Joint Constraints on Galactic Diffuse Neutrino Emission with ANTARES and IceCube

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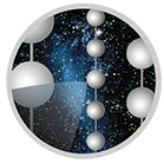
VLVnT 2018



IceCube
South Pole Neutrino Observatory

Bundesministerium
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Physics
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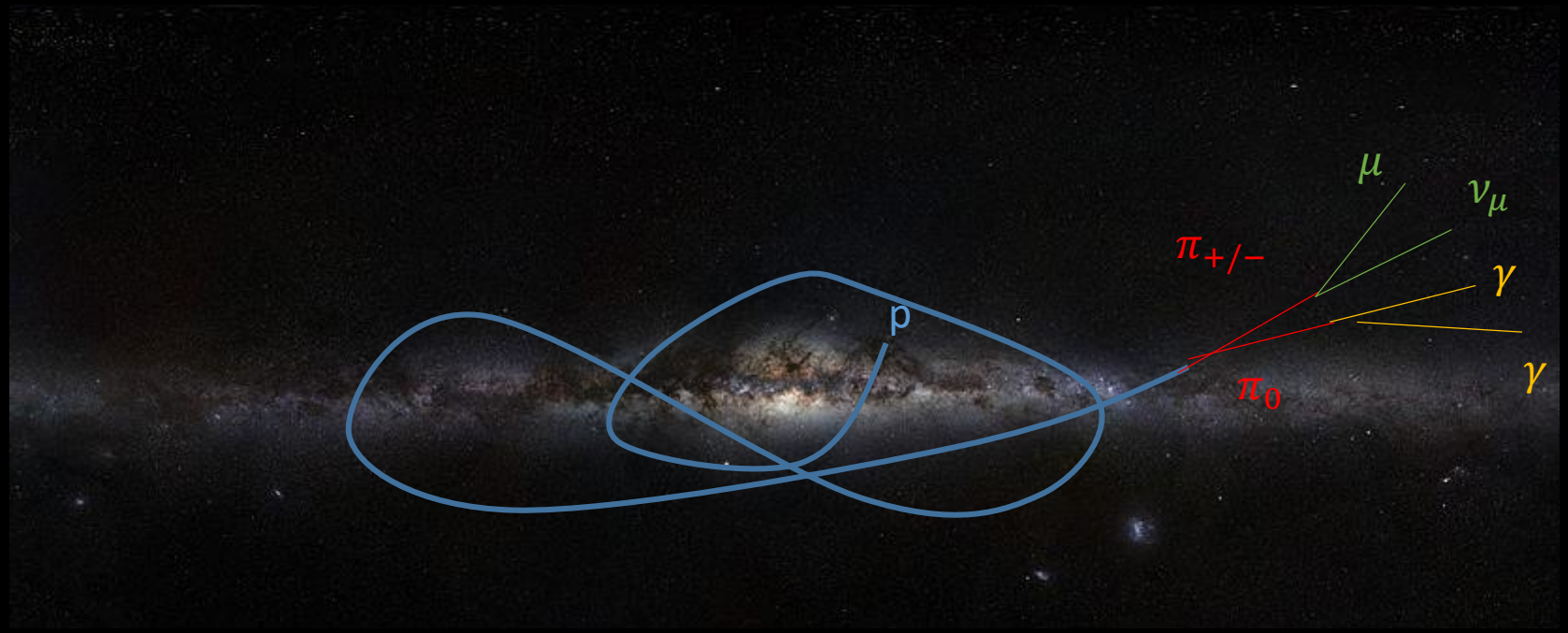
Galactic Cosmic Rays

- During propagation protons interact with material near the source or interstellar gas
- Interactions produce pions which decay into γ and ν
  →**Diffuse γ / ν emission**



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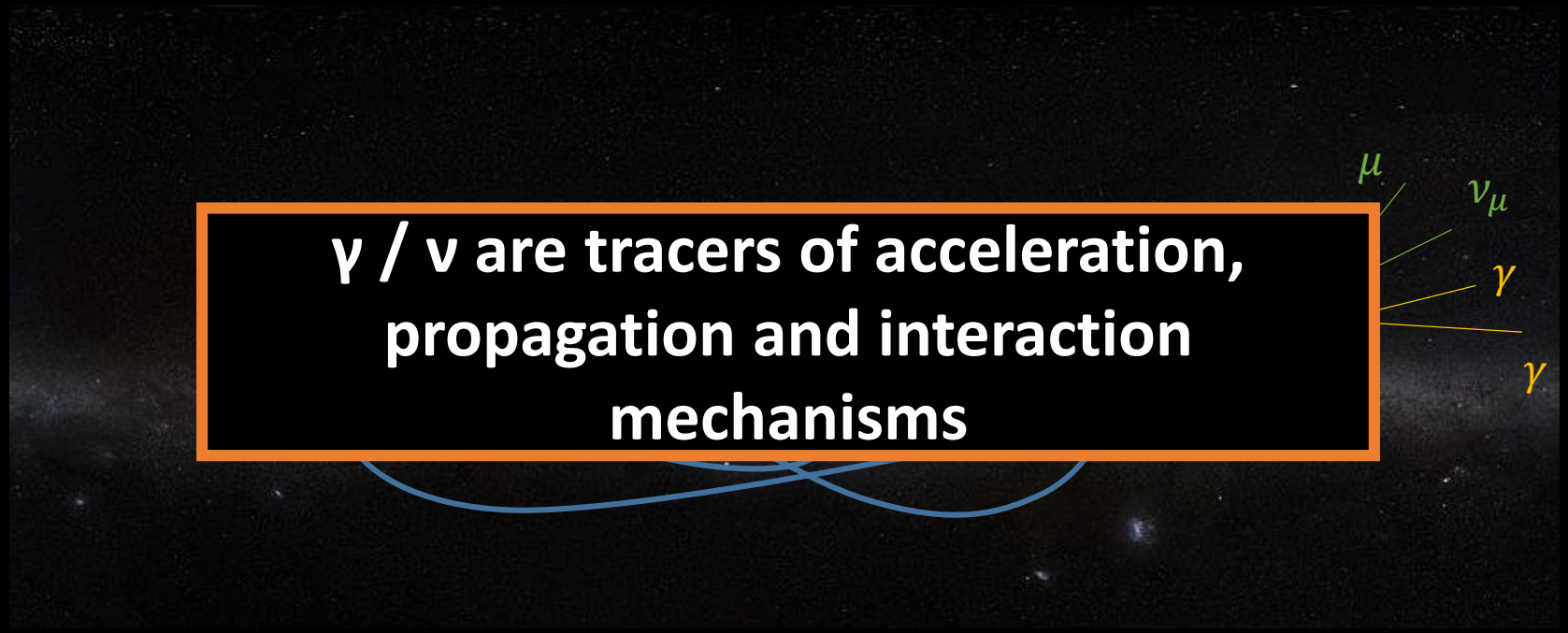
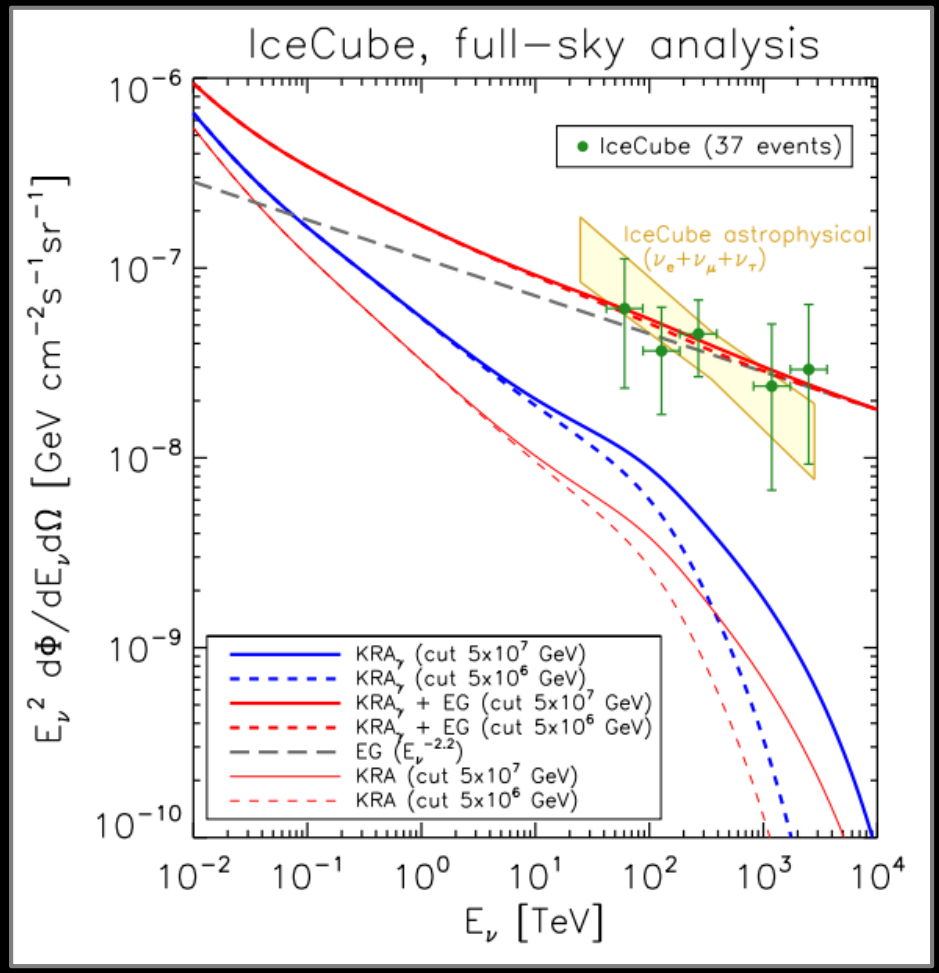


γ / ν are tracers of acceleration, propagation and interaction mechanisms

KRA_γ-Model of Galactic Diffuse Emission

- Model by Gaggero et. al. provides consistent picture of ν and γ diffuse emission
- Based on KRA_γ CR-diffusion model Assumes diffusion coefficient depending on galiocentric radius
- Developed to solve problems of conventional propagation models (e.g. “Milagro excess“)
- 5 PeV or 50 PeV CR cutoff (KRA_γ^5, KRA_γ^{50})

Daniele Gaggero *et al* 2015 *ApJL* **815** L25



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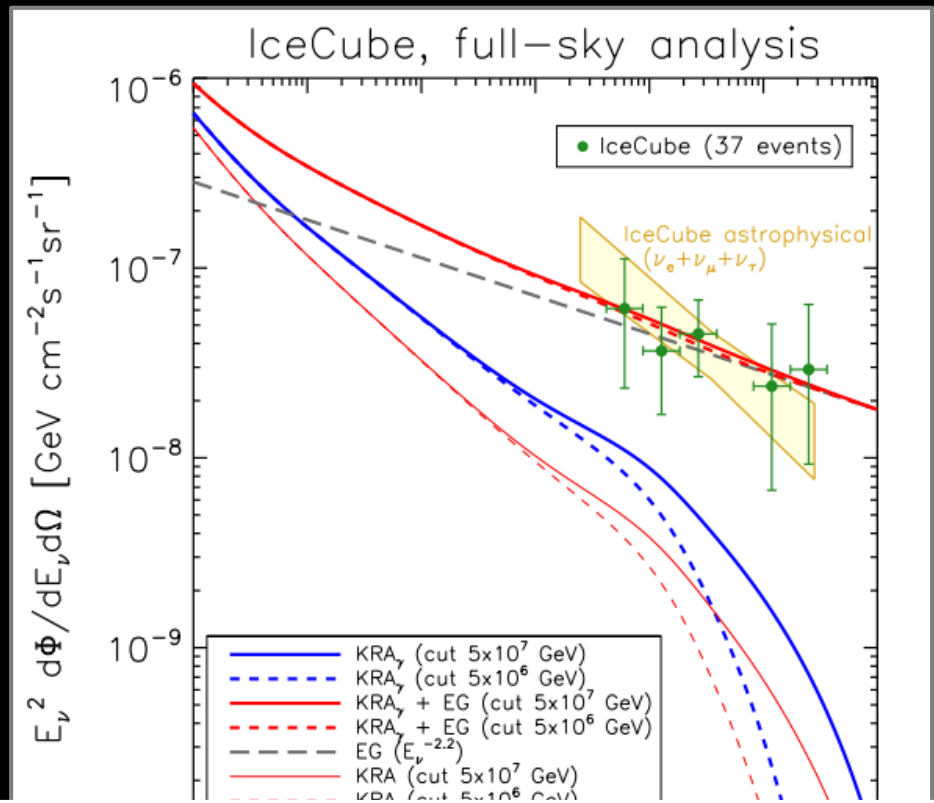
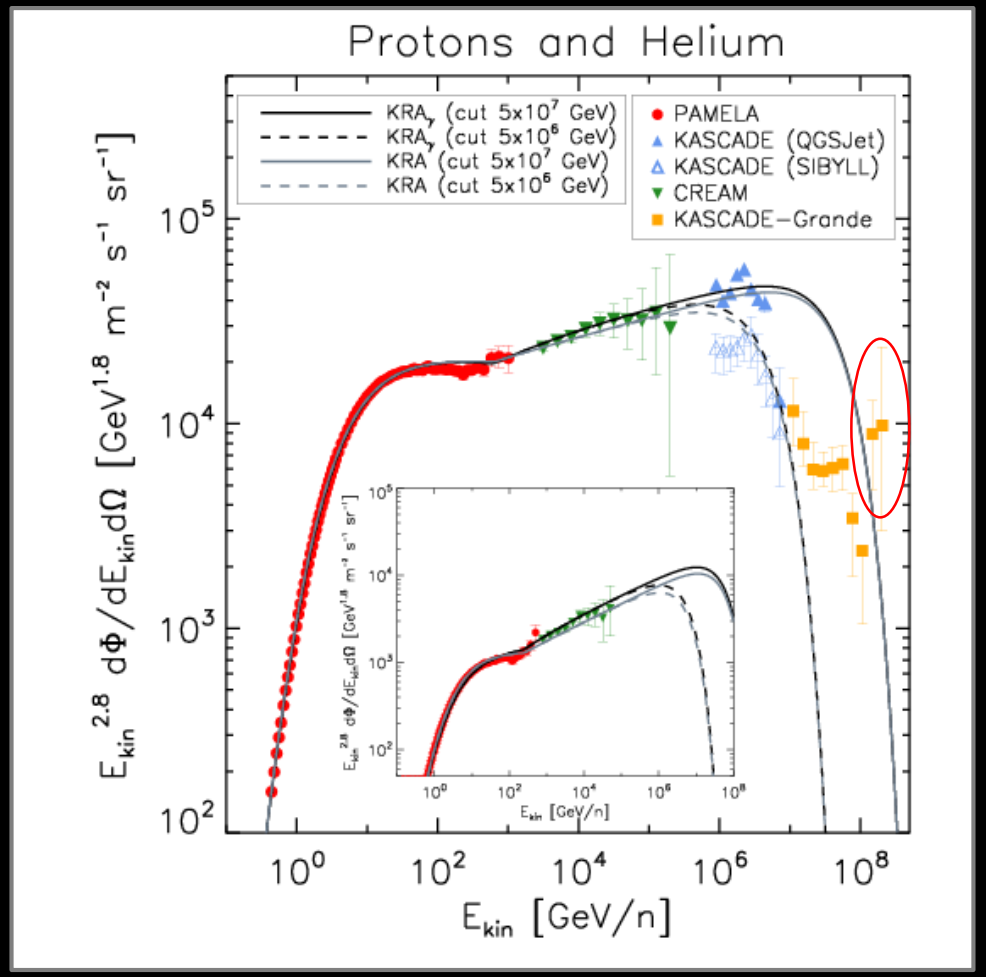


→ν measurement can help constrain diffusion models

5 PeV vs. 50 PeV CR Cutoff



https://arxiv.org/abs/1507.07796

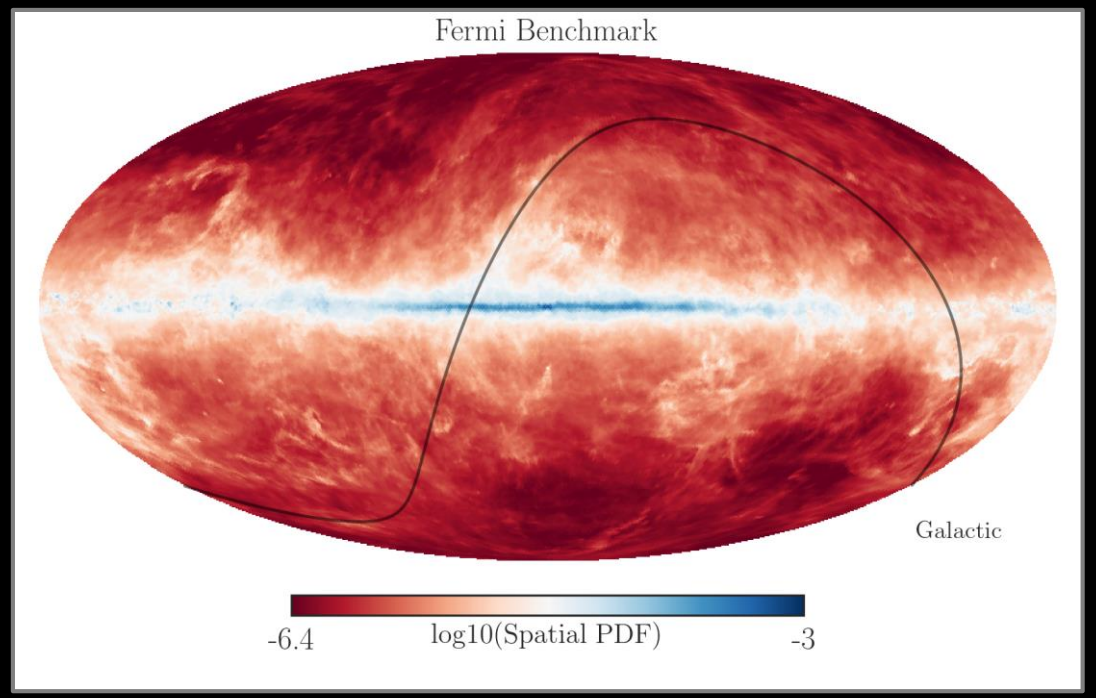
KRA$_\gamma$ –authors produced models for 5 PeV or 50 PeV galactic CR cutoff to bracket KASCADE-Grande measurements.

However CR experts say that at highest energies KASCADE-Grande data-points have extragalactic contamination.

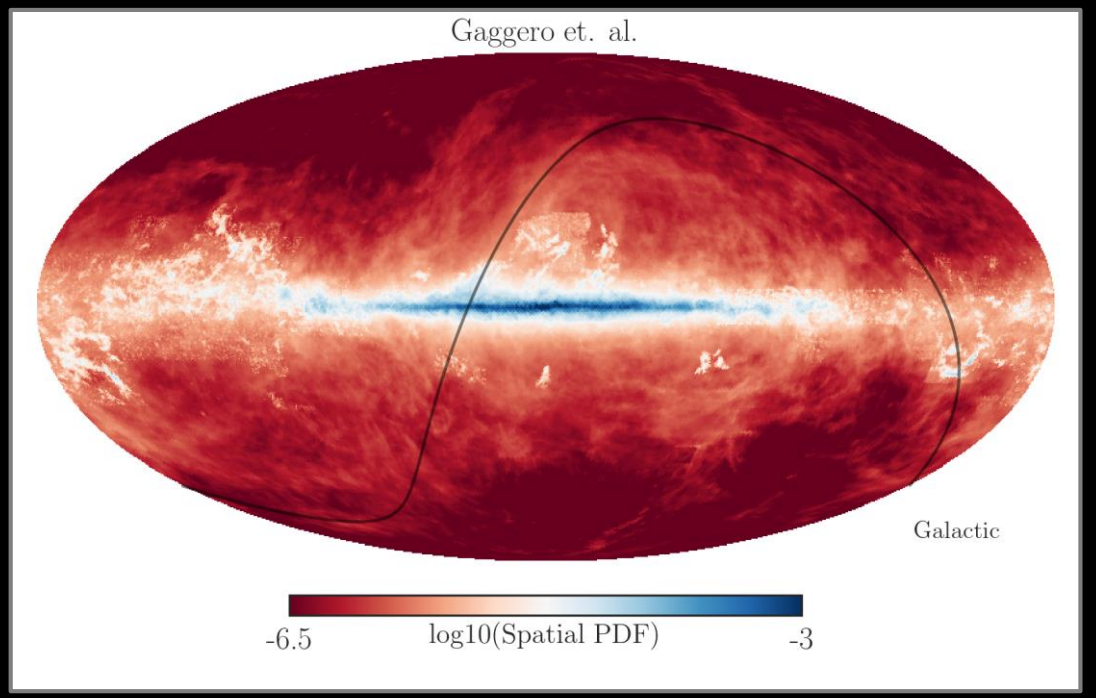
-> 5PeV cutoff seems to be more realistic

Galactic Plane Templates

Conventional Model
Assume ν-Flux ∝ Fermi π^0 spatial template



KRA$_\gamma$ (50 PeV cutoff)
Spatial template from tuned diffusion model

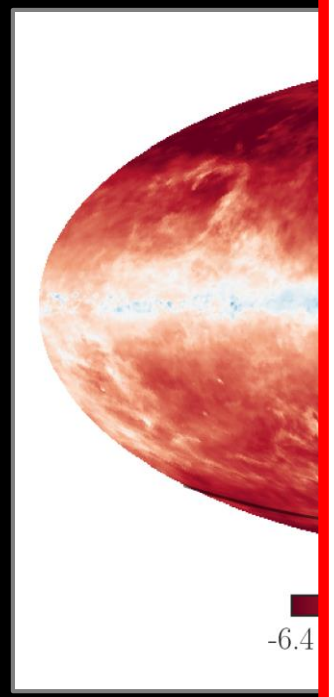


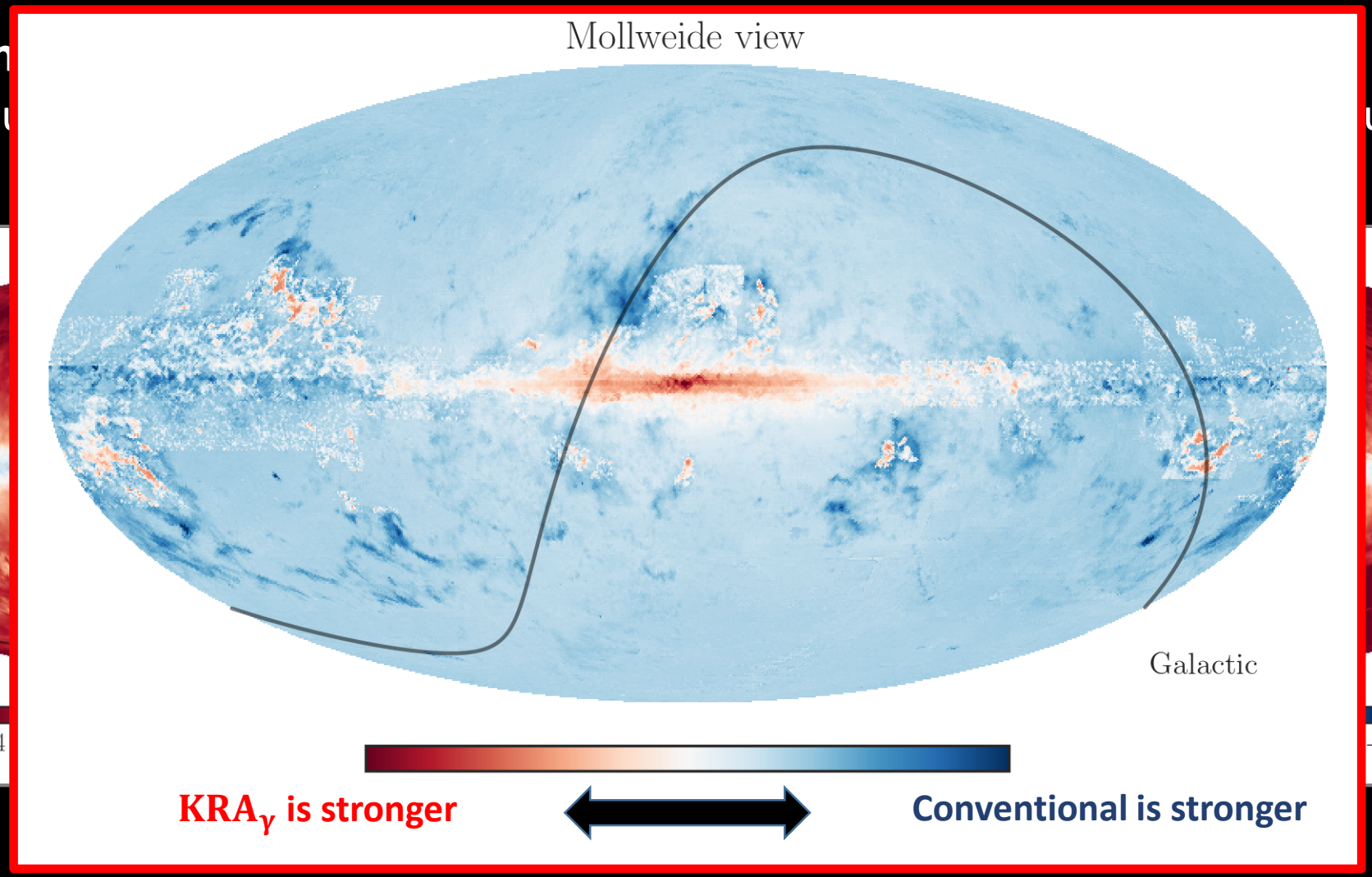
Galactic Plane Templates

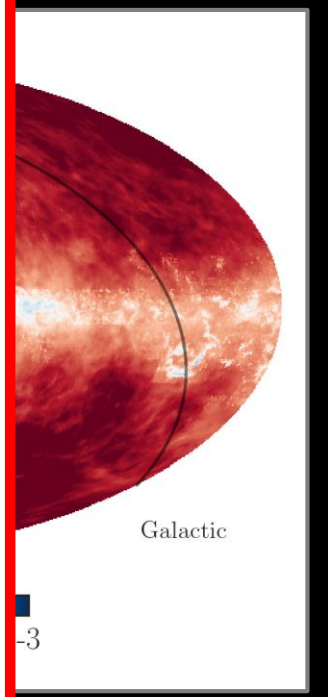
Convention

Assume ν-Flu

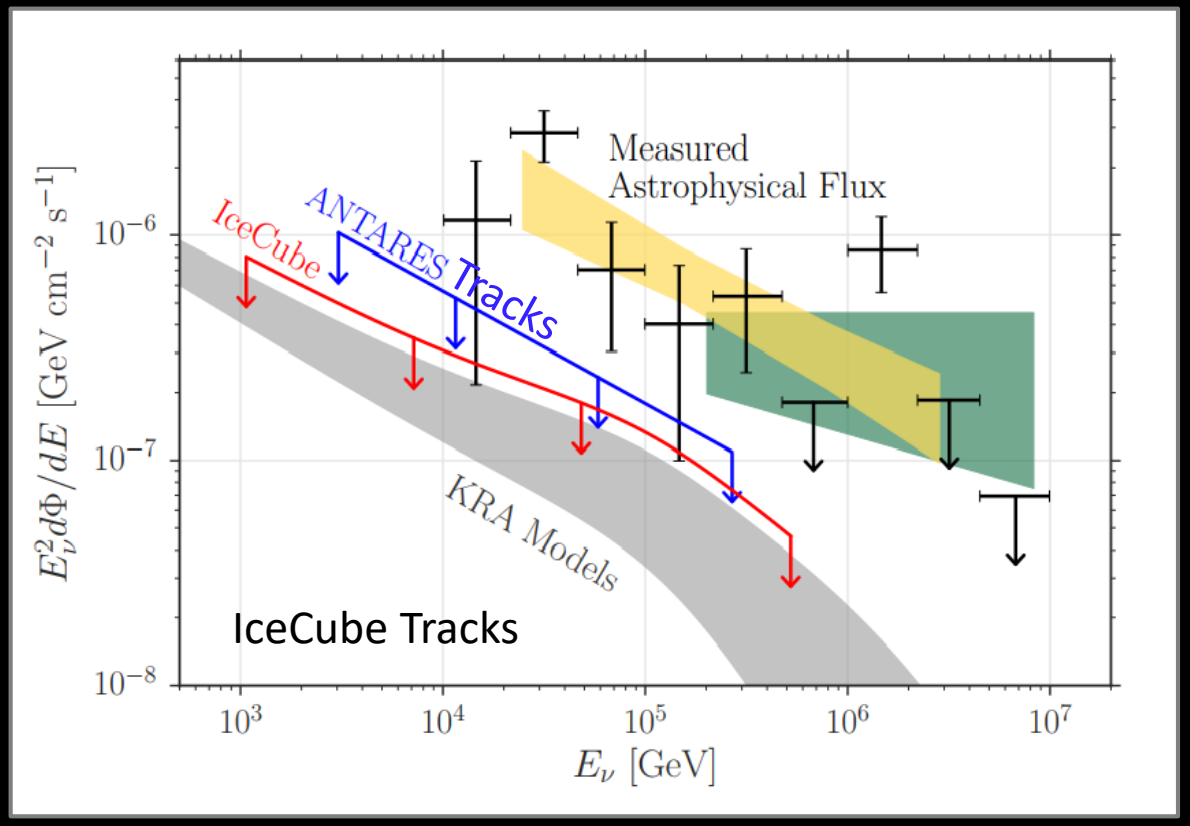
usion model

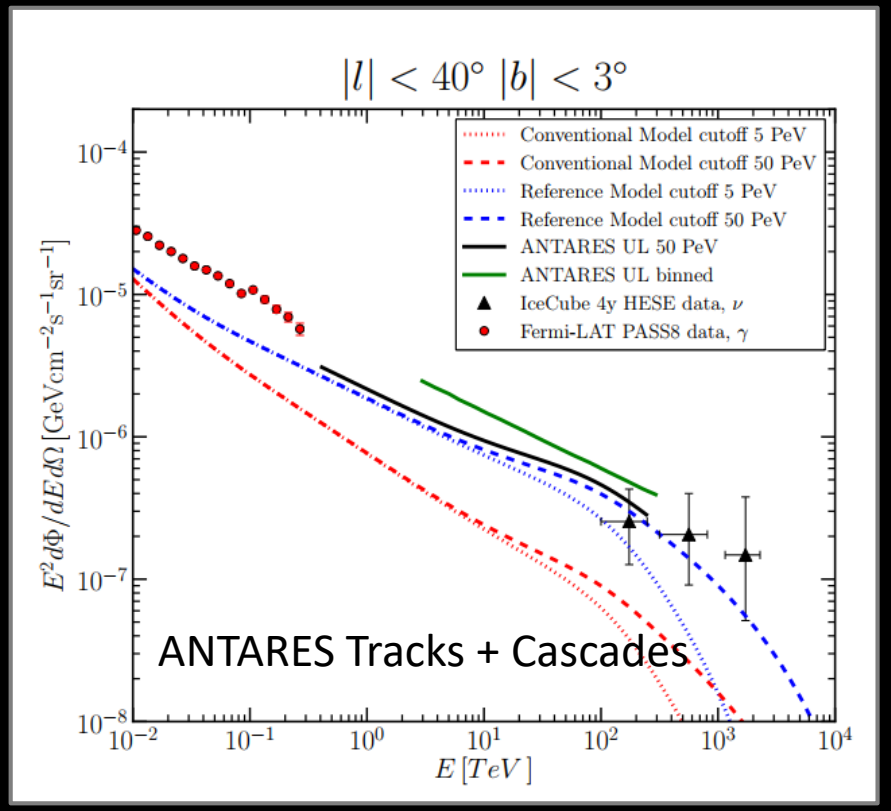






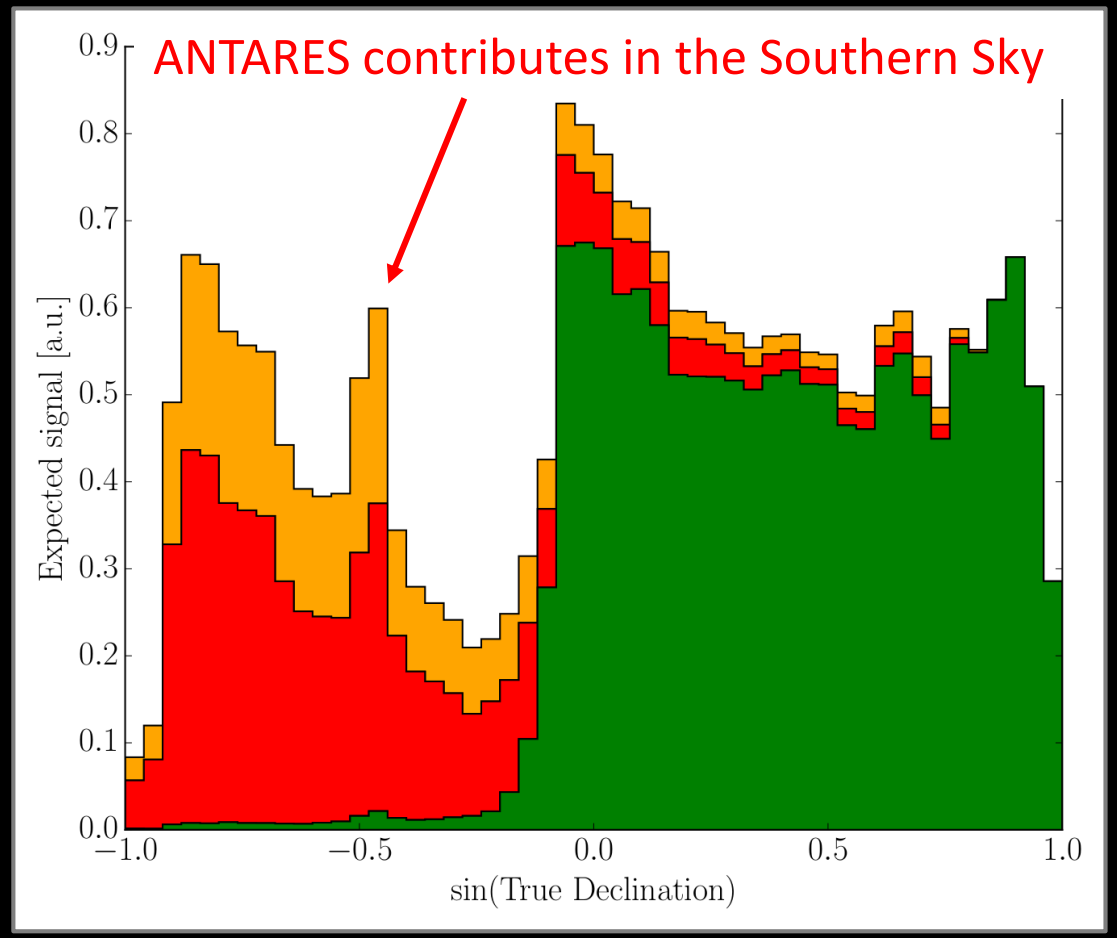
Joint IceCube + Antares Analysis

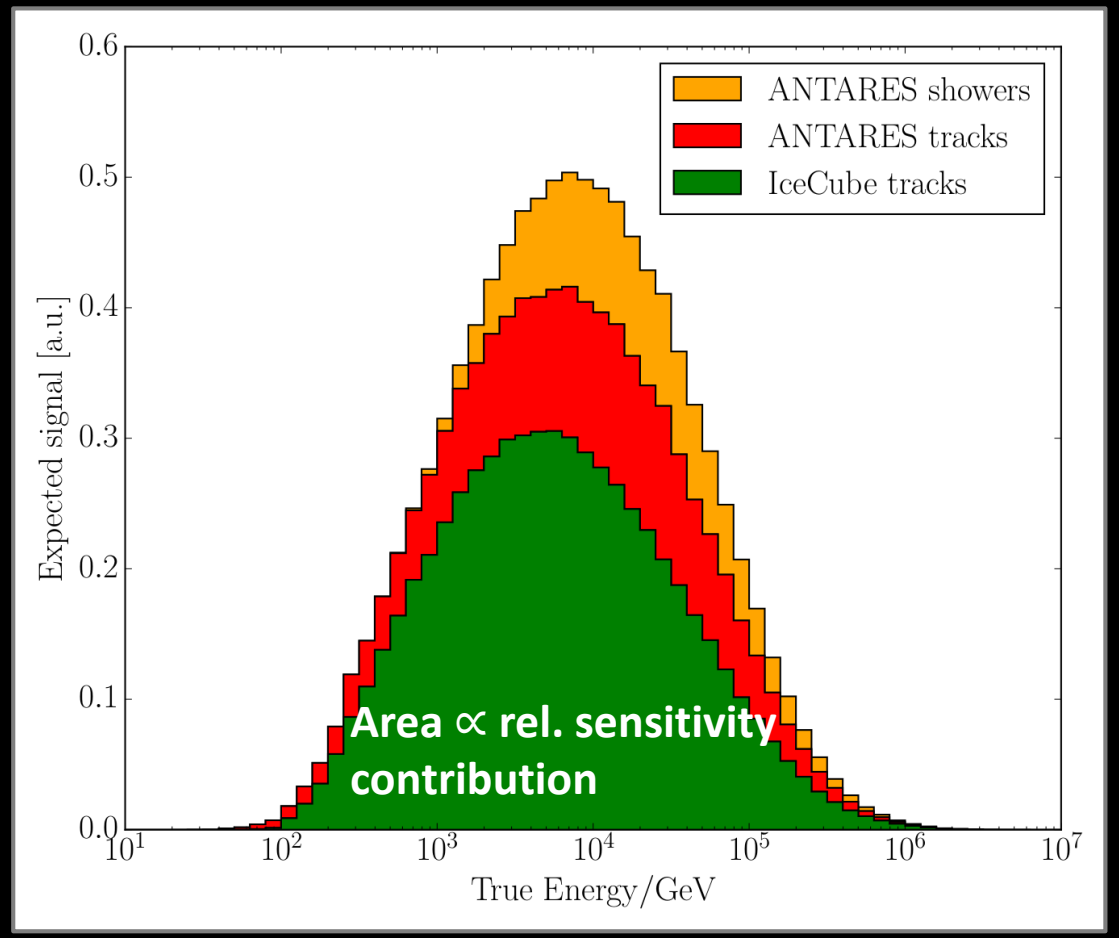




Individual IceCube and ANTARES GP analyses have roughly the same sensitivity, can greatly benefit from combined analysis.

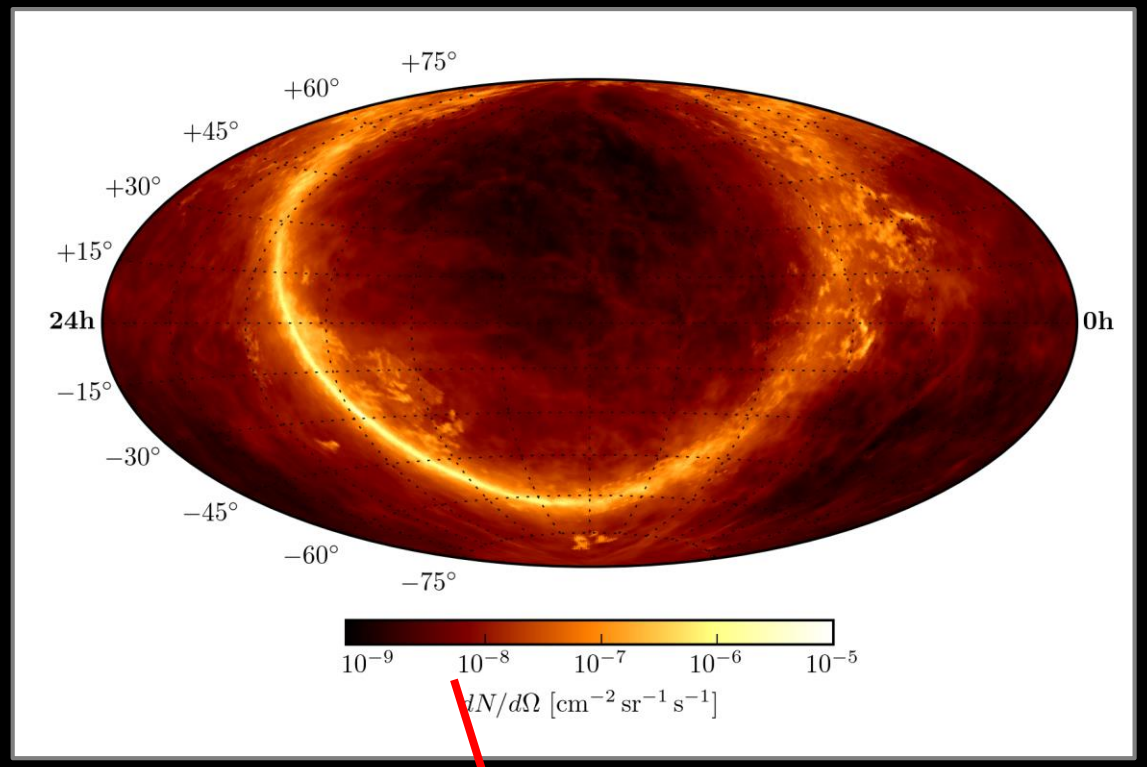
Complementarity ANTARES / IceCube





Analysis Method

For every sample:



$$\mathcal{L}(n_s) = \prod_{n_{events}} \frac{n_s}{N} \cdot \mathcal{S}(E_i, \delta_i, \alpha_i) + \left(1 - \frac{n_s}{N}\right) \cdot \mathcal{B}(E_i, \delta_i, \alpha_i)$$

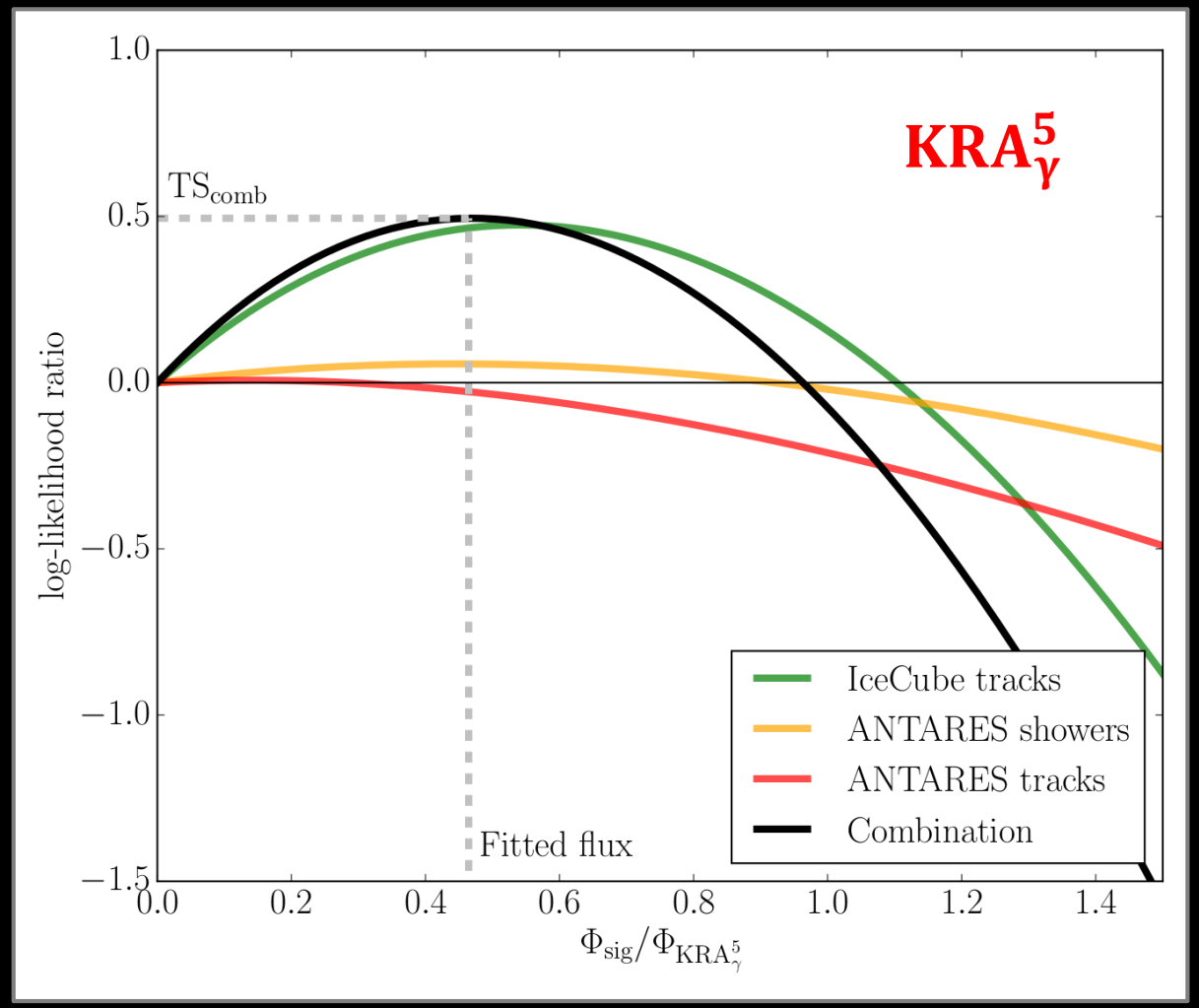
Bias Correction:

Calculate $f(\Phi_{sig}) = n_S$ for every sample

Combination:

$$\mathcal{L}_{comb}\left(f(\phi_{sig})\right) = \prod_{samples} \mathcal{L}\left(f(\phi_{signal})\right)$$

Analysis Result



Overfluctuation in IceCube tracks & ANTARES showers

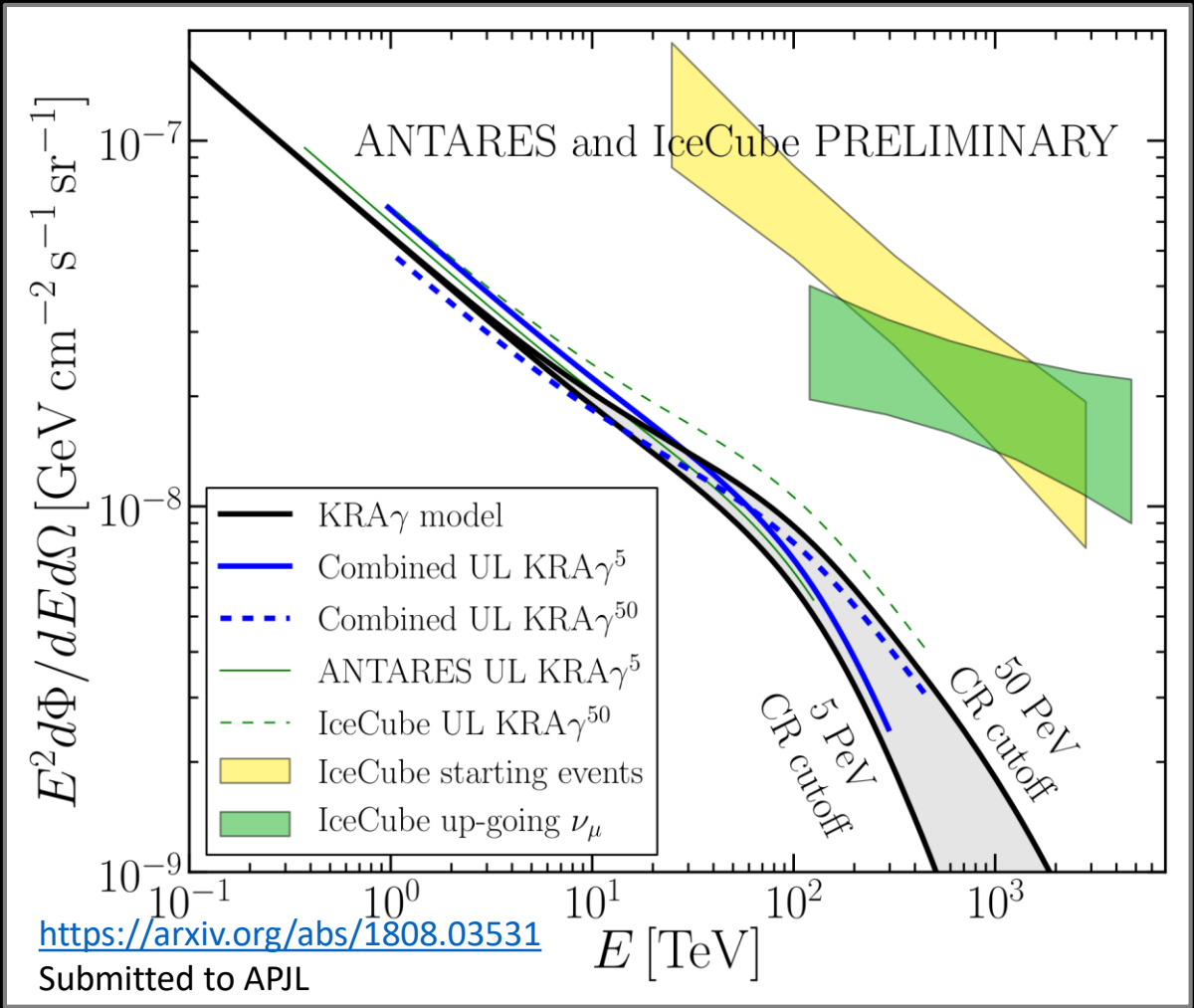
Combined bestfit flux:

0.47 x KRA_γ^5 (29% p-value) -> UL: 1.19

0.37 x KRA_γ^{50} (26% p-value) -> UL: 0.9

KRA_γ^{50} is excluded at 90% CL

Summary / Conclusion



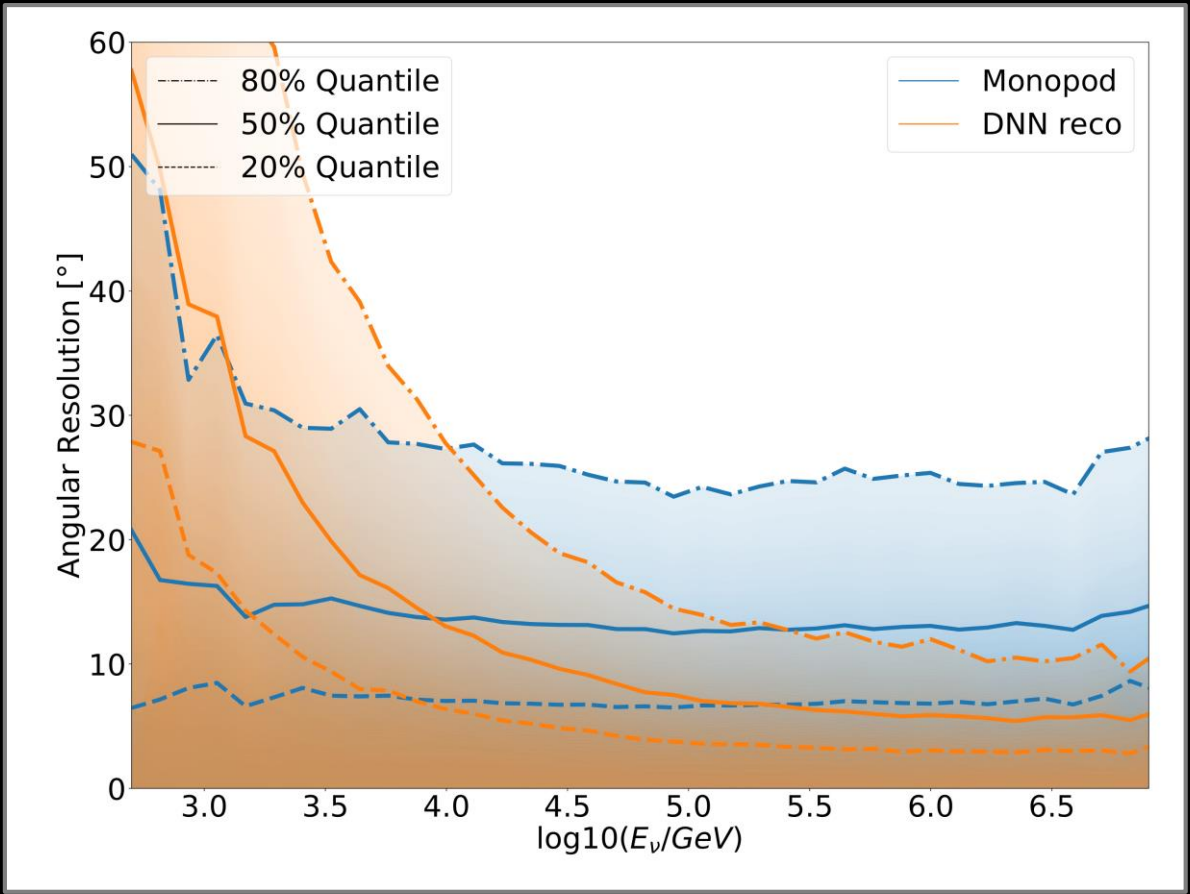
https://arxiv.org/abs/1808.03531
Submitted to APJL

IC/ANTARES are able to constrain KRA$_\gamma$ with 50PeV CR cutoff from 90GeV – 300TeV.
No exclusion for 5PeV CR cutoff – yet.

Total contribution to IceCube diffuse flux < 9%.

Beginning to constrain models for diffuse galactic neutrino production with impact on modelling of CR production and transport in the Milky Way.

Improved IceCube Shower Reconstruction using DNN's



Using Deep Neural Networks, IceCube has recently significantly improved the shower angular resolution.

Stay tuned for new Galactic Plane results!