Future of the Diffuse Galactic Plane Analysis

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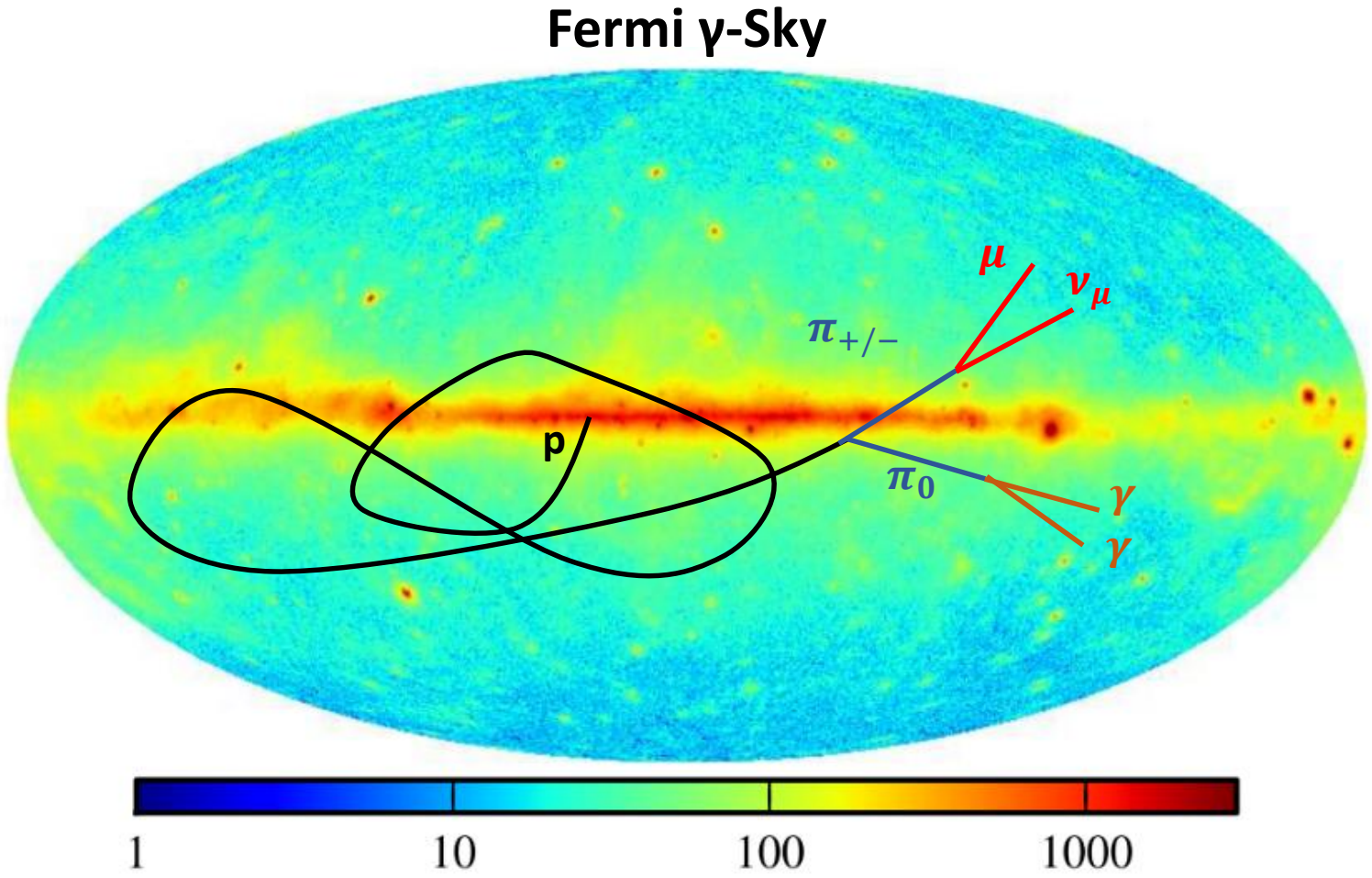
Chiba Collaboration Meeting 2019

Diffuse Workshop

Physics Institute III B
RWTH AACHEN UNIVERSITY

Analysis Goals

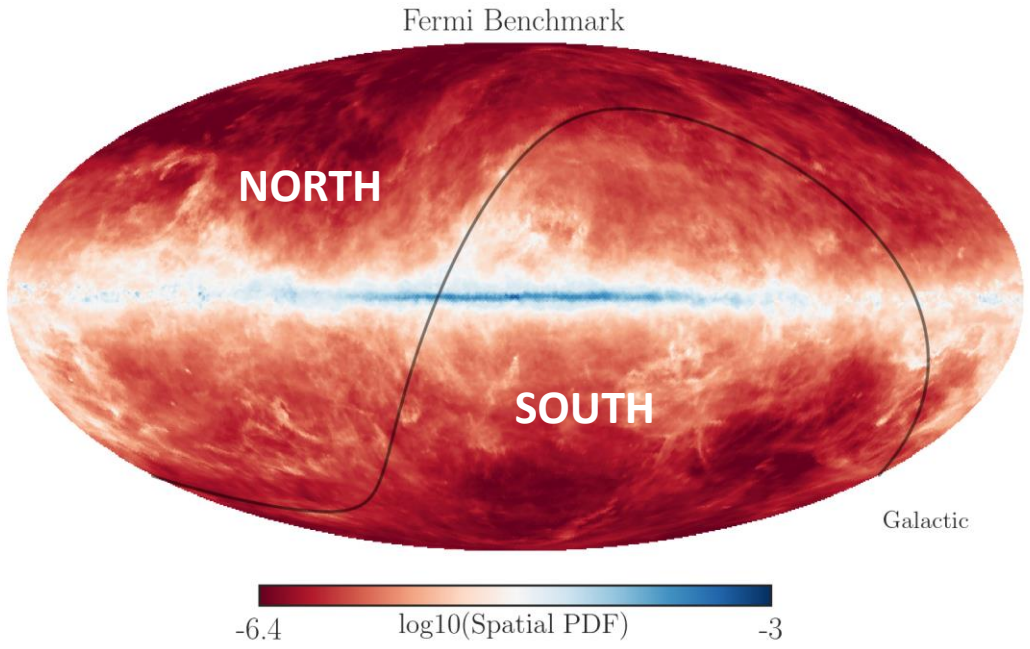


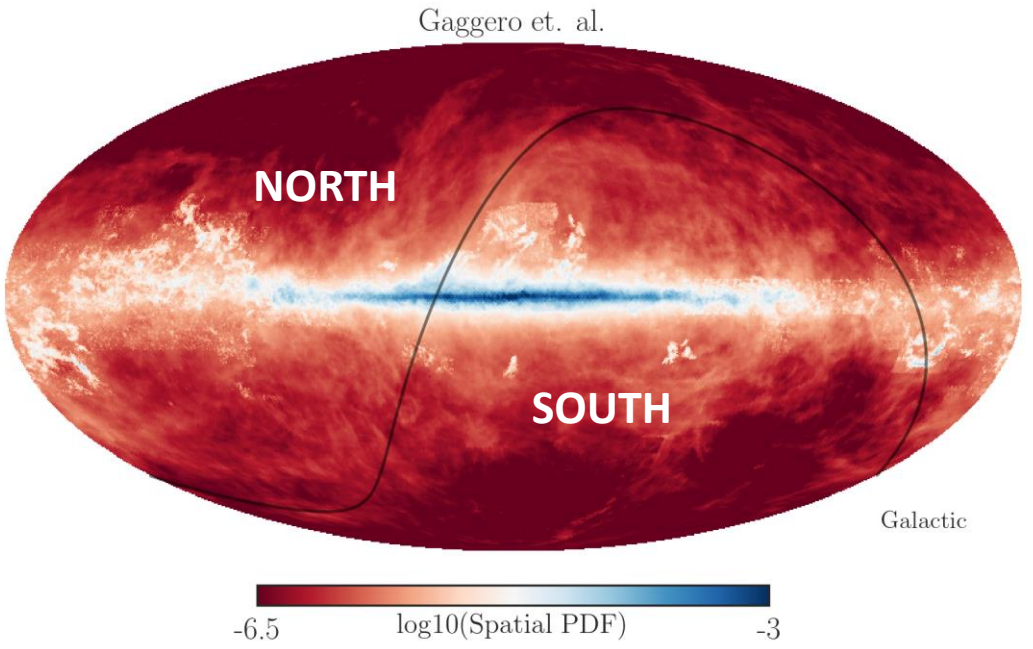
„Guaranteed“ diffuse ν-flux from CR interactions in our Galaxy

Diffused CR that have propagated away from acceleration site
=> ν carry information about propagation mechanisms

Can also search from combined emission from known (γ-resolved) PS
$\Rightarrow$ ν carry information about acceleration mechanism
$\Rightarrow$ Requires hadronic sources / target material close to source
$\Rightarrow$ Not focus of this talk (See HAWC/IC GP analysis)

Templates





Spatial PDF of π_0 component of Fermi background model
Uses conventional GALPROP CR propagation model
$\Rightarrow$ Constant diffusion coefficient
Assume $E^{-\gamma}$ powerlaw for energy spectrum

Uses KRAγ R propagation model
$\Rightarrow$ Diffusion coeff. depends on radial distance to GC
Comes with prediction of ν flux

Past Analyses

Diffuse Style

Extends ν_μ diffuse analysis:

$$\Phi_{total} = \Phi_{atmo} + \Phi_{iso} + \Phi_{gal}$$

3D binned analysis: Energy, Zenith(~35 bins), RA (~180 bins, using MC oversampling)

Six year upgoing tracks sample (C.H.) (*)

Also performed on MESE (Kai K.)

(*) Published

PS Style

Unbinned mixture model likelihood:

$$\frac{n_s}{N} S(\theta, \phi, E, \sigma) + \left(1 - \frac{n_s}{N}\right) B(\theta, E)$$

Background from scrambled exp. Data corrected for scrambled signal contribution ("BG subtracted LH)

Signal template convolved with Gaussian to account for angular resolution (σ)

Seven year PS + 3yr PS MESE (Jon D.) (*)

Combined with ANTARES tracks + cascades (C.H., Timothee G., Mike R.) (*)

Also done a posteriori on MESE casc. by Mike R. (*)

Studies on ESTES and a new cascade sample incl. cascade generator

Past Analyses

Diffuse Style

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$$\Phi_{total} = \Phi_{atmo} + \Phi_{iso} + \Phi_{gal}$$

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[illegible]convolved with Gaussian to account

[illegible]*)

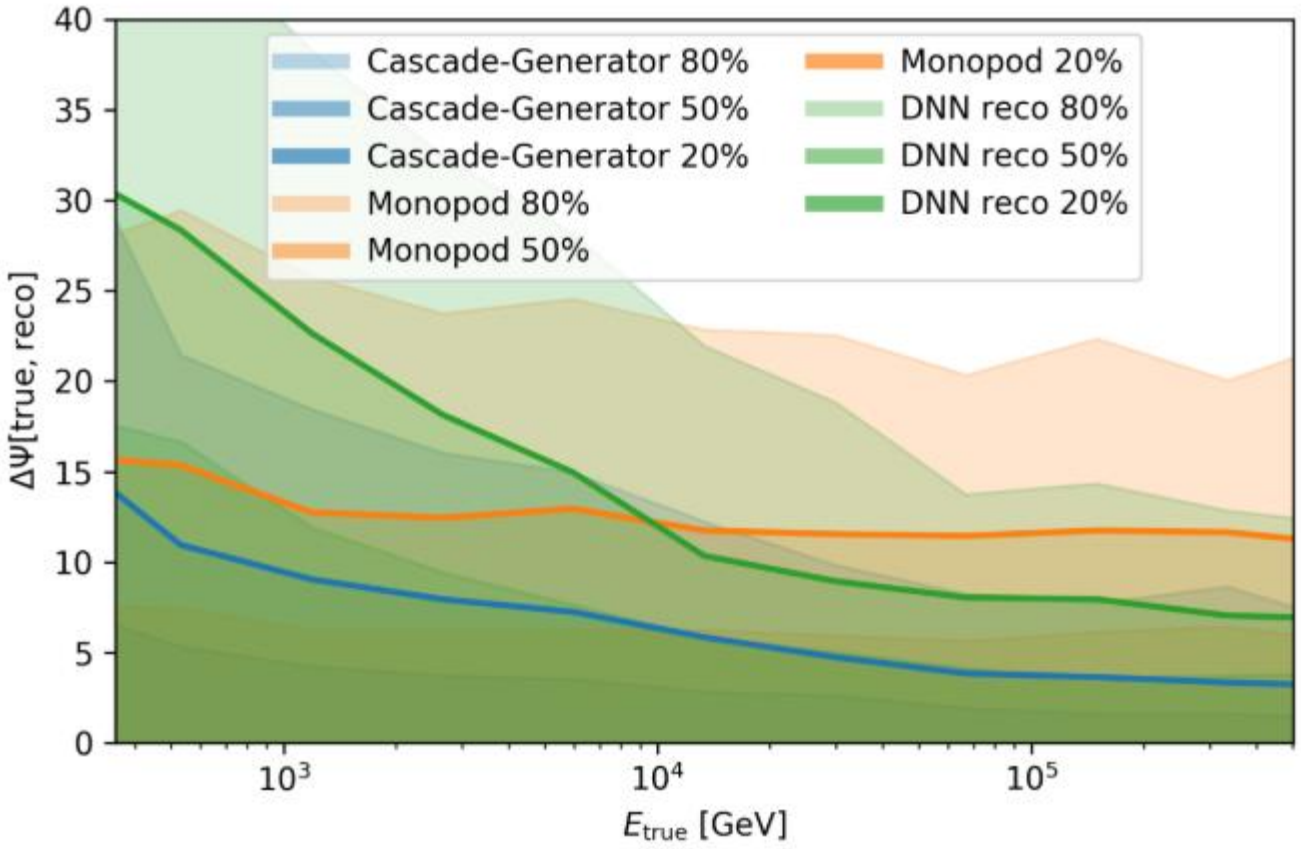
Combined [illegible]cades (C.H., Timothee G., Mike R.) (*)

Also done a posteriori on MESE casc. by Mike R. (*)

Studies on ESTES and a new cascade sample incl. cascade generator

Lots of analyses on different samples with different methods

Cascade Angular Resolution Improvements



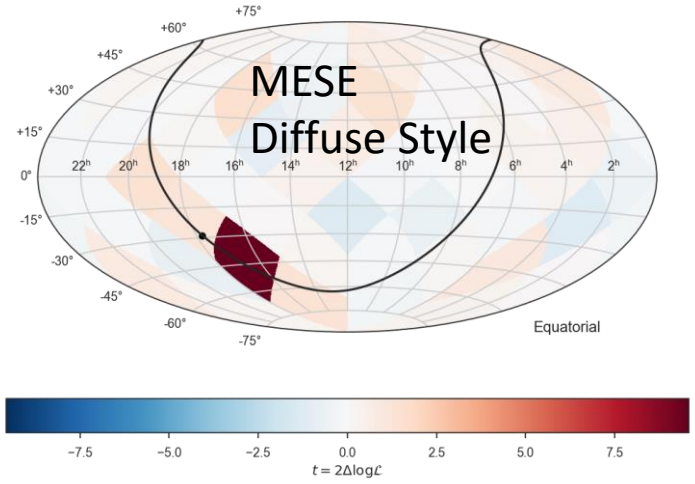
Sensitivity Overview

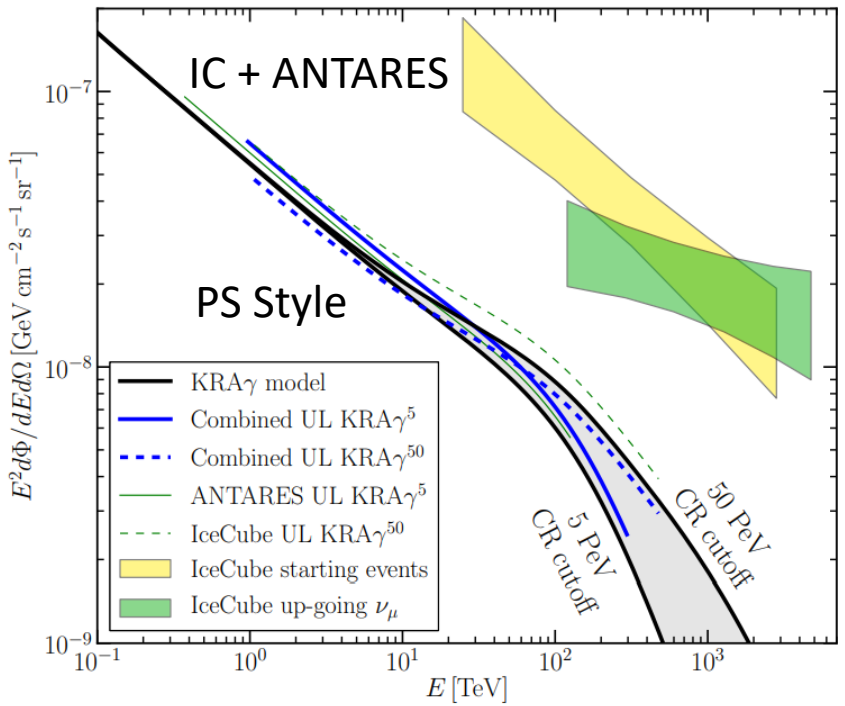
New cascade sample + cascade generator

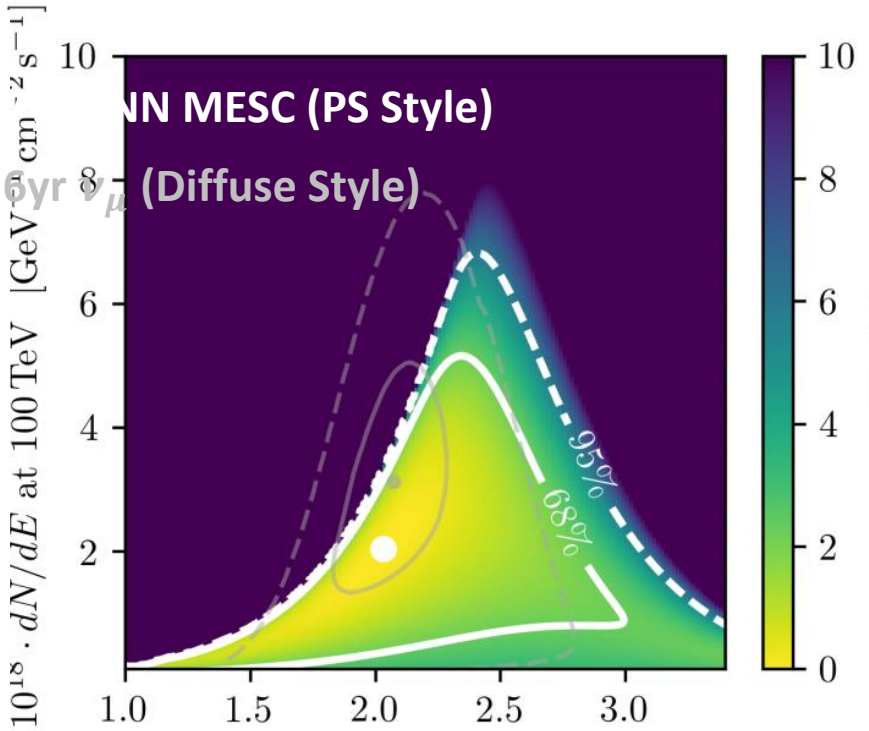
	This Work (7yr)	IceCube/ Antares	MESC-7yr	ESTES-8yr	7-yr Tracks
KRAγ - 5PeV (Model Flux)	**0.30**	0.81	0.58	0.46	----
KRAγ - 50PeV (Model Flux)	**0.21**	0.57	0.35	0.35	0.79
π-0 Template (GeV^{-1} s^{-1} cm^{-2})	**1.34×10^{-18}**	----	2.2×10^{-18}	2.45×10^{-18}	2.97×10^{-18}

Slide from Steve Sclafani's talk in NS call

Results





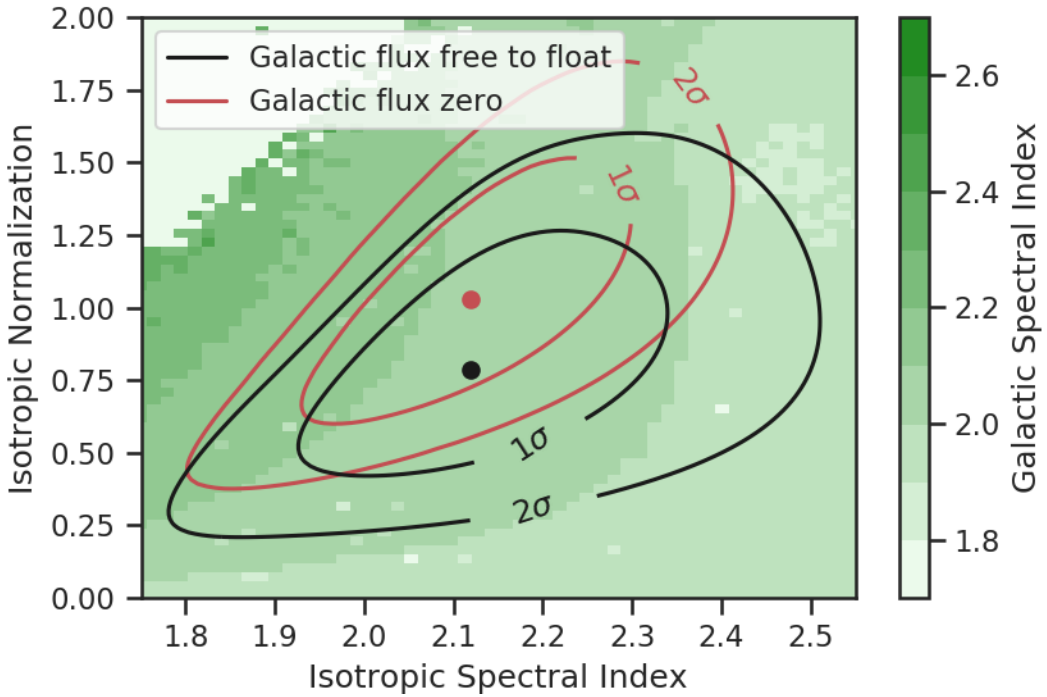


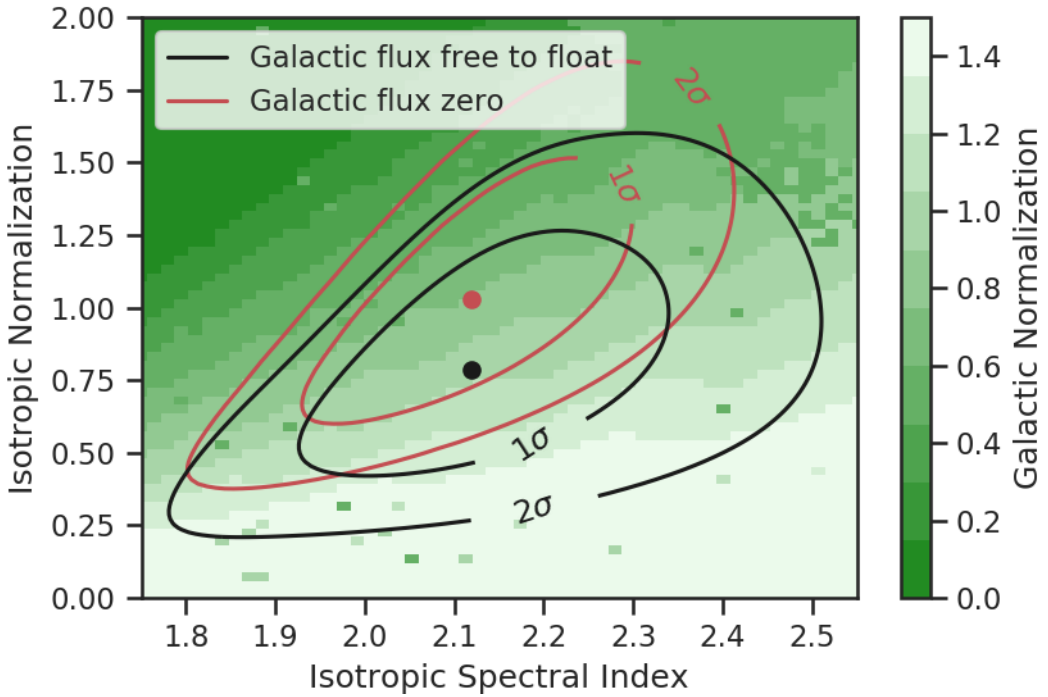
	7yr Cascades				Previous Work			
Template	p-value	Sensitivity	Fitted Flux	UL	p-value	Sensitivity	Fitted Flux	UL
KRA_γ^5	0.021	0.58	0.85	1.7	0.29	0.81	0.47	1.19
KRA_γ^{50}	0.022	0.35	0.65	0.97	0.26	0.57	0.37	0.90
Fermi-LAT π^0	0.030	2.5	3.3	6.6	0.37	2.97	1.28	3.83

Diffuse Style			
Tracks		MESE	
-	-	-	-
1.5σ	0.79	3.2σ	0.38
1.7σ	2.56	-	-

Isotropic flux with Galactic BG

Diffuse Style, 6yr Tracks





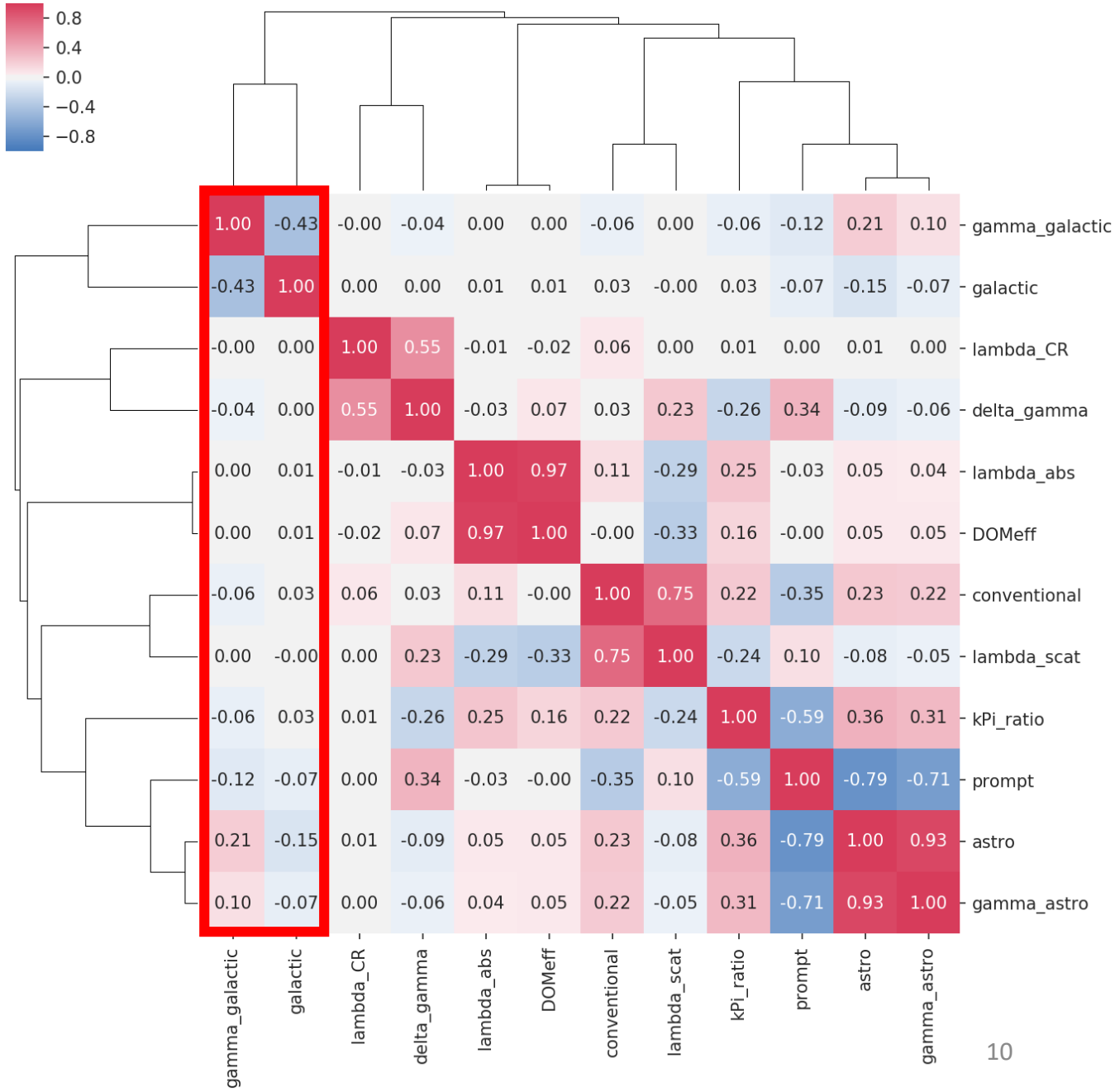
Galactic Components absorbes ~25% of isotropic flux

Spectral index not impacted

Correlation Matrix

Diffuse Style, 6yr Tracks

Galactic parameters uncorrelated to all nuisance parameters



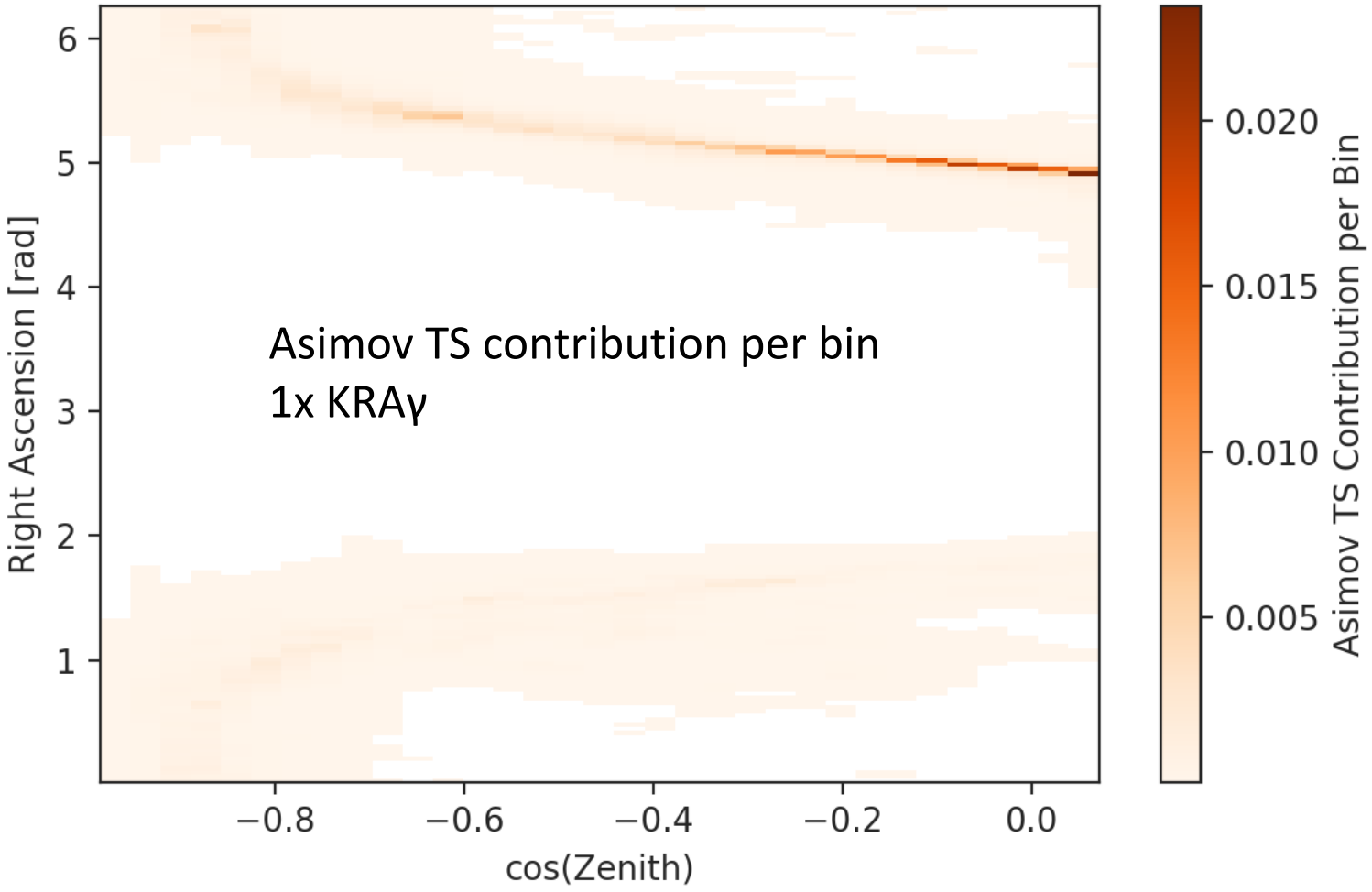
The Future

- Combine strengths of diffuse / PS style analysis methods:

Unbinned spatial LH with MC modelling of atmo and iso BG
=> Allows measurement of isotropic as well as galactic component

- Combine IC Tracks + Cascades and ANTARES Tracks + Cascades
- Develop a framework to fit (parametrizable) GP templates

Define a Control Region

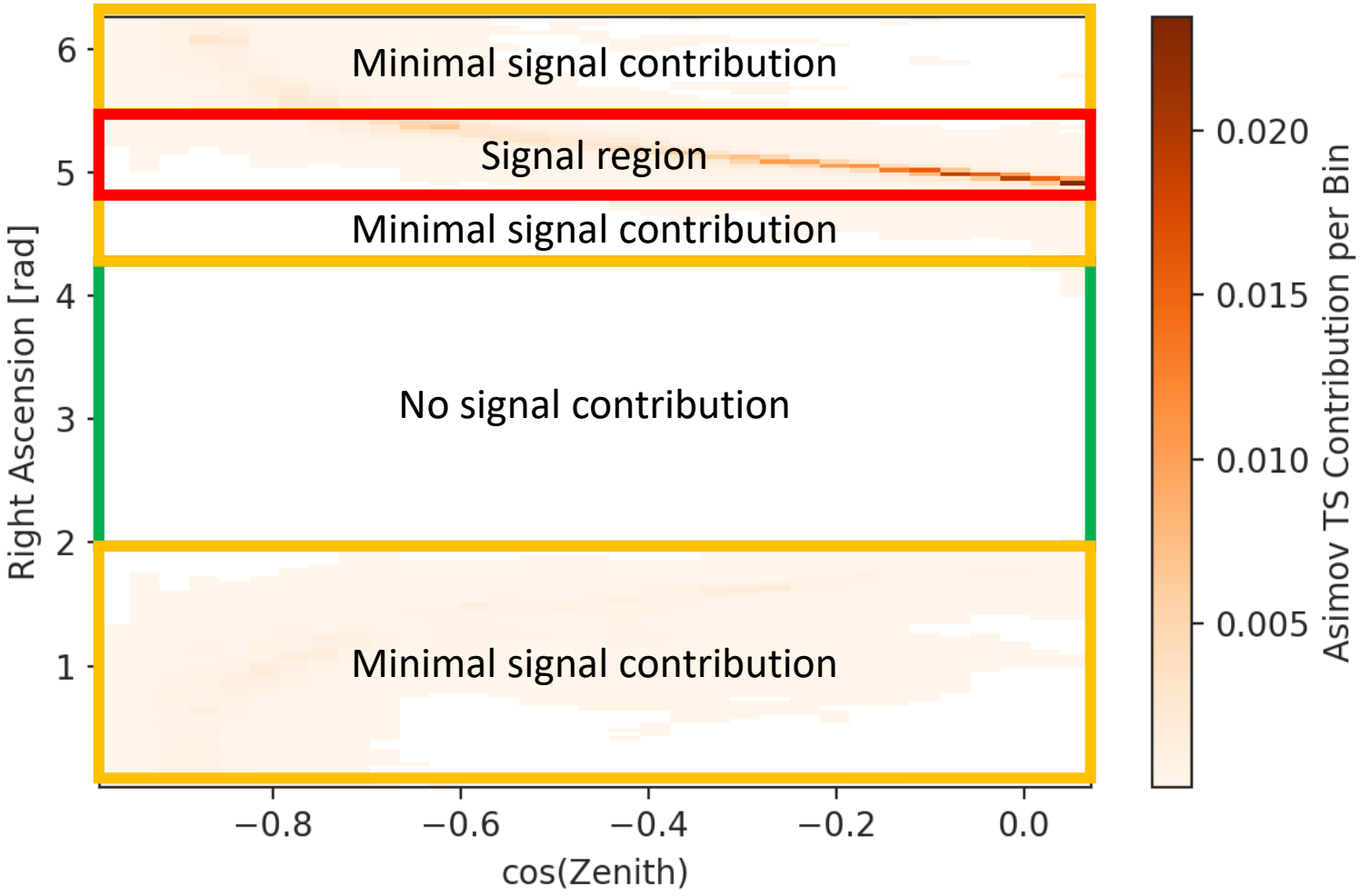


Instead of performing a 3D unbinned fit, define a **control region** with minimal galactic contribution. In this region perform (binned) diffuse analysis with full systematics free to float

In a second step, fit galactic with unbinned PDF generated from bestfit MC

Different variations possible, ie binned fit of galactic only to confirm nuisance parameters etc.

Define a Control Region



Its possible to define a control region containing ~30% of the events with no signal contribution

And another region containing ~50% of the events with minimal signal contribution

Requirements for GlobalFit (Global Sample?)

- DNNReco / Cascade Generator (Best cascade resolution we can get)
- MultiSim to propagate systematics into GP template
- Pure Tracks + Cascade sample (don‘t want to model atmo ..)
  - What about starting tracks? => Need a good reco for those as well
  - MESE? MESC? Hans‘ Cascades? Steve S. / Mirco Cascades?
  - ESTES?
  - Can we go to 84° or 83° for throughgoing tracks?