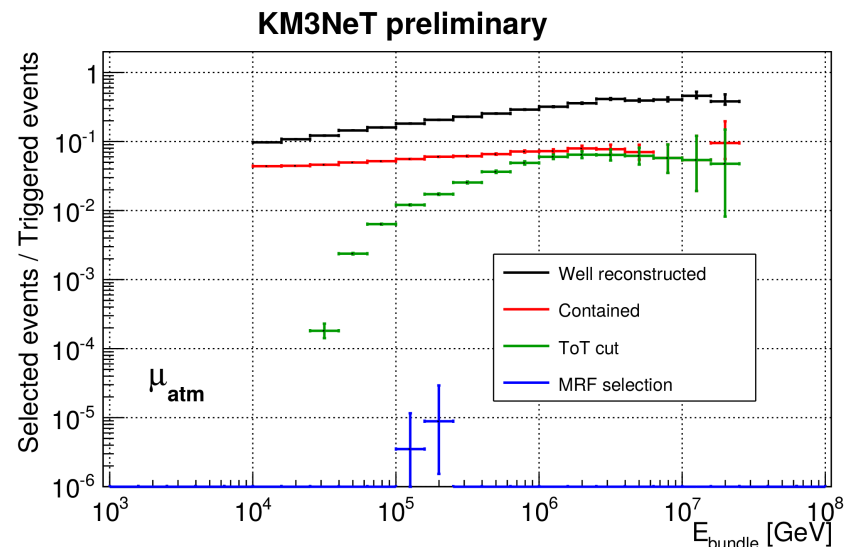


Selection on the reconstructed vertex  
to get rid of atmospheric muons



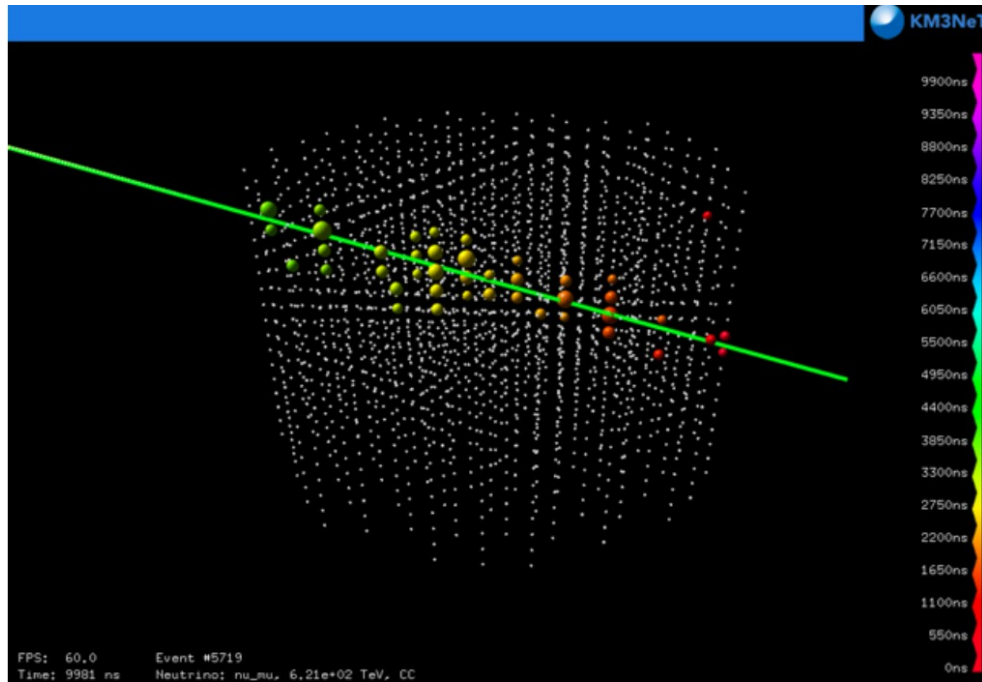
# The cascade channel

- High purity sample selected  
Background rejection factor  $\sim 10^7$  using reconstruction based observables only
- Great reconstruction performances



# The track channel

- Events given by CC  $\nu_\mu$



600 TeV  $\nu_\mu$  CC

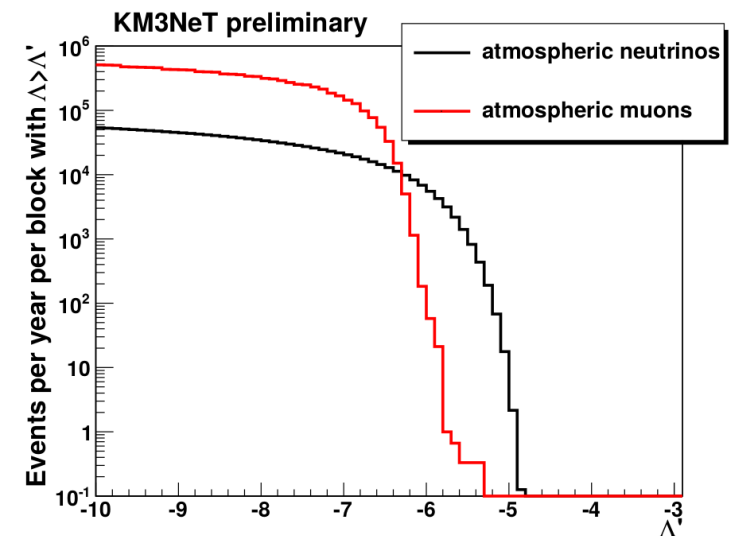
High purity sample obtained

Passing through tracks

Upgoing events to get rid of the atmospheric muon flux

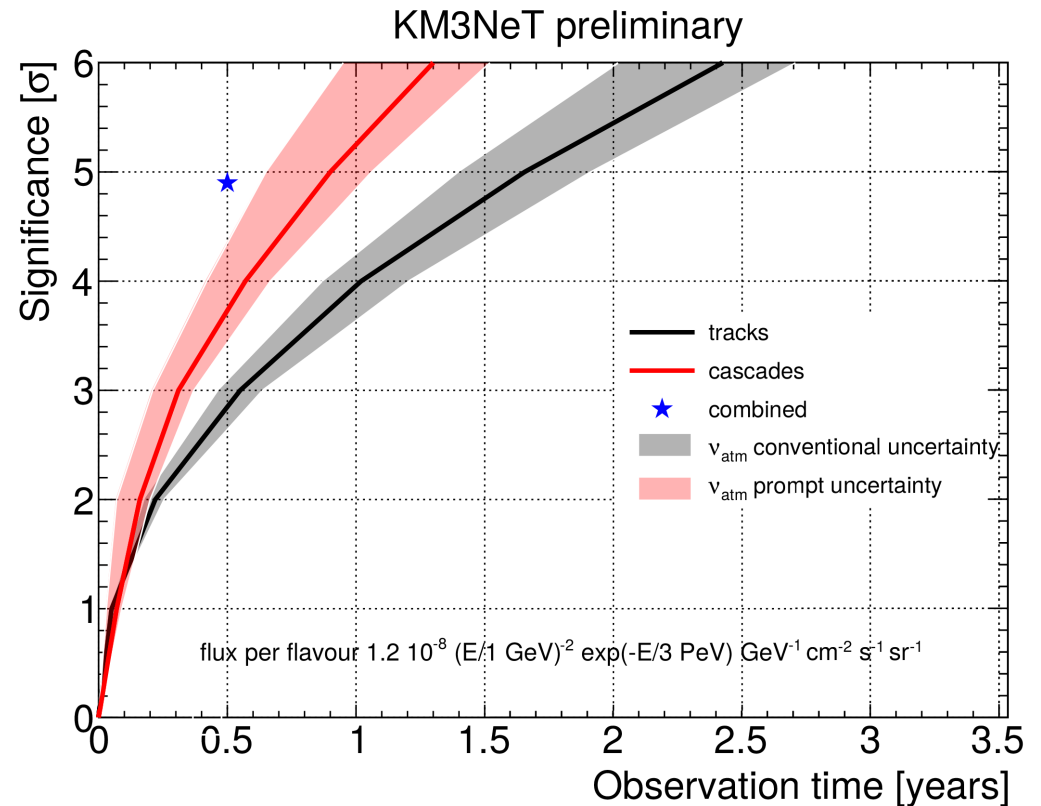
Sub-degree angular resolution

Track quality cut to suppress misreconstructed muons



# Results

- Short time for discovery
- Deep insight in the signal is then possible:
  - Energy spectrum/spectral fitting\*
  - Origin
  - Flavour composition
  - ...

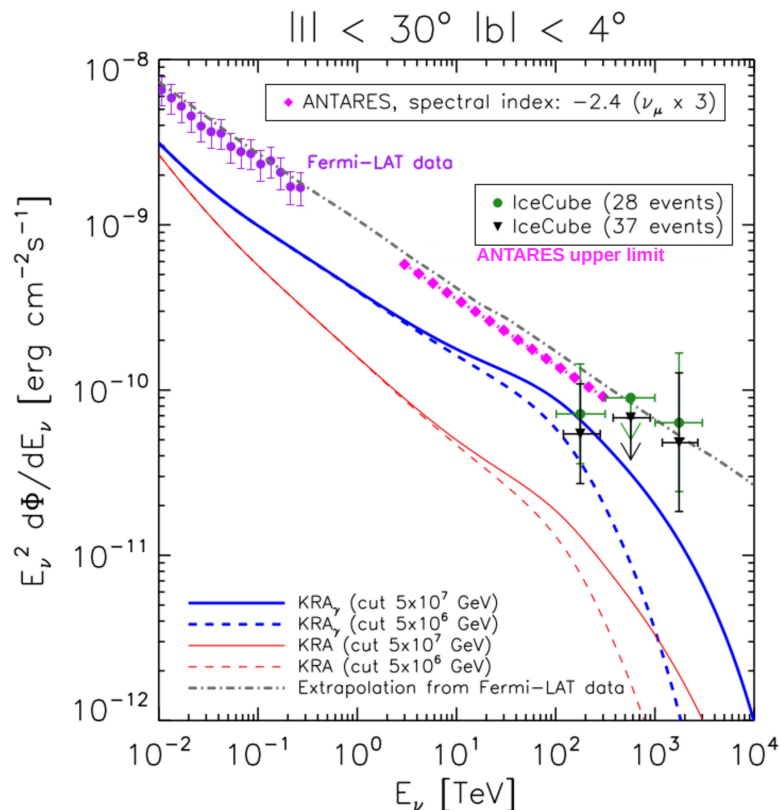


\* further analysis in development, not cut-based and with full likelihood-fitting

Also: combined analysis, optimised for using both the strategies

# The Galactic Plane

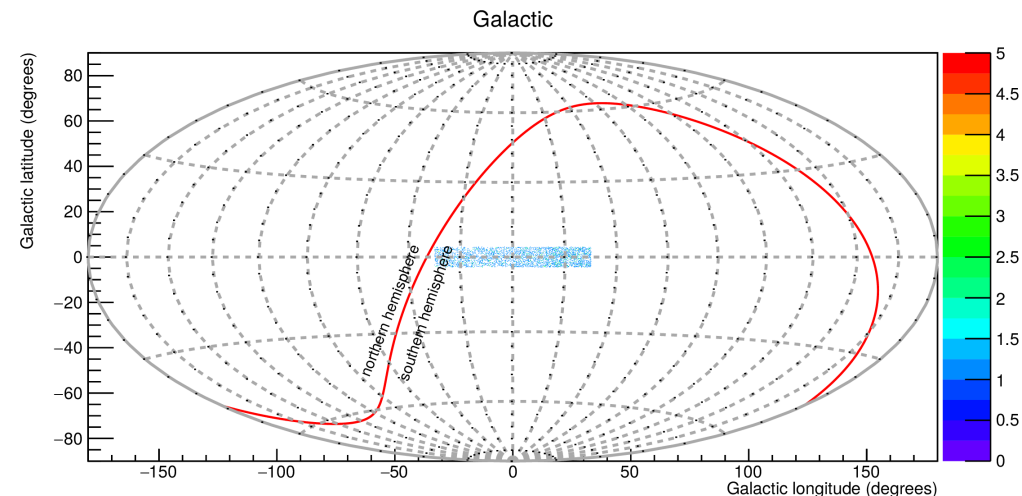
Guaranteed diffuse neutrino flux from CR propagation in the Galaxy. ANTARES has already put first limits on this flux



**Details on the model:  
A. Marinelli's talk**

Power law spectra with  $\Gamma \sim 2.4$   
→ can be compatible with part of the IceCube observation

Southern sky  
→ good visibility in the track channel

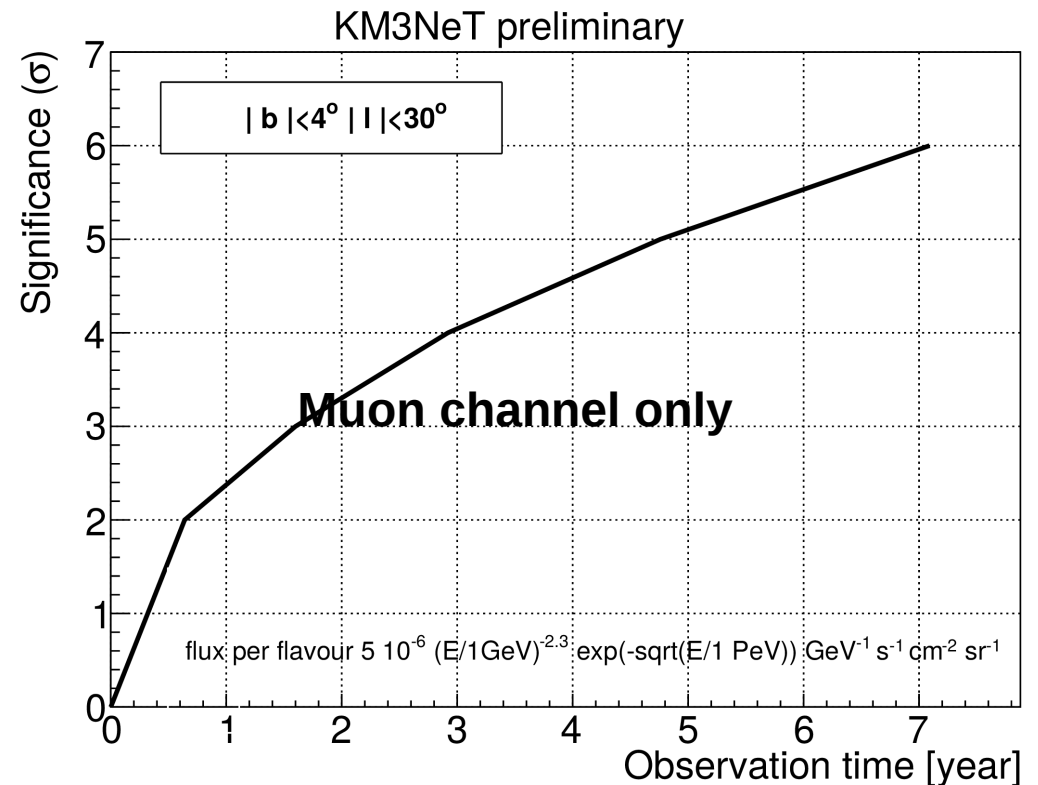


# The Galactic Plane

Based on the same strategy as for the track analysis

Central area of the Galaxy → most of the diffuse neutrino flux from CR propagation

Can be proved with unprecedented significance



Cascade analysis in development

# Outlook and conclusions

- The KM3NeT/ARCA detector will be able to observe an IceCube-like diffuse flux in a short time.
- Detailed studies of the signal can be performed thanks to its great reconstruction performances
- A diffuse Galactic flux can be proved and its influence in the cosmic signal can be studied