Diffuse HE Neutrino Factories in our Galaxy

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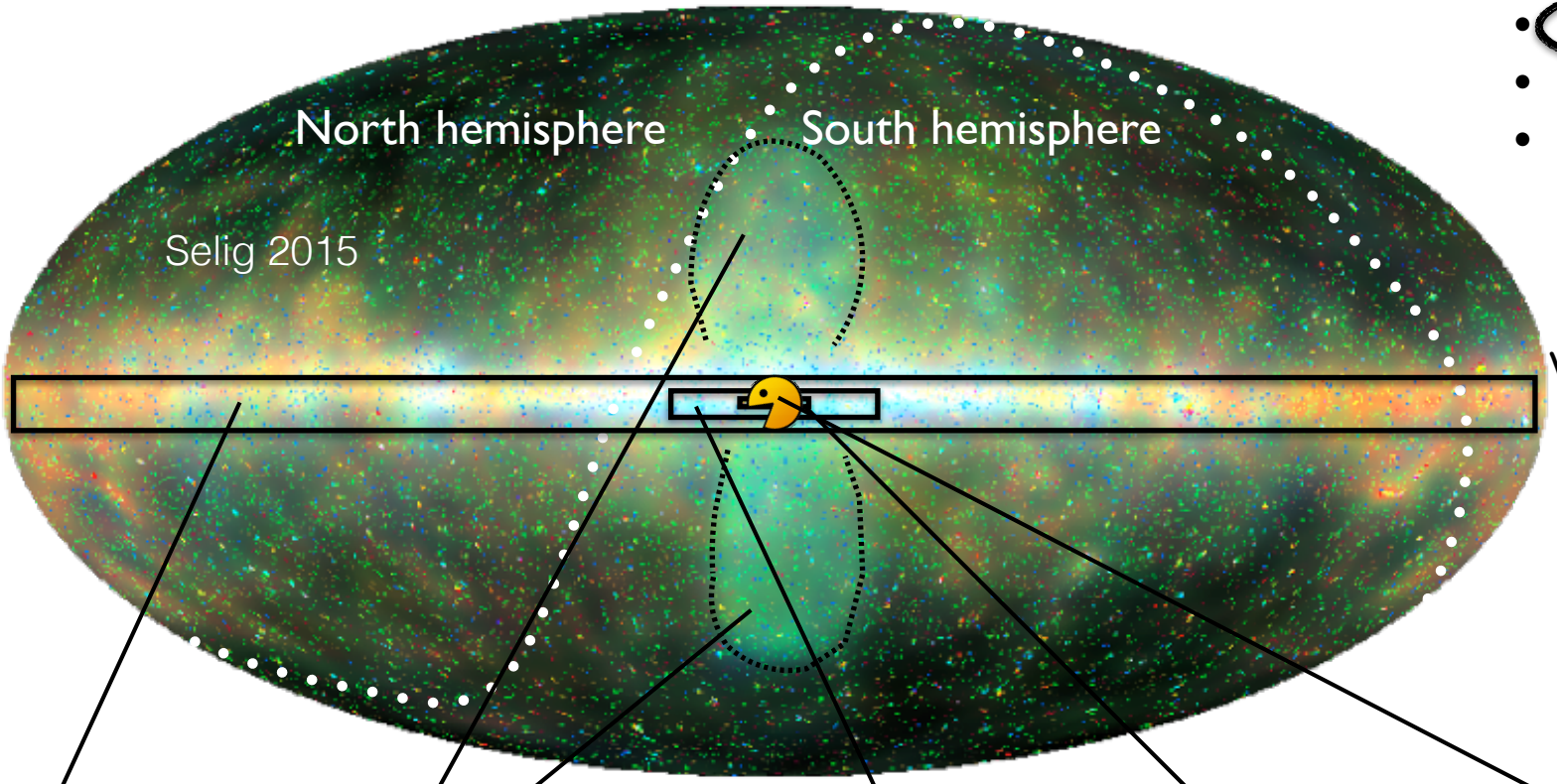
Diffuse γ-ray emission -> possibly ν counterpart



- Photopion
- Bremsstrahlung
- Inverse Compton

We expect also ν

Whole Galactic Plane	Fermi Bubbles	Galactic Ridge l< |30| b< |4|	Central Molecular Zone	Sagittarius A,B,C,HESS Ridge 2006, 2016

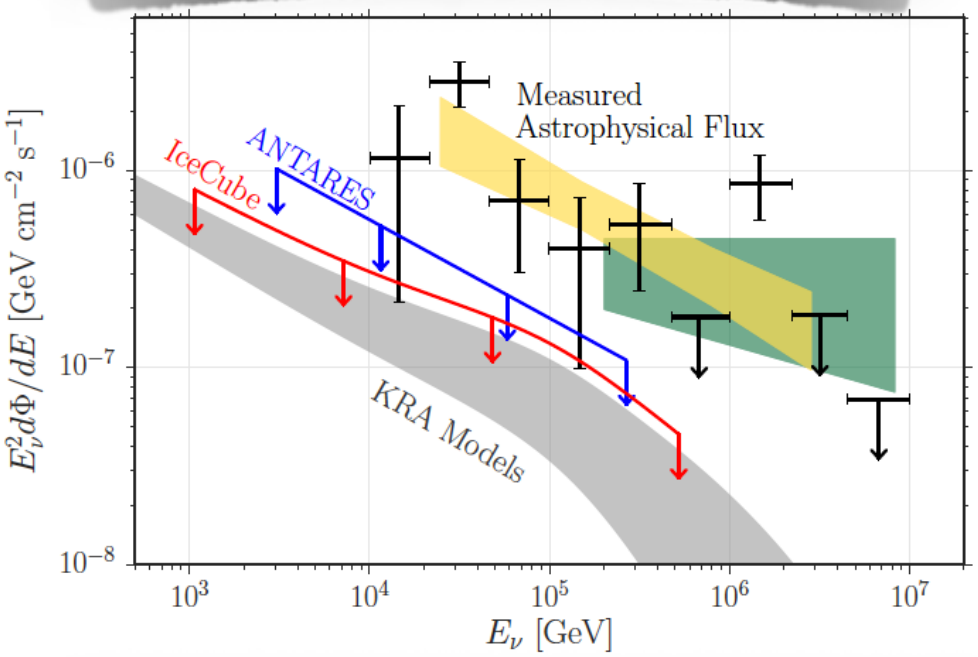
Computations of neutrino fluxes

Neutrino spectra produced following the parameters able to explain gamma-ray observation from GeV up to tens of TeV:

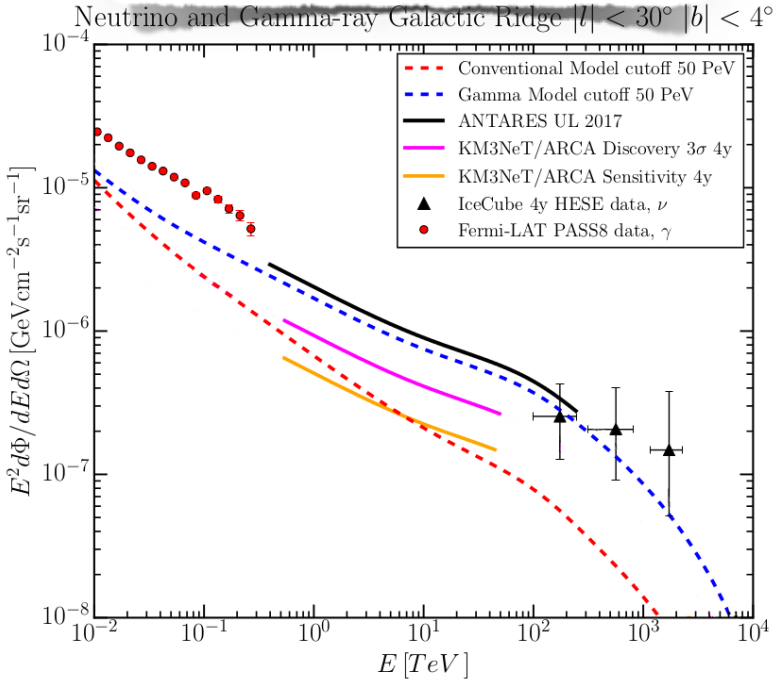
- The cosmic-ray transport obtained through DRAGON code (arXiv:1607.07886) with a radially dependent CR diffusion .
- For the gas: we set the Xco able to reproduce the gas column density obtained with gamma-ray observation (HESS + Fermi)
- Fermi Ring Model for the region at |l| > 1kpc and Ferriere Model for the region |l|<1kpc
- For primary CRs still open the possibilities of two possible cutoffs: 5 and 50 PeVs

Upper limits on Galactic diffuse emission

IceCube collaboration arXiv1707034161



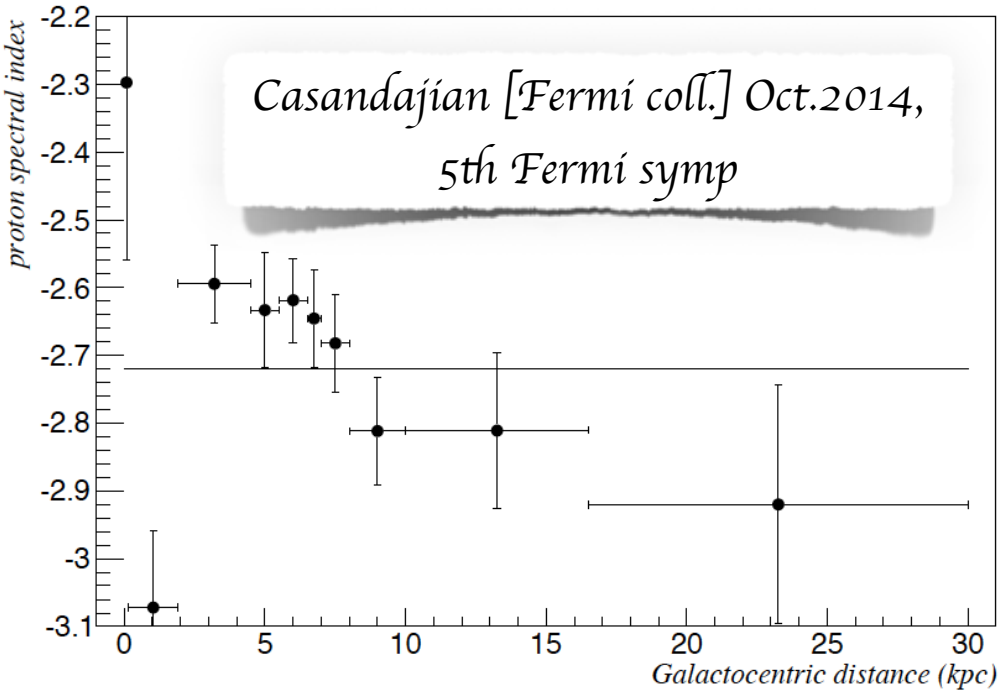
Coniglione et al. ICRC2017



ANTARES and IceCube constrained the maximum diffuse neutrino flux at a maximum value of ~20% of the total IceCube astrophysical measured flux.

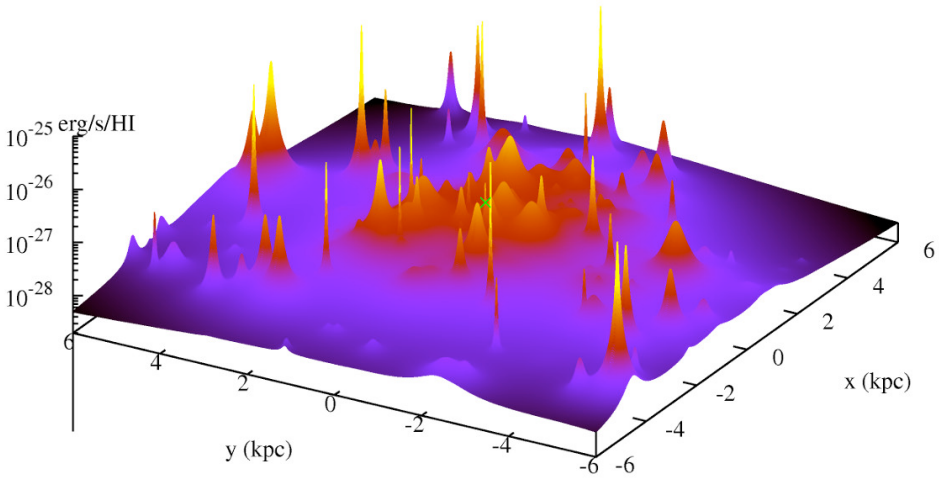
With the incoming KM3NeT/ARCA experiment maybe possible the study of different regions of the Galactic plane

Dishomogeneous Galactic neutrino emission



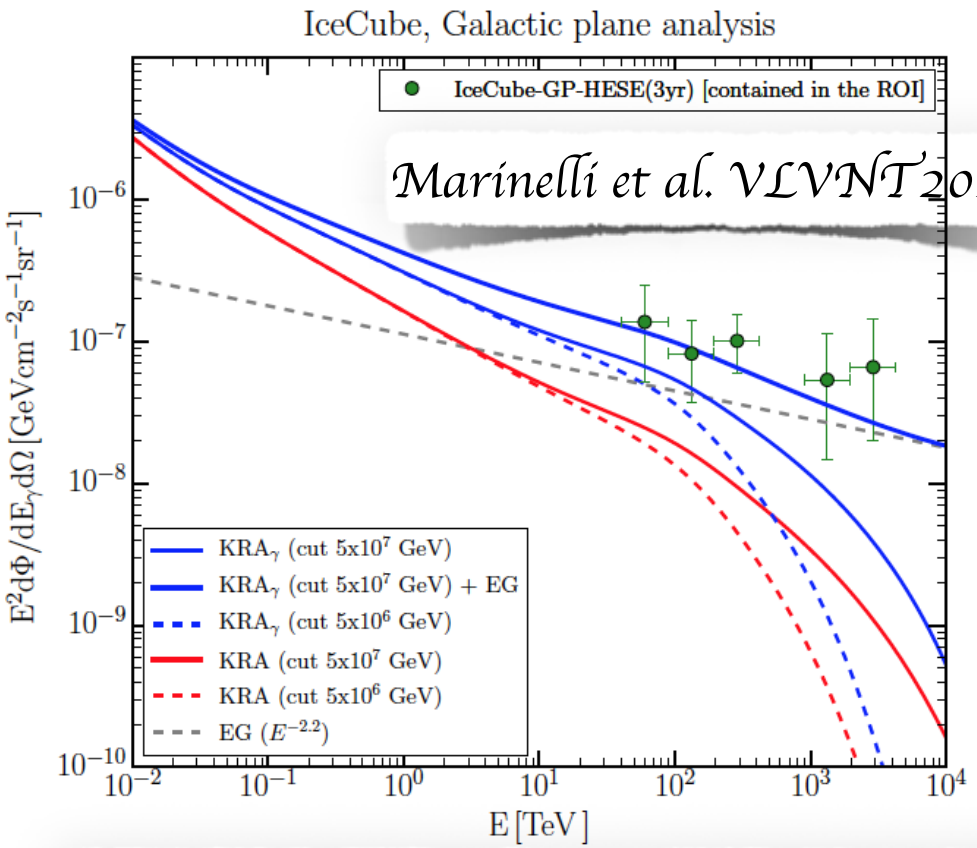
Casandajian [Fermi coll.] Oct.2014, 5th Fermi symp

Molaro et al. A&A 564, A107 (2014)

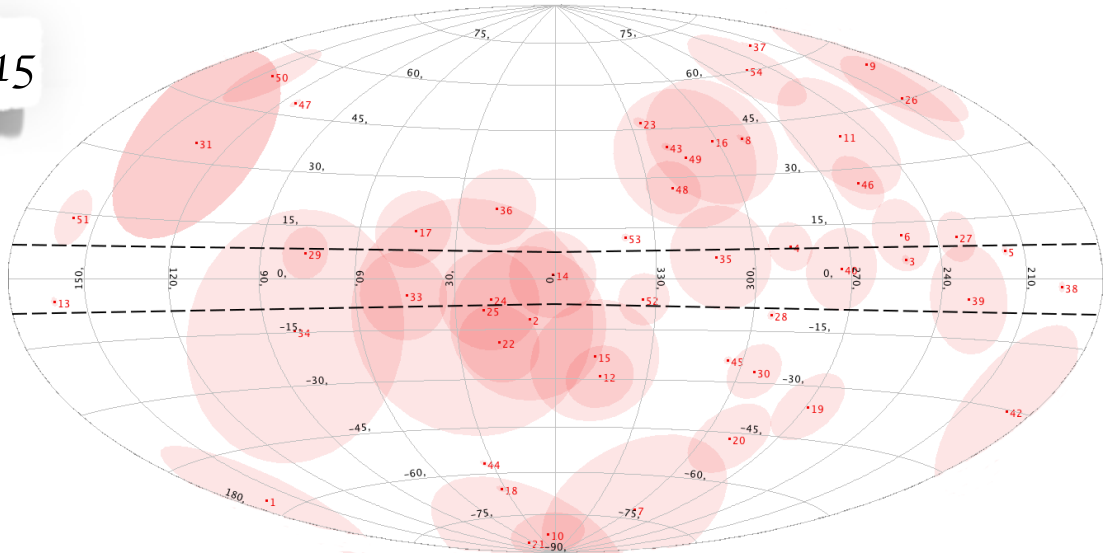


Dishomogeneous spectral index along the Galactic plane and dishomogeneous gas distribution will lead to a different neutrino expectations from different regions of the Galaxy

Whole Galactic plane diffuse emission

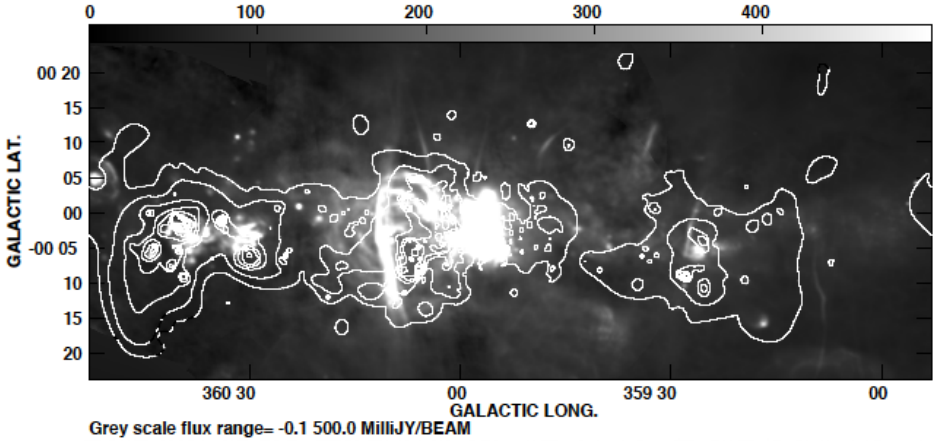


Marinelli et al. VLVNT2015



When considering the θ<7.5° region the diffuse Galactic contribution represent the 50% of the observed HESE neutrino flux leaving a large room for possible Galactic point-like contribution and EG in this region

CMZ: special Laboratory for Astrophysical Mechanisms

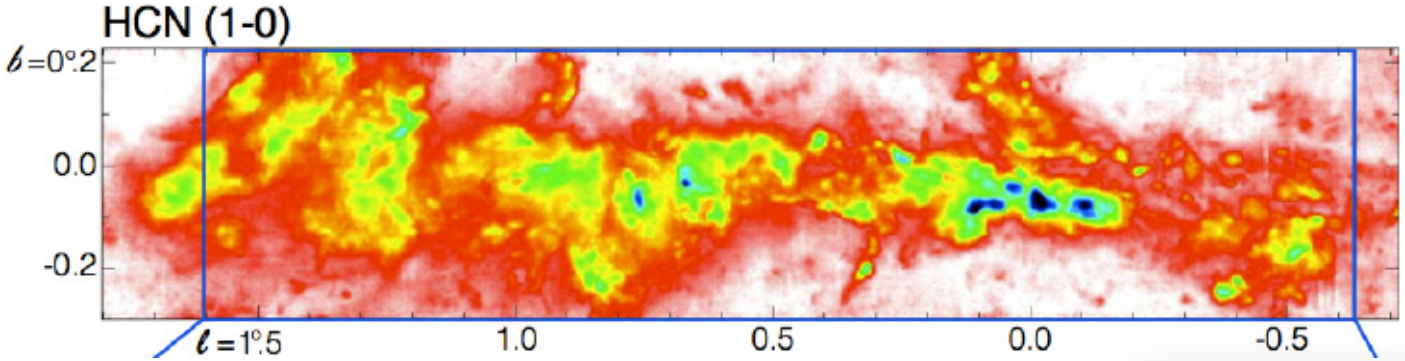


Hewitt et al. arXiv:1206.6882

Several hundreds of parsecs surrounding the central SMBH

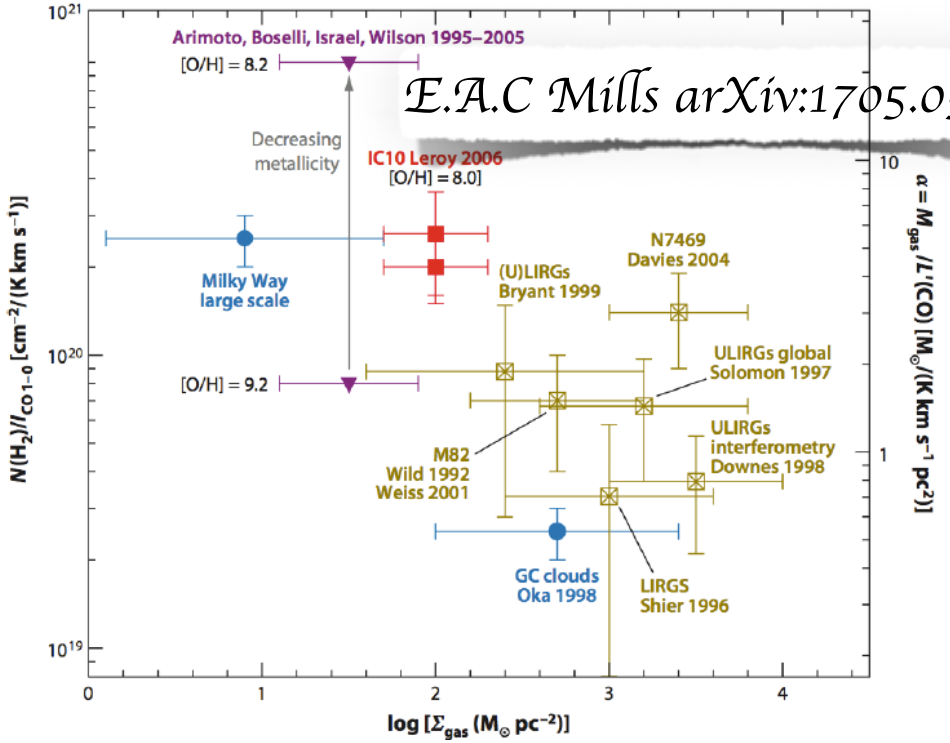
- Density of Gas 10^4 cm^-3 (2 orders of magnitude the average Galactic density at high scales)
- Total Molecular gas reservoir ~ 4 x 10^4 M⊙ (~5% of the total gas in the Milky Way)
- Star formation rate less than expected (higher activity in the past), high temperature, turbulent region, emitting radio, optical, UV, X and gamma, v -> way not?

A accurate gas description of the CMZ



arXiv:1705.05332

Due to our close distance to the GC, detailed maps



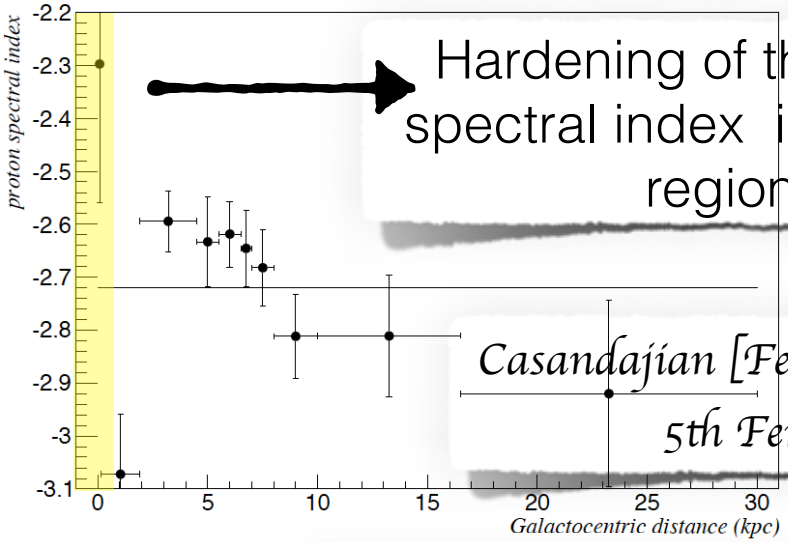
E.A.C Mills arXiv:1705.05332

Twisted ring of molecular clouds in the inner 200 parsecs with period of few 10^6 years

Characteristics of CMZ very similar to ULIRGS and Starbust galaxies!

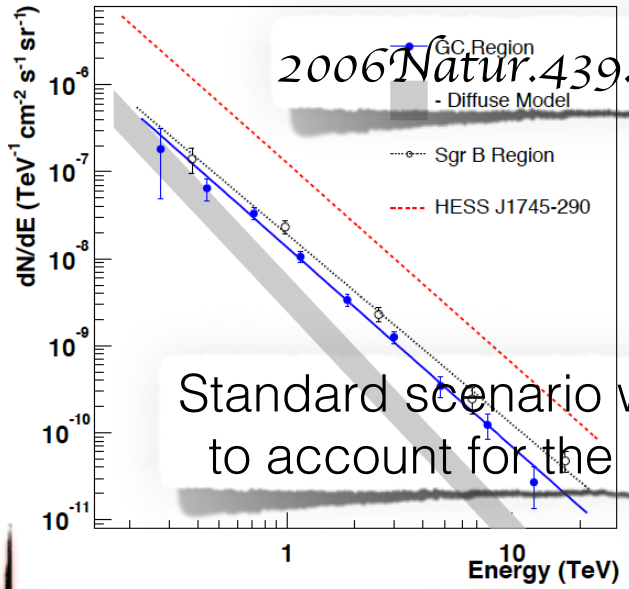
Possible extrapolation of v expected to EG objects.

Explanation of the previous CMZ flux up to VHE



Hardening of the proton spectral index in the CMZ region

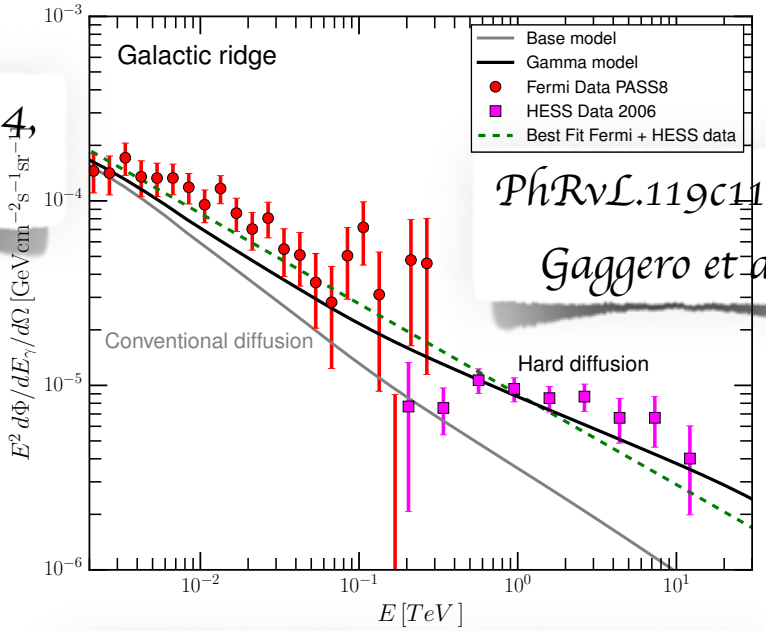
Casandajian [Fermi coll.] Oct.2014, 5th Fermi symp



2006Natur.439..695A (HESS coll.)

Standard scenario was not enough to account for the measured flux

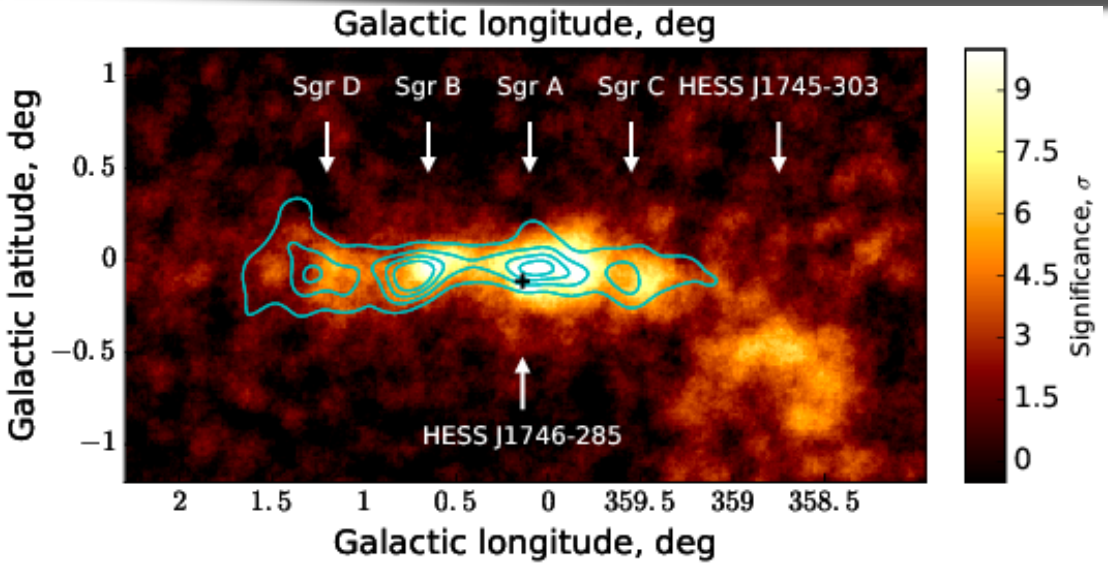
Look at the talk of Dario Grasso in GR session!!

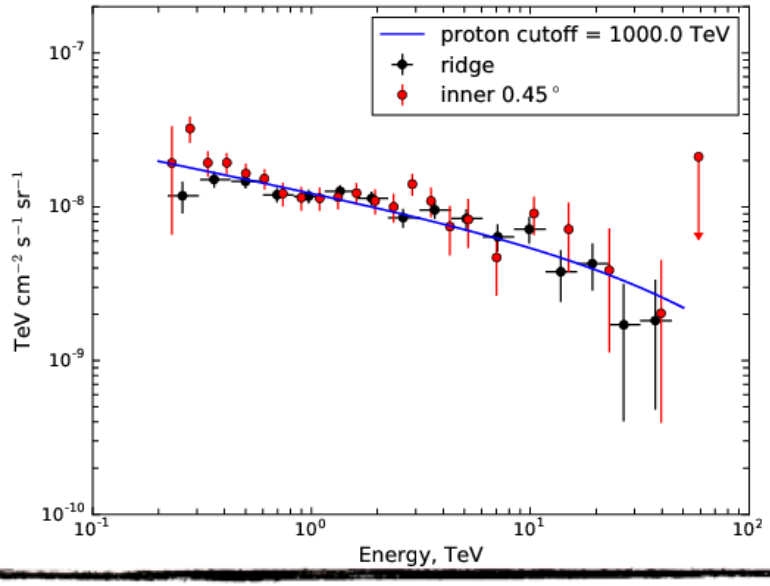


PhRvL.119c1101G Gaggero et al.

We explain it naturally with the Gamma model (non homogeneus CR transport)

New analysis of HESS for the central 200 parsecs





arXiv:1706.04535 HESS coll.

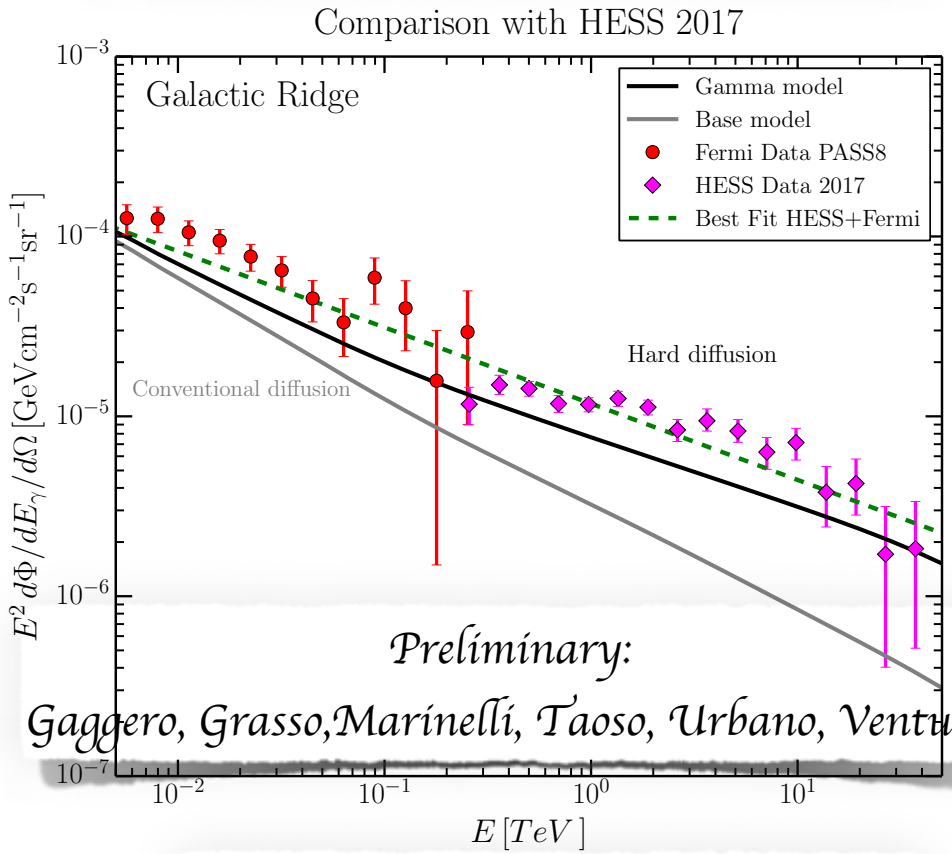
New morphological and spectral analysis of the gamma-ray emitting region with 250 hours of data

Spectral features of new GR 2017 similar to the ones of "Pacman" region

HESS coll -> Same population of fresh CRs from Pevatron
Our analysis -> Booth produced by CR sea hardening close to the GC

Fixing the parameters of source and gas distribution

Gamma & Base models
with Case and Battarchaya ('98)

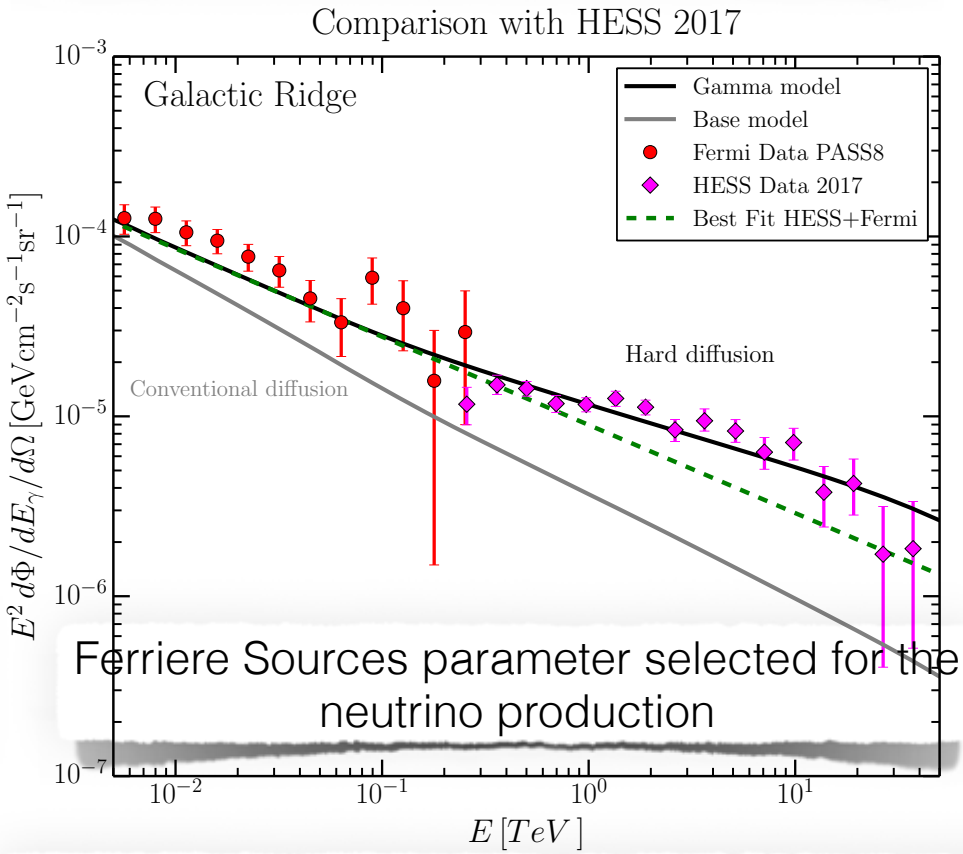


Preliminary:

Gaggero, Grasso,Marinelli, Taoso, Urbano, Ventura

$$\Phi_{GR} = 1.181 \times 10^{-5} \left(\frac{E_\gamma}{1TeV}\right)^{-2.42} GeV^{-1} cm^{-2} s^{-1} sr^{-1}$$

Gamma & Base models
with Ferriere source distribution ('01)

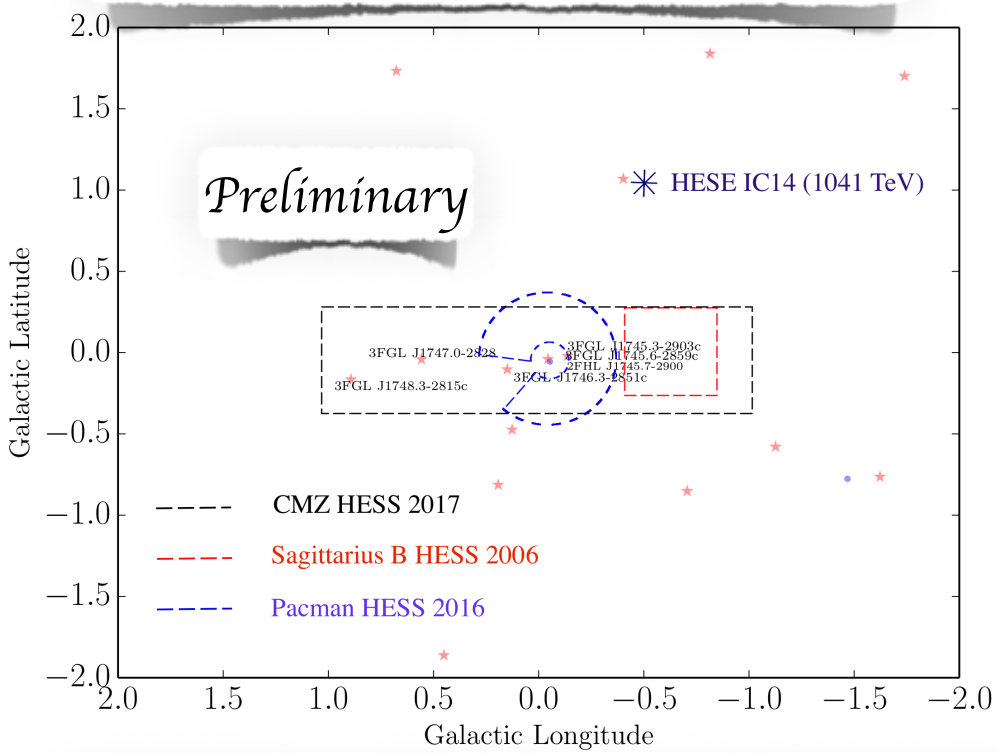


Ferriere Sources parameter selected for the neutrino production

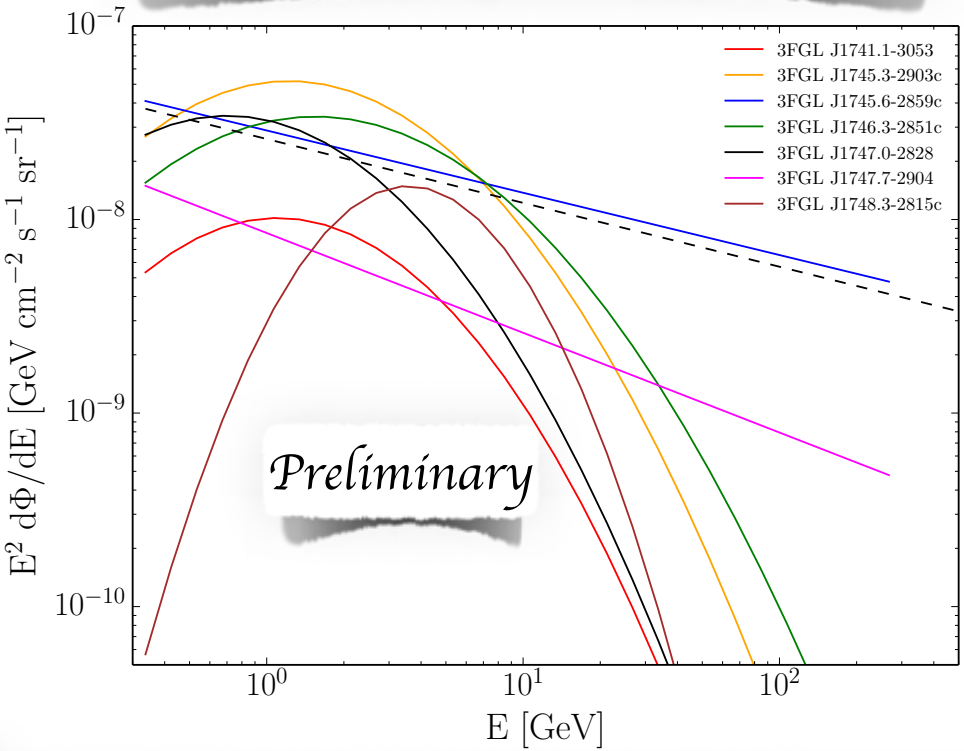
Gamma model fit with the hard spectrum

Regions of CMZ where we compute ν expectation

Regions of gamma diffuse



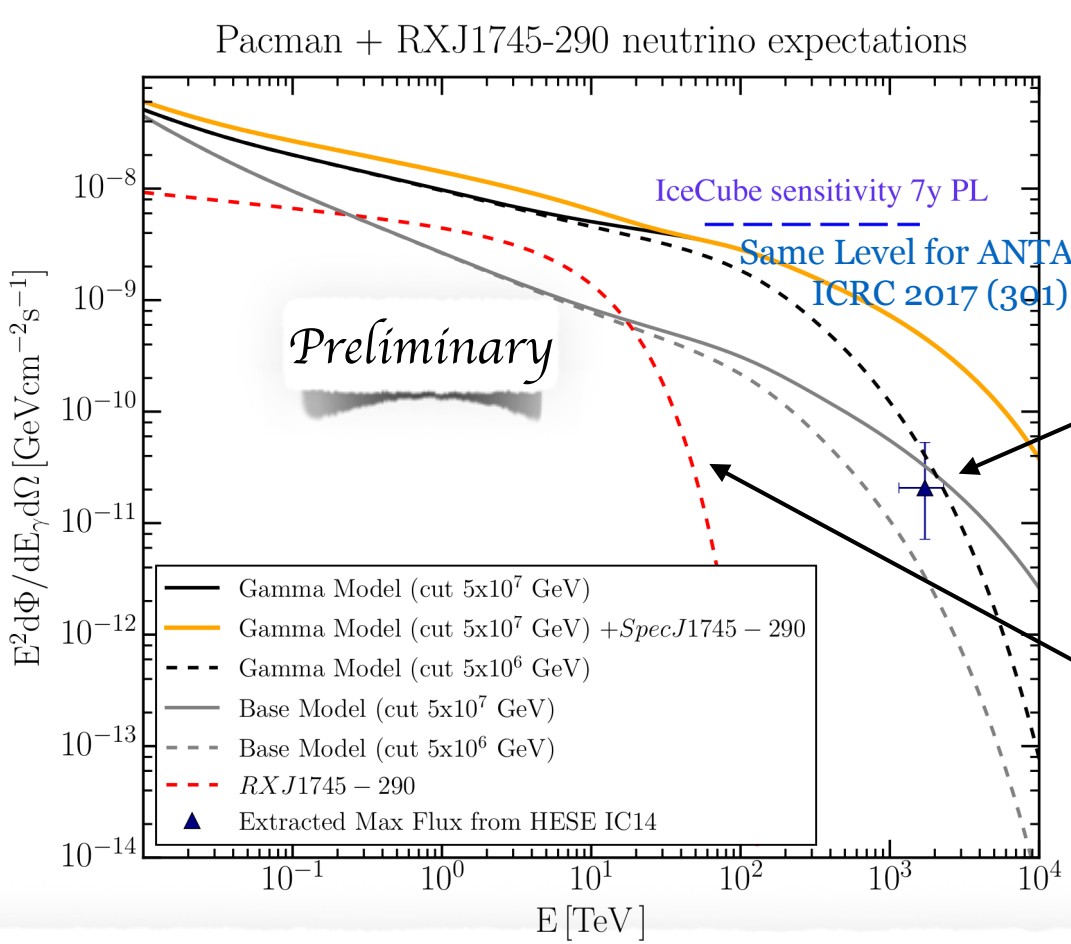
Fermi-LAT point like sources

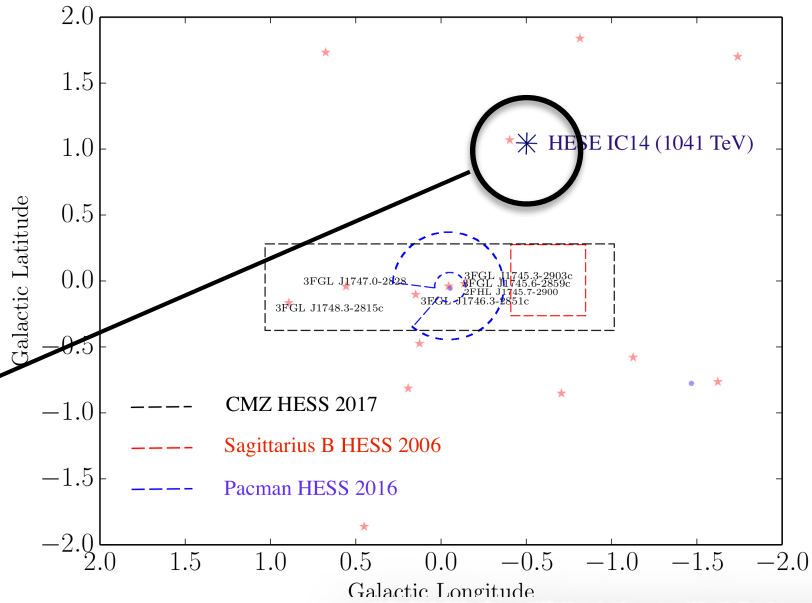


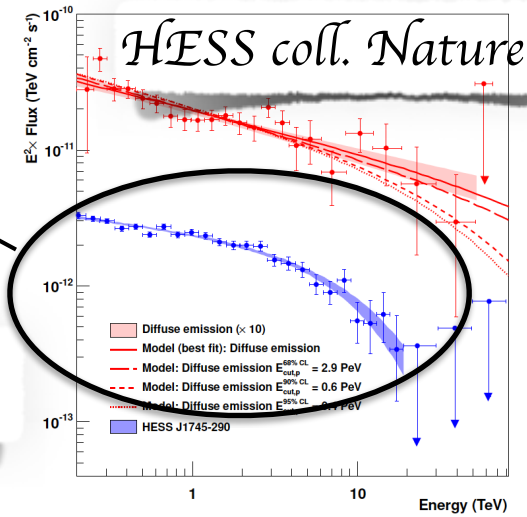
CMZ HESS 2017 |l|< 1°, |b|<0.3°
Sagittarius B 0.4°<l<0.9°, -0.2°<b<0.3°
Pacman, annulus 0.15<θ<0.4

SEDs of possible PLS (also 2FHL1745-290) from Fermi in the CMZ region of 200 pc

Neutrino from the Pacman region (HESS 2016)

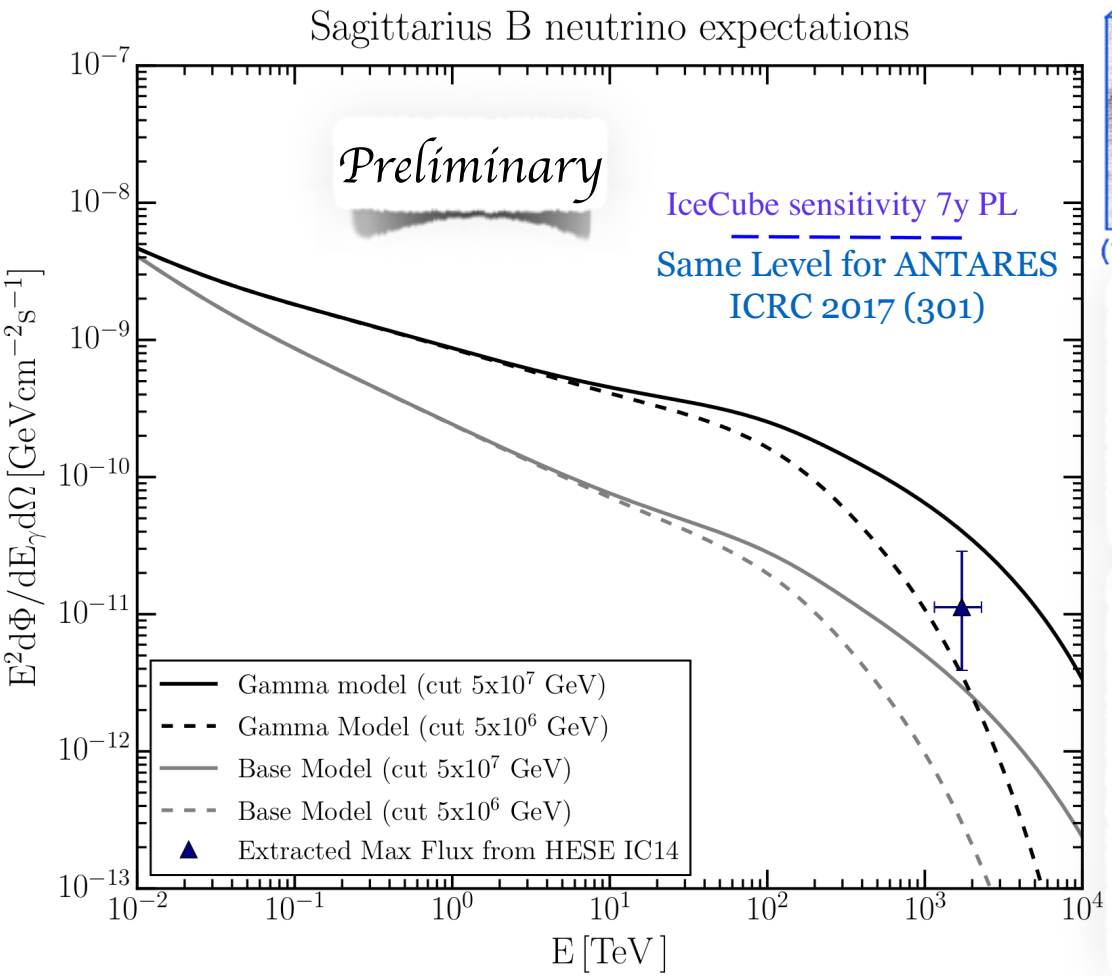




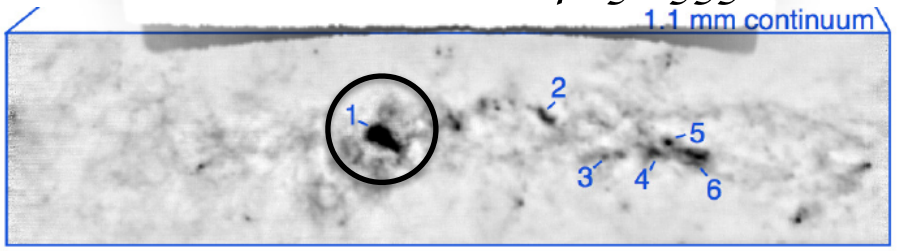


Better PLS sensitivity needed:

Neutrino from the Sagittarius B molecular complex



E.A.C Mills arXiv:1705.05332

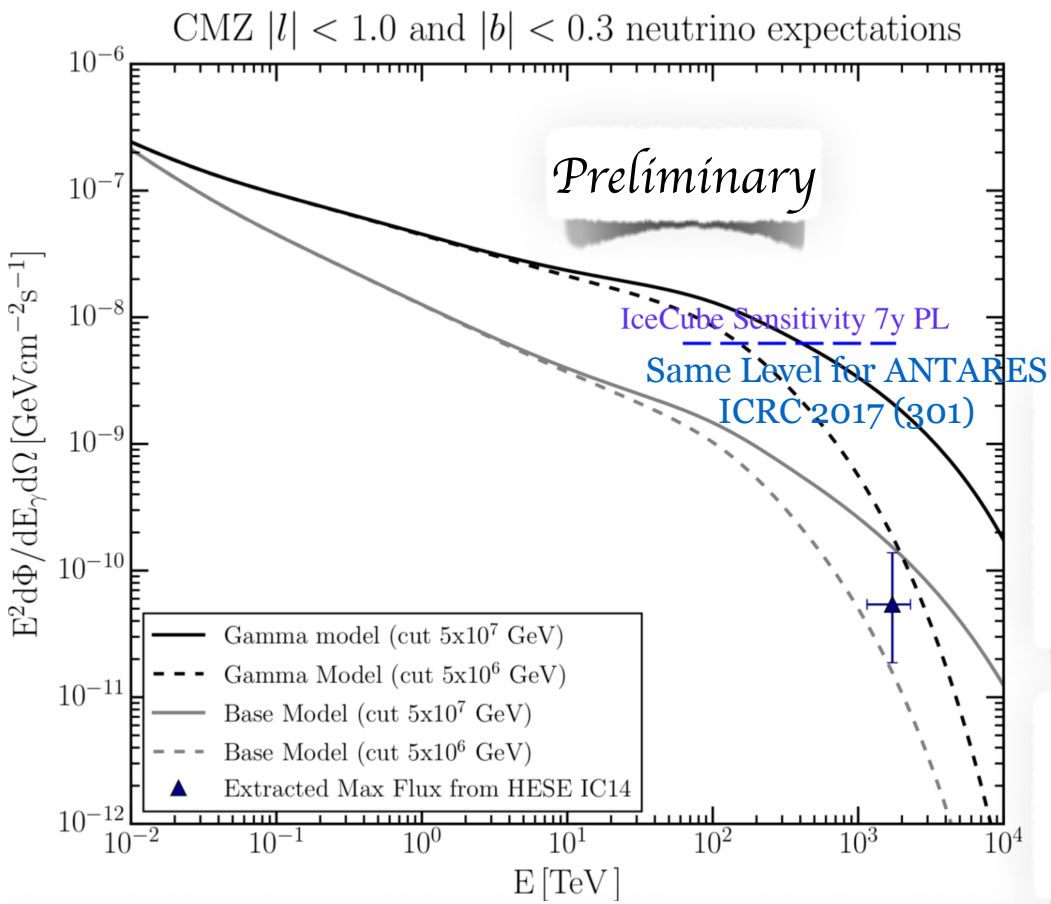


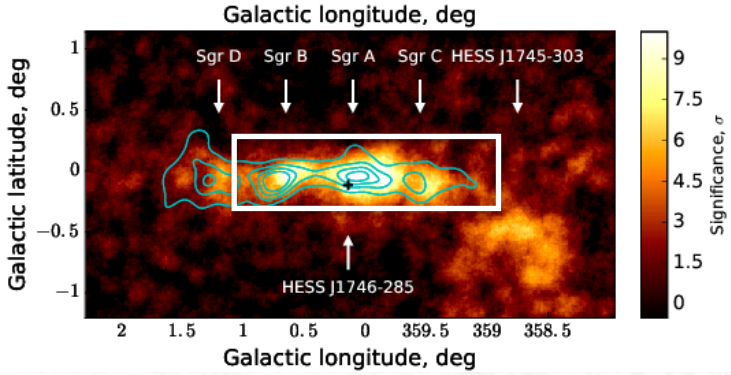
(1) Sgr B2, (2) M0.25+0.01, (3) M0.11-0.08, (4) M-0.02-0.07, (5) CND, (6) M-0.13-0.08

Sagittarius B far to be detected as a single PL source if the emitting region is only the one of HESS

Only one PeV HESE event gives not a strong limit however the extrapolated flux seems more compatible with a 5 PeV cutoff instead of 50 PeV.

Neutrino from the 200 pc of the CMZ (HESS 2017)





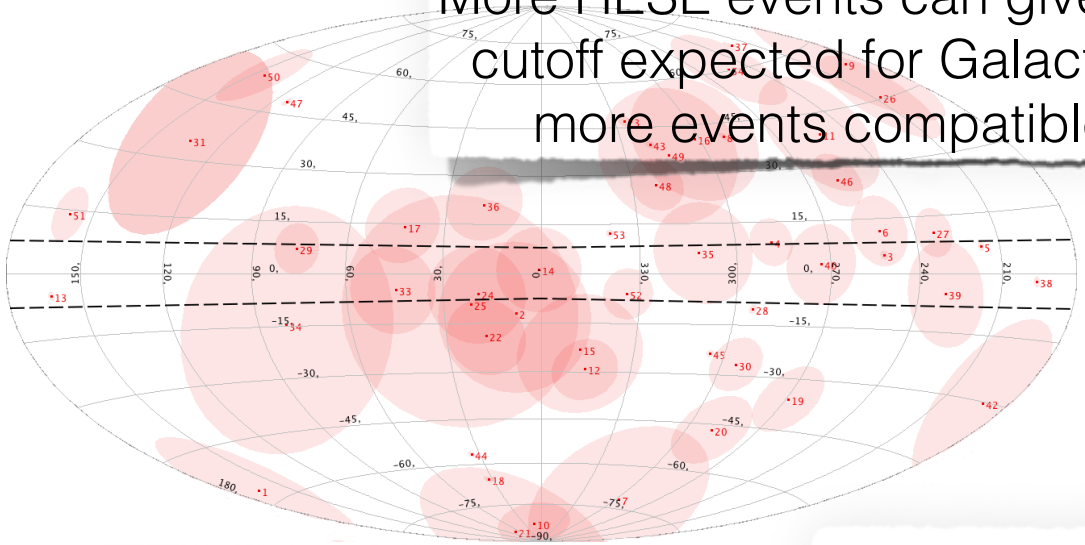
Integrating the flux of the full 200 parsecs better chances to see the signal for IceCube and ANTARES

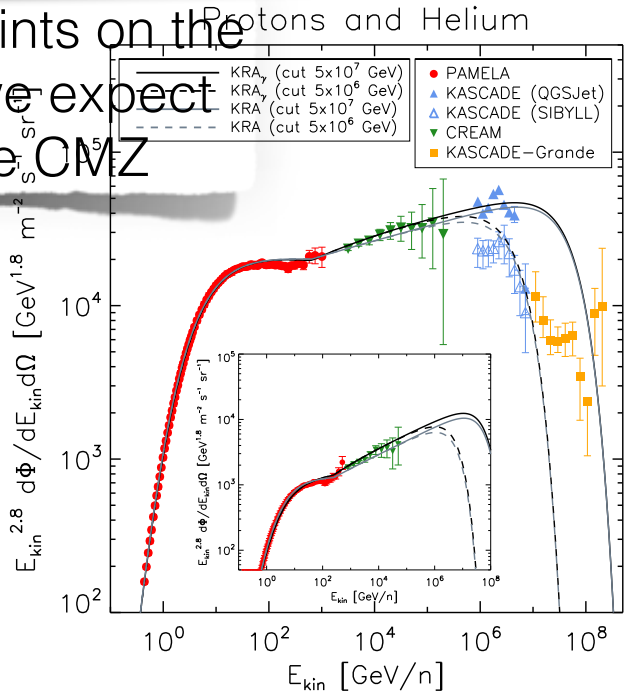
Good visibility should be expected for KM3NeT/ARCA

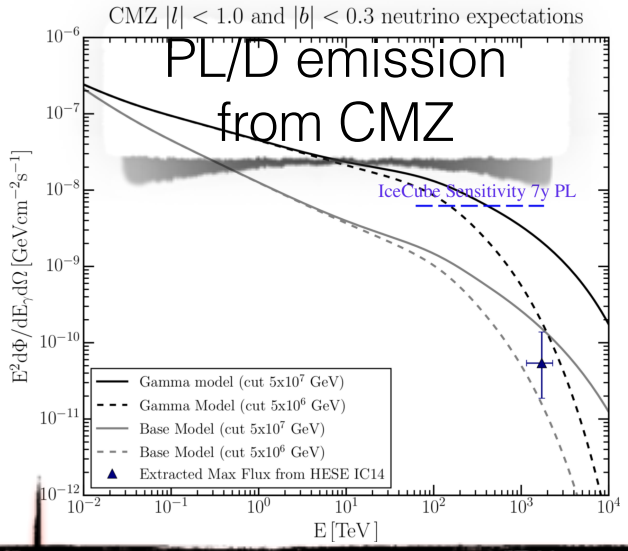
The extrapolated max flux from IC14 (1041 TeV) still more compatible with 5 PeV cutoff, we expect more HESEs in this region of the sky!

Constraints on the Galactic CR cutoff and model of ν

More HESE events can give good hints on the cutoff expected for Galactic CR, we expect more events compatible with the CMZ







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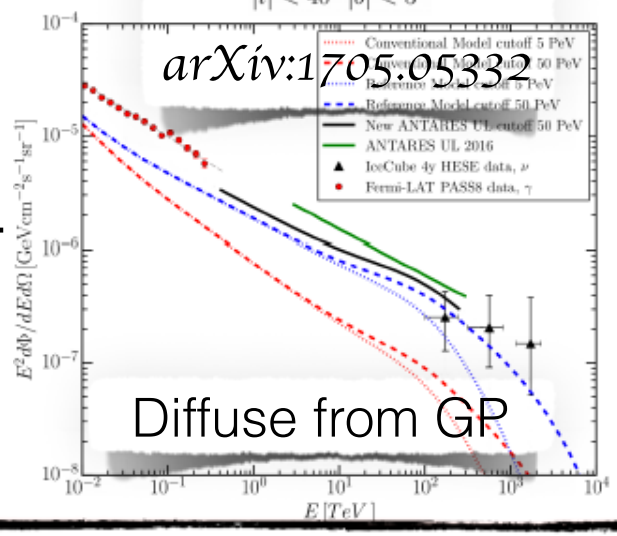
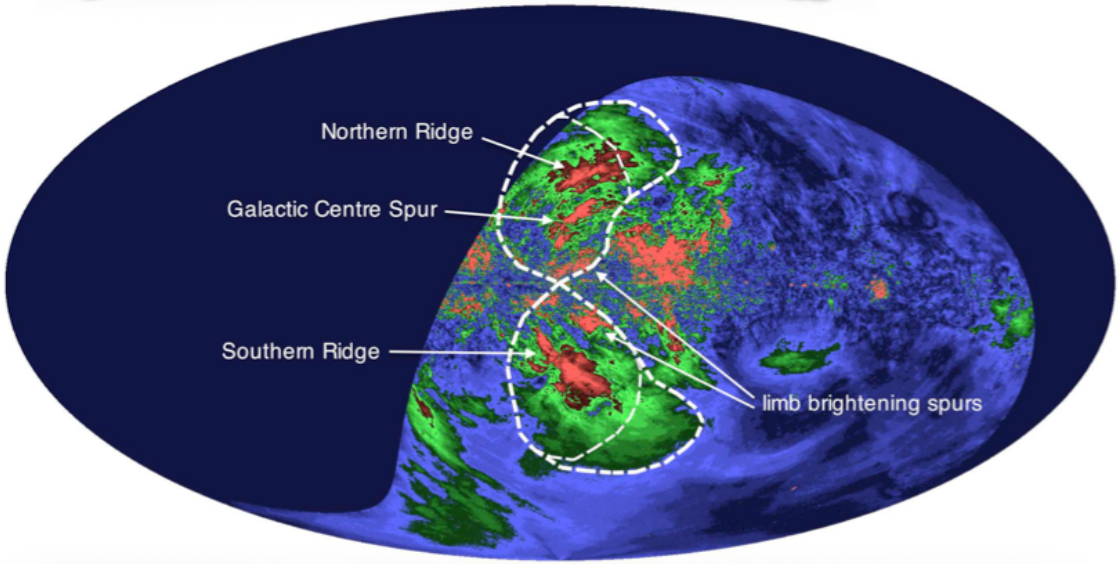


Template fitting analyses Can constrain the model of Galactic CR propagation with ν observations.

Fermi Bubbles emission from radio to gamma

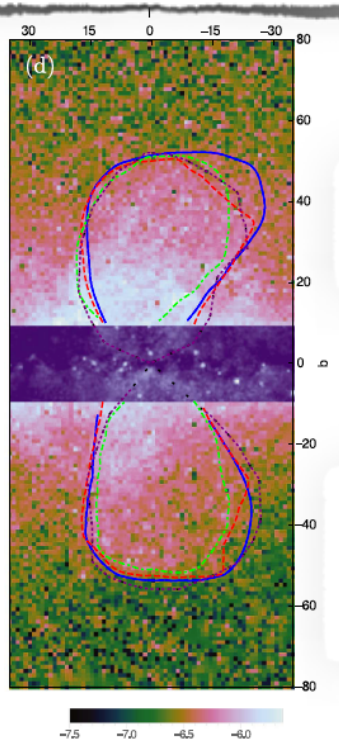
Carretti, et al. Nature 493 (2013) 66



Radio emission intensity of Bubbles

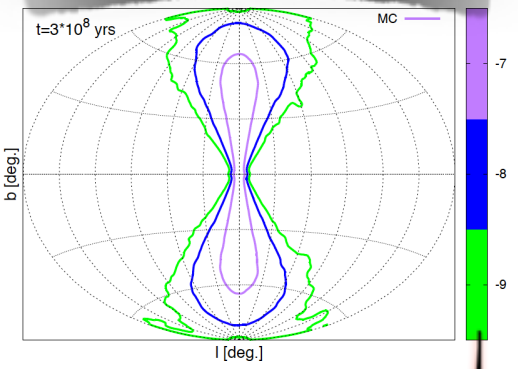
Giacinti & Taylor ICRC2017

CKeshet et al. APJ 2017 840 n7



Fermi Bubbles with PASS8 data

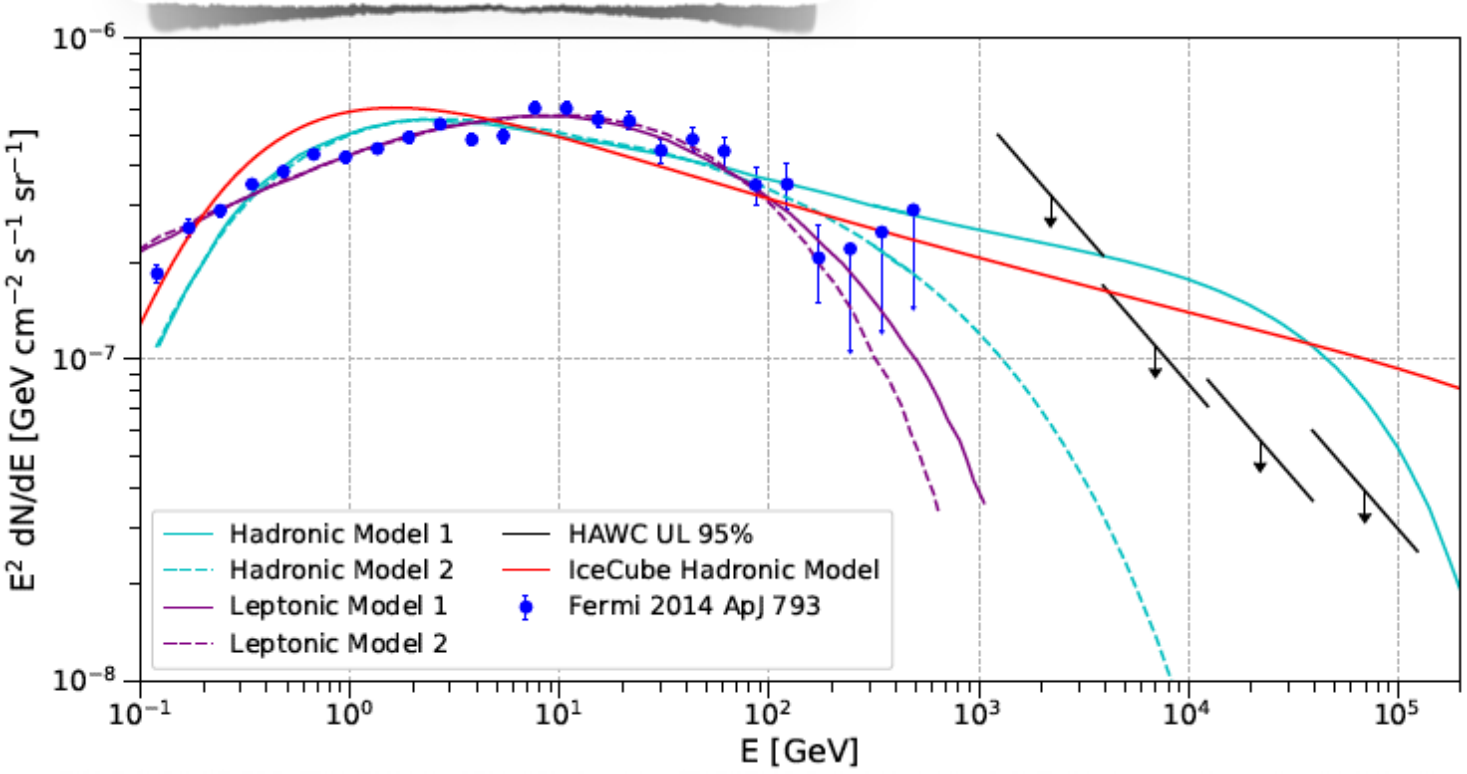
MC of hadronic emission at different energies



Extension of non thermal radio emission region outside the gamma-ray bubbles favors the connection with CR production

Fermi Bubbles observation with HAWC telescope

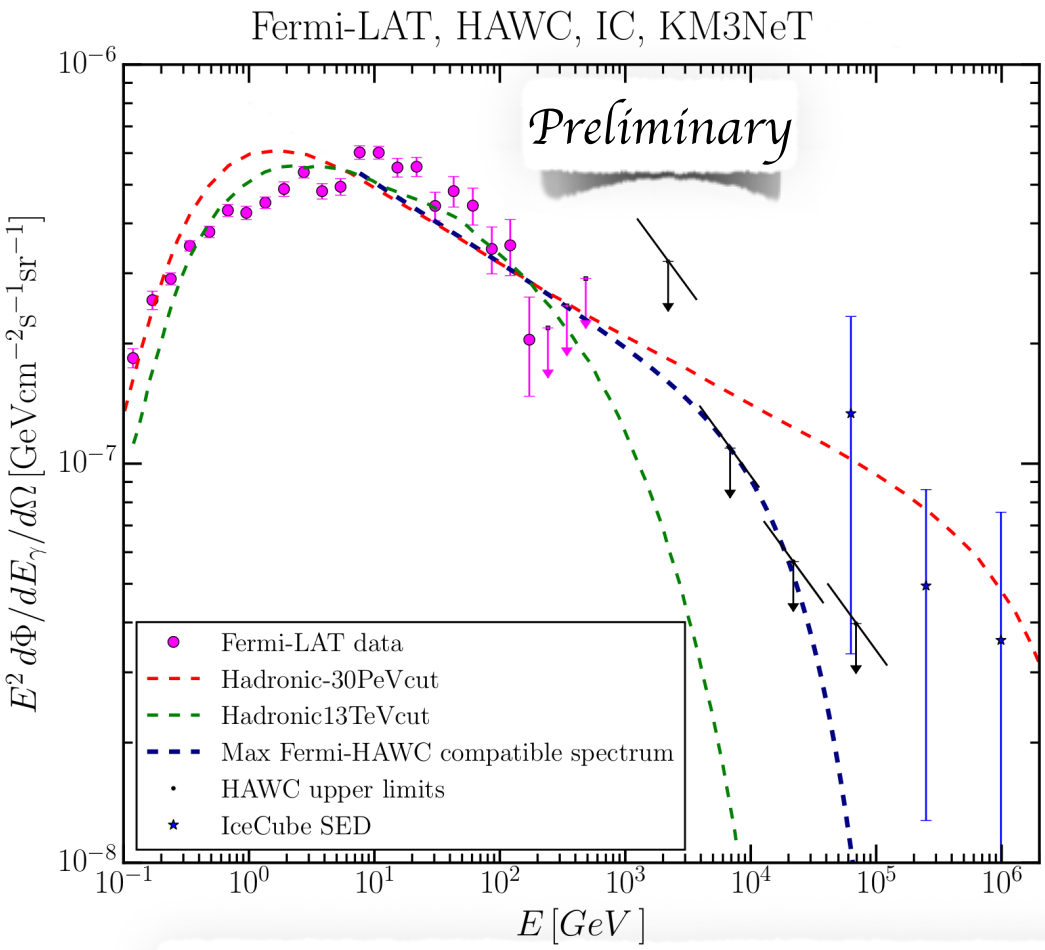
HAWC coll. 2017 ApJ .842..85A



A Cut-off on the SED needed at VHE

HAWC started to constrain the VHE emission from Fermi Bubble SED, still place for Hadronic models

Fermi Bubbles gamma+neutrino



The comparison between gamma-ray emission and possible neutrino flux obtained from IC HESE events disagree

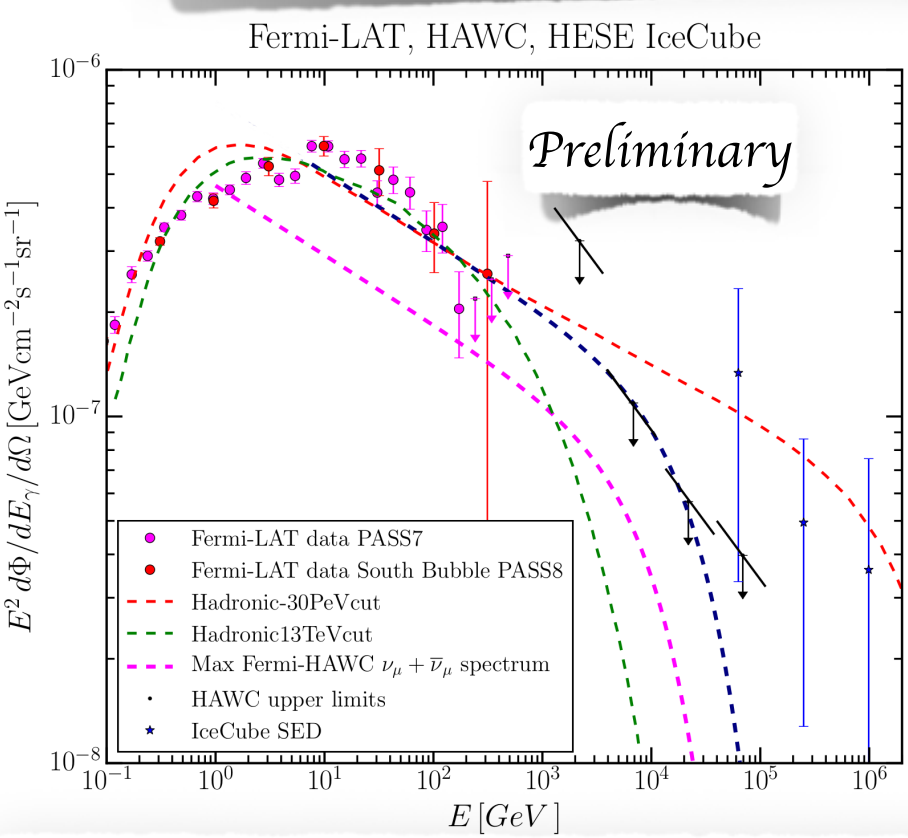
Two possible interpretations:

1) Strong absorption for gamma-ray
2) HESE events not correlated with Fermi Bubbles emission

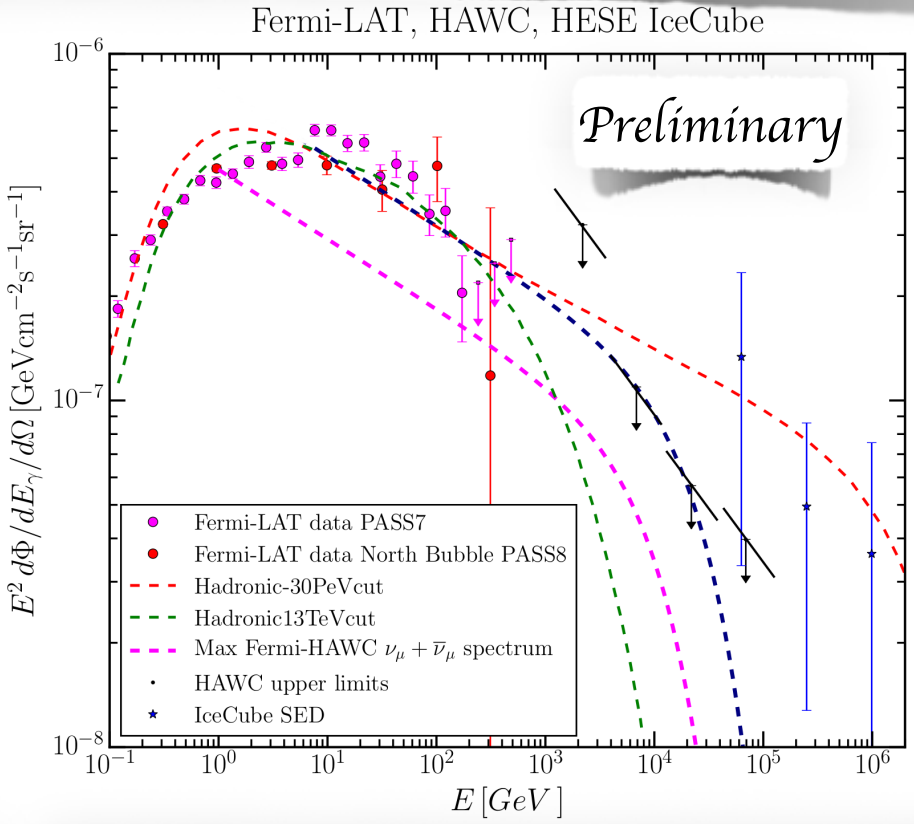
Still possible a SED with a cut-off at 30 TeV for gamma-ray emission

Introduction of PASS8 data for the Bubbles

PASS8 data allow for the same SED modeling of PASS7



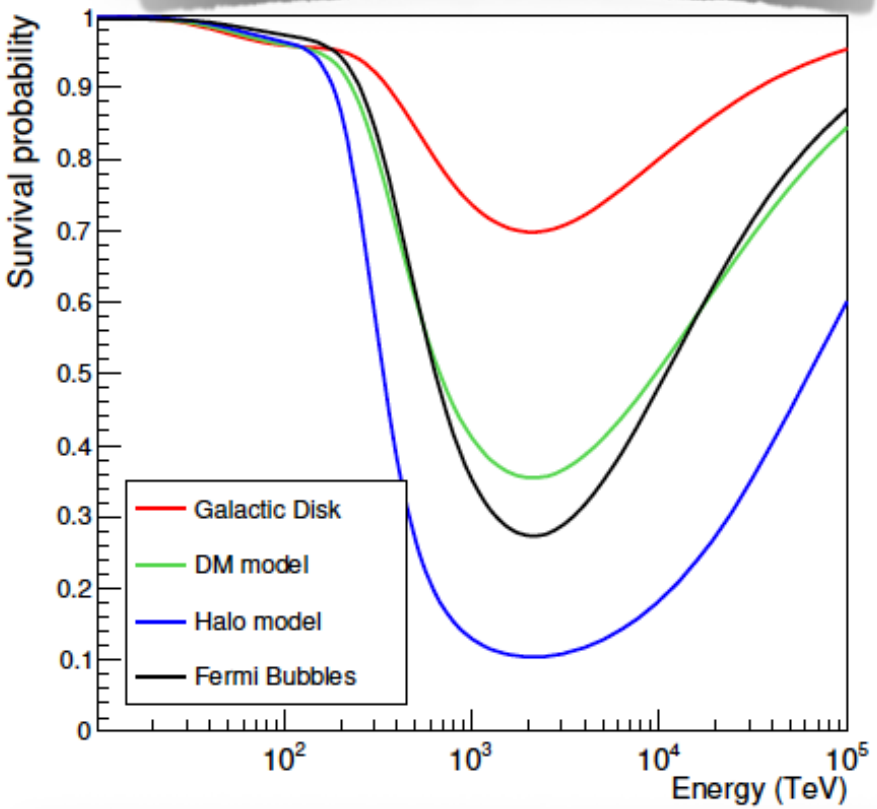
Introduction of PASS8 data for Bubble South

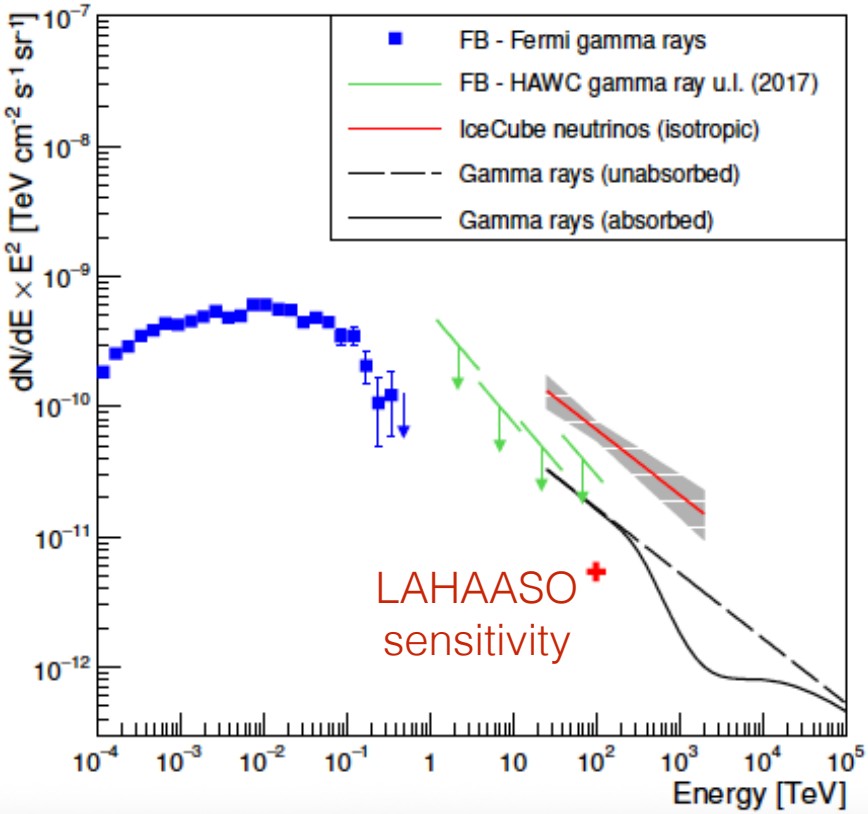


Introduction of PASS8 data for Bubble North

The possible absorption for VHE gamma-ray

ICRC 2017 Vernetto e Lipari

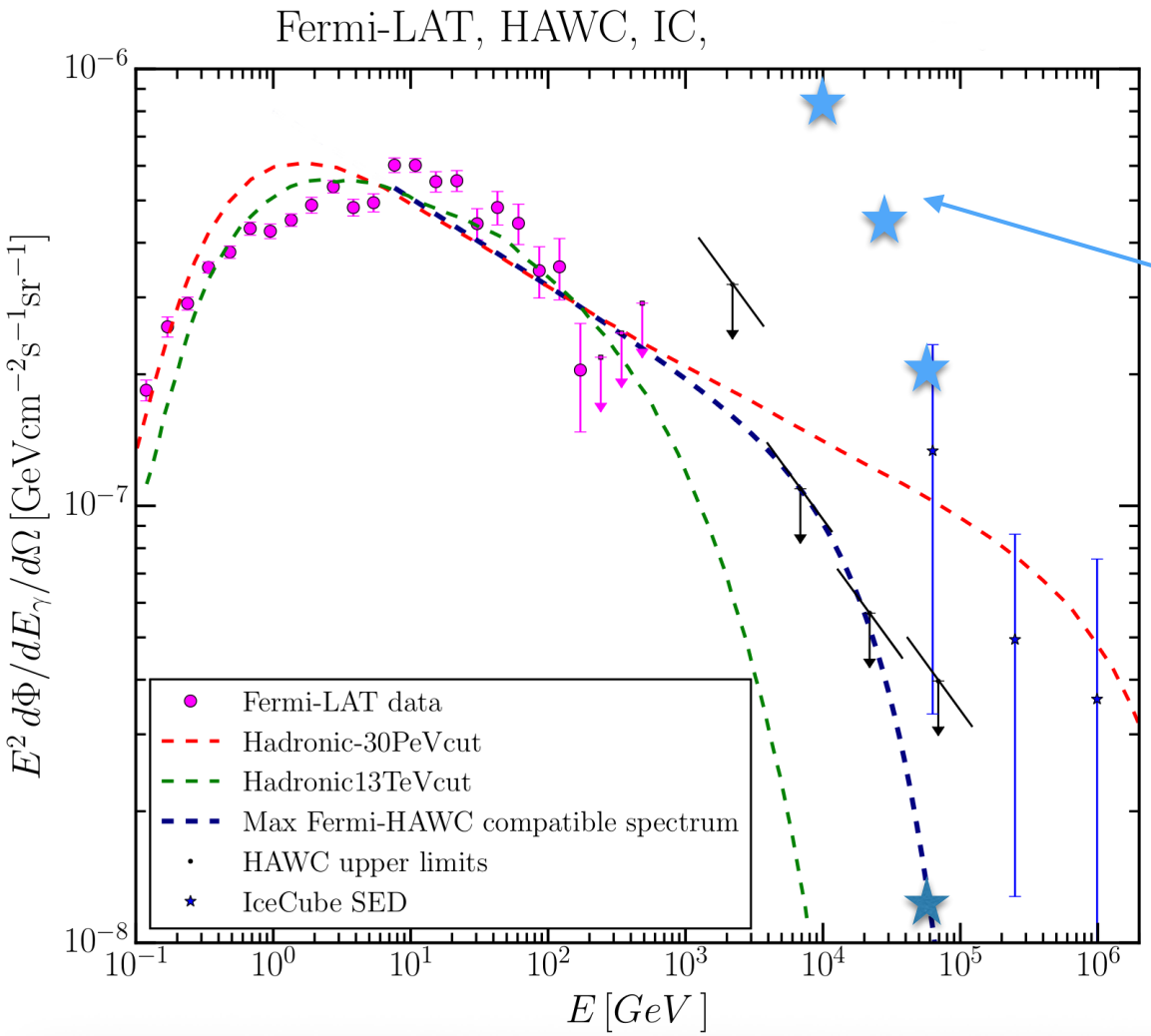




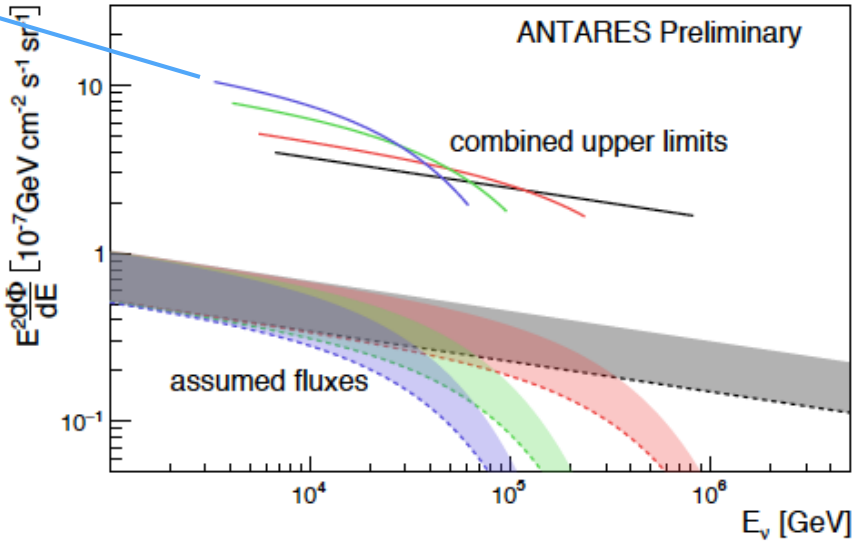
Absorption model built through the measured infrared emission from our Galaxy

No Major effects for the Bubbles below 100 TeV

Constraining the Fermi Bubbles neutrino emission



ICRC 2017 Hallmann for the ANTARES coll.



Neutrino telescopes cannot confirm at the moment the neutrino emission possibly associated with the Fermi Bubbles

SUMMARY & CONCLUSIONS

- Total diffuse Galactic neutrino emission starts to be constrained through ANTARES and IceCube telescopes.
- Central Molecular Zone and Galactic TeV cloud emitters possibly visible in the next years with the Global Neutrino Network.
- The PeV HESEs compatible with the Galactic plane will be crucial to have information about Galactic CR cutoff
- The Fermi Bubbles hard to be seen through neutrino telescopes in a short time scale if the HAWC upper limits will be confirmed.


Thanks for
the Attention!