KM3NET/ARCA PROSPECT

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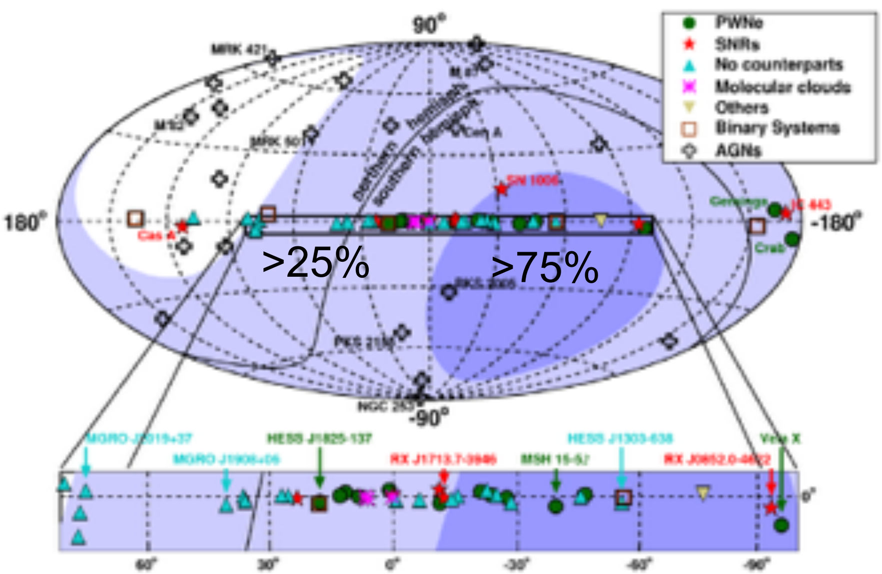
INFN - Laboratori Nazionali del Sud

MANTS meeting 1-2 October 2016

A telescope in the Northern Hemisphere

Higher density of sources in our Galaxy at negative declination.

Galactic objects well measured by High-Energy gamma detector. Hadronic mechanism invoked for many sources to explain their emission (IC443, W44, RCW86, RXJ1713…)



from F. Vissani, F. Haronian and N. Sahakyan Astropart.Phys. 34 (2011) 778-783 arXiv:1101.4842

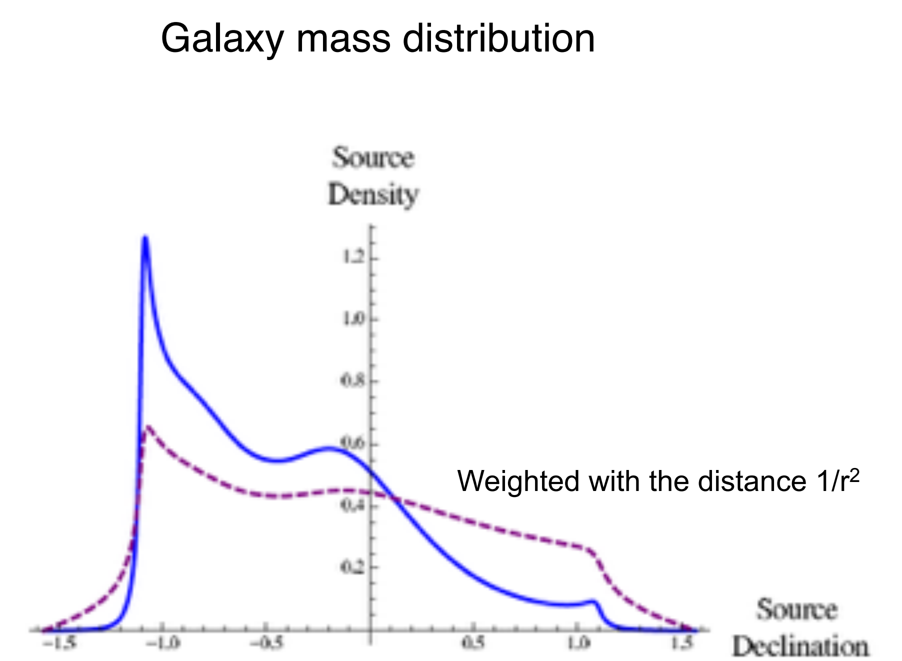


Figure 2: *Continuous line: normalized mass distribution of the Galaxy, as a function of the declination. Dashed line, the same but weighted with the inverse squared distance from the mass.*

KM3NeT/ARCA

Some Galactic sources/regions tested with KM3NeT/ARCA.

New track reconstruction is now available (JGandalf)

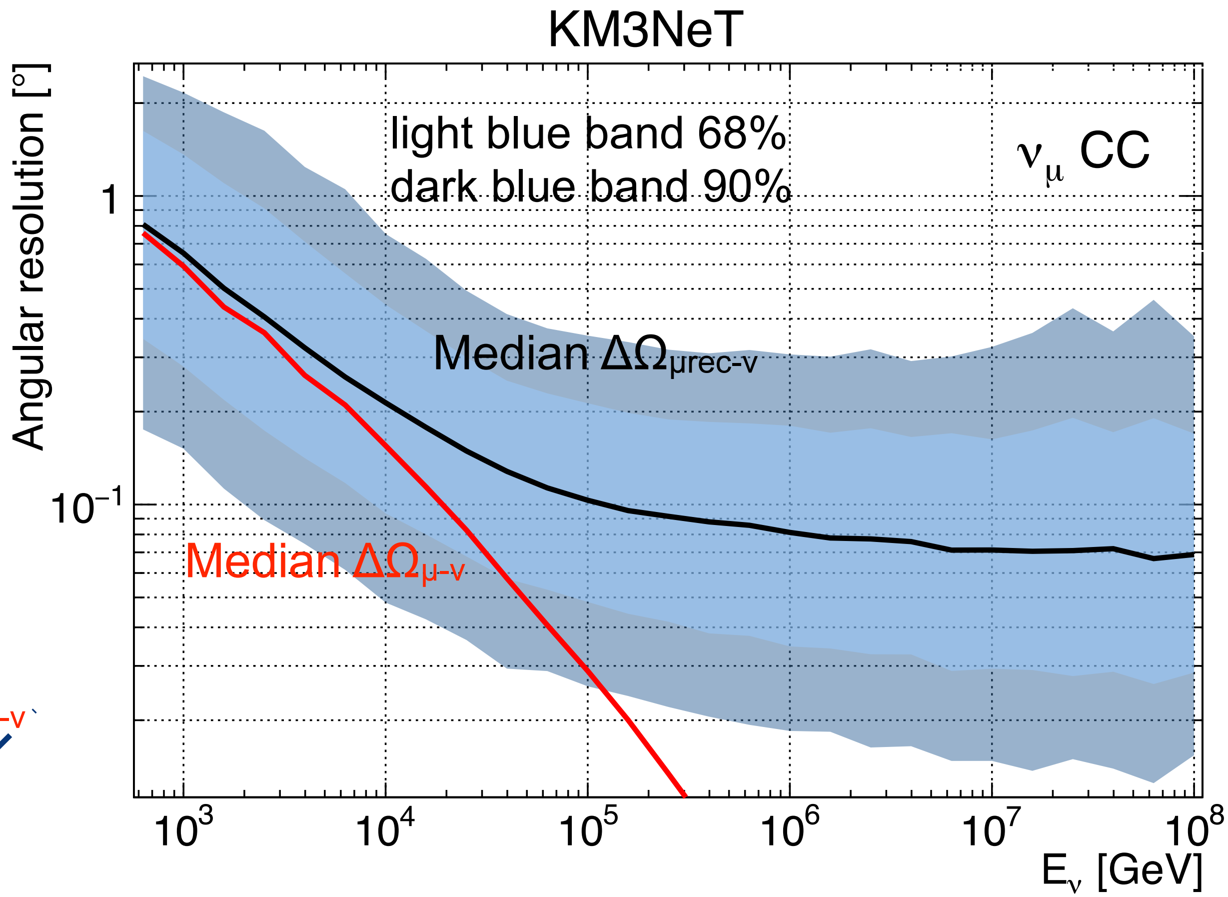
👇

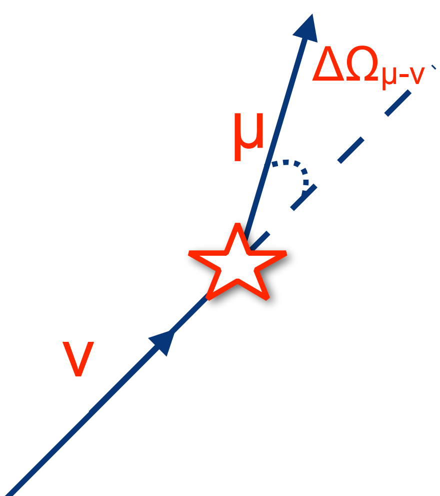
New (after LoI) preliminary and non official predictions shown in this talk

Predictions from up-going muon neutrino analysis

KM3NeT Letter of Intent at J. Phys. G: Nucl. Part. Phys. 43 (2016) 084001 and arXiv:1601.07459

New track reconstruction JGandalf



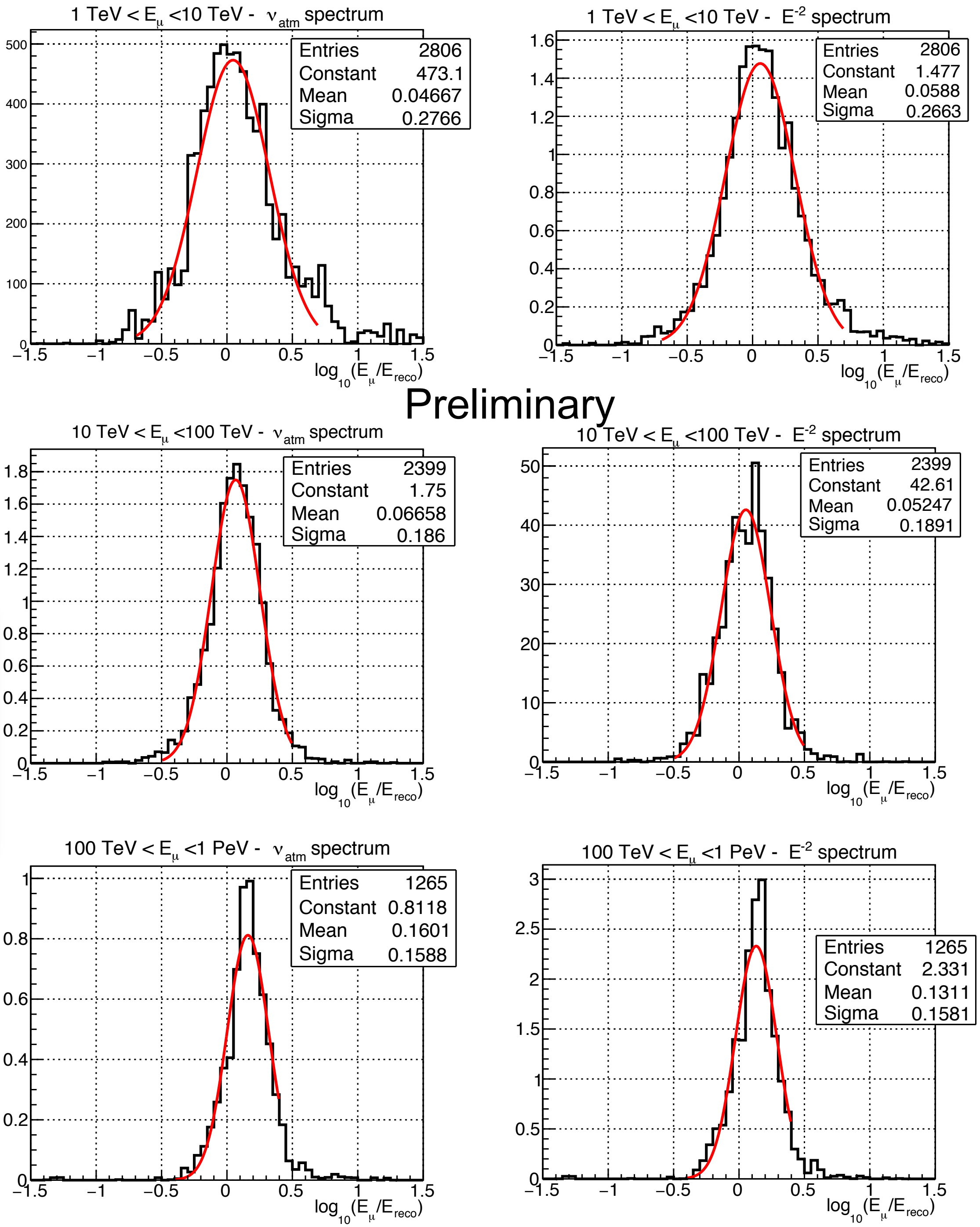


Angular resolution

$\Delta\Omega_{\mu rec\text{-}\nu}$ <0.1° above 10^5 GeV

New track reconstruction

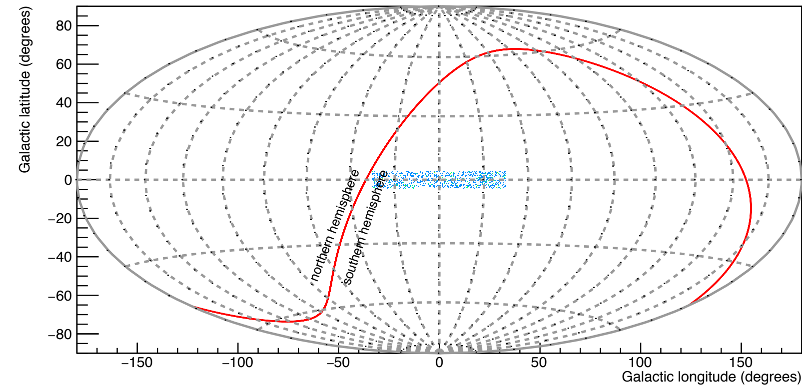
Energy resolution
from 27%@1-10 TeV
to 16%@0.1-1 PeV



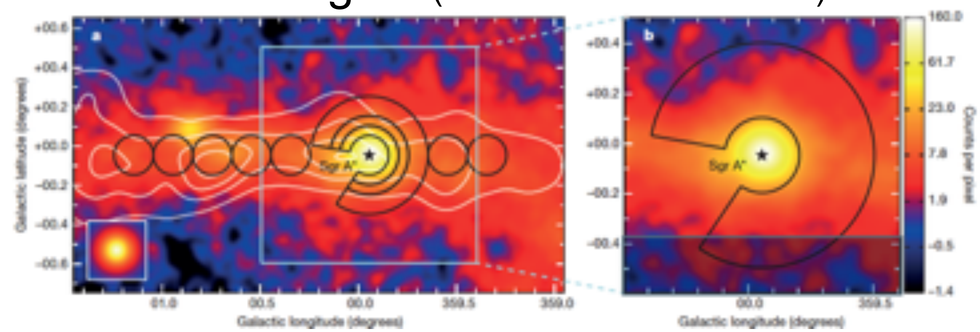
From our Galaxy

- Investigated:
  - Galactic Plane (GP)
    (|l|<30° and |b|<4°)
  - Galactic Center (GC) Hess source
  - The SNR RXJ1713
  - The PWN VelaX

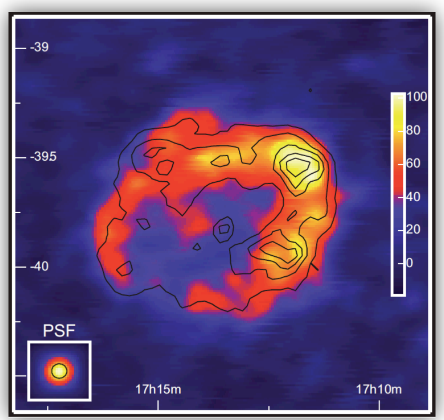
GP region with |l|<30° and |b|<4°



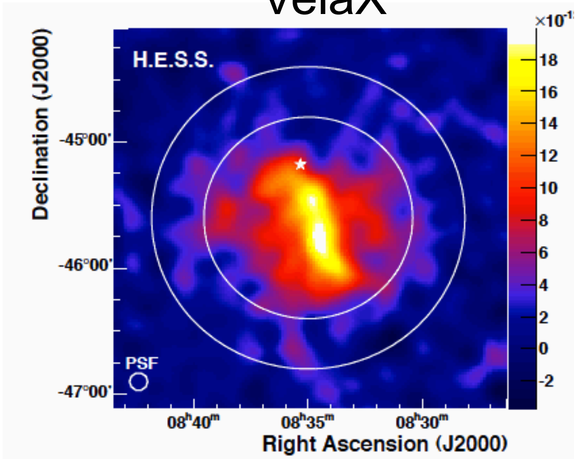
GC region (Nature 17147/doi10.138)



RXJ1713



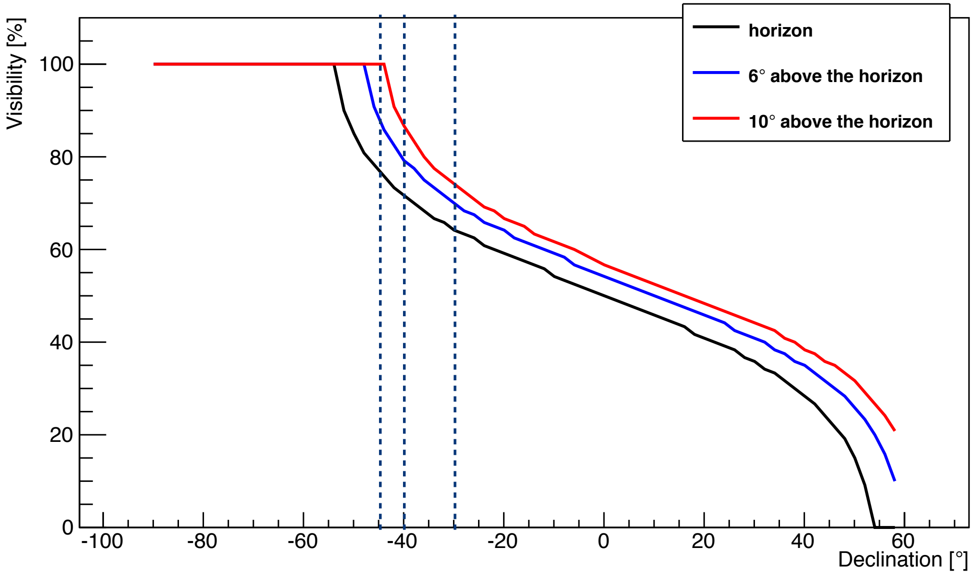
VelaX



Visibility

	declination	extension	Visibility*
GP	0° ÷ -50°	ΔΩ=0.146sr	77%
GC	-29°	R=0.45°	75%
RXJ1713	-40°	R=0.6°	86%
VelaX	-45°	R=0.8°	95%

*For up-going muons with θ_{zen}>80°



Main assumptions

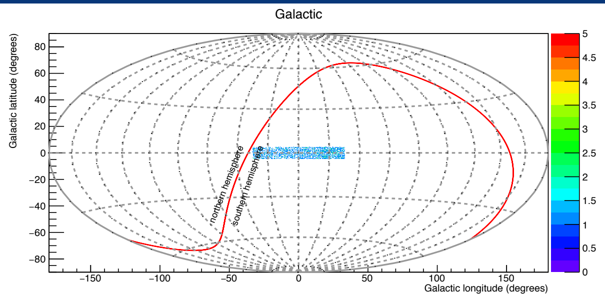
- ARCA detector
  - 2 building blocks of 115 strings each ($1km^3$)
  - depth 3500m (Capo Passero - Sicily site)

- Source assumptions
  - Expected neutrino spectra from (consistent) the measured gamma spectra
  - Source extension with homogenous distribution

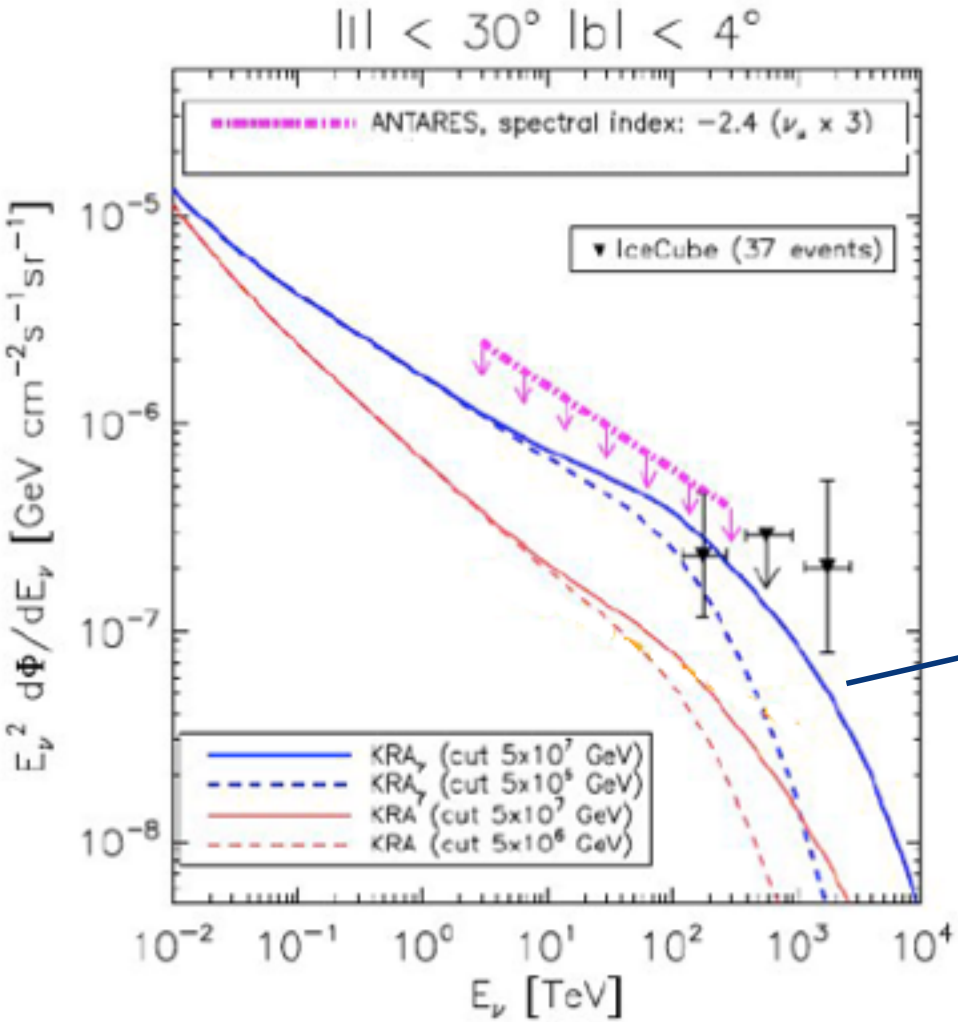
- Simulation assumptions
  - Atmospheric neutrino background Honda (conventional) and Enberg (prompt) with knee correction (H3a) (see the LoI)
  - Three years of atmospheric muon background simulated with MUPAGE
  - All NC and CC neutrino flavours interactions simulated with (ν_μ:ν_e:ν_τ=1:1:1)

- Up-going muon neutrinos analysis through the following steps:
  - Preselection cut applied (cuts on reconstruction algorithm parameters)
  - Boosted Decision Tree algorithm applied (only for RXJ1713 analysis)
  - A maximum likelihood method applied for the discovery and sensitivity fluxes

Performance GP



D. Gaggero et al., ICRC2015



Neutrino spectrum estimated from a non uniform cosmic-ray transport model with a radially dependent diffusion coefficient

D. Gaggero et al.,2015. arXiv:1508.03681.

3 flavour flux

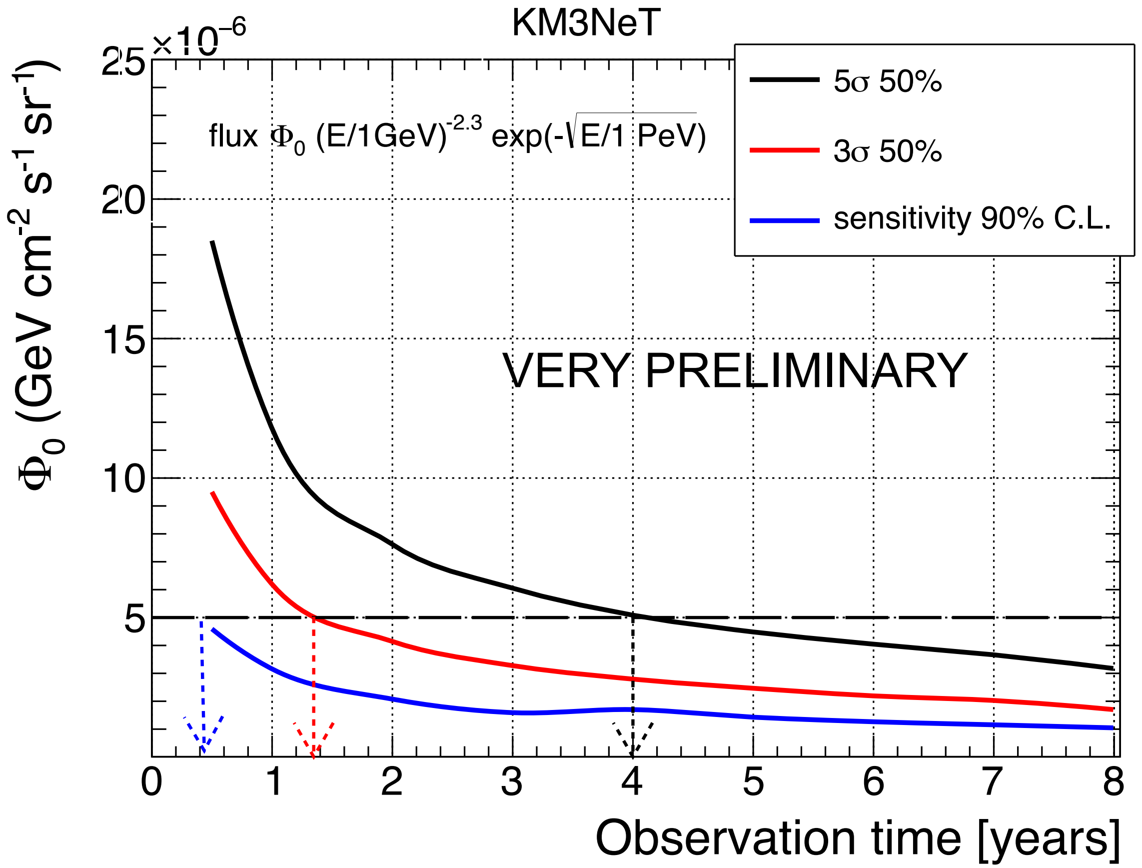
$d\phi/dE_\nu = K * E_\nu^{-\alpha} * \exp(-\mathrm{sqrt}(E_\nu/E_{cut}))$

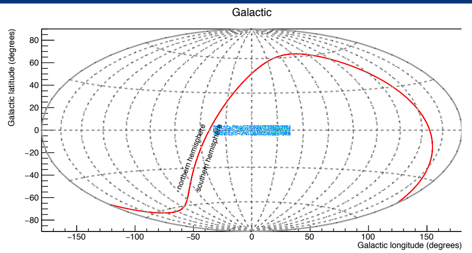
$K = 1.5\ 10^{-5}$ GeV $cm^{-2}\ s^{-1}\ sr^{-1}$

$\alpha = 2.30$

$E_{cut} = 1.05\ 10^6$ GeV

Performance GP





LoI 5σ in 5 years ☞ now 5σ in 4 years

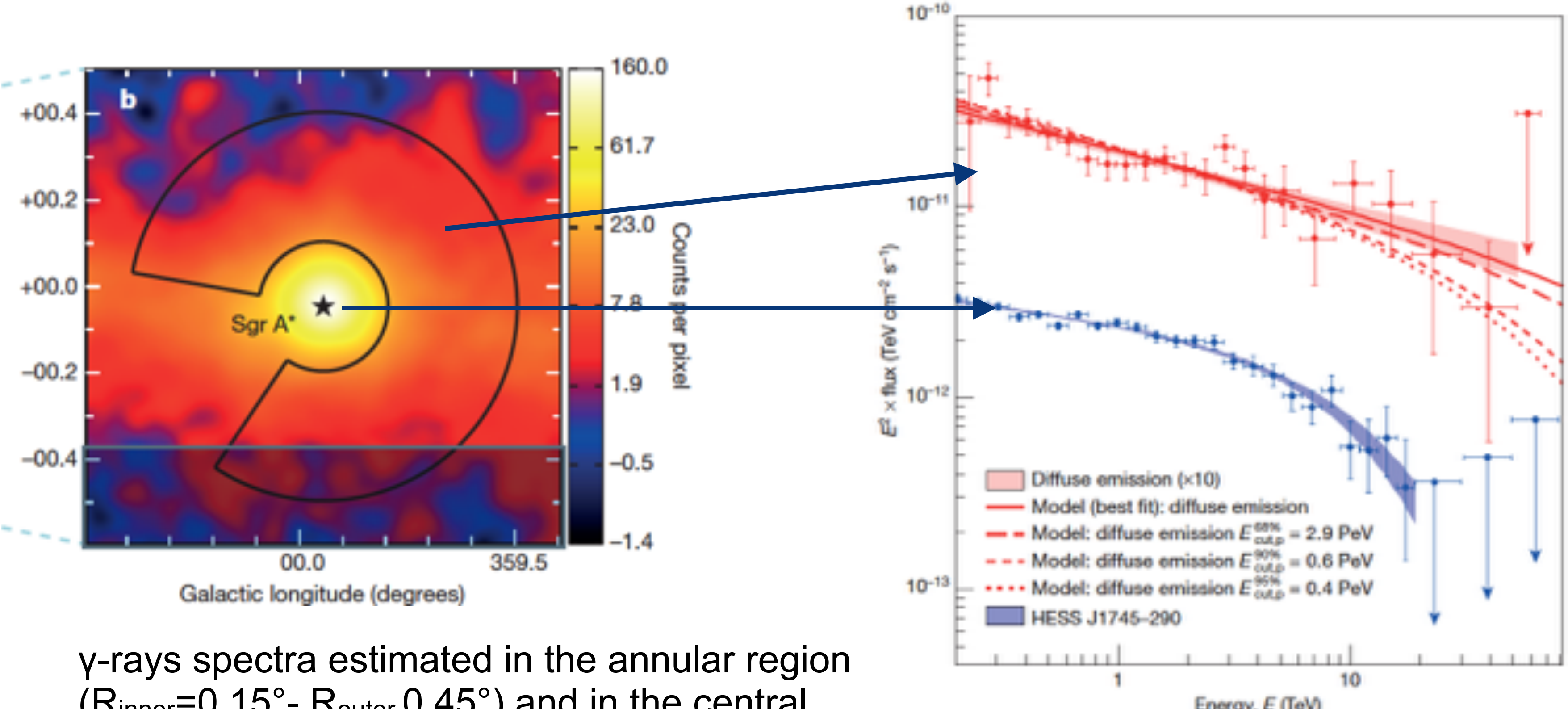
LoI 3σ in 1.6 years ☞ now 3σ in 1.3 years

few months to rule out the model

March 2016: a new GC measurement

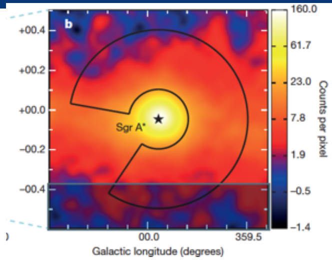
Petaelectronvolt proton source discovered by HESS at the Galactic Center (Nature 17147/doi10.138)

Dense molecular clouds present near the GC responsible of the hadronic origin of the high energy γ-rays detected



γ-rays spectra estimated in the annular region (R_{inner}=0.15°- R_{outer} 0.45°) and in the central region R<0.1°

Performance GC

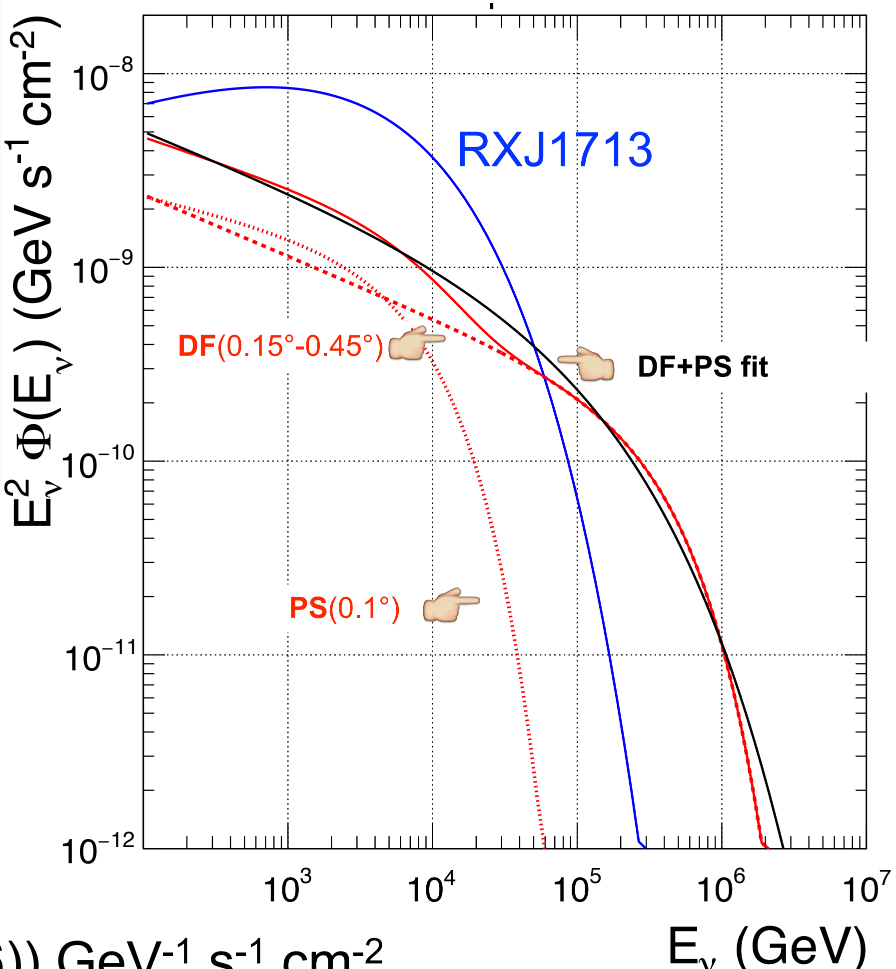


Neutrino spectra estimated from the measured gamma spectra under the hypothesis of

- pure hadronic mechanism
- source transparent to high energy gamma-rays

S. Celli et al., arXiv:1604.08791

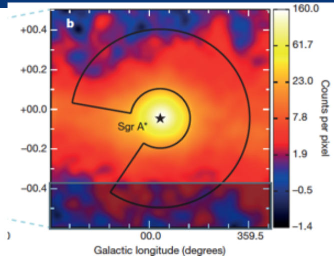
one flavour neutrino spectra

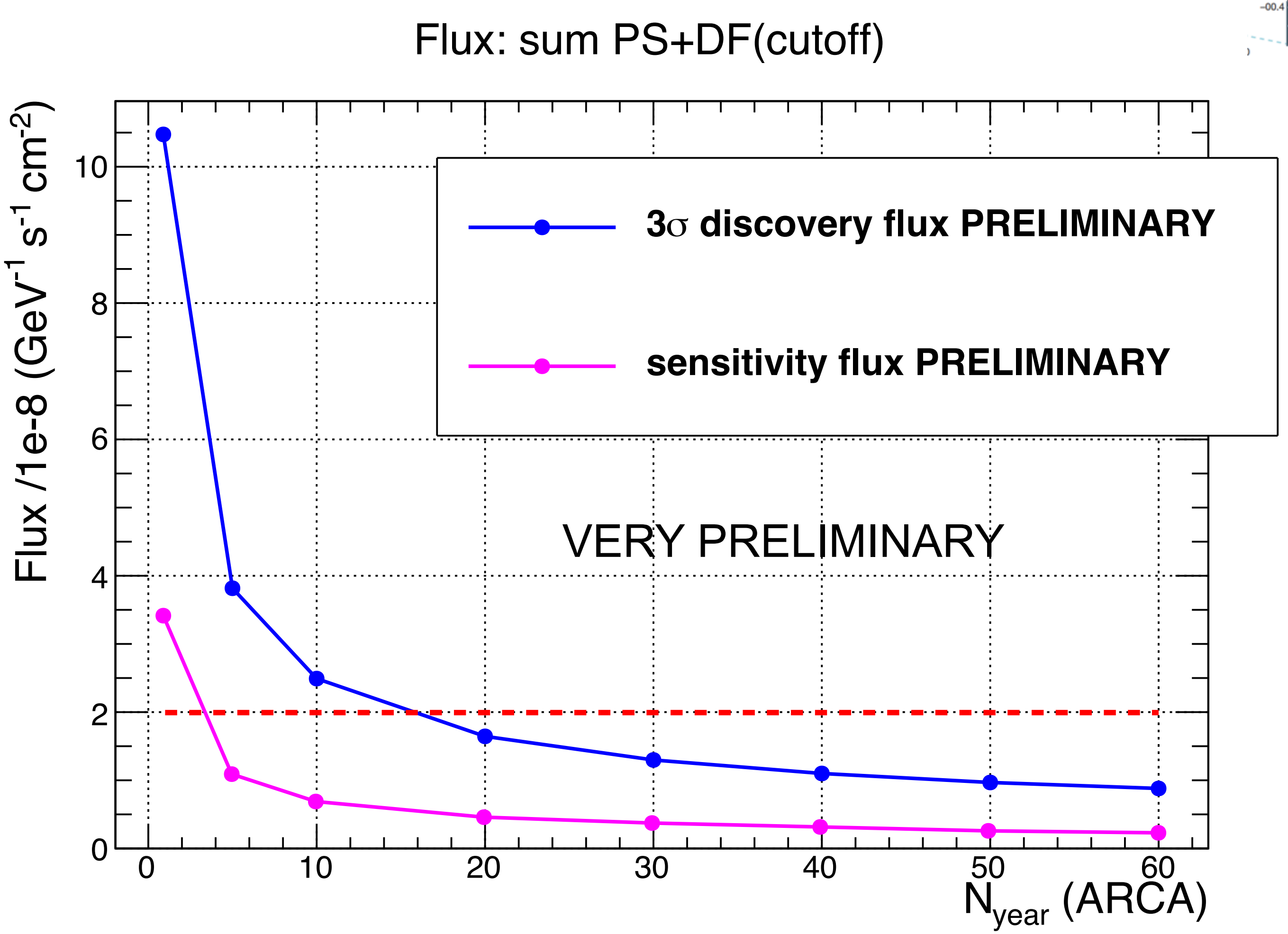


fit of **PS + DF(cutoff)**

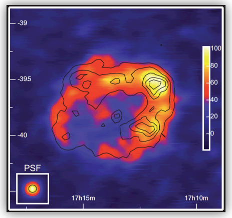
$\Phi(E_\nu)= 2\ 10^{-8}\ E_\nu^{-2.3} \exp(-\mathrm{sqrt}(E_\nu/0.8e06))\ \mathrm{GeV}^{-1}\ \mathrm{s}^{-1}\ \mathrm{cm}^{-2}$

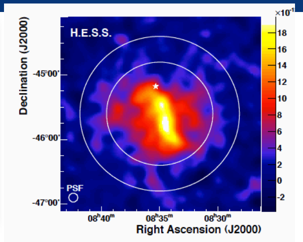
Performance GC





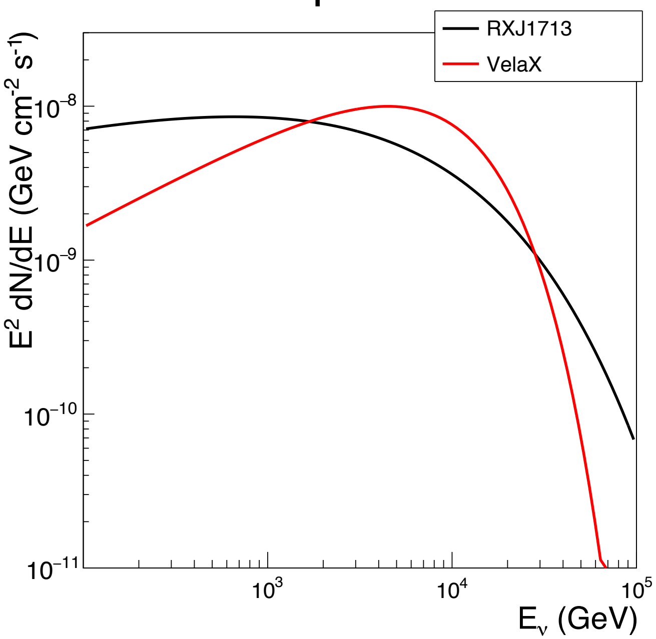
3σ in about 12 years
few years to rule out the model

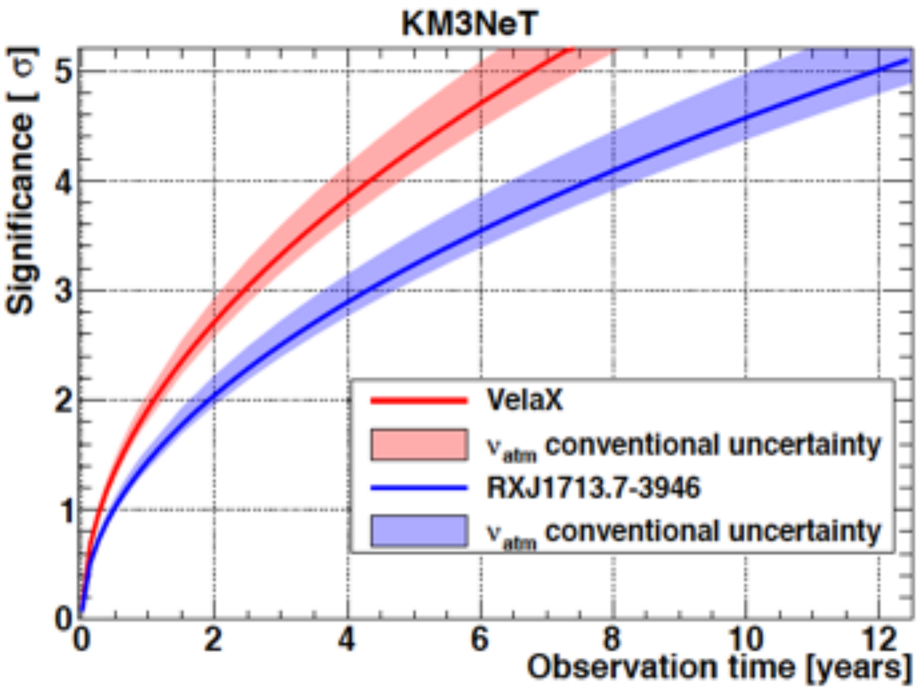




RXJ1713 & VelaX

Neutrino Spectra

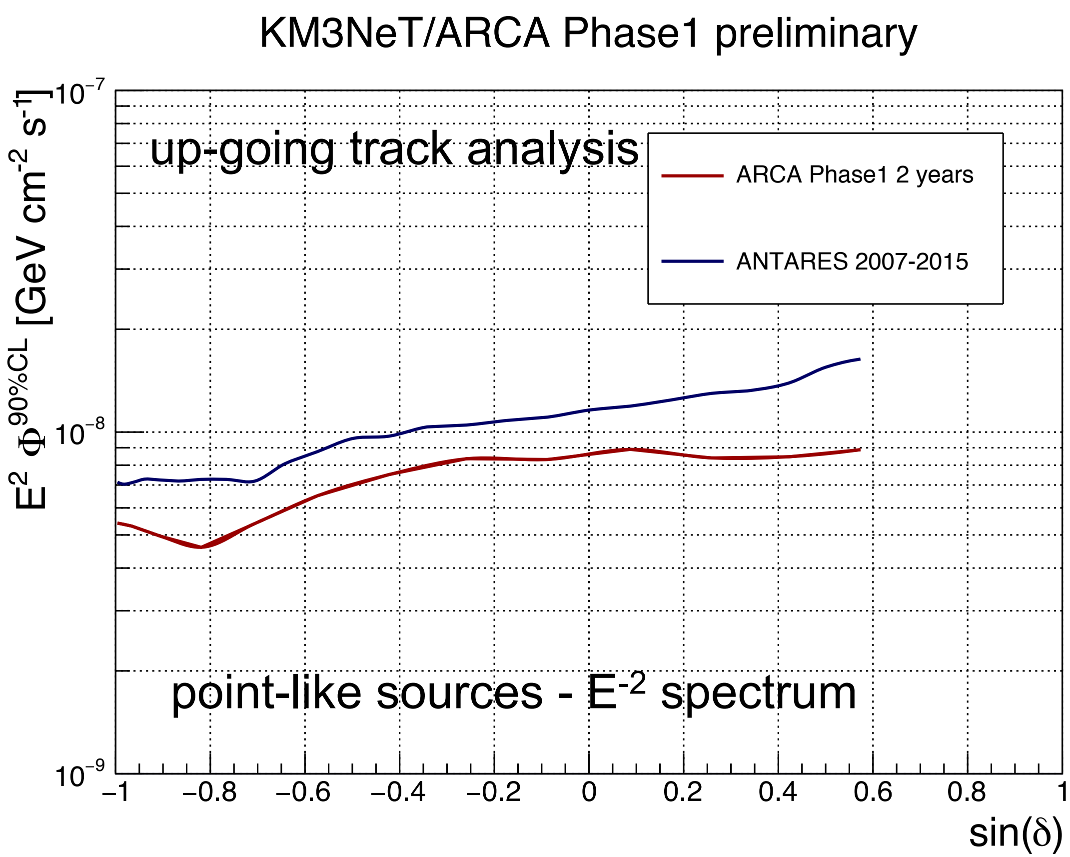




From first results improvement in the RXJ1713 discovery flux at 3σ of 10% ☞ discovery at 3σ in 4 years (LoI 3σ in 4.5 anni)

Analysis not yet completed

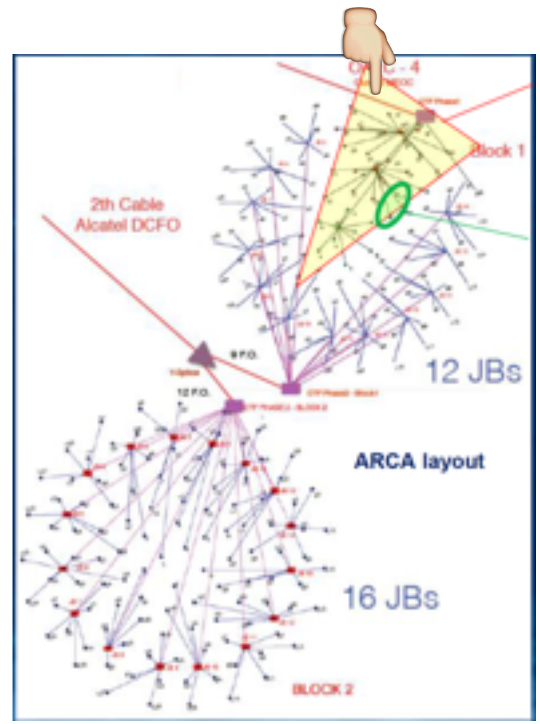
What in the next future



ARCA-Phase1 will reach the sensitivity of ANTARES in less than 2 years

ARCA-Phase1
24 strings

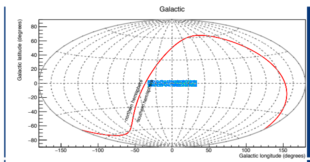
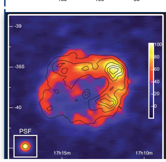
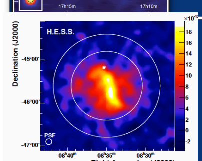
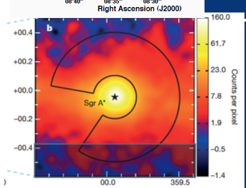
10% of the full ARCA detector



soon combined data analysis ARCA-phase1 / ANTARES

Summary

New high resolution (<0.1°) track reconstruction now available

	3σ discovery
 ***GP***	***1.3 years***
 ***RXJ1713***	***4 years***
 ***VelaX***	***2.5 years***
 ***GC***	***12 years***

Preliminary results from up-going muon analysis

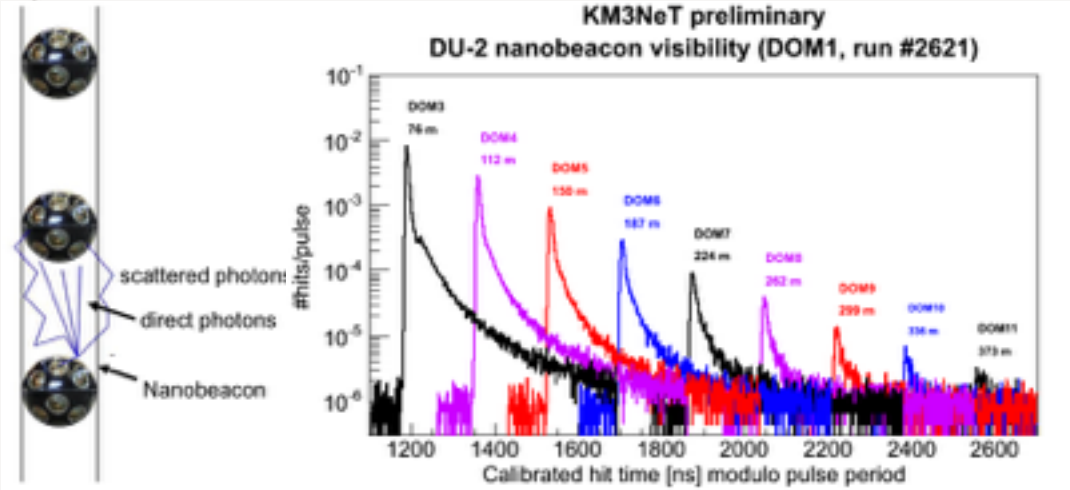
OUTLOOK

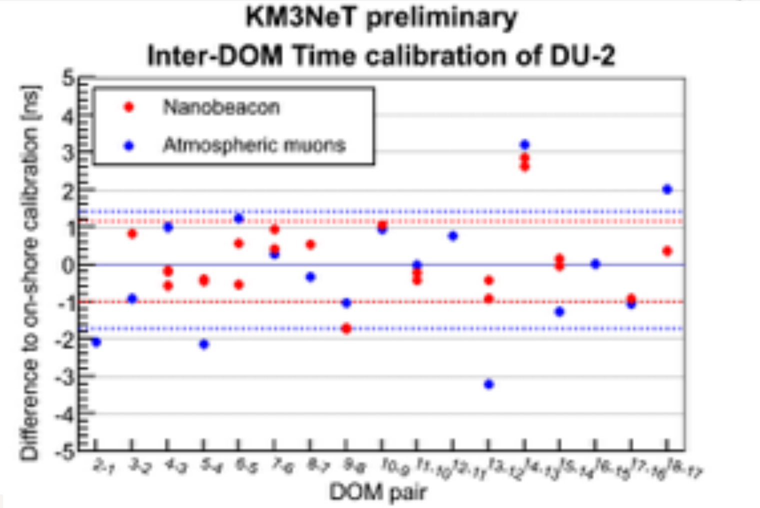
Improvements of these results expected combining up-going muons & cascade events

Galactic plane is very promising for KM3NeT/ARCA

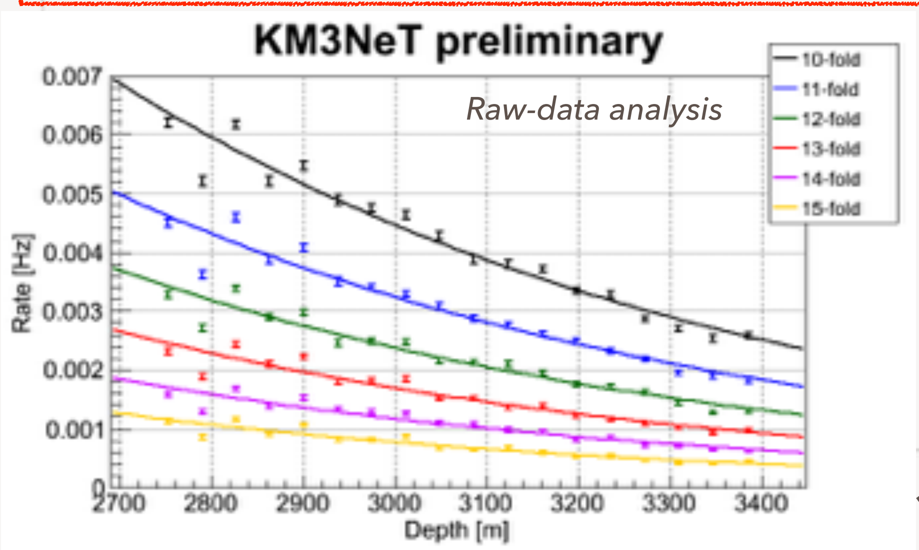
BACK UP SLIDES

FIRST RESULTS FROM ONE OF THE FIRST DUS INSTALLED





Comparison of calibration with LED nanobeacons and atmospheric muons in agreement.
In situ nanobeacon calibration and on-shore laser calibration agree to ≈1 ns

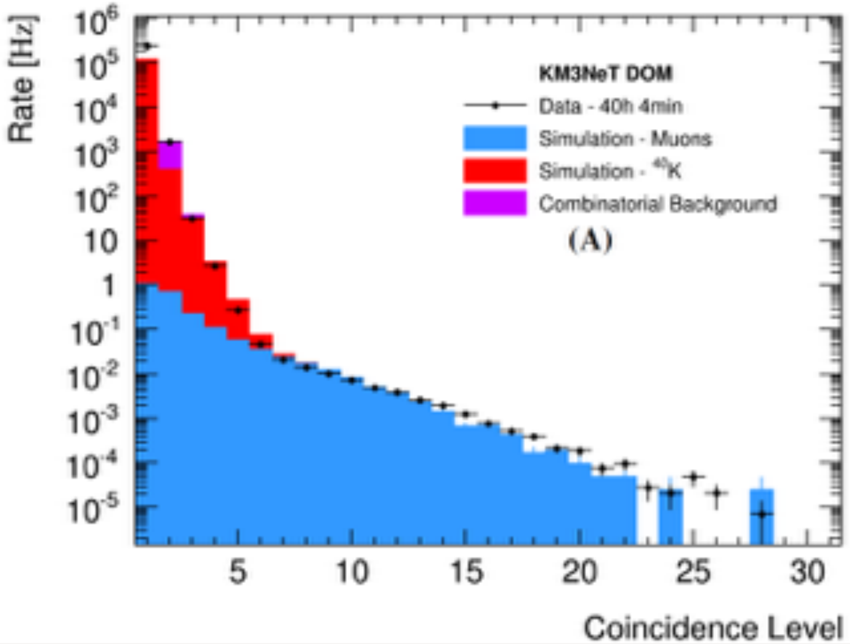


Rate of high coincidence events in the DOMs reflects the behavior of the atmospheric muon intensity as a function of the depth

THE DOM PROTOTYPE

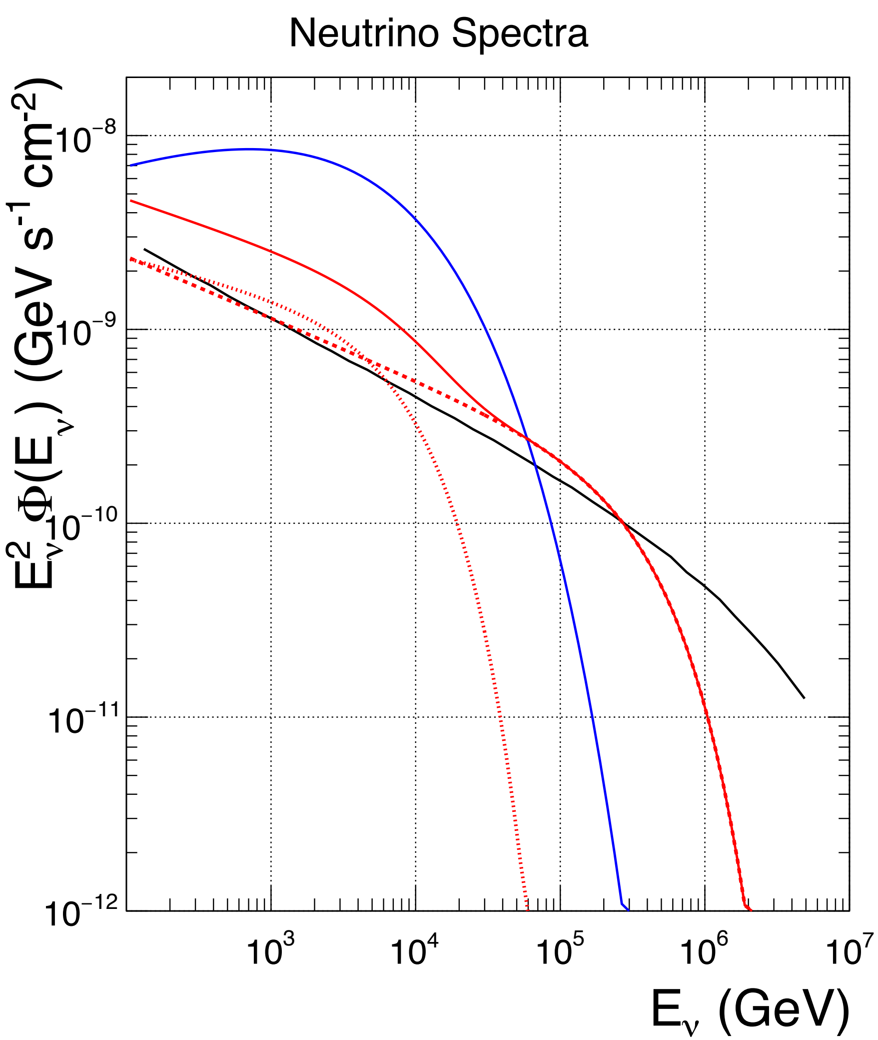
DOM prototype deployed at Antares site April 2013

validation of DOM capabilities in situ



Proved that with a single DOM the selection of events from atmospheric muons is possible

Result published in Eur. Phys. J. C (2014) 74: 3056


Neutrino Spectra
$E_\nu^2\Phi(E_\nu)$ (GeV s^{-1} cm^{-2})
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^3
10^4
10^5
10^6
10^7
E_ν (GeV)